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Building Ethiopia Since 1954

## **Density and Functional Mix in the Inner-city Kebele Housing:**

**The Case of Kebele 02 in Woreda 01 Lideta Sub-city, Addis Ababa**

This thesis is submitted to the Ethiopian Institute of Architecture, Building Construction and City Development (EiABC) and the School of Graduate Studies of Addis Ababa University for partial fulfillment of all requirements for the Master of Science in Housing and Sustainable Development.

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## Declarations

I, the undersigned declare that this thesis is my work and original work that has not been presented for a degree or diploma in any other institution or university. All the sources of material used for the thesis have been duly acknowledged following the scientific guidelines of the institute.

Addis Ababa

May 2022

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Confirmation

I state that Sisay Sulamo Sundedo has carried out this research work on the topic “Density and Functional Mix in the Inner City Kebele Housing: The Case of Kebele 02 in Woreda 01 Lideta Sub-city, Addis Ababa” under my supervision and it is sufficient for the partial fulfillment for awarding master’s degree in Housing and Sustainable Development.

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## Abstract

Addis Ababa's Primacy is high and the city is faced with fast demographic growth and sprawl. Accommodating the increasing population is becoming the new task and horizontal expansion is not possible. So the City's administration has planned to follow compact city policies and intends to further densify existing inner-city neighborhoods' especially near the transit line. This research tries to describe in detail the density and functional mix of the study area using multiple measures at neighborhood, compound, and housing unit levels. And it also explores different ways to bring a compact form for KHU dwellers. This descriptive and inferential research employs mainly the Survey of 234 housing units using a stratified sampling method. This was also supported by 32 qualitative interviews, an Observational study, focus group discussion, and secondary data analysis. And in the analysis, the thesis uses descriptive and statistical analysis supported by quantitative computations of correlation analysis. The results of the study reveal that the compounds with kebele housing units and the Kebele houses are the main reasons for the area to have a higher level of density in all measures when compared to average city density. According to a mix of functions, the area has a higher value in land-use diversity and mixedness indexes; a low level of intensity; a higher level of efficiency; and functional incompatibility. Also the transformation of housing has influenced the density and mix of function much. The research finally stresses the need for multiple measures in both aspects that allow the construction of models and detailed descriptions to understand the urban form. It also recommends choosing a more appropriate type of measure that is fit for the context of the area. Then recommends considering all factors that influence the density and mix of functions to attain the claimed results of development. And based on the form it recommends providing housing forms, especially for the existing dwellers that enable them to transform their unit for their subsequent family or for renting.

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## Local Terms and Abbreviation

- Kebele or qebele – the smallest administrative units
- Woreda – Administrative units that are one level higher than the kebele units
- Idir – a social organization that supports people, especially during the death of a family
- Chika or çqa houses – A house built by a local construction using mud and wood
- BHR – Building Height Regulation
- TOD – Transit Oriented Development
- LRT – Light Rail Transit
- IHDP – Integrated Housing Development Program
- AACA - Addis Ababa City Administration
- AASOID – Addis Ababa & Surrounding Oromia Integrated Development Plan project office
- OECD – Organization for Economic Co-operation and Development
- SARS - severe acute respiratory syndrome
- ORAAMP – Office for the Revision of Addis Ababa Master Plan
- AAHDPO – Addis Ababa Housing Development Project Office
- AAHCPO – Addis Ababa Housing Construction and Planning Office
- MUDHCo – Ministry of Urban Development and Housing Corporation
- FDRE – Federal Democratic Republic of Ethiopia
- MoWUD – Ministry of Work and Urban Development
- PASDEP – Plan for Accelerated and Sustainable Development to End Poverty
- MoUDC - Ministry of Urban Development and Construction
- GTP – Growth and Transformation Plan
- CIS – Corrugated Iron Sheet
- HU – Housing Unit/s
- KHU – Kebele Housing Units
- PHU – Private Housing Units
- CKHU – Compounds with Kebele Housing Units
- BAR – Built-up Area ratio
- FAR – Floor Area Ratio
- Km - Kilometers
- EiABC – Ethiopian Institute of Architecture, Building Construction and City Development
- AACPPPO – Addis Ababa City Plan Preparation Office
- hu/ha and hh/ha – Housing unit per hectare and household per hectare
- ppha – person per hectare or people per hectare
- pphu/ppdu – people per housing unit or people per dwelling unit
- m<sup>2</sup>pp – square meter per person
- pprm – people per room or person per room

**N.B**

All dates are in the Gregorian calendar.

The Currency used is all in Ethiopian birr with a current value of \$1 US dollar = 50 birr

All the maps used in the thesis and presented without a source are taken from the maps of Addis Ababa that are developed at different times like the 1972 map developed by Sofratop; the 1987 map developed by Nortek; and the 2011 GIS maps. Also, the 2020 satellite images were improved using georeferencing method and on-site measurement method utilizing GIS software using:

Projected Coordinate System: Adindan\_UTM\_Zone\_37N

Projection: Transverse Mercator

# Chapter One – Introduction

## 1.1 Background of the Study

Increase in population and built environment in an urban environment might create challenges especially if it has a fast pace and is in a developing nation. Therefore, to minimize the negative effect and bring a sustainable urban environment different concepts have been devised. Thus densification and mix of functions have been one of the principles to address the issues so the manipulation of this issues will become vital.

Human Settlement has grown from small rural villages to the conglomeration of urban areas called Conurbation<sup>1</sup>. Also, Addis Ababa started as a small garrison town (Village) and today the city is moving towards a Megacity<sup>2</sup> and this is confirmed by the rapid increase in population and built-up area. Any change in this regard in the urban environment brings a new form and structure that requires a new way of looking at things. Today ‘back to the inner city’ is the slogan and ‘compact form’ is the future. This is supposed to bring a sustainable urban form that generally will alleviate the current urban challenges.

Therefore, understanding the existing stage and context of development is basic to planning for the future. And compact city focuses on the center or existing urban area rather than on the outside or periphery. It’s appropriate in trying to understand the existing context of Addis Ababa's inner-city part. The central part of Addis Ababa is an old settlement in the city and it contains most of the kebele<sup>3</sup> houses. The Kebele house dwellers were subject to different redevelopments and are going to be subject in the future too and that is why they become the focus of the study.

The research mainly explores ways of approaching compact form under the general framework of sustainable development. And in doing so it tries to briefly describe the existing density, and functional mix and further it looks into the housing transformation of kebele houses.

This applied research, based on its goal can be categorized under descriptive and exploratory research. It approaches the research questions by using both structured quantitative and unstructured qualitative data. It mainly uses the survey method but employs both primary and secondary data. The multiple principles at stake need multiple measures that need different methods and techniques to be engaged during data collection and analysis. The

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<sup>1</sup> Patrick Geddes introduced the concept of "region" to architecture and planning and coined the term "conurbation". The word "conurbation" is to express the several great city-groups that had arisen in Britain, which were changing the future of local autonomy. Also mentioned in (Jenks, Burton, & Williams, Compact Cities and Sustainability: A Sustainable Urban Form?, 2005) page 13.

<sup>2</sup> In light of increasing levels urbanization, the United Nations defined the ‘mega-city’ as a new population dependent category in 2012: ‘In 2011, 23 urban agglomerations qualified as megacities because they had at least 10 million inhabitants’.

<sup>3</sup> Kebele or Qäbäle houses are low cost government rental houses

analysis includes the comparison study to the city's structure plan<sup>4</sup> and previous maps and using correlation and regression analysis tries to see relations and associations between different factors and values. Also, deductive analysis on density was selected as it was used by Martin & Lionel (1966); and Alexander et al. (1988). Also for the mix of functions the efficiency, compatibility (synergy), intensity, land use diversity, and mixedness indexes were used. The integrated research approach based on Asquith (2006), was used to study form and function at the household level. To achieve the above issues Pont & Haupt (2009), place syntax without including network; UN-Habitats' (2018), LGRPGR<sup>5</sup> calculation, land use index equations as employed by Chen & Song, (2020); Mavoa, et al. (2018); Huang et al. (2018) were used.

Realizing the effect of urban sprawl today compact city is followed by many municipalities and it is considered a mainstream policy approach to achieving urban sustainability<sup>6</sup>. These concepts have models like transit-oriented development (TOD) and compact development and they also have principles like high density, a mix of functions, and friendly public transport. For density different studies have described its complexity, controversial terms, confusion in measurements, vagueness, and inconsistency (Churchman, 1999; Dovey & Pafka, 2014; Forsyth, 2003; Jacobs, 1961; Cheng, 2010; Pont & Haupt, 2009; Rapoport, 1975; Vujic, 2014). And each type of measure can't be neglected and considering the multidimensionality and the need for a comprehensive way of looking at the environment becomes vital. The same goes for a mix of functions as it is described as an ambiguous and multifaceted concept that is repeatedly used but rarely defined term (Hoppenbrouwer & Louw, 2005; Rowley, 1996; Coupland, 1997). So studies need a closer look into these issues, especially in the unique context of a kebele house like ours.

## 1.2 Statement of the Problem

Ethiopia has been following sustainable development strategies and recently the structure plan also intends to follow compact development policies. Yet, signing to strategies or committing principles as a goal and following shiny policy objectives might be one step but not enough to bring imagined places. Addis Ababa has truly unique features in its historic, spatial, socio-cultural, and economic character. This has created an urban setting that is different from others and the direct adaptation of policies and principles will not work or bring an adverse effect.

Addis Ababa structure plan intends to follow compact development and bringing compact form requires the manipulation of different principles like density and mix of function (mix of land use) is need. But both density and mix of function are complex concepts and there are

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<sup>4</sup> In an interview conducted in Lideta sub city office confirmed that there is no lower level plan that is intended for implementation in the near future because all LDP's (Local Development Plans) in the sub-city are cancelled or Terminated. Therefore the remaining reference that shows the possible redevelopment site is the general plan (structural plan) of the city.

<sup>5</sup> Land growth rate per Population growth rate calculation was developed by UN-Habitat to see land use efficiency

<sup>6</sup> Itemized by the UNEP, OECD and the World Bank (OECD, 2012, p. 49 & 50)

different challenges to measure, understand and make decisions about them. Based on the character of each cities the types of measures and methods selected for the whole or specific range must fit the area. However, Addis Ababa like most of the developing cities lack useful empirical data and use conventional methods and measures that are rigid and weak in nature to explain existing context. This can be manifested by looking into the results of previous development plans and the low level of implement. Focusing on the housing sector despite more than a decade of housing projects conducted in the city since 2005, it did not meet the goal or meet the demand missed the target group, and sometimes created new challenges for the city (See page 43 and 44).

Considering the cities primacy, and fast demographic change and uncontrolled sprawl managing the fast growth of the city will be challenging. And the unique context of the city will not allow the direct adoption of policies so contextualization is needed. To bring about the intended urban form using compact city policies that have complex and multidimensional aspects while trying to measure and understand them with a conventional tools might create adverse effects. And lack of empirical data and clarity on appropriate indicators will bring problems in the assessment of policies. So the use and associated problems with principles will be much more which leads to misconception and inappropriate or misguided decisions. So based on the above statements the city's context and the nature of principles requires an area-by-area assessment that direct us to conduct research like this.

## **1.3 Objective of the Study**

### **1.3.1 General Objective**

To investigate the density and functional mix of the neighborhood to look for applicable housing forms for the Kebele housing dwellers that will bring compact and sustainable urban form.

### **1.3.2 Specific objectives**

- To assess the density and mix of functions of Kebele houses in the study area
- To assess the transformation of kebele housing units and their impact on the density and functional mix of Kebele houses in the study area
- To determine the type of housing form, which includes density and functional mix, that is appropriate for future redevelopment of inner-city neighborhoods that are dominated by Kebele houses.

## **1.4 Research Question**

1. What are the density and the functional mix of kebele houses in the study area?
  - 1.1 What is the density of the Kebele houses in the study area?
  - 1.2 What is the functional mix of the Kebele houses in the study area?
2. What are the reasons and processes for the transformation of kebele houses and their impact on the density and functional mix of the study area?
  - 2.1 How do dwellers transform the kebele Houses?
  - 2.2 Why do dwellers transform the kebele Houses?
  - 2.3 What is the impact of housing transformation on density and functional mix?
3. What type of housing form, including density and functional mix, is appropriate for future redevelopment of inner-city neighborhoods that are dominated by Kebele houses?

## **1.5 Scope of the study**

The study focused on the dwellers of the kebele houses and their dwelling units. The private housing units were also studied but it was used to better express the compound's situation and it was used to explain the context well by using a comparison study.

Geographically the scope of the study area included 11.3ha of land that exists in *Lideta sub-city Woreda 01 Kebele 02* in front of the EiABC campus or Federal first instance court. However, as the main focus was placed on the kebele houses detailed studies and surveys were conducted in compounds that have the kebele housing units. Based on the nature of the issues to be explained, and if the study uses measurements that need a detailed study, the scope of the study will narrow from the whole neighborhood to compounds with kebele housing units and selected kebele houses.

The thematic scope of the study is density (morphological density, population, and housing density) and a mix of functions. These subject matters were studied at the neighborhood, compound, and household levels.

## **1.6 Significance of the study**

First previous studies have sufficiently touched on the subject matters but it was not in a comprehensive way and not for purpose of finding applicable form. So this research to fulfill this gap looks for those multiple subject matters using different types of measurements at different levels of scale. It further employs multiple types of analysis that seek to reveal the context of the study area and the relationship between the subject matters and the factors influencing them. Second, it also suggests the types of measures that suit our context and stresses the use of multiple measures. Generally, the study gives a comprehensive way of looking towards urban form and suggests different approaches to achieving a compact form for the area.

## 1.7 Limitation of the study

Other than the geographic limit that is about a 400-500m radius from the coca-cola station and the study focusing only on the kebele housing there is also a thematic limit. If one needs to understand the spatial form of the area it is better to study the building envelope, the activities in it, and the movement framework that connects them. This is true as urban environments are mostly shaped by the street (movement framework), buildings, and the activities in them (the land use or building uses). However, due to the limit in time and finance, the study is dedicated to studying the density and mix of functions in as detail as possible.

The other limitations of the study included the problems faced while trying to get data from local government offices or federal office websites. Getting detailed lot records and data layers that contain comprehensive planning designations, zoning regulations, land cover information, and much more were very difficult or sometimes missing. Especially today census data provides data on population, housing, and employment at geographic units as small as city blocks but population data from the CSA (central statistics agency) of Ethiopia is limited and is mostly a projection. This makes the researcher spend a lot of time gathering and cross-checking population and spatial data.

## 1.8 Description of the study area

The inner city of Addis Ababa is a historic, vibrant, and unique part of the city. For example, according to density they cover 8.05% of the land but hold 32.48% of the population. Compared to other sub-cities they are dense settlements.

### Lideta Sub-city

- Area - 918.27 Hectares (1.76% of A.A total land cover)
- Contains 10 Woredas, 27 Sub Woredas, 75 Sefer or Neighborhoods
- Pop. No. - 201,613 (7.36 % of A.A. Population)
- Total Built up area = 2,705,521m<sup>2</sup> or 270.55ha (29.46% from total sub city area)

Woreda 01 has a land cover of 273.6 hectares and covers around 29.79 percent of the total sub-city area. The woreda has a total population of 21,427 people which is 11.08 percent of the total sub-city population. The population density of the woreda is 78.28 p/ha, this figure is very low compared to other woreda but shows the existence of big nonresidential blocks.

Location	Area	Types of Ownership	No. of Compounds	Total No. House Holds
Lideta Sub city Woreda 01 – Kebele 02	Gross 11.31 ha net	Kebele	134	366
		Private	116	128
	8.79 ha	Gov. Rental Housing	8	11
		Government	2	2

Table 1.1 Study Area Ownership Description (Source Woreda Office records)

### 1.8.1 Location of the Settlement

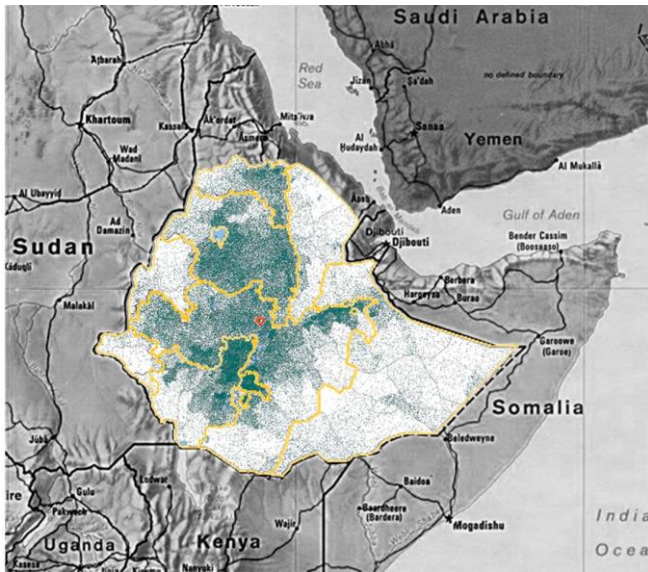


Figure 1.1 Population Dot Map showing total estimated population for 2004 based on 1994 census .... CSA (2006), each dot has a value of 500 people (Modified from Atlas of the Ethiopian Rural Economy. Addis Ababa, by Teller et al., 2007)

Ethiopia (see Figure 1.1) a landlocked country in East Africa is the second-largest population on the continent. The urbanization level is low even compared to Sub-Saharan countries but has a high urbanization rate in the world.

Population density varies substantially with altitude. The highest population density prevails in the highland areas whereas in the lowland areas density varies from 2 persons to 40 persons per km<sup>2</sup>. This shows that nearly 80% of the population lives on only 37% of the total area of the country, while the

remaining 20% lives on 63% of the country's land area (Teller et al., 2007, p. 4).

Previously it's stated that the issues of density should be considered at a different level from the national to the neighborhood level. And in a situation like our country urban areas can

play a role to distribute the population on the national level. We can recall also the primacy of Addis Ababa in which the capital city is more than ten times bigger than the second-largest city in population.

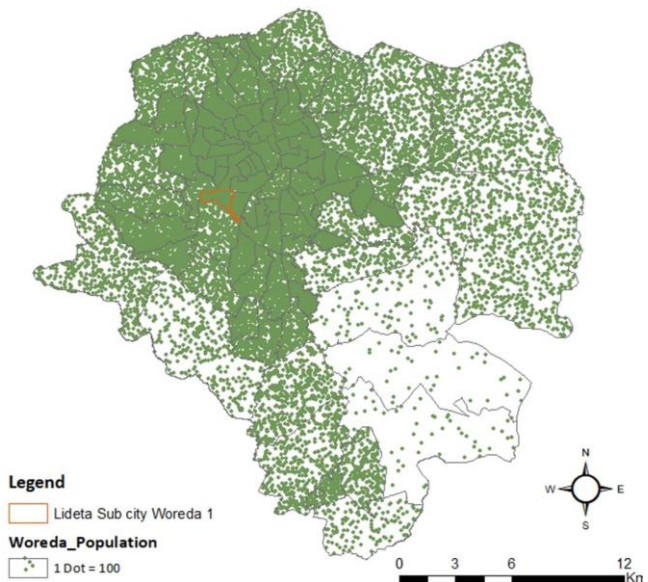


Figure 1.2 Population Dot Map of Addis Ababa Based on 2011 Woreda level Population Census – Each dot has a value of 100 people

Addis Ababa (see Figure 1.2) like the country has an uneven distribution of population in the city. The inner city has a high density than the intermediate and peripheral parts of the city.

The study area is located in the central and most densely populated area, the boundary is highlighted in

an orange line on the second map. The woreda has a large plot of land that is vacant and dedicated to government office, yet has higher a density, and can be categorized under the city core concentrating a large population on a small portion of the land.

## Urban Level Strategic Location of the Study Area

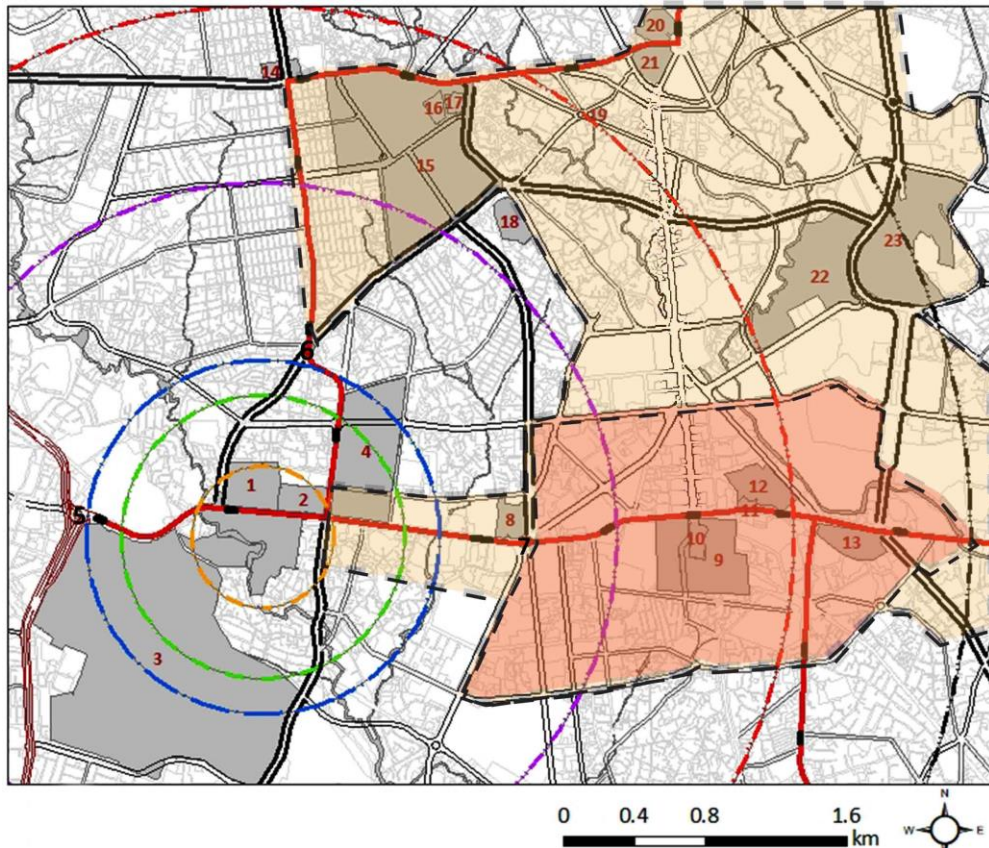


Figure 1.3 Location Map of Study Area in relation to the Cities Main Centers

### Transport Nodes

- (7) Mexico Square - in 1-2 km
- (10) Legahar Terminal - in 2-3 km
- (6) Abinet Square – nearly 1 km
- (5) Torhailoch Square - nearly 1 km

### Commercial Centers

- (15) Mercato - between 2-3 km

### Transport Terminal

- (14) Autobis Tera - in 2-3 km

### Sport Center

- (13) Stadium – Inside 3 km

### Mass Housing Sites

- (4) Lideta Condominium

- (9) Legehar Condominium

### Religious Center

- (19) Benin Mosque – in 2-3 km
- (21) St. George Church - within 4 km
- (18) Teklehaimanot Church in 2-3 km
- (16) St. Raguel Church
- (17) Anwar Mosque

### Education and Health Center

- (1) EiABC
- (8) AA. TVET

### Administrative Center

- (2) Higher Court
- (21) Municipality

The 2015 Addis Ababa Main City Center (MCC) Urban Design Guideline delineates a 330ha of city area for MCC, shaded in light red in the above Figure 1.3, and the influence area, consisting of about 1300ha in total, shaded in light orange. The guidelines and urban design were prepared by the Addis Ababa and Surrounding Oromia Integrated Development Plan project office (AASOID) together with EiABC.

## 1.9 Organization of the Document

The research is organized into five chapters: chapter one introduces the whole study, chapter two sets the literature review, and chapter three shows the research methodology. Chapter four gives the results and discussion, and finally, it finishes with chapter five which is the conclusion and recommendation.

The first chapter introduces the whole research; the background of the study gives the general framework of the study and the motivation behind it. This chapter defines the problems, sets the objectives, and based on the problems asks the questions that the research intends to answer. Again it sets the boundaries for the study and describes the study area roughly.

The second chapter 'Literature review' starts with giving a road map and the logic of how it is organized thus it follows thematic organization. It is divided into two parts the first one gives the general theoretical reviews and the second part contains a contextual review following the framework of the first. First, the review lays the foundation by explaining the issues related to sprawl, sustainability, compact city, and transit-oriented development. It follows theoretical order as sprawl is the antithesis of compactness and the second one 'sustainability' is developed to give a response to sprawl. Also, compact city and transit-oriented developments are some of the models that claim to bring about sustainable development they are next in line. Then finally the main subjects of the study will follow: density, mix of functions, and housing transformation; also the contextual review follows the same order as the general review.

The third chapter gives the logic behind the selection of the study area, thematic issues, and methods of the study. It explains what the main issues are based on the research questions, what type of data is needed to answer the questions, how the study is going to select our targets and how the study intended to collect data. It also contains the research design and based on the objectives it shows how the study planned to operate throughout the study. And it also shows what type of measures are used and the different types of analysis employed.

The fourth chapter presents the results based on the order of the specific objectives but the first two questions of the research are descriptive so the discussion focuses on those questions only. The third question of the study is answered in the final chapter when the conclusions are made they must show how the context is and how the community functions within that situation and implicate the urban form that suits them. And finally, on the recommendation, the research answers the third question of the research.

## Chapter Two - Literature Review

### 2.1 Introduction

The literature review is organized to follow each thematic issue separately but with a reasonable thematic and story flow that helps to connect them. It is divided into two main parts:

- Part One – Literature Review and
- Part Two – Contextual Review

The first part starts with the review of urban sprawl, this is to give a foundation for an easy understanding of the concepts that follow. Because urban sprawl can be taken as one of the reasons for the development of those concepts and it can also be taken as the antithesis of the sustainable urban form or compact city.

Sustainability is a broad concept so this study looks at it in relation to urban morphology only. The sustainable urban form also shares principles with the compact city and transit-oriented developments. These models are also claimed to bring about a sustainable urban form.

Based on the above grounds laid it moves to the main topics or subject matters of the study. First, the general concept was explained, second the models of development and finally, the specific principles of the models' density and mix of function were explained. And finally with the intention to better understand the above issues it reviews the transformation of housing.

The second part of the review also follows the above order of thematic issues but it focuses on the local context only Ethiopia, Addis Ababa, and mainly the inner city because the study area is also located in the inner city. There is also an attempt made to combine and compare the contexts explained in the literature to the contextual situation.

## PART ONE – Theoretical Review

### 2.2 Urban Sprawl

#### 2.2.1 Definition of Urban Sprawl and Its Measures

If there is a need to describe compact development one must first see about **urban sprawl**. According to Amnon & Maya (2002), urban Sprawl is a complex and controversial term that has particular interest among planners but simply put one can say that it's the physical expansion of cities and it is the result of the broad aspect of issues. It is acknowledged that this low density, mono-functional, automobile-dependent horizontal expansion of the urban environment brings a negative impact on the social, economic, and environmental aspects (Burchell, et al., 1997; Duany et al., 2000; Ewing, 2008).

According to Galster et al. (2001), sprawl can be grouped into six general categories defined by an example, aesthetic judgment, externality, consequence or effect, patterns of land development, and process of development. They state 'Sprawl (n.) is a pattern of land use in an

Urban Area that exhibits low levels of some combination of different dimensions like density, continuity, concentration, clustering, centrality, nuclearity, mixed uses, and proximity of uses' (ibid). Therefore the definition of urban sprawl can differ based on the aim of the study and the type of measure used.

In recent times sprawl is becoming a common issue stated by Giddings et al. (2005), as being a worldwide phenomenon. Also, Shlomo Angel and his colleagues introduced a quantitative dimension to this process, focusing on the population added to a global stratified sample of 200 cities between 1990 and 2014. According to Angel et al. (2021), on average, only one-quarter of the total population was accommodated within their 1990 urban footprints, while three-quarters were accommodated within their newly built expansion areas.

So if they are a worldwide phenomenon what are some of the common components? Here is a simple explanation by neo-traditionalists: they describe that it consists of very few homogeneous components arranged in almost any way. They are the housing subdivisions, the shopping centers, the office and business parks, the public buildings, and the roadways (Duany et al., 2000).

Urban sprawl might be a worldwide phenomenon with some common components but they differ in their cause, character, level of expansion, and impact on the environment. For example, it's stated that in the US, Canada, Japan, and Australia sprawl has tended to take the form of massive suburbanization, creating at its extreme form The 100 Mile City (Breheny, 2005 citing Sudjic, 1992).

**How to measure urban sprawl** - The most common ones measure sprawl from the standpoint of its cause and impact and others from the character of sprawl. Historical factors also play a role in differences in urban form and density. For example, Galster et al. (2001), distinguish and measure it based on the eight dimensions of sprawl as stated above. According to Amnon & Maya (2002), they used 13 measures of sprawl divided into five major groups: these five major groups are growth rates, density, spatial geometry, accessibility, and aesthetic measures and again they put these five into two dimensions: configuration and composition. They attempted to measure sprawl from a landscape perspective and claimed that the five major groups were suggested by most literature. Therefore like that of the definition, the measures of sprawl also differ generally.

**Cause and Characters of Urban sprawl** - Today some of the reasons for expansion or cause of urban sprawl can be attributed to government policies, economic system, transportation strategies, cultural factors, demographic growth, and housing development. Also, sprawl either causes or is caused by patterns of exclusive land use and it differs from one country to another (Galster, et al., 2001; Squires, 2002; Ewing, 2008; Duany et al., 2000; Breheny, 2005; Mumford, 1938). But what drives the process? As Burchel et al. (1997), describe the neo-traditionalists led by Andres Duany and joined by Elizabeth Plater Zyberk (1995), Anton Neleson (1994), Peter

Calthorpe (1993), and others view current development patterns (sprawl) as driven by engineering standards and, accordingly, devoid of the capacity for human interaction.

Based on Burchell et al. (1998), the characteristics of urban sprawl are described as follows:

- Low residential density,
- The unlimited outward extension of new development,
- Spatial segregation of different types of land uses through zoning,
- Leapfrog development,
- No centralized ownership of land or planning of land development,
- All transportation is dominated by privately owned motor vehicles,
- Fragmentation of governance authority of land uses among many local governments,
- Great variances in the fiscal capacity of local governments,
- Widespread commercial strip development along major roadways, and
- Rely on a process to offer a house to low-income (Neuman, 2005 citing Burchell et al., 1998).

### **2.2.2 Results of sprawl**

Generally, the form of the city influences the context of human settlement, affecting the travel pattern, climate, aesthetics, and many other factors of day-to-day life. The change in the urban form not only affects but shakes all different aspects of life and needs to be studied from a different perspective. And sprawl is accused of having destroyed the fabric of streets and sense of place and community (Burchell, et al., 1997; Jenks, 2004; Burgess, 2004; UN-Habitat, 2009).

Most of the early literature criticized sprawl, but much of the recent literature asks for an analysis that deliberately isolates both the costs and benefits of sprawl (Burchell, et al., 1997, p. 36). It is stated in this book that it was around the late 1950s and early 1960s, that sprawl as a planning term entered the literature. Then after understanding the negative impact of sprawl, studies tried to measure the cost and outcome of sprawl. The first observers of the result of sprawl were the economists and spread to other disciplines. The 'Costs of Sprawl' also sought to isolate both density and location of development as significant contributors to the costs of development and analyzed impacts on infrastructure, housing, transportation, energy, environmental, and quality of life costs of sprawl.

From the transport perspective Ewing et al. (2002), describe the results accordingly (i) de-investment in urban core areas and central city decline; (ii) reliance on the use of private cars and therefore the growing number of vehicle miles traveled, road congestion and decline of air quality; and (iii) the loss of open space and scenic areas in and close to metropolitan regions.<sup>7</sup>

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<sup>7</sup> *Costs of Sprawl* by Reid Ewing, Shima Hamidi published in the Year 2017 measures sprawl and studies the relationship between sprawl and quality-of-life outcomes.

From a morphological perspective also as cities experience demographic growth, they tend to expand spatially. One consequence of this process is the merging of previously non-adjointing towns and cities, resulting in metropolitanization<sup>8</sup> in some cases, or uncontrolled peri-urbanization (which often appears chaotic) in others. Therefore, urban sprawl has created a new type of urban form and this type of development that brought new forms is hard to manage the prospects and also need a new perspective or approach. That is why the process of sprawl led to the creation of new terms like edge city, suburbs, periurbanization, and satellite towns.

### **2.2.3 Future Prospects**

We have realized the challenges created by sprawl, but what did we intend to do about it? How did our perception change? According to Haynes & Fortheringham's (1984) prediction that if travel costs – in monetary costs or in time – decrease the result will be spatial dispersal of human activities and longer trip distances traveled. Also, Dieleman & Wegener (2004), while clarifying land use and transport; state that the likely scenario of urban growth is continued spatial dispersal.

Despite advice from different disciplines against the development pattern of urban sprawl, it is still increasing in different parts of the world. Even with a decreasing population, the urban sprawl tends to continue this was further explained by giving Japanese medium cities as an example. 'Once it has materialized, the built-up area appears to spread like an oil spill, whose surface is very difficult to reduce' (Okabe, 2005).

When most of the writers agree on the difficulty to control urban growth, they also admit to the negative influences of urban sprawl. Here also Stretton (2005), states that he does not think that is extravagant, stupid, culturally bad, or economically unproductive but believes in reducing the negative effects. However, as human society comes with some type of advancement we know that it tends to increase the size of their settlements. For example, only from the advancement of transportation perspective, we can imagine the effect of commuter rails and Heavy rails or metro lines<sup>9</sup>. Traveling at high speed, and connecting large areas are increasing or facilitating the horizontal growth of cities. So we can imagine the cumulative effect of all types of advancements making or facilitating the process sprawl further and increasing the challenges to mitigate the process. Despite the above realities, there are also different policies, models and theories developed that intend to mitigate the process and results of sprawl.

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*8 Metropolitanization entails the conversion of rural land into urban uses and the engulfment of adjacent municipalities by large cities to constitute new metro areas (UN-Habitat, 2009).*

*9 Heavy rails or rapid rail transits are big volume transits with isolated heavy rail line having stations between one and two kilometers except down town. Commuter rails have mostly 40 to 80km long line and sometimes above with stations erected five to ten kilometers apart.*

## 2.3 Sustainability and Urban Morphology

### 2.3.1 Development of the Concepts and their Meaning

So it seems we have agreed upon the impacts of urban sprawl as it is stated brilliantly in the next statement, 'Sprawl, car traffic, zoning, and major redevelopments have destroyed the fabric of streets, buildings and spaces, often replacing diversity with large single-use structures which can have a hostile or imposing presence' (UN-Habitat, 2009, p. 18). So sustainable development comes to play here and what type of sustainable development should we have that will not bring a negative or unintended impact on us?

**Development of the Idea** - Sustainability is a broad, vague term that has many meanings. It's a new idea, there is not yet a clear, single image of what sustainability is. 'Its' fuzziness and many facets contribute to its appeal. Sustainability draws from at least five intellectual traditions that are: **capacity, fitness, resilience, diversity, and balance**' (Neuman, 2005). He explains that adjusting built-up area to the environment, housing, and population density; fitting development to some urban fabric and fitness between urban form and local culture; seeing how well a place does absorb an organism or activity; functional diversity in land use, and balancing of natural resources with human development and others take roots from the above ideas (ibid). Also according to WCED (1987), it contains two key concepts: the concept of 'needs', and 'limitations'.

**Sustainability through Time** - Concerns about the unsustainability of modern urban development patterns have a much longer history. It is important to be aware of this history and other theories against it, to put our idea in perspective. First, it was the natural or the environmental factor that captivated writers, especially the 'Romantics' writers who expressed their love for nature. Hall (2014), mentions this in the title called 'The City of Dreadful Night' recalls the 1880 James Thomson poet and shows their influence.

The late 19<sup>th</sup> and early 20<sup>th</sup> c social reformers have given attention to the deterioration of urban conditions and the need for alternate living environments. Howard (2009), in his book "garden cities," tried to address the problems of the industrial city by attempting to balance city and country. Also, Mumford (1938), saw the extreme overcrowding and deterioration of early industrial cities as the main problem to be addressed. Yet Breheny (2005), states that they have been superseded by the belief that no such 'solution' exists.

Wheeler & Beatley (2009), state that post world war II Many critics began to realize that many twentieth-century development practices, both within cities and worldwide, were worsening inequities rather than improving them<sup>10</sup>. They also mention that Sustainable development from

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<sup>10</sup> for further reading this will give a general picture of what it looks like: In a book called Planet of Slum, Mike Davis in a title called "Back to Dickens" clearly show how the slum of the world cities got worse through time – page 11-19.

a social perspective is difficult compared to the environmental perspective because it challenges so directly the wealth and power structure within nations. We can take as an example how many critics F.L. Wright's Broad acres city proposal ushered because his proposition for equal distribution of land among citizens was thought to undermine the role of the government.

A third recurrent theme has to do with the notion of economic growth and the limitations of ecology in regulating human and natural systems. Daly (1973), in his work "Toward a Steady-State Economy," criticizes the previous economic system by referring to it as "Growthmania"<sup>11</sup>. And he advises following the steady-state economy that points out to the total population and the total stock of physical wealth to be maintained constant at some desired levels. But urban expansion mostly started to draw attention starting from the second half of the 19<sup>th</sup> century as mentioned before.

The most influential work on the subject come in 1972 by a group called Club of Rome's tried to use a computer model called system dynamics to analyze the future of the world. They point out limits to the growth of human society on the planet to be reached within a hundred years but they also believed in the possibility of reaching stable conditions. They finally proposed some sort of non-growing state for human society and called it 'The Equilibrium State'. They clarify it as 'An equilibrium defined in this way does not mean stagnation' and add that 'it is a dynamic equilibrium, which need not and probably would not "freeze" the world into the population-capital configuration that happens to exist at present' (Meadows et al., pp. 171-174).

'Sustainable development' then took its most used definition from the report by the Brundtland Commission as 'development which meets the needs of the present without compromising the ability of future generations to meet their own needs and aspirations' (WCED, 1987, p. 47). Then in the 1990s as Peter Hall (2014) puts it, the overwhelming theme of that decade was the search for sustainability, and sustainable urban development became almost a mantra. And after that, the acceptability of the development idea increased and entered different disciplines.

### **2.3.2 Sustainable Urban Form**

Therefore realization of finite world resources and excessive or extravagant utilization of resources led to the conception of sustainability. As Mumford (1938), puts it today we face not only the original social disruption but the accumulated physical and social results of urban form and environment, lasting more than a century. So what should a sustainable urban form supposed to look like? But first, how can we express or describe urban form or morphology? Both Oliveira (2016), and Kropf (2009), described urban morphology in several different ways by using different approaches. They describe it based on the persistence of Burgess and Hoyt models;

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<sup>11</sup> *Growthmania is a term for the paradigm or mindset of the late 19<sup>th</sup>, early 20<sup>th</sup> c and especially 1950s and 60s that always puts growth in the first place and presents it as a solution for every problem.*

based on the pragmatic insights of Kevin Lynch; based on the spatial analytical approach using Michael Batty's work; based on a configurational approach using Hillier's space syntax; based on the process typological approach to urban morphology rooted in the work of Saverio Muratori and based on the historico-geographical approach rooted in the geographer M. R. G. Conzen works. So we can imagine the different definitions based on the multiple approaches.

Mumford (1938), expresses the city as a conscious work of art and shows its impact by stating: 'Mind takes a form in the city; and in turn, urban forms condition the mind. This urban form has different components and these components have a relationship and they are interdependent.

Sometimes called urban tissues and sometimes elements of urban form or aspects, these are the main components - materials, structures, rooms or spaces, buildings, plots, streets, and blocks. And as a dimension used to describe urban form we can state them as density, transport infrastructure, land use, layout, and housing/building type (Kropf, 1996; Dempsey, et al., 2010).

If we describe urban form in its dimensions the next step is to see if there is a relationship between them. Dieleman and Wegener (2004) have examined the two-way interaction of land use and transport in three major theoretical approaches - technical theories (urban mobility systems), economic theories (cities as markets), and social theories (society and urban space). Again in another example showing their relation, it is stated "Getting the movement right affects uses and activities, density, security and the impact of the development on neighboring places" (Llewelyn-Davies, 2000, p. 34). This finally reveals that aspects of urban form are interdependent and interconnected.

A city form is accountable for many things that happen in the urban areas, or characters that influence on day to day life of the dwellers. For example, according to Lynch (1960), urban forms contribute to the experience we observe in the environment. The form must be somewhat noncommittal, plastic to the purposes and perceptions of its citizens. Yet he states that there are fundamental functions of which the city forms may be expressive: circulation, major land uses, and key focal points (ibid:91). And today neo-traditionalists and walkability advocates like Jan Gehl in many ways support the proposal of Lynch.

Gehl (2010), for example, focuses on the transportation aspects to bring the sustainable concept positive claims by using a better transportation strategy and policy. He advocates for a walking and bicycling city as an important step toward greater sustainability. And according to him, the sustainable urban form needs not just high density and a mix of functions but an urban environment that could facilitate the walking and biking experience, and the interaction between dwellers and their environment.

For sustainable urban form, Various components with the potential to impact the sustainability of urban form were identified as: the size, shape, density, and compactness of cities; processes

of intensification and decentralization; land use, mixed uses, layout & building type (particularly housing); and green & open spaces. (Jenks, 2004, p. 3).

Frey (2005), states commonly agreed on sustainability criteria for the city and city region as:

- Some form of containment,
- A reasonably high population density,
- A mixed-use environment,
- Adaptability to changing socio-economic conditions,
- Public transport,
- Reduced traffic volumes and dispersed vehicular transport,
- A hierarchy of services and facilities,
- An environment free of pollution, noise, congestion, accidents, and crime,
- Personal private outdoor space,
- A symbiotic relationship of the city with the country,
- Social mix,
- A degree of local autonomy, and
- A degree of self-sufficiency (Frey, 2005, p. 49).

As mentioned above Burgess shows how containing the size of the city contributes to its sustainability. The question of the economic efficiency of city size had been discussed extensively in the 'optimum city' size debates of the 1970s, but under the impact of the environmentalist critique, it was realized that this debate had to be revisited. Debates for achieving the best balance of agglomeration economies and diseconomies now had to consider the environmental implications of city size (Burgess, 2004).

Burgess's other factor mentioned for sustainable urban form was the shape of the city and it's based on Bertaud and Malpezzi's (1998), compactness indices for world cities. This measures the average distance per person to the central business district (CBD) as a ratio of the average distance to the center of a circle. This measure, called a 'dispersion ratio', assumes that the city is represented by a cylinder with a height corresponding to uniform density. The higher the ratio, the more dispersed the city. However, the truth of the matter is that the dispersion ratio is a better measure of the irregular shape of the city than of sprawl per se (W.Richardson, Bae, & Baxamusa, 2004). But focusing on housing what does the sustainability features look like? So sustainable housing neighborhoods will need to display the following general features:

- High density, mixed-use, and diversified tenure; integration of land use and transport planning with emphasis upon public means of transportation; an urban layout that creates shelter and safety; the exploitation of renewable energy supplies (wind, sun, etc.); capture of rainfall for certain water uses; use of open space (streets, parks, and squares) to facilitate

social interaction and ecological wellbeing; pollution and waste strategies; and creation of natural habitats integrated with housing (Edwards, 2005).

At the individual building level, sustainable housing will probably display a further list of features:

- Healthy comfortable, secure homes; householders able to adapt or extend space; designed-in ability to upgrade; low energy design exploiting renewable energy sources; super-insulated homes; and low water consumption (ibid).

## **2.4 Compact City**

### **2.4.1 Compact cities and urban sustainability**

**Contemporary compact city** approaches have become one form of achieving 'sustainable urban development', but that is not to say that they are coterminous with it (Burgess, 2004). However, UN-Habitat (2011), states compact city model is identified as being the most sustainable.

Nowadays the concept of compact form and the need for densification dominate today's belief in development. And based on Jenks et al. (2005), research is needed for three different elements of the compact city debate ... there is a need to test the claims about sustainability, there is a need to test the feasibility or social acceptability of the concept, and there is a need to generate tools to ensure successful implementation. Also According to Clifton et al. (2008), research on urban form at the scale of the neighborhood has largely been used in three ways: to analyze transportation behavior, to conduct hedonic price studies, and to assist in the planning process.

Burgess (2004), compact city approaches were to increase built area and residential population densities; to intensify urban economic, social, and cultural activities; and to manipulate urban size, form, and structure; and settlement systems in pursuit of the environmental, social, and global sustainability benefits derived from the concentration of urban functions.

There might be different characteristics or principles for the compact city but we are going to focus only on the issues of density and mix of function. "However, it should be noted that density is just one of a variety of factors that influences the sustainability of urban form. It has been argued that compactness alone is neither a necessary nor sufficient condition for sustainability, and at least seven design concepts for a sustainable urban form have been identified – namely, compactness, sustainable transport, density, mixed land uses, diversity, passive solar design, and greening" (UN-Habitat, 2011 citing Neuman, 2005; UN-Habitat, 2011 citing Jabareen, 2006).

### **2.4.2 Compact city through time**

It is difficult to know where to start in reviewing the history of discussions about appropriate urban forms (Breheny, 2005). The concept of a 'high-density compact city' originated with Le-Corbusier's higher density living idea of the radiant city. Also Dantzing and Saaty (1973), for the first time, proposed the 'compact city' (Breheny, 2005; Kotharkar et al., 2012). Further by end of the 1980s, public transit was incorporated to create livable concentrated cities. It had later

notions of the concentrated center city model by Haughton and Hunter in 1994. Since 1990, research has advocated the compactness and mix-use concept as it is justified on an ecological and environmental basis (ibid).

Rod Burgess states the current resurgence of interest in policies for compact cities dates from the late 1980s and has largely been propelled by the search for the global sustainability goals on climatic change and resource use embodied in the Brundtland Commission Report (WCED, 1987) and the UNCED Agenda 21 proposals (1993), (Burgess, 2004). He also describes that the reasons offered for making cities more compact have changed through time. Contemporary compact city approaches have become one form of achieving 'sustainable urban development' as stated above yet, they have to include economic, social, cultural, and political justifications for each character.

### **2.4.3 Characteristics of Compact Form and their Relationship**

According to OECD (2012), the three key characteristics of a compact city are first dense and proximate development patterns, a second urban area linked by public transport systems, and third accessibility to local services and jobs. Compact city policies can help achieve urban sustainability in many mutually reinforcing ways but there is no single, comprehensive compact city model. And based on 27 OECD countries, Policy case studies revealed that there is no single model because each must take local circumstances into account.

According to Rérat (2012), the compact city model is characterized by relatively high residential density and mixed land uses, the regeneration of brownfield sites, raising the height of existing buildings, functional mixing, joint development of public transport systems, new settlements, etc. And these characters have an intermingled relation and have a different impact on one another and the general compact form as we can see in the next paragraph.

A study by the spatial economic research center in 2017, identifies 3 compact city characteristics that have effects on 15 categories of outcomes. The three characteristics are economic density, morphological density, and mixed land use. Citing Holman et al. (2014), the study points to the possible problem in this type of study because different compact city characteristics can impact the same outcome in opposite directions and the same characteristics can have positive and negative effects on different outcomes. Finally 'Compared with the theoretical review the evidence not only confirms that the effects of compact city characteristics are predominantly positive but suggests that they are perhaps even more positive than theoretically expected, especially for economic and morphological density' (Ahlfeldt & Pietrostefani, 2017).

### **2.4.4 Critics of Compact City Development and the Context in Developing country**

Breheny (2005), divides the critics of the latter-day decentrists into two groups: 'the 'free-marketers'', who claim that it is interference by planners inland markets that causes problems,

and market solutions will optimize urban forms. And the 'good-lifers', who argue for a lifestyle that is decentralized, both geographically and institutionally, and a return to 'rural values'.

While testing the relation between compactness and sustainability Neuman (2005), explains what he called "The compact city Paradox" and states 'that for a city to be sustainable, the argument goes, functions and population must be concentrated at higher densities. Yet for a city to be livable, functions and population must be dispersed at lower densities' (ibid).

Comparing the compact city characters in terms of the five bases in intellectual traditions of sustainability Neuman (2005) criticizes the compact city as plan-based, not participatory, not place-specific, not a process but as result-based, and unhealthy. Again it describes the compact city as a very wide model considering all factors and tries to solve all resembling comprehensive planning. And finally concludes that 'The compact city fallacy holds that the compact city is neither a necessary or sufficient condition for a city to be sustainable and that the attempt to make cities more sustainable only by using urban form strategies is counterproductive' (ibid).

R'erat (2012), discusses three critiques that are usually made of the model of the compact city. The first is from both supply and demand in the housing market; secondly, its social consequence like gentrification; and the third critique of the compact city is its urban form is not necessarily compatible with the requirements of sustainable development.

The supply side is affected by the physical potential for densification and the demand side is affected by the choice people make depending on the push and pull factor. 'Flight from the city' the 'vicious circle' of urban sprawl and 'urban exodus' terms that come from the comparison of push and pull factors<sup>12</sup> exist in different cities with a different contexts. The second critique is on the social consequences of compact development and talks about gentrification. And it refers to a negative migration balance. The third critics are in the environment and claim compact form is not necessarily compatible with the requirements of sustainable development while focusing on transport and assessing people's choices. He concludes by stating that the detailed studies have revealed that the failures exist because of not fulfilling the required multiple factors supporting the claim of its multidimensionality.

**The Context in Developing country** - Any book about cities in developing countries faces the difficulty of tackling a vast diversity of countries and a large range of fast-growing cities and urban regions (Jenks, 2004). They state that compact city policies will have to address the problems of poverty and social inequality and are more appropriate at the regional and metropolitan scale

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<sup>12</sup> 'Flight from the city' and 'urban exodus' are terms used to describe the choice of inner city residents and the decisions following it as a consequence of challenges faced in the inner city like noise, pollution and in search for the comfort to establish a family unit. The 'vicious circle' of urban sprawl is the flight from urban core because of its push factor and pull factor of the suburbs and again creating those push factors in the suburbs as density increase.

and the application is possible only through certain other supporting conditions. According to Richardson et al. (2000), the prevalence of mixed land uses in the developing world reflects lax land use controls and led to uncontrolled increases in densities. According to demographic characteristics, the reality is different for developing county cities as their growth didn't reach attenuation or flatten the curve.

According to Jenks & Burgess (2000), in developing countries, housing preferences have favored high-rise apartments rather than single-family housing. The mixed-use structures and neighborhoods resulted in residential densities becoming higher the closer they are to the city center. Also, there remains considerable scope for further increases in densities in low-income settlements. There is a high rate of increase in automobile ownership. The transit use is higher in cities of the countries with a lower per capita GDP and appears to be related to transport costs than density.

Burgess (2004), explains the challenges we might face in developing cities while implementing compact development as:

- First, is the lack of empirical data on existing density levels and trends, and a lack of appropriate indicators to measure them;
- Second, he questions the applicability of densification in the time of global warming in tropical and subtropical climates, which could generate substantial demand for energy for cooling and diminish the desired energy savings;
- Third, citing Hardoy et al. (1990), the sustainability gains from further densification will be limited under conditions where densities are already high and if we decide to venture into it most cities are built in unsuitable conditions that need further consideration.

Burgess (2004), states that low capacity in infrastructure provision, the massive efforts required for public transport, lack of available domestic spaces (land for residential development), and demographic growth, the difficulty to address the demand are some of the challenges. And making matters worse the manipulation of urban forms is also limited because most of the countries have shifted from master and physical planning to strategic and social planning.

As an example, we can see the Indian case: for example, Delhi India, brought the inverted compact city, and Dhaka, brought overcrowding and environmental degradation. In the case of Delhi, it was because of the incomplete implementation of policies and proposals that resulted in an inverted compact city (Kotharkar et al., 2012 citing Kumar, 2000 and Mahtab-uz-Zaman, 2000).

## 2.5 Transit Oriented Developments (TOD)

### 2.5.1 Transit Oriented Development and its Classification

According to Gehl (2010), TOD is being implemented everywhere by fitting together non-motorized transport like biking and walking. He also states that TODs are typically built around light-rail systems surrounded by relatively high-density development. Dieleman & Wegener (2004), state that multifunctional land use is commonly observed in high-density urban environments, and at nodes of railway stations and metro stops. 'In the literature mixed land use locations around public transport modes are often referred to as Transit Oriented Developments (TOD)' (ibid).

According to Wright & Fjellstrom (2003), mass rapid transit or public transit is a passenger transportation service and is generally classified as heavy rail transit, light rail transit, metro, commuter rail systems and bus rapid transit, bus lane or priority bus lane, and busway. The defining features of MRT are the use of space, speed and passenger capacity, integration, and level of service. Also Cervero (1998), states in general way classification of transit services can be according to types of vehicles, passenger-carrying capacities, and operating environments.

As transit can somehow represent public transport it also holds the positive claims made by advocates of public transportation. Generally, Gehl (2010) states that TOD is a prerequisite for providing a sufficient number of dwellings and workplaces with a reasonable walking and biking distance to stations. Compact TOD cities with short walking distances and good city space provide numerous other environmental advantages such as short supply lines and reduced land consumption.

There are different types of terminologies used in mass rapid transit concepts and each of the terms is loose, so the study did not try to define each type but rather focus on the LRT only. Therefore LRT can range from the conventional on-street tramways to the elevated and segregated systems.

Therefore what are the features of LRT?

- In the use of space LRT often involves the reallocation of existing road space in favor of efficiency
- Related to speed and passenger capacity, it has an average speed of between 20-30km/hr.
- Related to integration, all MRT requires interchanges and integration to other modes of transport
- According to the level of service, all MRT including LRT has a superior level of service compared to other public transport (Wright & Fjellstrom, 2003).

Some of the main advantages of Light Rail include effective integration with new developments and park and ride facilities; the opportunity to renew the fabric of the urban areas it serves, and

the image of those areas; the permanence of infrastructure; vehicles and operations; creating confidence amongst individuals and business to make long term; and Locational decisions that produce long-term patronage growth (Luke & MacDonald, 2007 citing PTEG 2005). Other than this it is stated also that it needs high investment cost, brings disruption of the corridor during construction, and lower operating cost. The permanence of system performance or simply the permanence will affect land uses.

## 2.5.2 Transportation and Land Use

In this topic, we will see transportation with urban form, land use, and density. According to Muller (1984), the periods are classified into four eras as Walking-Horsecar Era (1800-1890), Electric Streetcar Era (1890-1920), Recreational Automobile Era (1920-1945), and Freeway Era (1945-present). Also, Newman and Kenworthy (1996), divide the cases into walking cities (from 10,000 years ago till today), transit cities (before WWII and accelerating after that), and automobile cities (from mid 20<sup>th</sup>c till today).

This paragraph has shown how much development in the transport sector affects the size, density, land use, and general form of an urban area. Accordingly, Newman & Kenworthy (1996), state that traditional walking is characterized by high density (100-200 people per ha), mixed land use, joined together by narrow streets in an organic form that fits the landscape. The transit cities expanded horizontally as the **train** and tram allowed faster travel to occur. While the trains created sub-centers at railway stations that were small 'cities' with walking scale characteristics; the trams created linear development that followed the routes in corridors or 'main streets'. In both cases medium-density, mixed-use areas were formed at the rail nodes and along the tram routes and the city could now spread 20-30 km. The city center where the rail lines met became a dominant focus for the city with intense activity. The overall density of transit cities reduced to between 50 and 100 people per ha. Then automobiles became a determining factor that shaped the city. This gave people to settle in any direction, first filling in between the train lines and then going out as far as 50 km. The city began to decentralize and disperse. The auto city reduced in density to between 10 and 20 people per ha.

First, the automobile city seemed a better way to connect land uses and transport system. But 'The unfettered automobile city 'dream' soon becomes a 'nightmare'" (Newman & Kenworthy, 1996). According to them, freedom comes at a cost of air pollution, a noisy environment and acres of paved surfaces for parking and roads, and urban sprawl. First cities deny the problem so even as far as the 1980s the problems were accumulating. According to Hall (2014), by the 1980s peak-hour delays extended to four hours twice a day, and also small incidents could cause paralysis of the system. So the search for an alternative solution in transport was set.

The development of transit from its start is planned mostly for the response of some existing context or for some type of intended urban form the result sometimes can be adverse. For

example, in the New York case transit was intended to give chance for congested inner city dwellers to establish settlements and house outer parts of the city favoring decentralization through transit (Hall, 2014 citing Veiller, 1900). But better transit was a double-edged sword: it could also spell even worse congestion in the city's core, by bringing more workers in and raising land values. This was the paradox, and it could be resolved only through a complementary measure: restrictions on the height and massing of buildings (Hall, 2014 citing Ford, 1936).

The context of transport and land use in the developed and developing world vary extensively. According to Cervero (2013), first, the challenges of rapid growth in developing cities are one aspect; rapid population growth and extreme poverty coupled with enormous challenges in urban planning in developing countries bring a different context. The second aspect is the motorization trend in developing countries is overwhelmed by the increase in car ownership and car population. In some cities like Mexico City, the increase in car population is even faster than an increase in population. The other aspect here is also the increase in daily trips in an urban area using private cars. The political imperative to overcome the negative aspects of automobile dependence is now appearing in all cities, including those in the developing world (Newman & Kenworthy, 1996 citing Laquian, 1993).

Also according to Cervero (2013), there are other contrasting urban contexts like Mono-centricity and primacy; higher density and more rapid decentralization; the existence of sparse road density and poor road hierarchies; and spatial mismatch, in social geography in addition to worsening traffic create a different context in developing countries. And he adds that when the cities invest in urban transport they impact the urban form, which is mostly negative as this transport solution becomes a force of decentralization. The other mentioned realities and challenges in the developing world include the existence of lax or non-existent land use regulations and the need for integrated transport and land-use planning.

## **2.6 Density**

### **2.6.1 The Concepts and Definitions of Density**

According to Mumford (1938), a matter of density first started to be felt in the renaissance time, especially in today's capitals of European cities. The main challenge and encounter with density were during the time of the industrial revolution. Then these environments brought different challenges which forced us to seriously think about the density and acceleration up to today. Determining density affects a lot of aspects of the urban environment and it is stated that 'urban density has long been central to theories relating urban form to city life' (Dovey & Pafka, 2014). Also, Alexander et al. (1988), state that density measures are an integral part of the design professional's vocabulary and "kit of tools".

Showing its complexity it was stated: 'first, the concept of density seems appealing to planners because it is objective, quantitative, and neutral. But a closer look at it reveals that it is a very complex concept and it is a multidisciplinary concept' (Churchman, 1999). Also to Cheng (2010), the word 'density', although familiar at first glance, is a complex concept upon closer examination. To him, the complexity mainly stems from the multitude of definitions of the term in different disciplines and under different contexts.

Density is related to different aspects of our life like that of urban form and has to be related to different concepts. For example, Scoffham & Vale (2005), show its relation to urban form by stating that density doesn't have to be only a quantitative figure the conception has to go beyond that. According to them, density has little importance unless it is related to a built form like that of density the compact is meaningless unless it is related to some facts and figures.

Also showing the social factor of the concept it is stated that 'City dwellings have to be intensive in their use of the land too, for reasons that go much deeper than the cost of land. On the other hand, this does not mean that everyone can or should be put into elevator apartment houses to live-or in any other one or two types of dwellings. That kind of solution kills diversity by obstructing it from another direction. Dwelling densities are so important for most city districts and their future development and are so little considered as factors in vitality' (Jacobs, 1961, p. 202). Here Jacobs supports the intensification of the urban environment but mentions that it has a limit.

But if a compact form is about higher density, it is better to describe the terminology of higher density? Cheng (2010), states that the meaning of high density is a matter of perception; it is subjective and depends upon the society or individual's judgment against specific norms. He tries to see the concepts of density from two perspectives – namely, physical density and perceived density. He states a thorough comprehension of these two distinct concepts of density will serve as a basis for understanding the meaning of high density (ibid).

### **2.6.2 Different Types of Measurements and Expressions of Density**

According to Alexander et al. (1988), it can be expressed using the three classifications as Perceived density, Physical density, and Measured Density. Measured density has been grouped into "Molecular" and "Molar" measures. The first reflects density within the dwelling unit: people per room or person per floor area. The second molar measure refers to the space outside the dwelling: the site, the neighborhood, or the community. Physical density is made up of those objectives and physical characteristics of the built environment and its users that contribute to the density that is perceived by people in an actual setting (ibid). Density is a perceived experience when it is matched against personal and cultural norms and it generates an "Affective density" that communicates evaluative judgments like a sense of isolation, a feeling of comfort; or a perception of crowding (Alexander et al., 1988 citing Rapoport, 1995).

According to Churchman (1999), spatial density is concerned with altering the number of society and social density focuses on changing the value of space. The four types of density measures in urban planning that he explained were somewhat similar to Alexander et al. (1988), and they are parcel density, street density (net density), gross density, and population density.

On a large scale to express density Cheng (2010) uses physical density and regional density which are the same as the above-mentioned physical density. In both cases, physical density is a measure of the concentration of individuals or physical structures within a given geographical unit. Regional density is the ratio of a population to the overall land area of a region which is often used as an indicator of population distribution in national planning policy. Also, he shows that to see the distribution pattern of population or buildings we can use density gradient and density profile. A density gradient is defined as the rate at which density falls (according to distance) from the location of reference. A density profile refers to a series of density measurements based on a reference location but calculated in different spatial scales and is used as an indicator of settlement structure (see Figure 2.5 and Figure 2.6).

There are a lot of measures expressing the components of physical environments and each has its importance. For example, Alexander et al. (1988), explained FAR which is the ratio of all floors to the area of the site and coverage, the area covered by buildings, as a “footprint” to the area of the site. Additional measures like light and shadow angle are used to define a building envelope with its site, street, or adjoining structure. Height and setback in combination determine maximum massing and building envelope. Again the measure of density in FAR is used (helps) to determine the amount of open space, living space, recreation space, and parking space.

Expressing density might seem a simple issue but, we have to understand that the misunderstanding of the measure might lead to serious misguided decisions. There are a lot of measures of density and equally different ways of expression but we have to focus only on the types this study uses (See Table 2.1). For example, Jacobs (1961) describes the confusion between high densities and overcrowding, and also Cheng (2010), describes how people confuse over the overall density and built-up density of the whole city that he calls the ‘boundary problem’. Another confusion exists when comparing the indoor density expressed on a small scale and large scale. According to Churchman (1999), there can be a large variation between the household density expressed on a large scale and different locations within the city. Before going to the indoor density another measure or determinant of density is spacing between dwelling units. Ranson (1988), states that providing adequate space between buildings is of central importance when planning the micro-environment.

### **Indoor Density**

According to Ranson (1988), in expressing Indoor space (i.e. the living area within the dwelling unit) is normally divided into dwelling space areas, such as living rooms, bedrooms, kitchens, and

ancillary space, such as corridors, stairs, and storage areas. So he states that when we say habitable room it excludes ancillary spaces. And in categorizing them Appolloni & D’Alessandro (2021), state that a diverse approach exists among European countries' regulations can be a market-oriented logic one (England and Wales) to a prescriptive one (Italy) and one that is functionality-oriented (the Netherlands). On the other hand, different criteria are used to determine standards for example fixed minimum interior space, determining size for each room especially living rooms, bedrooms, and bathrooms, or sometimes the total surface of useful rooms is determined. The other parameters can be minimum acceptable ceiling heights, side length, and the volume of rooms.

In Alexander et al. (1988), the UN suggestion of an average density of one person per room for privacy, with three or more persons suggesting undesirable crowding was mentioned. American Public Health Service/CDC of the US Public Health Service recommended the maximum occupancy not to exceed the next two standards First occupant, at least 14.2 m<sup>2</sup> habitable floor area; second and subsequent occupants at least 9.4m<sup>2</sup>. The permitted number shall be less than 2 times the number of habitable rooms within the dwelling unit (APHA-CDC, 1976). WHO (2018), defines household crowding based on different sources as a condition where the number of occupants exceeds the capacity of the dwelling space available, resulting in adverse physical and mental health outcomes.

Overcrowding occurs if there are more than three people per room (WHO, 2018 citing UN Habitat 2007). American Crowding index is 1.5 people per room and the air temperature between 18<sup>0</sup>C and 24<sup>0</sup>C is seen as creating no risk and recommends 18<sup>0</sup>c. The issue of temperature seems a small matter but it shows its effect on the comfort of dwellers and gives examples like if the UK has an improvement in housing and increasing heat in bedrooms they will save 1.4 billion medical expenses (WHO, 2018). When Blake and his colleagues were asked to prepare a guideline to measure overcrowding for US Housing and urban development they stated that overcrowding will happen when there is below 165sq.ft (15.33m<sup>2</sup>) for a person (Blake, Kellerson, & Simic, 2007).

