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AN INVESTIGATION OF URBAN EXPANSION LAND USE LAND COVERS DYNAMICS: THE CASE OF DUKEM TOWN, OROMIA SPECIAL ZONE

BY

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ADDIS ABABA

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An Investigation of Urban Expansion Land Use Land Covers (LULC) Dynamics: The Case of Dukem Town, Oromia Special Zone

By:

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A Thesis Submitted to the School of Graduate Studies of Addis Ababa University, Ethiopian Institute of Architecture, Building Construction and City Development (EiABC), in Partial Fulfillment for Master's Degree in Urban Planning

Advisor:

Birhanu Girma (PhD)

November, 2020

Addis Ababa, Ethiopia

Declaration

I, Girum Sisay, do hereby declare that this research work entitled **" An Investigation of Urban Expansion Land Use Land Covers Dynamics: The Case of Dukem Town, Oromia Special Zone"** is my own original work, and it has not been submitted to any other university/ institutions for any degree/ diploma & for other purposes. Materials and information used in this study other than my own are dually acknowledged and cited.

Name: Girum Sisay Alemu

_____

Signature

Approval

As a member of the Examiners board of the final Master's thesis open defense of Girum Sisay, we have read and evaluated the Thesis prepared by Girum Sisay entitled **"An Investigation of Urban Expansion Land Use Land Covers Dynamics: The Case of Dukem Town, Oromia Special Zone"** and recommended to Ethiopian Institute of Architecture, Building Construction and City Development, Addis Ababa University to accept the Thesis for the Fulfillment of Requirements for the award of Degree of Master 's of Science in Urban Planning.

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Abstract

This study investigates urban expansion land use land covers (LULC) dynamics in Dukem town between the years 2003 and 2019 through identifying driving factors and actors. Dukem town is expanding rapidly and this has brought land use land cover conversion into urban use for different purposes particularly to residential and industrial uses. The study was conducted based on both qualitative and quantitative approaches using spatial analysis of remote sensing and GIS techniques and survey methods. The Primary data sources were collected using questionnaires and observations in order to identify the perception of office employees and community of the town on the factors and actors that contribute a lot for the rapid expansion of Dukem town. The secondary data sources were collected using satellite images. The results of the study showed that built-up areas were increased dramatically from 698.06 ha in 2003 to 3,091.67 ha in 2019. While agricultural land extremely decreased in all years from 2,764.37 ha in 2003 to 999.05 ha in 2019. The study concluded that significant factors such as establishment of industries and manufacturing, location of the town and increase in population size and actors such as private investors, government officials and communities of the town were the top driving factors and actors that contribute a lot for the dramatic expansion of Dukem town. The town will be expected to reach about an average of 6,608.56 ha built area and an average of 181,520 populations by the year 2030. Therefore, all policy and planning issue should consider the expected future expansion of the town.

Key words: urban expansion, trends, land use land cover, change detection, factors, actors

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Acronyms

ALC	Agricultural Land Conversion
BA	Built-Up Area
°C	Degree Celsius
CSA	Central Statistical Agency
DC	Dynamic Change
DTSAO	Dukem Town Social Affairs Office
DTLDMO	Dukem Town Land Development and Management Office
EC	Ethiopian Calendar
EGM	Exponential Growth Model
EIZ	Eastern Industry Zone
Eq	Equation
ETM	Enhanced Thematic Mapper
ETB	Ethiopian Birr
ETM^{+}	Enhanced Thematic Mapper Plus
GC	Gregorian Calendar
GIS	Geographic Information System
GPS	Global Positioning System
Ha	Hectare
Hh	Household
HRT	Heavy Rail Train
Km^2	Square Kilometer
LULC	Land Use Land Cover
LULCC	Land Use Land Cover Change
LUP	Land Use Planning
MM	Millimeter
MSE	Micro Scale Enterprise
MSL	Mean Sea Level

MSS	Landsat Multispectral Scanner
NRL	National Railway Line
NUDP	National Urban Development Policy
NTR	National Trade Route
OA	Overall Accuracy
OUPI	Oromia Urban Planning Institute
ONRSUPI	Oromia National Regional State Urban Planning Institute
PA	Producer's Accuracy
SP	Structure Plan
SPSS	Statistical Package for Social Science
SRS	Satellite Remote Sensing
RGB	Red Green Blue
RS	Remote Sensing
RST	Remote Sensing Techniques
TM	Thematic Mapper
WGS	World Geodetic System
UA	User's Accuracy
UDP	Urban Development Package
UGGP	Urban Good Governance Package
ULA	Urban Land Administration
ULDM	Urban Land Development and Management
UN	United Nations
UNEP	United Nations Environmental Program
UN-Habitat	United Nation Human Settlement Program
USGS	United States Geological Survey
UTM	Universal Transverses Mercator