<b>Indoor density</b>		
HH size or Persons per dwelling unit	Total population per Total number of dwelling units	Churchman (1999); US Census Bureau (1950);
Persons per habitable room	Total population per Total number of rooms or floor area	Blake <i>et al.</i> (2007) (Alexander et al., 1988)
Floor area per person	The total area of dwelling units per Total population	UN-Habitat (1996); Blake <i>et al.</i> (2007)
Occupied floor area per person	Total occupied floor area per Total population	WHO (2009)
<b>Parcel density</b>		
Floor area ratio	Gross residential floor area per Residential plot area	ASPO (1958); Kogo <i>et al.</i> (2010), Churchman (1999)

Built-up area ratio or site coverage	Total Built-up residential area per Residential plot area	Churchman (1999); Cheng (2010)
Dwelling unit per hectare (ha)	Total number of dwelling units per Residential plot area	ASPO (1958); Forsyth (2003)
<b>Residential neighborhood density</b>		
People per residential neighborhood area	Total population per Residential neighborhood area	Eldridge (1984)
Dwelling units per residential neighborhood area	Total number of dwelling units per Residential neighborhood area	ASPO (1958); Alexander (1993); Forsyth (2003)
Dwelling units per 'developable land' area	Total number of dwelling units per Total 'developable land' area	Galster <i>et al.</i> (2001)
Built-up area density	Total population per Built up area in the urban footprint	Angel et al. (2016)
Residential share	The total area of residential plots per total area of the urban footprint	Angel et al. (2016)

Table 2.1 Measures of urban density in the literature and selected sources that mention them. (Adopted from Angel et al., 2021 and Alexander et al., 1988)

### 2.6.3 Density in Different Contexts

Here it is hoped to show the different contexts of density in different countries in a general way. As Burgess (2000), explains the demographic reality in developed and developing countries is very different as stated previously developing countries are facing fast population growth and a high rate of migration. These issues are somewhat similar to the compact development realities as stated previously between the developed and developing countries (see The Context in Developing country .

Today the history of the last century and the reality of a more urbanized world bring the concept of density to the forefront. Looking at the current image of the world the developing world cities (5000ppKm<sup>2</sup>) are already high in density and functional mix than the developed world has (2500ppKm<sup>2</sup>) (Demographia World Urban Area, 2012). In 2019 cities with a population of more than 500,000 belong to 30% of the urban population of the regions. Approximately 70 percent of the world's urban population lives in urban areas with fewer than 500,000 residents' (Demographia World Urban Areas, 2019).

To show density in different contexts below there is a compilation of the intended levels of density with their description including the time reference and individual's name that proposed it.

No	Density	Place/project name	Proposed by	year
1	Approximately 25–30 people per acre; 45 houses to the hectare, with average four-bed spaces per house is 180-bed spaces per hectare	<i>Garden city</i> and plan for <i>Hygeia: A City of Health</i>	Ebenezer Howard and Dr. Richardson	1902 and 1876

2	Population density would be five people per acre	<i>Broadacres</i>	Frank Lloyd Wright	1920
3	Each skyscraper with dimensions of about 190m x 190m and a height of over 200m was designed to house five to eight hundred thousand people.	The proposal of the <i>La Ville Radieuse</i> was first proposed for central Paris, then adapted to Algiers, Barcelona, Buenos Aires, and Sao Paulo.	Le Corbusier	1935
4	prescribed 247, 336, and 494 people per hectare commonly known as Abercrombie's maximum	New York and London	Thomas Adams' and Abercrombie's plan	1927-31 and 1945
5	Does not dictate some density but rather encourages progressive development according to the 'will of autonomously organized people and communities'	<i>legislative planning</i>	John Turner and other advocates like Cristopher Alexander	1976
6	Suggested that a net density of a minimum of 250 dwellings per hectare is a necessary condition for vital and participatory city life.		Jacobs, J.	1961
	60 persons per hectare (pph), accommodate about 7,000 persons <i>Urban neighborhood</i> : radius of 600 m density is thought to support local services and facilities	Govanhill, Glasgow	Hildebrand Frey	1999
7	5000 to 10000 mostly consider political aspects like individuals effective voice in a community or principles like no citizen be more than two friends away from higher members of a local unit	Jefferson's community and <i>Goodman's Rule</i>	By President Jefferson and Paul Goodman	
8	Gross Residential Density - Dwelling Units per Acre 5 to 10 Dwelling Units/Acre Minimum Net Residential Density 10 to 20 Dwelling Units/Acre 10 to 20 Dwelling Units/Acre	Florida Department of Transportation TOD Design Guidelines	"new urbanist," like Peter Calthorpe	2009
9	In the UK, for instance, the government has set a residential density of 30 dwellings per hectare as the national indicative minimum for new housing development	UK cities	UK Office of the Deputy Prime Minister	2006

Table 2.2 Level of density for different places and proposed projects with time reference compiled from multiple sources

Like in the above table deciding the level of density might take in to consideration different aspects for example 100ppha - 240 ppha will sustain a tram service" (Llewelyn-Davies, 2000), In

the 1860s Cerdá argued for a coverage ratio of 50% with no height restriction (Dovey and Patka, 2014 citing Soria y Puig, 1999).

#### **2.6.4 Different Studies on Density**

According to Alexander et al. (1998), there are different researches on density; the first one is related to human perception and behavior that focuses on crowding, privacy, and territorialism. The second type is based on economic variables focusing on housing price and development cost; the third focuses on planning prescriptions and descriptions, especially for optimum density. The fourth one seats on their impact to study the application and problems. The final one focuses on the urban form and the building types.

Some study to find the optimum density but to others, it is to be determined by the performance for example Jane Jacobs expresses it by asking as follows: 'what proper densities for city dwellings are. The answer to this is something like the answer Lincoln gave to the question, "How long should a man's legs be?" Long enough to reach the ground, Lincoln said. Just so, proper city-dwelling densities are a matter of performance. They cannot be based on abstractions about the quantities of land and people in an imaginary place' (Jacobs, 1961, pp. 207-8).

For others, density is related to transportation and fuel consumption like the study by Newman & Kenworthy. Again Llewelyn-Davies (2001), suggest that density is also related to the idea of supporting local Services and utilities. Different studies were also conducted on density measures and ways of description by connecting each value or with different parameters like form, intensity, connection, and use (Dovey & Pafka, 2014; Patel, 2011; Pont & Haupt, 2009; Vujic, 2014; Eizenberg, Sasson, & Shilon, 2019; Forsyth, 2003)

We can also study density with urban morphology. Because as stated 'building density has an intricate relationship with urban morphology; it plays an important role in the shaping of urban form. They can determine the urban land use, the proportion and organization of ground open space, building height, plot ratio, site coverage, and solar obstruction' (Cheng, 2010).

#### **2.6.5 Density Relation to Sustainability and High-rise Buildings**

At the level of cities, the area of debate has often distilled down to the relationship between urban density, form, and sustainability, and how their multifarious interlinkages can be explored to achieve better utilization of the Earth's resources and quality of human life (Heng & Malone-Lee, 2010).

Sustainability from the perspective of density is a story of more than half of the world's population in one up to two percent of the land area. However, most of the population resides in not the big urban centers but is fairly distributed all over the world. So sustainability asks how much density is acceptable by the society that will increase the opportunity for cultural and social

affairs to flourish. How much density will create a good competition between the businesses that is not so vigor and not so dull, for making cities a place where market relations create a vibrant environment. The level of density concerning the service it supports is also another concern as it is highlighted by Llewelyn-Davis (2000). From the environmental perspective, density is studied with open spaces and their ability to limit sprawl like green belts and facilitating social relations, it is also studied with the consumption of rural land. Density like Newman and Kenworthy (1989) is also studied with the level of density and their level of carbon emission. Generally, we can say that the matter of density and the issues of sustainable development are highly intermingled.

OECD (2010), also states that the total area occupied by urban centers or world built-up areas is 1,555,000 km<sup>2</sup> this means we have around 3000 urban centers like Addis Ababa. They consume around one percent of the world's total land cover but considering their impact they put a lot of pressure on the environment. Mostly described by a population of million their impact on the environment is emphasized. As a testimony to this Newman (1999), in 'Metabolism of a City' states how much a city consumes and how much it excretes by looking at the city as an organism.

City life does not happen by itself or develop automatically simply in response to high density. The whole issue requires a targeted and considerably more varied approach. Lively cities require compact city structure, reasonable population density, acceptable walking and biking distances, and good quality city space. Density, which represents quantity, must be combined with quality in the form of good city space (Gehl, 2010).

**Density and Building Height** - According to Shin (2010), high-rise buildings starting from Chicago spread to other parts of the US and started to display the national prestige and after WWII high-rise building boom shifted away from the US. After the failure of the eco-city sustainable compact city was introduced and to achieve it, high-rise or tall buildings are seen as one of the best solutions because of the benefit of concentrating numerous functions in one place. Based on their trend he mentions that they are inevitable and if we build them they should establish social and economic sustainability, as well as build artistic and culturally sustainable high-rise buildings through design multiplicity. And states that, if different methods of construction and technological inputs are not applied to these high-rise buildings the result may become reverse.

Roaf (2010) states that with global populations exponentially increasing and urbanizing, one can see that traditional vernacular solutions for building and city form are not capable of achieving the required densification of dwellings... for new developments, she states that the question has to be 'what is the optimal density for this city' not 'are high-density settlements sustainable' (ibid). The above two have mentioned the inevitability of densification and increasing building height but there are also who question and oppose the ideas of densification as Vale & Vale (2010), state that today further densification is accepted but stress that we have to think

thoroughly about how to sustain them by thinking for the available energy, and resource including food. Also, Ranson (1988), describes the modern slum of the 1950s, 1960s, and 1970s didn't "solve" the housing problem. And states that they resulted in adverse social and mental health consequences created by these high-density, high-rise developments. Fanning (1967), shows that the morbidity of families who lived in flats was 57% greater than that of those who lived in houses.

Churchman (1999), states that the connection made between density and high-rise housing is particularly instructive. Scoffham and Brenda (2005), citing Richards, 1946 state that from the high density, high-rise apartment buildings that permeated British cities; few reached Abercrombie's maximum of 494 people per hectare. Their failures remain associated with the confusion about high-rise and high density. Also, Jacobs (1961), states the dwelling densities should go as high as they need to go to stimulate the maximum potential diversity in a district but commands not to get too high as they will begin to repress diversity instead of stimulating it. Also, Gehl (2010), questions the assertion of a high-density city as a lively city, he states that there are countless examples of places with high building density and poor city spaces that do not work at all. Gehl like Jacobs points out new city spaces are too big and do not inspire anyone to venture into them.

## **2.7 Mix of Function**

### **2.7.1 Definition and Dimensions of Mix of Use**

In describing the theory of mixed use or in our case mix of functions is described as an ambiguous and multifaceted concept that is repeatedly used but rarely defined term (Hoppenbrouwer & Louw, 2005; Rowley, 1996; Coupland, 1997). The concept of multifunctional land use or a mix of functions is, directly related to the themes of the compact city and urban sprawl discussed in this study. And Dieleman and Wegener (2004), used it as one factor to distinguish between compact cities and urban sprawl. And stated that multifunctional land use is defined as the combination of different land-use functions in the same area. It recognizes that spatial functions need not always be examined as alternative and mutually competing uses of scarce land, but instead, a merging of land use functions at a certain location can lead to economies of synergy, save space, and be environmentally benign (Dieleman and Wegener, 2004 citing Rodenburg et al., 2003).

Herdon (2011), based on the urban land institute (ULI) (1987), and Grant (2002), define mixed-use development as three or more significant revenue-producing uses that in well-planned projects are mutually supporting. This mix of uses needs significant physical and functional integration of project components including uninterrupted pedestrian connections.

## **Scope and Dimensions of Mix of Function**

According to Turstall & Fenton (2006), when using the word mix we have to be very clear because it could represent many things in development. A place may be mixed in terms of its buildings, their built form, size, designated uses, tenure (if housing), and market value or rent levels.

There are different dimensions of a mix, for every type of mixed development, there are policy strands, a reason to pursue them, different ways to implement them, and some intended outcomes. Tunstall & Fenton, (2006) suggest that mixes of incomes, housing tenures, and other important social characteristics; are intended for delivering social housing, meeting other social policy goals (like inclusion, sustainability, cohesion, and balance), and principled opposition to the division between different types of people.

According to Cervero (1996), density is sufficiently studied in its influence on mode choice per capita energy consumption but not mixed use function. However, residential densities exerted a stronger influence on commuting mode choices than levels of the land-use mixture, except for walking and bicycle commutes. For non-motorized commuting, the presence or absence of neighborhood shops is a better predictor of mode choice than residential densities. Therefore the above reality shows us that a mix of functions is highly linked or has a positive relation to non-motorized transport modes.

Jacobs (1962) described a mix of functions in creating a vibrant and economically viable community. She divided the uses into primary and secondary, the first one being the main functions like schools and factories that draw people to the area and the second one is an enterprise that grows in response to the primary uses. And explains that 'when a primary use is combined, effectively, with another that puts people on the street at different times, then the effect can be economically stimulating: a fertile environment for secondary diversity' (ibid:162).

And from the perspective of form mix of function increase the chance of having different building types with it increasing the imageability of the area. When Lynch (1960), attempted to study the perception by comparing the sketches of each individual he mentions that the Boston sketches were full of characters from Jersey City and Los Angeles. Note that the Newbury street which he explained to be densely packed with detail was just old houses of mixed-use and it was also mentioned that the use is one of the characteristics that create the district, and also mix strengthens the node other than being a point of modal change.

### **2.7.2 Benefits of Mix of Function**

According to Llewelyn-Davies (2000), the benefits of mixed development are listed as

- More convenient access to facilities,
- Travel-to-work congestion is minimized,

- Greater opportunities for social interaction,
- Socially diverse communities,
- Visual stimulation and delight of different buildings within proximity,
- A greater feeling of safety, with 'eyes on the streets',
- Greater energy efficiency and more efficient use of space and buildings,
- More consumer choice of lifestyle, location, and building type,
- Urban vitality and street life,
- Increased viability of urban facilities, and
- Support for small businesses (such as corner shops) (Llewelyn-Davies, 2000, p. 139).

According to Cervero (1996), mixed-use was reflected in lower vehicular trip generation rates and higher non-motorized (e.g. walking, bicycling) modal splits in mixed-use settings. Also Turstall & Fenton (2006), Social dimension; Jacobs (1962), economic dimension; and Lynch (1960), urban form benefits were mentioned.

More than the above Gehl (2010), describes the prominence of a mix of functions in detail. According to him the treatment of the city's edges, particularly the lower floors of buildings, has a decisive influence on life in city space. This is where the city meets the building. And based on a physiological study of people showing that our senses need stimulation at fairly short intervals of four to five seconds. He then recommends a "soft edge" with shops lined up, transparent facades, large windows, many openings, and goods on display. Also, residential uses reinforce this area with semi-private front yards and also with balconies, and other types of outdoor areas. No single topic has a greater impact on the life and attractiveness of city space than active, open, and lively edges. Also, Alexander (1977), summarizes it as "If the edge fails, then the space never becomes lively".

Also, Ranson (1988) states the main advantage of mixed development schemes is in encouraging diversification of residents in terms of age groups, interests, and socioeconomic and cultural backgrounds, which in the long-term usually results in a better community and social interaction.

### **2.7.3 Mix of Function in Sustainable Models and the Typologies**

The concept of a mix of functions is so essential that it is used in the definition of some models or it is mostly mentioned as one of the key principles or characteristics of the sustainable model. Showing the close relationship to sustainability and describing its importance Jacobs (1961) states that to understand cities we have to deal outright with combinations, not separate uses, as the essential phenomena. A mixture of uses, if it is to be sufficiently complete to sustain city safety, public contact, and cross-use, needs an enormous diversity of ingredients. So the first question-and I think by far the most important question-about planning cities is this: How Can cities generate enough mixture among uses--enough diversity-throughout enough of their territories, to sustain their civilization? (Jacobs, 1961, p. 144).

Herdon (2011), states that the concept of multifunctional land use is, of course, directly related to the themes of the compact cities. Gehl (2010), states that multifunctional (urban) land use can most commonly exist near the nodes like railway stations and metro stops. Usually mixed land use locations around public transport modes are often referred to as Transit-Oriented Developments (TOD). Not only in TOD but also in compact cities, Smart Growth and Congress for New urbanism all take the concept of mixed-use under their wing.

The asserted principles to guide policy, development practice, urban planning, and design by CNU (Congress for the New Urbanism) state that a neighborhood should be compact, pedestrian friendly, and mixed-use (CNU, 1993). Smart growth supports the integration of mixed land uses into communities as a critical component of achieving better places to live. Berke, et al., (2006) state the difference is Smart Growth specifies a macroscale community land use and infrastructure policy frameworks in urban planning and policy principles while New Urbanism goes up to details of urban design principles.

### **Mixed Use Types and Models**

**Rowley's Typology** - Rowley (1996), created a conceptual model that is based on horizontal dimension, or between adjacent buildings and proposes that the physical form of mixed-use development is a function of urban texture, setting, and location. He states 'The texture of a settlement is a major determinant of its character and quality and its key features are grain, density (intensity of use) and permeability - derived from the layout of roads, streets and paths' (ibid). This conceptual model further considers the dimensions of the concept of how property is held and occupied and by whom but did not consider the vertical dimension.

**Hoppenbrouwer and Louw's Typology** - Hoppenbrouwer & Louw's (2005) model is developed from a spatial perspective and is organized by function, dimension, scale, and urban texture. The dimension component is composed of 4 elements: (1) the shared premise dimension, (2) the horizontal dimension, (3) the vertical dimension, and (4) the time dimension. Thus suggest the addition of location or employment and housing types, might help conceptualize mixed-use development.

The other aspect is the mapping of the areas to describe a mix of functions - Berke et al., 2006 citing Kaiser and Davies, 1999 show that there are 4 types of land use plans the first is area wide land policy plan (maps general policy districts – conservation, rural, urban), the second community wide land use design plan (specific spatial organization of land uses – location, type, mix and density), the third is small area plan and the fourth is the development management plan. But the modeling of mix use areas is recently being developed by incorporating GIS.

### **2.7.4 Studies of Land Use or Mix of Functions**

To understand and suggest or plan the land use (configuration of function) one must perform the inventory of existing land use and inventory of land available for future development or

redevelopment. According to Blake et al. (2007), a land supply inventory or land record system is a comprehensive database that relates the existing and projected supply of developable and redevelopable land of infrastructure availability, environmental quality and constraint, and market. It should document the nature and condition of the present built environment; current stock of land uses and structure; consider changes taking place in land use and built environment, and show available land for each use. Then it should be organized by relevant planning scale and planning unit and should be mapped as part of a geographic information system for easy access.

After data collection and organization the classification follows: according to Blake et al. (2006), land classification is a procedure of assigning land use categories to each location in the jurisdiction. Again they state that an early land use classification system was presented in the standard land use coding manual developed in 1963. And the contemporary land use classification is two: one is the land-based classification standard (LBCS), which is developed by the American Planning Association (APA) and is the most used one and the second one is the urban transect that joins the planning and landscape perspective. Further, they also state that the analysis can be based on land supply and capacity analysis; urban land scenario (uses key assumptions about future redevelopment); and land use intelligence.

Mashhoodi and Pont (2011), state that the definition of mixed-use development varies in different sources, and further the scale at which these mixed-use developments are defined differs from neighborhood, block, to building complex. The studies also show three different conceptual levels: The first level is dealing with increasing the intensity of land uses within one category of land use, usually residential; the second level deals with an increasing diversity of uses by combining compatible functions; and the third level is concerned with the integration of segregated uses which mostly means that barriers imposed by urban rules need to be dealt with (Mashhoodi and Pont, 2011 citing Grant, 2002).

While the description of land use or a mix of functions can be described at block, compound, and building levels the synergy and compatibility of land uses need further measurements. Again Mashhoodi and Pont (2011), show that there are several methods for analyzing the compatibility between land uses. Based on Wegner, (2004) and Dempsey et al., (2008) state that we can explore the compatibility between land uses by accessibility, based on spatial distance (in terms of length of time) and density to demonstrate the compatibility. Also based on Bertuglia et al., (1994) state that the most common measurements used include effectiveness and efficiency factors. Newly developed methods such as place syntax by Ståhle, 2008 also add topological distance to effectiveness and efficiency analysis.

The Space matrix developed by Berghauer Pont and Haupt (2010), makes it possible to link the urban form and structural types to density and the amount of open space. To make this possible, the space matrix treats density as a multivariable phenomenon, approaching and defining it in

terms of three indicators, in contrast with the usual practice of using a single indicator, such as the number of dwellings per hectare or FSI (Mashhoodi & Pont, 2011).

Pont & Haupt (2009), state that in Space matrix density is thus defined not only as intensity (FSI), but as a combination of intensity, compactness (GSI), and network density (N). The first two indicators together also determine the average building height (L) and pressure on non-built space (OSR). To assess FSI, GSI, L, and OSR<sup>13</sup> simultaneously one of the projections of the Space matrix is used, the Space mate. Mashhoodi & Pont (2011) stated the research by Van den Hoek in Amsterdam and Rotterdam has indicated that a relation exists between FSI and mixed-use developments. The FSI is 27% higher in the mixed blocks than in the mono-functional blocks and we can conclude that a correlation exists between density and the mix of land uses.

### **Study of a mix of functions at the building level**

At the neighborhood level inventory of each function as mentioned by Berke et al. (2006), can be used but at the individual building level, it is going to be the study of people (users) activity. And as our focus is on residential use we only focus on the study of people's activity in a household. Most of the world's buildings around 90% are vernacular (Asquith, 2006 citing Oliver, 2003) and according to Asquith, the reason for study can be to record and document building traditions and typological changes through history and understand the culture of space usage. They are constantly evolving, reacting to changes in the communities that shaped their form. So Asquith recommends the use of integrated approaches that include anthropological, sociological, behavioral, and architectural approaches. The study of housing also has to be interdisciplinary.

The conceptual framework of the study is based on the concepts that determine a house form. House forms were studied as they were determined by physical factors like climate, material, construction, technology, site, defense, economics, and religion. These views were called physical determinist views. The theories have inclined toward a rather excessively simplistic attempt to attribute form to a single cause. These theories ignore the fact that building form manifests the complex interaction of many factors (Rapoport, 1968, p. 18). Then he hypothesizes that house form is not simply the result of physical forces or any single causal factor, but is the consequence of a whole range of socio-cultural factors seen in their broadest terms. And he calls the socio-cultural forces primary, and the others secondary or modifying (ibid:47). The socio-cultural forces he stated were some basic needs, family, the position of women, privacy, and social intercourses. Doric phenomenon,

Asquith (2006) stressed that these socio-cultural factors are common to all cultures and should be applied in any assessment of housing needs. Social intercourse needs to be assessed not just in

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<sup>13</sup> FSI is a floor space index, GSI gross space index, L is the building height or floor level and OSR is the open space ratio – in this document the terms are used as floor area ratio, built up area ratio and the L is the the building height but the OSR are not used.

terms of communication between family members, but through the structuring and re-structuring of time and the spatial type itself. The way space is structured and re-structured according to time, influences the spatial and social organization and needs to be examined.

In developing the methodology to study the above-mentioned aspects a time diary, spatial mapping, or a spatial perception map, spatial configuration diagrams were developed. Time Diary helps to record activity, time, and space use with each individual, which can then be examined concerning age and gender, a time diary can be used (Asquith, 2006 citing Wallman, 1984).

The data for all people living in one dwelling can be recorded over some time and entered into a worksheet (See Annex XIAnnex XIAnnex XIAnnex XIAnnex XIAnnex XIAnnex XI). The data is then entered onto coded worksheets where activities can be grouped according to activity types as illustrated in. This qualitative data can be used in several ways to illustrate space claims within the home (Asquith, 2006). Also, the spatial mapping will show what space each associate with or claims and is an important aspect in the structuring of space within the home, which can be hierarchical depending on age, gender, or status outside of the home (ibid). The spatial configuration diagrams or j-graph can map the potential connections and movements between spaces more readily than the frequently used architectural plan (Asquith, 2006 citing Hillier and Hanson 1984). However, Asquith (2006), further develops the spatial configuration diagram thus each room is represented by a bubble, but the size of the bubble is indicative of the amount of time spent in each room by all members. Also Eloy & Guerreiro (2016), show how to use space syntax for transforming housing typologies.

## 2.8 Housing Transformation

### 2.8.1 Basic Definitions

**Housing, Home, and Dwelling** - at a closer look, the words we use daily but have never seen in detail reveal a lot or a wide concept in them. It was stated that 'it is a disturbing sign of the decay of language and values in the modern world that official housing, building, and planning terminology universally confuses the meanings of housing and housing value. It seems that all national and international housing and planning agencies miss-state housing problems by applying quantitative measures to non- or only partly quantifiable realities' (Turner, 1977, p. 65).

He defines housing as in English the word 'housing' means both the stock of dwelling units (a noun) and the process by which that stock is created and maintained (a verb).<sup>14</sup> He adds that it is entirely reasonable to speak about the market value of houses. It is also entirely reasonable to speak about the human and social values of housing action or housing processes. But it is absurd

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<sup>14</sup> John F. C. Turner, *Housing as a Verb*, in *Freedom to Build*, op. cit. in this paper he suggests that we have to consider both the housing process and end product, the market and social value, the standard and the performance: meaning what it is made of and what it do for dwellers.

to mix these sets of terms and their meanings regarding the performance of housing (what it does) vs. housing standards (what it is).

An article by Coolen and Meesters (2012), that tries to further our understanding of 'house', 'home', and 'dwelling' states that all three are complex, multi-faceted, and multi-layered concepts, whose diverse connotations are often used interchangeably. If we consider housing as a physical structure it is western-oriented however most housing in the world more than 90% are vernacular so we miss the social or cultural aspect of the house. They describe home from five facets:

- The first facet entangles an environmental object with the relationships people may have with this object. House and dwelling were used to indicate the physical structure, while the home used to refer to the relationships with the structure and the meanings we attach to it;
- From the spatial dimension home replaces country, city, or town as home-land, hometown...;
- From a temporal perspective it represents the current dwelling;
- It refers to social relations that home is often considered from the perspective of the family or the household; and the fifth looks at the product & use aspect (Coolen & Meesters, 2012).

A dwelling is defined as the system of settings, being a subsystem of the environment that affords certain systems of functions that make the inhabitants the primary anchor in the environment.<sup>15</sup> These systems of functions contain every household activity and include socio-psychological functions.

**Housing Transformation** - Transformation is to mean a complete change in somebody or something (Wehmeier & Ashby, 2000). But according to the Longman Dictionary of Contemporary English (2007), transformation simply means a complete or partial change, usually into something with an improved or disfigured appearance or usefulness. In the context of housing, Tipple (1991), defined the transformation of a dwelling as the alteration or extension involving construction activity using local assets. He clarifies further by stating that some look at it as a change in the appearance or character of building envelope components or others see housing transformations to include activities ranging from changing from internal furniture and painting to the addition of more rooms or even demolition of some housing units (ibid).

Putting these definitions into context, housing transformations can be said to be the changing of the original form and spatial configurations of a dwelling unit by the occupants to meet current needs and expectations. In this study, housing transformation is taken as any type of change in the dwelling units and the compound (parcel) that is done by the occupants or the kebele that

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<sup>15</sup> Rapoport, A. (1990). *Systems of activities and systems of settings*. In S. Kent (Ed.), *Domestic architecture and the use of space* (pp. 9–20). Cambridge: Cambridge University Press.

has implications on or impact on the density and function of the unit. Most observers of housing in developing countries will have noticed the phenomenon of self-help extensions to government-built housing. The (mostly small) single-household dwellings provided to the fortunate few, supposedly low income, households are being extensively altered and extended (Tipple, 1999). In Ethiopia, the transformation of Kebele housing has been sufficiently studied through time.

### **2.8.2 Why and How Houses Transform**

Before going into its transformation we have to ask how the existing dwelling form come into existence in the first place. It was stated that ‘there have been some attempts to take a deeper and more theoretical look at the forces that create house form, but most have been implicit rather than explicit. The house is an institution, not just a structure, created for a complex set of purposes. As building a house is a cultural phenomenon, its form and organization are greatly influenced by the cultural context. A house is a human fact, and even with the most severe physical constraints and limited technology man has built-in ways so diverse that they can be attributed only to choice, which involves cultural values’ (Rapoport, 1968). He mentioned that the following are some of the more important aspects which affect built form: Some basic needs, Family, Position of women, Privacy, and Social intercourse.

Today we are building cities at once but Christopher Alexander describes for a better pattern we have to allow some transformation in that he shows the importance of the concept. ‘These patterns can never be “designed” or “built” in one fell swoop – but patient piecemeal growth, designed in such a way that every individual action is always helping to create or generate these larger global patterns, will, slowly and surely, over the years, make a community that has these global patterns in it’ (Alexander C. , 1977, p. 3).

Research that tries to understand the capacity of mass-customization of dwellings of mass-housing blocks in the Netherlands states that it can be transformed to address the needs of new users and changing society. Transformation architects, understanding the building and the social context can lead to a process of subtraction (of outdated elements of the design) and the addition of new qualities. Housing transformation is therefore a process of addition of new, missing, and desired qualities to the housing complex.<sup>16</sup> So the reasons will be to subtract unwanted features and add the desired new qualities. Overall, according to Tipple (1991), the objectives for the transformation of housing can be classified as physical, social, cultural, and environmental.

People express their identities differently. People may express themselves by the objects they belong to and the physical environment they own. Location, exterior, and interior have

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<sup>16</sup> Ksiazek, J. (2017/2018). *Re-structured. A position on the transformation of structuralism-influenced, mass housing blocks. Explore Lab studio 24*

something to say about the social group one belongs to and provide information about one's lifestyle and personal character.

To see some cases for example a study in Ghana showed that housing transformation in public estates was a strategy to address shortfalls associated with the physical design, structure, and construction paucities, especially in living space, lifestyle, and size, and for addressing livelihood challenges through home-based enterprises. Avogoa et al., (2017) state that household needs and household assets (Human, Physical, social, and financial capital) were the significant factors affecting transformations. Next housing transformation is triggered by the quest to satisfy the housing needs of individual households which are determined by crowding.

And another study in Nigeria states those who have transformed their houses did so for economic reasons (through rent and adding shops); needed to provide more and better spaces and provide more rooms; and also make spaces available for religious rituals. Aduwo et al. (2013), citing Tipple (2000a), notes that housing transformations in developing countries are often illegal and involve modifications and extensions of the external and internal parts of dwelling units or both. They asserted that most transformations in these countries are done by small-scale contractors and single artisans using locally available materials and labor, and are so extensive to the extent that the original dwelling units could hardly be recognized.<sup>17</sup>

Results of housing transformations can be adverse there can be positive results at the household level and a negative impact on the whole environment. However, some link transformation to varied results for example Tipple explains uses of transformation as quite low-income people can extend, increase housing space, accommodate more people without extending the city (hold more people and households in one house), increase variety in housing size, form, cost, use, and tenure type. High-quality construction can be expected and on housing supply grounds, governments have much to gain from encouraging it (Tipple, 1999).

### **2.8.3 Housing Typology and Regulations towards Transformation**

Many have seen a transformation as a positive force especially if it is under the guidance of some regulations; also scholars like Christopher Alexander state that a transformation is highly needed and a city can't appear overnight. So can we consider transformation in planning and design? In a comparative evaluation of his case studies, Turner chooses the factory worker's progressive development house from the car painter's squatter shack (The supportive shack), the mason's project house (The oppressive house), and the government employee's project housing economy. He states that 'The factory worker's progressive development house is a positively

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<sup>17</sup> According to Aduwo et al. (2013), 26% did so for economic reasons, about 63% of them needed to provide more and better spaces to accommodate their growing families, while 11% needed to provide more rooms to accommodate their families and also make spaces available for worshipping and other religious rituals.

balanced housing economy' (Turner, 1977, pp. 84-85). Like Turner, many have considered transformation from an economic perspective however it influences density and dwellers' comfort. From a design perspective, it is stated as 'a housing estate is not like a jumbo jet: its designer is not drawing a blueprint for a manufactured object that, to function, must stay constant. Unlike a jumbo jet, a housing estate will not look the same twenty years after it was built' (Tipple et al., 2004).

Now housing typologies with the ability to enable dwellers for future transformation are being supported. The Incremental building is one such type that enables the owner to improve and 'complete' gradually over time. However, according to Wainer et al., (2016), they need a well-planned and carefully executed follow-up of the project for mid and long-term success. The project of Quinta Monroy, in Iquique, Chile is the best example that is designed in 2002 planning to build 100 units of low-income housing.

Wainer et al., 2016 quoting Paul Collier like Christopher Alexander state that there is no universal "appropriate density". It depends on the overall economy of the city, the period in a city and the neighborhood's evolution, and the very close local context and conditions for the neighborhood. So the role of the state is to create sustainable neighborhoods and facilitate the densification processes. The state cannot create density in an area people do not strongly desire to live (ibid). Supporting this also Tipple et al., (2004) state that a planner needs to regard the residential area as a constantly changing place, where special uses are likely to increase through time. Thus, the design needs to be understood as the beginning of a long process of growth and modification.

**Rule and Regulations towards the Housing Transformation** – According to UN-Habitat housing transformation processes for different reasons need building regulations and standards because they play important role in determining the success or failure of the process. Several researchers have confirmed that institutions, regulations, standards, and structural processes either promote or inhibit how transformations are done to determine the outcome of transformation processes. Therefore regulations serve as a mediator that determines how transformations are done using the available assets of households. It would seem that most low-income earners, without subsidy and given a choice on how to spend their limited budgets, would choose the cheapest housing that meets their basic requirements for shelter, security, and access to income and cultural opportunities. Such a choice would likely favor informal housing that does not meet the high building standards developed for more affluent households. The housing stock of cities in less developed parts of the world reflects this profile (UN-Habitat, 2003, p. 115).

<b>Summary of the Literature Review</b>	
<b>Authors</b>	<b>Author's thoughts</b>
(Burchell, et al., 1997; Duany et al., 2000; Ewing, 2008; Galster et al., 2001)	Low density, mono-functional, automobile-dependent horizontal expansion of the urban environment brings a negative impact on the social, economic, and environmental aspects
Neuman, 2005	Sustainability draws from at least five intellectual traditions that are: capacity, fitness, resilience, diversity, and balance
(Frey, 2005; Edwards, 2005)	Sustainability criteria for the city and city region included some form of containment, a reasonably high population density, a mixed-use environment and also Sustainable housing neighborhoods criteria included High density and mixed-use
(UN-Habitat, 2011; Burgess, 2004)	'compact city' model is identified as being the most sustainable or it is one form of achieving sustainable urban development
(Burgess, 2004; UN-Habitat, 2011; OECD, 2012, Jenks et al., 2005)	In explaining the characters or listing the principle of compact city have mentioned about higher density and mix of function or mixed land use
(Gehl, 2010; Dieleman & Wegener, 2004)	TODs are typically built around light-rail systems surrounded by relatively high-density development and mixed land use locations around public transport modes are often referred to as Transit Oriented Developments (TOD)
(Jacobs, 1961)	Proper city-dwelling densities are a matter of performance. They cannot be based on abstractions about the quantities of land and people in an imaginary place
Dovey & Pafka, 2014; Patel, 2011; Pont & Haupt, 2009; Vujic, 2014; Forsyth, 2003	Conducted studies on density measures and ways of description by connecting each value or with different parameters like form, intensity, connection, and use
(Heng & Malone-Lee, 2010; Llewelyn-Davis, 2000; Newman and Kenworthy, 1989; Jacobs, 1961)	Stated some benefits of density as it helps to achieve better utilization of the Earth's resources, supports the service provided, creates low level of carbon emission, environmentally sound and increase social relation
(Grant, 2002)	Mixed-use development as three or more significant revenue-producing uses that in well-planned projects are mutually supporting.
(Llewelyn-Davis, 2000; Cervero, 1996; Jacobs, 1962; Gehl, 2010)	highly linked or has a positive relation to non-motorized transport modes, creating a vibrant and economically viable community
(Mashhoodi and Pont, 2011;	Conducted studies that help to further study mix of function by connecting it to different aspects by using methods developed by Pont and Haupt (2010)
Tipple (1991),	Defined the transformation of a dwelling as the alteration or extension involving construction activity using local assets.

Table 2.3 Some main points from the theoretical literature review

## PART TWO - Contextual Review

### 2.9 Main Issues about Addis Ababa

Understanding contextual history is vital, especially from a form or morpho-typology perspective (Dendena, 2008). The urban history of the country is long, starting from the 1<sup>st</sup> c but in the long history of Ethiopia, the country lacks one standing capital city other than the Gonderian Period<sup>18</sup> expressed as “political nomadism” (Elias, 2008 citing Mesfin, 1976).

Dendena (2008) stated Addis Ababa started as a settlement made up of tents and huts and the

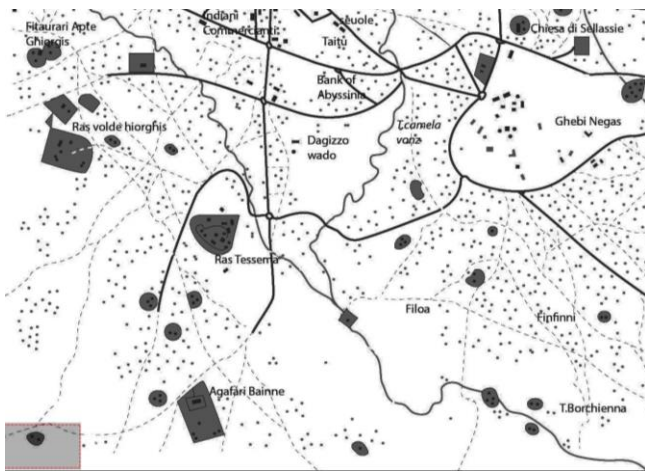


Figure 2.1 Map of Addis Ababa 1912, the highlighted rectangle shows the study area (Source by Anteneh T. Tola)

most influential factor that still affects the urban form of the city is the allocation of land that formed a cluster of residences known as ‘Sefer’ meaning a camp.

Elias (2018), describes the city as clusters of semi-organized urban processes having similar origins as overlapping ‘cities’ which, give rise to the urban assembly. The city has emerged as a “collage of cities” including the old city, the industrial city, the informal city, the market city, the condominium city, and so forth.

Previous development plans for Addis Ababa were not implemented due to the lack of financial and technical capacity (UN-Habitat, 2017). According to Yirgalem (2007), all the plans had little impact on the growth of Addis Ababa. Even unlike most African cities Elias et al. (2018), state that Addis Ababa has only the thinnest traces of a colonial legacy.

#### Recent Development Plans and Challenges

From recent plans we have to understand their attitude towards the inner city for example the 1986 master plan suggests the renewal of a substantial part of the inner-city settlements, as a result, discouraging their upgrading. The master plan could only be fully implemented if 75% of the city’s built-up areas were demolished and reconstructed (Elias, 2008 citing Dierig, 1999).

The Addis Ababa City Development Plan (2002-2012)<sup>19</sup> has also proposed the development of a strong CBD around La Gare and three important nodes (Arada, Merkato, and Arat Killo) linked through strong business corridors. The core comprises diverse urban functions within a 1km

<sup>18</sup> Gonderian period – holds several royal castles - 1635-1855

<sup>19</sup> ‘The revised plan of 2003’ is sometimes referred as ‘The Addis Ababa City Development Plan of (2002-2012)’ and ‘The revised plan of 2002’ in different government documents

radius of La Gare (AACPPO, 2017, p. 50). And the recent plan adapts the five guiding principles that are stated as Compact and green development, Mix, Balanced growth, Efficient use of land, and Environmental sustainability (ibid:111).

### **The Challenges**

Addis Ababa has a high level of primacy – According to UN-Habitat (2017), around one-fifth (1/5<sup>th</sup>) of the urban population and one-third (1/3<sup>rd</sup>) of the share in GDP from the total urban centers is in Addis Ababa. Also, CSA (2014), shows that the city encompasses half the population of twenty-seven (27) largest urban centers in the country. Addis Ababa's population size is also eleven times more than that of the second-largest city (AACPPO, 2017, p. 4). This shows that we need to think seriously regarding population distribution starting from the national scale.

There is also the implication to that demographic feature, as the city faces a rapid population increase has become one of the reasons for increasing housing demand. The structure plan puts 'the total number of housing units that have to be built during the next ten years within Addis Ababa is estimated to be 1,172,195' (ibid:110) which was a hundred thousand just before decades.

UN-Habitat (2003), and UN-Habitat (2009), have mentioned different challenges that contribute to the failure of municipalities. In our context studies have mentioned problems with housing development and/or urban redevelopment as not considering existing context, economic feasibility for the municipality, underestimation of the social capital and disregard for societies tie to their neighborhood, confusion in the economic capacity of dwellers, and prioritization in space provision, affordability of the units, increasing demand, etc (Elias et al., 2018; Meseret & Sebawit, 2016; Yonas & Imam, 2018; Rebecca, 2018; Angel et al., 2021; AACPPO, 2017).

Land Supply Problem as the structure plan states that 'Given Addis Ababa's context, densification on the existing built-up area is the available option to accommodate future urban growth' (AACPPO, 2017). It also states that the land designated for residential area expansion will soon become exhausted in Addis Ababa. Larsen et al., 2019 citing Keller & Mukudi-Omwami, 2017 state that the result of previous projects based on the preference of the community shows that around seventy percent (70%) of these condominium owners rent it and live elsewhere. The area considered a slum (inner city) has higher density and also showed an increase in residential density indicating our misconception about the area (ibid). They also found that the overall density of the city decreased while the share of the area occupied by residential use increased.

The result of successive failures of the development plan has created a challenging situation as Addis Ababa, is putting much pressure on the natural resources of the hinterland, including groundwater and river pollution. There is also a horizontal expansion that brought the extinction of the city boundaries, a challenge in administration and management, a problem in

transportation, environmental deterioration, and development plans often bring controversy and conflict<sup>20</sup>. Mumford's (1938), the statement becomes a reality for Addis Ababa as we are facing the accumulated physical and social results of urban form and environment, lasting more than a century.

Politically influence is another challenge Meseret and Sebawit assess the recent two major projects of the Addis Ababa LRT and Integrated Housing Development Program (IHDP). For example, in the AA-LRT project, despite the recommendation of BRT by two consultancies and against the wish of AACA what happened was the reverse. They clearly show the influence of the political arena on the project by stating 'Once LRT was introduced as his "Ethiopia' renaissance" showcase, all cabinet members backed the idea without any confrontations' (Meseret & Sebawit, 2016). Based on a critical study and a report by the EiABC, 2015 identified major wastages and permanent costs totaling 834.6 million or nearly 42 million USD (ibid).

## **2.10 The Morphology of Addis Ababa and the Inner City**

According to Dendena (2008), the first settlements known as Sefer were formed, articulating the major figures or the established churches, surrounding them. 10 churches between 1884 and 1903 were established along with these sefers (Dendena, 2008 citing Hailegebriel, 1987). The basic concept of the settlement pattern is to reflect hierarchical positions in land occupation with the higher locations reserved for the most important structure. The earliest known display of government interest in influencing the spatial organization of urban life was in a 1907 proclamation where private ownership of urban land became legal in Addis<sup>21</sup>. The analysis also states that the settlements had significant distance between them to protect against conflict but the establishment of the municipality in 1909 started to join the cluster of the settlements and connect others through infrastructure. Then the major change in the formation of the neighborhoods was that the developments started to be based on or follow infrastructure lines rather than sefer cluster system. And as mentioned previously up to 1910 Addis Ababa housed around 65,000 people. The famine and the returning military must have increased the number of settlers at the time which had a camp or temporary type of form dominated by huts.

The Italian mark in the city during their stay included the formation of big districts with a grid street pattern in Mercato and Addis ketema areas. The major housing development was during the Italian occupation which created a native city by relocating 30,000 city dwellers to Mercato

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<sup>20</sup> *The plan intended to expand the existing 56,000 hectares to 1.1 million hectares and sparked public protest in 2014 and 2016. Taken from article by Minority Rights Group; Ethiopia's 'Master Plan' – good for development, damaging for minorities and another report called Country Policy and Guidance Note Ethiopia: Oromo's including the 'Oromo Protests' Nov. 2017 from <https://www.refworld.org/pdfid/5a1d65e14.pdf>*

<sup>21</sup> (UN-HABITAT, *Situation analysis of informal settlements in Addis Ababa*, 2007, p. 7)

and Addis Ketema. While the natives moved to other areas the Italians established settlements for themselves in Arada, Casanchis, and Casapopolare (Dendena, 2008; Yonas & Imam, 2018).

After the Italian occupation, the role of trade routes became more prominent in the city's spatial growth. There was an informal development of residential units in the periphery of the city that brought horizontal expansion and one of the reasons for the invitation of the British was to halt this process (Elias Y. , 2008; Dendena, 2008).

After Italians, the city's condition based on a survey from 1961 revealed that in an area of 212 square kilometers, 58 percent of the total land was owned by 1,768 persons, each owning more than 10,000 square meters. Twelve percent of the land belonged to the church. Some areas are still named after the owners of that time (Elias Y., 2007 citing Pankhurst 1962).

Other than internal expansions or infill developments the British had planned satellite settlements around the city in Repi, Gefersa, Qality, and Kotebe along with the major outlets to Jimma, Ambo, Mojo, and Dessie respectively (four regional highways). During 1956-1966 the British had a park system plan with green belts and satellite towns but their organic form was hard to integrate and implement and Sir Patrick Abercrombie's plan didn't get an endorsement. This path without a development plan also further fueled the informal housing expansion. In 1965 L. De Marien's plan brought a lot of single-story low-cost construction housing to the city as it focused on implementation rather than spatial planning like the British (Dendena, 2008).

Housing provision in pre-1975 was predominantly handled by the private sector and the housing market during this period operated somehow on a free market principle as landlords were leasing urban land and constructing residential houses to tenants, and there was no restriction as regards the selling and buying of houses (Esayas, 2004). The only project focused on low-income housing provision that is worth mentioning is the Kolfe Housing Project which involved the delivery of 911 low-income houses (UN-Habitat, 2017 Citing Palen, 1974). So the owners of urban land build low-quality rental houses or rooms in their compounds, usually as additions to their own homes. Esayas (2004), states this laissez-faire condition was one of the factors blamed for the unplanned development of most of the urban centers in Ethiopia particularly in Addis Ababa.

Under the popular phrase 'land to the tiller' all rural and urban land was nationalized in 1974. The 'famous' Proclamation No.47<sup>22</sup> "Government Ownership of Urban Land and Extra Houses" was issued in 1975. This proclamation nationalized rental houses in the city and minimized their rent value by half. Then miss management, lack of finance, and insufficient supply brought

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<sup>22</sup> Proclamation No. 47/1975- commonly stated as Government Ownership of Urban Lands and Extra Houses Proclamation stating - all urban lands shall be the property of the Government, private ownership of land is prohibited and no compensation for urban land. The proclamation also prohibits the transfer of urban land and limits the size of holding land up to 500 square meters that can be transferred to wife or husband or children.

deterioration and further densification in the inner city. As stated, “Therefore, despite its original intentions, the nationalization of additional dwelling units used as rentals has contributed to the stagnation, dilapidation, overcrowding, and unhealthy living conditions” (Yonas & Imam, 2018).

During that time C.K Polonyi's plan proposed the development of a residential layout for self-help housing projects (Dendena, 2008). According to Esayas (2004), production, other than the construction of new rental dwelling houses, which are administered by the Agency for the Administration of Rental Houses (AARH) self-help and assisted self-help housing as well as housing cooperatives flourished to assist the low -income group. So the development of low-rise residential housing continued in the city.

The 1986 plan was used to develop large residential development sites such as Gerji and Kotebe in the east, Lafto and Mekanissa in the south-west, and Keraneyo in the western parts of the city. The access road to the new housing areas including the extension of the east-west road axis to the CMC special housing and Meri area were built as the result of this plan (Dendena, 2008).

Based on UN-Habitat (2017), despite the presence of a high magnitude of slum dwellings in urban centers, efforts to reduce urban slums through upgrading have been limited during the 1990s. In Addis Ababa, one notable government slum upgrading program was led by the Environmental Development Office (EDO), established in 1994, but this does not directly address the housing units but rather focused on the urban infrastructure and services improvement.

After the fall of the Derg regime, the housing cooperative allotment continued for about two years and was later replaced by the real-estate-housing that is developing the housing units and transferring to individual owners. On the other hand, private developments permitted parallel growth. The revised plan of 2003, has proposed main housing development areas on the eastern and south-western sides of the city (Dendena, 2008). The Addis Ababa Development Plan of 2003 placed a diversified set of land and housing delivery instruments, not only condominiums and self-help housing, but also land readjustment, design of realistic pro-poor housing standards, and construction of affordable rental housing. However, this plan required wide-ranging regulatory, institutional, and financial adjustments to engage the private sector, which was not enacted.<sup>23</sup> Then the inner-city character is stated as “About 70% of the houses located in the inner city are government-owned. These houses, which are commonly known as qäbäle houses are generally single-story çqa (mud and wood) construction. They are occupied by the majority of low-income people” (Elias Y. , 2007).

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<sup>23</sup> Graham Tipple and Elias Yitbarek Alemayehu, *Stocktaking in the Housing Sector in Sub-Saharan Africa: Ethiopia (Affordable Housing Institute, 2014)*.

According to MUDHCo (2014), Urban renewal/upgrading on a wider scale as a major urban development policy instrument is a relatively recent phenomenon. During the start of the IHDP program, about 80% of the area is structurally classified as a slum (UN-Habitat, 2002; ORAAMP, 2002). With the launching of IHDP and the growing attention of the government to urban

development, the initiative has been extended to cover wider localities of Addis Ababa and other secondary cities in the country, especially during the last Decade (MUDHCo, 2014). The total number of households affected up to 2008 by these projects exceeds 25,000, out of which around 75% were previous tenants of Kebele housing (Yonas & Imam, 2018).

The first-ever urban development policy of Ethiopia, released in 2005, the introduction of key legislation like Proclamation No. 80/1993 that is the land lease law of 2002 (revised again in 2011), as well as regulation and directives, all established a clear legal framework. Also, the restructuring of the administrative units and the establishment of new agencies like LDURA in 2008 were underway. According to Yonas & Imam (2018), all of these were instrumental in setting the stage for large-scale urban renewal. In addition to the land lease law, other measures have contributed to the liberalization of the housing market. Subsidies on the sale of building materials have been removed and interest rates for housing construction have been set at market rates, etc. (MUDHCo, 2014 citing Regulation No. 3/1994).

The first projects (infill condominiums) exhausted the inner city open spaces and worsened the situation in the

inner city. Also according to Yonas and Imam (2018), it did not respond to a chronic housing shortage in the city so the projects moved to the intermediate zone of the city like (Gotera-81 Blocks and Gofa 178 Blocks) and the same scenario was repeated like the inner city. So as we can see in Figure 2.2 large projects were initiated in the periphery of the city. However, Larsen et al. (2019), state this created environmental stress (pollution and consumption of peripheral open land), administrative challenges, and also problems like sprawl and congestion. Showing this Fekadu (2014) has found that the rate of urban sprawl along the major outlets is double that found in other directions (see Figure 2.3). Therefore urban growth spilled across city boundaries

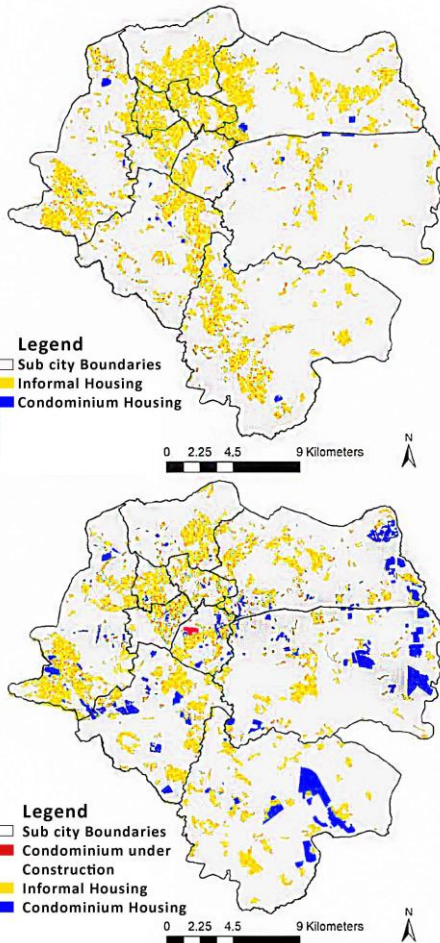


Figure 2.2 Addis Ababa Map Comparing the Informal and Condominium Housing Share between 2008 and 2019 (Adopted and Updated from Larsen et al., 2019)

and influenced the neighboring region. So the administration is turning its face to the inner city in an attempt to create a compact urban form.

Since 2004, 'The project has resulted in the completion of 175,000 units within the city with 132,000 more under construction (Larsen et al., 2019). This Integrated Housing Development Program (IHDP) is also mentioned for building nearly 400,000 units in 12 years (Matsumoto & Crook, 2021) and the recent administration has also continued to deliver previously promised units.

## **2.11 Issues of Sustainability and Sprawl in Addis Ababa**

### **2.11.1 The Concepts of Sustainability in Ethiopia**

After the 1992 Rio Conference Ethiopia prepared a National Conservation Strategy also known as the Conservation Strategy of Ethiopia (CSE). Since 1992 Ethiopia has introduced a series of medium to long-term plans and focused policies. A Climate Resilient Green Economy Strategy (CRGE)<sup>24</sup> was also developed in 2011 and launched at the 17<sup>th</sup> Conference of the Parties to the UNs Framework Convention on Climate Change in Durban, 2011. And finally, the Growth and Transformation Plan (GTP) II has been started for the period from 2015/16 to 2019/2020 embracing the sustainable development goals. After 2020 the recent plan is not fully revealed because of the political condition of the country. But a lot of green initiatives have been launched at a national scale and new restructuring of institutes up to the ministerial level has taken place appropriating the ground for the next plan. The GTP realizes that the environmental aspects are an important pillar of sustainable development, and states that “building a ‘Green Economy’ and ongoing implementation of environmental laws are among the key strategic directions to be pursued during the plan period” (MoFED, 2010)...<sup>25</sup>

Concerning conformity to international and regional agreements, the successive development plans recognized the need for sustainable development and worked to achieve it. The GTP being implemented from 2010/11 - 2014/15 recognized the prevalence of slum (30% of urban housing were in good or fair condition and the remaining 70% were in bad condition). Therefore adopting the millennium development goal 7, target 11<sup>26</sup> is planned to decrease the share of a slum in urban areas by 30 percent.

The second GTP is also built on Sectoral policies, strategies, and programs, lessons drawn from the implementation of GTP I and the post-2015 sustainable development goals (SDGs) (NPC,

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<sup>24</sup> Federal Green Economy Plan: The Climate-Resilient Green Economy (CRGE) initiative follows sectoral approach and has so far identified and prioritized more than 60 initiatives to achieve development goals, while limiting GHG emissions to 150 Mt CO<sub>2</sub>e

<sup>25</sup> In the National Report of Ethiopia, the UN Conference on Sustainable Development (Rio+20). FDRE, EPA, 2012 states the Green Economy Strategy has been completed for seven sectors that offer the highest greenhouse gas abatement potential, from this Buildings and Green Cities is one.

<sup>26</sup> MDG Goal 7, Target 11 – improving the quality of lives of slum dwellers

2016, p. 76). According to AACPPO (2017), the Structure Plan of Addis Ababa (2013-2023) applies the basic principles of urban planning as adopted by Article 5 of proclamation no. 574/2008. These include: Balancing public and private interests to ensure sustainable development.

Moreover, Ethiopia has also ratified international conventions, on environmental issues. Also, threshold densities that are proposed for developing nations by UN-Habitat are applied. The thresholds include net dwelling less than 15du/ha for low, 15-40du/ha for low to medium, 40-120du/ha medium, 120-500du/ha high, and greater than 500du/ha for very high density.<sup>27</sup>

First, from a housing perspective, the UN habitat (2012) points out that there is environmental, social & cultural, and economic sustainability to housing. The environmental aspect considers the life cycle & environmental Performance of the results of the buildings, the urban form, and the residential density, and others the social aspect looks for affordability, dignity, resilience, and adaptability of the housing and includes the spatial, inclusiveness and coping strategies. The economic aspect includes the affordability of the supply, balancing the market increasing the available choice, creating jobs recognizing local enterprises & mobilization of gaining & domestic finances.

The sustainability of that housing policy according to Matsumoto & Crook (2021), adapting from Housing policies for sustainable and inclusive cities, (2020) they applied the global mapping of national housing policy instruments affecting urban compactness and housing affordability to the context of Ethiopia. Finally, they found that, out of 16 global policy instruments, seven policy instruments are in place in Ethiopia.

### **2.11.2 Compact Form and Transit-Oriented Development**

One of the pillars for the GTP II recognizes the effect of sprawl and it proposed strategic planning that follows the development of higher density, mixed neighborhoods, high capacity public transport, and smarter more efficient buildings and utilities (NPC, 2016, p. 87). At the national level, Ethiopia has developed the National Urban Development Spatial Plan (NUDSP), mapping a vision to 2035 for urban development (not been officially approved). Also, Addis Ababa's tenth master plan accounts for a range of traditional zoning regulations regarding road width and building use height, floor area ratio, and setback distance. However, they suggest that these are not always strictly respected in practice (Matsumoto & Crook, 2021).

Above one can see that the ground for the development of a compact city is being laid. The next question should be how much land we have for developing a compact form. Vacant land<sup>28</sup> within

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<sup>27</sup> (<http://unhabitat.org/wpcontent/uploads/2014/06/Leveraging-Density-Urban-Patterns-for-a-Green-Economy.pdf>).

<sup>28</sup> While the street share is low In central Addis Ababa, for example, the proportion of land allocated to streets (LAS) is only 13.4 percent and undeveloped land often constitutes a high proportion of total city territory: about 46 percent in Addis Ababa - includes greenery/open space/protected areas, urban agriculture, forests, water bodies, and land labeled as having a "special function," which includes vacant land, military camps, and reservoirs (World Bank, 2015, p. 41 & 54)

the urban core, of Addis Ababa, is extensive and often remains undeveloped for years. Also as stated in the structure plan eventually accommodating more inhabitants, new jobs, and services are objectives of redevelopment. Density analyses done on selected areas in the capital indicate that it is possible to add additional inhabitants and open up some areas for basic facilities. The density analysis was done by taking the standards of the Structure Plan and other elements that determine the density threshold (AACPPO, 2017, p. 41).

According to Matsumoto & Crook (2021), the main reasons for the high proportion of vacant urban land are low government capacity for land management (efficient land leasing); unfeasible zoning regulations (in BHR); the relative absence of financial instruments such as taxes on property (split-rate property taxes or vacant urban land tax). Lack of adequate land-use control, coupled with inadequate government compensation for land expropriation and the absence of a development tax, has driven informal urban expansion into largely agricultural peri-urban areas, as with the case of Addis Ababa. Stating from Ministry of Urban Development and Housing (MUDH) estimates that the informal market prices for rural land converted to urban land may be 50 to 100 times greater than the level of compensation provided by local governments. This also forced farmers to subdivide and sell their land on the informal market, so this has incentivized urban sprawl and the expansion of informal settlements. However, Matsumoto & Crook, 2021 citing Franklin, 2019 stated that TOD has not yet been implemented in Addis Ababa and nearly all IHDP condominiums built between 2013 and 2018 are located more than 15 km away from the city Centre.

According to Matsumoto & Crook (2021), and AACPPO (2017), state the existing spatial growth pattern has many shortcomings. Like Fekadu (2014), they also state that although they are distinct municipalities administratively, the towns adjacent to the capital are expanding rapidly, especially along with Addis Ababa's five regional outlets. They state that there are several emerging challenges so for the more efficient functioning of socio-economic activities and a sustainable environment, and for a better arrangement to guide edge settlements, a broader and farsighted strategy is required. The national urban system, states the hierarchical functional organization for easier management and dissemination of uses. Then, the spatial development framework was outlined (*see below*).

But first, let's see the compactness measures like how the extent to which the overall geographic shape of urban extent approximates a circle. Compactness, in the sense used here, is the two-dimensional shape compactness of the urban extent in geographic space, to be distinguished from other measures of the compactness of cities that are associated with density or with its three-dimensional compactness (Angel, et al., 2016).

The proximity index is the ratio of the average beeline distance of all points in the equal area circle to the city hall and the average beeline distance of all points in the urban extent to the city

hall. The cohesion index is the ratio of the average beeline distance of all points to all other points in the equal area circle and the average beeline distance of all points to all other points in the urban extent. Its proximity index was 0.84 and its cohesion index was 0.82 that year.

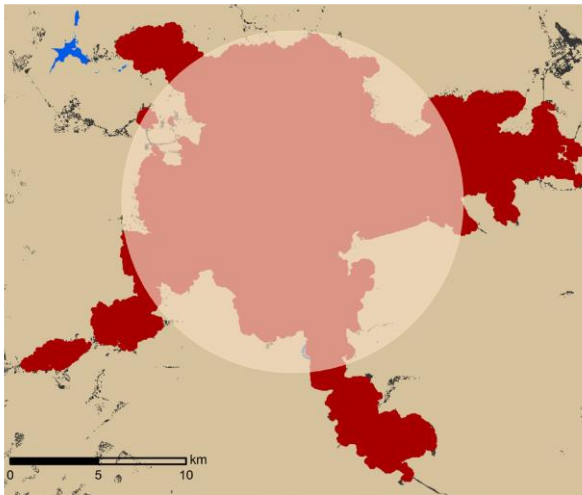


Figure 2.3 The urban extent of Addis Ababa, Ethiopia, in 2010 and its associated equal area circle (Source Angel et al., 2021)

### Future Spatial Growth and Urban Structure

The AACPPPO intends for introducing transit-oriented urban development (TOD) and the Development of nodes with reasonable distance (NODs). High density mixed residence land use is located along mass transport corridor lines with a depth of up to 80m or 120m. The land use of such area will have commercial activities and businesses on the ground floor of buildings, or the function at a human scale will be commerce to make the street-level activity lively. Any development within a designated high-density mixed residence should accommodate at least 50%

residence. Minimum gross density 150hu/ha.

**The Sustainability of IHDP** - The IHDP is taken as not affordable even the studios, which are the cheapest units, are unaffordable for the two lowest consumption quintiles in all Ethiopian cities (Matsumoto & Crook, 2021 citing World Bank, 2015 and Zhang et al., 2019). Also according to preference, it is stated that many IHDP households – up to an estimated 70% – lease their condominium units (often informally) (World Bank, 2015:32 citing Elias and Tipple, 2014). And according to Matsumoto & Crook (2021), the IHDP has also inadvertently incentivized the recipients to lease their units.

Financially the highly subsidized financial system brings a lot of challenges for the municipality. According to MUDHC reports by the end of 2012/13, a loan was provided to regions and cities to implement the IHDP. Out of this 56.5% repayment was made to CBE. And recently the average cost to the government for the delivery of IHDP units was is increasing. WB, 2015 states the IHDP program was stopped in smaller cities and towns in 2010, and due to rising construction costs (from Br 1,000/m<sup>2</sup> in 2005 to Br 12,094/m<sup>2</sup> in 2021) and high level of subsidy the city's ability to finance and sustain such a large-scale and subsidy-intensive program remains questionable.

The other mentioned points include the land cost in Addis Ababa is very high and showing high subsidy of the IHDP forgone revenues from land allocated at no cost or benchmark prices amounted to 206 billion ETB annually in Addis Ababa between 2013 and 2017 (approximately

seven times the city's annual budget), which is equivalent to the construction costs of approximately 300,000 IHDP units (ibid). But stress that the municipality has to find different revenue sources as it is highly dependent on the source like land leasing. The new land lease proc. certainly increased the government's capture of land value in the short term (land leasing remains much less sustainable in the long term than property taxation).

A study that used a methodology to quantitatively measure the existing TOD in terms of a TOD index around the stations by measuring the criteria that define TOD levels. The criteria include density (Population density and commercial density); land-use diversity; destination accessibility (land-use mixedness); distance to transit (pedestrian path and intersection density) and design were used. 'The TOD index is calculated for areas of 22 stations on the East-West LRT line of Addis Ababa. Depending on the value of the TOD index, certain stations are identified to have a potential TOD but poor transit accessibility' (Teklemariam & Shen, 2020). Our specific area (the study area) has a rank in 9<sup>th</sup> place highest value but most of the stations that have higher value are already developed or have a small segment in the developable areas for TOD.

### **2.11.3 Addis Ababa's Sprawl and Segregation of Function**

In Addis Ababa also economic stagnation during the feudal time, different plans allowing the construction of low-cost single-story housing, their lack of understanding of local context (plans were based on western planning tradition and principles), successive proposals of decentralization and zoning in master plans, failure in delivering sufficient housing, high population increase, and migration, and trend of following infrastructure lines are some of the stated reasons for the sprawl of city (Angel et al., 2016; Fekadu, 2014; Dendena, 2008; MWUD, 2007).

One factor for fueling urban sprawl is a population increase, in Ethiopia, the change in total population in millions looks like this: in 1960 -22.8, in 1975 - 32.1, in 1984 – 40, in 1994 – 53.4, in 2008 – 79.2, and 2021 it is 120. The number of cities and towns has more than doubled increasing more than 500 new urban settlements in the last sixty (60) years<sup>29</sup> (from 384 in 1960 to 1,156 in 2014. Most of the rapid urbanization count was in smaller towns from a total of 925 urban settlements 820 were below the population of 20,000. Urban population in millions shows in 1960 was 1.5, in 1975 - 3.2, in 1984 - 4. 5, in 1994 - 8.5, in 2008 - 13.2 and 2021 it is 20.<sup>30</sup>

The other main factor influencing the city was the railroad reaching the city in 1917 spreading the city to the south and creating settlements around the station. It is stated that horizontally,

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<sup>29</sup> CSA survey of 1960 and 1975; CSA Census of 1984, 1994 and 2007 and based on CSA projections

<sup>30</sup> Compiled from MWUD, 2007 MUDHCo, 2012) CSA survey of 1960 and 1975; CSA Census of 1984, 1994 and 2007

the city expanded to 1,863 hectares in the fifty years from 1886 to 1936' (Fekadu, 2014 citing ORAAMP, 1999 and 2001, CSA, 2007).