CHAPTER ONE

1. INTRODUCTION

1.1. Background of the study

Urbanization as a process of urban expansion is a universal phenomenon. In which consists of quick population growth, rise in the proportion of non-agricultural workforce, and conversion in land use from agricultural to built-up urban form (UN-Habitat, 2006). The process of urbanization is continuous one and is generally one of the top agendas influenced by various economic activities such as socio-cultural, political, commerce, transportation and industrial activities (G/Hiwot, 2006; Beka, 2016).

The cause of urban expansion differs from scholar to scholar in context. But, most of them approve that migration, natural birth and rural village reclassification to urban settlement are the major reasons for rapid urban expansion (Kaleb & Samuel, 2017). Among other factors, the population pressure, as Firew, (2010) argues caused horizontal expansion of urban areas.

Many reports and literature show that urban expansion is increasing at an alarming rate in developing countries comparing developed countries. According to Marshall et.al., (2009) this rapid urban growth in developing nations is encouraged by different factors including rural urban migration, social, cultural, economic and technological change and rapid population growth. Such rapid urban growth and consequential change has its own positive as well as negative consequences. This worldwide population growth increases the conversion pace of agricultural land in to urban land uses (G/Hiwot, 2006; UN-Habitat, 2000).

According to Aburas et.al., (2017) the method of measuring urban expansion to evaluate trends and patterns of urban development with the use of RS and GIS techniques is different from that of statistical and mathematical techniques. Hence rather it takes a form of mapping urban expansion and LULC changes which is one of the important and modest techniques that can be used in urban related studies.

Recently, African urbanization is characterized by rapid and uncontrolled urban growth. This results in LULC changes and environmental problems (Shishay, 2011).

In Ethiopia urban areas are growing at elevated rate than ever before. This rapid urbanization is accelerated by multi factors such as rural urban migration, natural population growth, economic growth, and favorable government policy (Leulsegged et.al., 2011). Urbanization and urban growth are considered as a modern way of life manifesting economic growth and development in many countries.

However, urbanization and urban development in Ethiopia faced a number of problems due to sometimes unplanned settlement (Tamirat, 2016; Tegenge, 2002).

According to Adem, (2010) In Ethiopia, the internal political developments, the introduction of motor vehicles, the improvements of communications and the introduction of railway significantly impacted the process of urbanization of the country. Particularly, the introduction of the Ethio Djibouti Railway was a major development of the period that stimulated the country's foreign and domestic trade and resulted in the formulation of a number of Towns along the line. The construction of this Rail way line took place between the years 1894 and 1917. The rail way provided the first modern link between Ethiopia and the outside world. It became the main artery of foreign trade and the line became Ethiopians umbilical cord with civilization. It also gave birth along the railway line, to new Towns such as Dire Dawa, Adama, Mojo, Bishoftu, Dukem and Aqaqi. Accordingly Dukem Town was established around 1914 as a center of posting for Ethio- Djibouti rail way line (Bahiru, 1991; cited by Adem, 2010).

Dukem town is the fast growing urban centers in Oromia special zone surrounding the capital Addis Ababa. Hence the expansion of the town is becoming uncontrolled. The town is growing industry, manufacturing sector, service and its proximity to Addis Ababa has led to increased investments and has resulted in fast economic and social growth. Thus Dukem town has practiced the highest level of land use land cover conversion for new residential settlements and industrial uses following its proposal as an 'Industrial Hub' or 'Eastern Industry Zone (EIZ)' of the country in 2005 (Diriba, 2016).

Increasingly focused studies were carried out in Ethiopia to assess urban expansion and its socio-economic impacts on the livelihood of the farming community (Ahlam, 2017; Abebe, 2012; Beka, 2016; Adem, 2010; Efa & Gutema, 2017; Firew, 2010; Tamirat, 2016; Kaleb & Samuel, 2017; Leulsegged et al., 2011 and Shishay, 2011). However, integrated discourse regarding the driving factors, horizontal expansions measurement through spatial analysis functions of GIS and remote sensing techniques to specify the urban expansion characteristics, implications of LULC changes and major determinants of land management have been limited indicating the need for further studies. Focusing on this section, this study attempts to contribute to the limited literature in line with the major drivers of LULC change, horizontal expansions measurement through spatial analysis functions of GIS and remote sensing techniques to specify the urban expansion characteristics in different periods, driving factors and key actors responsible for the expansion of town and its future growth.