According to Dendena (2008), Le Corbusier's plan was based on strict zoning but it was not implemented. However, the 1938 Guidi and Valle master plan was responsible for new isolated settlements of the natives in the Mercato and Addis Ketema area. Also, both Sir Patrick Abercrombie's and Bolton Hennessy's and Partners' plans proposed satellite settlements but the second one was only implemented a little. Other than these satellite settlements that added to the process of sprawl most of the plan was hard to implement. The 1965 plan by Luis de Marien has also subdivided the city based on function. This plan contributed to the city's sprawl because it allowed the construction of low-cost single-story housing developments. The C.K. Polonyi plan in 1978 proposed the megalopolis plan of Addis Ababa connecting Addis Ababa to cities south up to Nazareth(Adama).

Above we have seen that successive plans for Addis Ababa had been proposed based on decentralization or zoning which could have impacted the sprawl of the city but most of them were not implemented to a significant extent. According to Dendena (2008), the 1986 master plan was delayed for more than eight years and due to the delay urban sprawl, fragmentation of services and public areas, and unplanned developments that affected the intended structure and urban form of the city were created.

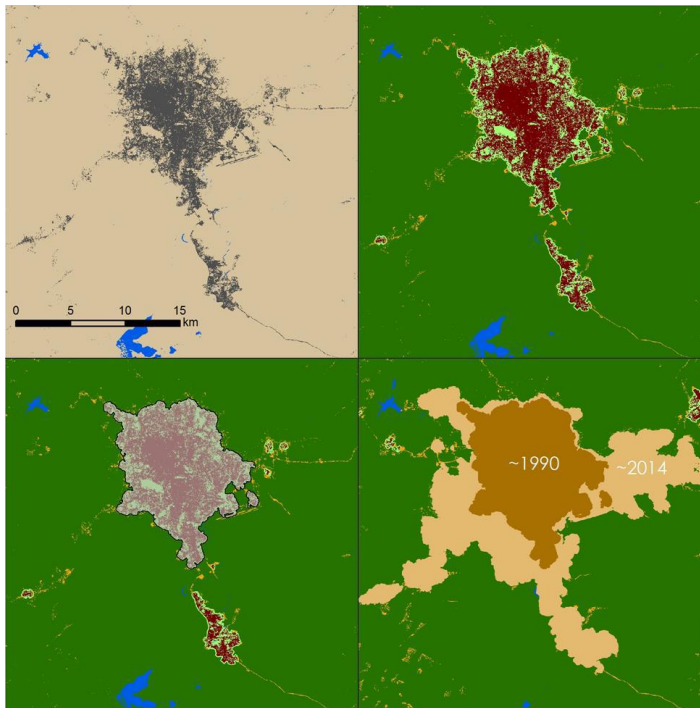


Figure 2.4 Addis Ababa Sprawl (Source Angel et al., 2016 Vol.1: Areas and Densities)

The open (light brown) and water pixels (blue), top left; the determination of its circa 1990 urban clusters showing the built-up area (dark red) and the urbanized open space (light green) within it, top right; identifying its "urban extent" circa 1990 using an inclusion rule, bottom left; and superimposing its urban extents for circa 1990 and circa 2014 on each other, bottom right.

Based on the 1965 master plan Dendena shows the city was just 21 thousand hectares but during the 1986 master plan, the city area increased to 51,000 hectares. Also According to Fekadu (2014), from

1984 to 1994, the built-up area was amplified by 4,788 hectares, thus increasing the cumulative total to 10,838 hectares. While the first data talks about the whole area of the city including open spaces the second figure is about the built-up area only. The trend that started during the 1920s after the arrival of the railroad to follow infrastructure lines has also continued still today. According to Fekadu 2014, the rate of both conurbation and urban sprawl along the major outlets is double that found in other directions.

Angel et al. (2016), studied 200 cities across the world, Addis Ababa has been included in the results for the city are as follows. Fragmentation measures the degree to which the built-up area saturates the city’s urban extent or, conversely, the extent to which the built-up area within it is fragmented by urbanized open space. Therefore it is expressed by openness index and saturation.

- Saturation is the ratio of the built-up area within the urban extent of the city and its urban extent. For Addis Ababa, the saturation increased from 0.65 in 1986 to 0.71 in 2010.
- The openness index is the average share of open space pixels within the Walking Distance Circle (a circle with an area of 1km<sup>2</sup> and a radius of 564 meters) of every built-up pixel within the urban extent. The openness index for Addis Ababa for the year 2010 was 0.24 and it decreased from 0.29 in 1986 (Angel, et al., 2016).

This means the city has population gain within its 1990 footprint accompanied by increased built-up area density within that footprint. And there is also expansion to the periphery of the city. But we have to note that it is a bit different for Addis Ababa because the increase in a built-up area is not for residential use rather it is for other urban land use. The increase is in population density of the inner-city as a result of overcrowding and consumption of land in an already existing residential area (see Table 2.4).

The increase in saturation and decrease in openness index shows infill development and utilization of urban open space in the city. There is an increase in urbanized open space from 4,018 ha in 1986 to 8,494 in 2010 showing urbanized open spaces in the periphery of the city not in the inner city (ibid).

Sprawl contributes to the decrease in the density of the city. Likewise, Addis Ababa's density decreased from 192 ppha in 1986 to 142.4 ppha in 2010 in built-up area density and in urban extent density from 125 ppha in 1986 to 101.6 ppha in 2010 (ibid).

No.	Year	(Estimated) Population	Area Coverage in Ha	Built-up Area in Ha
1	1889	15,000	--	--
2	1910	65,000	In 1920 3,300	--
3	1930s	80,000		--
4	1935	140,000	--	--
5	1960s	300,000 – 400,000	--	--
6	1961	455,490	--	--

7	1967	683,530	--	--
8	1979	1.27 million	--	In 1975 6,487
9	1984	1.42 million	In 1984 22,400	In 1884 11,989
10	1994	2.11 million	In 1990 53,000	In 1997 29000
11	2007	2.7 million	--	--
12	2010	3.3 million	56,000	In 2016 35,050
13	2027	4.4 million	56,000	

Table 2.4 Addis Ababa Estimated Population (In thousands, 1889-2016) (Source: UN-Habitat, 2017; Addis Ababa City Government, 2002; CSA, 2012; Mahiteme, 2007; Palen, 1974)

Angel et al. (2016), shows that the most of added area in Addis Ababa is in Extension. Between 1986 to 2000 and 2000 to 2010 the added area in extension is 2,012 ha and 5,520 ha which is 48% and 58% share of the total added area respectively. The area added in inner-city or as infill development at the same time is 1,077 ha and 2,996 ha which is 25% and 31% of the total share in the respective time. There is no leapfrog development in the city so with 0% share at the whole time. Inclusion is bigger for the first time from 1986 to 2000 with the addition of 1,091 ha which is 26% of the total share. And contributes a little in the next period from 2000 to 2010 with 903 ha added with 9% share (Angel, et al., 2016).

## 2.12 Density in Addis Ababa and Inner City

Trends show that the built-up areas of Addis Ababa are increasing at a speed of 4-5 km<sup>2</sup> per year (UN-Habitat, 2017). In another study it's stated as: spatially, Ethiopian cities are growing in a low-density pattern as compared to global standards supposed for developing countries and national contexts (housing as well as population density). For this, a range of different factors is considered. Housing typology, land delivery system for development purpose, and deficiency in enabling environment (water supply, sewerage system, road network) and the lack of the policy directions and density standards which indicate where.....what level of density and how it can be achieved, presence of significant proportion of vacant or underused land in core areas by government institutions as well as individuals are contributed for the existence of low-density developments (Abaynew & Wubalem, 2017).

Cities	Dire Dawa	Hawassa	Mekelle	Jimma	Dessie	Addis Ababa
Population density per Hectare	107	109	41	44	64	130
Housing density per Hectare	25	23	10	10	15	32

Table 2.5 Population and Housing Density per hectare of six cities in Ethiopia (Source Abaynew and Wubalem, 2017)

While the overall density (built area/people) of Addis Ababa, decreases from 109pph. to 98pph. The residential density values increased from 170pph. to 201 pph. However, it is interesting to note how residential density varies throughout the sub-cities and has increased in the central sub-cities (Larsen et al., 2019).

In 2006, the 'built' portion of Addis Ababa was 24,942 ha or 48% of the area within the city's municipal boundary (they included transitional bare land and mineral and gravel pits as 'built'

areas but excluded areas of agriculture and vegetation). By 2016, the ‘built’ portion of the city had expanded by 10,108 ha to 35,050 ha (67% of the area within the city’s boundaries). The annual rate of expansion during this decade was 1.9%. Based on the 2007 census and 2017 population projections, the population increased by an estimated 714,000 people. Between 2006 and 2016, every additional person increased the urban area by .014 ha (Larsen et al., 2019). Therefore residential density has increased, while overall population density decreases. They also found that between 2006 and 2016, the land occupied by residential housing increased from 33% to 39% and the proportion of informal housing decreased from 57% to 38%.

A study in “Ethiopia Urbanization Review” by World Bank asserts that land consumption surpasses the rapid population growth, and densities decline with serious implications for service delivery, as recognized by the government’s “Compact City” plans. In Addis Ababa, from 2007 to 2014, the average density of the built-up area is declining from 146 persons per hectare to 136 (World Bank Group, 2015).

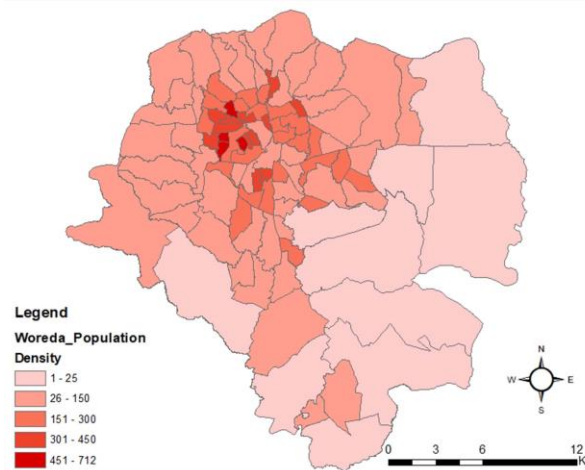


Figure 2.5 Map of Addis Ababa’s density profile using woreda population

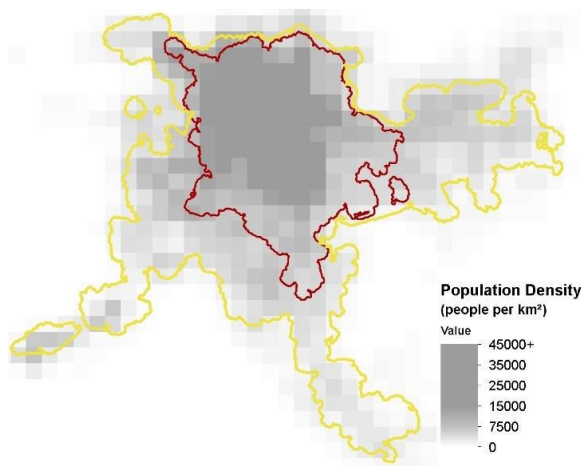


Figure 2.6 Superimposing a WorldPop population grid on a three-zone map of Addis Ababa, Ethiopia, in a 1 km grid (Source Angel et al., 2021)

As stated in the literature density can be expressed using density gradient and density profile. Here there is a density profile map for Addis Ababa using a 1 km grid (see Figure 2.6) and the administrative boundary of woreda subdivisions (see Figure 2.5). While the first one considers Administrative boundaries the second map uses the built-up area of the city.

### Density in Recent Development plan

According to the Norm and Standard of the 2003 plan, it pushes for social mixing and allocates land according to their income from 500m<sup>2</sup> to 75m<sup>2</sup>. average land area per House Hold (M.sq./HH) in the core area for pure residential use is 40-80m<sup>2</sup>, for housing units and supporting physical and social infrastructure services 80-100m<sup>2</sup>, and for housing units, supporting physical and social infrastructure and higher-level uses 100-120m<sup>2</sup>. It shall be noted that the area/hh standard for core areas is not plot area parse

but are the ground area share of pure residential use per household. Communal spaces and facilities are excluded.

The intended housing typology in the city core was G+0-G+5, row houses, duplexes, clusters, flats in rental, and condominium walk-up apartments. The proposed density for the core area was: Net household density of 125-380 HH/Ha, net population density levels of 650-2000 Inh./hect. The catchment radius and areas included under the category of the inner city were areas within a 5 Km radius: Merkato, Piazza, Teklehaimanot, Lagaar, Mexico, Kazainchis, etc.

	Mixed residence zones	Min. Gross density	Location
1	High density mixed residence	150 hh/ha	Centers, corridors, high-density mixed residence zones, and commercial areas
2	Medium-density mixed residence	100 hh/ha	Mixed residence inside the ring road
3	Low density mixed residence	50 hh/ha	Mixed residence outside the ring road

Table 2.6 Share of Density in different parts of the city (Source Structure plan of Addis Ababa; AACPPO, 2017)

The residential density of Addis Ababa or housing density is very low but the net population density in the built-up area of the city is 125 people/ha (AACPPO, 2017, p. 116). As a strategy for

Residential areas: one of the major challenges is how and where to provide housing for the current as well as future demand. And describes, that vertical densification is the only available option (ibid:42).

According to the city-wide plan “Within the mixed residence land use, density varies from the center to periphery depending on location with the transport system and width of the street. This variation in density is also reflected in building height and functions” (AACPPO, 2017). Here they studied and decided on the location of development but density can be determined based on different criteria like how much density will sustain bus and tram service (See Table 2.2). But looking at Addis Ababa BHR we can see that the most influencing factor seems to be the

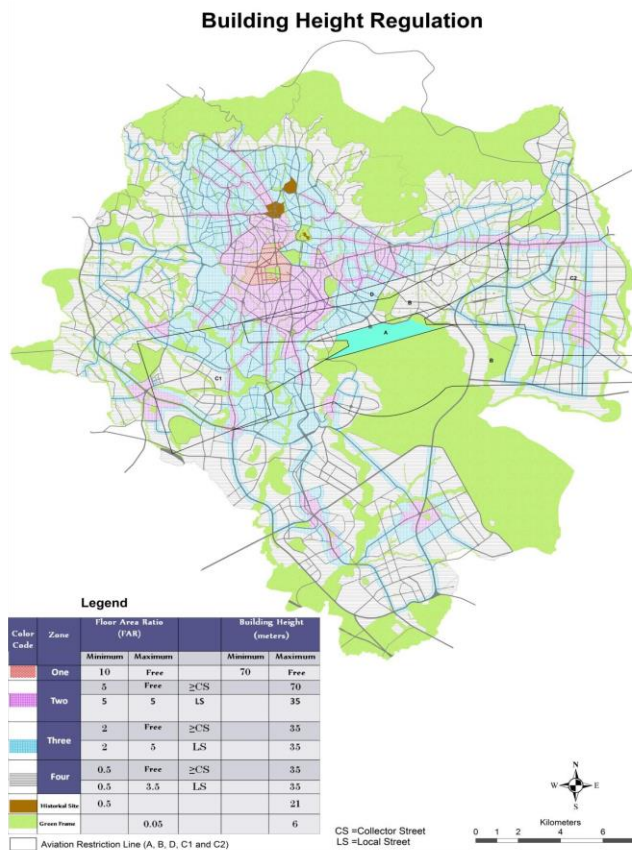


Figure 2.7 Building height regulation and aviation zones (Source from Addis Ababa Structure Plan; AACPPO, 2017)

locational value of the area and type of land use.

In many urban situations, medium-rise, high-density buildings (of about 3 – 4 stories) in general provide an optimum form that maximizes density whilst minimizing perceived intensity or overcrowding. Again they have benefits of reducing costs of land acquisition and site infrastructure; avoiding costs of lifts and other services; providing a robust form; forming terraces or low-rise flats, the most cost-effective building form in housing; increasing energy efficiency and the ability to be orientated for passive solar gain; etc. However, Addis Ababa's recent development shows an increase in building height from time to time which is a good example of the perception or association of density with building height.

### **2.13 Mix of Function in Addis Ababa and Inner City**

Other than the recent structure plan the previous master plans as we have seen in the above descriptions proposed a decentralization and zoning of functions for the city. Because of the low level of implementation, the city went through a high level of a mix of functions, especially in the inner city. Based on the development trend and history of the city we can say that it has a mix of functions, especially in the inner city and it is also stated in the structure plan of the city that the existing settlement pattern is a mixed vibrant environment, but with diminishing functional hierarchies. Also, Burges (2004), has stated that the inner cities of the developing country cities have a high level of mixed development.

A study that compared the type and distribution of land uses in Addis Ababa, between 2006 and 2016 shows the largest changes exist in the four central sub-cities (core area) of the city were the “gains in retail and business (353 ha), manufacturing and storage (147 ha), and bare land (20 ha) and losses in residential (405 ha) and community services (36 ha). In general, these changes are expected as retail and business operations push out residential housing and community services”. Besides this the study states that in the six surrounding sub-cities, “agricultural areas and vegetation land that is more than 10,000 ha were converted to residential housing (3,520 ha), manufacturing and storage (1,784 ha), mineral and gravel pits (1,575 ha) and retail and business (154 ha). While vegetation decreased, a botanical garden was established near the city’s northern boundary and this increased the recreation and conservation land by 773 ha” (Larsen et al., 2019).

The same study shows between 2006 and 2016 the residential land area of the city increased from 17,008 ha (33%) to 20,122 ha (39%). When this is categorically observed the amount of share in the central area dropped from 51% to 43% while in surrounding sub-cities increased from 31% to 38%. And looking at the residential housing types there is a decrease in the informal housing in the inner city and an **increase** in new residential the surrounding sub-cities. “In the central sub-cities, the greatest decreases were in informal housing (from 1,990 ha to 1,540 ha) and low-rise/mixed-use development (602 ha to 294 ha). In the surrounding sub-cities, the area

of new condominiums increased notably from 186 ha to 2,155 ha and the area of informal housing decreased from 7,647 ha to 6,181 ha” (ibid). However how “informal housing” is stated in the study is not clarified and they stated that the dramatic increase in single-family housing was an unexpected finding (ibid).

<b>Residential Housing Types</b>	<b>2006</b>	<b>2016</b>
Informal housing	57%	38%
low-rise/mixed development (< 4 floors)	37%	26%
Single-family homes	5%	25%
Condominium housing (4 floors or greater)	1%	11%

Table 2.7 change in residential housing types in Addis Ababa between 2006 and 2016 (Source Larsen et al., 2019)

### **A mix of Functions in Recent Development plan**

According to the 2002/3 plan of the city, land use mix standards for the core area were 35-45% Residential, 20-30% was intended to be mixed containing Residential, Religious, Administrative, and commerce, 10-20% for services, 0-5% for compatible manufacturing, 5-10% for recreation and green areas 80% of the area to be strictly used for soft landscaping, vegetation, and planting trees, 15-20% for roads (local access and collector streets). The Actual land use mix was intended to be based on the specific site conditions (ORAAMP, 2002). Comparing this to the intermediate and peripheral areas the residential share grows as we move out to the periphery reaching 50-65%.

Accordingly, the Addis Ababa City Development Plan (2002-2010) had set major land use principles that had to be strictly adhered to. These were the promotion of intensive uses of land and space; urban-rural harmony; decentralization of urban activities; promotion of mixed/compatible land use; integration of different components along activity spine/mass transport lines; and increased foresight and practicality of plan (AACPPO, 2017, p. 33). And states that these principles are adopted by the current Structure Plan and will henceforth serve as major land-use principles.

2002, plan the share of the proposed mixed residential land use, which is about 48% of the built-up area of Addis Ababa, is significantly large as compared to other land uses. The concept promotes working, living, and getting different services nearby (ibid:33). Showing the change in use states that there have been many conversions of residential use to commercial purposes in some neighborhoods, mostly along main axes and corridors (ibid:34).

The existing settlement pattern is a mixed vibrant environment, but with diminishing functional hierarchies. The need to generate additional income by any means is constantly redefining the organization of activities and neighborhoods. Moreover, this is also a period where most open spaces and green zones disappeared under concrete. The process of keeping the social mix of

dwellers in residential settlements ('mixing), which had also been an important aspect of the duality of Addis Ababa is disappearing especially in new settlements (AACPPO, 2017).

As a Structure plan<sup>31</sup> is a legally binding plan we must look at what it states about the density and land use (mix of use). A mixed residence is a concentration of inhabitants or housing units in a defined area, that includes but is not limited to a residence, commerce, lower level service, access, and local streets, community open space playground, neighborhood park, and local market. There are three densities and each has its mandatory residence share from the total floor area. High density mixed residence 50 %, Medium density mixed residence 60%, and Low density mixed residence 60%.<sup>32</sup> Also, the share of built and open space shows a Built-up area with 40%, a green area, an open space, a plaza, etc. to be 30%, and a Street network at 30%. And all mix of use will be included in the share of a built-up area which is 40%.

Land uses that are allowed in mixed residences but need strict supervision are Woodwork, Metalwork, Car maintenance garage, and Mill. Land uses that are allowed in mixed residence but restricted to a certain location include Night club/Bar, Chat selling kiosks/shops. Prohibited land uses in mixed residence are manufacturing and storage that require a plot area of more than 500m<sup>2</sup> inside the ring road and 2000 m<sup>2</sup> outside the ring road respectively, Treatment plant and landfill sites, Cemetery, Religious institutions, Stadium, and quarry.

The other thing is about the potential of cities to usher compact development in existing city space (available land). Stating a study on the Ethiopian urban expansion initiative indicated that out of total territory within the city administration, about 46 percent in Addis Ababa and Mekele, 25 percent in Bahir Dar, 77 percent in Dessie, and 32 percent in Hawassa are undeveloped lands. Based on his study in terms of employment density, spatial concentration varies among inner-city, intermediate, and peripheral zones. (Abaynew & Wubalem, 2017). They also show that the core area with concentration and intensity of mix of function has a high revenue source.

## 2.14 Transformation Studies in Addis Ababa

There are different housing transformation studies in Ethiopia for example a Master's thesis by Alemayehu Hailemariam examines secondary dwelling units (a local name called "*Service biet*") extension in *Woreda 2 Akaki-Kality* sub-city in Addis Ababa. He studied the transformation of those units and their contribution to housing needs. The study found families' space needs led to the extension of secondary dwelling units. These are rental income, home-based business, accommodation of matured and married children, accommodation of close relatives, and adding

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<sup>31</sup> Urban Plan Proclamation No. 574/ 2008 exists in the third level plan after National Urban Development Scheme, and Regional Urban Development Plan and categorized under Urban Plans

<sup>32</sup> Team, L. U. 2017. *Structure Plan Spatial Framework Implementation Guidelines and Standards (AAC Land use and City Structure Plan) 2016-2040. Addis Ababa.*

functional space for the primary house. The study also found that the extension of secondary dwelling units relatively produces rapid, convenient, affordable varieties of housing options. Besides, it is a means of income generation for livelihood improvements.

According to Essayas (2000), wide varieties of changes can be observed in residential housing including decoration, changing colors and materials, the addition of gardens, fencing, etc. Results of housing transformations can be adverse there can be positive results at the household level and negative impacts on the whole environment. Shiferaw (1998), identified some of the adverse consequences of uncontrolled transformation to include overstretching of the existing infrastructure, urban services, and land use, creating an obstruction to vehicular/pedestrian circulation and channels for services.

Another Masters's research by Elham Mohammed is conducted to understand the residential density, housing transformation, and the relation between the two in a small plot residential neighborhood commonly known as 'Mekelakya Sefer'. The study found that Housing unit density was decreased and conversely household density has increased in the site due to housing transformation. Research by **Filmon Gebrehitsan** measures the residential density of ADWA Park's informal settlement and studies the physical transformation of the settlement. The study found that the gross residential density and housing unit density of ADWA Park's informal settlement is higher than the existing density of Addis Ababa city; per person required area is also less compared to the city<sup>33</sup>.

Considering the context on a large scale, Elias Y. (2008), suggests seeing settlement upgrading interventions as settlement transformation processes, not as time-bound projects. The study tries to understand transformation processes that are set in motion through catalyst interventions and it looked at housing transformation on a larger scale. Three case studies showed a different trend like engaging in uncontrolled housing transformations. The lessons were that uncontrolled house-level alterations and extensions had immediate advantages, however, of disadvantages for the collective good and the quality of the overall settlement. And in places like "Menen" has the local organization restrained any form of uncontrolled transformation and this has resulted in relatively better housing quality, at least at the cluster and settlement levels.

Yonas (2003), also studied the dwellers-initiated housing transformation of kebele houses and put the reasons as follows: social and physical demands, cultural demands, physical condition, surrounding context, economic demand, and government policy were the reasons for creating the demands. Also, he concludes that they are the result of multiple factors and their process

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<sup>33</sup> Both are Masters researches done in EiABC that connected the issues of density to transformation of housing

creates an employment opportunity. The transformations also contribute to sustainable development by allowing the reuse of materials and control of urban sprawl. Again these transformations enabled residents to produce housing without any expense from the government so this has a potential that could be used as an alternative way of addressing the problem of affordable shelter for the low income.

## 2.15 “Kebele” Housing

### 2.15.1 Description of Kebele Houses

Ass Elias Y. (2007) states the *kebele* housing-dominated settlements are the result of unique urban history and political developments in Ethiopia. He explains that since SAP in the 80s, public housing has been privatized in many countries, but not in the case of Ethiopia. According to Matsumoto & Crook (2021), more than 80% of Ethiopia’s housing market is owner-occupied. In Addis Ababa the rental housing share increases or is bigger than in the other cities, in the city, the owner-occupied units reach around 247,511 units covering 29.80% of the total housing share and rental housing reaches 507,265 units with 61.06%. Kebele housing is especially prevalent in urban areas, where 345,428 kebele units are located in urban areas (95% of all kebele units). From this, 148,645 units exist in Addis Ababa (43% of all urban kebele units in the country) and account for nearly 40% of all rental housing in the city.

Addis Ababa’s housing share was compiled from the 2007 Population and Housing Census of Ethiopia:

- Total Housing Units – 628,986
- Total Owner-Occupied Units - 205,196 (32.62%) from total housing units
- Total Rent-Free Units - 37,293 (5.93%) of total housing units
- Total Rental Units – 386,497 (61.45%) of total housing units
- Rental from kebele - 148,645 (38.46%) of total rental units
- Rental from private households - 222,384 (57.54%) of total rental units
- Another Type of Rental from private HHs is 15,468 (Matsumoto & Crook, 2021).

According to Location, the dominant number of kebele housing units exist in the inner city, in 2011 there were 51,089 KHUs in the six outermost sub-cities of Addis Ababa and there were 97,895 KHUs in the four centrally located (inner city) sub-cities<sup>34</sup> which account for around 12 percent of the total city area. According to UN-HABITAT (2003), housing is considered a Slum if it lacks one or more of the following: durable housing, sufficient living space, easy access to safe water, access to adequate sanitation, and security of tenure. However, the case of Addis Ababa is unique for example the UN definition and categorization cannot explain the environmental

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<sup>34</sup> Data computed from Addis Ababa city housing development project office, 2011 report

condition of Addis Ababa. According to the origin, it is a historic city center slum but the deteriorated government rental house is not only the result of age or time but the result of government policy towards them. According to Locations and Boundaries Elias (2008), describes Addis Ababa as a sea of the slum with sprinkled islands of good neighborhoods. Therefore the description of the UN as a scattered slum island does not fit the Addis Ababa context. According to size and scale, he also states that it should have included a category indicating a situation where slums are the norm rather than the exception. According to legality & vulnerability, Addis Ababa slums are formal or a mix of the formal and informal that doesn't fit the UN description.

No	Year	No. of unit	% of total Housing supply	Function
1	Up to 1975	-	60 % – private rental	Residential and Commercial
2	After 1975	-	55.8 % kebele and 4.2 AARH	residential and Commercial
3	1984	140,250	54%	residential
4	1994	139,947	37.9%	residential
5	2000	142,095	37.92 %	residential
6	2003	136,330	25.8 %	residential
7	2007	148,645	24 %	residential
8	2010	173,000	-	85% residential
9	2017	150,000	-	Residential and Commercial

*Table 2.8 the Amount of kebele housing units in Addis Ababa at a different time compiled from multiple sources*

## **Chapter Three – Research Methodology**

### **3.1 Introduction**

This research looks for the answer by assessing multiple characteristics of the neighborhood (comprehensive way) and employs multiple types of measures that need a different method of collection and analysis. The whole neighborhood is the study area however according to each issue the scope of the study area changes. Based on the type of measure employed and the level of detail needed the scale of area and quantity of data are determined. The research also follows a mixed type of research in its approach to solving the questions raised in the research by using both qualitative and quantitative methods and both secondary and primary data were collected... In addition, the survey research is found to be fit for the study, and questionnaires and interviews were prepared accordingly.

The criteria to select a study area is to be inside the inner city and nearby the Light rail transit line that is dominated by government rental houses and can be designated as most likely to be redeveloped. The Sampling method used both probability and non-probability sampling. Then choosing stratified sampling each urban block was used as a unit of strata in the qualitative study. Again each CWKHUs were used as a unit of strata for qualitative study.

### **3.2 Methodology in Selecting the Thematic Scope and Study Area**

#### **3.2.1 Methodology in Selecting Thematic Scope**

Literature reveals the complexity of the concept of compact development. Each principle used to bring about a compact form are multi-dimensional and depends on the successful implementation of the other principles to bring about the desired characteristics. Also for the third question to suggest any possibilities for urban form one must study the building envelope (that is determined by the height, shape, or BAR), the land use (or the activity of dwellers in the area), and the Movement framework (street). These are the factors that are believed to carve out the urban form. However, due to time limits, the study selects at least two characters and the transformation of the housing units to find out their impact on the selected characters or principles.

The city, whether compact or not, is a holistic system and the relationships between the parts are complex, and the effects are not easy to predict. The need for more scientific and objective knowledge has led to measurement and monitoring at the local scale and the strategic level. But the ability to cope with very large and complex systems gives rise to a dilemma, as the larger the scale, the more indicative and uncertain the outcomes are likely to be. Many methodologies tend to separate issues into discrete and researchable parts to reduce that uncertainty. Well-founded knowledge about the parts is valid, but for many problems associated with urban development and the city, more sophistication is needed. For the compact city, it may be that the only certainty

is uncertainty itself (Jenks et al., 2005, p. 185). Considering the complexity of the housing sector, looking for isolated issues might increase the credibility. However the intertwined behavior of the characters creates a challenge to select (Isolate) one character, so it is in this manner that the two characters/principles were selected.

### 3.2.2 Selection of case study area

As Frey (2005), states there must be a reasonably accurate understanding of the microstructure of urban forms to compare city forms and structures. The choice of one neighborhood rather than a block is because of their organic development. And the unique form of each block makes it hard to get a defined identity by selecting just one block. The selection must consider the establishment of the area “sefer” as its impact exists up to date. The studies in density faces ‘Boundary problems’ so the selection of the area tries to avoid them.

- The Selected Area (study area) has to exist in one administrative boundary (helps to create easy conditions during the data collection and avoid boundary problems)
- The selected area must avoid boundary problems (helps to increase the clarity of measures)
- They should have an abundant number of kebele dwellings (Dominated by qebelle Houses) (helps to have enough study subjects – in our case 65% of the housing units are KHUs)
- To be in the inner city (Considering future development and the kebele houses)
- To be near the Light rail transit within a 400-500m radius of the LRT station (designated as an area for high-density future redevelopment)

According to C. Alexander, a neighborhood can have 100 to 1,000 people each and a community with 5, 000 to 10,000. Therefore the study area can be consider as a large neighborhood considering the population but according to the area it is nearly an area of half a circle with a radius of 500m.

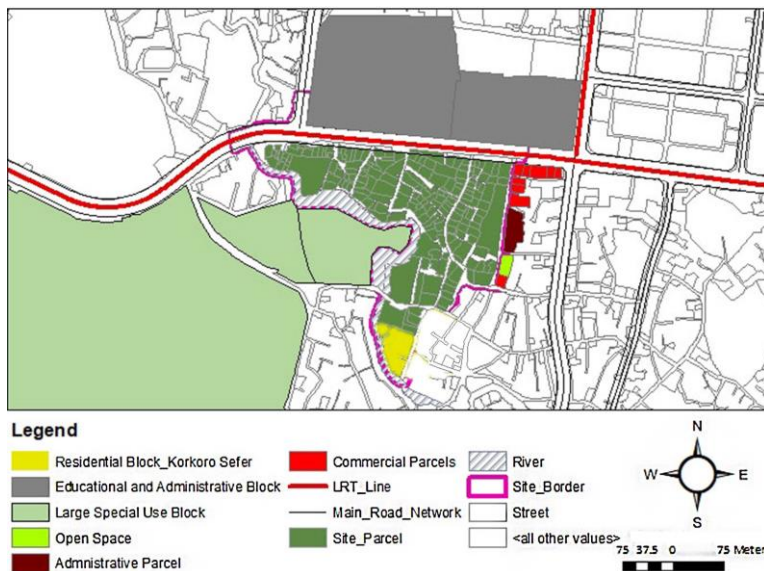


Figure 3.1 Study Area Selection

There are 22 stations only on the east-west LRT line so the reason for selecting the study area in or around coca cola station is based on the developability of the area. It has high land use diversity suited for TOD and low commercial density with potential for more residential development.

and low commercial density with potential for more residential development.

### 3.3 Research Design

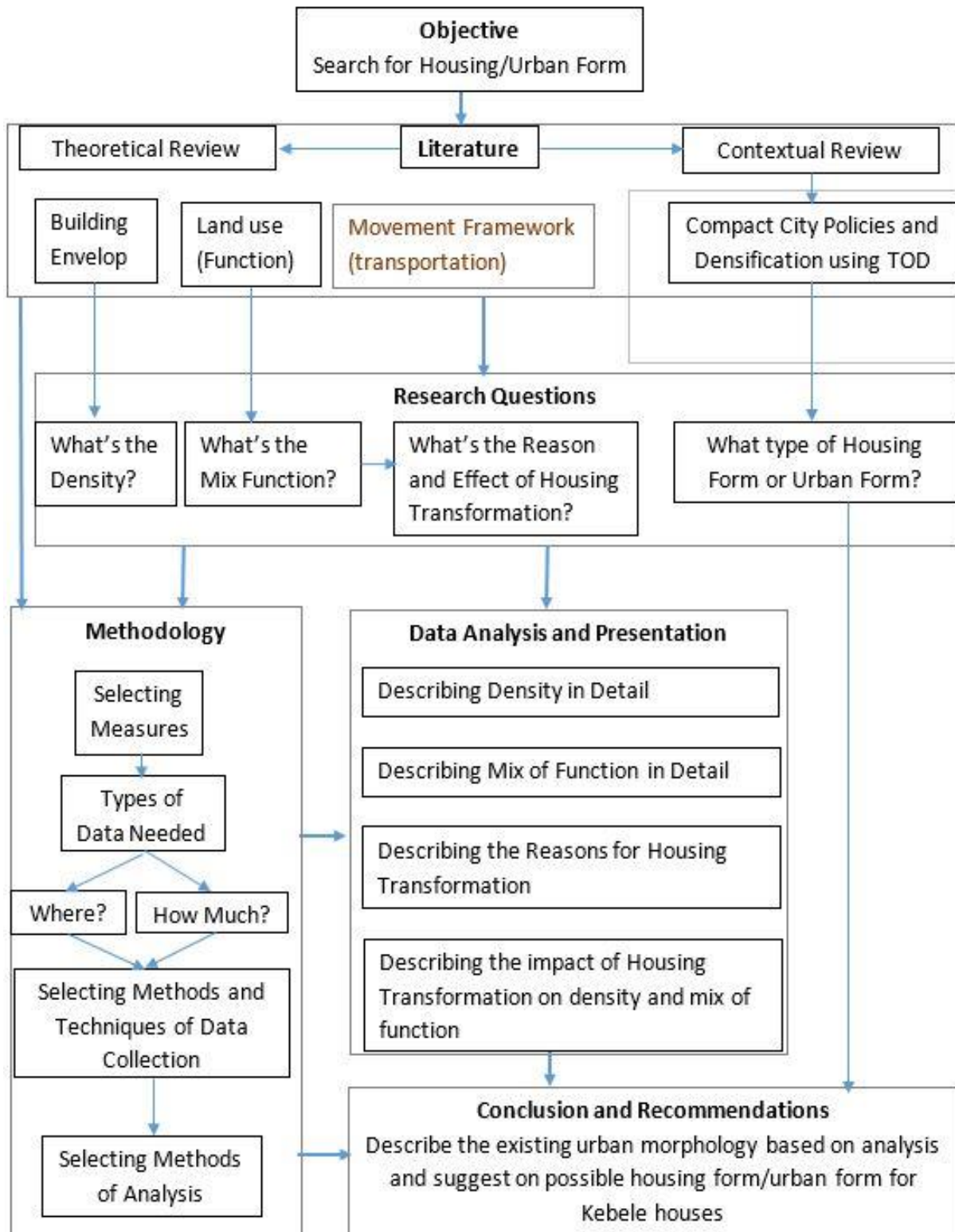


Figure 3.2 Research Design (Source own construction)

### 3.4 Choice of Method and Type of Data

The choice of method depends on the type of research questions asked and the type of data that provides me with a sufficient answer. The first question is: concise

1. *What are the density and functional mix of kebele houses in the study area?*

- *What is the density of the Kebele houses in the study area?*
- *What is the functional mix of the Kebele houses in the neighborhood?*

The first question is descriptive and tries to describe the density and mix of a function of the neighborhood. According to Kothari (2004), Surveys are conducted in the case of descriptive research studies. Further, to avoid misconceptions we have to look at them from a different perspective. Therefore both density and mix of function has to be studied at different scale and should be approached by a different measure. These different measures will also require different techniques and methods to measure, collect, organize and analyze. Then the second question is:

2. *What are the reasons and processes for the transformation of kebele houses and their impact on the density and functional mix of the study area?*

2.1 *How do dwellers transform the kebele Houses?*

2.2 *Why do dwellers transform the kebele Houses?*

2.3 *What is the impact of housing transformation on density and functional mix?*

This question asks a cause-and-effect question by exploring the transformation of housing units. There is an already established awareness that housing transformation has its effect on accommodating the increasing housing density and need for additional functions. The study of transformation intends to see the influence of transformation on the density and mix of functions. The third question is:

3. *What type of housing form, which includes proper density and functional mix, is appropriate for future redevelopment of inner-city neighborhoods that are dominated by Kebele houses?*

When the study reaches this question one will already see what the density and functional mix of the area looks like, and finally, this question will explore what they should be in the future. The analysis of the previous questions will be presented with housing form specifically and urban form in general to lay a foundation for this question. This third question is a normative question type that is exploratory so it's guided by a less formal method to look for root causes and background information, therefore to answer this question different analyses will be used.

**Choice of Measures** - in selecting the type of measure they should hit their target (answer the question) and should have the potential to be correlated to one another (for further analysis). The different measures will also help us to conduct a correlation analysis. The other thing is to avoid unnecessary types of measures for example measure of the built-up potential helps to

suggest some type of form in urban upgrading projects (but has less chance to occur in the study area). Also, the measure of the indoor density of the KHU will help us to see the crowding of the houses. But the results matched against desired standards cannot fully express the existing context. This quantitative measure should be related to other qualitative measures (like perceived density). Density itself is a perceived experience (Alexander et al., 1988 citing Rapoport, 1975) and should be complemented against personal and cultural norms. The same goes for a mix of functions that the data compiled from each measure should relate to urban form or housing form specifically.

Measures	Type of Data Needed	Method of Collection	Techniques used
Morphological density	Previous maps, built-up and floor area, building height, and compound area	On-site measurement	Updating the base map
Household density	Number of households in a compound and neighborhood	Survey Questionnaire and interview	Updating worda files
Population density	Number of people in a household, in a compound, and neighborhood	Survey Questionnaire and interview	Updating worda files
Perceptual density	People's perception and effect of density	Survey Questionnaire and Observation	Categorization of effect
Land use	List of every function	Site visit and inspection	Land use Inventory
Building use	List of every function	Site visit and inspection	Building use inventory
Compound activity	Activity in a compound shared space and buildings	Observation and in-depth interview	Activity Mapping
Household activity	Activity in residential buildings	Observation and in-depth interview	Time Diary
Housing Transformation	Area and number of rooms of the original and additional unit	Survey questions and onsite measurement	Using floor plan drawing

Table 3.1 Types of Measures and Data Needed with Methods and Techniques Used for Collection (Source own construction)

### 3.4 The Source of Data

- **In-depth interview** - life story & detailed conversation
  - **Interview with key informants and Officials:** Woreda officials – like Lideta sub-city woreda one housing development corporation officers, Land development office, construction permit and control officers, and record officers. These offices helped me to collect the recent rule and regulations for kebele houses (Government house Administration directive no. 5/2011), recent city administration construction bureau building directive 2/2010, and give me a clear image of the formal process for the transformation of kebele houses. The Record officer of the woreda helped me by showing me the official records of woreda 01 dwellers.
  - From sub-city, land use maps, Building height regulation maps, and ownership data from different offices like that of the Woreda were collected. What was unexpected during sub-

city data collection was that all the local development plans were canceled which could help me to see the future intention of the government toward that specific study area.

- **FGD that includes Community leaders & community association leaders** - community leaders and idir leaders in woreda 1 were interviewed; sub-neighborhood “Ketena Committee” and woreda Cabinets W/ro Etetu G/Mariam and Meto-Aleka (Sergeant) Birhanu Diribsa were also included in the focus group discussions.
- **Observation** – observations were made using first-hand on-site observation, site reconnaissance, and also during the survey questionnaire. The observation method employed for different measures like time diary, land use inventory, and building use inventory should be systematic, easy to organize, quantify, and present.
- **Document analysis:** - structural plan manuals, design manuals, program manuals, and administrative (legal base) manuals were studied and analyzed.
- **Measurement** - while studying the housing units & change in the compound we have measure the compounds, buildings & indoor spaces that were used for further analysis.
- **Photographs and Mapping** - there is a saying called “an image tells a story more than a thousand words”. Therefore to show the existing exact situation of the livelihood & type of activity in the area photographs are used. Aerial Orthographic Photos of the years 1984, 2013, and 2019 were collected from sub-city and other offices. The change in density is studied from 1972 to 2020 and the 1972 Sofratop map was taken from the school (EiABC) library archives that show measurable accurate and detailed information about the site before 1975.
- **Questionnaire Survey** The questionnaire has 7 parts that include: Family Profile; Acquisition and building history; Building study and its transformation; Transformation study inside the compound; Mix of Function and Compatibility study in the Neighborhood; Social and Cultural aspect of density and mix of function and Time diary and Life story for 6 households

### **The questionnaire design**

The issues of housing and built environment can't be fully explained by mathematical or statistical data they hold a social and cultural aspect that cannot be explained by quantitative method. So the research follows a mixed type of research in its approach to solving the questions using both qualitative and quantitative methods. The lesson learned from the first two pilot surveys and qualitative interviews helped to eliminate hard questions and design the questions that will lead us to find a clear answer and see the targeted issues in a quantitative questionnaire.

How clear was the questionnaire? The questionnaires were designed to obtain data effectively in a clear manner. So the type of questions that have limitations and that will lead to the ambiguous conclusion were avoided. For example, how do you perceive the density of the neighborhood? With choices of crowded, high, medium and low will have so many limitations. First, the estimation of each respondent and their definition of the neighborhood will vary and the choices will create a conclusion that does not have a justification. Therefore the perceived

density will be assessed by indicators that help us to see the level of comfort, privacy, and territorialism in a way that will help us to see the perception of the residents. Further, the questions were not only made to obtain data easily but also a way of an organization (coding) and analysis was thought first.

### **3.4 Sampling Design**

#### **3.4.1 Sampling Design for Qualitative Study**

The sampling method depends on the level (scale) of measurement and the level of detail. Also, the main focus of this study lies with the kebele housing units. The study will be conducted on the neighborhood scale but as the focus zooms to the compound and the housing unit the level of detail is going to increase so the amount will be limited. The questionnaire is also designed in this manner to assess each topic at a different level (Spatial unit). While selecting study subjects they should have a variety for example, in selecting compounds they should vary based on their size, location, and tenure mix.

By drawing a grid line that is equally apart and deciding to collect data from the compound under the gridline intersection make sure of the fair spatial distribution across the study area, eliminate the chance of repetition at least to have one or two compounds to be surveyed from one block. This is a clustered sampling technique and it is recommended for a study in a geographical area. However, because the organic shape of the blocks and uneven distribution of the KHU in the study area will not bring a fair distribution, therefore, it will be more appropriate to choose the compounds from each Block (strata). So that is why I choose a stratified sampling method. Expressing the density, mix of function and housing transformation starts from the neighborhood level, then for selecting the compounds and Housing units I used both the **probability sampling and non-probability** sampling techniques.

For selecting compounds I used **stratified sampling**. If a population from which a sample is to be drawn does not constitute a homogeneous group, a stratified sampling technique is generally applied to obtain a representative sample. Under stratified sampling, the population is divided into several subpopulations that are individually more homogeneous than the total population (the different sub-populations are called 'strata') and then we select items from each stratum to constitute a sample. Since each stratum is more homogeneous than the total population, we can get more precise estimates for each stratum and by estimating more accurately each of the parts, we get a better estimate of the whole. In brief, stratified sampling results in more reliable and detailed information (Kothari, 2004). The Selection can be usually based on the experience and personal judgment of the researcher (non-probability sampling). Also, qualitative study is thus a type of empirical inquiry that entails purposive sampling for gathering data (Zegeye et al.,

2009.p36). Therefore the in-depth interviews in a qualitative study and observations study for a mix of functions at the building level were purposively selected. The next step will be how to

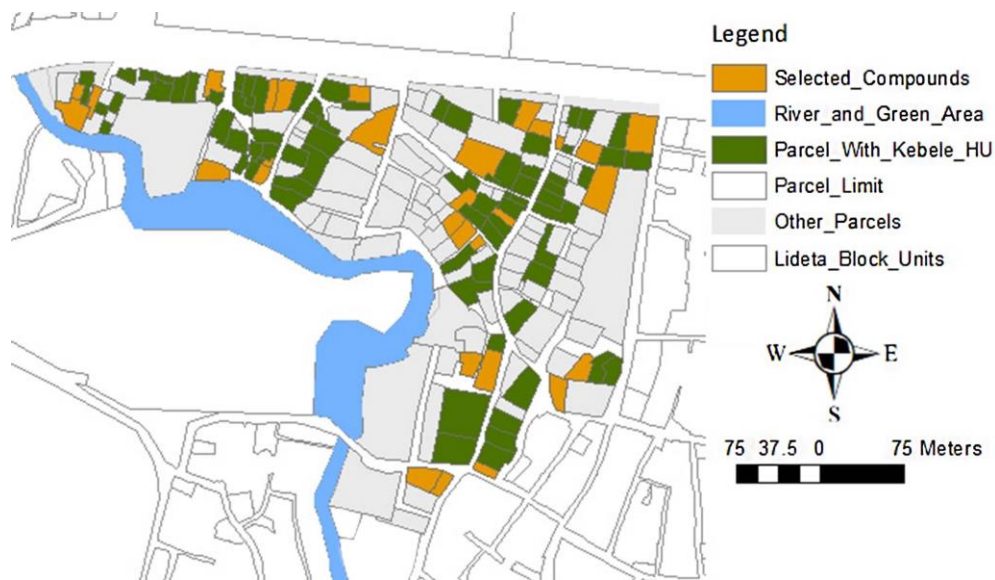


Figure 3.3 Selected Compounds for study using Stratified Sampling

decide the number of compounds from each Strata or block in our case. The table below and the map next to it will show us the detailed procedure.

Block no.	No. of Cmpds with Kebele HU	Cal. result	No. of H.U	Cmpd surveyed	H.U Surveyed
1	14	3.96	4	4	4
2	5	1.41	1	1	1
3	14	3.67	4	4	4
4	12	3.39	3	3	3
5	11	3.11	3	3	3
6	13	3.67	4	4	4
7	4	1.13	1	1	1
8, 10, 11 & 12	7	1.98	2	2	2
9 and 13	0	0	0	0	0
14	5	1.41	1	1	1
15	4	1.13	1	1	1
16	18	5.09	5	5	5
Total	107+27 new	28.54	29	29+3	29+3

Table 3.2 The method used for having proportional allocation for each stratum or urban block (Source own construction)

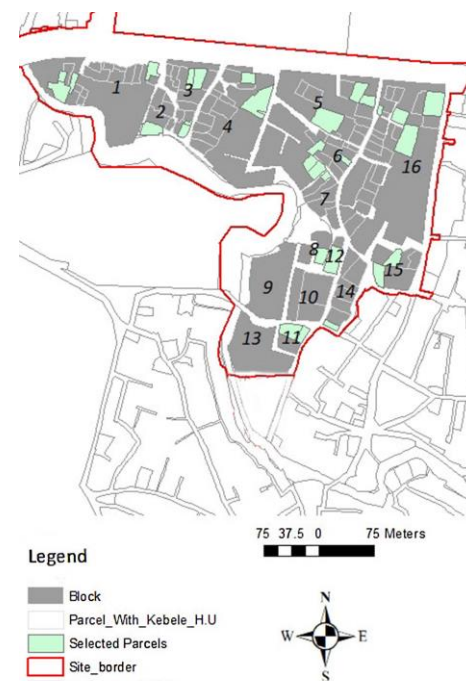


Figure 3.4 Each urban block with its number

In systematic sampling, the calculation used above can be simply put as if  $P_i$  is the proportion of the population included in stratum  $i$ , and  $n$  is the total sample size, the number of elements selected from stratum  $i$  is  $n \cdot P_i$ . Then the rounded-up number gives the proportion of units to be selected in each stratum. Then selecting the kebele housing units in each compound is based on non-probability sampling because selection depends on the primary residence of that compound.

### 3.4.2 Sampling Method for Qualitative Study

Kothari (2004), defines Universe and Population as follows: from a statistical point of view, the term 'Universe' refers to the total of the items or units in any field of inquiry, whereas the term 'population' refers to the total of items about which information is desired. Therefore in our case, all the housing units regardless of tenure type become the 'universe' and the study focuses on kebele housing units so the tenures inside CWKHU become the so-called 'population'.

The total study area or residential compounds can be a sampling frame at a large scale. For example, in studying morphological density and mix of functions the neighborhood or residential compounds become the sample frame. However, in studying household density or a mix of functions in a compound and household the residential compounds or CWKHU becomes the sample frame. The stratified sampling method was employed while taking each CWKHU as a stratum.

According to Kothari (2004), the confidence level or reliability is the expected percentage of times that the actual value will fall within the stated precision limits. Also, precision is defined as the range within which the answer may vary and still be acceptable; the confidence level indicates the likelihood that the answer will fall within that range, and the significance level indicates the likelihood that the answer will fall outside that range. Based on the above expression and following the Addis Ababa University research standard this study uses a 95% confidence level. We know that if the confidence level is 95%, then the significance level will be  $(100 - 95)$  i.e., 5%.

Therefore sample size = total population/  $1 + \text{total population} (0.05)^2$

$$N = 366 / 1 + 366(0.05)^2$$

$$N = 366 / 1.915 = 191.12 \approx 192 \text{ housing units (Kothari, 2004; Krejcie \& Morgan, 1970)}$$

To ensure a fair and enough selection of sample units during the survey all the CWKHU were selected as a 'Strata'. Therefore to select the housing unit from the strata I used to start from the right side and survey households by jumping one household every time and avoiding households already addressed by qualitative interview. However, the selection of the kebele houses doesn't fully represent all the compounds not only that it doesn't represent the CWKHU. Around half of the compounds contain private housing units that have a different character so using the above calculation 42 private housing units were added to the sample size. Therefore totally 234 households were surveyed.

### 3. 5 Method of Data Collection

I conducted a pilot questionnaire study in two (2) selected areas the first one is in Lideta sub-city Woreda 03 Abinet Area and the second one is also in Lideta sub-city woreda 01 kebele 02. Both sites I have a close encounter and familiarity with during my stay on the campus. During the pilot study, I met with Administrative officials and locally active residents of the study area. This helps to measure their cooperation level and willingness respectively especially to work as a guide while collecting data. During the pilot study, I collected data from five households at each site. And finally decided in selecting the second site because of the support I got from residents and officers.

The two guides that helped me during data collection were long-time residents of the area one was retired military corporal “Asraleqa” Kassu Amare and Mr. Siyoum Bahiru was an elder with experience and spent his life in different public services. The guides helped me by introducing and acquainting me to the residents. I can almost say that they know everyone in the neighborhood and showed me the primary dwellers in each selected compound and notify me if the elders are alive and well to give me an interview. The atmosphere they create during the interview always attracts people and creates the chance to make it feel like a free social discussion. While the ideas and stories flow freely all I have to do is systematically guide them around the question. I found this technique to be efficient in getting pure data but they were very time-consuming almost two compounds in one day. And when the conditions are favorable I will initiate a focus group discussion that assesses the needs of the dwellers, capacity, willingness, and preference for housing development.

The questionnaires were very long and time taking so the residents sometimes get bored quickly. After the pilot study, I tried to manage the length of the interview and make them to have flow for example I start from the family profile making them think about each member, like recalling their birth or age then move to the Acquisition and Building History, the house which binds them together. Then to the compound and move to the neighborhood level and finally the social and cultural aspect of their life in the community is assessed. The questionnaires were arranged in a way that will make them have a flow meaning the previous question will somehow lead (Pave the way) to the next question. The grid lines help for sketching and the printed or traced compound map from the 1987 E.C (1995) map prepares and guides me through the interview and makes the process also much faster. Preparing a translated version of the questionnaire in Amharic and familiarizing myself to memorize the questions and their orders during the pilot study helped me a lot in speeding up the tedious process.

Based on information from my guides and occupants of the compound, I select the primary households preferably with elders and longtime occupations. This is to fetch from the experience they have due to their longtime association with the compound. The interview is with the

household head because mostly they are ought to be responsible for decisions related to the transformation of the dwelling. But for the Time diary survey, I dominantly choose the female members because mostly they spend more time in the house and the responsibility of taking care of the family falls upon them. Therefore in performing their duty they use the space more dominantly than the male members. Selecting the subjects for the life story interview was based on their willingness, available time on their hand, expression ability, and willingness to share the story.

The qualitative questionnaire was collected from 32 Housing units which have 53 households and after the collection tabulation, coding, and data encoding to SPSS. And the best exercise was trying to quantify those questionnaire data and trying to analyze them. Then this process showed me how much the questions are targeted and how much the organized data answer the question. Then based on this experience, the quantitative questionnaire was prepared, first, it was conducted for 192 selected housing units that are all under Kebele Administration. But after a while, I recognized that there is a large difference between the KHU and PHU. And the conclusions drawn from this data will only work for KHU and will not represent not only the character of the neighborhood but also CWKHU. So Adding 42 PHU also helped to further explain the KHUs using comparison analysis, so 234 housing units were addressed by the qualitative study. Then six households were selected that were already covered and the detailed life story and time diary data were collected.

The other thing was to record and collect physical data especially a mix of functions done by land and building use inventory and updated while conducting the survey. On-site measures conducted for morphological density were also collected by an update of the previous maps. Also using GIS software I have changed the print map data to a CAD (Computer Aided Drawing) by Georeferencing it using GIS. However, in addition to updating the base map & functional change on-site data collection of the physical environment was used to make a recent map (base map).

### **3.6 Method of Data Analysis and Presentation**

After the data collection editing, coding, classification, and tabulation of collected data were done so that they are agreeable to analysis (some presented in annex). As Kothari (2004), describes the term analysis refers to the computation of certain measures along with searching for patterns of relationships that exist among data groups. So the data was made suitable for analysis at last.

#### **3.6.1 Descriptive and Inferential analysis**

As the first question of the research is a descriptive question and the method used was the survey method the best-suited analysis would be descriptive analysis and inferential analysis (statistical analysis). And this study works out various measures that show the size and shape of the

distribution(s) along with the study of measuring relationships between two or more variables. The Inferential analysis is concerned with the various tests of significance for testing factors influencing the density and mix of function to indicate some conclusion or conclusions. It is mainly based on inferential analysis that the task of interpretation (i.e., the task of drawing inferences and conclusions) is performed.

Different measures were used to summarize the survey/research data like averages, dispersion, and ranges. In the study, density is expressed in a ratio. The numerator contains population, household, housing units or dwelling units, and built-up area or floor area. The unit area is explained in two ways one is the area unit of measure and the other is boundary definition. So in this research hectares will be used mostly and sometimes square meters for the first one and the boundary definition is in the neighborhood, compound, and dwelling unit. These expressions are deeply thought out for easy but a thorough expression of both density and mix of function and further are intended for conveying some reality. For describing the distribution – I can use central tendency - like mean, median, and mode, or for explaining spatially distribution we can compute the number of population and number of services in the radius of the area.

The mix of functions has the procedure of assigning land and building use categories that follow the land-based classification standard (LBCS), and the analysis can sometimes use urban land scenario (uses key assumptions about future redevelopment) analysis.

For comparing the results of different measures to the existing regulations and standards use the structure plan. Because the structure plan has stated that simply under Art. 9(2) of the Federal Proclamation No. 574/2008 the structure plan is intended to shape the form of the city. This includes issues of density by determining the magnitude and direction of growth of the urban area; issues of a mix of function by providing principal land use classes; housing development; the layout and organization of major physical and social infrastructure; and others. So the site data will be mainly weighed based on the structure plan of the city.

### **3.6.2 Exploring relationship**

Other than using common types of data analysis and spatial data analysis we will use the exploration of relationships. Especially for the third question that tries to determine the future form, it is vital to select and see the factors (independent variables) that affect the dependent variables (density and mix). These variables by themselves affect the urban form.

Martin & Lionel (1966), analysis in density and built form was a model for the later used deductive analysis on density. It was developed in the process of criticizing the conventional measures of density. Alexander et al. (1988), using factors affecting density perform deductive analysis. So using the same method in this study the dependent variables will be the different measures of density in neighborhood, compound, and dwelling level descriptions of density. And the

independent variables are family size, built-up and floor area, lot size or compound area, and dwelling form.

Correlation analysis studies the joint variation of two or more variables for determining the amount of correlation between two or more variables. Causal analysis is concerned with the study of how one or more variables affect changes in another variable. It is thus a study of functional relationships existing between two or more variables. This analysis can be termed regression analysis and this uses a simple regression equation.

Simple Regression Equation =  $Y = a + bX + e$

Where: Y = predicted value of the dependent variable; a = the constant or Y intercept (where the imaginary line crosses the Y axis), b = the regression coefficient; X = the independent variable; and e = error (the computer will estimate the likely association).

### 3.6.3 Different Analysis for Land use or Mix of Function

**Urban Land Use Efficiency (ULUE)** - This thesis also analyzed **ULUE** using different time maps and georeferencing was done using ArcGIS software. The population data for different times were taken from the population record file of the woreda office and the final result was taken from field observation and survey. It uses ULUE which agrees with the ratio of built-up expansion to the population size for a specified period as indicated in UN-Habitat, 2018.

ULUE (LCRPGR) = annual land consumption rate (built-up area growth) per annual population growth rate (population growth) or  $ULUE (LCRPGR) = LCR/PGR$

$$LCR = \frac{(\ln(Urb(t_2)/Urb(t_1)))}{Y}$$

$$PGR = \frac{(\ln(Pop(t_2) Pop(t_1)))}{Y}$$

Where: ln = Natural logarithm; Urb(t<sub>2</sub>) = Surface occupied by urban areas at the final year; Urb(t<sub>1</sub>) = Surface occupied by urban areas at the initial year; Pop(t<sub>2</sub>) = Population living in urban areas at the final year; Pop(t<sub>1</sub>) = Population living in urban areas at the initial year; y = Number of years between the two-time intervals (UN-Habitat, 2018).

**Land Use Diversity and Mixedness** - Land-use diversity is the diversity of a mix of functions or different land uses and it is widely measured using an entropy method. A high entropy value indicates high land-use diversity within an area. The formula used to calculate this index is the equation employed by (Chen & Song, 2020; Mavoa, et al., 2018), depending on the actual data availability. The land-use types considered for this indicator are pure residential and mixed residential together, manufacturing and storage, commercial, administration, service, religious place, and open space. The existing land use of the study area is presented in chapter four (see Figure 4.15).

$$Land\ use\ mix = -A/(\ln(N))$$

Where Area =  $(b_1/a) * \ln(b_1/a) + (b_2/a) * \ln(b_2/a) + \dots + (b_7/a) * \ln(b_7/a)$

Therefore,  $A = \sum_{i=1}^7 (b_i/a) * \ln(b_i/a)$

Where  $a$  = Total Area in  $m^2$  of all seven land uses presented within the study area,  $b_1$  = Residential Area;  $b_2$  = Manufacturing Area  $b_3$  = Commercial Area;  $b_4$  = Service Area;  $b_5$  = Administrative Area;  $b_6$  = Religious Area;  $b_7$  = Open space Area.

**Land-use Mixedness** - Land-use mixedness is used to measure the mixedness of residential land use with other land uses, which indicates the easiness to access places within short trips. Land-use mixedness is also different from land-use diversity. Non-work trips can be made on foot if the residential land use is sufficiently mixed with other land use types. Huang et al., 2018 citing Zhang and Guindon, 2006 revealed that land-use mixedness can be computed using the following equation:

$$M(i) = (\sum_j L_o) \div (\sum(L_r + L_o))$$

Where  $M(i)$  is the mixedness index of the study area;  $L_r$  and  $L_o$  refer to residential and non-residential land uses, respectively. For each residential point of “j”, the proportion of non-residential is calculated. The mixedness value can range from 0 to 1; and the balanced land-use mixedness is 0.5, implying an equal share between residential and non-residential land uses.

**Compatibility and Intensity of Functions** - Again the **compatibility** of the functions is analyzed based on the availability or access to different functions and the distance traveled to each function. Another method is to assess the information from the residents and the questionnaire survey and observations were used.

The other analysis is to see for the intensity of function and **Space matrix** as developed by Berghauser Pont and Haupt (2010) makes it possible to link the urban form and structural types to density and the amount of open space. To make this possible, the Space matrix treats density as a multivariable phenomenon, approaching and defining it in terms of three indicators, in contrast with the usual practice of using a single indicator, such as the number of dwellings per hectare or FSI (Mashhoodi & Pont, 2011). So the floor area of each building inside the compounds of the neighborhood was assigned to their function and their floor area value and correlation analysis were used to see if there is any relationship between the five major functions of the site.

#### **3.6.4 Integrated Research approach to study Housing Form**

Asquiz has developed an integrated research approach to study housing form and its conceptual framework based on the concepts that determine a house form. In developing the methodology to study the factors affecting housing from a time diary, spatial mapping, or a spatial perception map, spatial configuration diagrams were developed. In this study time, diaries and life stories were analyzed with the graph analysis.

**Graph Analysis** - Based on the floor plans of the dwellings the layouts of 32du were drawn to enable systematic and equal analyses. Within space syntax, two main techniques are used to analyze each dwelling type through graph information. Graph Analyses, a grid of points is overlaid on the plan and then a graph is made of those points, where each point is connected to every

other point that it can see (Eloy & Guerreiro, 2016 citing Turner, 2004:1). It helps to see the shortest path, routes, and room connection.

Thematic Issues	The scale of the study	Presentation Method	Analysis
Density	Neighborhood Level	Built-up density	Descriptive and Statistical Analysis; comparing to Standards; and correlation and association; urban land scenario
		Population Density	
		Housing Unit Density	
	Compound level	Built-up density	Descriptive and Statistical Analysis; comparing to Standards; and correlation and association
		Population Density	
		Housing Unit Density	
	Household Level	Av. Family Size	Descriptive and Statistical Analysis; comparing to Standards; and correlation and association
		Built up area per Person	
		Gross R. floor area per Person	
		Occupied floor area per person	
Persons per habitable room			
Perceptual Density	Compound and Household level	Statistical Descriptions	Compared to Measured density
Mix of Function	Neighborhood level	Building use map	Compatibility is checked based on spatial distance (in terms of length of time) and to see the efficiency ULUE Analysis of UN-Habitat (2018) was used and the Land use diversity index and Mixedness Index was also used (Eizenberg et al.,2019)
		Compound use map - based on entropy for land-use diversity and other Evaluative indexes	
	Compound Level	Mapping based on LIR (land-use intensity Rating)	Finally to see the intensity and synergy space matrix is used by quantifying functions and population catchment of land uses using Space matrix density analysis and Correlations.
Household Level	Activity Space Time Mapping and graph Analysis	Integrated Research approach by Asquith (2006) and Graph Analysis Method	
Transformation	Household Level	Statistical Descriptions	Effect on density and mix of function

Table 3.3 The Different Types of Analysis and Presentations Used in the Study (Source own construction)

## **Chapter Four - Data Presentation and Analysis**

### **4.1 Introduction**

In the data presentation and analysis, both quantitative and qualitative methods are used and the approach is that the data presented in the quantitative method will be further explained by a qualitative method as designed during the questionnaire preparation.

Then the next section, explains the density of the study area in selected measurements that are categorized at different scales. Therefore density will be explained at a neighborhood, compound, and household level. First, it shows how the built environment changed through time and describes density at different levels using different measurements. Then the study tried to connect the measured densities and measured densities to perceived density to give a clear image or feel of the environment.