1.2. Statement of the Problem

Urbanization as a growth in the proportion of a population living in urban centers and further horizontal expansion of already existing urban areas and wide alterations of the environment represents a significant type of land use land cover (LULC) conversions changes which considered as an inevitable phenomenon in today's world (Pickett et.al., 2001).

The expansion of varied agricultural activities, timber removal and development in infrastructure are the major direct causes of land use land cover (LULC). While, complexes of economic, technological, demographic, political, institutional and socio-cultural factors are classified as a major root causes of land use land cover changes. Additionally, biophysical factors such as topography, landslides, droughts, and natural fires are referred to as biophysical factors that underpin land use land cover (LULC) conversions (Lambin et.al., 2006, Berhan & Woldeamlak, 2014). Therefore, like many other developing countries, Ethiopia has been facing environmental deprivation problems including land use land cover changes, loss of forest and vegetation and water resource (Berhan & Woldeamlak, 2014).

According to Abebe, (2012) One of the typical manifestations of the undesired effects of urbanization is informal and/or illegal ownership of land and housing which are particularly intensified in the peripheral areas. Intense urban growth and rapid land use conversions due to increasing population and economic growth is being perceived of in Ethiopia like any other developing countries. Ethiopian urban areas are growing in dramatic pace and this has its own consequence particularly, peasant displacement with concomitant loss of agricultural land and production (Kaleb & Samuel, 2017). The urbanization process of towns in Oromia special zone surrounding Addis Ababa in general and its horizontal expansion caused several prospects and challenges on the farming land (Efa & Gutema, 2017).

According to Diriba, (2016) Dukem is characterized by low density and low-rise development. Like any third world town, leap frogging and sporadic developments are common in Dukem. According to Abebe, (2012) The result of the land use and housing ownership survey shows that there are informal housing constructions and extension in all areas of the town especially at the peripheries. The population of the town has been raised and consequently the need for residence homes became serious.

Dukem is one of the fast growing towns but the expansion of the town is becoming irregular, uncontrolled and often resulting in creation of fragmented development (Diriba, 2016). Urban expansion in Dukem town increases rapidly and these brought Landuse conversion into urban use for different purposes like residential settlement, industry, manufacturing sector, service

and its proximity to Addis has led to increased investments and has resulted in high speed economic and social development this condition reduced the farmland and increased built areas through time. Furthermore, the growth of the town is a continuous process so that it is important to measure its horizontal expansions through spatial analysis functions of GIS and RS techniques and also assess major factors and key actors then identify the impact of urban expansion on land use land covers (LULC) change and its future growth.

1.3. Objective of the Study

1.3.1. General Objective of the study

The general objective of this study is investigating urban expansion trends and measuring its effects on land use land covers (LULC) Change in the case of Dukem town using remote sensing and GIS techniques between the year 2003 and 2019 through identifying its responsible driving factors and actors.

1.3.2. Specific Objectives of the study

The study is based on the following specific objectives:

- ✓ To map horizontal expansion of Dukem town between 2003 & 2019 and estimate future expansion for the coming ten years;
- ✓ To measure the effect of urban expansion on land use land cover (LULC) change;
- ✓ To identify the major driving factors and key actors responsible for the expansion of Dukem town and
- ✓ To recommend appropriate strategies that can address rapid expansion of the study area.

1.4. Research Questions

The study focuses on the following research questions:

- ✓ What changes occurred in Dukem town between the years 2003 & 2019 and expected for the coming ten years?
- ✓ What are the effects of urban expansion on land use land cover (LULC) change?
- ✓ What are the major driving factors and key actors responsible for the expansion of Dukem town?
- ✓ What are the appropriate strategies that can address rapid expansion of the study area?

1.5. Significance of the Study

The study has attempted to extract useful information from remotely sensed images and analysis in the context of a given research problem, so that it was significant for academic purposes and it could be used as an input and bench mark for other researchers, policy makers, urban planners and practitioners in the similar areas. Hence, the outputs of the study were a methodological contribution of the significance of GIS and remote sensing in the analysis of urban expansion.