The third part of this chapter deals with the mix of function and its approaches by considering it as an activity or place of activity. At the neighborhood level, it assigns each activity to the corresponding building and compound, then assesses the effectiveness, compatibility, and intensity of the activity or function. At a compound level, it assesses the activities in the compound shared spaces and functions of each building in the compound. Then studying the space, time, and activity in selected households explains the function of housing units.

The last section deals with the transformation of housing units and mainly focuses to dig out the reasons for the transformation of housing units. The above three subject matters which are density, a mix of function, and housing transformation each have two life stories at the end. These life stories will help to reveal the human or social aspect of the dwellers that can't be explained only by using the quantitative method.

### **4.2 General Description of the Study Area and the Population**

#### **4.2.1 The Character of Family and Population**

Based on Alexander C. (1977) large family size increases the social experience of the dwellers. In the whole neighborhood, the average family size is 4.87pphu and the average family size for KHU only (65% of the neighborhood household) is 5.3pphu. Further from a detailed interview, 6.3% have a single-family unit and 31.25% with a family unit. The rest 20hus or 62.5% have a traditional family unit (asks primary settlers so the chance of having a large family is high). But still, the observable universe is rich for growing children, especially those below the age of ten, and the sharing of life experiences are plenty because of the existence of elders (grandfather and mother). This is because the traditional families have a relative in addition to the regular family unit. However, if this family size is not reinforced by enough space overcrowding and related problems will suppress the living condition of dwellers.

Another aspect is that 32.3% have more than one married and/or divorced member in the housing unit and 41.7% with one married member or one pair while the remaining 26% have no married member in the hu. Most children tend to live together with their family, sometimes even after a failed marriage. As most of the primary occupants of the KHU are now elders and in low economic condition, they need someone close by. The children cannot afford the overly priced housing market of the city therefore, it becomes profitable to help out their family nearby while saving the rent burden themselves. This also increases the chance of the creation of subsequent families in one housing unit. Showing this 88.5% of housing units have a child or family member at the age of 18 or above. Based on gender the study area has 48.3% male and 51.7 female.

The detailed study reveals that society has a strong relationship with its neighbors and the community. Around 85% of the interviewee know more than 200 families or more up to all families in the area they consider to be their neighborhood. They have also a close relationship with many family units of the area (70% have a close relationship with more than 50hh or more than 50% responded that they have a close relationship with everyone). This interview shows also almost all involve in social visitations, weddings, and graduation ceremonies and it is almost mandatory to participate in an activity of mourning. More than half of the housing units have a member (especially the female household heads) that involve in frequent coffee ceremonies and sometimes birthdays and visitations during holidays is also a common practice.

The community has community-based associations that involve religious, economic, and social matters. Accordingly, almost all of the households have 'idir' and more than 78% have multiple Idir in the neighborhood; 30% have an economic association with their neighbors called 'Iqub' and few have a religious association called 'mahber'. So it is fair to say that the neighborhood has strong social interaction that goes beyond the simple social relation.

#### **4.2.2 Economy of the Dwellers**

From the total survey 36% have some type of formal and informal job and the rest 64% have no employment. Isolating KHU only there are 192hu with 1106 population surveyed - 39% are with some type of income and 25% with no income or employment. And 37% are not able to contribute to household income as they are either below the age of 15 or above 65 and sometimes disabled or sick.

As Cervero (2013), describes the issue of social geography that most slum dwellers face a problem of differences in job and living area location. Further, most of the dwellers involve in an informal jobs (52% of people with some type of income). And the majority of people work in nearby places whether it is formal or informal as they dominantly use walking to go to their jobs (76% dominantly use walking as a mode of transport to work). This has its implication on social geography that both jobs and living areas are located together in the mixed inner city and around

11% work inside or connected to their dwelling unit 76% work in the neighborhood or nearby area.

### The economic condition and saving capacity for housing

Household income or estimate of the family members' total Expenditure in a month is around 2,100 birr per month. As Jenks (2004), stated that compact city policies will have to address the problems of poverty and social inequality in developing countries and this has to be also our reality. However, this does not change the need and housing demand as it did not impact the saving capacity of the community.

Despite the low economic condition of the dwellers, their saving capacity seems hopeful. Some of the families want to save but have no capacity (8%); some have started it but didn't continue (13%); around 6% have finished their savings; another 8% didn't want to save at all, and the rest 71% has savings mostly below 500 birrs per month (55%).

### 4.2.3 Housing Acquisition and Description

**Time of acquisition** - Most of the dwellers have been in the study area for a long time around 64% of the occupants were already living in the neighborhood before 1990. The longtime occupation of the dwellers will make the housing units and the neighborhood subject to a lot of transformation and appropriation. These changes enabled them to hold this much population and create the means to resist challenges created in the community. There is also a significant number of housing unit renters (29%) that acquired their units before the 1975 nationalization.

<b>Previous Residence Place</b>	<b>Out</b>	<b>In</b>	<b>Both</b>
	28.6%	51.3%	20.1%
<b>Size of Dwelling</b>	<b>Av. DU size</b>	<b>KHUs</b>	<b>PHUs</b>
	48.76m <sup>2</sup>	42.14m <sup>2</sup>	103.76m <sup>2</sup>
<b>Mode of Acq.</b>	<b>Gov't</b>	<b>Inheritance</b>	<b>Exchange and Others</b>
	65.1%	26.5%	8.3%

Table 4.1 General Description of dwellers and their unit

Today there are 6.3%hu have one room, 8.9%hu with two rooms, 58.3%hu with three rooms, 17.2%hu with 4 rooms, and 9.4%hu with 5 rooms. When one says that around 75% of the HUs have three rooms or more, most people would imagine big houses. Also, it is stated above that the KHU has an average dwelling unit size of 42.14m<sup>2</sup>. These two statements do not go together with the conventional knowledge concerning KHUs. So to understand these, one must know the transformation trend of the KHU. This will be further discussed in the section that explains the transformation of KHUs. The surveyed KHUs has a built-up area of 6634m<sup>2</sup>. And 41% have an area of below 30m<sup>2</sup>, another 50% have an area of 30 up to 50m<sup>2</sup>, and 9% have an area above 50m<sup>2</sup>. However the average occupied floor area of the housing units is 46.28m<sup>2</sup>, isolating KHUs it gives

31.12m<sup>2</sup> and for private housing units only it is 84.47m<sup>2</sup>. The total average room size for KHU is 10.98m<sup>2</sup> and the average room size for each room is given at the end (See Annex IV).

### Housing Description

The dwellers were asked to compare the housing condition of the existing unit to a previous time or the housing condition during the time of acquisition. Accordingly, 62% have stated that the housing condition is better than the previous time. 19.8% stated that it is in the same condition at the time of acquisition, and the rest 18.75% described that the housing condition in the



Figure 4.1 Common Type of Kebele Housing with Attached Unit with CIS Wall and the Narrow Paths of the Neighborhood (Source photograph by the Author)

previous time was better than today's condition. In all cases, we have to consider the impact of housing transformation.

To identify the housing unit the materials or types of wall, floor, ceiling, and roof were used. From this, 91.14% of the original HUs wall material is wood and mud. And 9.3% of original HUs have wood and mud on one side and other types of material on the

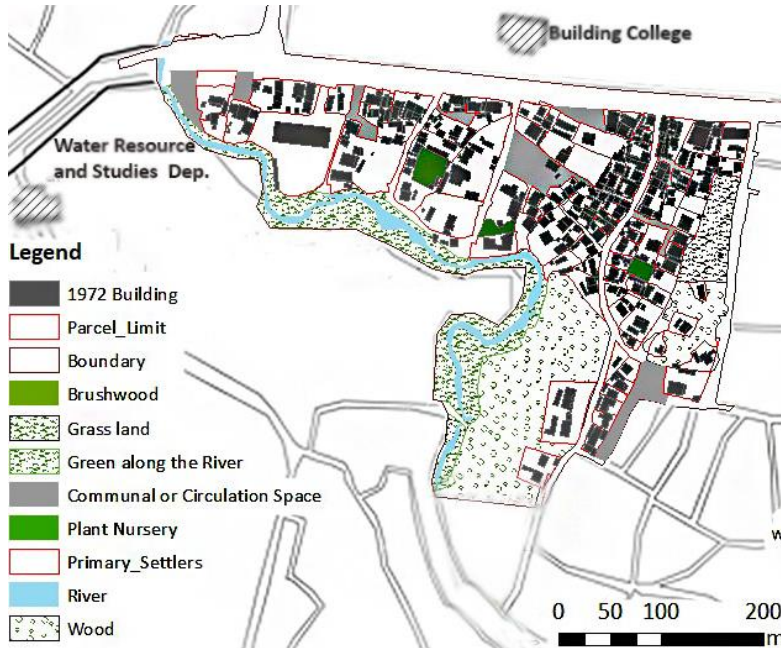
other sides of the wall. Most additional units are built with a metal sheet or wood and mud.

The red arrows at the top of the picture show the main reasons for the difference between the built-up area, gross residential floor area (that measures the perimeter of an exterior wall), and occupied floor area. Adopting the floor area from the base map will falsify our result because the eve and site measures reveal that there is a significant difference between the built-up area and the floor area. The floor material of the KHUs of 21.3% earth material, 25% have a cement floor, 47.4% have cement and earth material, and 6.3% wood floor.

## 4.3 Density of the Neighborhood

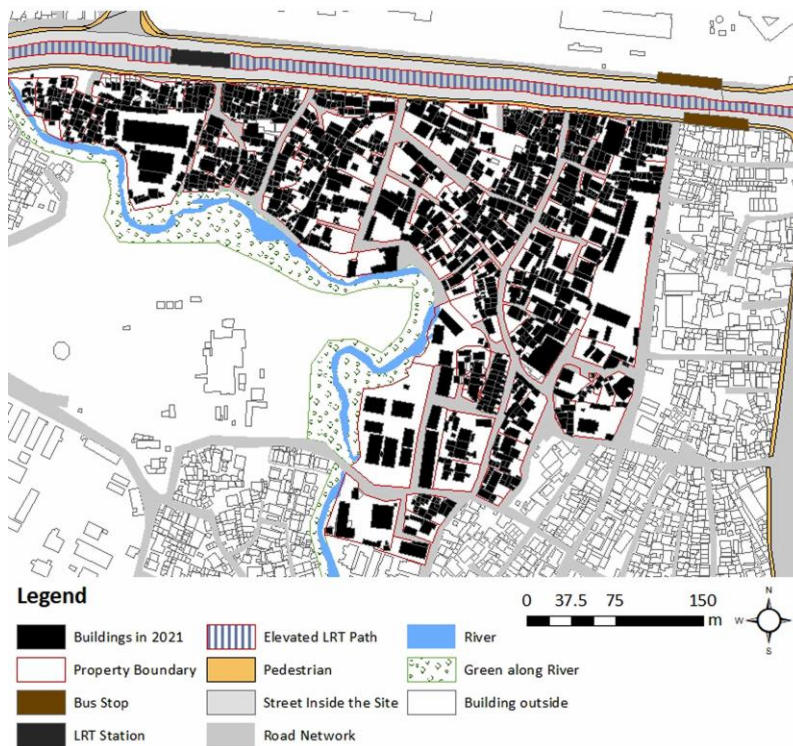
### 4.3.1 The Change in Built-Up Density

#### Built-up Density of the Neighborhood in 1972



In 1972 (Figure 4.2) there are only 445 buildings with a total built-up area of 22,762m<sup>2</sup> the average building size at the time is 51.15m<sup>2</sup>.

Figure 4.2 Figure Ground map of the study area in 1972 - Digitized from 1972 Sofratop map of Addis Ababa



#### Built-up Density of the Neighborhood in 2021

Today (Figure 4.3) there are 1207 buildings with a total built-up area of 47,026m<sup>2</sup> and a mean or average building size of 38.99m<sup>2</sup>.

Figure 4.3 Figure Ground map of the study area in 2021

## Summary of Built Up Density Transformation

Year	Number of Compounds	Compound Area in m <sup>2</sup>	Mean	Number of Buildings	Total Built Up Area in m <sup>2</sup>	Mean	BAR
1972	99 compounds	66,764	674.38	445	22,762	51.15	0.34
1995	180 compounds	75,512	419.5	903	34,068	37.72	0.45
2005	189 compounds	83,462	438.23	970	43,920	45.27	0.52
2011	195 compounds	89,610	461.07	1146	45,303	39.53	0.50
2021	227 compounds	89,780	395.50	1207	47,026	38.96	0.52

Table 4.2 Summary of Built-up Transformation from 1972 to 2021G.C (Source own computation)

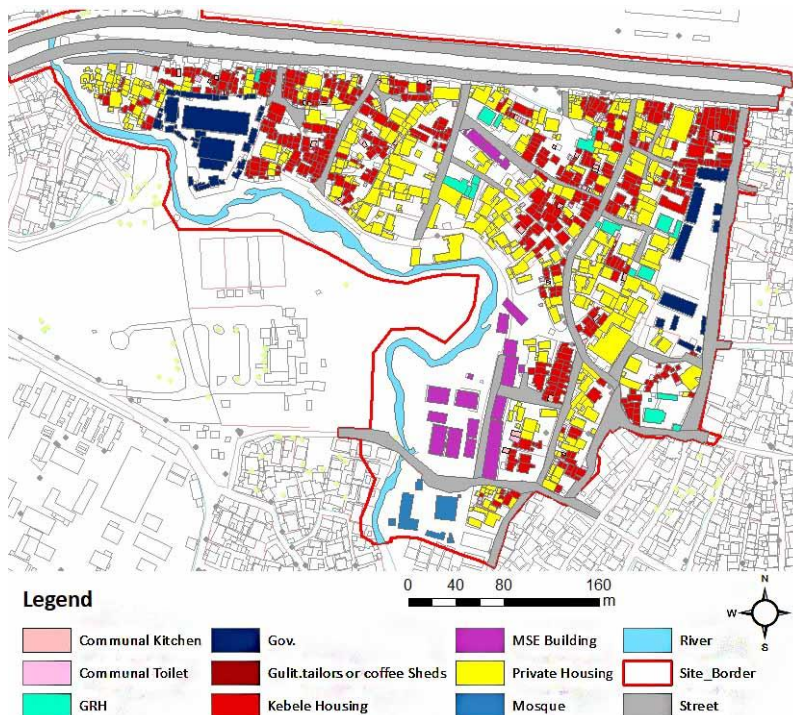


Figure 4.4 Ownership Map of the Study Area Updated from the 1995 Ownership Map

There is an increase in compound number and size but at a different rate. While the number of compounds more than doubled or increased by 129.29% but the total compound area increased by around 23,000m<sup>2</sup> which is 34.4%. Therefore most of the increase can be attributed to the subdivision of plots and housing in undeveloped land in the neighborhood. The largest share of change in the number and area of the compounds and buildings is in the first 20 years which can also be

attributed to the establishment of the kebele houses. Based on the tables presented in (See Annex V) the change in the Compound area by comparing the CWKHU to the previous year's data shows a decrease.

According to ownership other than the communal uses the average building size decreased in all cases and public buildings are larger with an average building size of 134.5m<sup>2</sup>. Looking at the increase in number and area public buildings almost tripled by adding 51 buildings. Based on the built-up area of these public units increased by 6,059m<sup>2</sup> that is 188% increase. The private housing units added 127 new buildings which increased the built-up area by 3,770m<sup>2</sup> which is a 24.3% increase. And the CWKHU added 125 buildings which increased the area by 3285m<sup>2</sup> which is a 26.3% increase while decreasing the compound area.

D. Measures	Ratio	Result	Result for CWKHU
Residential Share and R. built-up area Density	T. residential plot area per Total compound area and Residential BUA per neighborhood footprint	$6.54\text{ha}/11.31\text{ha} = \mathbf{0.57}$ or <b>57.8%</b> and $37,765\text{m}^2/47,026\text{m}^2 = 0.80$	
Built up Area and Floor Area	Total Built-up area or Floor Area per Total neighborhood area	Gross and Net BUA density $47,026\text{m}^2/113,109\text{m}^2 = \mathbf{0.41}$ $47,026\text{m}^2/89,780\text{m}^2 = \mathbf{0.52}$ Gross and Net density $55,420\text{m}^2/113,109\text{m}^2 = \mathbf{0.48}$ $55,420\text{m}^2/89,780\text{m}^2 = \mathbf{0.61}$	
Dwelling Unit or Housing Unit Density	Total number of housing units per neighborhood area	Gross density $560\text{hu}/11.31\text{ha} = \mathbf{49.5\text{hu/ha}}$ Net density $560\text{hu}/8.97\text{ha} = \mathbf{62.4\text{hu/ha}}$	
People per neighborhood or population density	Total population per Total neighborhood area	Gross density $2730/11.31\text{ha} = \mathbf{241\text{ppha}}$ Net density $2730/8.97\text{ha} = \mathbf{304\text{ppha}}$	
Built-up area ratio or Site coverage	Total residential built up area per Residential plot area	$37,765\text{m}^2/65,424\text{m}^2 = \mathbf{0.57}$ or <b>57%</b>	$21,926\text{m}^2/34,829\text{m}^2 = \mathbf{0.63}$ or <b>63%</b>
Floor area ratio	Total residential floor area per Residential plot area	$37,826\text{m}^2/65424\text{m}^2 = \mathbf{0.57}$ or <b>57%</b>	$22,012\text{m}^2/34,829\text{m}^2 = \mathbf{0.63}$ or <b>63%</b>
Total Household or HU per hectare	Total number of household per Residential plot area	$731\text{hh}/6.54\text{ha} = \mathbf{111.7\text{hh/ha}}$ <b>560HU/6.54ha = 85.62hu/ha</b> and for CWPHU = <b>43.8hu/ha</b>	$593\text{hh}/3.48\text{ha} = \mathbf{170.4\text{hh/ha}}$ & <b>122.4hu/ha</b>
People per residential compound	Total population per Residential plot area	$2730\text{ people}/6.54\text{ha} = \mathbf{440.3\text{ppha}}$	$2146\text{ people}/3.48\text{ha} = \mathbf{616.66\text{ppha}}$
Persons per housing unit and household	Total population per Total number of dwelling units	$2730\text{ people}/560\text{hu} = \mathbf{4.87\text{pphu}}$ and <b>3.74pphh</b> <b>4pphu for PHU</b>	$1944\text{people}/366\text{hu} = \mathbf{5.31\text{pphu}}$ and <b>3.27pphh</b>
Built up area per Person	Total residential floor area per Total population	$32,768\text{m}^2/2730\text{ people} = \mathbf{12\text{m}^2\text{pp}}$ <b>21.62ppm<sup>2</sup></b>	$15,774\text{m}^2/1944\text{ people} = \mathbf{8.11\text{m}^2\text{pp}}$ for <b>366hu</b>
Gross R. floor area per Person	Total R. floor area of du per Total population	$12,450\text{m}^2/1,296\text{ people} = \mathbf{9.6\text{m}^2\text{pp}}$ <b>22.9</b> for PHU	$8,092.51\text{m}^2/1106\text{ people} = \mathbf{7.3\text{m}^2\text{pp}}$
Occupied floor area per person	Occupied floor space per Total population	$10,831\text{m}^2/1296\text{ people} = \mathbf{8.35\text{m}^2\text{pp}}$ for 234hu $18.6\text{m}^2\text{pp}$ for 42phu 924rm	$6633\text{m}^2/1106\text{ people} = \mathbf{5.99\text{m}^2\text{pp}}$ for 192 khu with 711 rm
Persons per habitable room	Total population per Total habitable room	$1296\text{ people}/784\text{ room} = \mathbf{1.65\text{pprm}}$ & $1.05\text{pprm}$ for 42phu 9,307.15m <sup>2</sup> hs	$1106\text{people}/604\text{room} = \mathbf{1.83\text{pprm}}$ 6633m <sup>2</sup> hs

Table 4.3 Computation of Density at Neighborhood, Compound, and Housing unit or Dwelling Level (Source own computation)

## 4.3.2 Neighborhood Density

### A. Residential Share

The residential share density of the neighborhood takes 57.8% of the total study area. This is the result of the addition of all compounds that have a residential housing unit that is occupied at the time and have at least 10% residential floor area from the total floor area.

There is no mention of determined residential share, and pure residential land use is not allowed (only mixed residential use) in the structure plan. It also proposed a 30:40:30 share for open spaces and recreation, built-up area, and street network respectively. According to residential share at the city level Larsen et al. (2019), stated the land occupied by residential housing increased from 33% to 39% between 2006 and 2016. For comparison the study area takes 57.8% from the land use cover; 69% from floor area; and 80% from the built-up area for residential function.

And at the building level, there is mention of residential share for example in the study area from 40% of the total built-up area the allowed residential share is 50% of the floor area. In general at the city level 'the share of the proposed mixed residential land use, is about 48% of the built-up area of Addis Ababa' (AACPPPO, 2017, p. 33).

The total residential plot area in the site is 6.54ha and if we build 40% of this space it is going to be 2.61ha of built-up space and if we build ground plus one building we will have a 5.22ha floor area. Of this 5.22ha, 50% has to be residential therefore 2.61ha or 26,100m<sup>2</sup> residential space (489hu with 40m<sup>2</sup> floor space). By using conventional condominium housing area and share we have to give 6,525m<sup>2</sup> for circulation which is 25% and the rest of 19,575m<sup>2</sup> will be divided into 20:40:20:20 percent share for studio, one bedroom, two bedroom, and three bedroom housing units respectively with 20m<sup>2</sup>, 30m<sup>2</sup>, 45m<sup>2</sup>, and 55m<sup>2</sup> floor area. Based on this allocation we will have 196 studios, 260 one-bedroom, 86 two-bedroom, and 70 three-bedroom housing units together accounting for 612 housing units. Therefore it can accommodate more than existing housing units (560hu), not households while the other floor area is assigned for other functions. Therefore the buildings have to be at least g+1 just to accommodate the existing households. Further to reach the minimum density of the city standard (150hh/ha) we must add one more floor (g+2) then with this height we can have 1229 units making the density 188hu/ha.

And if we allocate 40m<sup>2</sup> for all housing units the buildings have to be at least ground plus two buildings just to accommodate existing households. And it reaches minimum density standard if we have a g+2 buildings then the density will reach just 150hh/ha. For subsidy and for getting more finance from increased clients and for increasing density we can assume that the building heights will increase more. And if we take from the existing residential share for other land uses it is going to increase the building height. And this seems inevitable as the land allocated for streets (LAS) and the share of open space in the neighborhood are below the city standard.

## B. Morphological Density

Based on Larsen et al., (2019), the built-up portion of the city increased from 48% to 67% between 2006 and 2016 while including transitional bare land, mineral, and gravel pits as 'built'. According to AACPPPO (2017), also the built-up area of the city has increased by at least 25% in the last decade only (2007-2017) and around 50% of the city area is built. Considering the issue of a built-up area the structure plan intends to achieve compact and green development by infill development. This is done by filling the existing condominium developments that have below 20% built-up area, and for new developments specifically, it set a 40% of the built-up area. We have seen that the city built-up area has increased by 25% in the last decade but the specific site has increased around 7% in the last 15 years this difference can be attributed to the site being in an already dense inner city.

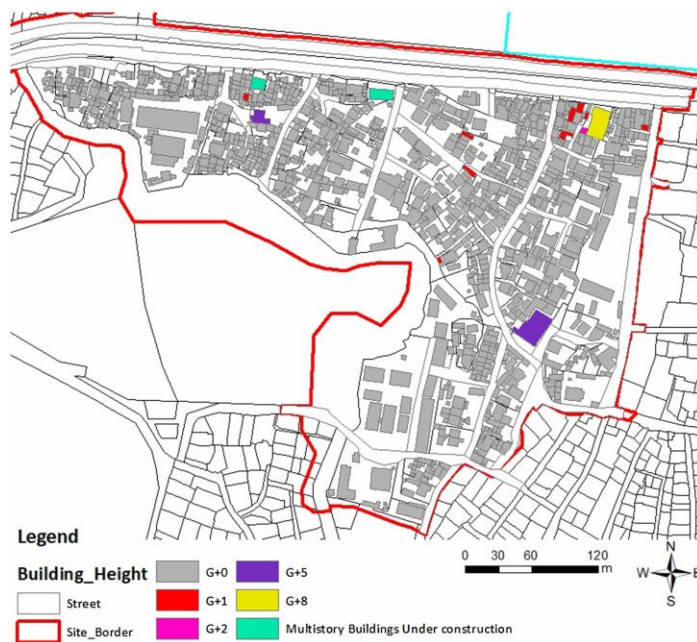


Figure 4.5 Building Height Map of the Study Area

Our specific site's gross built-up area is 47,026m<sup>2</sup> giving a 0.41 built-up area density this means it has 41.6% of built-up area and it is below the existing city average. And net built-up that excludes streets and open space increases the built-up area to 0.52 or 52% for all parcels.

Based on the BH map (see Figure 4.5) the total built-up area of around 96% is covered by one-story buildings. And considering all buildings the floor area reaches 55,420m<sup>2</sup>. So the gross floor area ratio (FAR) in the neighborhood

is 0.48 and the net FAR increases to 0.61. The BAR and FAR values have a little different and this fact is attributed to the area being dominated by buildings with only ground floors. The structure plan states more than 90% of the houses in the capital are one-story buildings and out of the total built-up area, almost one-third (8,339 ha) is occupied by one-story mud houses indicating inefficient land use. FAR/BAR equals average BH and the site has an average BH of 1.17.

## C. Housing Unit and Population Density

The city structure plan and other documents set the housing density of the city at around 29dupha. While it is in the range of most African cities (40-10 housing units per ha) but below the cities of developed countries. Therefore it intends to develop inner city brown land and peripheral area open spaces, it is stated as 'one option could be to prepare 4,301 ha of land to accommodate the 645,120 units in the inner part of Addis Ababa (brown land) with a housing

density of 150 units per ha' (AACPPO, 2017). The four sub-cities account for 41.97km<sup>2</sup> or 4,197ha so most of the area in these sub-cities will be under this delineation.

The total area of the site is 11.3 hectares with 560 dwelling units, so the gross housing density of the area equals 49.55hu/ha and the net housing density of the area equals 62.4hu/ha. Based on the total area the gross population density equals 241.59 people per hectare and the net population density of the area equals 304.3ppha. The city has a population density of close to 65 people/ha for the total land area; and the net population density (for the built-up area) is 125 people/ha (AACPPO, 2017). The study area in both housing and population density is above the existing city average but below the standards set for the future. And comparing it to 'dejach wube sefer' which is 99hh/ha the neighborhood gross density is 731hh/11.3ha which is equal to 64.69hh/ha is below the dejach wube's gross density.

The dwelling and population densities do not only vary in gross and net density they also show the difference in considering the whole site and built-up area. Like Cheng (2010), showed in hong kong we can relate total density to built-up density. So the dwelling unit density increases from 62.4Hupha to 119Hupha and population density increases from 304ppha to 580.85ppha which shows around a 90% increase in both cases. This high population density and low housing density is also indication of overcrowding.

### **4.3.3 Compound or Parcel Density**

#### **A. Morphological Density**

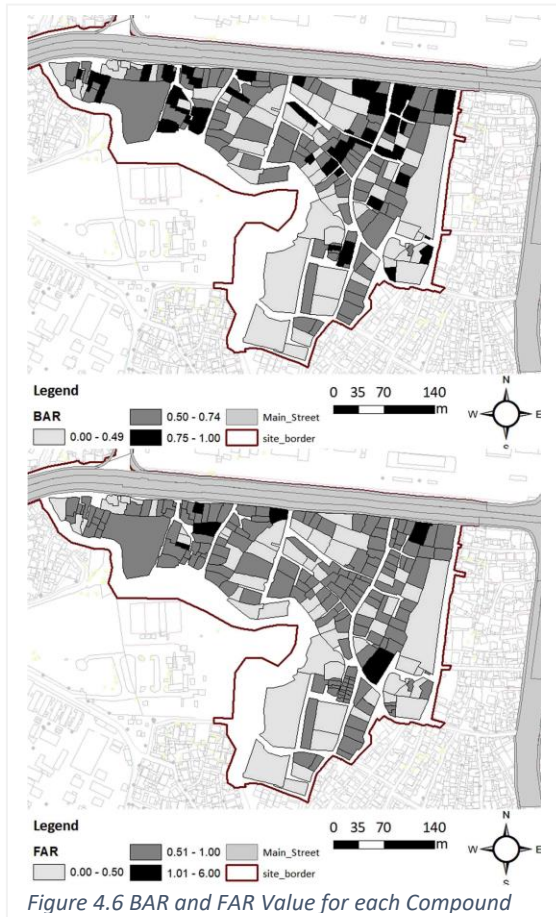
The structure plan explained that FAR is the most important factor in BHR that helps to determine the intensity of activities that development brings. And BAR helps to show the relation between open and built-up space that determines the quality of such places. Therefore the plans state that the appropriate density for a locality and intended functional mix depends on FAR. It uses different regulations as a tool to measure, like building height, floor area ratio, setback, and road width for guiding the implementation process the plan uses.

The study area is located in zone 2 for BHR, so the maximum building height for this zone is 35m and 70m for Local Street and Collector Street or above respectively. And in zone 2 the minimum and maximum floor area ratio (FAR) is 5, which is five times the size of the given plot but it is free for areas near Collector Street. Built-up area and floor area in residential plots help us to compare the result to the whole neighborhood and city. The BAR value, in this case, is 0.57 and the FAR value is also 0.57. This means while considering all compounds the BAR value is 0.52 but in residential compounds, it increases to 0.57 showing that the built-up to share is higher in residential compounds. Considering all compounds FAR value is bigger than the BAR value but in residential compounds, the result is the same. This shows that the average building height considering the whole neighborhood becomes 1.17 but in residential compounds, the result is 1 and in compounds, with other functions, the building height is 1.9.

Computing from the structure plan around 27,000ha of built-up area in the urban extent which is more than 50% of the total urban area is found. Further continuing to the existing growth rate today we can be sure that we will have around 30,000ha of the built-up area which is around 57% of the total area. Also, Larsen et al., (2019) have shown that the residential share has increased from 33 to 39%, and with it, there is an increase in population density in those areas. On the site, there is no significant change in residential land use share. Further for purpose of comparison, we will categorize compounds based on ownership. The residential compounds have higher morphological density than the whole neighborhood and CWKHU has higher morphological, housing, and population density than other residential compounds (See Annex V).

No.		Net BAR	Net FAR	Net Housing Density	Net Population Density
1	Whole Neighborhood	0.52	0.58	62.4hu/ha	304.3ppha
2	All Residential parcels	0.57	<b>0.57</b>	111.7hh/ha	440.3ppha
3	For CWKHU only	<b>0.63</b>	<b>0.63</b>	170.4hh/ha	616.66ppha

Table 4.4 Net BAR and FAR on a different scales and their result on housing and population density (Source own computation)



According to own public buildings and compounds occupy large areas for example only 5 compounds hold 21,193m<sup>2</sup> area with the average size of 4,238.6m<sup>2</sup> taking 19% of total land area.

Comparing the years 1995 and 2021 we find that 47 new compounds were added from this 38 compounds were residential and 9 compounds were for other functions. The residential compounds took 2.86% of the area from the total neighborhood (all by Private housing units) and the other functions took 9% of the area from the total neighborhood. But the CWKHU increased in several compounds but decreased in the total land area this means they were subject to compound subdivision and compounds with only private housing units increased in number also increasing the area by 530m<sup>2</sup> for every new compound.

Based on the map (see Figure 4.6) FAR is muchly related to functions other than residential use as most of the compounds with a FAR value above 1

are non-residential functions and likewise, the BAR value is more related to residential use. The built-up density is around 63% which decreases the relative space between the housing units and it affects privacy and comfort negatively. For example, 33% of the housing units can't open their

window because they are physically blocked and 21% have no freedom to open them because of related problems of privacy, smell, and noise. Therefore only 46% can open their window.

## **B. Household and Population Density**

According to World Bank (2015), in Addis Ababa, from 2007 to 2014, the average density of the built-up area declined from 146 persons per hectare to 136. Also in Angel, et al., (2016) it is stated that built-up area density decreased from 192ppha to 142.4ppha and the urban extent density decreased from 125.2ppha to 101.6ppha between 1986 and 2010. Based on Larsen et al. (2019), the overall density of Addis Ababa decreases from 109ppha to 98ppha between 2006 and 2016. But the density of the residential area or residential density values increased from 170ppha to 201pph. Therefore from this, we can see that the population density decreased in the whole urban area and built-up area but the resident density has increased in recent times.

Based on data on population growth and built-up area increase World Bank states that land consumption surpasses the rapid population growth, and densities decline with serious implications. But this raises doubt about how the density declined while the city delivered more than 150 thousand housing units in multistory buildings in the last 15 years. The first reason would be in this construction boom in the city the residential share in new developments is low (see Figure 2.2) and the second reason will be that most of the delivered units must be occupied by a small number of family members. Showing another aspect Larsen et al. (2019), showed that the share of single families increased from 5% to 25% and most of the increase in residential density is in the inner city not in the newly developed area.

The residential housing density which is the total number of dwelling units per residential plot area equals 111.7hh/ha. Also, the residential housing density in CWKHU equals 170.4hh/ha. And the compounds with only private housing have 44.77hh/ha. The second measure is the population density in the residential compounds which is the total population per residential plot area of the study area which is 440.3ppha. The density for CWKHU equals 616.66ppha and for CWPHU equals 260.71ppha. Therefore the CWKHU is the main reason for the neighborhood having higher residential housing density and population density. Larsen et al. (2019) state in 2016 the land allocated for residential purposes equals 39% of the total area and computing from the structure plan gives around 40du/ha for the residential housing density of the whole city. Also, the city residential density in 2016 was 201ppha and if it continues with the same rate it will not pass 216.5ppha in 2021. Therefore the study area's residential density is above the city average but here also the density is higher because of the CWKHU which has a 52% increase in total residential density and around 152% increase from CWPHU. Larsen et al. (2019), shows the increase of density in residential housing area is because of infill development of the inner city not by the condominium housing in the city periphery that has a 20% or below BAR value. Also, they concluded that residential housing was not the cause of the city's declining overall density.

### 4.3.4 Indoor or Housing Unit Density

**A. People per Household and HU** - On the whole site from data collected and cross-checked with the woreda population record, there are 2,730 people in 560 housing units or 731hh. The average

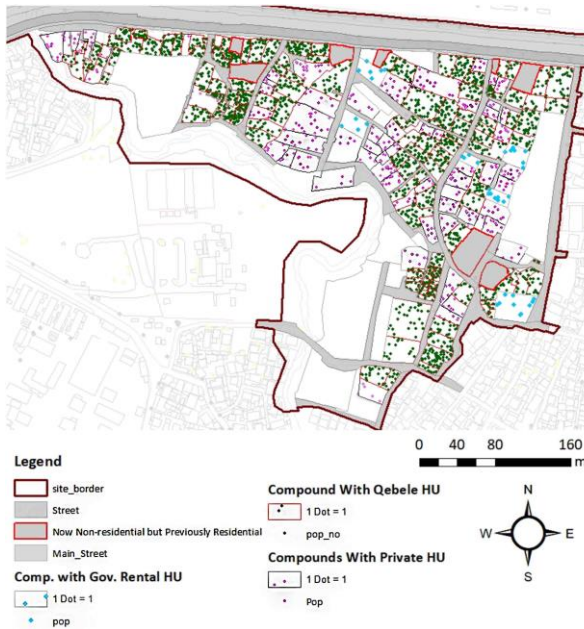


Figure 4.7 Population dot map of the area by assigning each dot for people belong to each dwelling

family size or person per household will be 4.87pphu and 3.74pphh. But isolating only the Kebele houses in the study area average family size for KHU becomes 5.3pphu & 3.27pphh.

Considering their small size one can expect overcrowding in the KHU. Person per Household for Other Types of households is low. There are 786 people in 194 housing units and they will have 4pphu on average compared to KHU they have a lower family size. In the population dot map, in Figure 4.7 we can simply notice the higher population density of the CWKHU. But further, we can see the floor area for each person.

**B. Dwelling Area per person** - The first one is the built-up area per person which shows the

total residential floor area of the dwelling units per total population, but as in other neighborhoods, we cannot use all the built-up area in the compounds under consideration. This is because here the compounds sometimes have buildings with public ownership like community police or idir house and mostly we can find buildings with communal uses of toilet and kitchen. Therefore isolating this we will have 32,768m<sup>2</sup> of the built-up area under residential function and dividing this by the total population of 2730 we get 12m<sup>2</sup> of area for each person. And isolating the CWKHU we have a 15,774m<sup>2</sup> area for 1944 people get 8.11m<sup>2</sup>pp. Comparing the whole area to KHU we have a decreased area of share for the dwellers. To compare this to average or to the city's minimum standards we do not have such density measures yet.

**C. Gross floor area per person** - What we consider a built-up area using the municipality map sometimes include footpaths or sitting area therefore we have to measure the gross floor area per person that uses the entire area within the perimeter of the exterior walls of the building.

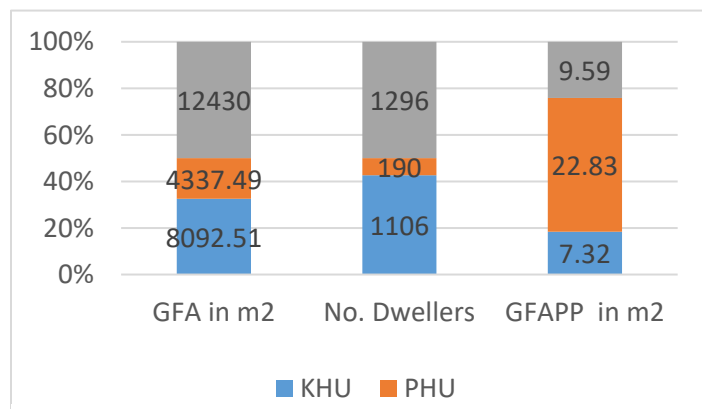


Figure 4.8 Gross Floor Area per Person

For 234 buildings surveyed the size of their perimeter was measured to find their gross floor area which is around 12,450m<sup>2</sup> and the total number of people residing in those units is 1,296 people. Therefore one can see here that the neighborhood's density is high because of the KHU as they have bigger family sizes and lower floor area per person.

Still, this lacks clarity because it uses the perimeter of the outer wall of the dwelling units and includes the space occupied by interior walls, circulation spaces, and stairs in multifamily dwellings. Therefore it doesn't represent the habitable or accessed floor space by the dwellers. This is very ambiguous and should be clarified as stated by Appolloni & D'Alessandro (2021), that the various regulations and/or indications are handled in different ways and the criterion with which space is measured is different for different cities.

**1. D. Occupied floor area per person and person per habitable room** – The first measure intends to show usable space and during the survey, the interior space was measured for each occupied room (see also **Housing Description**

). For 234 dwelling units measured we have a total of 10,831m<sup>2</sup> floor area and dividing this by 1296 people we get 8.35m<sup>2</sup>pp and separating KHUs only we have 5.99m<sup>2</sup>pp and for the private tenure types 18.6m<sup>2</sup>pp. Here one can see a big gap between the KHU and the private tenure types.

The above-occupied area per person calculates the overall occupied rooms including kitchen, storage units, corridors, and bathrooms if they are attached and privately used. Again to see the exact rooms used as living space meaning a space for living and sleeping we have to perform further computation. Therefore person per habitable room will be measured and based on this there are 1296 people in 784 rooms indicating that there are 1.65 people per room (1.65pprm). Separating the KHU we have 1.83pprm and for Private HUs we have 1.05pprm.

As stated the minimum floor allocation is mostly 14m<sup>2</sup> to 21m<sup>2</sup> floor space per person and 1.5pprm is used. Compared to this figure the study area has below the standard value which will have the stated negative influences on the dwellers. But isolating each tenure type the KHU has a much lower value with 5.99m<sup>2</sup>pp and 1.83pprm, but the private tenure types have an acceptable minimum standard with 18.6m<sup>2</sup>pp and 1.05pprm. Floor space occupancy shows the number of people per gross residential floor area. Therefore as stated there is 12,450m<sup>2</sup> residential floor space for 1296 people, so residential floor occupancy becomes 1,045. This measure is just the reciprocal of the gross floor area per person and is used mostly because it has a direct relationship with an overall density as one increases the other will also increase. Floor area density showing total residential floor area per site footprint equals 0.69/80. It resembles residential share density but its share is not from the total land area but it is from the built-up (Appolloni & D'Alessandro, 2021; WHO, 2018; Ranson, 1988).

#### **4.3.5 Combining Measured Density to Perceived Density**

According to observation (see Annex IV - The Context in Developing country ) by the dwellers of the population is, 81% have observed an increase and in housing unit's observation 58% observed an increase in the housing units. From this we can see that there is an increase in population or family size but not in housing units or built-up areas; this supports the small floor area share for each individual which is 9.6m<sup>2</sup>pp in gross floor area and 8.35m<sup>2</sup>pp in occupied floor space.

In describing the number of people living in the compound 63% perceived it as having from very small to a medium number of people, 37% as a large number of people and a crowded compound. As having multiple numbers of housing units in a compound with an average size of 4.87pphu it is obvious to expect some crowdedness in the compounds. As stated here around one-third of the people observed crowding in their compound.

And when asked how often they see an, unlike person around 70% answered that they sometimes or rarely see a visitor and around 19% see very often and 11% see always. This mostly can be attributed to the strong social bond of the society. However, we have to note that there are compounds that rarely see unlike person and there are compounds near the main road that see unlike person or stranger always, especially those who share facilities like a toilet with other land uses or building use. So the factor is also influenced by location and mix of functions.

Looking for the issue of privacy it was found that 57% have some type of issue regarding privacy while the rest do not have any type of issue. And from those 57% (133hu) 52% face problems while using the toilet and while bathing; 5% while performing household activities; 8% when they are socializing, 14% during different ceremonial events, and 17% when they try to relax or take their own time in the compound and the rest 4% while performing different types of activity.

Assessing the issue of disturbance 42% have stated that they face some type of disturbance. And from these 98hu 22% get disturbed because of different social and ceremonial events; 18% from activities across the street, 29% because of different functions other than a residence; 9% because of their neighbors' activity; 6% because of different activities in communal space and the rest 16% from other sources like illegal activity, and activity along the river line. We can combine this with the built-up area ratio or site coverage of the CWKHU and they have on average 63% of their compounds area is covered by the building. This minimizes the adjacent space between units, the setback distance with the street, and in addition to the reality of most compounds having multiple housing units, it increases the chance of seeing, unlike a person, a challenge in using the facility, and being disturbed by activities all influencing the level of privacy.

Above we have seen the dwellers' perception of their compounds and now we will see their view of their own home. When they are asked to compare the family size to available or dwellable space 93.3% have answered that their dwellings are crowded or are creating a challenge. Only sixteen interviewees answered enough or more than enough. From this, we can see that the

challenge of the dwellers does not lie at the neighborhood scale or compound level. The challenges presented by density are felt at a household level.

It is expected to get some issues with privacy while looking into the average 8.35m<sup>2</sup>pp in occupied floor space and 5.99m<sup>2</sup>pp for KHUs. As expected 72% of the housing units from the total of 234HU stated that they face some type of issues related to privacy. This is much higher than the privacy issue at a compound level which is 57% because it is easy to avoid the issue of privacy and freedom at a compound level. At the dwelling unit level they face problems related to privacy when they have a visitor (26%) when they want to bath or change clothes (43%), and during some activities like working, studying, resting, and feeding (31%).

According to WHO (2018), associates household crowding with adverse physical and mental health outcomes. Therefore assigning space or a room for household members is essential but it seems impossible in our case yet, 87% of the households have a culture of assigning space or room for the dwellers. Especially when the members are household heads, when they are married, and when members are old they are mostly assigned their room. Other than this there is no habit of assigning any floor space to any member or activity almost all things move around and change their function through time.

According to Ranson (1988), providing adequate space between buildings is important and it affects privacy, lighting, ventilation, and temperature. Likewise in our case with a higher built-up area ratio of 63% in residential compounds with small size fine grain patterns of randomly arranged units (see Figure 4.2) we have a smaller space between dwellings. As Ranson mentions spacing between parallel rows of buildings in England and Wales recommends a general width of 21.5m for privacy and lighting and 18m in Scotland. But in the Addis Ababa city structure plans of 2002, there is a mention of the site occupancy ratio however, the recent plan standards focus on the setback and the enclosure the buildings create. This is because the allocation of land for an individual resident is no more an option and today multi-story dwellings are being provided. Yet, spacing between these units should be provided. This is essential as the city is planning to further densify existing condominium sites.

In the study area, 175KHUs (91%) are physically connected to other dwelling units or other buildings and the front space clearance sometimes can be as small as a corridor. To show the issue of spacing the questionnaire asked for the ability to use openings in the dwelling units and the availability of natural light inside. Around 56% of the dwelling units do not use their window because of physical blockade (32%), visual interruption (40%), smell (21%), sound pollution (4%), and the rest 2% do not have any or because of adjacent function and other reasons. According to lighting, 65% have partial access, 22% have full access while 13% have no access to natural lighting.

With all these defects around 79% feel a sense of comfort in their compound based on the number of housing and number of dwellers. In a qualitative interview, their attitude towards

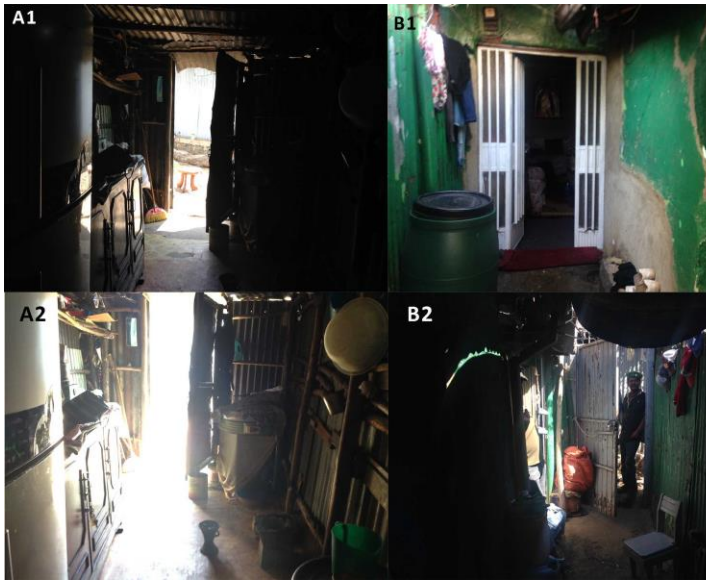


Figure 4.9 A picture of two housing units showing access to natural lighting (Source Photograph by the author)

their neighborhood was put to test by asking them to compare their neighborhood to a condominium neighborhood. The criteria given were privacy and the freedom to perform HH activity. As their comfort is dependent on their privacy and freedom to perform hh activity one might expect a result supporting the above statement. The result shows that 62.5% prefer their neighborhood for privacy and 84.4% prefer also their neighborhood for freedom to perform hh activities. In this case, when respondents choose between their neighborhoods there

are other factors like socioeconomic factors that influence their decision.

### Density Measures and their Relation

Based on Richardson et al., 2000 citing Malpezzi, 1999 showed that the correlation between high densities and overcrowding is quite low (in core cities in their data set, the correlation coefficient was 0.18) and similarly, density and household size appear to be unrelated. In our case, the correlation between housing unit density and gross floor area is not only low but also has an inverse relation (correlation coefficient of - 0.507) meaning as the gross floor area per person increases the value of housing unit per hectare will decrease. This is somewhat expected as most dwelling units are single-story buildings. Again the relationship between average dwelling size and housing density has a weak correlation and association with (correlation coefficient of - 0.606 and adjusted R square value of 0.363). However, the slope ( $b = -2.22$ ) suggests that doubling the size of the dwelling units would produce a 2.22HU/ha decrease in density. The main point here is to show that the combination of density and its factors combined will show us something so in the next table what we will do is just that based on the collected data (see Annex VI).

The second column in the above table represented by R is a Pearson R-correlation (Pearson product moment correlation coefficient) that shows the level of correlation between the variables. For quantitative variables that are normally distributed Pearson's Correlation is mostly used and for variables that are not normally distributed Spearman's non-parametric correlation is used here the research used the first one but checked if there is a big difference between the

two. And the correlation result is between 1 and -1, and if the result is 1 it means it has a perfect correlation, and the result between 1 and 0 has a positive correlation also the result between 0 and -1 shows that there is a negative correlation between the variables. Positive correlation signifies that as one variable increases there will be an increase in another variable too.

Regression for All Blocks						
Variables	R	Adj.r <sup>2</sup>	Sig.	B (Slope)	B const.	B 95% Conf. Interv.
BUA - Comp.A	0.891	0.793	0.00	0.485	37.65	0.442 - 0.527
BAR - Comp.A	- 0.458	0.204	0.00	0.00	0.794	0.00 - 0.00
Res.A – BUA	0.909	0.825	0.00	0.752	15.57	0.693 – 0.812
No.DU – Cmpd.A	0.673	0.449	0.00	0.007	1.362	0.006 – 0.008
No.DU – BUA	0.757	0.57	0.00	0.014	0.81	0.012 – 0.017
HUpha – Cmpd.A	- 0.457	0.202	0.00	- 0.214	221.72	- 0.285 - -0.142
HUpha – FAR	0.479	0.224	0.00	280.62	- 31.84	192.15 – 369.09
Ppha - HUpha	0.906	0.819	0.00	4.01	173.78	3.691 – 4.339
nm	- 0.26	- 0.007	0.77	- 0.051	8.01	0.770 - - 0.393
Regression for Linear Block with Row Housing						
Variables	R	Adj.r <sup>2</sup>	Sig.	B (Slope)	B const.	B 95% Conf. Interv.
BUA - Comp.A	0.99	0.98	0.00	0.68	8.01	0.637 – 0.742
BAR - Comp.A	- 0.44	0.13	0.08	- 0.01	0.93	-0.002 – 0.00
Res.A – BUA	0.985	0.96	0.00	0.96	0.07	0.86 – 1.06
No.DU – Cmpd.A	0.98	0.95	0.00	0.006	0.76	0.005 – 0.006
No.DU – BUA	0.965	0.92	0.00	0.008	0.71	0.007 – 0.009
HUpha – Cmpd.A	- 0.693	0.443	0.003	- 1.185	305.98	- 1.892 - -0.478
HUpha – FAR	0.337	0.050	0.202	247.87	27.18	- 148.83 – 644.59
Ppha - HUpha	0.773	0.569	0.00	3.826	306.39	2.028 – 5.625
GFApP - PpDU	- 0.16	- 0.071	0.95	- 0.051	6.20	- 0.836 - - 0.885
Regression for the Organic Blocks with Mixed Housing						
Variables	R	Adj.r <sup>2</sup>	Sig.	B (Slope)	B const.	B 95% Conf. Interv.
BUA-Comp.A	0.866	0.749	0.00	0.469	42.81	0.419 - 0.518
BAR-Comp.A	- 0.374	0.132	0.00	0.00	0.75	0.00 - 0.00
Res.A – BUA	0.902	0.812	0.00	0.746	0.07	0.68 – 0.81
No.HU – Cmpd.A	0.629	0.391	0.00	0.007	1.535	0.005 – 0.008
No.HU – BUA	0.728	0.52	0.00	0.014	0.92	0.012 – 0.016
HUpha – Cmpd.A	- 0.390	0.145	0.00	- 0.181	209.00	- 0.260 - -0.103
HUpha – FAR	0.361	0.123	0.00	201.56	20.05	105.83 – 297.29
Ppha - HUpha	0.907	0.821	0.00	3.937	174.26	3.601 – 4.273
GFApP - PpHU	- 0.36	- 0.007	0.69	- 0.072	8.32	- 0.438 - 0.293

Table 4.5 Analysis of Density Related Variables (Source own computation by summarising SPSS data)

**Key** - BUA – built-up area                      Comp.A – Compound area                      Res.A – Residential BUA  
 No.DU – Number of Dwelling Units              Ppha – People per Hectare                      FAR – Floor Area Ratio  
 HUpha – Housing unit per hectare              PpHU – People per Housing unit              BAR – Built-up Area Ratio  
 and GFApP – Gross Floor Area per Person

The third column with Adj.r<sup>2</sup> value shows the association between the dependent and independent variables. In the fourth column, Sig. is to mean significant value, and all the values less than 0.05 are generally determined as statistically significant values.

**Dwelling form and Density** - Density and dwelling form are highly associated for example the linear block with row housing has a higher association in all variables measured than the organic block with mixed housed form. The random configuration of the housing units in disorganized parcels of the organic blocks has created a waste of space and decreased density. To show this we can see the net housing unit density of both and in the case of organic blocks it gives us 111.7hh/ha and for the linear block, it gives us 192.4hh/ha. Therefore we can conclude that the variations in block size, shape, a possible configuration of the buildings, and their form influence the density.

**Built-up Area and Compound Area** - The relation between compound area and built-up area shows a high level of correlation and strong association with a correlation coefficient (R=0.89) and with an adjusted R value (adj.r<sup>2</sup>=0.79). However, the partial correlation by controlling for all other variables gives us a negative value of (R = - 0.126). This indicates that the other variables have also an impact on determining the level of built-up area. The Scatter plot graph shows that they have a positive correlation between the two and the probability-probability graph (p-p graph) shows that for small compounds the increase in the compound area results in a much increase in built-up area than the large compounds (See Annex VII).

**Built-up Area Ratio and Compound Area** - The association between the BAR and compound area is weak (adj.r<sup>2</sup> = 0.204) and the correlation coefficient R value equals (R = - 0.458) indicating that they have an inverse relation. See the scatter plot graph that the dispersed results in the graph show that they have a weak association between the two and one can also see the decreasing value of BAR as the area of the compound increases.

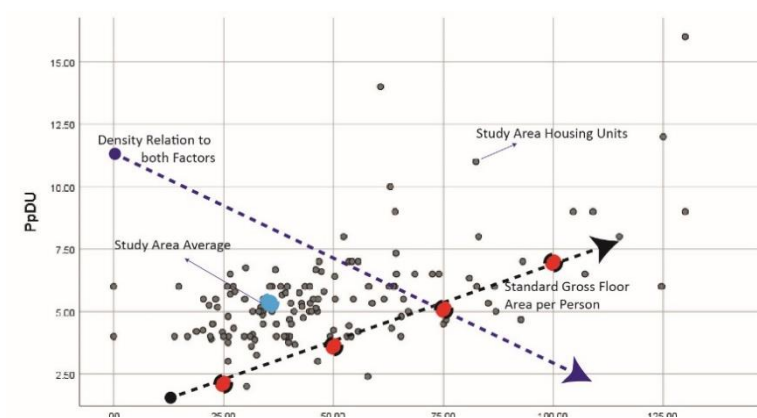
**Residential Share of Built-up Area to the Total Built-up Area** - As expected as the total built-up area increases the residential share or residential built-up area also increases. The association between the two has a higher value in both linear and organic blocks with an adj. r<sup>2</sup> value of 0.909.

**Net Housing Unit per Hectares to Compound Area** - The association between the lot size (compound area) and net dwelling density (net housing unit per hectare) in the case of single-family detached housing has an exponential function (inverse relation) (Alexander et al., 1988). The same is true for our case the graph resembles an exponential function graph (see Annex VII). Not only the graph but also the correlation coefficient also shows a negative value of (R= - 0.457). And based on the association between the net housing density and compound the study found out that it is true that for multifamily housing, lot area drops out as a relevant variable.

**Net Housing Unit per Hectares to Floor Area Ratio** - The FAR has a positive correlation to the housing density but the relationship or association is very weak. As Alexander et al., 1988 puts it for a single family detached housing the association will be very small because there will be less variance in the number of stories. Likewise, the compounds in the study area have several housing units but very few housing units with multiple-story housing. Therefore the association between FAR and HUpHa is expected to be low ( $adj.r^2 = 0.224$ ). The slope of linear regression ( $b = 280.62$ ) is another surprise suggesting that an increase of 100% in FAR would produce a 280.62hu/ha increase in net housing density. But for different variables results have fluctuated highly, so the above mention would become an oversimplification.

**Housing Unit per Hectares to People per Hectares** - The relationship between housing and population density will have a high association ( $adj.r^2 = 0.906$ ) because as the number of housing units increases the population number will also increase especially when those housing units (around 85%) have family size of four or more.

**Gross Floor Area per Person to Peoples per Dwelling Unit** - The association has an inverse relationship (negative value) this is expected because as the number of family members increases the available floor area will decrease.



The correlation between the two while controlling for all variables will have a bigger value ( $R = -0.701$ ) and controlling for Average dwelling size it becomes high ( $R = -0.848$ ). So we can say that the gross floor area per person is highly related to the dwelling size than the people per Housing Unit.

Figure 4.10 Graph showing the relationship between different density measures - 1 (Source own computation using SPSS software)

As form depends on morphological density one can see what the BAR and FAR values result in:

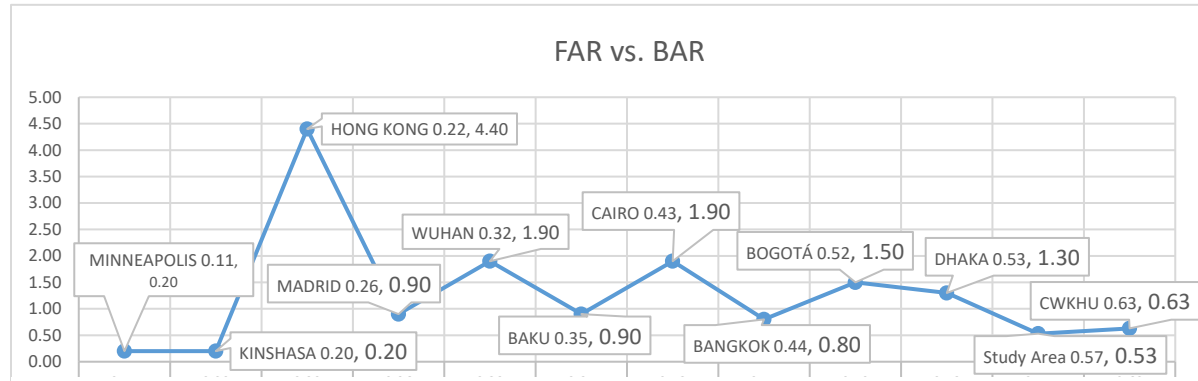


Figure 4.11 Graph showing Relationship between different density measures -2 (modified from Angel et al., 2021)

### 4.3.6 Life story's on Density

#### Mr. Asfaw Yame



Figure 4.12 Pictures of Asfaw Yame's Dwelling Unit and compound (Source Photograph by the author)

Mr. Asfaw Yame age 78 lives in the Lideta area married to Mrs. Tsige Balcha age 76. They had nine children together and have been married for more than fifty years. Mrs. Tsige was born in a region near Addis Ababa and during the marriage, they settled around the Bole area and lived in different places before acquiring this unit.

She states, *'I went to the qebelle and fall on my knees and begged the qebelle leader to give me a house by explaining my situation. I remember the name Mr. Belete he brought me up from the ground and promised me to find a house. After some visits, she found an abandoned building. So I told him the story. However, he warned her that the housing unit is not dwellable with holes all over the wall and he feared that the cold or wild animal might kill her child. She told him that 'it is better to get eaten by a wild animal than by her own.*

The owner Mrs. Tiruwork Gutema a widow whose husband used to work in the Imperial court nearby was generous and willing to Passover the building.

Therefore together with her husband they fixed the house it was a two-room dwelling unit with a detached kitchen in 1977 and they had a family size of five. In this dwelling, they added 6 children they had nine children but three of them died.

She remembers that after the acquisition she used to work in different households nearby by baking Enjera, and her husband got a job in the qebelle administration office as a security officer. But after 1994, her husband was jailed for not testifying on the previous officials for killing EPRP members, as she explains: *'My Husband told all the truth but they were*

already determined to jail him if he didn't testify against the leaders so they jailed him for eight years from 1994-2002'.

During that time she used to do any job in the locality by washing clothes, baking enjera, and selling sugar cane in Sebategna and Mercato 'the city's largest market'.

Her husband got released in 2002. During this hard time, they lost their three children, at which

two of the three left her with four grandchildren. After the release her husband was sick most of the time, today he has almost lost his eyesight and is very angry and depressed most of the time because of his past. He doesn't work and moves out of the compound unless it is to church once a week with help from her and daily sends four to six hours in the compound.

She is also ill from womb (uterus) cancer and she has been getting treatment from the 'Black lion' hospital for years, before that she was also ill twice for more than a year and no one from her children was able to look after her. She says 'All my neighbors washed my body, changed the sheets, feed me, and took me to a holy water place to the church, I am what I am today because of them'. So the responsibility of caring for her husband, her son, and her 4 grandchildren fall on Mrs. Tsige. Mrs. Tsige today has a Ruta graveolens 'Tena Adam' and Arundo donax (Shembeko) plantation in the compound (See numbers 7 and 10 in Figure 4.13), they have no other income other than this and get around 1200 birr/month.

When they entered the dwelling they had only five family members and a deteriorated building with two rooms. Today they have a family size of twenty-five distributed to six housing units for their children who established their own families. Mr. Asfaw and

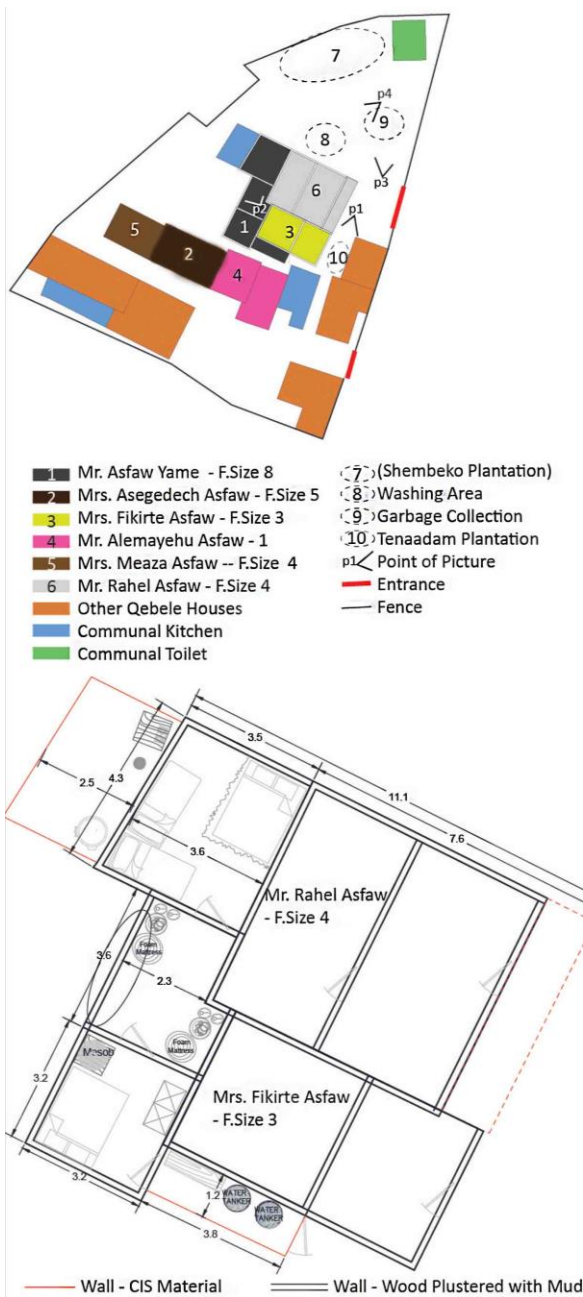


Figure 4.13 Compound Map and floor Plan of Mr. Asfaw Yame Compound (Source on site Measurements by the author)

Mrs. Tsige have a family size of eight, one sick child, and four grandchildren Soleana Solomon age 7, Sabela Abdulkadir 23, Amen Kaleab age 7, and Nasir Hilme age 2. Tigist Asfaw age 27 is also a grandchild but named after her grandfather because her family died and she is a divorce living together with her grand family with one child Nasir Helme age two.

- Aseggedech, age 49 with a family size of five acquired the building in 1990 when she got married.
- Alemayehu age 34 is a fourth child and he is single and works as a driver for the private sector. He moved out of his family's house around 2006 in need of privacy.
- Fikirte, age 32 is the fifth child and a counselor in a private hospital and is married to Haile Faye age 48. They acquired their dwelling during the birth of their first child Milkias age 12.
- Meaza, age 31 is the sixth child and a housewife married to Gashaw Bayu they have two children together Yafet and Biruk Gashaw ages 13 and 4 respectively. They acquired their dwelling when they got married in 2008.
- Mesfin Asfaw, age 30 is the seventh child in the house and he is single and unemployed still living together with his family.
- Rahel Asfaw, age 28 is the eighth child in the house and is married to Belayneh Bekele age 32, and a taxi driver. They have a family size of four with their two children Betselot and Eyobed Belayneh ages 3 and 1 respectively. They changed one room of Aseggedech's house to another housing unit and moved out from Alemayehu's house.

No.	Density Measure or Ratio	Value	Mean Value for CWKHU/192HU
1	Compound Area	1012.36m <sup>2</sup>	259.91m <sup>2</sup>
2	Compounds Shared Space Area	368m <sup>2</sup>	51.98m <sup>2</sup>
3	Compounds Built Up Area	444m <sup>2</sup>	163.62
4	Residential Use Share in BUA	86.29%	84.76%
5	BAR	0.43	0.63
6	FAR	0.43	0.63
7	household per hectare	118.53hh/ha	170.4hh/ha
8	People per residential compound	385.23ppha	616.66ppha
9	Persons per housing unit	3.25pphu	5.31pphu
10	Gross R. floor area per Person	5.25m <sup>2</sup>	7.3m <sup>2</sup> pp
11	Persons per habitable room	2.6pprm	1.83pprm

*Table 4.6 Density Profile for Mr. Asfaw Compound and Dwelling Unit (Source own computation)*

As we can see in Table 4.6 they have a large shared space and compound area with low BAR and FAR values bringing low value in both housing and population density compared to the other compounds. The available open space is used for different social, livelihood, and household activities. But even if they had enough space and freedom to build the density at the household level is below average because of their low economic condition.

## 4.4 Neighborhoods Mix of Function

### 4.4.1 Change in Mix of Function

#### The Mix of Functions at Compound Level in 1972 and 2021

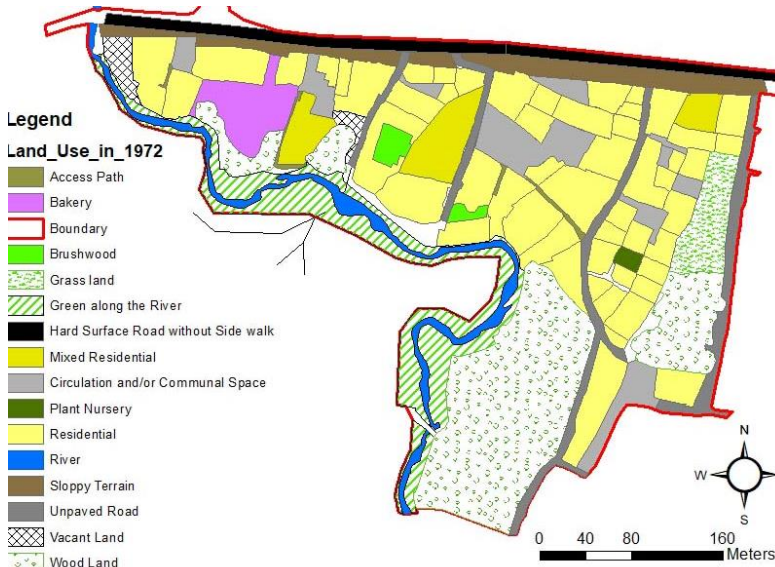


Figure 4.14 Study Area Land use in 1972

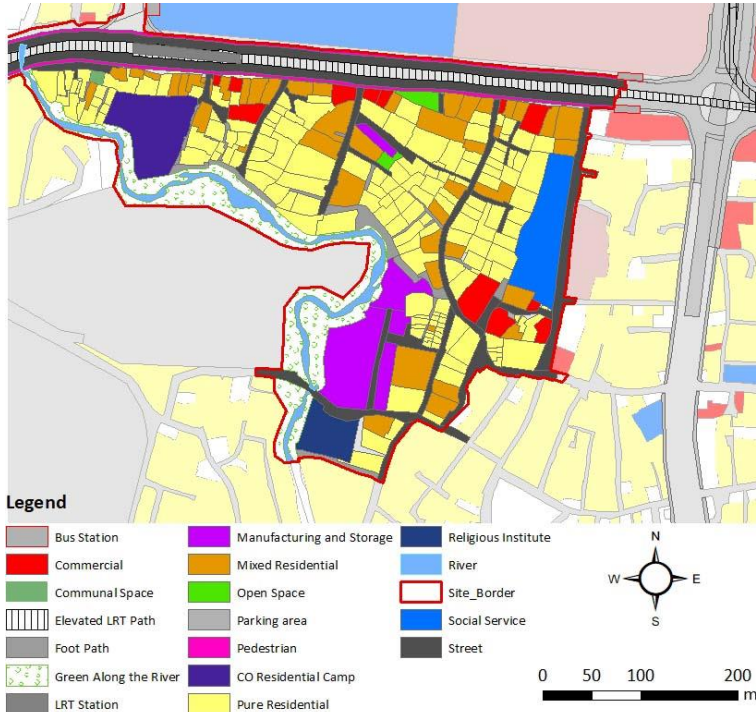


Figure 4.15 Study Area Land use in 2021 – the color coding uses LBSC (Berke et al., 2006, p. 210) with some modifications

From the two maps of 1972 and 2021 (Figure 4.14 and Figure 4.15), we can generalize that:

- There is an increase in pure residential land use (2.71%) and an increase in the number of mixed residential land use (11.82%) but in recent times the site showed a decrease in both functions.

- Increase in Manufacturing and storage land use (3.15%).

- The addition of new types of land uses like churches, mosques, schools, and correctional officer's camps created or increased a land use share for a religious institute, and a service land use.

- A decrease in the natural landscape and an increase in manmade features

If we take the vacant land, brushwood, grassland, woodland, and plant nursery together as open space they account for 25.28% in 1972. However, we can see that there is a significant decrease in open space as it accounts for 0.82% in 2021.

- The emergence of multistory buildings in place of private residences as the residential units changed to full commercial

use brought new land uses for commercial use only (see Annex VIII).

The mix of functions at the compound level was compared to the 2002 structure plan norm and standard. And this norm and standard follow the allocation of land area for each function. Based on this the existing share of use of the open space and pure residential functions are within the allowed standards. Manufacturing and storage land use is a little above the allowed standard and the other land uses (service, street, and mixed residence) are a little below the standard. However, it doesn't specify the expected floor area for each function in a building (See Annex VIII-C).

#### 4.4.2 Mix of Function (Building use) at Neighborhood Level

The study area is dominated by pure and mixed residential building uses both have around 75% of built-up space and about 10 percent is MSE and the CO or police camp. There are also new buildings rising from the concentration of G+0 buildings with a higher value of floor area ratio in a gradual gentrification-like process. The built-up area values in red are not included in the total value because most are temporary shelters and open spaces or are already included in mixed residences (See Annex VIII-D).

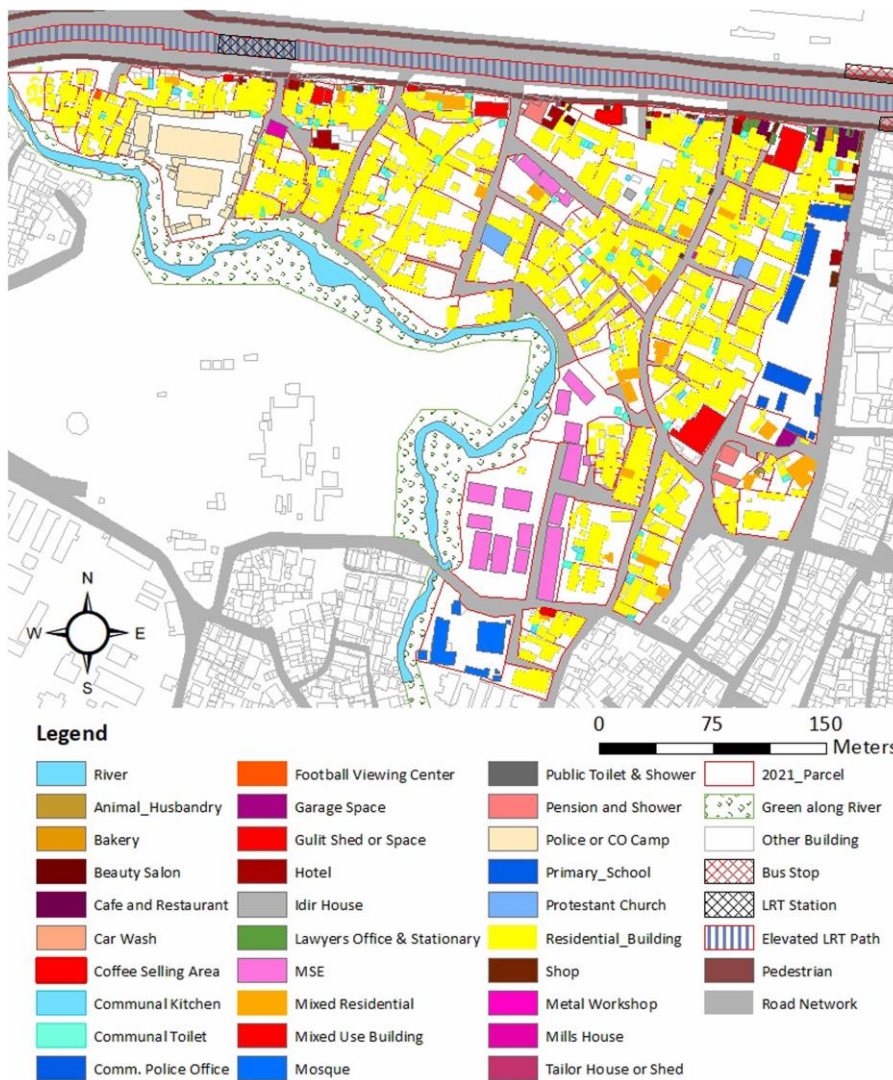


Figure 4.16 Study Area Building Function/use

value because most are temporary shelters and open spaces or are already included in mixed residences (See Annex VIII-D).

No.	Building Use	Gross Built-up Area (m <sup>2</sup> )	%	Standard	Remark
1	Mixed Residential Use	1561	3.3	50%	Below
2	Pure Residential Use	31226	66.4	Not Allowed	
3	Commercial Use	2390	5.1	50%	Below
4	Service and Administration	4491	9.6		
5	Religious Inst.	1335	2.8		
6	Manufacturing and Storage	3239	6.9		
7	Communal Use	2784	5.9	unknown	
	Total	47026	100		

Table 4.7 Mix of functions with their total built-up area coverage and percent share (Source own computation)

### Compatibility, Intensity, and Efficiency of Functions

For further analysis first, the study will describe the residential share density of the neighborhood which takes 57.8% of the total study area. There is no determined residential share in the proposed land use or land area in the structure plan. This structure plan focuses on floor area rather than land area and doesn't specify land cover share for each function. Also according to Larsen et al. (2019), the amount of residential share in the central area dropped from 51% to 43% while in surrounding sub-cities increased from 31% to 38%. Compared to the city scale the study area residential share taking 57.8% in land use cover and 80% in a built-up area is decreasing in recent times like that of the inner city. This is expected in core areas of the city as commercial and other functions tend to push the residential use outward.

The street takes 16.5% and looking into conventional and fully accessible streets for all public, we find that they account for 10.4%, open space takes 6.49%, and other land uses other than residential use take 19.1%. So based on this description the area falls short in open space and street share. The pedestrian share is 1947.57m<sup>2</sup> which is only 8.4% of the total area of the existing road. The structure plan intends to increase road density from the existing 13% to 25%, Dedicate 50-60% of the street area to centers located inside the existing ring road, and identified sections along transit-oriented development corridors for NMT.

Also based on the review we know that the street density is below the acceptable level and 53% of streets in the city core do not have enough pedestrian facilities. So our site has also the same character as the rest of the city's inner city area.

We have 7,335.8m<sup>2</sup> of open space which is 6.49% of the total area. And according to the structure plan green area, open space, plaza, etc. should cover 30% of the total site area. So we have a significantly below standard share in open spaces. It is going to take a lot of space from residential share. Around 21% of the land on the site is used for other types of functions and also 20% of the built-up area is occupied by this function of the total built-up area. That is why they have a low BAR value of 0.37 while the residential plots have 0.57 and CWKHU has 0.63. After observing the mismatch between existing context and standard we move to other assessments.

In a qualitative interview, the available functions in the neighborhood and the distance to this activity, and the ability to access them was assessed. Based on their response all of the households have available functions of guilt (street vendor) or small market, education center, health posts/centers, shops, and different commercial centers like hotels and restaurants. This shows that the study area has abundant service and commercial centers. The most absence in function is attributed to playing ground, communal spaces, and parks showing the shortage of open spaces. There is also a high level of access or availability to religious centers and transport nodes.

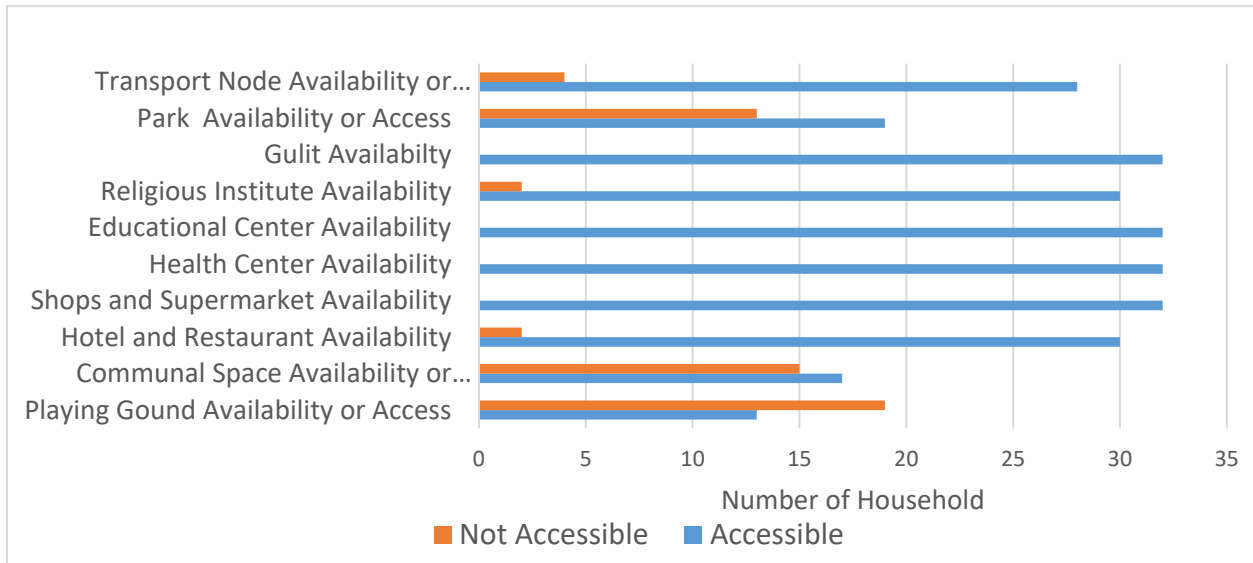


Figure 4.17 Availability or Access to Different Functions (Land Use)

While accessing the distance of available functions the distance was encoded into four categories. The first one that is available at the nearest location is assigned for activities that exist inside or next to the interviewee compound. The second distance exists within a 100m radius and is taken as a nearby location, the third one exists within a walking distance (400-500m) and is taken as medium distance, and activities above 500m are taken as far.

Therefore based on this allocation the different types of open spaces like parks, communal spaces, and playing grounds exist dominantly in far or medium locations and the same is true for religious centers and health services. For example, 65.62% for playing ground, 40.62% for communal spaces, 37.5% for a park, and 59.37% for the religious institute has to travel more than 500m to access them meaning they have to travel more than the distance that is considered easy walking distance.

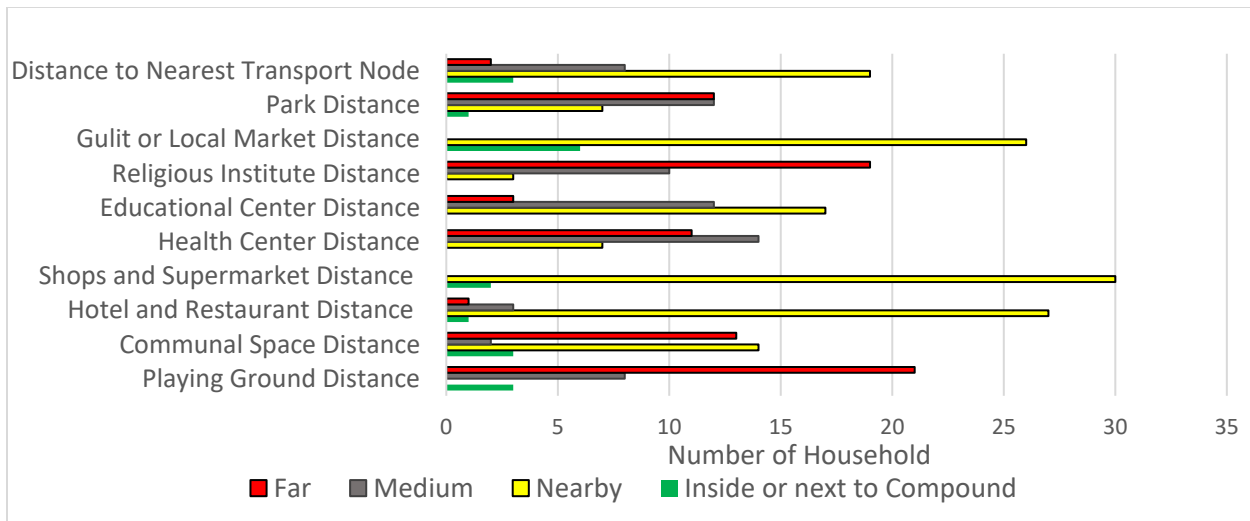


Figure 4.18 Distance to Different Land Uses or Functions

The most available or easily accessed from a nearby location are the commercial centers like shops, hotels, and restaurants, and gulits or informal fruit and vegetable vending's. The transport stations or nodes are also dominantly accessed (93.75%) within a walking distance or mostly in a nearby location. The services are relatively in a medium distance or mostly can be accessed within a walking distance. For health centers, 65.62%, and for education centers, 90.62% of households can access them within walking distance. However, we have to note that around 34.37% of households can't access a health center within this distance meaning they have to travel more than 500m or take a taxi during the time of need.

Checking the compatibility of each function to residential use we get that 23% of the residents are negatively affected by commercial uses and 12% by manufactory activities. The other land uses that negatively affect the dwellers include the river and activities attached to it, large factories to chili mills, some religious centers, and football viewing centers. And the problem they face because of the above functions is dominantly categorized under smell and noise pollution together a counting for 85% and the other problems they face can be categorized under visual, and privacy challenges.

The compatibility of the land uses in the study area during analysis can not only be from inside it because the issues of incompatibility can arrive from or influence the area outside the site. The area has already installed an LRT line and is already defined for future TOD Development. However looking into the surrounding area holds large plots of administrative, service, and manufacturing land uses. First, this minimizes the share of residential use and second, it holds large manufacturing that discharges waste to the river and creates pollution that affects the residents.

## Land Use Diversity and Mixedness

Using the computation developed by Shannon & Weaver, 1949 that was also used by (Mavoa, et al., 2018; Chen & Song, 2020) land use diversity can be analyzed for different purposes. The Land use mixedness based on Zhang and Guindon's, 2006 computation was also used by (Huang et al., 2018). The above two methods connected to other measures that help to determine transit nodes for potential TOD were also used for 22 stations of Addis Ababa (Teklemariam & Shen, 2020). Based on their result this area shown in the map that includes our site has a 0.61 value in land use diversity and a 0.79 land use mixedness. But they did not include manufacturing use and

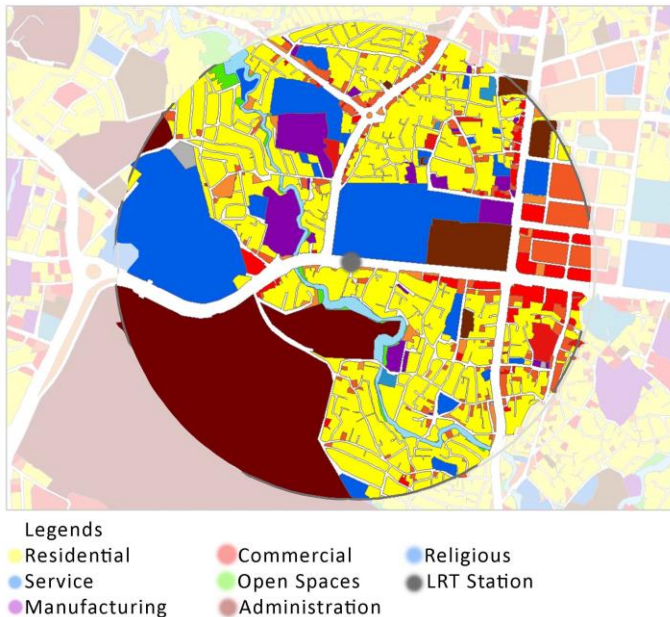


Figure 4.19 Existing Land Use Map of the Area in 800m Radius from the Station

here all land use is considered and results show a 0.92 in land use diversity and 0.76 in land use mixedness.

Specifically, the computation was used for the study area only and it shows that it has a 0.83 value in land use diversity (meaning there are numerous land uses). Here a detailed study was conducted and saw each land use at the building and compound level so the increase in diversity is expected but still, it shows how much diversity of use the area has. The second measure is land use mixedness with the value of 0.33 this shows that despite the high level of diversity the area has a lower

level of a mix while relating residential function with other functions (see Annex VIII-C).

## Intensity of Functions

Using a space matrix that treats density as a multivariable phenomenon approaching and defining in terms of five indicators by using the existing floor area gives us the unique character of the area and it is effective to differentiate or describing the urban form. Using the organized data (See Annex X. Floor Area Index for Five Types of Functions) the study checked the correlation between all variables (the floor space area of all functions) and almost all of them have a very weak relationship with each other ( $R=0.2$ ).

This is because every function has its plot (compound) and the building is dominantly G+0 so it is expected to have a low level of relation. However, as we have seen in (See Figure 4.6) the floor area ratio is much more related to other functions except residential ones. And here we can simply witness that the intensity of function is much more related to or is influenced by the type

of street in other words it is more related to the level of access. This is because streets with more traffic attract different functions. And residences resist the other types of functions.

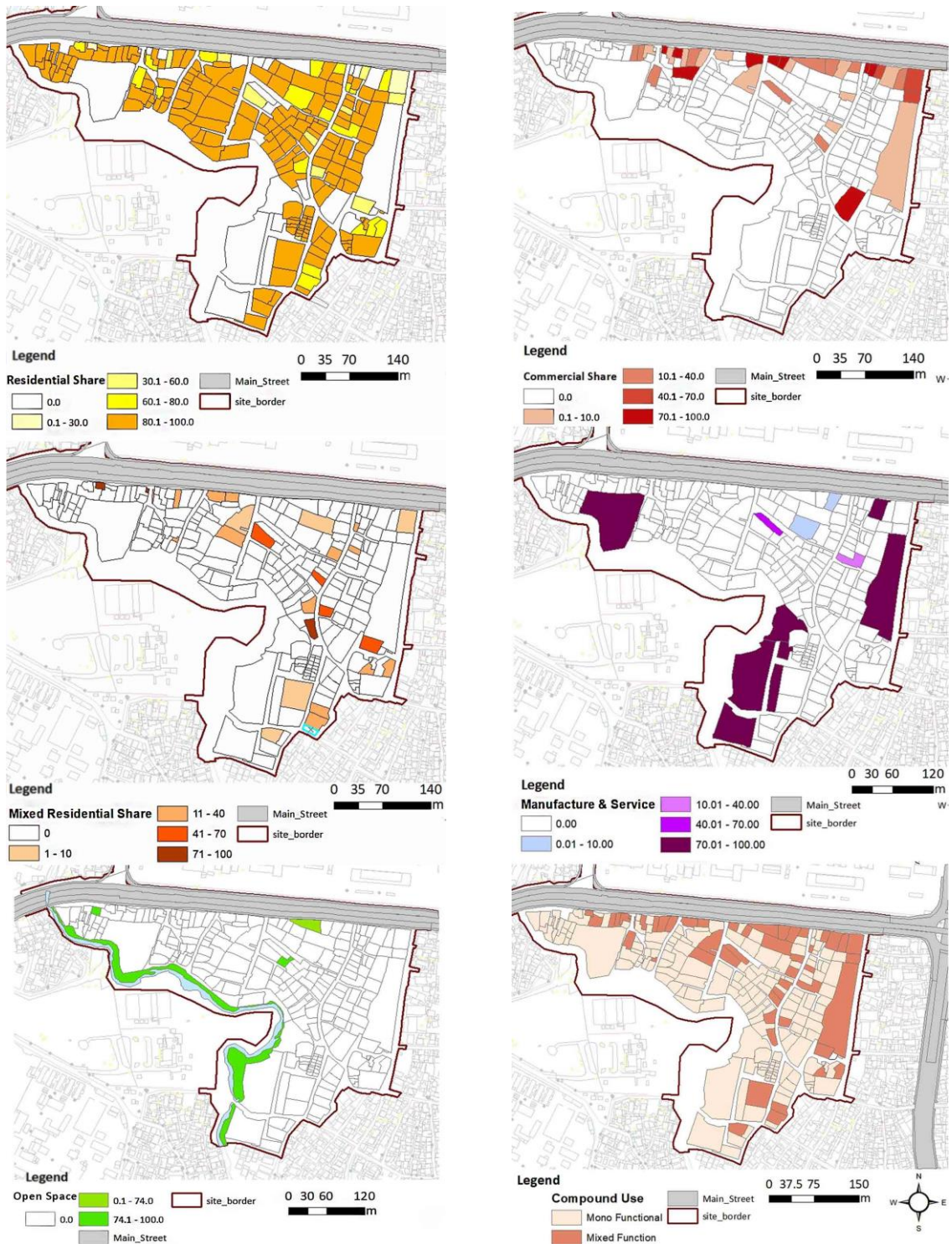


Figure 4.20 Accessible Residential, Mixed Residential & Open Spaces of the Neighborhood or within 500m from LRT station  
 Second row - Accessible Commercial, Manufacturing & Service with Mono and Mixed Functions of the Neighborhood within 500m radius of LRT Station

## The efficiency of the Land Use

Year	No. of Comp.	Built Up Area in m <sup>2</sup>	Av.	BAR	Population	Change in Built up area	Pop. change	Land gro. Rate	Pop. growth rate	LGRPGR
1972	99	22,762	51.15	0.34	1025	49%	92.7%	0.017	0.028	0.607
1995	180	34,068	37.72	0.45	1,975					
1995	180	34,068	37.72	0.45	1,975	38%	38%	0.012	0.012	1
2021	227	47,026	38.96	0.52	2,730					
Year	No. of Comp.	Built Up Area in m <sup>2</sup>	Av.	BAR	Year	% change in infill	Pop. change	Land gro. Rate	Pop. growth rate	LGRPGR
2011	195	45,303	39.53	0.50	2345	3.8%	16.41 %	0.0037	0.0152	0.24
2021	227	47,026	38.96	0.52	2,730					

Table 4.8 Study Area Land Use Efficiency Computation of LGRPGR (Adopted from UN-Habitat, 2018)

Based on the structure plan and World Bank assessment in the city of Addis Ababa, the growth in the built-up area is outpacing the increase in population. Also, another study that analyzed ULUE in Bole and Akaki-Kality sub-city found that in almost all expansion frontiers (of both sub-cities) there is a prevalence of urban land use inefficiencies, i.e. pervasive practices of land hoarding and land use fragmentation. They also state that urban sprawl is rampant with a significant part of the land transferred being left vacant or underutilized for years (Koroso et al., 2020). And this is expected as both sub-cities exist in the outer sub-cities and have a large open space that is booked by the municipality for future development.

However, in the above table the specific site that exists in the inner city has a different result. Our study area shows from the computation above, between 1972 and 1995, the study area built

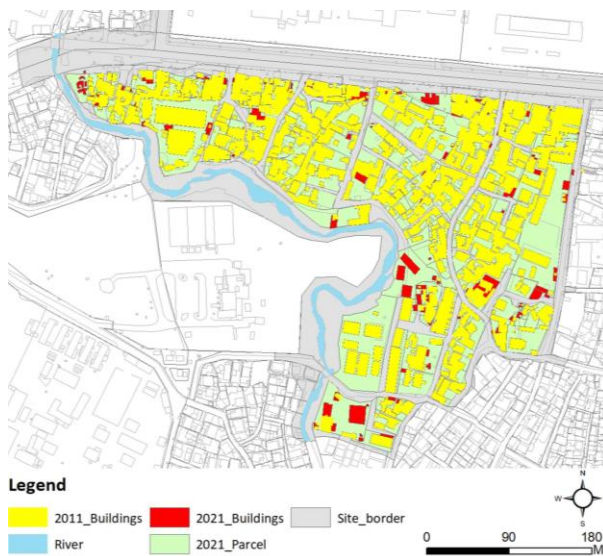


Figure 4.21 Change in Built Up Area between 1995 and 2021

up cover consumed open spaces inside the neighborhood and compound shared spaces at an annual rate of 1.7%. But in recent times the population change in the area is around four times bigger than the change in infill development. And if we consider the change in a built-up area in residential compounds there is a large increase in population number with an insignificant increase in a built-up area. The largest share of change in number and area of the compounds and buildings is in the first 25 years between 1972 up to 1996 which can also be attributed to the establishment of the kebele houses.

Recently the increase in a compound is mostly the result of the subdivision of the previously existing compounds and the subdivision and appropriation of linear kebele housing units constructed in undeveloped areas of the neighborhood.

#### 4.4.3 Mix of Function in a Compound

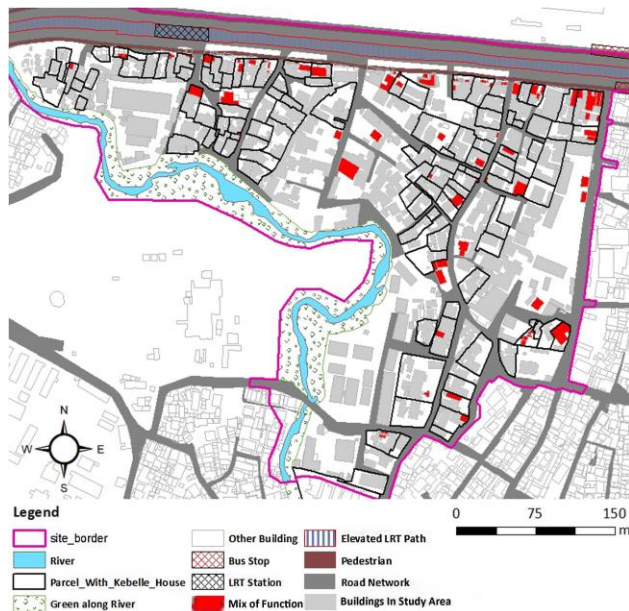


Figure 4.22 Mixed residential units in CWKHU

In the map, the buildings highlighted in red represent a mix of functions with residential units. Therefore to study the mix of functions we can assign the functions for each dwelling unit as presented in the previous section (See Figure 4.16). So approaching CWKHU most compounds use detached units that serve as a communal toilet and kitchen; 26% of the compounds have communal kitchens and 47% of the compounds have communal toilets. Sometimes there might be a communal kitchen and toilet but some of the households will provide their kitchen and toilet isolated from other households inside the compounds or in some cases

they might use the facilities from another compound.

From 134 CWKHU 30 compounds or 22.38 % have other types of function in addition to residential function the rest of the compounds are pure residential. In these thirty compounds, we have forty-five households with a mix of functions. But the mix is not always a commercial unit, sometimes these compounds contain services like community police stations, social services like Idir meeting halls 'idir bet', and small-scale productions like chili mills.

But mostly the mix of functions that exist in the residential compounds have an income-producing activity or some type of economic activity. And looking into the types of those economic activities indicates that there are six shops, nine gultis' (informal fruit or vegetable vending) mostly in front of or nearby their dwelling), one animal husbandry, one small farm, five SMEs, seven coffee selling, four construction work, two local tailors, one metal and woodwork and two other commercial activity exist in the neighborhood.

Asking those households with economic activity attached to their HU, for their preference of location to conduct their activity. 75.5% choose their neighborhood and 24.4% have preferred another neighborhood. and while asking for their cause they give reasons like the number of customers, isolation of the household especially near the river, availability of space, the type of

commerce they involve in, and its profitability, and lack of access due to infrastructure failure where the main reasons. Based on their answer we can say that the commercial activities mostly depend on location, access, and the density of the area.

**Shared spaces** inside the compound are the other places with a mix of functions or with different types of activity that shape the form of the neighborhood. And these spaces exist in 73.5% of the compounds, the rest 26.5% have no shared space or sometimes they can have space between

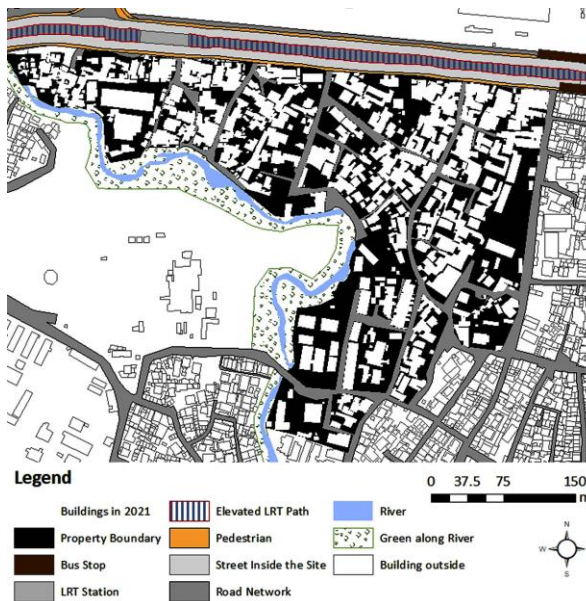


Figure 4.23 Reverse Figure Ground Map of the Study Area

buildings but they are linear and small only used for circulation and are not suitable to perform any activity.

Also, the dwelling units in CWKHU are small and the available space in the housing units is below standard. And in average these compounds have 96.29m<sup>2</sup> open space but the measured area that is accessed and is used as a shared space in the compound has an average area that equals 52m<sup>2</sup>.

Therefore because of the size of the dwelling unit and the availability of shared space in the compound the dwellers use it for a different purposes. To understand the shared spaces we have to see first a simplified form of buildings'

orientation in CWKHU that exist dominantly in the study area and how they shape the mentioned shared spaces.



Figure 4.24 A simplified form of dwelling units' orientation in CWKHU (Source illustrative description by the author)

In describing the general character of the study area we have seen that the dwellers involve in different social activities and they have close relationships with each other (see Annex IV-2). And now we can see the place for those activities from the qualitative Interviews. Accordingly, the study of the shared spaces demonstrates that different activities spill out from the housing units to the compound and sometimes to the nearby street or communal space. The dominant share of activity takes place inside the household but the activities also take place in multiple places.

The assessment of both collective activities and individual activities was assessed during the study. There is a fine transformation from the public domain to the private domain and this existed because most compounds are fenced. So they create a semi-private domain inside compounds that is suitable for different activities before going to a full private domain.

Based on the category applied to study people's activity in 'life between buildings' of Gehl (2011), the study categorized different types of activities of the inhabitants into three categories social, household, and livelihood activities, and based on it the study assesses the compounds shared spaces. These spaces host different household activities, livelihood activities, and social activities.



Figure 4.25 Different Pictures showing the compound space and activities in them (Source Photographs by the author)

The household activities include washing clothes, washing utensils, cooking, preparing spices, hair braiding, etc. The livelihood activities include any type of activity that brings income to the household. Social activities as Gehl describes them: are all activities that depend on the presence of others in public spaces (compounds' shared space). Social activities include children at play, greetings, and conversations, communal activities of various kinds, and finally – as the most widespread social activity – passive contact, that is, simply seeing and hearing other people.

From this assessment, 42.18% do not use a compound shared space because there isn't one of the shared spaces are not accessible or they can only be used for circulation because they are very narrow. The rest of the households 57.82 % use the compound space for some activity. The dominant activities in the compound are household and social activities. And around 60% of surveyed households do not have any activity in the vicinity of their compound. Around 40% have some activity around their compound. Looking into the types of activity the dominant one is a social activity with more than half of the hh having some type of space and daily encounter for regular social activity. And around 18% of households have a livelihood activity in front of or nearby their compound also 14% perform some type of household activity outside.

When asking for the comfort level of their compound 21% have described it as good and 13% as a medium while 24% expressed it as not comfortable. Based on their description and based on a qualitative interview the available freedom in a compound to perform any activity, the slope, the relationship to their neighbor, and the size of the compound shared space (see pictures no.3 & 4 Figure 4.25), the existing visual, sound and smell quality of the area where some of their criterion. As we can see in the pictures presented below the compound shared space is used for a different activity and the other aspects that affected the quality of the space where the existence of different functions in a compound. Also when the shared space is too big they tend to fence the immediate space in front of their housing unit (Figure 4.25 picture no.1).



Figure 4.26 Pictures showing some of the study areas shared spaces and different activities in them (Source Photographs by the author)

#### 4.4.4 Mix at Household Level

Because of the size of the dwelling the households use multiple places and outdoor spaces for different activities. Also the level of economy and available household materials; utensils used and the adopted way of performing that activity (tradition of work) are the other reasons for the activities being performed in multiple spaces. For example, making coffee is not a simple task of taking a finished packed coffee flour from a cabinet and mixing it with hot water in a boiler that can be performed in one place or small floor area. In our case it might involve buying a coffee bean from a neighborhood shop, taking coal from storage space and burning coal in the compound, processing the coffee bean in the kitchen and living room, setting up a coffee ceremony place, and drinking it together with family and sometimes with neighbors. The same goes for preparing food and spices which are also processed and stored in multiple spaces.



Figure 4.27 Most common types of Kitchen  
(Source Photograph by the author)

The tools used in the household activity can determine the way we perform each activity and this contributes to the changes made in the space of the household. For example, the replacement of coal and fire woods by electric utilities has brought functional change to the

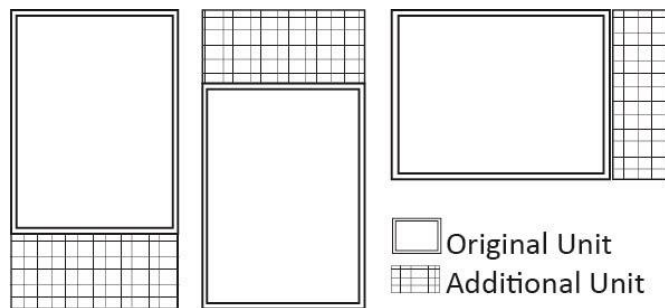


Figure 4.28 Most Common types of extension for the kitchen (Source illustrative description by the author)

kitchen. These electric tools do not have smoke and do not require a large space as the previous devices. And to take good care of the tools by putting them in safe places and because of fear of robbery, the electric tools are kept inside the house. So the kitchens are becoming less frequently used unless they have some type of activity for a ceremonial event, so they are being transformed into another room mostly into a bedroom. Being evident of this the study on the transformation of housing revealed 14% of functionally changed rooms were from kitchen to another function.

The type of material used for the construction of the units also becomes a reason for the activities to take place outside or in the compound shared space. For example, washing clothes or utensils in a house constructed from wood and mud and sometimes also the floor being earth material will create a mess and physically deteriorate the conditions of the wall. Therefore almost all households perform the activity of cleaning and washing in the compound shared space.

**The rotational use of space** - Most activities in the household are collective acts, drinking coffee, eating, watching TV, and sleeping. What is a simple act in western culture becomes a collective act and a ritual-like endeavor in our case. So based on their activity the room will be structured and re-structured for such activity at different times of the day. As stated the KHU have a small available space an average of 3.14 room per housing unit and also the size of the rooms is small on average there is a 11m<sup>2</sup> floor space area. The activities are distributed in all rooms and sometimes spill over to the compound shared space and sometimes to the detached communal kitchens in the compound. But most household activity takes place in the living room, this room is mostly the immediate room from the compounds' shared space or if the rooms are arranged sideways the room with the entrance becomes the living room.

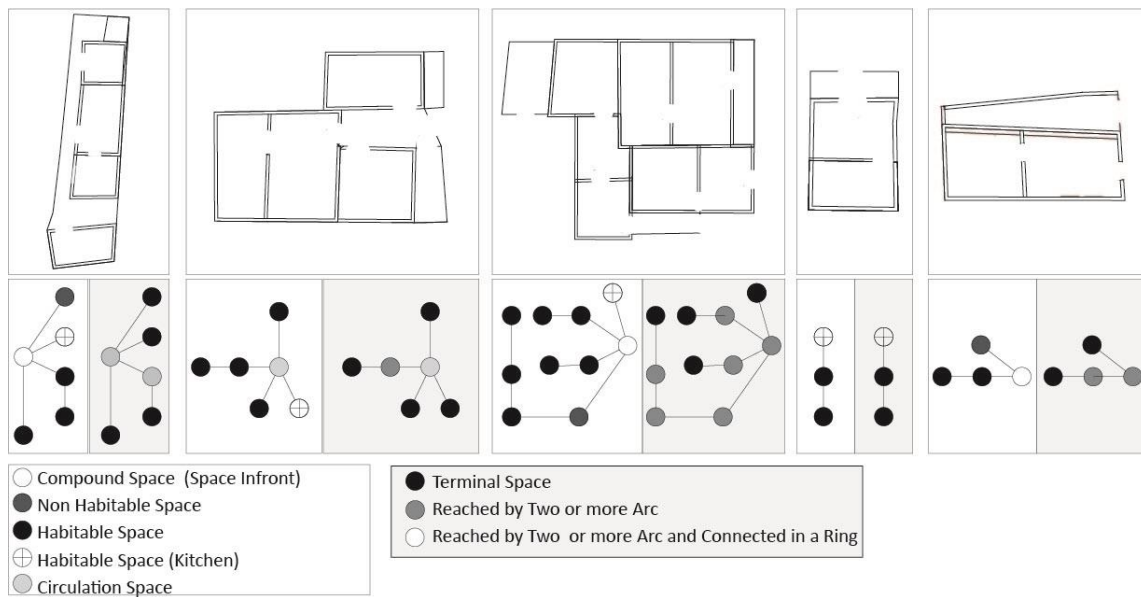


Figure 4.29 Some of the dwellings floor plans and justified graphs showing distributed-ness (Source diagrams computed by the author)

Activities of dining; working or studying; watching TV and other entertainments; coffee drinking and talking; preparing food and in family units it also serves as a bedroom for children. The second room in the back or side is mostly isolated deprived of natural lighting and mostly lacking a window (*look at all the floor plans in the life stories*). So they are almost always assigned to a bedroom for the household heads and additional activities might be attached like: dressing, temporary storage of processed foods, and sometimes they include storage spaces and cooking areas.

**Meaning of furniture** - A piece of furniture is not a simple material it sometimes becomes a means to show others the material wealth of the family, and in other cases becomes a decorative object to be displayed. In a different aspect, it can hold a memory of a family member, or sometimes it can also be used in separate spaces to create privacy within one room. When the furniture is expressed as something that holds a memory it is to mean that if it is from their

previous house or village, or if it is inherited from their family it will hold some memory of their previous life (beloved one).

**Space vs. Person (Space claim)** - As stated in the previous sessions 87% of households have a culture of assigning a space for some activity or member of the family. But from those (87%) the dominant households assign a bedroom for the household heads and kitchen space for female members of the families. Other than this the collective and shared use of space and rotation of multiple activities in those spaces is adopted. Further claiming is possible when there is a sufficient space to be claimed as we have seen previously the available floor space for each individual by itself is very small, so to claim a room or a chunk of space inside seems impossible in this situation.

The other appropriation of space to accommodate activity or claim space is by using the method of segregating activity or the space for a person by subdivision. Mostly the segregation of space occurs when there is an increase in family number and mostly it is done by subdivision of a room. The subdivision can be done by simple methods using curtains, using furniture arrangements, and after a while by using a permanent wall.

- For example, 53hhs have gone under the process of subdivision which is 27.6%. And the internal space change by appropriating the building and internal space is mostly the change from kitchen to bedroom 16 households changed their kitchen to a bedroom.

**Space vs. Space and Activity vs. Activity** – Asquith, 2006 citing Hanson, 1998 states that the important thing about a house is not that it is a list of activities or rooms, but that it is a pattern of space, governed by intricate conventions about what spaces there are, how they are connected and sequenced, which activities go together and which are separated. Based on this the spaces allocated for each function were mapped on the floor plan (see the life story of Ms. Etetu Gebremariam).

The study finds it to be true that ‘There are very few unnecessary buildings in the vernacular and within the buildings themselves, very few unwanted spaces’ (Asquith, 2006 citing Oliver 1979: 9). The patterns of space were mapped for 6 households and from that, we can conclude that there are no unwanted spaces and most spaces are used for multiple purposes (***See the Activity pattern mapping in Mrs. Etetu’s life story below***). The dominant spaces or most rooms have a low level of integration (***see the dwellings floor plans and justified graphs showing distributed-ness***) this is because there’s a little connection between the rooms both visually and physically. Almost all housing unit does not have any circulation space and because of their size, the furniture uses most of the space so movement is restricted. That is why we have terminal spaces in dominance and because most housing units have isolated kitchens and processed food is stored near the dining space even if that area is used as a sleeping space.

The dwellers spend significant time in the housing unit and the vicinity and each dwelling unit are highly appropriated to suit the needs of the dwellers. Also, it's highly attached to the space in front it absorbs the overflow of activity from the house and as we have seen throughout the graph analysis in the above space syntax technique they also connect each room serving as a circulation space.

The female adults or household heads mostly spent their time inside the household and the compound (on average they spent 6-7hrs inside the dwelling units and 7-8hrs inside or nearby the compound). Compared to the male adults or household heads they spent less time in the housing unit and the compound (on average the male adults spend 4-5hrs inside the housing unit and 1-2hrs inside or nearby the compound). The same goes for the children, the females in both age categories above and below 18 spend 3-5hrs in the housing unit and 1-3hrs in the compound while the males spend 3-4hrs in the housing unit and 1-3hrs in the compound. The other aspect is that as the subjects become elders and children the time they are in the housing unit and the compound significantly increases. The elders because of health deterioration and the children to be under the watch of their mothers or older siblings mostly spend their time inside the housing unit or the compound. All this is based on the time diary of 25 interviewees taken from 5 families and each family time diary is compiled in a worksheet and tabulated in age and sex (**See Annex XI. Collective Time Diary Worksheet for One Household**).

#### **4.4.5 Life Story on Mix of Function**

##### **Ms. Etetu Gebremariam**

Etetu's Grandparents on her mother's side migrated from the northern Ethiopia region to the Oromia region of Arsi and her father's family were native to the area. Her mother Debabe Demisse was born there and got married to Etetus's father Mr. Gebremariam Gemedo. First, Etetu's mother was not able to give him any child so he added a wife however during this time Mrs. Debabe also gave birth to Etetu. But the father tried to take the child (Etetu) from the mother and wanted to move completely to his second wife. This time her mother left all her belongings including a house and a plot of land that she inherited and fled to Addis Ababa.

In Addis Ababa, they stayed in the Tikur Anbesa locust protection compound for a year and acquired this dwelling by a rent from Debella Biru who looks after the land for the owner Mr. Taddesse Anqassa. During the nationalization of extra land and housing units in 1974/5, the house turned to Qebelle housing, and the rent value lowered to three birrs. The housing unit during acquisition has two rooms and her mother added an attached unit and gave the added one room to a local woman who needed a shelter without charging anything. Also, Mrs. Debabe added a detached kitchen in front in 1990.

When the government realizes this situation they apprehended the units and gave the room for the women as 'Debal' or Shared tenancy and the Kitchen for another family. Until 2013 the inherited dwelling of Etetus' was attached to the dwelling of the previous owner.

But after 2013 they agreed to reconstruct the dwelling separately because it was so weak in structure. In 2013 Etetu was elected as woreda cabinet so she handled the process of getting a permit while they helped her with construction costs because detaching the dwelling will help

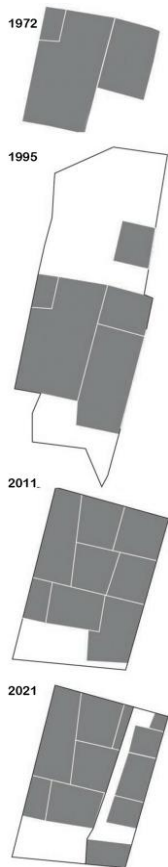


Figure 4.30 Etetu's Compound Transformation (Source previous maps and onsite measures by the author)

them to isolate their compound will give them freedom to make improvements or even sell it. Today they already fenced their compounds' and finished the isolation process and Etetu also acquired the seized dwelling because the woman in need got a condominium and was not able to contribute financially to the reconstruction.

Etetu was married to Mr. Temtim who was a soldier for the military government (derg), they got married right after she finished her high school education in 1987. First, they lived together with her mother and after the death of her mother in 2012 she acquired it by inheritance because she was in the dwelling while already establishing her own family. Her husband died in 2006 so during her mother's death she was the only legal recipient.

From the above compound maps, one big compound of Mr. Gulilat changed to four separate compounds in 1995 and in the time of the survey to seven separate compound units.

The compound and building transformation here shows the different changes made specifically by Mr. Tadesse and Mrs. Etetu. Now Etetu Gebremariam age 60 is a single mom and works in the Woreda administration office as a cabinet member since 2013 and owns a shop with other local women called 'Yehibret Suq' meaning Union Shop. She has three children Tewodros, Tigist, and Yegziabher ages 31, 25, and 18 respectively.

No.	Density Measure or Ratio	Value	Mean Value for CWKHU/192HU
1	Compound Area	43.83m <sup>2</sup>	259.91m <sup>2</sup>
2	Compounds Shared Space Area	5m <sup>2</sup>	51.98m <sup>2</sup>
3	Compounds Built Up Area	29.7m <sup>2</sup>	163.62
4	Residential Use Share in BUA	100%	84.76%
5	BAR	0.67	0.63
6	FAR	0.67	0.63
7	household per hectare	228.15hh/ha	170.4hh/ha
8	People per residential compound	912.6ppha	616.66ppha
9	Persons per household	4pphu	5.31pphu
10	Gross R. floor area per Person	7m <sup>2</sup>	7.3m <sup>2</sup> pp
11	Persons per habitable room	1.33pprm	1.83pprm

Table 4.9 Density Profile for Mrs. Etetu's Compound and Dwelling Unit (Source own computation)

The first child works in a bank, the second one is her daughter Tigist who works in a personal sales and the third child is a student at Kefitegna Arat School. They have a Collective expense of monthly expenditure that is near 5,000 – 8,000 birr. One room is dedicated to the first child, picture numbers 3 and 4 above. She now is comfortable and happy in her home except for the river smell from Awash Winery and plans to build a private toilet that is to a standard and connected to the city sewage line passing in front of her compound.

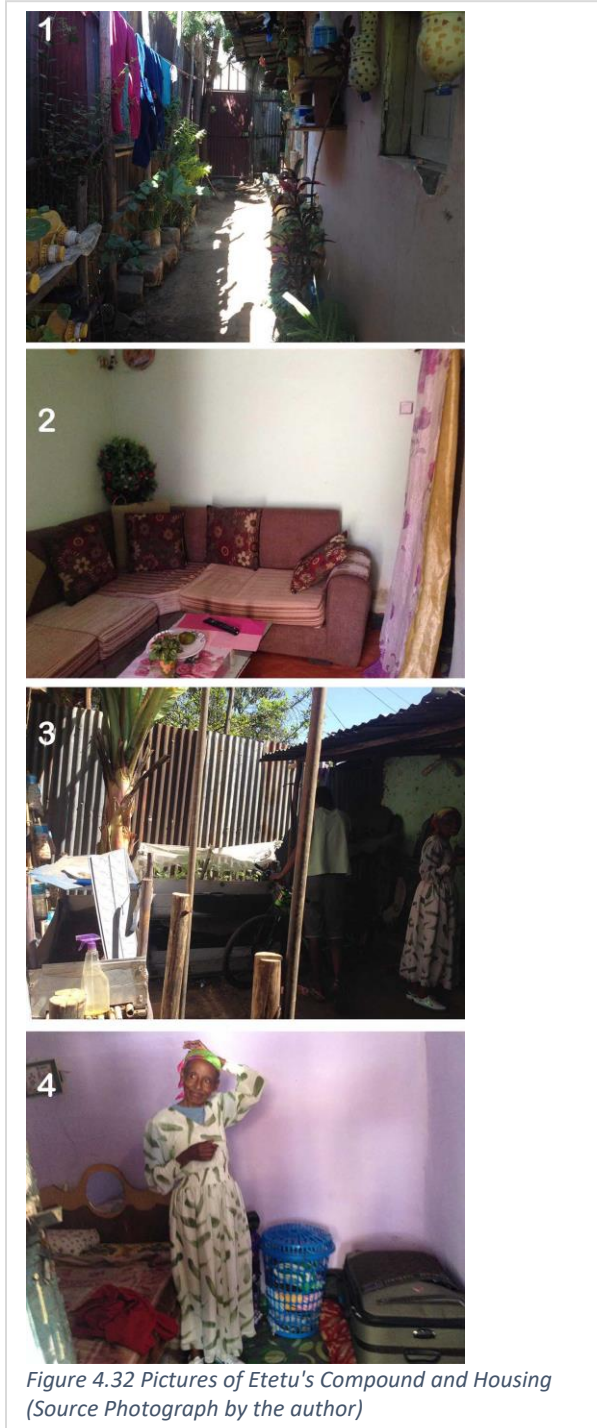


Figure 4.32 Pictures of Etetu's Compound and Housing (Source Photograph by the author)

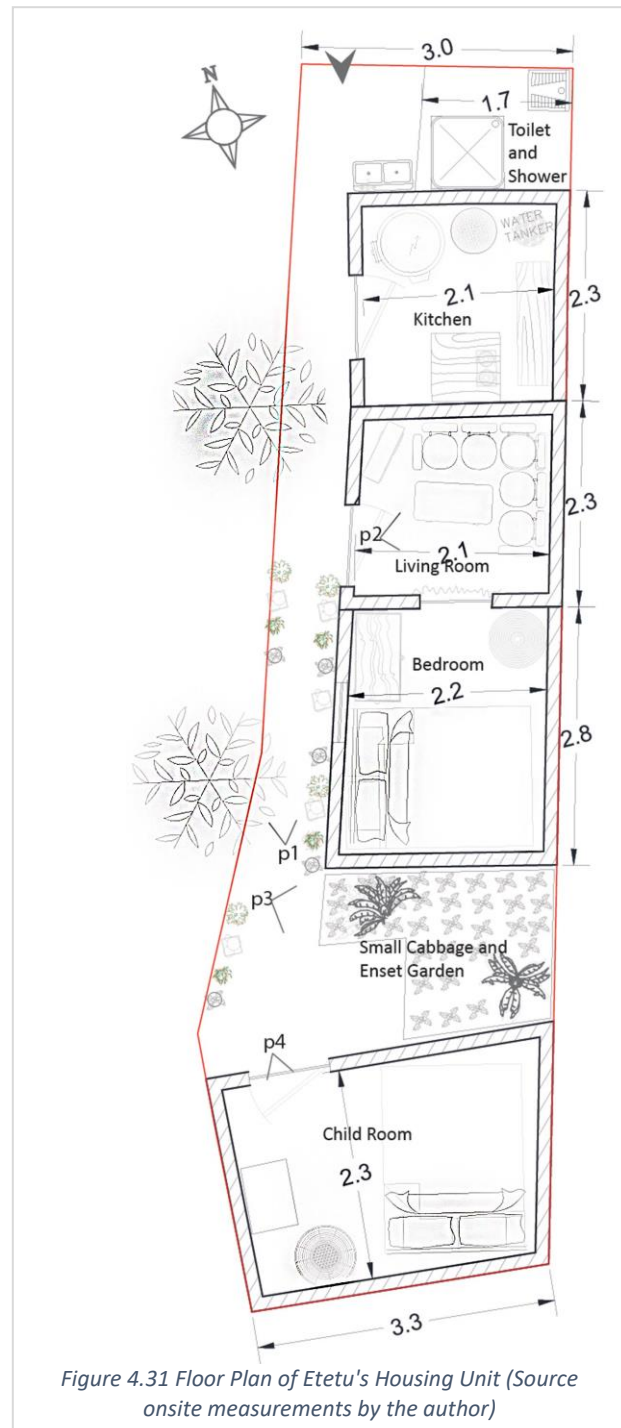


Figure 4.31 Floor Plan of Etetu's Housing Unit (Source onsite measurements by the author)

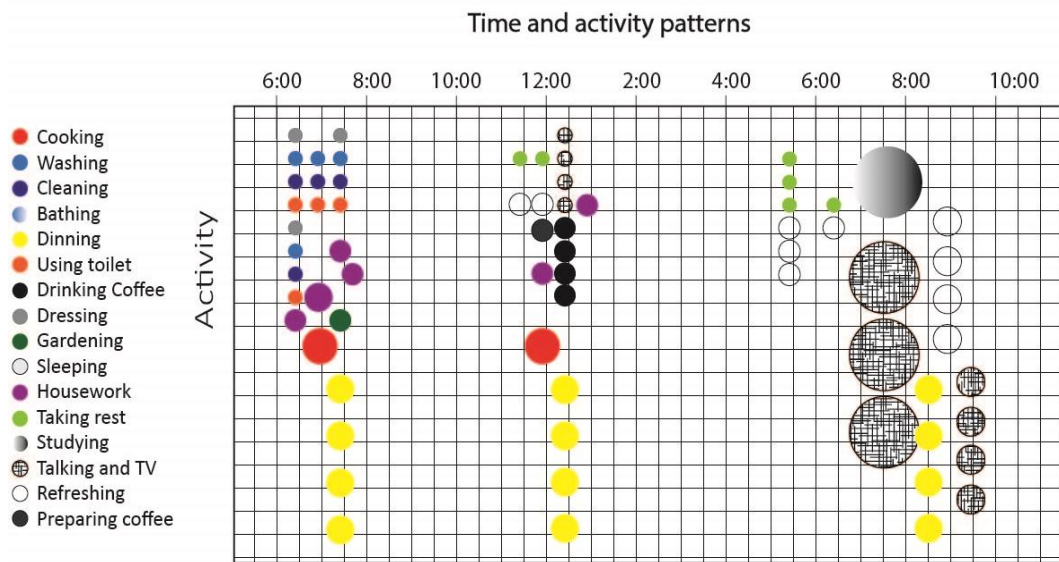
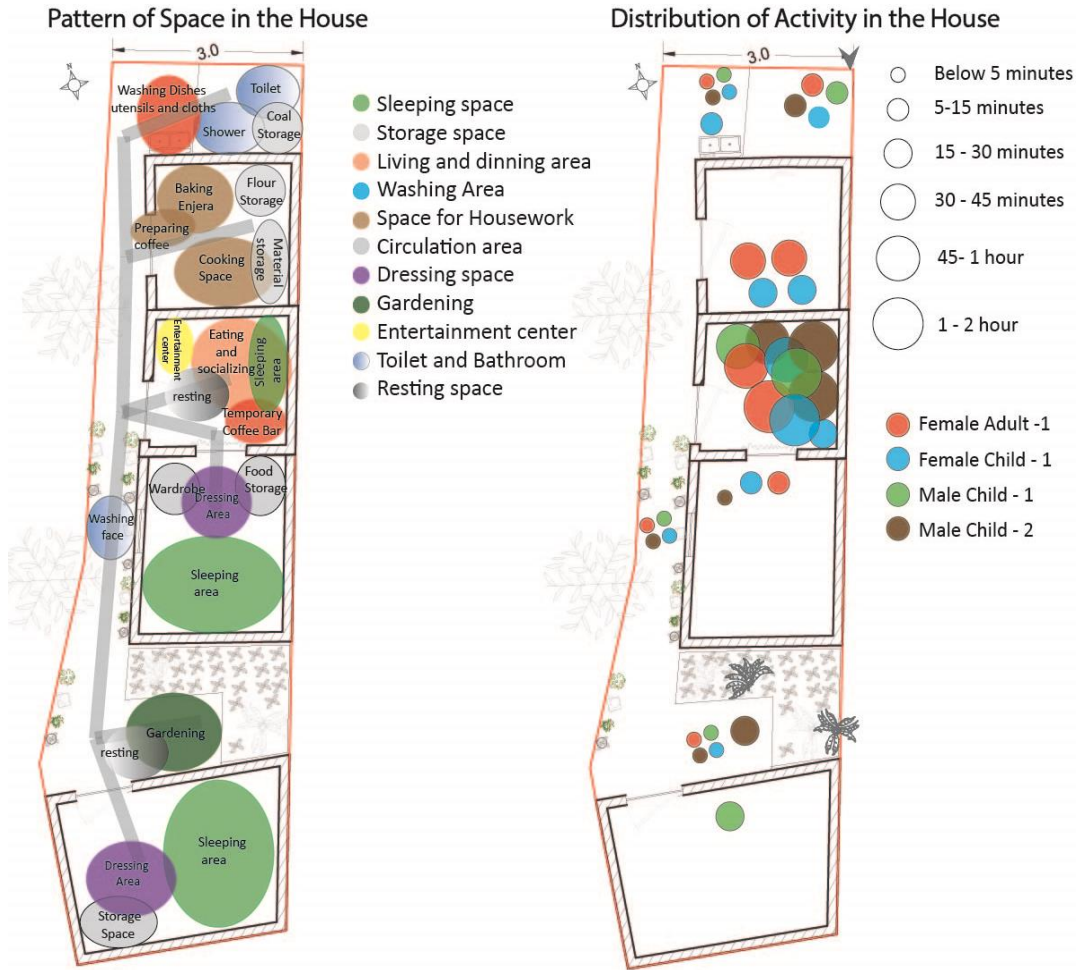


Figure 4.33 Pattern of Space and Distribution of Activity in the House (Source of the above figures are diagrammatic descriptions by the author using graphics softwares and the figure below is adopted from Asquith, 2006)

## 4.5 Housing Units Transformation

### 4.5.1 The Process of Housing Unit Transformation

Despite hindering rule towards any alteration to the housing units 181HU or 94.27% had transformed the housing units in one form or another. Only 11 households 5.73% did not make any change to the dwelling unit they occupied. As previously stated most dwellers up to 64% had acquired the HU before 1990. This is a very long time which increases the chance of adding new family members, increases the possibility of the HU to deteriorate through time, and many other factors that force the occupant to make a change in the HU.

From this, one can see that there were one and two-room housing units during the acquisition dominantly (92.18%). But today these HUs have shifted to mostly three-room HU (75.5%). This can be attributed to the subdivision or the addition of new attached or detached units to the original housing unit.

In describing the additional units 72% have used the same type of material as the original unit and 28% have used a different type of material from the original unit. These households use a material like a metal sheet or a simple plastic shed and some have different types of material on the four different sides of the wall.

And during any type of transformation, the construction work is done by family members, local artisans, or professional masons which is very rare. Of 192hhs 11 of them didn't make any change and from 181hhs that changed their dwelling 39% have performed the job by themselves, 59% have made it possible by hiring a local artisan, and 2% have hired a professional mason for the job.

To get a glimpse of what was needed the most and asking for dwellers' need for further change tells us that still many want to make a change in their hu. 174hhs or 90.62% want to make a change and only 9.37% do not want to make any change. From the first category, 46hhs want to make a change in the hu but have no capacity for it and 62hhs want to make a change but there is no available space for it. While asking for the type of transformation that is needed the most include expansion (17%); Subdivision (10%); adding detached unit (19%); and adding attached unit (29%).

#### **Number of Transformation**

First 34hhs or 17.71% transformed their house once, 38hhs or 19.79% transformed their house twice, 109hhs or 56.77% transformed their house more than twice, and 11hh or 5.73% did not transform their unit at all. The number of transformations if computed with other variables can give us factors affecting the motive to transform. The number of transformations of the housing units was computed against family size and time of acquisition (See Statistics on Transformation of the Kebele Houses **Statistics on Transformation of the Kebele Houses**). Both have some effect

on the transformation of the housing units and most transformation was made by households who acquired the HU before 1990 and the other most transformation took place in households with a family size of four and above.

### Types of Processes of Transformation

These are the different types of transformations that took place in the study area. The first one is a physical transformation that resulted in the increase in floor space to existing rooms, the second one is a functional transformation that adds a function to the original unit. The first one can be further divided as an extension, adding units, subdivision, full reconstruction (which changes the form or size of the original unit), and a type that makes any to the interior space by subdivision and appropriation of internal space that bring a change in the room function. The

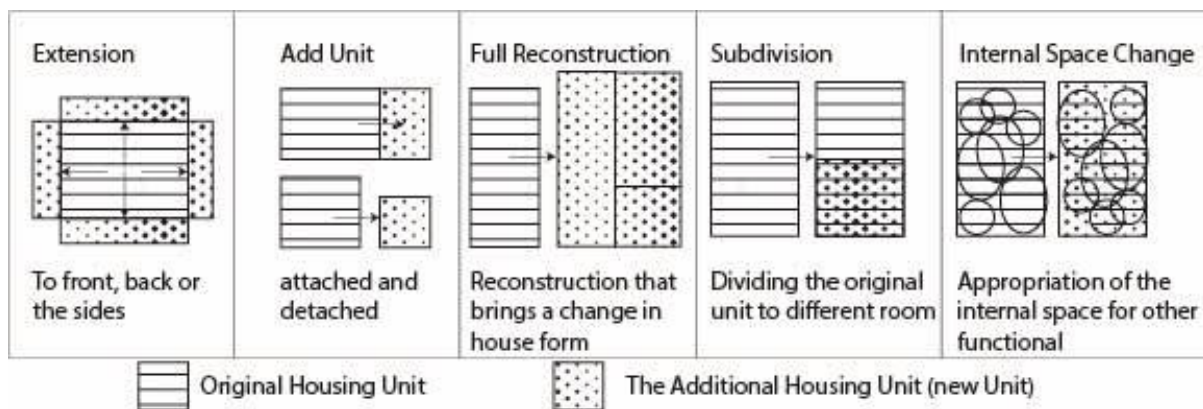


Figure 4.34 Types of Housing Unit or Dwelling Transformation (Source Illustrative diagram by the author)

second is different from other transformation types because it is not a physical change but a functional one that might be achieved by small maintenance to accommodate the new function. The type of functions that were the reason for the transformation to happen include: including some type of commercial functions on living spaces; providing a simple shade for gullit or household activity on the veranda; mostly changing an existing kitchen to a room for a household member by improving the unit is among the witnessed reasons that account for the 7% of transformation.

Most of the housing conditions are in deteriorated conditions so they need a repair at some point and while dwellers maintain their houses they tend to extend in every possible way if the conditions allow them. Therefore if we ask thoroughly we can find those maintenance to be a transformation process, and this was further proven while conducting the qualitative interview. This shows that there is a severe need for additional space to accommodate their day-to-day activity. The process of an extension was made by 43hh or 22.4% of the hu from the total of 192 kebele houses.

As previously mentioned full reconstructions because of structural failure most of the time tend to increase the area of the house, they also change room height, and room size while changing

the internal configuration. This reconstruction will open up the suppressed need of the dwellers and create opportunities to add some floor space. There were 23hhs or 11.9% of the HUs surveyed went under the process of full reconstruction and some of them even collapsed while they were already occupied by the dwellers.

If the conditions to change the hu are not possible and can be certain of internal changes that are made without the knowledge of the administration. From 192hh, 53 hhs have gone under the process of subdivision which is 27.6%. Other types of internal space change for other functions account for 9.37% or in 18hhs. There are also 44hhs or 22.9% of us who have added a unit and the rest 11 housing units didn't transform at all.

#### 4.5.2 Reason for Transformation

Generally from the physical and spatial aspects the size of the building, the structural quality, and the available space in the surrounding are some of the factors that affect housing transformation. Also, the economic capacity and building standards and regulations are some of the factors that affect the transformation of housing. Most of the reasons for transformation can be included under the addition of a household member. We have to know that one reason for transformation can support the other reason or can facilitate or initiate another one. For example, the increase in age, variation in gender between household members, and marriage could contribute to the increase in the need for privacy. Marriage increases the number of household members or will contribute to the increase.

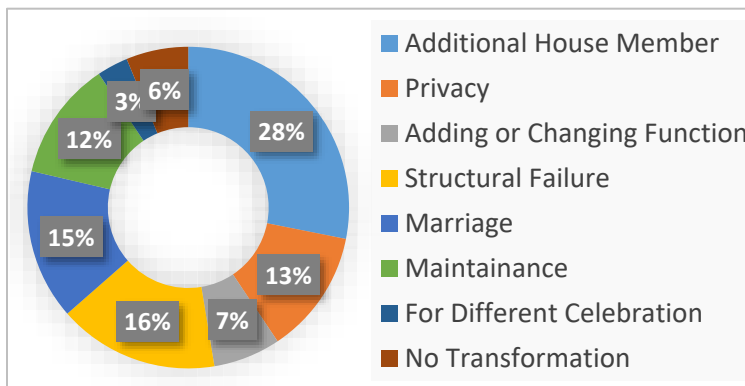


Figure 4.35 Reason for transformation

From the questionnaire, other issues were also identified: the first reason for transformation is a structural failure that accounts for 16%. During reconstruction, they would not miss the chance to expand their hu if they have the capacity and space to build. From the qualitative study of 32hh - 10hh had reconstructed their unit and 8 of them had increased the

housing area and the remaining two had no option to add a unit or expand the dwelling.

Some social factors contribute to transformation and in our case, the relationship between the dwellers was a reason, for example, two people can acquire one housing unit and through time they erect a simple structure in between and subdivide a room. This process is called 'Debal' which has a meaning like 'to live together or something like a flatmate'. Sometimes it can happen between married couples in the time of divorce, or sometimes between unrelated people. And

in another aspect after the death of the owner, the right of use is passed from one member to another mostly to children below 18 or to a child already living with his/her family while establishing their household. Also, it is expected that the new owner will appropriate the room or housing unit according to his/her own need. However, in most cases witnessed the challenge faced by members is not simple because of the overcrowded condition of the house.

Because of the overcrowded condition, most adults' wish is on hold, like having extended privacy, buying their home furniture to start their own life, sometimes even bringing their loved partner to start a family, and many other wishes start to burst during the transfer of ownership. What makes them similar is in one way or another they need a transformation like closing the previous door and opening a new isolated one to increase privacy, extending a room for extra furniture, and a new type of subdivision among the siblings starts to take place. Therefore when we say the change in ownership of a housing unit it is not a simple internal alteration to mark or reflect his/her belongingness, however, in KHU, the change in ownership is mostly followed by a basic type of transformation.

#### **4.5.3 The Effect of Housing Transformation on Density and Functional Mix**

Generally, the transformation of the neighborhood shows an increase in the built-up area especially uses for other residential functions. And according to a mix of functions, the study area increased man-made features and showed a decrease in natural features that increased the intensity of function near main roads, increase in land use mixedness and diversity.

**Addition of Rooms to the Original Building** - We have seen that a lot of us have transformed from one and two-room housing units to three-room HUs. The next question should be how many hhs have been added and how much room. Therefore the addition of a room or unit is another type of transformation that needs further explanation and 58.85% (113hh) have added a unit using different types of transformation. The rest 79hh or 41.14% did not add any unit.

**Increase in Floor Area** - Also in the detailed qualitative study of 32hh few buildings didn't transform and the total floor area during the time of acquisitions was 896.44m<sup>2</sup> today they have a total floor area of 1351.72m<sup>2</sup>. The floor area increased by 455.28m<sup>2</sup> area giving an average area of 14.22m<sup>2</sup> increase in each housing unit. First, the available floor area per person was 15.19m<sup>2</sup> and decreased to 6.96m<sup>2</sup>. This is because of an increase in the number of people (in 192hhs surveyed the increase was from 379 to 1106) that brought an increase in family size. The number of transformations was also multiple in households that stayed long in the neighborhood and the addition of rooms brought an increase in floor area (*See also* Statistics on Transformation of the Kebele Houses).

As mentioned before the area of each room is small so while stating this type of figure one has to be careful not to distort any type of conception about KHUs. Therefore it is better to see the transformation from a measurable standard point of view, so we have to compare the area of

housing units during acquisition and survey from a qualitative interview of 32hhs. During the time of acquisition, 74.6% had a room size below 30 m<sup>2</sup>, and 25.4% have a room size between 31-50m<sup>2</sup>. Also, 31% have room areas below 30m<sup>2</sup>, 50% have room sizes between 30.1-50 m<sup>2</sup>, and 9% have room sizes between 50.1-70 m<sup>2</sup>. So as mentioned before the floor area increased by 455.28m<sup>2</sup> area giving an average area of 14.22m<sup>2</sup> increase for each housing unit. The transformation of the housing units brought an increase in a built-up area and an increase in the number of households, however, it did not bring an increase in housing unit density and floor area per person. This is because there is no more space to increase the number of the housing unit and because of efficient use of land the rate of increase in population is higher than the rate of increase in the built-up area. Therefore despite the increase in the built-up area and floor area, there is a decrease in available floor area per person.

**Accommodate Functions** - While assessing the functions of the additional units 37% of changes were for a function of a bedroom, 16% have added a unit for purpose of changing or adding new living space, 32% is for a kitchen, and simple structures used for household activity. 14% have modified the previous kitchen to a bedroom. So around 51% have performed the transformation to add a bedroom.

**Compound level change** - Being evident for hard densification like that of the households which increased the number of rooms in the housing units the compounds have also added the number of households inside. Before 1975 around 69% of the compounds have less than 4 households in the compound and the rest 28.3% have four or more households in a compound. But today the number of compounds with one household increased to 33% of the total CWKHU. But this is the result of compound subdivision it doesn't claim additional land area. And almost all compounds with four or more households in 1975 have increased in several households (See also Statistics on Transformation of the Kebele Houses).

In the graph below the y-axis is the area of the compounds and the x-axis is the house number interviewed. And the average area of the compounds during acquisition is 459.6 m<sup>2</sup> and this

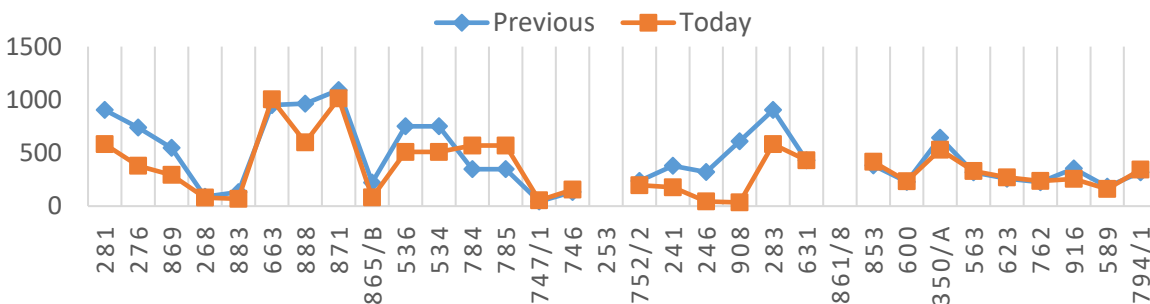


Figure 4.36 Compound size during acquisition and today size

dropped to 347.28 m<sup>2</sup> during survey time. The compound size has decreased through time but the average number of households in those compounds has increased from 4hhs to 6hhs. The

changes made inside include fencing the area around their housing unit, fulfilling utility, adding a unit for communal function, maintaining pavements of shared space and walkways, and others.

#### 4.5.4 Life Story

**Mr. Gudeta Mideqsa** - is a fifty-five years old man but when his family moved to the city he was just a little child as he expresses. He was born in the rural villages of Western Shoa, when his family moved to the city at the time of Emperor Haile Silase they rented a small housing unit in front of today's compound around 1970. After a few years, Kegn Azmach Mezemir Hailu constructed row house units containing around eight to ten houses for rent and workers' houses just a few years before the Derg took power (pic no.2). At the time his father (Ato Mideqsa) was expecting his second child and seized the opportunity to move from the small house to the new units. Mr. Gudeta remembers that they were the first to acquire or rent the housing unit and their first neighbor was Mrs. Bizunesh Yimer who moved next house to them from Piassa, St. George Area. After a few years when the Derg took power, all the dwellings were nationalized and the housing units were turned to the newly established Kebele administration. He mentions that he has no clear memory of the time and didn't care about the rent as he was a child but today they pay 47 birrs all together (For three qebelle houses).

When he was around the age of thirty in 1994 his father passed away and all the responsibility of the family fall upon him. He tells that both his siblings Kebede Mideqsa and Jifare Mideqsa were youngsters between the age of 14 and 20. His father struggled for some years until he manages to take a grip on city life and until his firstborn

started to lend a hand in their life. Our father all his life was struggling to give us what he can offer us the best, but city life has made my elders soft and weak he says and claims that he was



Figure 4.37 Pictures of Mr. Gudeta Mideqsa's House  
(Source Photographs by the author)

the only one who understands his family's struggle. When their father passes away he had planned to move out but there was no one to look after his mother and his elders. Therefore he

### Building Transformation

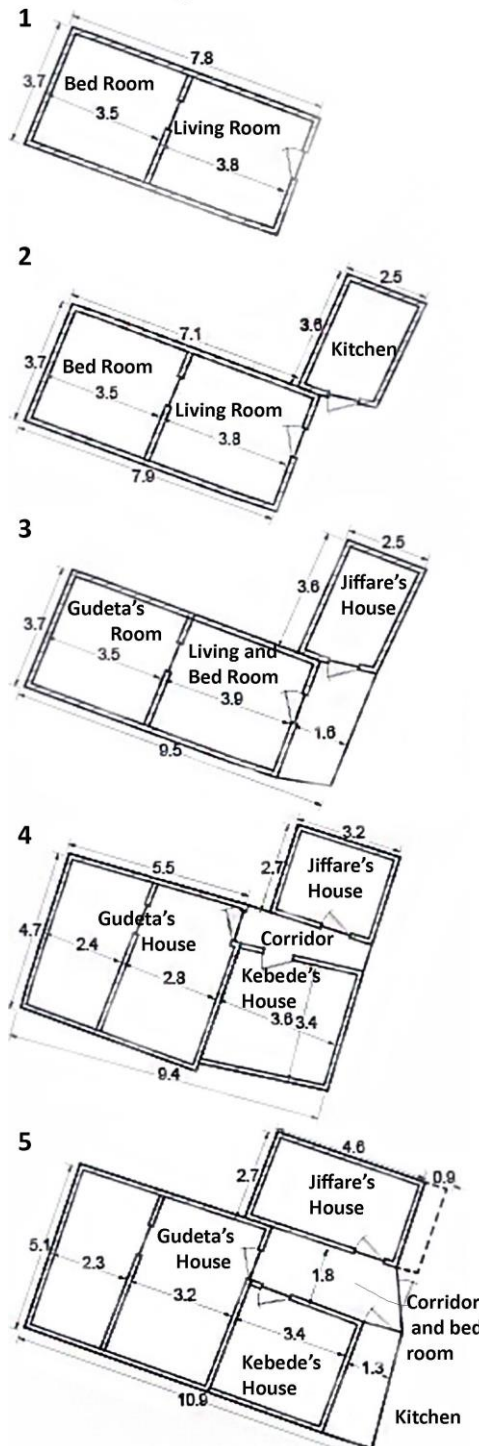


Figure 4.38 Housing Unit Transformation of Mr. Gudeta Mideqsa (Source onsite measurements by the author)

began to establish his own life while taking care of his family and that is when he decided to marry his current wife Mrs. Asnaqech Ayu. The next year they got their first child Yordanos Gudeta now she is 24 and works temporarily in the federal court near their house. Then the others followed; the second child is Eyerusalem, the third child Bethlehem and the fourth child Mastewal all of whom are students with ages 22, 16, and 6. The last child Anafist Mideqsa is just a year and a half old, he explains about his family by saying 'I believe that every child is the gift of God but I needed a son too. The first four were girls which is why we had a large family in search of a boy and finally God has given us what we wished for. So I think this is our last child besides am getting old and waiting for my retirement from Awash wine factory.' During this time his brother had also acquired a room got married and now he has a family of four. Mr. Gudetas's youngest sister today is forty-five and has a family size of seven. She had three children before she got divorced and took her mother from Mr. Gudeta and even added three relatives.

When they first acquire the dwelling it was a two-room housing unit. The first room with an area of around 13m<sup>2</sup> is the living room and the next room around 12m<sup>2</sup> is the bedroom (no.1 below). Then he explains that after the birth of his brother and sister (Kebede and Jiffare) they added a kitchen in the pocket space created when others extended their housing unit (no.2). In 1998 when his sister gets pregnant and decides to marry Mr. Gudeta and his brother Kebede maintained the kitchen by plastering the wall with mud, covering the smoke-covered CIS roof with a ceiling made of fabric, and changing the earth floor to cement. With it, they fenced the space in front of the dwelling (no.3) but the buildings started to deteriorate and after

seven or eight years in 2005 the Kebele administration permitted them to maintain their housing units. At that time his sister has already established her own home with a family size of four.

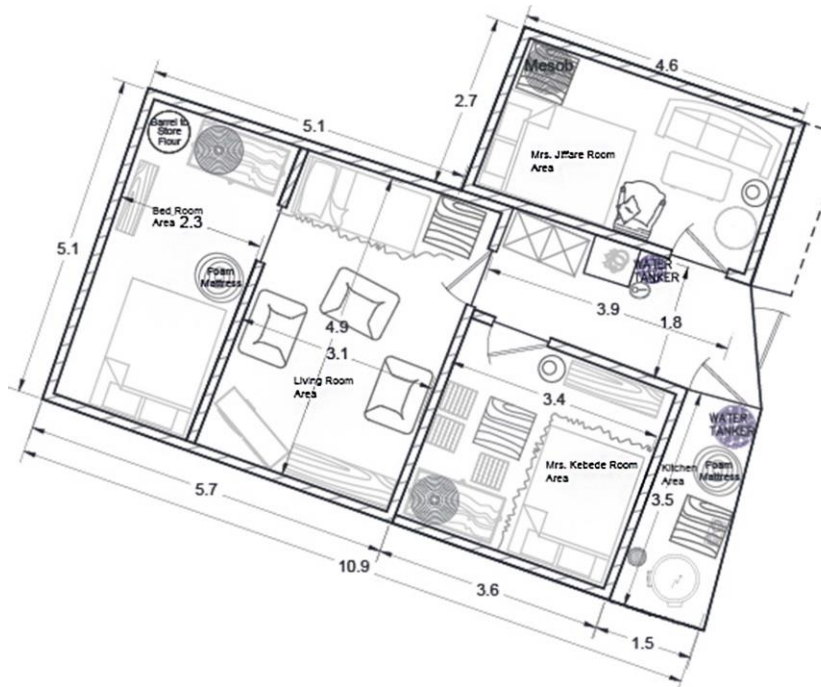


Figure 4.39 Floor Plan of Mr. Gudeta Mideqsa House (Source onsite measurements by the author)

When they maintained their house around 2005 they tried to expand the previous house to the side and front as much as possible and also added a room for Mr. Mideqsa's brother who was thinking to marry. In 2005 Mr. Mideqsa has three children, his brother is already expecting a child, and Mrs. Jifarre had her second child (no.4).

In 2012 the building cannot continue to give function by only maintaining it like the previous time. The previous transformations might

change the mud that was plastered on the wooden structure and cementing the floor and adding a ceiling might increase the appeal of the dwelling. However, the wood used inside the mud is the structure of the dwelling and it has been there since the 1970s'. Therefore in 2012, all the buildings which are attached were reconstructed by the dwellers organized by the qebelle again this time the building was expanded a little by claiming the space between the buildings.

No.	Density Measure or Ratio	Value	Mean Value for CWKHU/192HU
1	Compound Area	67.3m <sup>2</sup>	259.91m <sup>2</sup>
2	Compounds Shared Space Area	0m <sup>2</sup>	51.98m <sup>2</sup>
3	Compounds Built Up Area	67.3m <sup>2</sup>	163.62
4	Residential Use Share in BUA	97%	84.76%
5	BAR	1	0.63
6	FAR	1	0.63
7	household per hectare	445.76hhpha	170.4hh/ha
8	People per residential compound	2,674.6ppha	616.66ppha
9	Persons per household	6pphu	5.31pphu
10	Gross R. floor area per Person	3.7m <sup>2</sup>	7.3m <sup>2</sup> pp
11	Persons per habitable room	3.6pprm	1.83pprm

Table 4.10 Density Profile for Ms. Gudeta's Compound and Dwelling Unit (Source own computation)

## Chapter Five - Conclusion and Recommendation

### 5.1 Major Findings and Conclusion

The conventional density measures have a lot of limitations and don't describe the neighborhood in detail enough so that we can have a clear image of the area, therefore multiple measures were needed and used. For example, while existing in the same compounds the average dwelling unit size of the private housing units is more than twice the size of the kebele housing units. The same is true for the difference in average occupied floor area, gross floor area, and room size. This is attributed to the *gradually developed unique and organic character of the inner city neighborhoods*. They have no pinch of standardization (similarity) within each block, compound, and among dwelling units making it impossible to predict and estimate the density.

While looking into the changes in the neighborhood all land uses except residential functions have increased in the area significantly. As the area exists in the inner-city the push factors of the residential function are expected and are going to increase in the future too as commercial and service functions are already creeping into the area. The increase in land use and the built-up area was also possible at *the expense of open space that almost vanished in time*.

On Residential share – As the city is in a fast growth the land occupied by residential housing increased at the city level while decreasing in the inner city. Yet the study area showed a slight increase in its residential share however it is starting to decrease in recent times as expected. Using urban land scenario analysis if we redevelop the neighborhood based on existing development trends and planning standards we have to build multiple stories (g+1) just to accommodate the existing households because it allocates a large share of area for street and open space. And if we want to attain the density standard or increase the residential floor area we have to increase the building height further (g+2). We have to note that this result is attained without considering the building height regulation.

Compared to the city the built-up area of the neighborhood did not increase that much this is because the site is in an already dense inner-city area. However, the residential share in the built-up area has shown a large increase. Therefore we can say that the residential use was subject to *hard densification (infill development)* and this type of densification helps in decreasing the urban sprawl.

The total neighborhood has a built-up area ratio that is almost equal to the city's proposed standard (40% built-up). The average building height in the neighborhood for compounds other than residential use is twice that of the residential units. The residential compounds have an equal value of FAR and BAR showing that almost all houses in the study area are single-story units.

Other than morphological density the population and housing units' density at the neighborhood level which includes the land area of other functions will distort the description of the area. This type of measure can be used in a planned neighborhood when the other functions are thought to be in connection to the neighborhood compatible, and when they're used by the dwellers. However, we should not use this measure to describe Addis Ababa's inner city neighborhoods that have a higher value of land use mixedness. Here around the study area, we can find for example two higher-level education institutes, three factories, and administrative sectors all having large plots of land within a 1km radius of the nearest station. Even though these measures have some flaws despite their inefficiency they show that the neighborhood has a higher density both in the housing unit, and population than the city's average. However, in general, the neighborhood has a lower value of gross housing units' density.

So the measure of the Compound Level Density (residential density) is required that considers the residential compounds only. And this measure shows that they are highly compact (use most of the land area) with dominantly single-story buildings. Here it shows that the CWKHUs have a higher level of built-up, household, and population density than the other residential compounds exceeding every measure of density. Being evident for this while observing residential compounds the most decrease in land area and moderate increase (30%) in the built-up area was witnessed in CWKHU. So we can conclude that the KHUs contribute more to the densification of the area.

The BAR value is mostly related to the residential function and also the FAR is much related to non-residential uses. This indicates that the residential compounds preferred the horizontal expansion while the others intermingle vertical densification. So we can conclude that the increase in built-up density (infill development) brought a decrease in the relative space between the housing units, the access to natural lighting, and wind flow so affecting the quality of the area and comfort level of the dwellers negatively.

Household and population density in the compounds - while studies show that the built-up area density and the urban extent density of Addis Ababa show a decrease from time to time but the density of the residential area or residential density has increased in recent times. What is interesting and known about the inner city is that despite the decrease in the residential built-up area they are the main reasons for the increased residential density of the city. This is attributed to the increased family size of inner city households and the increase in the share of single-family households especially in the new condominiums because mostly the owners rent the units rather than occupying the units. Being evidence of this the neighborhood has also increased in population during the last 25 years without a significant increase in residential land share.

The household density which is the total number of households per residential plot area shows that this area has a high residential density. Again compared to the existing city household

density both gross and net density and with most of the Sub-Saharan cities, it has high density. Categorizing the residential compounds into compounds having kebele housing and private housing reveals that the HH and HU density in CWKHU is more than twice denser than the other compounds.

The measure of residential density enables us to see the household density in those compounds (CWKHU). And they have a higher density of households not only than the overall city average but also it is above the minimum value of the structure plans norm and standard (150hh/ha). But as the housing units are single-story buildings they have a congested small-size fine-grain arrangement that has a low open space share for each unit.

The other measure is the population density of the residential compounds which is the total population per residential plot area of the neighborhood is around Abercrombie's maximum and is denser than the city's average residential density. Again the population density for CWKHU is more than twice dense as the population density of compounds with only private housing and is also above Abercrombie's maximum.

Therefore the study area's residential density is above the city average but here also the density is higher because of the CWKHU. These results also show that the density of the households or increase in floor area and the increase in population is not balanced and it indicates the prevalence of overcrowding. But we cannot conclude like this (be sure) it is only indicative unless we perform further measures of indoor density.

Indoor density - People per Housing unit - The average family size or people per housing unit and household will be 4.87pphu and 3.74pphh respectively. But the Kebele houses in the study area have a higher family size and the average value for the housing unit is 5.3pphu but the average value for a household is 3.2pphh.

Using the municipal maps we have measured built-up area density which shows that the study area has a compact form and using the gross floor area per person we have measured the available area for family members within the perimeter of the exterior wall was revealed. Further to see the usable floor area that is used by dwellers the occupied floor area per person (uses the interior space) and person per habitable room was measured. In all measures the average indoor density for the kebele housing units was low. And again the different measures show that the dwellings inside CWKHU have a value that is below the required standards of UN and WHO in both minimum floor area and person per habitable room. But isolating each tenure type the KHUs have a much lower value with both floor area per person and person per habitable room measures. But the private tenure types have an acceptable minimum standard in both cases.

Therefore the indoor density measures show that kebele houses are overcrowded by having a very small floor area for the dwellers but the number of people per habitable room is not that

much big as expected. This is what appropriation brought them because the challenges created by the small floor area share for everyone were resisted by providing as small rooms as possible. So we can conclude that the area has long passed the condition of one family per one room and further subdivided those rooms reaching one family per one small room.

Combining Measured Density to Perceived Density - The measure of density should reflect the conditions of the existing context or else it is going to be just some numerical expression (quantification) of the built environment. And it is more accurate and reliable if we use the expression of society to understand the context and so the perceived density measure was used. The established results support the expectations, indications, and claims drawn from the results of measured density.

Therefore we can conclude that the single-story buildings with high BAR value and low spacing between buildings that were also further densified by infill developments inside compounds created a compact form. This dense settlement that is created by a gradual process and transformed through time on the dweller's initiative has brought many challenges to the dwellers. There are issues of privacy, disturbance, access to natural lighting, indoor temperature, and a sense of comfort.

The issues of privacy and disturbance are higher and are more frequently mentioned at the household level. And the available or dwellable floor space in most of the dwellings is small and crowded that are suspected to bring negative effects on physical and mental health outcomes. However with all these flaws, one can expect a high level of dissatisfaction. However, most of the dwellers feel a sense of comfort in their surroundings. And most of them prefer their neighborhood to the new developments (condominium neighborhoods) for privacy and freedom to perform household activities.

The computation and analysis of Density Measures and their relation with each other will help us to see the factors that influence the level of density in existing settlements. The Analysis was made using the Pearson's correlation to see the relationship and an analysis of linear regression was used to see the association. And based on the analysis, the dwelling form and density are highly associated for example the linear block with row housing has a higher association in all variables measured than the organic blocks with mixed house form. Proving this if the linear blocks were used all over the neighborhood the density of the neighborhood will be more than twice the density of the organic blocks with mixed housing forms. Therefore we can conclude that the variations in block size, shape, a possible configuration of the buildings, and their form influence the density.

According to the analysis the increase in Compound Area will result in increasing built-up area; moderately increasing the number of dwelling units, households, and total population; and

slightly increasing the average dwelling size and gross floor area. And it also has negative relation or will decrease the BAR value, housing unit, and household density.

The Increase in the built-up area will result in increasing the available residential built-up area; moderately increasing the number of dwelling units and the total population of the compound, and slightly increasing the average dwelling size and available gross floor area. So we can conclude that people will expand their unit if there is available space in the compound but the result of the expansion mostly goes to subsequent families so it increases the household number rather than the size of the dwelling unit.

As the number of dwelling units increases, they also tend to increase the number of households and the total population of the compound. However, as the number of dwelling units increases the compound area also increases together so the overall effect on both housing units and households per hectare is negative. This shows if we want to increase density we have to increase the dwelling units without increasing the residential land share. Yet the relationship in our site is very weak and insignificant when compared to compound level density. The overall housing unit density has a strong relationship with overall household and population density.

The other main thing is that the indoor densities have more relation to the compound than the total neighborhood. The compound level density measures affect more the condition of the compound than the overall context. For example increase in the number of households and housing units results in affecting the compound total population than the total population per hectare. The increase in gross floor area per person tends to affect the average size of the dwelling in a compound than affecting the overall housing density. As stated in different studies we can also conclude that urban density is affected by multiple factors and the quantitatively decided or measured density values have qualitative factors.

The Mix of Function - As mentioned before the increase in a built-up area and land use was at the expense of open spaces and communal spaces of the area, but this resulted in the increase in the types of land use and intensity of function in the neighborhood. While public functions, services, and manufacturing invaded most of the land area the residential function increased in concentration (intensity). Especially the CWKHU while decreasing in land share increased their built-up area and the number of households so their intensity increased significantly.

According to 2011/12 (2002e.c) structure plan norms and standards, the area has a dominantly acceptable context in both land use and density standards. However, based on the recent structure plan the level of acceptance decreases because it has mostly under-standard and undesirable land use. Based on land use allocation the city intends to increase the land allocated to the street (LAS) and the open space share. But the study area has below half of the expected share in the street and an almost vanished open space. So we can say that future redevelopments

are going to take a chunk of land for these functions and it is going to decrease the residential share.

Looking into the effectiveness of the area based on the availability (accessibility) of functions and the corresponding distance to those functions was observed. The most available functions that exist within a 100m radius or nearby the residential compound include mostly the commercial uses and services so the households in the study area have abundant service and commercial centers. The most absence in function is attributed to playing ground, communal spaces, and parks showing the shortage of open spaces. There is also a high level of access or availability in the religious center and transport nodes. While assessing distance the most available from a nearby location are the commercial functions and transport nodes; the services are relatively in a medium distance or mostly can be accessed within a walking distance. So we can conclude that the residential compounds have resisted the mix of use unless they are needed by most and on a daily bases. The analysis in ULUE has shown that between 1972 and 1995 there is a slower consumption of land each year for other functions and recently despite the decrease in the built-up area there is an increase in population. So we can conclude that there is an efficient use of land in the study area.

Checking the compatibility of each function to residential use we get that 23% of the residents are negatively affected by commercial uses and 12% by manufactory activities. The other land uses that negatively affect the dwellers include the river and activities attached to it, large factories to chili mills, some religious centers, and football viewing centers. And the problem they face because of the above functions is dominantly categorized under smell and noise pollution together accounting for 85% and the other problems they face can be categorized under visual, and privacy challenges. The compatibility among functions can emanate from distant places covering a large area so the study within an 800m radius of the LRT Station was needed. And using the land use mixedness and land use diversity index analysis the area shows a higher value in the land use diversity index and also has above medium level value in land use mixedness. So we can conclude that the area has more diversity in land use but is a little above the right level of land use mixedness.

To check the intensity of use space matrix was used that treats density as a multivariable phenomenon approaching and defining in terms of five indicators by using the existing floor area gives us the unique character of the area and it is effective to differentiate or describe the urban form. Using the organized data the study checked the correlation between all variables (the floor space area of all functions) and almost all of them have a very weak relationship with each other ( $R=0.2$ ). So we can say the change in one function does not affect the other function and intensity is mostly related to floor area.

This is because every function has its plot (compound) and the buildings are dominantly G+0 so it is expected to have a low level of relation. And here we can simply witness that the intensity of function is much more related to or is influenced by the type of street in other words it is more related to the level of access. This is because streets with more traffic attract different functions and residences resist the other types of functions.

Assessing the mix of function in compounds for some selected occasional group activities show that the activities take place dominantly inside the housing units but also they spill over to the compound's shared spaces and sometimes the activities could be dragged to the street or neighborhood shared space.

Around 80% of compounds are pure residential and the rest have different types of informal small commercial units or community service units (so mixed). Besides buildings, most compounds have some type of shared space inside the compounds. On average these shared spaces are large but because of unplanned organic forms and irregularly arranged buildings, they create pocket spaces and irregular narrow spaces that are not fully utilized. Because of this, the size of the available shared spaces decreases almost by half.

The residents perform different types of activities in those shared spaces. The activities were categorized using the concept of Gehl (2011), the categorization of activity while he studied the life between buildings. And the results show that the compounds shared spaces have dominantly household and social activity. These activities also go side by side or are complementary to each other. And the third type of activity called livelihood activities can take place in the housing units, compounds, or neighborhood streets depending on the type of activity and nature of the surrounding.

Studying dwellers' activity inside the household using Asquith's (2006), integrated research approach shows that activities take place in multiple spaces. the reasons for the activities to take place in multiple spaces can be affected by factors like the size of the dwelling, the building's construction material, the dweller's level of the economy, available household materials and utensils, and tradition of performing the household activities. And also every space (room) hosts multiple activities (rotational use of space for different activities at different times of the day).

Using graph Analysis the arrangement of spaces (rooms) was assessed and the usual linearly arranged rooms of the house (front and back or side by side) use compound space in the immediate front as part of the housing units to perform activities or use them as a circulation space. These spaces are highly connected to the dwelling units and it will be difficult to even draw graph analysis without considering these spaces as part of the dwelling units. Most of the activities are also accumulated in one or two rooms of the housing unit (mostly the living rooms

hold most of the activity). So the culture of assigning activities to a space or spaces for a person (space claim) is rare and mostly temporary not permanent.

Because of the size and nature of the dwelling units, most activity has become a collective action for the dwellers of KHUs. This clearly shows how the house form has affected the dwellers inside (there is no me ... there is only we). This can create a strong attachment but can affect individuals' comfort and mental health. People have also influenced the dwelling form by the transformation of their unit. This transformation enabled the dwellers to make some changes and additional functions. The dominant change in function is from the kitchen to the bedroom and the addition of the unit is mostly attributed to a room for a subsequent family.

More or less all housing units have transformed and the dominant HUs during acquisition were one or two-room HUs but today it is a three-room HU. So the act of transformation enabled the dwellers to increase the number of rooms by it increasing the floor area of the units too. While the increase in floor area increased the morphological density and household density but not the available floor area per person and housing unit density. However, there is a decrease in the available floor area per person this is because of efficient use of land, especially in the residential compounds. This means that the rate of increase in population density outpaces the rate of increase in the built-up area.

The transformations that took place include extension, full reconstruction, subdivision, internal space change, and addition of detached and attached units. Or generally, they can be categorized as functional and physical transformations. Thus the reasons for those transformations also include the need to increase available space, structural failure, for including different functions, addition of or increase in household members, the need for privacy, different celebrations that trigger social competitions, marriage, and the change or transfer of ownership. Generally, they can be grouped as spatial, sociocultural, and economic reasons and are linked to one another.

In another aspect, transformation is affected by factors like the time of stay in the dwelling unit and family size. The relation is positive, meaning the increase in both factors will increase the number of transformations made by the dwellers. The other factors include the availability of space, economic capacity of the dwellers, rules, and regulations mostly by PHUs than the KHUs, structural stability, social relation, and location of the dwelling inside the compound and the neighborhood.

## 5.2 Recommendation

The recommendation must recognize the fast population growth of the country and when results and future intentions are assessed it is not based on some abstract or inherent judgment but in behind it considers the principles of the sustainable housing neighborhood and sustainable housing as a framework. So it gives priority and focuses on the existing community.

The main thing is that this organic and unique neighborhood as Mumford (1938), states the city is a fact in nature but it is also a conscious work of art, and it also holds a communal framework, many simpler and more personal forms of art. The main thing is that this organic and unique neighborhood is nearly a century-old environment that passed through a lot of transformation and appropriation performed by the residents. We can take the study area, especially the kebele houses as urban vernacular. So before preceding to detail future redevelopments and studies should consider a detailed reading of the area that enables them to soak-up spatial features and usage to learn and adopt from the neighborhoods. This helps future developments to construct housing units and a neighborhood that recognizes the previous urban form lifestyle so it will not be a lien for the occupants.

While measuring the inner city we have to be careful in selecting the type of measurement. This study has shown the measure of the density of the overall neighborhood (gross density) is inconsistent and distorts our understanding of the reality. So it is recommended for future studies to consider residential compounds in choosing the boundary of the study area. And if the study is conducted at the housing unit's level it will enable professionals to have the household data. This is because every plan's success depends on the knowledge how of the planner or designer about the dwellers and their neighborhood. Therefore, choosing a type of measure that reveals the context of the area becomes vital.

We can understand from the development trend that the effort to increase density is focused or is highly dependent on increasing the building height. However, we have to note that increasing the building height will increase the number of housing units and floor area but we cannot take for granted that it would increase the overall neighborhood or urban density. Further, the application of multiple measures has enabled us to see the qualitative aspects of density. And combining the values of different measures and perceived density while analyzing for their correlation and association showed that different factors affect the level of density. So it is recommended that future studies must consider multiple measures to understand the factors affecting the density and urban form. We might make density complex in trying to explain it in detail so they should be presented in a clear and simplified manner. Again measures should be associated with housing type and housing ownership. The literature reveals the multidimensionality of compact city principles and the analysis of the study also confirms that. So, the manipulation of one aspect could influence other principles and alter the character of the

neighborhood. So considering each factor influencing the principles and all the principles creating the compact form become significant.

Thus lack of these measures and detailed data made the structure plan focus on the quantitative aspect (like 150hh/ha), the height of buildings (BHR) that focused on land value. These factors not only disregard the existing context but also are repeatedly mentioned for their adverse effect in different studies. Again the city standards do not mention the spacing between the buildings, indoor density standards, and population density that have an impact and could alter the results of overall urban density. So it is recommended that future standards and regulations should consider every factor while determining the level of density. Again the disregard for indoor density has created a culture of allocating new HUs based on the economic capacity of the dwellers that should be based on the number of family members.

The compound level study reveals that the KHUs and the CWKHUs are the reasons for the increased level of housing units, households, and population density in the area (see Annex V-table 7). The kebele houses and their compounds have a higher value in density than the city standards. Therefore for the kebele houses and the CWKHU those density values cannot be the issue unless we consider the indoor density that shows over-crowdedness. The issue exists in indoor density level that the administration does not have a clear image about. The solution for the problem we did not understand well might bring adverse effects and considering sustainability principles the act of redevelopment for densification will not have socio-economic justifications. So before starting any project or providing policy statements in the city it would be better to conduct multiple measures that enable us to construct a density model of the city. This will help us to understand the context of the project area and will help us to make not only environmental and economic aspects only but also gives social justification to our project. Because redevelopment already deals with the settlement of the poor to increase density. While there are low-density settlements of well-established families and neighborhood is not socially justified.

Considering the mix of functions first, we have to note that what is stressed above to conduct multiple measures that enable us to conduct further descriptions and analysis equally works for a mix of functions. Different studies have also mentioned that are factors like recognizing the character or identity of the place; emphasizing the legibility; maximizing synergy and minimizing conflict (incompatibility); choice of location in injecting mix; and timespan (activities to be stretched beyond daytime) are among some of the factors to be considered for a successful mix. So, the density considering multiple aspects of the principle will also increase the success of the project's mix of functions.

The study likewise conducted multiple measures and analyses that showed the efficient use of land; incompatibility that exists inside and beyond the study area and higher values in land use

diversity and mixedness. Also, the land use synergy assessment based on compound level land use while using a correlation analysis showed that they have an insignificant relationship with each other. Rather they are related to the available floor area and transportation (amount of access) as affected by the location of the function. This is because the mix of function affects the street life as the connections between the building and the street is highly determined by the connection between the ground floor of the building and the functions attached to its changing the whole vibe of the area.

But the norm and standard of the structure plan seem to approach a form-based coding system and somehow disregard the land use and zoning aspect by allocating all buildings for a mix of functions (uses). Here the mix is focused on getting return value by selling those units and generating revenue for the future. But it should be suggested that future redevelopments consider keeping the existing high level of land use diversity; increasing the residential share to bring balance in land use mixedness; considering distances from the LRT station, and the location of the function with access and movement. This simply means that future developments should provide a mix of functions where it is acceptable and where it can flourish rather than generalizing and making all built-up areas have a mix of functions.

Because the area of the small-sized buildings in a fine grain pattern resulted in a decrease in available shared space. However, being small and distributed in all compounds allocated those spaces for fewer households enabling them to use the shared spaces intensively. Also, the graph analysis and study of people's activity in the compound and housing units revealed a higher level of association between the compound space and the dwelling units. Again because of this the activities of the dwellers spill over to adjacent spaces and it is the result of numerous socio-economic factors. So unless the provision of housing address this issues future standards and redevelopment projects should consider allocating small spaces for a household activity or allocating existing dwellers to the ground floor. And the continuation of small and distributed open spaces for fewer residents should continue as it assures the intensive and interactive use of the spaces. This is vital because what we decide for the future should be based on or be a continuation of our existing context. For example in a city with the lowest level of private car ownership and with a plan to invest and motivate public transport allocating 30% for streets does not seem reasonable and this will also result in a decrease in the available land area for residential use affects the density.

The study on people's activity in the housing unit revealed that people's activity and housing form have some level of association. While people's activity shaped the form of the HU the form and size of the HU in their turn affect the activity of people and the arrangement of space. Also, the assessment of the transformation of the housing units and their impact on density showed a positive aspect as it enabled dwellers to accommodate their increasing family size, spatial need,

and addition of function. And in general, at the compound and neighborhood level, it brought an increase in household density and population density. Therefore future housing projects would be recommended to provide housing forms (ex. linear forms) that enable the transformation of the units. This again provides the chance of further densification and minimizes future sprawling effects, also it can be a source of income for dwellers if they rent the subdivided units and even for the city if they provide contract agreements with the landlords to gain from rent values. And if dwellers are provided with a unit that has enough space which further provides them with an income the chance of dwellers relocating themselves to the city periphery and contributing to the effect of urban sprawl will be halted.

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## Annex

### Annex I: Article

Addis Ababa University, Ethiopian Institute of Architecture, Building Construction and City Development (EiABC) - Housing and Sustainable Development (HASD)

#### Constructing Density Model for Inner City Residential Compounds with Kebele Housing: The Case of Kebele 02 in Woreda 01, Lideta Sub-city, Addis Ababa, Ethiopia

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#### Abstract

In recent times the issues of density and its effect on the built environment or urban form are becoming the center of attention. The manipulation of density will significantly affect the morphology of urban areas. In both urban sprawl and proposed alternative development paths, the issue of density is used both to define and measure the concepts. However, there are multiple definitions and methods of measures to describe density that further contribute to the confusion on the subject. And if we consider the issues of optimum density we will find a wide variety of views. Addis Ababa's overall urban density has decreased from time to time and the administration intends to increase the density of the city using compact development by focusing on vertical densification around the light rail transit route and station. However, there is a lack of more detailed, precise, and up-to-date data and the appropriate type of measures for the city administration that are crucial for making a better decision. So this article focuses on multiple types of density and land use measures conducted for developing a density model. The study area is one of the areas that are delineated for high-density transit-oriented development by the structure plan. It depends on the morphological analysis and assemblage theory as used by different studies that required multiple sources for information and methods. Then results of the different conventional measures were combined again with land use and building use to construct a density model. And it shows detailed density measures that helped to develop models that help to reveal the density and urban morphology of the area well and help us to make improved decisions. It recommends constructing and using density models at the city level that are fit for our context and for choosing density measures that describe up to floor area level.

Keywords – Density, Land use, Density measures, Density Models, and Kebele Housing

## **Introduction**

Showing its complexity Churchman (1999) states that density seems appealing to planners because it seems objective, quantitative, and neutral but a closer look reveals that it is a very complex concept. Others have also described its complexity, its controversial terms, confusion in measurements, vagueness, and inconsistency (Dovey & Pafka, 2014; Forsyth, 2003; Jacobs, 1961; Cheng, 2010; Pont & Haupt, 2009; Rapoport, 1975; Vujic, 2014).

It is also related to the urban form and transport, different socio-cultural aspects, economic conditions, and environmental capacity and quality (Newman & Kenworthy, 1996; Gehl, 2010; Jacobs, 1961; Alexander et al., 1998; Scoffham & Vale, 2005). Therefore, it is going to affect every aspect of our life. Today the history of the last century and the reality of a more urbanized world with global warming and the metabolism of the city bring the concept of density to the forefront (Demographia, 2012; Angel et al., 2021; Newman, 1999). Discussions of urban density have also long been central to theories relating to urban form. Both maximum and minimum measures of density have been linked to qualitative aspects like health, safety, creativity, vitality, and sustainability, and determining them has been a source of controversy.

Different studies were also conducted in density measures and ways of description by connecting each value or with different parameters like form, intensity, connection, and use and developed different charts and models of density. (Angel et al., 2021; Dovey & Pafka, 2014; Eizenberg et al., 2019; Forsyth, 2003; Pont & Haupt, 2009; Patel, 2011; Vujic, 2014). Likewise, the study based on the morphological study, building and compound use maps, and multiple measures try to describe density well and construct simple models and charts based on our context.

This complex multidimensional concept affects the urban form by itself and affects different aspects of the daily life of dwellers. For making decisions or determining the optimum density and manipulating the urban form we have to understand issues of density. But in our case like the other developing countries, there is a lack of empirical data and appropriate measures that consider the context. Therefore the study aims to describe density or the area using multiple measures aiding us to choose the appropriate measures and construct a density model.

This descriptive and exploratory research employs mainly the Survey method using a stratified sampling method. This was also supported by qualitative interviews, Observational study, and secondary data analysis. And for conventional density measures, the analysis of the study uses descriptive and statistical analysis and uses clustering techniques for constructing density models.

The study shows that the combined density descriptions describe the study area better than that of the individual density measures (conventional measures). And connecting different types of density measures, and measures to land use and other aspects helps for a better description.

## Location of the Study Area

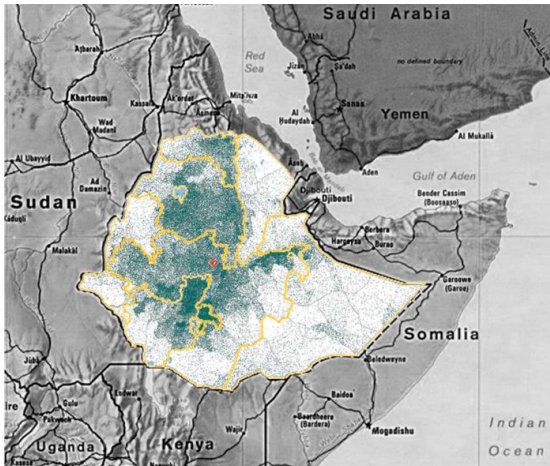


Figure 2 Population Dot Map for 2004 based on 1994 census .... CSA (2006), Modified from Atlas of the Ethiopian Rural Economy. Addis Ababa – Each dot value = 500 people

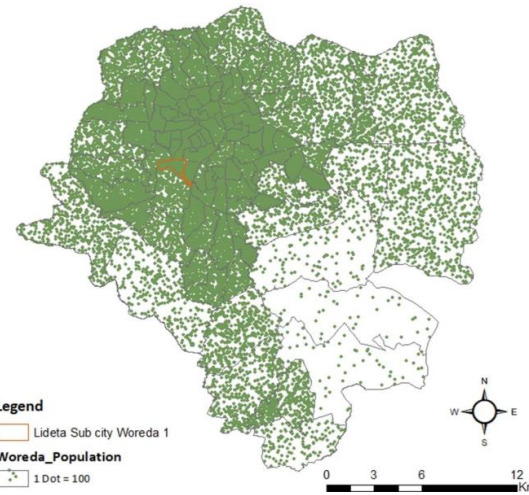


Figure 3 Population Dot Map of Addis Ababa Based on 2011 Woreda level Pop. Census – Each dot value = 100 people

Theoretically, its scope is to issues that are related to the density and to different ways of describing it. geographically it is limited to the study area that is located in the inner city of Addis Ababa, Lideta sub city, woreda 01 kebele 02 (area in front of EiABC or near the coca-cola LRT station).

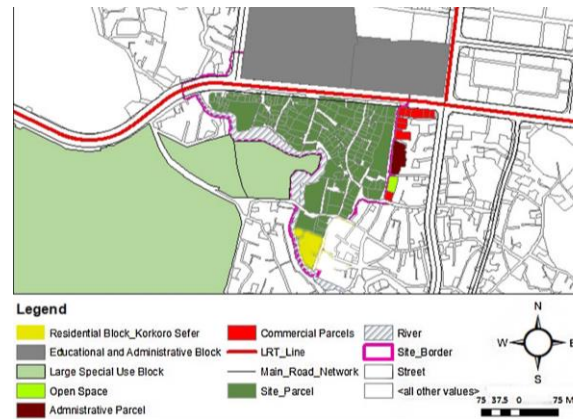


Figure 4 Study Area Selection

## Literature Review

One of the factors that pushes density to the forefront is the issue of urban sprawl, and it is simply the physical expansion of cities and it is the result of the economic, social, and planning ideology. According to Giddings et al. (2005), urban sprawl has become a worldwide phenomenon. And a study in 200 cities showed an overall decline in urban densities (Angel et al., 2021).

In Addis Ababa also economic stagnation during the feudal time, different plans allowing the construction of low-cost single-story housing, their lack of understanding of local context, a successive proposal of decentralization and zoning in master plans, failure in delivering sufficient housing, high population increase, migration, and trend of following infrastructure lines are some of the stated reasons for the sprawl of city (Angel et al., 2016; Fekadu, 2014; Dendena, 2008).

Despite the consensus on the negative impacts of sprawl, some have described the likely scenario of continued spatial dispersion and its difficulty to stop (Haynes & Fortheringham, 1984; Dieleman & Wegener, 2004; and Okabe, 2005). But there is a change in perception of the concept

and today more than understanding its effect and cost, administrations also try to mitigate the problems. Policies such as 'new urbanism', 'smart growth', 'compact city', and 'multifunctional land use' were developed, and also Peter Calthorpe's TOD and CNU's UGB all intend to halt urban sprawl in one way or another.

In the above descriptions of urban sprawl and related issues presented to mitigate it, we can find density at the center of the discussion. Neuman (2005), explained that sustainability is a concept that draws from five intellectual traditions of capacity, fitness, resilience, diversity, and balance. Here also the capacity is highly intertwined with the management of density. The non-growing state for human society or 'The Equilibrium State' as proposed by a group called Club of Rome in 1972 can be related to the concept of infill densification. From Ebenezer Howards' 'garden cities', to F.L. Wright's 'Broad acres city' proposals were about decreasing overcrowding. Le-Corbusier's higher density living idea in the 'radiant city', and the Dantzing and Saaty's (1973), proposal of the 'compact city' all have imagined higher density in their core.

Today the matter of density is highly related to the issues of sustainability. In Jenks (2004), density and compactness of cities were described as components with the potential to influence the sustainability of urban form. Frey (2005) included "A reasonably high population density" as one of the commonly agreed sustainability criteria. Gehl (2010), also suggests that this reasonable density must be combined with quality in the form of good city spaces. Again in Edwards (2005), high density is among the issues that are needed to be displayed in a sustainable housing neighborhood.

The structure plan of Addis Ababa also intends to develop a compact city (regarded as being the most sustainable by UN-Habitat, 2011) and develop a higher-density housing neighborhood near the LRT line (TOD). 'Compact City', as the name shows its concept emanates from further densification of an existing environment. Likewise, TOD depends on developing higher-density neighborhoods around the stations of the transit line, and in both cases, density is at a focal point.

**The Concept of Density** - According to Mumford (1938), a matter of density first started to be felt in the renaissance time, especially in today's capitals of European cities. And today it has become the center of discussion in the built environment profession. Vujic (2014), describes that density becomes vague when it is related to land use, transport, and intensity; Dovey & Pafka (2014), mention the inconsistency of naming and usage; Pont & Haupt (2009), criticize the lack of convention in the studies that create the above-stated inconsistencies.

**Definition** – Alexander et al. (1988), states that density measures are an integral part of the design professional's vocabulary and "kit of tools". The most general type of definition of density can be a measure of the concentration of individuals, households, and physical structures within

a given geographical unit. The concept of density derives originally from physics as a quantity of mass per unit volume. As applied within urban studies density applies to certain quantities per unit area Dovey & Pafka (2014).

**Measures** - According to Alexander et al., (1988), density can be a perceived experience that focuses on the effects and experiences of people, or it can be physical density. Also, Churchman (1999), shows density from an urban planning perspective and he puts them as parcel density, street density (net density), gross density, and population density. And Ng. (2010), uses physical density and regional density which are the same as the above-mentioned physical density. However, he states that issues related to defining density as high or low is a matter of perception; it is subjective and depends upon the society or individual's judgment against specific norms.

The other measures of density can be included under indoor or household density and include floor area per person, people per room, and habitable floor area per person. First this internal, indoor or household density also seems simple but it has also a lot of ambiguity, especially in determining the spatial aspects. According to Ranson (1988), in expressing Indoor space (i.e. the living area within the dwelling unit) is normally divided into dwelling space areas, and ancillary space (like corridors, stairs, and storage). So when we say habitable room it excludes ancillary spaces. And when we take the floor area does it include the wall space or consider the accessible floor space only is not described. And Appolloni & D'Alessandro (2021), state that a diverse approach exists among European countries' regulations.

Overcrowding occurs if there are more than three people per room (WHO, 2018 citing UN Habitat 2007) American Crowding index is 1.5 people per room, and the air temperature between 18<sup>0</sup>c and 24<sup>0</sup>c is seen as creating no risk and recommends 18<sup>0</sup>c. Blake et al. (2007), stated that overcrowding will happen when there is below 165 ft<sup>2</sup> or 15.33m<sup>2</sup> for a person. There are a lot of definitions and measures that contribute to ambiguity so this study will follow **table 3**.

**Density in Our Context** - Abaynew & Wubalem (2017), state that Ethiopian cities are growing in a low-density pattern as compared to global standards (housing as well as population density). Specifically, trends show that the built-up areas of Addis Ababa are increasing at a speed of 4-5 km<sup>2</sup> per year (UN-Habitat, 2017). While the overall density (built area/people) of Addis Ababa, decreases from time to time (Larsen et al., 2019; World Bank, 2015). But the residential density values increased between 2006 and 2016, every additional person increased the urban area by .014 ha (Larsen et al., 2019). The residential density of Addis Ababa or housing density is very low but the net population density in the built-up area of the city is 125 people/ha (AACPPPO, 2017, p. 116). And describes, that vertical densification is the only available option (ibid:42).

Elias Y. (2007) states the *kebele* housing-dominated settlements are the result of unique urban



Figure 5 Common Type of Kebele Housing with Attached Unit with CIS Wall and the Narrow Paths of the Neighborhood

history and political developments in Ethiopia. According to Matsumoto & Crook (2021), more than 80% of Ethiopia's housing market is owner-occupied. In Addis Ababa the rental housing share is bigger than in the other cities, reaching 507,265 units (61.06%). Kebele housing is especially prevalent in urban areas, where 345,428 kebele units are located in an urban area (95% of all kebele units). From this, the 148,645 units exist in Addis Ababa (43% of all urban kebele units in the country) and account for nearly 40% of all rental housing in the city.

## Methodology

**Different studies on Method and Modeling Density** - The methodology first asks for the existing studies that focused on density description and the type of methods they used. Patel (2011), trying to define and analyze urban layout describes six parameters of urban design and plots graphs and develops charts in trying to understand particular measures and their combinations. Forsyth (2003), uses 20 types of measures to describe a residential density and tries to clear confusion and clarify the context. Pont & Haupt (2009), stated the inconsistency and gap in conventional measures of density have provided a multivariate definition of density. They used network morphology, FSI, and GSI (land coverage) and represented density by space matrix. Also, Vujic (2014) states that it is crucial to include the other layers of information to unravel the exposed intricacies. And uses assemblage theory to analyze urban intensity by relating the 3 Cs.

Eizenberg, Sasson, & Shilon (2019), used morphological and qualitative topological analyses, to produce a more nuanced understanding of the interconnections between urban forms and users' experiences of these forms. Dovey & Pafka (2014), state that despite extensive research and practice, the modeling of interconnections between different concepts and measures has proven difficult. They proposed an integrative approach to conceptualizing urban density that seeks to clarify and link key concepts within a loose framework of assemblage theory.

Urban density can be factored into its constituent parts in different ways that expose its anatomy. Factoring is simply defined as breaking down a quantity into its constituents in such a way that multiplying them by each other yields that quantity (e.g.  $12 = 3 \times 4$  or  $12 = 2 \times 2 \times 3$ ). Exposing the components of urban density in a city makes it possible to treat them individually while considering their effect on urban density as a whole (Angel et al., 2021).

The aim or question of the study is to describe density; so it has a descriptive question and tries to describe the density of the neighborhood while focusing on kebele houses. According to Kothari (2004), Surveys are conducted in the case of descriptive research studies and they are concerned with describing, recording, analyzing, and interpreting conditions that either exist or existed. Regardless of their type, the method of data collection happens to be either observation or interview or questionnaire, or some projective technique(s). The other aim of the study is to construct a model and this asks a normative question that is exploratory so it's guided by a less formal method in looking for the model and uses different measurements, therefore to find the answer different analyses will be used.

### Selection Criterion

- The Selected Area has to exist in one administrative area(to avoid boundary problems)
- The selected area must avoid boundary problems (helps to increase the clarity of measures)
- They should have an abundant number of kebele dwellings (65% qebelle Houses)
- To be in the inner city (Considering future development and the kebele houses)
- To be near the LRT within a 400-500m radius (chosen for high-density redevelopment)

### Choice of Method

Measures	Type of Data Needed	Method of Collection	Techniques used
Morphological density	Previous maps, built-up and floor area, building height, and compound area	On site measurement	Updating the base map
Household density	Number of households in a compound and neighborhood	Survey Questionnaire and interview	Updating worda files
Population density	Number of people in a household, in a compound, and neighborhood	Survey Questionnaire and interview	Updating worda files
Land use	List of every function	Site visit and inspection	Land use Inventory
Building use	List of every function	Site visit and inspection	Building use inventory

*Table 1 Types of Measures and Data Needed with Methods and Techniques Used for Collection*

**The Source of Data** - Qualitative questionnaire interviews and observational studies using first-hand on-site observation, and site reconnaissance, were used. Measurement and Photographs were used to measure the compounds, buildings & indoor spaces, and site pictures that described the context. Aerial Orthographic Photos were used for updating and Mapping density and use. A questionnaire survey was also conducted for the qualitative study.

**Sampling Method** - As Kothari (2004), indicates a clustered sampling technique is recommended for a study in a geographical area but the study used **stratified sampling because of the shape**

**of the blocks.** And compounds from those blocks were selected in a way that assures the fair distribution using a **systematic sampling calculation**. The Selection of the housing units from each compound is based on a judgment of the researcher (so non-probability sampling). Also, a qualitative study is a type of empirical inquiry that entails purposive sampling for gathering data (Zegeye et al., 2009.p36). Therefore the selection of the housing units was based on personal judgment.

Based on the Addis Ababa University research standard this study uses a 95% confidence level. We know that if the confidence level is 95%, then the significance level will be (100 – 95) i.e., 5%. Therefore  $sample\ size = total\ population / 1 + total\ population \cdot (0.05)^2$

$$N = 366 / 1 + 366(0.05)^2$$

$$N = 366 / 1.915 = 191.12 \approx 192\ \text{housing units (Kothari, 2004; Krejcie \& Morgan, 1970)}$$

However, the obtained data from the kebele houses doesn't fully represent all the compounds including the CWKHU. Around half of the compounds contain private housing units that have a different character so using the above calculation 42 private housing units were added to the sample size. Therefore totally 234 households were surveyed.

### Analysis

Thematic Issues	The scale of the study	Presentation Method	Analysis
Density	Neighborhood Level	Built-up density	Descriptive and Statistical Analysis; urban land scenario
		Population Density	
		Housing Unit Density	
	Compound level	Built-up density	Descriptive and Statistical Analysis; and comparing to Standards
		Population Density	
		Housing Unit Density	
	Household Level	Av. Family Size	Descriptive and Statistical Analysis; and comparing to Standards
		Built up area per Person	
		Gross R. floor area per Person	
		Occupied floor area per person	
Persons per habitable room			
Mix of Function	Neighborhood level	Building use map	The land use diversity index and Mixedness Index were also used

Table 2 Methods used for Analysis and Presentation

**Descriptive and Inferential analysis** - As the first question of the research is a descriptive question and the method used was the survey method the best-suited analysis would be descriptive. Analysis may, therefore, be categorized as descriptive analysis and inferential analysis (statistical analysis).

The mix of functions has the procedure of assigning land and building use categories that follow the land-based classification standard (LBCS), and the analysis can sometimes use urban land scenario (uses key assumptions about future redevelopment) analysis.

### Results of the Study

D. Measures	Ratio	Result	
Residential Share and R. built-up area Density	T. residential plot area per Total compound area and Residential BUA per neighborhood footprint	6.54ha/11.31ha = <b>0.57 or 57.8% and</b> 37,765m <sup>2</sup> /47,026m <sup>2</sup> = 0.80	
Built up Area and Floor Area	Total Built-up area or Floor Area per Total neighborhood area	Gross and Net BUA density 47,026m <sup>2</sup> /113,109m <sup>2</sup> = <b>0.41</b> 47,026m <sup>2</sup> /89,780m <sup>2</sup> = <b>0.52</b> Gross and Net density 55,420m <sup>2</sup> /113,109m <sup>2</sup> = <b>0.48</b> 55,420m <sup>2</sup> /89,780m <sup>2</sup> = <b>0.61</b>	
Dwelling Unit or Housing Unit Density	Total number of housing units per neighborhood area	Gross density 560hu/11.31ha = <b>49.5hu/ha</b> Net density 560hu/8.97ha = <b>62.4hu/ha</b>	
People per neighborhood or population density	Total population per Total neighborhood area	Gross density 2730/11.31ha = <b>241ppha</b> Net density 2730/8.97ha = <b>304ppha</b>	
D. Measures	Ratio	Result	Result for CWKHU
Built-up area ratio or Site coverage	Total residential built up area per Residential plot area	37,765m <sup>2</sup> /65,424m <sup>2</sup> = <b>0.57or 57%</b>	21,926m <sup>2</sup> /34,829m <sup>2</sup> = <b>0.63 or 63%</b>
Floor area ratio	Total residential floor area per Residential plot area	37,826m <sup>2</sup> /65424m <sup>2</sup> = <b>0.57or 57%</b>	22,012m <sup>2</sup> /34,829m <sup>2</sup> = <b>0.63 or 63%</b>

Total Household and HU per hectare	Total number of household per Residential plot area	731hh/6.54ha = <b>111.7hh/ha</b> <b>560HU/6.54ha = 85.62hu/ha</b> and for CWPHU = <b>43.8hu/ha</b>	593hh/3.48ha = <b>170.4hh/ha &amp; 122.4hu/ha</b>
People per residential compound	Total population per Residential plot area	2730 people/6.54ha = <b>440.3ppha</b>	2146 people/3.48ha = <b>616.66ppha</b>
Persons per housing unit or dwelling unit	Total population per Total number of dwelling units	2730 people/560hu = <b>4.87pphu and 3.74pphh</b> <b>4pphu for PHU</b>	1944people/366hu = <b>5.31pphu and 3.27pphh</b>
Built up area per Person	Total residential floor area per Total population	32,768m <sup>2</sup> /2730 people = <b>12m<sup>2</sup>pp 21.62ppm<sup>2</sup></b>	15,774m <sup>2</sup> /1944 people = <b>8.11m<sup>2</sup>pp for 366hu</b>
Gross R. floor area per Person	Total R. floor area of du per Total population	12,450m <sup>2</sup> / 1,296 people = <b>9.6m<sup>2</sup>pp 22.9m<sup>2</sup>pp</b> for PHU	8,092.51m <sup>2</sup> /1106 people = <b>7.3m<sup>2</sup>pp</b>
Occupied floor area per person	Occupied floor space per Total population	10,831m <sup>2</sup> /1296 people = <b>8.35m<sup>2</sup>pp</b> for 234hu 18.6m <sup>2</sup> pp for 42p hu 924rm	6633m <sup>2</sup> /1106 people = <b>5.99m<sup>2</sup>pp</b> for 192 khu with 711 rm
Persons per habitable room	Total population per Total habitable room	1296 people/784 room = <b>1.65pprm</b> & 1.05pprm for 42phu 9,307.15m <sup>2</sup> hs	1106people/604room = <b>1.83pprm</b> 6633m <sup>2</sup> hs

Table 3 Results of the Study

## Results presentation for Morphological Density and Land Use Mix

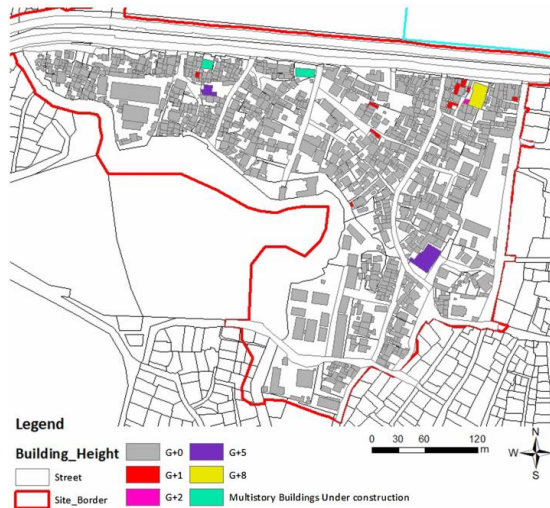


Figure 6 Building Height Map of the Study Area

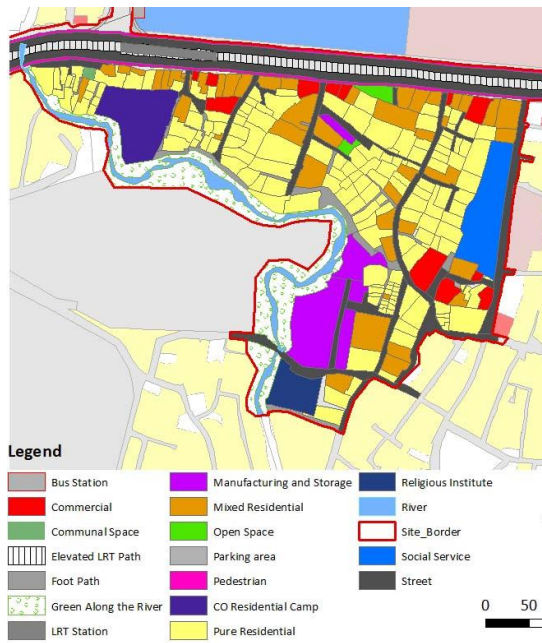


Figure 7 Study Area Land use in 2021 – the color coding uses LBCS (Berke et al., 2006, p. 210) with some modifications

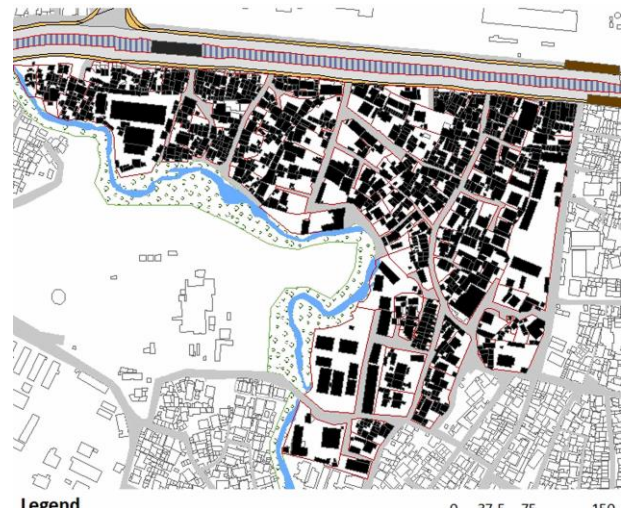


Figure 8 Figure Ground map of the study area in 2021

	Land Area in Ha	Compound Built-up Area in m2	Residential Built-up Area	Total Population
Neighborhood	11.3	47,026	35,108	2,730
Residential compound	6.54	35,108	32,768	2,730
CWKHU	3.48	21,926	19,801	2,194
Other Residential Compounds	3.06	13,182	12,967	540

Table 4 Morphological and Population Density for Different Types of Compounds

	Built-up Area Occupancy	Built-up Area Ratio	Residential Share
	People per Built-up Area	Built-up Area per Compound Area	Residential Area per total neighborhood Area
Neighborhood	2730/3.5 = 779.3	3.5/6.54 = 0.53	6.54/11.3 = 0.58
CWKHU	2194/1.98 = 1108	1.98/3.48 = 0.56	3.48/6.54 = 53%
Other Res. compounds	540/1.29 = 418.6	1.29/3.06 = 0.42	3.06/6.54 = 47%

Table 5 Selected Types of Measures and Computations used for Constructing Density Models

No.	Land Use Type	LU.Area in m <sup>2</sup>	%	Built-up Area	%	Number of Bldg	Av. BAR	Av. BH
1	Commercial	3,476.74	3.07	1,839	3.91	8	0.53	4.125
2	Open space & Recreation	7262	6.42	20	0.04	1	0	1
	<i>Communal Space</i>	180	0.16	0	0	0	0	0
	<i>Green Along the River</i>	6,118.8	5.41	0	0	0	0	0
	<i>Open Space</i>	964	0.82	0	0	1	0	1
3	Manufacturing & Storage	7877	6.96	3,239	6.89	19	0.41	1
4	Mixed Residential	19,222	16.99	11,024	23.44	110	0.57	1.09
5	Pure Residential	46,202	40.85	25,127	53.43	1,021	0.54	1
6	Religious Institute	2,432	2.15	1336	2.84	10	0.55	1
7	Service	11,919	10.54	4441	9.44	38	0.41	1.1
8	Street	14,718	13.01	0	0	0	0	0
	<b>Total Area</b>	113,109	100.0	47,026	100.0	1207		

Table 6 Detail Land Use Description

## Discussions and Conclusion

The conventional density measures have limitations and don't describe the neighborhood in detail enough so that we can have a clear image of the area so multiple measures were needed and used. Generally, the study area has a gradually developed unique and organic character like that of the other inner city neighborhoods. They have also no pinch of standardization (similarity) within each block, compound, and among dwelling units.

However, reminding us that each measure has its contribution that cannot be disregarded and looking into conventional measures and connecting them will be the first task. Based on Residential share – As the city is in a fast growth the land occupied by residential housing increased at the city level while decreasing in the inner city. Yet the study area showed a slight increase in its residential share however it is starting to decrease in recent time as expected.

The total neighborhood has a built-up area ratio that is almost equal to the city's proposed standard (40% built-up area). The average building height in the neighborhood for compounds other than residential use is twice that of the residential units. The residential compounds have an equal value of FAR and BAR because almost all houses in the neighborhood are single stories.

Other than morphological density the population and housing units' density at the neighborhood level (gross density) that includes the land area of other functions will distort the description of the area. This type of measure can be used in a planned neighborhood when the other functions are thought to be concerning the residential use, are compatible, and used by the dwellers. However, we should not use this measure to describe Addis Ababa's inner city neighborhoods where we can find other non-residential uses with a large plot of land. Even though this measure has some flaws despite its inefficiency it will describe density at the neighborhood level.

For a better look, the measure of the **Compound Level Density** (residential density) is required that considers the residential compounds only. And this measure shows that they are highly compact (use most of the land area) with single-story buildings. Here it shows the CWKHU has a higher level of built-up, household, and population density than the other residential compounds exceeding in every measure of density.

While looking into the building height map and connecting to function the BAR value is mostly related to the residential function and also the FAR is much related to non-residential uses. This indicates that the residential compounds preferred the horizontal expansion while the others intermingle vertical densification. So the increased built-up density decreased the relative space between the housing units, and the access to natural lighting and wind flow so affecting the comfort level of the dwellers negatively.

The household density which is the total number of households per residential plot area shows that this area has a high residential density. Again compared to the existing city household density both in gross and net and with most Sub-Saharan cities it has high density. Connecting density to ownership and categorizing the residential compounds to compounds having kebele housing and private housing reveals that the household density in CWKHU is more than twice dense than compounds with private housing.

The measure of residential density enables us to see the household density in those compounds (CWKHU). And they have a higher density in a household not only than that of the overall city average but also it is above the minimum value of the structure plans norm and standard (150hh/ha). But as the housing units are single-story buildings they have a congested fine grain arrangement that has a low open space share for each unit. The other measure is the population density in the residential compounds which is the total population per residential plot area of the neighborhood is around Abercrombie's maximum and is denser than the city's average residential density. Again the population density for CWKHU is more than twice dense in the population density than compounds with only private housing.

Therefore the study area's residential density is above the city average but here also the density is higher because of the CWKHU which has a 52% increase in total residential density and around

152% increase from CWPHU. These results also show that the density of the households and the population is not balanced and it indicates the prevalence of overcrowding. But we cannot conclude like this (be sure) it is only indicative unless we perform further measures of indoor density.

In-door density - People per Housing unit - The average family size or people per housing unit and household will be 4.87pphu and 3.74pphh respectively. But the Kebele houses in the study area have a higher family size and the average housing unit value becomes 5.3pphu but the average household value is 3.2pphh.

Using built-up area density shows that the study area has a compact form and using the gross floor area per person that shows the available area for family members within the perimeter of an exterior wall. Further to see the usable floor area that is used by dwellers the occupied floor area per person (useable interior space) and person per habitable room was measured. In all measures the average indoor density for the kebele housing units was low. And again the different measures show that the dwellings inside CWKHU have a value that is below the required standards of UN and WHO in both minimum floor area and person per habitable room. But isolating each tenure type the KHU has a much lower value with both floor area per person and person per habitable room measures. But the private tenure types have an acceptable minimum standard in both cases.

Therefore the indoor density measures show that kebele houses are overcrowded by having a very small floor area for the dwellers but the number of people per habitable room is not that much big as expected. This is what appropriation brought them because the challenges created by the small floor area share for everyone were resisted by providing small rooms. So we can conclude that the area has long passed the condition of one family per one room and further subdivided those rooms reaching one family per one small room.

Further, we can combine different factors affecting density and values of measure to plot different graphs. For example, the household size compared to building size can show the existing housing unit condition or indoor density. And further drawing the line across the standard gross floor area per person value we see how many of the units reside in a crowded situation. And we can even talk about the severity of the overcrowdedness for each unit and collectively in general.

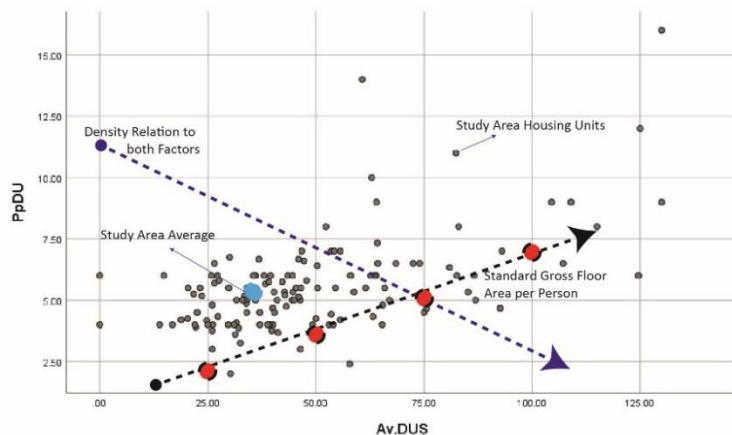
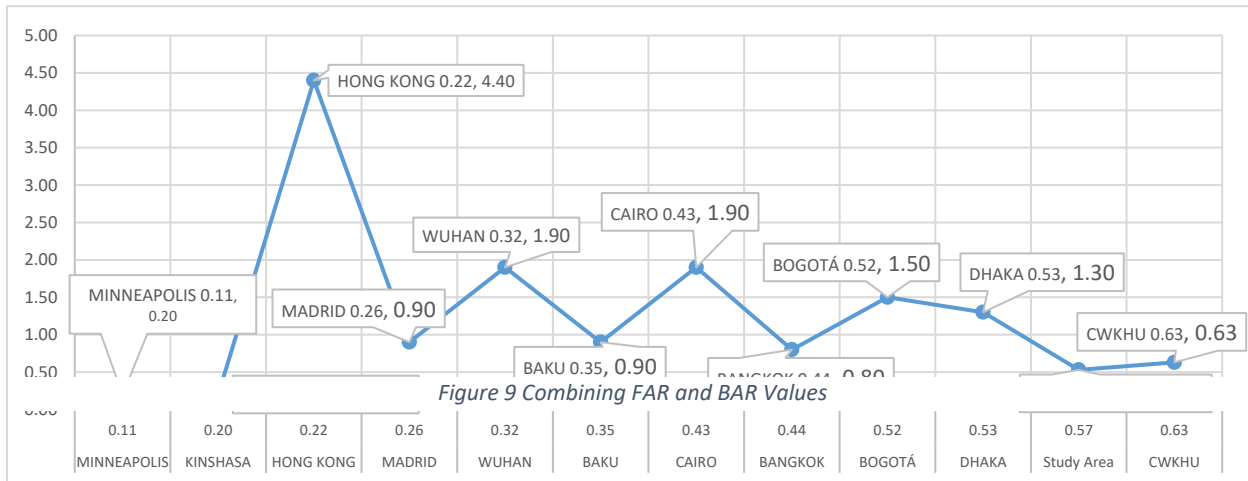


Figure 8 Connecting Family size to the Dwelling size

For example, the household size compared to building size can show the existing housing unit condition or indoor density. And further drawing the line across the standard gross floor area per person value we see how many of the units reside in a crowded situation. And we can even talk about the severity of the overcrowdedness for each unit and collectively in general.

Again the second chart of BAR and FAR values is much related to the built environment or the morphology of the area. and the graph can be used to show the character of the area to form and by adding the data of other neighborhoods and cities we can employ a comparison analysis and it will also help to decide for future as to which direction is possible and appropriate with other adjacent studies could help to guide our decision.

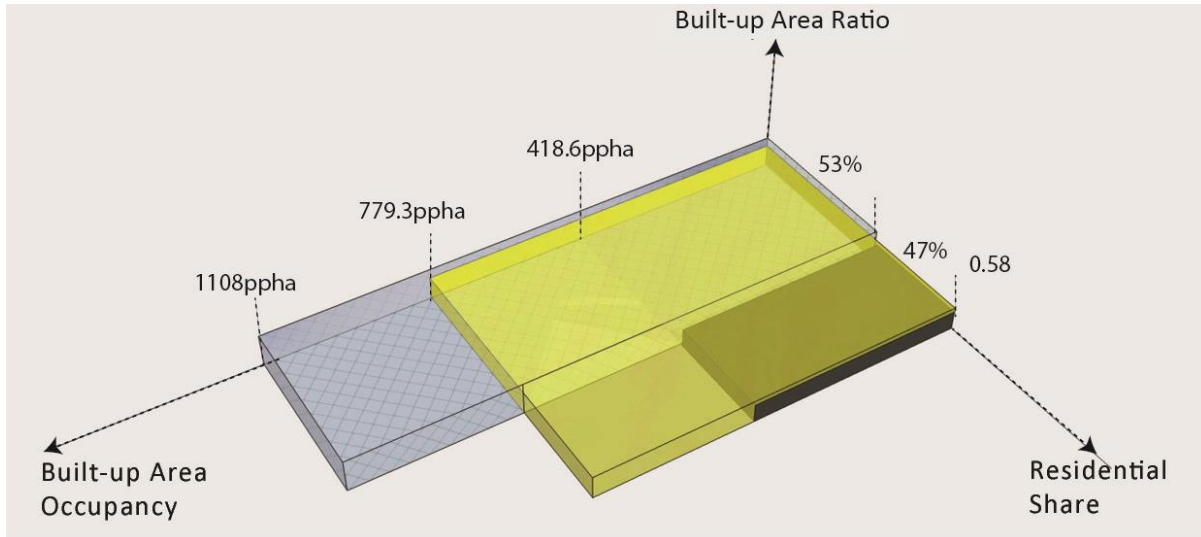


Further combining three and four values of the density will enable us to construct a model. Below for example the three-dimensional approach to density using BAR, Residential share, and built-up area. Below we have two Models the first model (see fig.4) uses three factors in it the yellow box represents the average value of the neighborhood but the gray and brown boxes represent the CWKHU and the other residential compounds. The second model (see fig.5) joins the share of the same land and building functions and combines them with their respective total built-up area and average building height. The percent in the figure represents the amount of share of land use from the total neighborhood area and the amount of share of the total built-up area from respective land uses.

### Constructing the Models

Finally, we can state that based on previously used theories of constructing models and combining them with the land and building use this research article presents a new way of describing density. And this comprehensive way of presenting density connects multiple factors but in a simple manner. And this type of description will inform us a lot for example with the knowledge of the total area we can extract each function in built-up and land use share. Again

Again this type of description at a neighbourhood scale helps us to suggest different design and planning ideas and if we have this at the city scale it will help us to suggest different policy issues.



Legend ■ All Residential Compound ■ CWKHU (kebele) ■ Other Res. Compounds

Figure 10 Average Residential Density for the Neighborhood

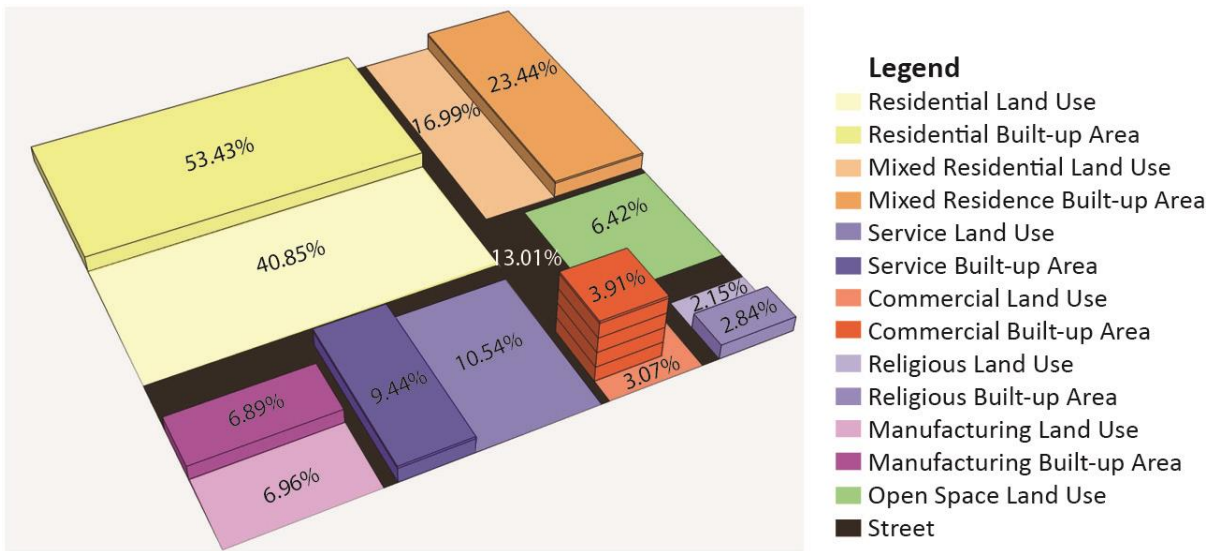


Figure 11 Neighborhoods Density Description by Combining Different Factors

### Further Study

The modeling of density here is constructed by connecting the overall built-up area and average building height to get the volumetric three-dimensional image of the built environment in their respective land use. And further, it is assigned to different colors showing the function of the buildings and the area that they occupy. Yet this has its character and strength that intends to simplify density. But future studies could construct three-dimensional features of each building in their respective location and connect them to the movement framework and access points of each building that could tell further stories about the urban form.

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## Annex II: Quantitative Questionnaire

Date of the Interview \_\_\_\_\_

Name of Household Head \_\_\_\_\_ I.D Card no. \_\_\_\_\_

House Number: \_\_\_\_\_

Ownership: \_\_\_\_\_

### Family Profile

No.	Name of a family member	Sex	Age	Marital Status	Employment (x,v)	Job Loct.

- House hold income or estimate of the family members total Expenditure in month \_\_\_\_\_
- Have you been saving for condominium housing? a. yes \_\_\_\_\_ b. no \_\_\_\_\_
- How much were you saving per month? \_\_\_\_\_
- If you have a chance to win a condominium lottery at what floor do you want to live  
a. ground floor b. first floor c. second floor d. third floor e. above third floor f. I do not care

### Acquisition History

- When did you come to this neighborhood and acquired this house? \_\_\_\_\_  
a. Before 1975 b. Between 1976-1983 c. Between 1984-2005 d. Between 1976-1983
- Where was you living before coming to this neighborhood? \_\_\_\_\_  
a. Addis Ababa b. Out of Addis Ababa
- How did you acquire this House?  
a. From government b. By inheritance – ‘Be ene’ or ‘Be ena’ c. Rent  
d. Change e. Other \_\_\_\_\_

### Perceived Density

- What did you observe through time in your locality?  
a. Increase in population and Housing unit b. A decrease in population and Housing unit  
c. Increase in population, not in Housing unit d. Increase Housing unit, not in population  
e. Other \_\_\_\_\_
- How do you perceive or describe the number of people living in your compound?  
a. very Small b. small c. medium d. large e. very large or crowded
- How often do you see unlike person in the compound?  
a. Always b. Very often c. Sometime d. rarely e. not at all
- Is there any problem of privacy in the compound? a. yes b. no

5. If yes, when do you feel the violation of privacy in the compound mostly?
  - a. while using toilet and bathing
  - b. performing hh activity
  - c. when am socializing
  - e. during different ceremonial events
  - f. when I try to relax
  - f. other \_\_\_\_\_
6. Do you face any type of disturbance in the compound? a. yes b. no
7. What type of activities do mostly disturb you or your family?
  - a. social and ceremonial
  - b. activity from street
  - c. functions other than residence
  - d. from my neighbors
  - d. activities from the communal space
  - e. other \_\_\_\_\_
8. How do you describe the condition in your house in relation to the number of family members to available space?
  - a. more than enough
  - b. enough
  - c. crowded
  - d. challenging
9. Is there any problem of privacy in the household? a. yes b. no
10. When do you mostly face any violation of privacy and disturbance in the household?
  - a. when a visitor comes
  - b. while changing clothes
  - c. while working or studying
  - d. while feeding
  - e. while resting
  - f. while trying to bath
  - g. other \_\_\_\_\_
11. Do you have any habit of assigning a room or space for any member or activity? a. yes b.no
12. What type of space do you have in the household?
  - a. my own room
  - b. siting place
  - c. working/studying area
  - d. praying
  - e. eating place
  - f. other type
  - g. none
13. Does everybody in the household have his/her own space other than sleeping space?
  - a. yes
  - b. no
14. Does the dwelling unit share wall to other households or buildings? a. yes b. no
15. Do you have the freedom to use your window regularly? a. yes b. no
16. If your answer is no would you be able to explain why?
  - a. physically barrier
  - b. invasion of privacy
  - c. bad Smell
  - d. avoid noise
  - e. other \_\_\_\_\_
17. How much of the floor area or rooms have enough access to natural lighting?
  - a. all rooms have access
  - b. Some of the rooms' have access
  - c. no room has access
18. Do you feel any sense of comfort in the number of people or number of housing that exists in your compound? a. yes b.no

Wall	Floor	Roof	Ceiling
a. Mud b. Wood and Mud c. Wood and thatch d. Wood e. Concrete block f. Stone, g. Mixed and h. Other	a. Earth material b. Cement c. Wood d. Others e. Mixed	a. CIS b. Tiles c. Plastic d. Bamboo e. Thatch f. others	a. Wood b. Cheap wood or hardboard c. Fabrics d. no ceiling e. others

## Housing Description and Indoor Density

No.	Rooms name	Size (area)	Room function or associated function	Habitability	Material			
					wall	Floor	Roof	ceiling
1								
2								
3								
4								
5								
6								

1. The gross floor area of the Housing Unit or the entire area within the perimeter of the exterior walls of the building \_\_\_\_\_
2. How many rooms does your family uses as a bed room? a. one b. two c. three d. four e. more

### Transformation of the Building

1. How many Rooms were there when you acquired it? - without kitchen and toilet  
a. 1 b. 2 c. 3 d.4 e. more
2. Describe the condition of the house at the time? \_ compared to today's condition  
a. better condition b. the same condition c. bad condition d. other \_\_\_\_\_
3. How many family members did you have when you first acquired the housing unit? \_\_\_\_\_
4. Have you made any change on the building since you acquired it? a. yes b. no
5. How many times did you change the house form?  
a. Once b. Twice c. More than twice d. no changes were made until today
6. Why did you make the change to the house? \_\_\_\_\_
7. Describe the type of change you made to the house? \_\_\_\_\_  
a. Expansion – extending the original HU in  
b. Division – subdivision of a room  
c. Maintenance or reconstruction that brings change in house form  
d. Add unit - Attached and Detached  
e. Internal space change  
f. Other \_\_\_\_\_
8. How many rooms did you add to the original housing unit? Compared to the time acquisition \_\_\_\_\_
9. What material did you use for additional unit?  
A. The same with the original Building B. Different from original house
10. Who did the construction of the unit?  
A. Family members B. Local Artisan C. Professional Mason d. other \_\_\_\_\_
11. What is the function of the additional unit now? \_\_\_\_\_
12. How many houses were in the compound during time of Acquisition? \_\_\_\_\_

13. What changes did you make inside the compound in recent time?
- Fencing
  - Subdividing the compound
  - Fulfilling utilities like electricity and water or building drainage path
  - Construction for extra-function or room – Commercial activity, kitchen, corridor, shade, veranda or room
  - Building a pavement or walkways
  - No changes were made
  - Other \_\_\_\_\_
14. do you want to make a change in the housing unit
- Want to Make a Change
  - Do not want to make a Change
  - Want to make a Change but have No Capacity
  - Want to make a Change but no Available Space
15. If you have a space and capacity to make a change in your housing unit what would you do
- Expansion
  - Subdivision
  - Internal Space Changed
  - Full Reconstruction
  - Add Detached Unit
  - Add Attached Unit
  - Nothing

**Compound Study**

No.	House Hold head name	Number of a family member	Type of Ownership	Building function or associated function
1				
2				
3				
4				
5				
6				
7				
8				

- What type of kitchen do you have?    a. private            b. communal kitchen            c. no kitchen
- What type of toilet do you have        a. private            b. communal kitchen            c. no toilet
- Do you have communal (Shared) spaces?        a. yes                b. no
- What is the area of the compounds Shared space? \_\_\_\_\_
- What type of activities do you do outside the house or inside the compound? \_\_\_\_\_

- 
- Household Activity
  - Household & HH Activity
  - No Compound
  - Social Activity
  - Livelihood & Social Activity
  - No Shared Space
  - Livelihood Activity
  - Livelihood & Social Activity
  - HH & Social Activity
  - All Activity
  - Not Accessible

6. What activities do you perform inside the neighborhood or outside the compound? \_\_\_\_\_

- 
- a. Household Activity      b. Social Activity      c. Livelihood Activity      d. HH & Social Activity  
e. Livelihood & HH Activity      f. Livelihood & Social Activity      g. All Activity  
h. No Activity

7. How much comfortable are they? \_\_\_\_\_

- a. Very Comfortable      b. Comfortable      c. Fine      d. Not Comfortable  
e. No Shared Space      f. No Compound      g. Not Accessible

**Mix of function in the neighborhood level**

1. What functions influence you negatively in your neighborhood?

- a. Hotels and bars      b. Commerce activity      c. Garages and wood work      d. other \_\_\_\_\_

---

2. What problems do you face in your surrounding because of the above function?

- a. Visual      b. Noise      c. Privacy      d. Smell      e. Other \_\_\_\_\_

**Mix of the neighborhood and compound in relation to economic activity**

1. Do you have any economic activity in the compound or neighborhood?

- A. Yes      B. no

If yes

2. What type of economic activity do you perform? \_\_\_\_\_

---

3. Where do you prefer to perform your economic activity?

- A. Here in this neighborhood  
B. Other neighborhood

4. What type of function or service do you need in your neighborhood? \_\_\_\_\_

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# Annex III: Qualitative Interview

Date of the Interview \_\_\_\_\_

Name of House Hold Owner \_\_\_\_\_ I.D Card no. \_\_\_\_\_

House Number: \_\_\_\_\_

## Family Profile

No.	Name of a family member	Age	Marital Status	Employment	Mode of transport to Job	Family member relation to HHH

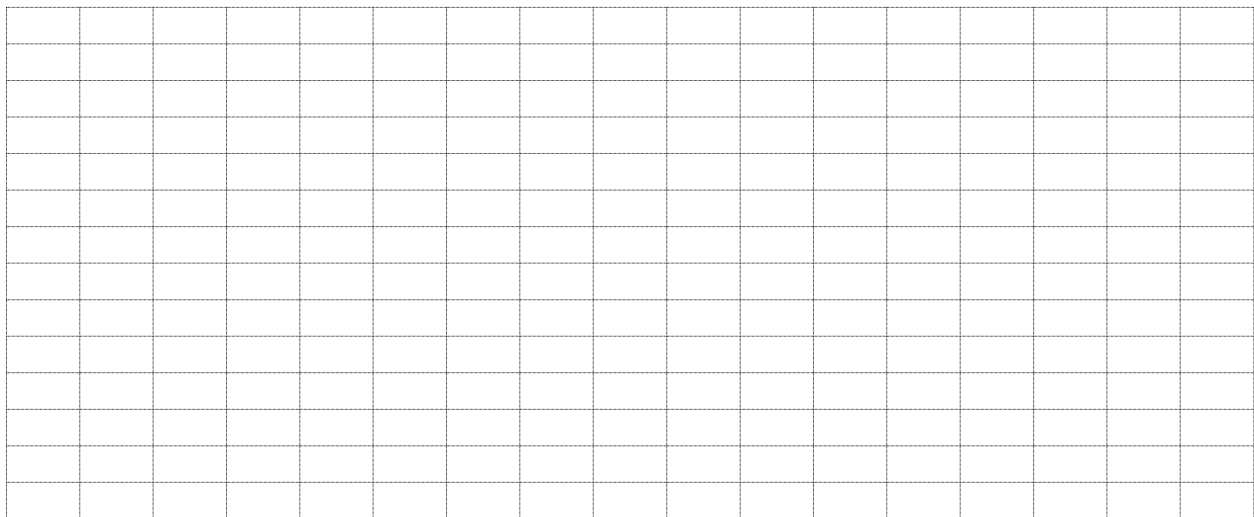
## Acquisition and Building History

4. When did you come to this neighborhood and acquired this building? \_\_\_\_\_
5. Where was you living before coming to this neighborhood? \_\_\_\_\_
  - d. Addis Ababa \_\_\_\_\_
  - e. Out of Addis Ababa \_\_\_\_\_
6. How did you acquire this House?
  - b. From government
  - c. By inheritance – ‘Be ene’ or ‘Be ena’
  - d. Rent
  - e. Other \_\_\_\_\_
7. How many Rooms were there when you acquired it? - without kitchen and toilet
  - a. 1
  - b. 2
  - c. 3
  - d. 4
  - e. more
8. Describe the condition of the house at the time? \_ compared to today’s condition \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_
9. How many houses were in the compound or nearby at that time? \_\_\_\_\_
10. What did you observe through time in your locality?
  - b. Increase in population and Housing unit
  - c. A decrease in population and Housing unit
  - d. Increase in population, not in Housing unit
  - e. Increase Housing unit, not in population
  - f. There was no visible change
  - g. Other \_\_\_\_\_
8. Have you been saving for condominium housing? a. yes \_\_\_\_\_ b. no \_\_\_\_\_
9. How many member of families were saving for condominium? \_\_\_\_\_
10. How much were you saving per month? \_\_\_\_\_
11. How much can you save per month for housing today? \_\_\_\_\_

**Transformation of the Building**

16. How many times did you change the house form?  
 b. Once    b. Twice    c. More than twice    d. no changes were made until today
17. Why did you make the change to the house? \_\_\_\_\_
18. What was the change you made to the house?  
 g. Expansion -  
 h. Division -  
 i. Maintenance or rebuild  
 j. Add Unit for extra-function – trade, kitchen, corridor, shade, veranda  
 k. Other
19. When did the construction take place?  
 a. The first time was in \_\_\_\_\_ The second time was in \_\_\_\_\_ The third time was in \_\_\_\_\_
20. What changes did you make inside the compound?  
 h. Fencing  
 i. Fulfilling utilities like electricity and water  
 j. Add Unit for extra-function – Commercial activity, kitchen, corridor, shade, Toilet  
 k. Other \_\_\_\_\_

**Sketch the evolution of the buildings – Hatch the new unit**



21. If you could what type of improvements would you make? \_\_\_\_\_

**Building Study**

No.	Rooms	Size( area)	Room function or associated function	House Material		
				wall	Floor	ceiling
1						
2						
3						
4						
5						
6						

### Compound study

No.	House Hold head name	Number of a family member	Type of Ownership	When did they acquire it	Type of building function or associated function	Code on the sketch
1						
2						
3						
4						
5						
6						
7						
8						

*Compound map sketched or printed for modification*

*Any type of change and further descriptions will be recorded like this*

**Private and communal space**

1. Do you have a private or communal kitchen?
2. If it is communal how many families use the communal kitchen?
3. Do you have a private or communal Toilet?
4. If it is communal how many families use the communal Toilet?
5. Do you have communal (Shared) spaces? \_\_\_\_\_
6. If it is yes how much comfortable are they? \_\_\_\_\_
7. What activities do you do outside the house? \_\_\_\_\_

---

**Study and map Activities between buildings inside the compound or street**

A large grid for mapping activities between buildings. The grid consists of 15 columns and 20 rows of small squares, providing a space for drawing or mapping the layout of buildings and the activities occurring between them.

### The mix of function in the neighborhood

3. What type of activities do you do in the neighborhood?

N o.	Type of function and trip generation	Availability or access	Frequency of trip per day/week	Distance from home Or place	Mode of transport	Time it takes
1	Playing ground					
2	Communal (shared) space in the Neighborhood					
3	Hotels and restaurant					
4	Shops and supermarket					
5	Health centers					
6	Education Facility					
7	Religious Institute					
8	Public Library					
9	Other commerce – Gult					
10	Leisure facility – cinema ...					
11	qebele recreation center					
12	Visit Friends and neighbors' house					
13	Park					
14	Transport Node					

4. What functions influence you negatively in your neighborhood?

- b. Hotels and bars    b. Commerce activity    c. Garages and wood work    d. other \_\_\_\_\_

5. What problems do you face in your surrounding?

- b. Sewage  
c. Noise  
d. Solid waste  
e. Smell  
f. Other \_\_\_\_\_

### The mix of the neighborhood and compound with economic activity

5. Do you have any economic activity in the compound or neighborhood?

- B. Yes    B. no  
If yes

6. What type of economic activity do you perform? \_\_\_\_\_

7. How many customers do you serve daily? \_\_\_\_\_

8. Where do you prefer to perform your economic activity?

- C. Here in this neighborhood  
D. Other neighborhood

9. Can you explain the reason for your selection? \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_
10. If it was possible what type of economic activity do you think is more profitable in your neighborhood? \_\_\_\_\_  
 \_\_\_\_\_ why? \_\_\_\_\_  
 \_\_\_\_\_
11. What type of commerce or service do you need in your neighborhood? \_\_\_\_\_  
 \_\_\_\_\_

**The Social and cultural context**

2. Do you think that there is a lot of people in your compound? A. yes B. No
3. If yes, what challenges do you face because of overcrowding? \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_
4. What type of neighborhood do you prefer for privacy?  
 A. Your Neighborhood B. Condominium Neighborhoods
5. What type of neighborhood do you prefer for Freedom? Freedom to perform any Household or livelihood Activity  
 B. Your Neighborhood B. Condominium Neighborhoods
6. How many families do you know in this neighborhood? \_\_\_\_\_
7. With how many families do you have a close relationship? \_\_\_\_\_
8. Is there any member of the family that do not involve in social matters?  Yes  No

**Cultural and Religious Association**

Type	Idir	Equb	Mahber/Ze ka/Senbete	qebele (administrative or political matters)
Involvement				
Name				
No. of members for the largest Association				
Location(inside/ outside the NH)				

9. Does your Family or Housing units inside the compound involve different celebrations?  
 a. Birthdays\_\_\_\_\_ b. funerals\_\_\_\_\_ c. coffee \_\_\_\_\_d. social visitation\_\_\_\_\_ e. graduation ceremony\_\_\_\_\_ f. Holidays\_\_\_\_\_ g. wedding ceremony\_\_\_\_\_
10. Where do the activities for the above gatherings take place?  
 a. Inside the house b. inside the compound c. Inside the Neighborhood/street d. a and b e. b and c f. a and c g. Other Places

**Time diary** - To study How the Daily Activity Influence Space Usage and the Mix Influence Housing Unit  
**Interviewee profile** - House Hold Code: \_\_\_\_\_

- Name: \_\_\_\_\_
- Relation to the HH \_\_\_\_\_
- Age: \_\_\_\_\_
- Gender: \_\_\_\_\_
- 

1. What are your daily activities during regular days?

No.	Activity	Time	Place	Remark
1				
2				
3				
4				
5				
6				
7				
8				
9				

2. What other activities do you have?

Time Frame	No.	Activity	Time	Place	Remark
Weekly					
Monthly					
Yearly					

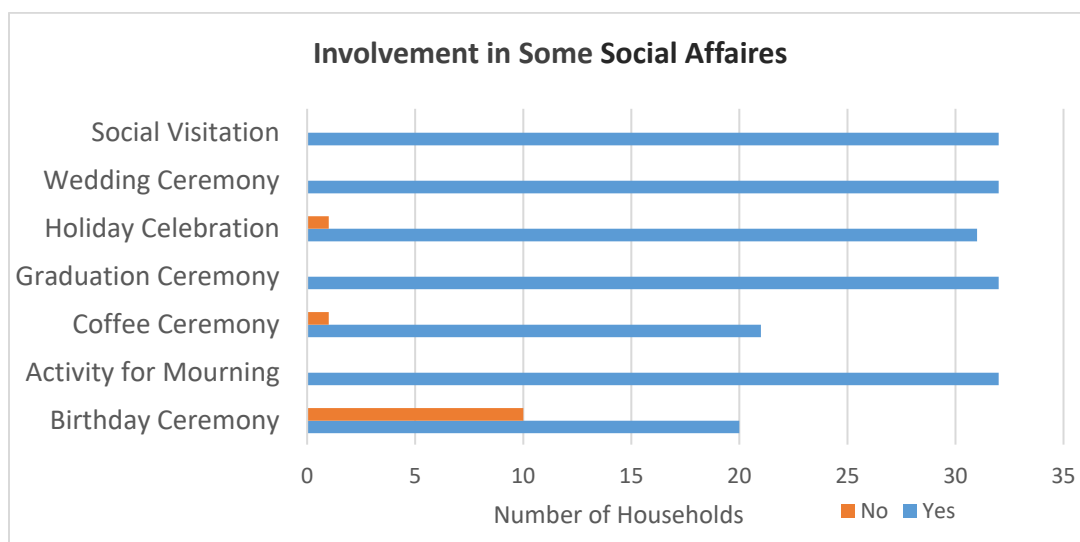
## Annex IV. Some of the questionnaire data Statistical Presentation

### 1. Population Statistics

Study area Population Data statistical summary	Family Size	No. household	Total Population	Percent
	0	2	0	0.5
	1	9	9	2.5
	2	10	20	2.7
	3	37	111	10.1
	4	65	260	17.8
	5	83	415	22.7
	6	76	456	20.8
	7	41	287	11.2
	8	21	168	5.7
	9	12	108	3.3
	10	5	50	1.4
	11	2	22	0.5
	12	1	12	0.3
13	2	26	0.5	
<b>Total</b>	<b>91</b>	<b>366</b>	<b>1944</b>	<b>100.0</b>

### 2. Social Relations

No. of Family they Know	Nearby Only	Around 50	100 - 150	Above 150	All in the Area
Frequency	1	3	1	2	25
No. of Family they have Close Relation	Nearby Only	Around 50	100 - 150	Above 150	All in the Area
Frequency	4	8	1	1	18



### 3. Economic Status - Employment and Savings

	Frequency	%	Cumulative %
Employed or with income including pension	432.0	40.19	40.19
Unemployed (18-65)	220.0	20.47	60.66
Population out of the working age class	423.0	39.35	100.00
Total	1075	100.0	

Amount of Savings	Frequency	Percent
Want to save but have no capacity	15	8
Started Saving but didn't continue	25	13
Below 300	46	24
Between 301-500	60	31
Between 501-1000	13	7
Above 1000	6	3
Already finished the payment	12	6
Does not want to save	15	8
Total	192	100

### 4. Housing Description

Time of Acquisition	Before 1975	1976-1990	1991-2005	After 2005
Frequency	56	67	46	23
Percent	29	35	24	12

Area of Housing Units	7m <sup>2</sup> -20m <sup>2</sup>	20m <sup>2</sup> -30m <sup>2</sup>	30m <sup>2</sup> -40m <sup>2</sup>	40m <sup>2</sup> -50m <sup>2</sup>	Above 50m <sup>2</sup>
Frequency	56	67	46	23	
Percent	29	35	24	12	

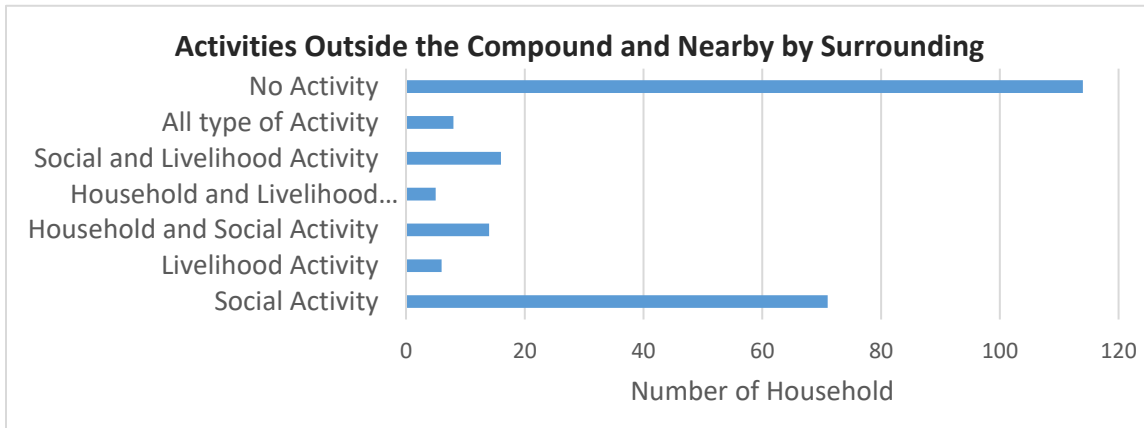
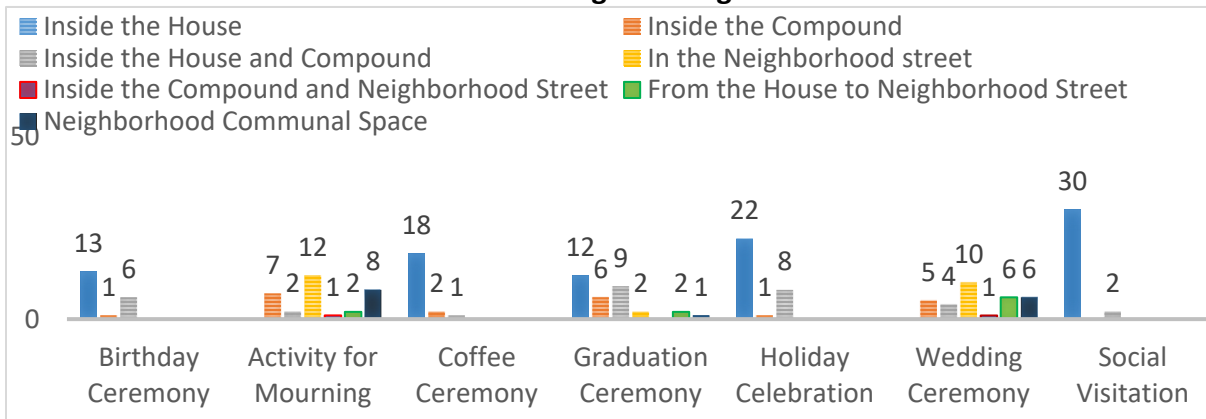
	Room			
	Living room or space	Bedroom or sleeping space	Children bedroom or space	Store and/or Kitchen room or space
Number of Housing	192	172	207	33
Percent	35.57	28.79	32.08	3.54
Total area	2,361	1,910	2,128	235
Average Room Size	12.3	11.1	10.28	7.12

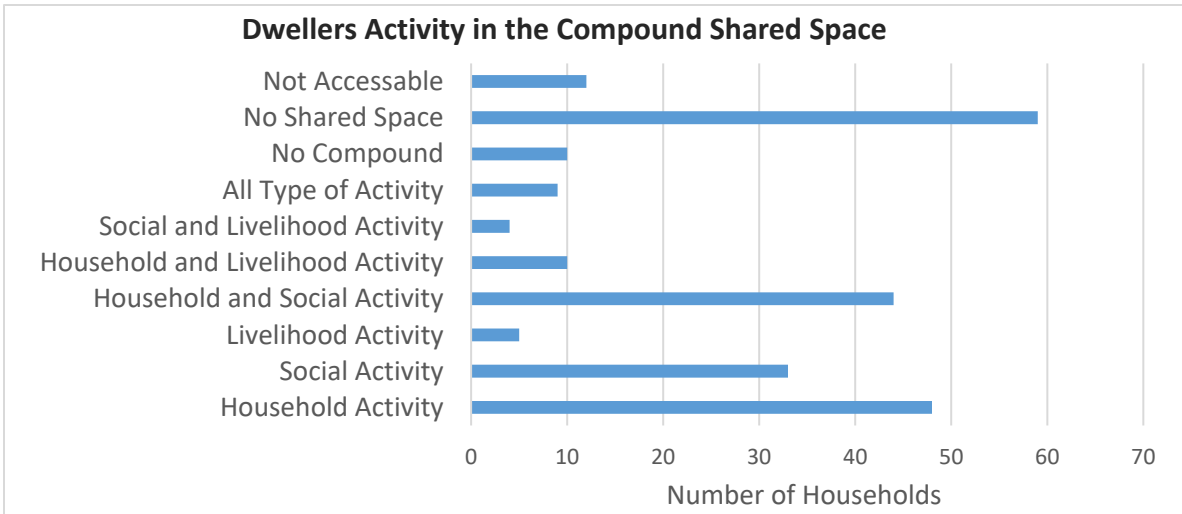
### 5. Observation of the Society

No. of family vs available space	More than Enough	Enough	Crowded	Challenging
Frequency	4	10	109	69
Percent	2	5	57	36

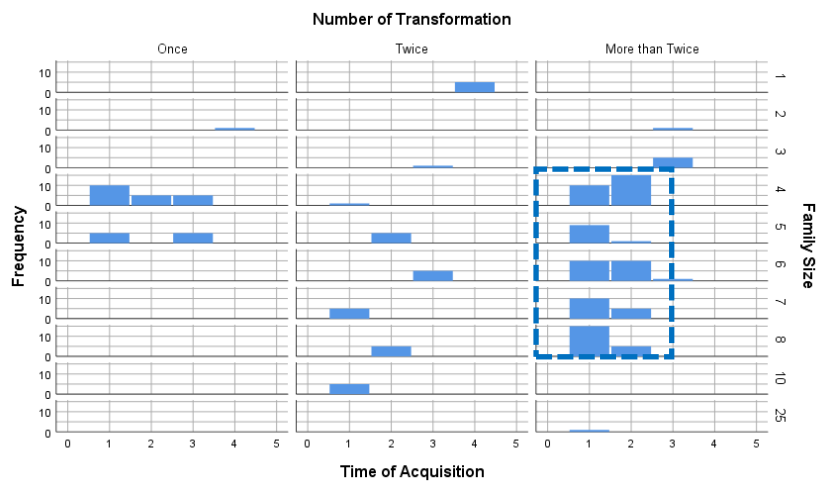
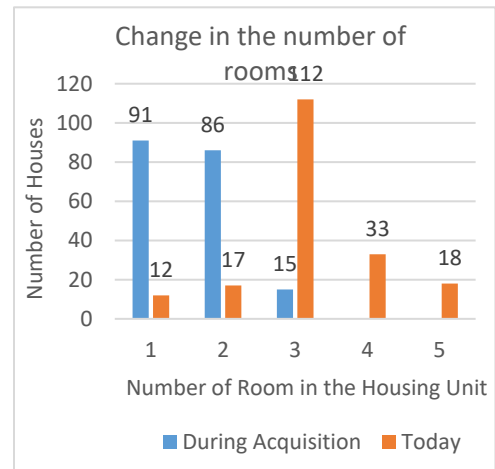
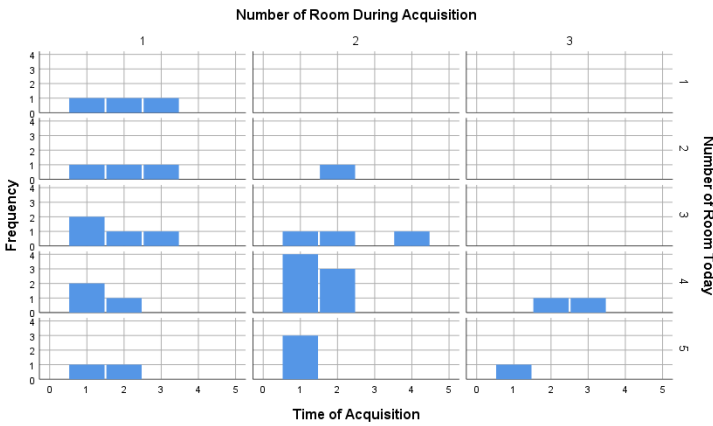
Changes they saw in a compound	Frequency	Percent
Increase in population and housing unit	111	58
Decrease in population and housing unit	4	2
Increase in population but not in housing unit	40	21
Increase in population and decrease in housing unit	4	2
No visible change	33	17

### 6. Activities in a Surrounding and Neighborhood



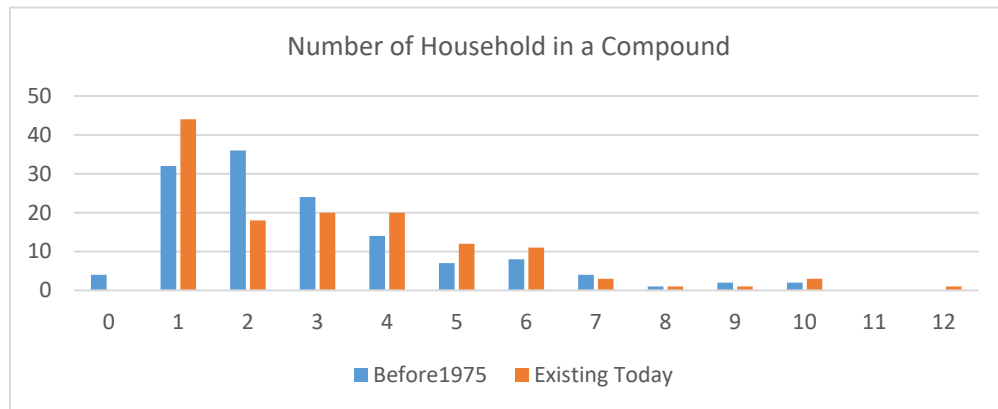


## 7. Some Statistics on Transformation of the Kebele Houses



Further, the combination of both as increased in family size and time of stay can be noticed in the graph below in the blue rectangle who had transformed their housing unit more than twice are those who acquires their unit before

1990. The frequency in the above chart shows the number of households. The time of acquisition 1 2 3 4 show the timeline



## Annex V. Study area Density Descriptions

No.	Types of Buildings	Number of Buildings	Total Built Up Area in m <sup>2</sup>	Mean
1	House with archway or over hang	2	210	105
2	Local Construction	363	17,387	47.89
3	Masonry	32	4,069	127.15
4	Shed	48	1,096	22.83

### 1. 1972 Housing Data Based on Construction Material

No.	Tenure Type of Building	Number of Buildings	No. of HH	Total number of people	Total Built-Up Area in m <sup>2</sup>	Mean
1	Communal Use	96			1,167	12.15
2	Public Buildings	69			9281	134.5
3	Government Rental House	21	8	40	1511	71.95
4	Commercial unit Sheds	6			37	6.16
6	Private Housing & Rentals	426	122+64	746	19,256	45.20
7	Kebele Housing	580	366	1944	15,774	27.19
	Total	1207	560	2730	47,026	

### 2. 2021 Housing Data Based on Ownership

Year	Number of Compounds	Total Compound Area in m <sup>2</sup>	Mean	Number of Buildings	Total Built Up Area in m <sup>2</sup>	Mean
1995	101 compounds	34,972	346.25	683	18,145	26.56
2021	134 compounds	34,829	259.91	821	21,926	26.30

### 3. Comparison between the 1995 and 2021 for compounds with qebelle housing unit

Year	Number of Compounds	Total Compound Area in m <sup>2</sup>	Mean	Number of Buildings	Total Built-Up Area in m <sup>2</sup>	Mean
1995	69 compounds	24,672	357.56	183	11,070	60.49
2021	74 compounds	27,320	369.18	292	14,525	49.74

### 4. Comparison between the 1995 and 2021 for Compounds with only Private Housing Units

Year	Number of Compounds	Total Compound Area in m <sup>2</sup>	Mean	Number of Buildings	Total Built Up Area in m <sup>2</sup>	Mean
1995	55 compounds	16,598	301.78	311	8,454	27.18
2021	82 compounds	27,023	329.45	418	13,182	31.53

### 5. Comparison between the 1995 and 2021 for Compounds with only Kebele Housing Units

Year	Number of Compounds	Total Compound Area in m <sup>2</sup>	Mean	Number of Buildings	Total Built Up Area in m <sup>2</sup>	Mean
1995	6 compounds	3300	550	16	1,633	127.15
2021	7 compounds	3275	545.83	17	1314	77.29

### 6. Comparison between the 1995 and 2021 for Compounds containing only GRH Units

No.	Density Measures in	BAR-net	FAR-net	Housing unit Density	Household Density	Population Density
1	All parcel	0.52	0.58	49.55hu/ha	62.4hh/ha	304.3ppha
2	Residential parcel only	0.57	0.57	85.62hu/ha	111.7hh/ha	440.3ppha
3	For CWKHU only	0.63	0.63	122.41	170.4hh/ha	616.66ppha

7. Describing density values for the whole neighborhood, residential compounds and CWKHU

## Annex VI. Density Layout Scheme

	Built up area	BAR	FAR	Cmpd. Area	Res.A	GRFA	R %	No. DU	Tot po p.	KH U	KHU pop.	hu/ha	No. hh	Pop.D	PPDU	Gross R. floor area per Person	Av. DU Size	hh/ha
3	137.00	0.63	0.63	217	137	120.56	100.00	2	13	1	6	92.17	3	599.08	6.50	9.27	68.5	138.25
4	315.90	0.62	0.62	509	267.8	235.66	84.77	4	20	4	20	78.59	6	392.93	5.00	11.78	67.0	117.88
5	107.30	0.66	0.66	161.6	93	81.84	86.67	2	11	1	7	123.76	3	680.69	5.50	7.44	46.5	185.64
6	334.80	0.63	0.63	530.7	264.8	233.02	79.09	10	57	8	48	188.43	12	1074.05	5.70	4.09	26.5	226.12
7	213.78	0.51	0.51	419	129.9	114.31	60.76	5	24	3	19	119.33	5	572.79	4.80	4.76	26.0	119.33
8	250.00	0.57	0.57	441.5	242.7	213.58	97.08	3	19	2	14	67.95	6	430.35	6.33	11.24	80.9	135.90
11	125.00	0.35	0.35	362	125	110.00	100.00	1	12	1	12	27.62	3	331.49	12.00	9.17	125.0	82.87
13	279.70	0.31	0.31	895	255.6	224.93	91.38	3	16	3	16	33.52	7	178.77	5.33	14.06	85.2	78.21
14	629.00	0.39	0.39	1594.6	555.4	488.75	88.30	6	28	3	17	37.63	8	175.59	4.67	17.46	92.6	50.17
31	67.90	0.52	0.52	131	67.9	59.75	100.00	2	11	2	11	152.67	3	839.69	5.50	5.43	34.0	229.01
32	40.00	0.61	0.61	66	40	35.20	100.00	1	4	1	4	151.52	1	606.06	4.00	8.80	40.0	151.52
33	93.00	0.79	0.79	118	93	81.84	100.00	1	7	1	7	84.75	3	593.22	7.00	11.69	93.0	254.24
34	40.60	0.74	0.74	54.5	38	33.44	93.60	1	6	1	6	183.49	2	1100.92	6.00	5.57	38.0	366.97
36	53.00	0.83	0.83	63.5	53	46.64	100.00	1	4	1	4	157.48	2	629.92	4.00	11.66	53.0	314.96
37	83.00	0.89	0.89	93	83	73.04	100.00	1	8	1	8	107.53	3	860.22	8.00	9.13	83.0	322.58
38	64.00	0.90	0.90	71	64	56.32	100.00	1	9	1	9	140.85	2	1267.61	9.00	6.26	64.0	281.69
39	107.00	0.47	0.47	226	107	94.16	100.00	2	14	2	14	88.50	3	619.47	7.00	6.73	53.5	132.74
41	13.80	0.42	0.42	33	13.8	12.14	100.00	1	4	1	4	303.03	2	1212.12	4.00	3.04	13.8	606.06
42	54.00	0.52	0.52	103	54	47.52	100.00	1	4	1	4	97.09	2	388.35	4.00	11.88	54.0	194.17
43	82.00	0.34	0.34	239.5	62.9	55.35	76.71	1	10	1	10	41.75	2	417.54	10.00	5.54	62.9	83.51
44	76.00	0.22	0.22	340.9	60.7	53.42	79.87	1	14	1	14	29.33	2	410.68	14.00	3.82	60.7	58.67
45	275.80	0.77	0.77	360	191.7	168.70	69.51	3	18	1	7	83.33	6	500.00	6.00	9.37	63.9	166.67
52	296.50	0.62	0.62	474.7	277.5	244.20	93.59	6	30	6	30	126.40	8	631.98	5.00	8.14	46.3	168.53
54	16.80	0.80	0.80	20.9	16.8	14.78	100.00	1	4	1	4	478.47	1	1913.88	4.00	3.70	16.8	478.47
62	159.80	0.41	0.41	391	131.8	115.98	82.48	2	11	1	6	51.15	4	281.33	5.50	10.54	65.9	102.30
65	241.00	0.58	0.58	418	219	192.72	90.87	6	31	6	31	143.54	8	741.63	5.17	6.22	36.5	191.39
73	412.00	0.78	0.78	530.8	278	244.64	67.48	5	21	4	19	94.20	7	395.63	4.20	11.65	55.6	131.88
74	130.00	0.48	0.48	270	130	114.40	100.00	1	16	1	13	37.04	4	592.59	16.00	7.15	130.0	148.15
75	126.90	0.71	0.71	178.5	126.9	111.67	100.00	2	12	2	12	112.04	4	672.27	6.00	9.31	63.5	224.09
77	658.00	0.71	0.71	925.8	589	518.32	89.51	15	60	14	54	162.02	17	648.09	4.00	8.64	39.3	183.62
78	123.90	0.83	0.83	149	68	59.84	54.88	2	9	2	9	134.23	2	604.03	4.50	6.65	34.0	134.23
81	138.00	0.66	0.66	210	128	112.64	92.75	3	16	2	12	142.86	4	761.90	5.33	7.04	42.7	190.48
83	234.80	0.62	0.62	378.5	134	117.92	57.07	3	16	3	16	79.26	4	422.72	5.33	7.37	44.7	105.68
84	215.00	0.60	0.60	360	215	189.20	100.00	1	8	1	8	27.78	3	222.22	8.00	23.65	215.0	83.33
85	317.00	0.84	0.84	379	300	264.00	94.64	4	18	1	4	105.54	7	474.93	4.50	14.67	75.0	184.70
86	58.00	0.87	0.87	66.9	45	39.60	77.59	2	9	2	9	298.95	2	1345.29	4.50	4.40	22.5	298.95
87	76.00	0.93	0.93	81.6	59	51.92	77.63	4	15	4	15	490.20	5	1838.24	3.75	3.46	39.8	612.75
91	159.70	0.91	0.91	175	130	112	81.76	1	6	1	6	57.14	2	342.86	6.00	0.00	0.0	114.29
92	188.70	0.81	0.81	232.6	73.5	64.68	38.95	4	13	4	13	171.97	5	558.90	3.25	4.98	32.5	214.96
94	283.60	0.71	0.71	411.6	185.5	163.24	65.41	4	12	4	12	99.75	6	299.25	3.00	13.60	46.4	149.63
95	701.00	0.83	0.86	844.6	201	176.88	27.53	6	31	6	31	71.04	7	367.04	5.17	5.71	33.5	82.88
98	145.00	0.25	0.25	570	139.4	122.67	96.14	6	33	6	33	105.26	6	578.95	5.50	3.72	23.2	105.26
99	198.00	0.53	0.53	377	158	139.04	79.80	4	24	3	19	106.10	5	636.60	6.00	5.79	39.5	132.63
102	226.00	0.66	0.66	344	218	191.84	96.46	2	18	1	6	58.14	5	523.26	9.00	10.66	109.0	145.35
103	86.60	0.81	0.81	107	86.6	76.21	100.00	1	6	1	6	93.46	2	560.75	6.00	12.70	86.6	186.92
104	257.00	0.78	0.78	329.9	257	226.16	100.00	4	26	4	26	121.25	7	788.12	6.50	8.70	64.3	212.19
106	144.60	0.55	0.55	263.7	120	105.60	82.99	4	27	4	27	151.69	4	1023.89	6.75	3.91	30.0	151.69
121	213.00	0.61	0.61	348	200	176.00	93.90	4	17	3	13	114.94	6	488.51	4.25	10.35	50.0	172.41
122	135.70	0.52	0.52	259.6	124.6	109.65	91.82	1	6	1	6	38.52	3	231.12	6.00	18.27	124.6	115.56
124	232.60	0.85	0.85	273.5	216.9	190.87	93.25	4	28	4	28	146.25	6	1023.77	7.00	6.82	54.2	219.38
125	234.60	0.75	0.75	314.7	214	188.32	91.22	5	26	5	26	158.88	6	826.18	5.20	7.24	42.8	190.66
127	37.00	1.00	1.00	37	37	32.56	100.00	1	4	1	4	270.27	1	1081.08	4.00	8.14	37.0	270.27
128	82.60	0.90	0.90	91.9	82.6	72.69	100.00	1	6	1	6	108.81	2	652.88	6.00	12.11	82.6	217.63
129	185.00	0.69	0.69	268.7	168.9	148.63	91.30	4	23	4	23	148.86	5	855.97	5.75	6.46	42.2	186.08
130	115.00	0.71	0.71	161	103.9	91.43	90.35	4	15	3	12	248.45	4	931.68	3.75	6.10	26.0	248.45
131	162.60	0.73	0.73	224	56.7	49.90	134.87	5	18	4	14	223.21	5	803.57	3.60	2.77	31.3	223.21
132	148.00	0.53	0.53	280.7	130	114.40	87.84	1	9	1	9	35.63	4	320.63	9.00	12.71	130.0	142.50
133	256.00	0.83	0.83	309.9	170	149.60	66.41	5	25	4	24	161.34	5	806.71	5.00	5.98	34.0	161.34
134	142.00	0.73	0.73	193.9	115	101.20	80.99	3	17	3	17	154.72	3	876.74	5.67	5.95	38.3	154.72
136	308.80	0.75	0.75	411.6	290	255.20	93.91	4	26	3	21	97.18	7	631.68	6.50	9.82	72.5	170.07
137	246.00	0.91	0.91	269	239	210.32	97.15	5	29	4	23	185.87	8	1078.07	5.80	7.25	47.8	297.40
139	389.80	0.71	0.71	551	368	323.84	94.41	8	41	7	36	145.19	11	744.10	5.13	7.90	46.0	199.64
141	289.59	0.76	0.76	379	237	208.56	81.84	7	34	6	29	184.70	8	897.10	4.86	6.13	33.9	211.08
142	44.50	0.76	0.76	58.46	44.5	39.16	100.00	1	5	1	5	171.06	1	855.29	5.00	7.83	44.5	171.06
143	434.36	0.43	0.47	1015.76	378.78	333.33	79.85	12	49	12	49	118.14	15	482.40	4.08	6.80	31.6	147.67
145	300.42	0.89	0.89	336.29	226.8	199.58	75.49	3	14	2	9	89.21	5	416.31	4.67	14.26	75.6	148.68
147	283.98	0.62	0.62	455.8	251.51	221.33	88.57	5	32	4	27	109.70	8	702.06	6.40	6.92	50.3	175.52

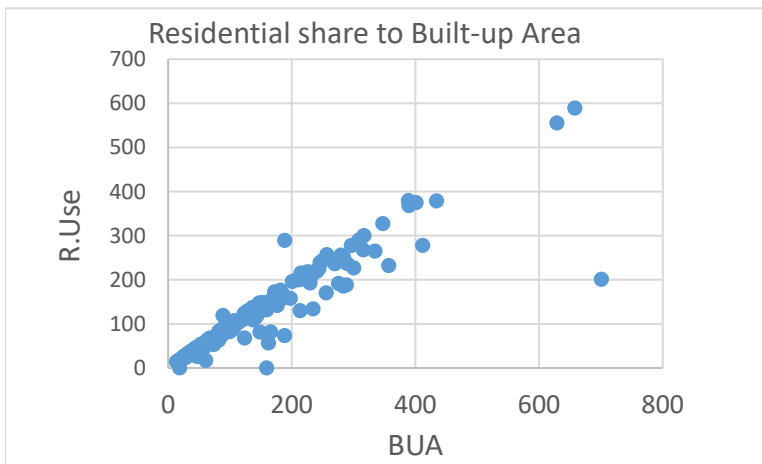
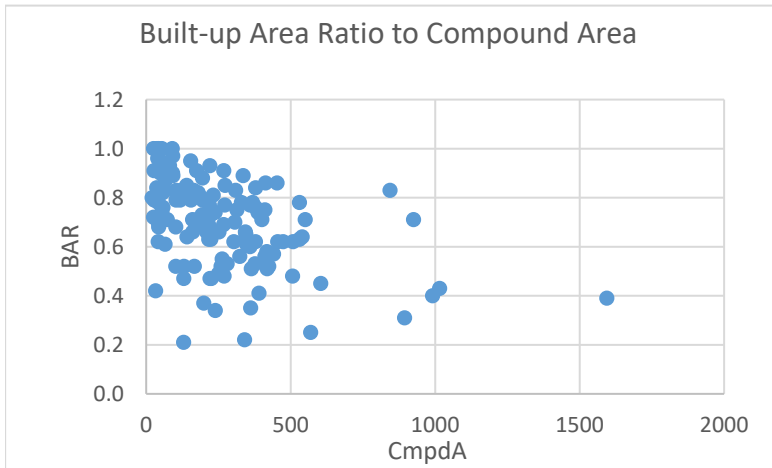
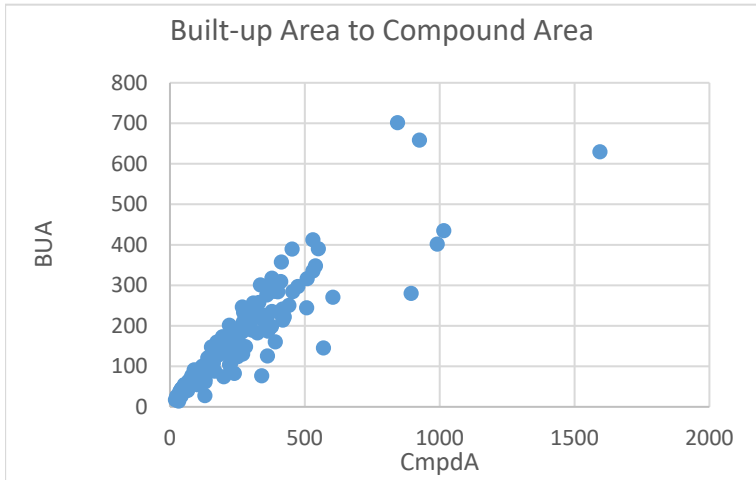
150	140.90	0.63	0.63	224.28	120	105.60	85.17	3	14	2	11	133.76	4	624.22	4.67	7.54	40.0	178.35	
153	401.28	0.40	0.40	991.6	374.8	329.82	93.40	7	31	7	31	70.59	9	312.63	4.43	10.64	53.5	90.76	
160	229.90	0.56	0.56	411.24	192.72	169.59	83.83	3	22	2	16	72.95	5	534.97	7.33	7.71	64.2	121.58	
161	153.04	0.80	0.80	191.8	137.96	121.40	90.15	5	29	5	29	260.69	5	1511.99	5.80	4.19	27.6	260.69	
162	221.57	0.52	0.52	424.63	214.34	188.62	96.74	2	13	1	7	47.10	4	306.15	6.50	14.51	107.2	94.20	
164	270.00	0.45	0.45	604.48	236	207.68	87.41	5	33	5	33	82.72	8	545.92	6.60	6.29	47.2	132.35	
165	182.00	0.56	0.56	324.51	176.3	155.14	96.87	3	16	2	13	92.45	5	493.05	5.33	9.70	58.8	154.08	
168	347.41	0.64	0.64	540.27	327.11	287.86	94.16	5	24	4	21	92.55	7	444.22	4.80	11.99	65.4	129.56	
170	147.47	0.95	0.95	154.44	147.47	129.77	100.00	3	12	3	12	194.25	4	777.00	4.00	10.81	49.2	259.00	
171	99.76	0.83	0.83	120.7	82.36	72.48	82.56	1	11	1	11	82.85	3	911.35	11.00	6.59	82.4	248.55	
172	87.46	0.52	0.52	167	74.09	65.20	84.71	2	9	1	5	119.76	3	538.92	4.50	7.24	37.0	179.64	
174	134.60	0.69	0.69	194.14	121	106.48	89.90	3	16	3	16	154.53	4	824.15	5.33	6.66	40.3	206.04	
175	166.12	0.66	0.66	252.65	81.77	71.96	49.22	4	22	2	14	158.32	4	870.77	5.50	3.27	20.4	158.32	
176	288.58	0.78	0.83	368.98	188.37	165.77	61.56	10	42	8	36	271.02	11	1138.27	4.20	3.95	18.8	298.12	
177	148.61	0.82	0.82	180.7	138	121.44	92.86	3	20	3	20	166.02	5	1106.81	6.67	6.07	46.0	276.70	
178	54.53	1.00	1.00	54.53	44.34	39.02	81.31	3	18	3	18	550.16	3	3300.94	6.00	2.17	14.8	550.16	
179	137.60	0.83	0.83	165.06	109	95.92	79.22	2	11	2	11	121.17	3	666.42	5.50	8.72	54.5	181.75	
180	154.61	0.79	0.79	196.22	148	130.24	95.72	6	25	6	25	305.78	6	1274.08	4.17	5.21	24.7	305.78	
181	215.87	0.70	0.70	307.08	209	183.92	96.82	2	18	2	18	65.13	5	586.17	9.00	10.22	104.5	162.82	
183	120.26	0.85	0.85	140.7	110.41	97.16	91.81	3	20	3	20	213.22	4	1421.46	6.67	4.86	36.8	284.29	
184	176.75	0.74	0.74	239.31	141.37	124.41	79.98	6	31	6	31	250.72	7	1295.39	5.17	4.01	23.6	292.51	
185	29.07	0.70	0.70	41.63	23.47	20.65	80.74	3	11	3	11	720.63	4	2642.33	3.67	1.88	41.2	960.85	
186	225.48	0.65	0.65	345.38	201.6	177.41	89.41	4	22	3	17	115.81	6	636.98	5.50	8.06	50.4	177.42	
187	284.87	0.74	0.74	387.5	242.34	213.26	85.07	6	27	5	24	154.84	8	696.77	4.50	7.90	40.4	206.45	
188	148.89	0.69	0.69	216.29	81.14	71.40	54.50	4	17	3	13	184.94	4	785.98	4.25	4.20	20.3	184.94	
190	168.93	0.77	0.77	219.2	156.33	137.57	92.54	4	23	4	23	182.48	6	1049.27	5.75	5.98	39.1	273.72	
192	389.00	0.86	0.86	453.62	379.4	333.87	97.53	6	26	5	21	132.27	9	573.17	4.33	12.84	63.2	198.40	
193	52.32	0.71	0.71	73.39	52.32	46.04	100.00	1	8	1	8	136.26	2	1090.07	8.00	5.76	52.3	272.52	
194	90.72	1.00	1.00	90.72	90.72	79.83	100.00	2	11	2	11	220.46	3	1212.52	5.50	7.26	45.4	330.69	
196	89.09	0.97	1.29	92.31	119	104.72	100.00	4	22	4	22	433.32	4	2383.27	5.50	4.76	29.8	433.32	
197	123.00	0.49	0.49	251	111.2	97.86	90.41	2	14	2	14	79.68	4	557.77	7.00	6.99	55.6	159.36	
198	357.14	0.86	0.86	413.48	232	204.16	64.96	4	24	4	24	96.74	7	580.44	6.00	8.51	58.0	169.29	
200	116.11	0.80	0.80	145.27	108	95.04	93.02	3	15	3	15	206.51	4	1032.56	5.00	6.34	36.0	275.35	
201	18.79	0.72	0.72	26.14	0	0.00	0.00	1	4	1	4	382.56	2	1530.22	4.00	0.00	0.0	765.11	
202	201.00	0.93	0.93	220.91	196	172.48	95.45	3	12	2	9	135.80	5	543.21	4.00	14.37	65.3	226.34	
204	103.92	0.47	0.47	221.6	86.64	76.24	83.37	4	21	4	21	180.51	4	947.65	5.25	3.63	21.7	180.51	
205	208.87	0.77	0.77	272.62	200	176.00	95.75	9	35	9	35	330.13	10	1283.84	3.89	5.03	22.2	366.81	
206	186.53	0.51	0.51	364.09	158.06	139.09	84.74	5	25	5	25	137.33	6	686.64	5.00	5.56	31.6	164.79	
207	61.14	0.47	0.47	130.66	17.22	15.15	28.16	3	16	2	11	229.60	4	1224.55	5.33	0.95	35.7	306.14	
208	73.93	0.37	0.37	199.92	53	46.64	71.69	2	13	2	13	100.04	2	650.26	6.50	3.59	26.5	100.04	
209	244.00	0.48	0.48	507.21	224.96	197.96	91.84	7	27	5	27	138.01	8	532.32	3.86	7.33	32.1	157.73	
210	123.05	0.79	0.79	155.32	123.05	108.28	100.00	2	11	1	6	128.77	4	708.22	5.50	9.84	61.5	257.53	
212	86.93	0.83	0.83	104.21	86.93	76.50	100.00	1	5	1	5	95.96	2	479.80	5.00	15.30	86.9	191.92	
214	70.41	0.68	0.68	102.92	62.71	55.18	89.06	1	6	1	6	97.16	2	582.98	6.00	9.20	62.7	194.33	
216	172.37	0.88	0.88	195.31	172.37	151.69	100.00	4	19	2	8	204.80	6	972.81	4.75	7.98	43.1	307.20	
217	27.15	0.21	0.21	130	27.15	23.89	100.00	1	6	1	6	76.92	2	461.54	6.00	3.98	27.2	153.85	
219	29.70	0.68	0.68	43.83	29.7	26.14	100.00	1	4	1	4	228.15	1	912.62	4.00	6.53	29.7	228.15	
224	90.68	0.64	0.64	141.54	90.68	79.80	100.00	3	6	1	4	211.95	3	423.91	2.00	13.30	30.2	211.95	
225	189.00	0.62	0.65	304.00	289.00	254.32	145.96	5	12	1	2	164.47	5	394.74	2.40	21.19	57.8	164.47	
226	26.00	0.62	0.62	42.00	26.00	22.88	100.00	1	3	1	3	238.10	1	714.29	3.00	7.63	26.0	238.10	
227	82.00	0.79	0.79	104.00	82.00	72.16	100.00	3	13	1	1	288.46	3	1250.00	4.33	5.55	27.3	288.46	
15	46.80	0.95	0.95	49.16	26.06	22.93	55.68	1	4	1	4	203.42	1	813.67	4.0	5.73	26.1	203.42	
16	36.00	0.73	0.73	49.00	36.00	31.68	100.00	1	6	1	6	204.08	1	1224.49	6.0	5.28	36.0	204.08	
17	38.80	0.96	0.96	40.60	38.80	34.14	100.00	1	4	1	4	246.31	1	985.22	4.0	8.54	38.8	246.31	
18	46.74	0.82	0.82	57.30	46.74	41.13	100.00	1	7	1	7	174.52	2	1221.64	7.0	5.88	46.7	349.04	
19	33.50	0.78	0.78	42.80	33.50	29.48	100.00	1	5	1	5	233.64	1	1168.22	5.0	5.90	33.5	233.64	
20	35.50	0.83	0.83	42.60	35.50	31.24	100.00	1	6	1	6	234.74	1	1408.45	6.0	5.21	35.5	234.74	
21	25.80	1.00	1.00	25.80	25.80	22.70	100.00	1	6	1	6	387.60	2	2325.58	6.0	3.78	25.8	775.19	
22	31.00	0.84	0.84	37.00	31.00	27.28	100.00	1	4	1	4	270.27	1	1081.08	4.0	6.82	31.0	270.27	
23	45.00	1.00	1.00	45.00	45.00	39.60	100.00	1	5	1	5	222.22	2	1111.11	5.0	7.92	45.0	444.44	
24	33.00	0.80	0.80	41.00	33.00	29.04	100.00	1	5	1	5	243.90	1	1219.51	5.0	5.81	33.0	243.90	
25	43.50	1.00	1.00	43.50	43.50	38.28	100.00	1	6	1	6	229.89	2	1379.31	6.0	6.38	43.5	459.77	
26	44.60	0.90	0.90	49.49	44.60	39.25	100.00	1	6	1	6	202.06	2	1212.37	6.0	6.54	44.6	404.12	
27	41.00	1.00	1.00	41.00	41.00	36.08	100.00	1	5	1	5	243.90	1	1219.51	5.0	7.22	41.0	243.90	
28	22.00	0.79	0.79	28.00	22.00	19.36	100.00	1	4	1	4	357.14	1	1428.57	4.0	4.84	22.0	357.14	
29	25.00	0.91	0.91	27.50	25.00	22.00	100.00	1	4	1	4	363.64	1	1454.55	4.0	5.50	25.0	363.64	
30	152.00	0.72	0.72	210.00	148.00	130.24	97.37	2	13	2	13	95.24	5	619.05	6.5	10.02	74.0	238.10	
	21926																		

## Some of the Pearson's Correlation Coefficient Results from SPSS

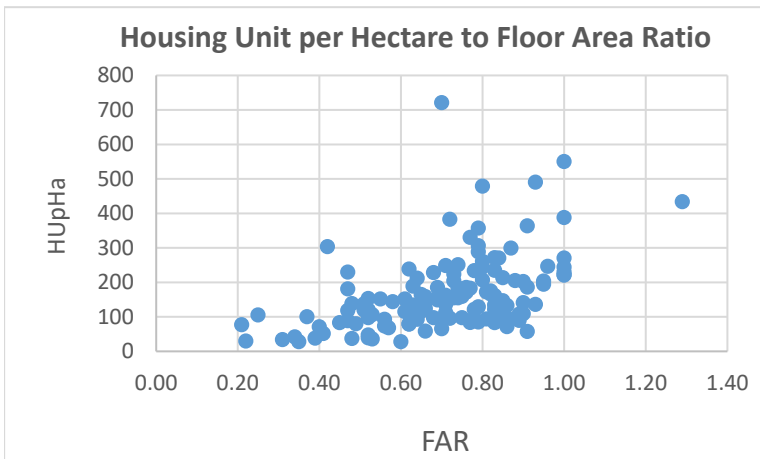
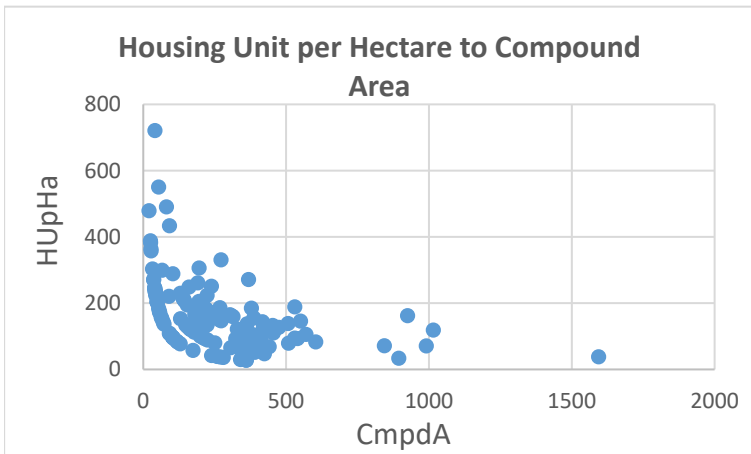
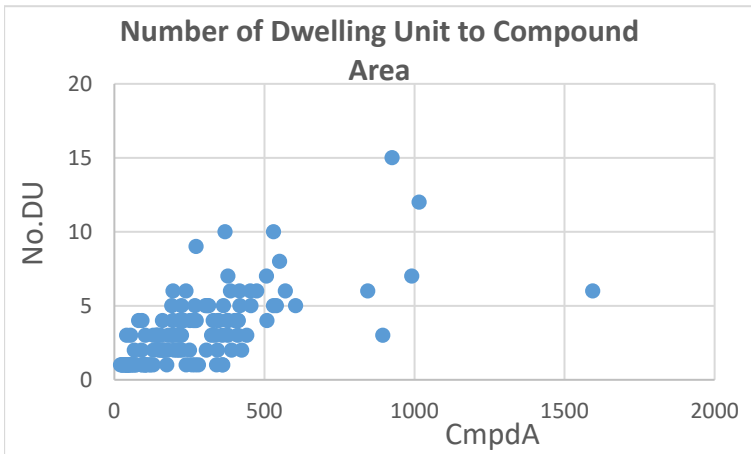
		Correlations													
		CmpdA	BUA	R.Use	BAR	No.DU	HUpHa	PpHa	PpDU	GFApP	Av.DUS	No.hh	hhpha	Tot.pop	
CmpdA	Pearson Correlation	1	.891**	.867**	-.458**	.673**	-.457**	-.495**	.001	.324**	.225**	.760**	-.494**	.694**	
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.995	.000	.009	.000	.000	.000	
	N	134	134	134	134	134	134	134	134	134	134	134	134	134	
BUA	Pearson Correlation	.891**	1	.915**	-.158	.757**	-.400**	-.440**	-.083	.319**	.180*	.842**	-.437**	.766**	
	Sig. (2-tailed)	.000		.000	.067	.000	.000	.000	.338	.000	.038	.000	.000	.000	
	N	134	134	134	134	134	134	134	134	134	134	134	134	134	
R.Use	Pearson Correlation	.867**	.915**	1	-.195*	.747**	-.401**	-.431**	-.054	.448**	.277**	.862**	-.419**	.756**	
	Sig. (2-tailed)	.000	.000		.024	.000	.000	.000	.538	.000	.001	.000	.000	.000	
	N	134	134	134	134	134	134	134	134	134	134	134	134	134	
BAR	Pearson Correlation	-.458**	-.158	-.195*	1	-.131	.461**	.500**	-.259**	-.064	-.182*	-.180*	.460**	-.197*	
	Sig. (2-tailed)	.000	.067	.024		.131	.000	.000	.002	.460	.035	.038	.000	.022	
	N	134	134	134	134	134	134	134	134	134	134	134	134	134	
No.DU	Pearson Correlation	.673**	.757**	.747**	-.131	1	.001	-.081	-.295**	-.055	-.231**	.937**	-.154	.937**	
	Sig. (2-tailed)	.000	.000	.000	.131		.992	.350	.001	.530	.007	.000	.075	.000	
	N	134	134	134	134	134	134	134	134	134	134	134	134	134	
HUpHa	Pearson Correlation	-.457**	-.400**	-.401**	.461**	.001	1	.906**	-.413**	-.507**	-.552**	-.179*	.856**	-.119	
	Sig. (2-tailed)	.000	.000	.000	.000	.992		.000	.000	.000	.000	.039	.000	.169	
	N	134	134	134	134	134	134	134	134	134	134	134	134	134	
PpHa	Pearson Correlation	-.495**	-.440**	-.431**	.500**	-.081	.906**	1	-.124	-.582**	-.469**	-.222**	.831**	-.093	
	Sig. (2-tailed)	.000	.000	.000	.000	.350	.000		.154	.000	.000	.010	.000	.287	
	N	134	134	134	134	134	134	134	134	134	134	134	134	134	
PpDU	Pearson Correlation	.001	-.083	-.054	-.259**	-.295**	-.413**	-.124	1	-.026	.541**	-.129	-.223**	-.033	
	Sig. (2-tailed)	.995	.338	.538	.002	.001	.000	.154		.770	.000	.138	.010	.709	
	N	134	134	134	134	134	134	134	134	134	134	134	134	134	
GFApP	Pearson Correlation	.324**	.319**	.448**	-.064	-.055	-.507**	-.582**	-.026	1	.749**	.108	-.420**	-.107	
	Sig. (2-tailed)	.000	.000	.000	.460	.530	.000	.000	.770		.000	.212	.000	.218	
	N	134	134	134	134	134	134	134	134	134	134	134	134	134	
Av.DUS	Pearson Correlation	.225**	.180*	.277**	-.182*	-.231**	-.552**	-.469**	.541**	.749**	1	.009	-.358**	-.121	
	Sig. (2-tailed)	.009	.038	.001	.035	.007	.000	.000	.000	.000		.922	.000	.165	
	N	134	134	134	134	134	134	134	134	134	134	134	134	134	
No.hh	Pearson Correlation	.760**	.842**	.862**	-.180*	.937**	-.179*	-.222**	-.129	.108	.009	1	-.214*	.930**	
	Sig. (2-tailed)	.000	.000	.000	.038	.000	.039	.010	.138	.212	.922		.013	.000	
	N	134	134	134	134	134	134	134	134	134	134	134	134	134	
hhpha	Pearson Correlation	-.494**	-.437**	-.419**	.460**	-.154	.856**	.831**	-.223**	-.420**	-.358**	-.214*	1	-.231**	
	Sig. (2-tailed)	.000	.000	.000	.000	.075	.000	.000	.010	.000	.000	.013		.007	
	N	134	134	134	134	134	134	134	134	134	134	134	134	134	
Tot.pop	Pearson Correlation	.694**	.766**	.756**	-.197*	.937**	-.119	-.093	-.033	-.107	-.121	.930**	-.231**	1	
	Sig. (2-tailed)	.000	.000	.000	.022	.000	.169	.287	.709	.218	.165	.000	.007		
	N	134	134	134	134	134	134	134	134	134	134	134	134	134	

\*\*. Correlation is significant at the 0.01 level (2-tailed).  
\*. Correlation is significant at the 0.05 level (2-tailed).

## Annex VII. Scatter Plot Graph and Probability Probability Plot



*Different Scatter plot graphs showing the relationship between each variables and their respective graphs of normal P-P plot of regression standsrzided residual*



*Different Scatter plot graphs showing the relationship between each variables and their respective graphs of normal P-P plot of regression standardized residual*

## Annex VIII. Study Area Land and Building Use Detail Description

### A. Study Area 1972 Land Use Detail Description

No	Land Use Type	Count/Length	Area (m <sup>2</sup> )	Mean in m or m <sup>2</sup>	%
1	Access path	232 m	601	58.25	0.53
2	Manufacturing - Bakery	1	3,842	3842	3.40
3	Brushwood	2	1,201	600.5	1.06
4	Grass land	1	3,649	3649	3.23
5	Green along the River with the River	1	6118.8	880m long	5.41
6	Hard Surface Road without Side walk	616 m	3024	616 m	2.67
7	Mixed Residential	3	5,839	1,946.33	5.16
8	Circulation or Communal Space	10	9,068	906.8	8.02
9	Plant Nursery	1	360	360	0.32
10	Residential	53	43,143	814.02	38.14
11	Unpaved Road	1,147 m	6,201	286.75 m	5.48
12	Vacant Land	2	1,519	759.5	1.34
13	Wood Land	4	21,868	5467	19.33
14	Sloppy Terrain/Set back	700m	6,675	6,675	5.90
	<b>Total</b>		<b>113,109</b>		<b>100.0</b>

### B. Study Area 2021 Land Use Description compared to 1972

No.	Land Use Type	Count/dist.	T. Area in m <sup>2</sup>	Mean - m or m <sup>2</sup>	2021%	1972%
1	Commercial (Retail)	12	4,942	394.41	4.37	0
2	Communal Space	1	180	180	0.16	8.02
3	Foot Path		4,007	Inside Compound	--	0.54
4	River with Green Along	880m	6,118.8	6,118.8	5.41	5.41
5	Sloppy Terrain/Set back	700m	6,675	6,675	----	5.90
6	Manufacturing & Storage	4	7411	1,852.75	6.55	3.40
7	Mixed Residential	46	19,222	384.23	16.98	5.16
8	Open Space	2	923	461.5	0.82	25.28
9	Parking area	1	41	41	0.04	0
10	Pedestrian	1	1947	Included in street	--	0
11	CO Camp	1	5,371	5371	4.75	0
12	Pure Residential (Housing)	158	46,202	282.62	40.85	38.14
13	Religious Institute	1	2,432	2432	2.15	0
14	Social Service (Edu.Inst.)	1	5,548	5548	4.91	0
15	Street		14,718		13.01	8.15
	<b>Total Area</b>		<b>113,109</b>		<b>100.00</b>	<b>100</b>

### C. Entropy Calculation for Land Use Diversity

Selected Land Uses	Area	Percent	$b_i$	$b_i * \ln b_i$
Commercial (Retail)	4,942	5.02	0.050229	-0.1502
Open Space	7,262.00	7.38	0.073808	-0.1923
Manufacturing & Storage	7411	7.53	0.075323	-0.1947
Mixed Residential	19,222	19.54	0.195365	-0.319
Admn - CO Camp	5,371	5.46	0.054589	-0.1587
Pure Residential (Housing)	46,202	46.96	0.46958	-0.3549
Religious Institute	2,432	2.47	0.024718	-0.0914
Service (Edu.Inst.)	5,548	5.64	0.056388	-0.16214
	98,390	100.0	1	-1.62334
			LUM	0.83423

### D. Mix of Function with their Respective land area Compared to Previous Structure Plan Norm and Standard

No.	Land Use Type	T.Area in m <sup>2</sup>	%	Standard	Remark
1	Commercial	4,942	4.37		
2	Open space and Recreation		6.39	5-10%	With in
	Communal Space	180	0.16		
	Green Along the River	6,118.8	5.41		
	Open Space	964	0.82		
3	Manufacturing & Storage	7411	6.55	0-5%	Above
4	Mixed Residential	19,222	16.98	20-30%	Below
5	Pure Residential	46,202	40.85	35-45%	With in
6	Religious Institute	2,432	2.15		
7	Service	10,919	9.66	10-20%	Below
8	Street	14,718	13.05	15-20	Below
	<b>Total Area</b>	113,109	100.00		

## E. Study Area Building Use Detail Description

No.	Type of Building Function	Description	No. of Bldg	Area in m <sup>2</sup>	Mean	%
1	Animal Husbandry	One Household	2	20	10.0	0.04
2	Bakery	Buildings are used for baking and Selling	3	92	30.7	0.20
3	Beauty Salon	3 Male and 3 Female	6	90	15.0	0.19
4	Cafe and Restaurant		4	382	95.5	0.81
5	Car Wash	Activity is done in outside space building is for ticket Office and workers	2	16	8.0	0.03
6	Coffee Selling Area or Shed	They incorporate selling other materials and renting Video and 7 out of 13 are attached to other functions	6	37	6.2	0.08
7	Communal Kitchen	Mostly serve one compound	33	492	14.9	1.04
8	Communal Toilet	Sometimes serve multiple compounds	63	675	10.7	1.44
9	Community Police		1	13	13.0	0.03
10	Football Viewing Center	Incorporate Coffee selling and hangout place for local youngsters	1	23	23.0	0.05
11	Garage Space	No building but uses the space	1	113	113.0	0.24
12	Gulit Shed or Space	Mostly in front of their dwelling	6	26	4.3	0.06
13	Hotel	One G+6 building and only two give bed room service	8	584	73.0	1.24
14	Idir House	Have store and is space for meeting	1	37	37.0	0.08
15	Lawyers Office and Print House	8 of them also provide stationery service	10	168	16.8	0.36
16	Mixed Residential	This includes small businesses attached	30	1,542	51.4	3.28
17	Mixed-Use Building	Private and multistory new buildings	6	1,617	269.5	3.44
18	Mosque		8	854	106.8	1.82
19	MSE	18 shades-Metal & wood works with one food processing	19	3,239	170.5	6.89
20	Pension and Shower		6	419	69.8	0.89
21	Police Camp	Holds more than a 100 family	28	2,908	103.9	6.18
22	Primary School		10	1,533	153.3	3.26
23	Protestant Church		2	481	240.5	1.02
24	Residential Building	366 kebele, 231 private and private rents and 7 Government rental house	925	31,226	33.8	66.4
25	Shop	Most are general mercantile with some specialized in kids, cosmetics	18	278	15.4	0.59
26	Cereal and Chilli Mills House	Small Scale	1	115	115.0	0.24
27	Small Metal Workshop	private	1	10	10.0	0.02
28	Tailor House or Shed	The 3 out of 6 are local or informal	6	37	6.2	0.08
29	Total or Average	/ 1206/46244	1207	47,026	39.0	100

## Annex XI. Collective Time Diary Worksheet for One Household

No.	Activity	Time		Place	Person
		From	To		
1	Dressing up, Washing face, cleaning up, using the toilet - getting prepared for Kitchen work	6:30	6:45	Bedroom, Inside compound, Bathroom, and Living room	Female adult -1
2	Dressing up, Washing face, cleaning up, using the toilet, fixing the house	6:30	7:00	Bedroom, Inside the compound, Bathroom, Bedroom, & living room	Female Child - 1
3	Cooking Breakfast	6:45	1:25	Kitchen	Female adult -1
4	Using the toilet, Washing face, and cleaning up	7:00	7:15	Bathroom and Inside compound	Male Child – 2
5	Setting up dishes and helping out her mother	7:00	7:25	Living room and Kitchen	Female Child - 1
6	Watering the small garden	7:15	7:30	Inside the compound	Male Child – 2
7	Washing face and cleaning up, using toilet, fixing the room and Dressing up	7:15	7:30	Inside compound, bathroom, & Child bedroom	Male Child - 1
8	Breakfast	7:30	7:50	Living room	Female adult -1
9	Breakfast	7:30	7:50	Living room	Female Child - 1
10	Breakfast	7:30	7:50	Living room	Male Child - 1
11	Breakfast	7:30	7:50	Living room	Male Child – 2
12	Collecting dishes cleaning up the room	7:50	8:00	Living room	Female Child - 1
13	Taking rest and refreshing	11:30	11:45	Living room	Female Child - 1
14	Cooking Lunch	11:45	12:30	Kitchen	Female Child - 1
15	Taking rest and refreshing	12:00	12:15	Living room	Female adult -1
16	Helping daughter and preparing Coffee	12:15	12:45	Kitchen and Living room	Female adult -1
17	Lunch	12:30	12:50	Living room	Female adult -1
18	Lunch	12:30	12:50	Living room	Female Child - 1
19	Lunch	12:30	12:50	Living room	Male Child - 1
20	Lunch	12:30	12:50	Living room	Male Child – 2
21	Drinking Coffee and talking	12:45	1:00	Living room	Female adult -1
22	Drinking Coffee and talking	12:45	1:00	Living room	Female Child - 1
23	Drinking Coffee and talking	12:45	1:00	Living room	Male Child - 1
24	Drinking Coffee and talking	12:45	1:00	Living room	Male Child – 2
25	Cleaning up the dishes and coffee cups	1:00	1:15	Living room and kitchen	Female Child - 1
26	Taking rest and refreshing	5:30	5:45	Living room & Inside compound	Female adult -1
27	Taking rest and refreshing	5:30	5:45	Child bedroom and Inside Compound	Male Child - 1
28	Taking rest and refreshing	5:30	5:45	Living room and inside compound	Male Child – 2
29	Taking rest and refreshing	6:30	6:45	Living room and inside compound	Female Child - 1
30	Talking and TV	6:45	8:30	Living room	Female adult -1
31	Talking and TV	6:45	8:30	Living room	Female Child - 1
32	Talking and TV	6:45	8:30	Living room	Male Child - 1
33	Studying	6:50	8:30	Child bedroom	Male Child – 2
34	Dinner	8:30	8:50	Living room	Female adult -1
35	Dinner	8:30	8:50	Living room	Female Child - 1
36	Dinner	8:30	8:50	Living room	Male Child - 1
37	Dinner	8:30	8:50	Living room	Male Child – 2
38	Refreshing up, talking and going to bed	8:50	10:00	Living room and bedroom	Female adult -1
39	Refreshing up, talking and going to bed	8:50	10:00	Living room and bedroom	Female Child - 1
40	Refreshing up, talking and going to bed	8:50	10:00	Living room	Male Child - 1
41	Refreshing up, talking and going to bed	8:50	10:00	Living room and child bedroom	Male Child – 2

### Time Spent Inside or nearby the compound

	Mr. Yimer Family	Mr. Mideqsa Family	Mrs. Etetu Family	Mr. Asfaw Family	Mr. Zelalem Family	Mrs. Yeshe Family	No.	Total Time Spent	Average Time spent
Female Adult (HHH)	6:20	8:10	0:40	8:55	10:35	8:35	6	43:15:00	7:12:30
Male Adult (HHH)	0:30	0:30		3:00	1:45		4	5:45:00	1:26:15
Female Child ≥ 18	2:25	3:10	0:45	3:30		0:30	7	10:20:00	1:28:30
Female Child < 18	1:45	3:05					2	4:50	2:25:00
Male Child ≥ 18			1:10	6:00	1:05		5	8:15:00	1:39:00
Male Child < 18	2:30	1:45			2:40		3	6:55:00	2:18:00
Grand Children				16:40			4	16:40:00	4:10:00
Close Relative						0:15	1	0:15	0:15

### Time Spent in the Household

	Mr. Yimer Family	Mr. Mideqsa Family	Mrs. Etetu Family	Mr. Asfaw Family	Mr. Zelalem Family	Mrs. Yeshe Family	No.	Total Time Spent	Average Time spent
Female Adult (HHH)	9:45	6:50	5:45	6:15	5:15	6:30	6	40:20:00	6:43:00
Male Adult (HHH)	4:05	4:10	--	8:00	4:30	--	4	20:45:00	5:11:00
Female Child ≥ 18	6:15	7:10	6:00	5:35	--	4:10	7	29:10:00	4:10:00
Female Child < 18	3:50	2:50	--	--	--	--	2	6:40:00	3:20:00
Male Child ≥ 18	--	--	7:40	8:00	4:15	--	5	19:55:00	3:59:00
Male Child < 18	4:20	3:30	--	--	3:10	--	3	11:00:00	3:40:00
Grand Children	--	--	--	18:00	--	--	4	18:00:00	4:30:00
Close Relative	--	--	--	--	--	2:10	1	2:10:00	2:10:00

## Annex X. Floor Area Index for Five Types of Functions

	Built-up-area	Floor area	BAR	FAR	Compound area	Open Space Area	Com p. LU type	own ership type	Residential area	commercial floor area	Manufact uring & storage floor area	Mixed Residential floor area	Service floor area	Buld ings in OS	Comm unal use floor area	Compo und shared Space Share
1	278.0	278.0	0.49	0.49	564	286.0	1	1	278	0.0	0.0	0.0	0.0	0.0	0.0	0.51
2	222.0	222.0	0.43	0.43	515	293.0	1	1	222	0.0	0.0	0.0	0.0	0.0	0.0	0.57
3	137.0	137.0	0.63	0.63	217	80.0	1	2	137	0.0	0.0	0.0	0.0	0.0	0.0	0.37
4	315.9	315.9	0.62	0.62	509	193.1	2	2	267.8	0.0	0.0	23.1	0.0	0.0	25.0	0.38
5	107.3	107.3	0.66	0.66	161.6	54.3	1	2	93	0.0	0.0	0.0	0.0	0.0	14.3	0.34
6	334.8	334.8	0.63	0.63	530.7	195.9	2	2	264.8	0.0	0.0	46.9	0.0	0.0	23.1	0.37
7	213.8	213.8	0.51	0.51	419	205.2	2	2	129.9	0.0	0.0	46.6	0.0	0.0	37.2	0.49
8	250.0	250.0	0.57	0.57	441.5	191.5	1	2	242.7	0.0	0.0	0.0	0.0	0.0	7.3	0.43
9	135.0	135.0	0.45	0.45	303	168.0	1	1	135	0.0	0.0	0.0	0.0	0.0	0.0	0.55
10	219.8	219.8	0.64	0.64	343	123.2	1	1	198.9	0.0	0.0	0.0	0.0	0.0	20.8	0.36
11	125.0	125.0	0.35	0.35	362	237.0	1	3	125	0.0	0.0	0.0	0.0	0.0	0.0	0.65
12	294.7	294.7	0.70	0.70	422.5	127.8	1	1	294.7	0.0	0.0	0.0	0.0	0.0	0.0	0.30
13	279.7	279.7	0.31	0.31	895	615.3	1	3	255.6	0.0	0.0	0.0	0.0	0.0	24.1	0.69
14	629.0	629.0	0.39	0.39	1594.6	965.6	2	2	555.4	0.0	0.0	21.4	0.0	0.0	52.2	0.61
15	46.8	46.8	0.95	0.95	49.16	2.4	1	3	46.8	0.0	0.0	0.0	0.0	0.0	0.0	0.05
16	36.0	36.0	0.73	0.73	49	13.0	1	3	36	0.0	0.0	0.0	0.0	0.0	0.0	0.27
17	38.8	38.8	0.96	0.96	40.6	1.8	1	3	38.8	0.0	0.0	0.0	0.0	0.0	0.0	0.04
18	46.7	46.7	0.82	0.82	57.3	10.6	1	3	46.74	0.0	0.0	0.0	0.0	0.0	0.0	0.18
19	33.5	33.5	0.78	0.78	42.8	9.3	1	3	33.5	0.0	0.0	0.0	0.0	0.0	0.0	0.22
20	35.5	35.5	0.83	0.83	42.6	7.1	1	3	35.5	0.0	0.0	0.0	0.0	0.0	0.0	0.17
21	25.8	25.8	1.00	1.00	25.8	0.0	1	3	25.8	0.0	0.0	0.0	0.0	0.0	0.0	0.00
22	31.0	31.0	0.84	0.84	37	6.0	1	3	31	0.0	0.0	0.0	0.0	0.0	0.0	0.16
23	45.0	45.0	1.00	1.00	45	0.0	1	3	45	0.0	0.0	0.0	0.0	0.0	0.0	0.00
24	33.0	33.0	0.80	0.80	41	8.0	1	3	33	0.0	0.0	0.0	0.0	0.0	0.0	0.20
25	43.5	43.5	1.00	1.00	43.5	0.0	1	3	43.5	0.0	0.0	0.0	0.0	0.0	0.0	0.00
26	44.6	44.6	0.90	0.90	49.49	4.9	1	3	44.6	0.0	0.0	0.0	0.0	0.0	0.0	0.10
27	41.0	41.0	1.00	1.00	41	0.0	1	3	41	0.0	0.0	0.0	0.0	0.0	0.0	0.00
28	22.0	22.0	0.79	0.79	28	6.0	1	3	22	0.0	0.0	0.0	0.0	0.0	0.0	0.21
29	25.0	25.0	0.91	0.91	27.5	2.5	1	3	25	0.0	0.0	0.0	0.0	0.0	0.0	0.09
30	152.0	152.0	0.72	0.72	210	58.0	1	3	148	0.0	0.0	0.0	0.0	0.0	40.0	0.28
31	67.9	67.9	0.52	0.52	131	63.1	1	3	67.9	0.0	0.0	0.0	0.0	0.0	0.0	0.48
32	40.0	40.0	0.61	0.61	66	26.0	1	3	40	0.0	0.0	0.0	0.0	0.0	0.0	0.39
33	93.0	93.0	0.79	0.79	118	25.0	1	3	93	0.0	0.0	0.0	0.0	0.0	0.0	0.21
34	40.6	40.6	0.74	0.74	54.5	13.9	1	3	38	0.0	0.0	0.0	0.0	0.0	40.0	0.26
35	278.0	278.0	0.45	0.45	618	340.0	1	1	278	0.0	0.0	0.0	0.0	0.0	0.0	0.55
36	53.0	53.0	0.83	0.83	63.5	10.5	1	3	53	0.0	0.0	0.0	0.0	0.0	0.0	0.17
37	83.0	83.0	0.89	0.89	93	10.0	1	3	83	0.0	0.0	0.0	0.0	0.0	0.0	0.11
38	64.0	64.0	0.90	0.90	71	7.0	1	3	64	0.0	0.0	0.0	0.0	0.0	0.0	0.10
39	107.0	107.0	0.47	0.47	226	119.0	1	3	107	0.0	0.0	0.0	0.0	0.0	0.0	0.53
40	224.0	224.0	0.39	0.39	580	356.0	1	1	0	224.0	0.0	0.0	0.0	0.0	0.0	0.61
41	13.8	13.8	0.42	0.42	33	19.2	1	3	13.8	0.0	0.0	0.0	0.0	0.0	0.0	0.58
42	54.0	54.0	0.52	0.52	103	49.0	1	3	54	0.0	0.0	0.0	0.0	0.0	0.0	0.48
43	82.0	82.0	0.34	0.34	239.5	157.5	2	3	62.9	0.0	0.0	19.0	0.0	0.0	0.0	0.66
44	76.0	76.0	0.22	0.22	340.9	264.9	1	3	60.7	0.0	0.0	7.6	0.0	0.0	39.0	0.78
45	275.8	275.8	0.77	0.77	360	84.2	2	2	191.7	0.0	0.0	84.1	0.0	0.0	0.0	0.23
46	854.0	854.0	0.35	0.35	2432	1578.0	1	0	0	0.0	0.0	0.0	854.0	0.0	0.0	0.65
47	1409.0	1409.0	0.30	0.30	4632.8	3223.8	1	0	0	0.0	1409.0	0.0	0.0	0.0	0.0	0.70
48	710.0	710.0	0.73	0.73	970.8	260.8	1	0	0	0.0	710.0	0.0	0.0	0.0	0.0	0.27
49	302.9	302.9	0.71	0.71	427	124.1	1	0	0	0.0	402.9	0.0	0.0	0.0	0.0	0.29
50	500.0	500.0	0.28	0.28	1811	1311.0	1	0	0	0.0	463.0	0.0	0.0	0.0	15.0	0.72
51	877.5	877.5	0.72	0.72	1227	349.5	1	1	0	3217	0.0	0.0	0.0	0.0	0.0	0.28
52	296.5	296.5	0.62	0.62	474.7	178.2	1	3	277.5	0.0	0.0	0.0	0.0	0.0	19.0	0.38
53	141.7	141.7	0.25	0.25	569.7	428.0	2	1	56.7	0.0	0.0	85.0	0.0	0.0	0.0	0.75
54	16.8	16.8	0.80	0.80	20.9	4.1	1	3	16.8	0.0	0.0	0.0	0.0	0.0	0.0	0.20
55	128.0	128.0	0.40	0.40	319	191.0	1	1	128	0.0	0.0	0.0	0.0	0.0	0.0	0.60
56	187.0	187.0	0.64	0.64	290.7	103.7	2	1	80	0.0	0.0	107.0	0.0	0.0	0.0	0.36
57	227.0	227.0	0.79	0.79	285.9	58.9	1	1	227	0.0	0.0	0.0	0.0	0.0	0.0	0.21
58	118.0	118.0	0.67	0.67	175	57.0	1	1	118	0.0	0.0	0.0	0.0	0.0	0.0	0.33
59	230.0	230.0	0.68	0.68	336	106.0	1	1	230	0.0	0.0	0.0	0.0	0.0	0.0	0.32
60	1483.0	1483.0	0.27	0.27	5548	4065.0	2	0	0	114.9	0.0	0.0	1368	0.0	0.0	0.73
61	311.0	311.0	0.61	0.61	514	203.0	1	1	311	0.0	0.0	0.0	0.0	0.0	0.0	0.39
62	159.8	159.8	0.41	0.41	391	231.2	1	2	131.8	0.0	0.0	12.8	0.0	0.0	15.2	0.59
63	218.0	218.0	0.65	0.65	333	115.0	1	1	218	0.0	0.0	0.0	0.0	0.0	0.0	0.35
64	157.9	157.9	0.51	0.51	308.8	150.9	1	4	157.9	0.0	0.0	0.0	0.0	0.0	0.0	0.49
65	241.0	241.0	0.58	0.58	418	177.0	1	2	219	0.0	0.0	0.0	0.0	0.0	21.9	0.42
66	151.6	151.6	0.38	0.38	401	249.4	1	1	151.6	0.0	0.0	0.0	0.0	0.0	0.0	0.62
67	132.0	132.0	0.61	0.61	216.8	84.8	1	1	132	0.0	0.0	0.0	0.0	0.0	0.0	0.39
68	147.8	147.8	0.66	0.66	222.8	75.0	1	4	147.8	0.0	0.0	0.0	0.0	0.0	0.0	0.34
69	132.0	132.0	0.38	0.38	351	219.0	1	1	132	0.0	0.0	0.0	0.0	0.0	0.0	0.62
70	225.8	225.8	0.79	0.79	285	59.2	1	1	225.8	0.0	0.0	0.0	0.0	0.0	0.0	0.21
71	189.7	189.7	0.64	0.64	298	108.3	1	1	189.7	0.0	0.0	0.0	0.0	0.0	0.0	0.36
72	209.0	209.0	0.40	0.40	525	316.0	1	4	209	0.0	0.0	0.0	0.0	0.0	0.0	0.60
73	412.0	412.0	0.78	0.78	530.8	118.8	2	2	278	0.0	0.0	0.0	133.9	0.0	0.0	0.22
74	130.0	130.0	0.48	0.48	270	140.0	1	3	130	0.0	0.0	0.0	0.0	0.0	0.0	0.52

75	126.9	126.9	0.71	0.71	178.5	51.6	1	3	126.9	0.0	0.0	0.0	0.0	0.0	0.0	0.29
76	128.0	128.0	0.42	0.42	305	177.0	1	1	128	0.0	0.0	0.0	0.0	0.0	0.0	0.58
77	658.0	658.0	0.71	0.71	925.8	267.8	1	2	589	0.0	0.0	0.0	0.0	0.0	69.1	0.29
78	123.9	123.9	0.83	0.83	149	25.1	2	3	68	0.0	0.0	47.5	0.0	0.0	38.0	0.17
79	155.9	155.9	0.88	0.88	177	21.1	1	1	155.9	0.0	0.0	0.0	0.0	0.0	0.0	0.12
80	103.0	103.0	0.82	0.82	126	23.0	1	1	103	0.0	0.0	0.0	0.0	0.0	0.0	0.18
81	138.0	138.0	0.66	0.66	210	72.0	1	2	128	0.0	0.0	0.0	0.0	0.0	46.0	0.34
82	92.6	92.6	0.87	0.87	107	14.4	1	1	92.6	0.0	0.0	0.0	0.0	0.0	0.0	0.13
83	234.8	234.8	0.62	0.62	378.5	143.7	2	3	134	100.7	0.0	0.0	0.0	0.0	0.0	0.38
84	215.0	215.0	0.60	0.60	360	145.0	1	3	215	0.0	0.0	0.0	0.0	0.0	0.0	0.40
85	317.0	317.0	0.84	0.84	379	62.0	1	2	300	0.0	0.0	0.0	0.0	0.0	17.1	0.16
86	58.0	58.0	0.87	0.87	66.9	8.9	1	3	45	0.0	0.0	0.0	0.0	0.0	13.0	0.13
87	76.0	76.0	0.93	0.93	81.6	5.6	2	3	59	0.0	0.0	17.0	0.0	0.0	0.0	0.07
88	81.0	81.0	0.85	0.85	95	14.0	1	1	81	0.0	0.0	0.0	0.0	0.0	0.0	0.15
89	159.0	159.0	0.76	0.76	208	49.0	1	1	159	0.0	0.0	0.0	0.0	0.0	0.0	0.24
90	95.2	95.2	0.95	0.95	99.8	4.6	1	1	0	95.2	0.0	0.0	0.0	0.0	0.0	0.05
91	159.7	159.7	0.91	0.91	175	15.3	1	3	0	148.0	0.0	0.0	0.0	0.0	40.0	0.09
92	188.7	188.7	0.81	0.81	232.6	43.9	2	3	73.5	115.1	0.0	0.0	0.0	0.0	0.0	0.19
93	471.0	2365.0	0.74	3.71	636.7	165.7	2	1	0	199.8	0.0	0.0	2164	0.0	0.0	0.26
94	283.6	283.6	0.71	0.71	401	117.4	2	3	185.5	98.1	0.0	0.0	0.0	0.0	0.0	0.29
95	701.0	730.0	0.83	0.86	844.6	143.6	2	3	201	465.7	0.0	25.6	0.0	0.0	38.0	0.17
96	294.7	294.7	0.26	0.26	1138.5	843.8	1	4	294.7	0.0	0.0	0.0	0.0	0.0	0.0	0.74
97	188.0	188.0	0.54	0.54	347	159.0	2	1	0	0.0	0.0	188.0	0.0	0.0	0.0	0.46
98	145.0	145.0	0.25	0.25	570	425.0	1	3	139.4	0.0	0.0	0.0	0.0	0.0	5.7	0.75
99	198.0	198.0	0.53	0.53	377	179.0	2	2	158	0.0	0.0	24.9	0.0	0.0	15.0	0.47
100	51.7	51.7	0.19	0.19	274	222.3	1	1	51.7	0.0	0.0	0.0	0.0	0.0	0.0	0.81
101	108.9	108.9	0.58	0.58	186.5	77.6	1	1	108.9	0.0	0.0	0.0	0.0	0.0	0.0	0.42
102	226.0	226.0	0.66	0.66	344	118.0	1	2	218	0.0	0.0	0.0	0.0	0.0	7.9	0.34
103	86.6	86.6	0.81	0.81	107	20.4	1	3	86.6	0.0	0.0	0.0	0.0	0.0	0.0	0.19
104	257.0	257.0	0.78	0.78	329.9	72.9	1	3	257	0.0	0.0	0.0	0.0	0.0	0.0	0.22
105	129.0	129.0	0.41	0.41	311	182.0	1	1	129	0.0	0.0	0.0	0.0	0.0	0.0	0.59
106	144.6	144.6	0.55	0.55	263.7	119.1	1	3	120	0.0	0.0	0.0	0.0	0.0	24.6	0.45
107	164.0	164.0	0.44	0.44	371	207.0	1	1	164	0.0	0.0	0.0	0.0	0.0	0.0	0.56
108	57.0	57.0	0.41	0.41	140.5	83.5	1	1	57	0.0	0.0	0.0	0.0	0.0	0.0	0.59
109	102.0	102.0	0.79	0.79	129	27.0	1	1	102	0.0	0.0	0.0	0.0	0.0	0.0	0.21
110	211.0	211.0	0.67	0.67	315.6	104.6	1	1	229.9	0.0	0.0	0.0	0.0	0.0	0.0	0.33
111	102.0	102.0	0.52	0.52	195.9	93.9	1	1	102	0.0	0.0	0.0	0.0	0.0	0.0	0.48
112	143.0	143.0	0.69	0.69	208	65.0	1	1	143	0.0	0.0	0.0	0.0	0.0	0.0	0.31
113	137.0	137.0	0.66	0.66	209	72.0	1	1	137	0.0	0.0	0.0	0.0	0.0	0.0	0.34
114	412.0	412.0	0.50	0.50	825.6	413.6	1	1	412	0.0	0.0	0.0	0.0	0.0	0.0	0.50
115	497.0	497.0	0.52	0.52	965	468.0	1	1	497	0.0	0.0	0.0	0.0	0.0	0.0	0.48
116	307.0	307.0	0.56	0.56	549.8	242.8	1	4	307	0.0	0.0	0.0	0.0	0.0	0.0	0.44
117	173.0	173.0	0.28	0.28	614	441.0	2	1	75	0.0	0.0	97.9	0.0	0.0	0.0	0.72
118	350.0	350.0	0.79	0.79	443	93.0	2	0	0	140.0	202.0	0.0	0.0	0.0	0.0	0.21
119	10.0	10.0	0.04	0.04	256	246.0	1	6	0	0.0	0.0	0.0	0.0	10.0	0.0	0.96
120	146.0	146.0	0.48	0.48	303	157.0	1	1	146	0.0	0.0	0.0	0.0	0.0	0.0	0.52
121	213.0	213.0	0.61	0.61	348	135.0	1	2	200	0.0	0.0	0.0	0.0	0.0	13.0	0.39
122	135.7	135.7	0.52	0.52	259.6	123.9	1	3	124.6	0.0	0.0	0.0	0.0	0.0	11.1	0.48
123	79.0	79.0	0.62	0.62	127.9	48.9	1	1	79	0.0	0.0	0.0	0.0	0.0	0.0	0.38
124	232.6	232.6	0.85	0.85	273.5	40.9	1	3	216.9	0.0	0.0	0.0	0.0	0.0	15.6	0.15
125	234.6	234.6	0.75	0.75	314.7	80.1	1	3	214	0.0	0.0	0.0	0.0	0.0	20.6	0.25
126	95.8	95.8	0.89	0.89	108	12.2	1	1	95.8	0.0	0.0	0.0	0.0	0.0	0.0	0.11
127	37.0	37.0	1.00	1.00	37	0.0	1	3	37	0.0	0.0	0.0	0.0	0.0	0.0	0.00
128	82.6	82.6	0.90	0.90	91.9	9.3	1	3	82.6	0.0	0.0	0.0	0.0	0.0	0.0	0.10
129	185.0	185.0	0.69	0.69	268.7	83.7	2	3	168.9	9.0	0.0	0.0	0.0	0.0	7.0	0.31
130	115.0	115.0	0.71	0.71	161	46.0	1	2	103.9	0.0	0.0	0.0	0.0	0.0	11.2	0.29
131	162.6	162.6	0.73	0.73	224	61.4	2	2	56.7	0.0	0.0	97.1	0.0	0.0	8.8	0.27
132	148.0	148.0	0.53	0.53	280.7	132.7	2	3	130	18.1	0.0	0.0	0.0	0.0	0.0	0.47
133	256.0	256.0	0.83	0.83	309.9	53.9	2	2	170	0.0	0.0	50.9	0.0	0.0	35.1	0.17
134	142.0	142.0	0.73	0.73	193.9	51.9	1	3	115	0.0	0.0	0.0	0.0	0.0	27.0	0.27
135	161.7	161.7	0.66	0.66	246	84.3	2	1	150	11.6	0.0	0.0	0.0	0.0	0.0	0.34
136	308.8	308.8	0.75	0.75	411.6	102.8	1	2	290	0.0	0.0	0.0	0.0	0.0	18.8	0.25
137	246.0	246.0	0.91	0.91	269	23.0	1	2	239	0.0	0.0	0.0	0.0	0.0	6.9	0.09
138	169.5	169.5	0.70	0.70	241	71.5	2	1	134	35.4	0.0	0.0	0.0	0.0	0.0	0.30
139	389.8	389.8	0.71	0.71	551	161.2	1	2	368	0.0	0.0	0.0	0.0	0.0	21.8	0.29
140	374.7	374.7	0.34	0.34	1107.12	732.4	2	2	311.79	0.0	0.0	28.0	0.0	0.0	34.8	0.66
141	289.6	289.6	0.76	0.76	379	89.4	2	2	237	19.0	12.8	0.0	12.8	0.0	8.1	0.24
142	44.5	44.5	0.76	0.76	58.46	14.0	1	3	44.5	0.0	0.0	0.0	0.0	0.0	0.0	0.24
143	434.4	474.4	0.43	0.47	1015.76	581.4	1	3	378.78	0.0	40.3	0.0	40.3	0.0	15.2	0.57
144	227.1	1760.0	0.53	4.08	431.3	204.2	1	1	0	1760	0.0	0.0	0.0	0.0	0.0	0.47
145	300.4	300.4	0.89	0.89	336.29	35.9	2	2	226.8	73.5	0.0	0.0	0.0	0.0	0.0	0.11
146	184.0	184.0	0.28	0.28	666.74	482.8	2	6	0	50.8	0.0	0.0	0.0	133	0.0	0.72
147	284.0	284.0	0.62	0.62	455.8	171.8	1	2	251.51	0.0	0.0	0.0	0.0	0.0	32.4	0.38
148	245.6	245.6	0.38	0.38	653.24	407.7	1	1	245.56	0.0	0.0	0.0	0.0	0.0	0.0	0.62
149	177.4	177.4	0.34	0.34	529.15	351.7	1	4	177.42	0.0	0.0	0.0	0.0	0.0	0.0	0.66
150	140.9	140.9	0.63	0.63	224.28	83.4	2	2	120	11.0	0.0	0.0	0.0	0.0	9.9	0.37
151	141.0	141.0	0.70	0.70	200.9	59.9	1	1	0	141.0	0.0	0.0	0.0	0.0	0.0	0.30
152	193.7	193.7	0.91	0.91	212.76	19.1	2	1	0	193.7	0.0	0.0	0.0	0.0	0.0	0.09
153	401.3	401.3	0.40	0.40	991.6	590.3	2	3	374.8	16.0	0.0	6.0	0.0	0.0	4.4	0.60
154	271.3	271.3	0.37	0.37	731.08	459.8	2	1	222.13	0.0	0.0	49.2	0.0	0.0	0.0	0.63
155	803.4	803.4	0.64	0.64	1264.98	461.6	1	1	792	0.0	0.0	0.0	0.0	0.0	11.2	0.36
156	181.5	181.5	0.23	0.23	781	599.5	1	1	167	0.0	0.0	0.0	0.0	0.0	14.5	0.77

157	129.9	129.9	0.25	0.25	518.89	389.0	1	1	129.86	0.0	0.0	0.0	0.0	0.0	0.0	0.75
158	144.5	144.5	0.64	0.64	224.26	79.8	1	1	144.49	0.0	0.0	0.0	0.0	0.0	0.0	0.36
159	213.7	213.7	0.58	0.58	369.2	155.5	1	1	213.72	0.0	0.0	0.0	0.0	0.0	0.0	0.42
160	229.9	229.9	0.56	0.56	411.24	181.3	1	2	192.72	0.0	0.0	0.0	0.0	0.0	37.2	0.44
161	153.0	153.0	0.80	0.80	191.8	38.8	1	3	137.96	0.0	0.0	0.0	0.0	0.0	15.2	0.20
162	221.6	221.6	0.52	0.52	424.63	203.1	1	2	214.34	0.0	0.0	0.0	0.0	0.0	7.3	0.48
163	156.2	156.2	0.58	0.58	266.96	110.8	1	1	156.17	0.0	0.0	0.0	0.0	0.0	0.0	0.42
164	270.0	270.0	0.45	0.45	604.48	334.5	1	3	236	0.0	0.0	0.0	0.0	0.0	34.0	0.55
165	182.0	182.0	0.56	0.56	324.51	142.5	1	2	176.3	0.0	0.0	0.0	0.0	0.0	5.6	0.44
166	98.4	98.4	0.67	0.67	146	47.6	1	1	98.4	0.0	0.0	0.0	0.0	0.0	0.0	0.33
167	28.8	28.8	0.40	0.40	71.63	42.8	1	1	28.8	0.0	0.0	0.0	0.0	0.0	0.0	0.60
168	347.4	347.4	0.64	0.64	540.27	192.9	1	2	327.11	0.0	0.0	0.0	0.0	0.0	20.1	0.36
169	64.3	64.3	0.47	0.47	137.32	73.0	1	1	64.3	0.0	0.0	0.0	0.0	0.0	0.0	0.53
170	147.5	147.5	0.95	0.95	154.44	7.0	1	3	147.47	0.0	0.0	0.0	0.0	0.0	0.0	0.05
171	99.8	99.8	0.83	0.83	120.7	20.9	1	3	82.36	0.0	0.0	0.0	0.0	0.0	17.4	0.17
172	87.5	87.5	0.52	0.52	167	79.5	1	2	74.09	0.0	0.0	0.0	0.0	0.0	13.4	0.48
173	415.2	415.2	0.58	0.58	712.95	297.7	1	1	415.22	0.0	0.0	0.0	0.0	0.0	0.0	0.42
174	134.6	134.6	0.69	0.69	194.14	59.5	1	3	121	0.0	0.0	0.0	0.0	0.0	13.6	0.31
175	166.1	166.1	0.66	0.66	252.65	86.5	2	2	81.77	0.0	0.0	64.0	0.0	0.0	20.4	0.34
176	288.6	306.0	0.78	0.83	368.98	80.4	2	2	188.37	22.5	0.0	67.2	0.0	0.0	27.8	0.22
177	148.6	148.6	0.82	0.82	180.7	32.1	1	3	138	0.0	0.0	0.0	0.0	0.0	10.6	0.18
178	54.5	54.5	1.00	1.00	54.53	0.0	2	3	44.34	0.0	0.0	10.2	0.0	0.0	0.0	0.00
179	137.6	137.6	0.83	0.83	165.06	27.5	1	3	109	0.0	0.0	0.0	0.0	0.0	28.6	0.17
180	154.6	154.6	0.79	0.79	196.22	41.6	1	3	148	0.0	0.0	0.0	0.0	0.0	6.6	0.21
181	215.9	215.9	0.70	0.70	307.08	91.2	1	3	209	0.0	0.0	0.0	0.0	0.0	6.9	0.30
182	236.1	991.1	0.40	1.67	593.83	357.7	1	1	0	991.1	0.0	0.0	0.0	0.0	0.0	0.60
183	120.3	120.3	0.85	0.85	140.7	20.4	1	3	110.41	0.0	0.0	0.0	0.0	0.0	21.9	0.15
184	176.8	176.8	0.74	0.74	239.31	62.6	1	3	141.37	0.0	0.0	21.2	0.0	0.0	14.1	0.26
185	29.1	29.1	0.70	0.70	41.63	12.6	2	3	23.47	0.0	0.0	5.6	0.0	0.0	0.0	0.30
186	225.5	225.5	0.65	0.65	345.38	119.9	2	2	201.6	5.3	0.0	0.0	0.0	0.0	18.5	0.35
187	284.9	284.9	0.74	0.74	387.5	102.6	2	2	242.34	29.8	0.0	0.0	0.0	0.0	13.1	0.26
188	148.9	148.9	0.69	0.69	216.29	67.4	2	2	81.14	10.5	0.0	42.2	0.0	0.0	15.0	0.31
189	143.1	858.8	0.74	4.47	192.33	49.2	1	1	0	858.8	0.0	0.0	0.0	0.0	0.0	0.26
190	168.9	168.9	0.77	0.77	219.2	50.3	2	2	156.33	12.6	0.0	0.0	0.0	0.0	0.0	0.23
191	82.0	82.0	0.95	0.95	86	4.0	1	3	0	82.0	0.0	0.0	0.0	0.0	0.0	0.05
192	389.0	389.0	0.86	0.86	453.62	64.6	1	2	379.4	0.0	0.0	0.0	0.0	0.0	9.7	0.14
193	52.3	52.3	0.71	0.71	73.39	21.1	1	3	52.32	0.0	0.0	0.0	0.0	0.0	0.0	0.29
194	90.7	90.7	1.00	1.00	90.72	0.0	1	1	90.72	0.0	0.0	0.0	0.0	0.0	0.0	0.00
195	280.5	280.5	0.51	0.51	545.58	265.0	1	1	264.8	0.0	0.0	0.0	0.0	0.0	15.7	0.49
196	89.1	119.0	0.97	1.29	92.31	3.2	1	3	119	0.0	0.0	0.0	0.0	0.0	0.0	0.03
197	123.0	123.0	0.49	0.49	251	128.0	1	1	111.2	0.0	0.0	0.0	0.0	0.0	11.8	0.51
198	357.1	357.1	0.86	0.86	413.48	56.3	2	3	232	115.0	0.0	0.0	0.0	0.0	10.0	0.14
199	2934.5	2934.5	0.55	0.55	5370.51	2436.1	1	0	0	0.0	0.0	0.0	2934	0.0	0.0	0.45
200	116.1	116.1	0.80	0.80	145.27	29.2	1	3	108	0.0	0.0	0.0	0.0	0.0	8.1	0.20
201	18.8	18.8	0.72	0.72	26.14	7.4	2	3	0	0.0	0.0	18.8	0.0	0.0	0.0	0.28
202	205.3	205.3	0.93	0.93	220.91	15.6	2	2	196	9.2	0.0	0.0	0.0	0.0	0.0	0.07
203	136.2	136.2	0.73	0.73	187.6	51.4	2	1	119.74	16.5	0.0	0.0	0.0	0.0	0.0	0.27
204	103.9	103.9	0.47	0.47	221.6	117.7	2	3	86.64	17.3	0.0	0.0	0.0	0.0	0.0	0.53
205	208.9	208.9	0.77	0.77	272.62	63.8	1	3	200	0.0	0.0	0.0	0.0	0.0	8.8	0.23
206	186.5	186.5	0.51	0.51	364.09	177.6	2	3	158.06	0.0	0.0	0.0	0.0	0.0	28.5	0.49
207	61.1	61.1	0.47	0.47	130.66	69.5	2	3	17.22	0.0	0.0	43.9	0.0	0.0	0.0	0.53
208	73.9	73.9	0.37	0.37	199.92	126.0	1	3	53	20.9	0.0	0.0	0.0	0.0	0.0	0.63
209	245.0	245.0	0.48	0.48	507.21	262.3	1	2	224.96	20.1	0.0	0.0	0.0	0.0	0.0	0.52
210	123.1	123.1	0.79	0.79	155.32	32.3	1	2	123.05	0.0	0.0	0.0	0.0	0.0	0.0	0.21
211	79.5	79.5	0.85	0.85	93	13.5	1	1	79.47	0.0	0.0	0.0	0.0	0.0	0.0	0.15
212	86.9	86.9	0.83	0.83	104.21	17.3	1	3	86.93	0.0	0.0	0.0	0.0	0.0	0.0	0.17
213	161.7	161.7	0.58	0.58	279.3	117.6	1	1	161.68	0.0	0.0	0.0	0.0	0.0	0.0	0.42
214	70.4	70.4	0.68	0.68	102.92	32.5	1	3	62.71	0.0	0.0	0.0	0.0	0.0	7.7	0.32
215	110.2	110.2	0.76	0.76	145.59	35.4	1	1	110.22	0.0	0.0	0.0	0.0	0.0	0.0	0.24
216	172.4	172.4	0.88	0.88	195.31	22.9	1	1	172.37	0.0	0.0	0.0	0.0	0.0	0.0	0.12
217	27.2	27.2	0.21	0.21	130	102.9	1	3	27.15	0.0	0.0	0.0	0.0	0.0	0.0	0.79
218	139.9	139.9	0.48	0.48	294.55	154.6	1	1	139.93	0.0	0.0	0.0	0.0	0.0	0.0	0.52
219	29.7	29.7	0.68	0.68	43.83	14.1	1	3	29.7	0.0	0.0	0.0	0.0	0.0	0.0	0.32
220	162.7	162.7	0.66	0.66	247.67	85.0	1	1	162.67	0.0	0.0	0.0	0.0	0.0	0.0	0.34
221	86.7	86.7	0.97	0.97	89.59	2.9	1	1	86.72	0.0	0.0	0.0	0.0	0.0	0.0	0.03
222	208.7	208.7	0.56	0.56	373.86	165.2	1	1	208.69	0.0	0.0	0.0	0.0	0.0	0.0	0.44
223	112.4	112.4	0.22	0.22	516.23	403.8	1	1	112.41	0.0	0.0	0.0	0.0	0.0	0.0	0.78
224	90.7	90.7	0.64	0.64	141.54	50.9	1	2	90.68	0.0	0.0	0.0	0.0	0.0	0.0	0.36
225	26.0	26.0	0.04	0.04	604.01	578.0	1	2.00	26.00	0.0	0.0	0.0	0.0	0.0	0.0	0.96
226	289.0	298.0	0.96	0.99	300.00	11.0	1	2.00	60.69	0.0	0.0	237.2	0.0	0.0	0.0	0.04
227	82.0	82.0	0.28	0.28	292.00	210.0	1	2.00	82.00	0.0	0.0	0.0	0.0	0.0	0.0	0.72

## **Annex XI. Key Informants, Government office workers Interviewed and Data Collected Offices**

- Woreda Administration

Lideta sub-city woreda one housing development corporation officers, Land development office, construction permit, and control officers

- Sub-city Administration
- Sub-city Housing Corporation
- W/ro Genet – Woreda Administration Record Officer
- Woreda cabinet Members
- Ms. Etetu Gebremaram
- Sergeant Birhanu Diribsa