This study has indicated policy implication on how to manage urban expansion and can be support material for governmental authorities who have direct or indirect connections to subject matter. In addition, it fills the literature gaps in the area.

1.6. The Scope of the Study

The thematic scope of this study mainly focuses on investigating trends of urban expansion between 2003 & 2019 periods using spatial analysis of GIS and RST and the major driving factors and key actors responsible for the expansion and its future expansion direction, as well as measuring the effect of urban expansion on land use and cover (LULC) change. On the other hand the spatial scope of the study is covering all areas of Dukem town.

1.7. Limitation of the Study

The main limitation faced while working with this study is access to satellite imageries of high resolution and downloading the images. However, I tried to overcome the problem looking into another option which I can reduce the limitation of spatial resolution. Therefore, I used Landsat TM 7 for the year 2003 good resolution and Landsat TM 8 for the years 2008, 2013 and 2019 of very good resolution also I used Orthopoto excellent resolution from the cadaster office of Dukem town for further interpretability of the images and to ease feature extraction through pre-processing and processing activities.

The other limitation faced while working with this study is acquiring further relevant data's from Dukem town administration office and community of the town regarding the aim of the study that is driving factors and actors responsible for the rapid expansion of the town due to the world phenomenon of COVID-19 pandemic. However more than 70% of the data were collected before the pandemic, while the remains 30% of the data were collected with the pandemic just through ask and then I filled the survey questionnaires by own self in order to avoid contact, keeping physical distance and wearing face mask.

1.8. Organization of the Study

The study is divided into five chapters; the contents of those chapters are discussed briefly. Accordingly, the first chapter gives the background information on urbanization, urban expansion and its driving factors and also the effect of urban expansion on land use/land cover (LULC) change and general overview of the background information from general world perspective to the specific study area. This chapter also contains statement of the problems, objective of the study both general and specific objectives, research question, significance of the study, scope of the study, limitation of the study and organization of the study.

The second chapter is the reviews of academics discourses that were important for this study. The review are related to general theoretical concepts of urbanization and urban expansion, urban expansion and its driving factors as well as its impact on Landuse change, GIS and RS techniques or tools for analyzing the trends of urban expansion and finally summary and conclusion of literatures.

The third chapter is about research methods and materials used for this study. This chapter discusses issues like method and justification for the methods, type of data, sample size and techniques, methods of data collection and data collection tools and data analysis and data analysis tools.

The fourth chapter is about result and discussion of the study. This chapter is discussing the results and discussion in respect to the research questions. Under the result section description of data, spatial data analysis using GIS mapping techniques, qualitative and quantitative analysis were discussed using map, graphs, charts and tables.

The fifth chapter is about conclusion and recommendation. The paper's findings are summarized in respective to research questions. The recommendation is based on the findings of research questions.

CHAPTER TWO

2. REVIEW OF LITERATURES

2.1. Introduction

This section presented the review of literature including research papers and reports regarding theoretical concepts of urbanization and theories of urban expansion. The review also assessed in detail the driving factors and key actors for urban expansion and its consequences on Landuse land cover (LULC) change and forms of urban expansion, urban expansion and applications of GIS and RS, and the significance of application or tools for analyzing the trends of urban expansion, policies to contain rapid urban growth and horizontal expansion of cities. Furthermore, this section also reviewed different methodological techniques/tools and finally summarizes the studies done by different researcher in the same area of the research and concluded the literatures by identifying the research gaps.

2.2. Definition and Concepts

i. The Concept of Urbanization

Urbanization is defined as the nonstop process of change of population from rural to urban (Bekure, 1999). Dejene, (2011) also define urbanization as a demographic shifts from rural area to cities, growth of populations. Ciparisse, (2003) also defined Urbanization as "the process of development of towns and cities where population size and population flow typically result in rapid acceleration in the size of the urban areas".

ii. Urban Growth

Urban growth is to the rate of urbanization and related with the physical expansion of cities and towns. It is the process through which a city changes its spatial structure as a result of an increase in population size (Reis et.al, 2015).

iii. Urbanization and Urban Expansion

According to Adem, (2010) urban expansion is the extension of the attentiveness of people or urban settlement to the surrounding area whose functions are non-agricultural activity. As with urban population growth, urbanization can contribute to the expansion of urban built-over land, and some of this urban expansion is likely to cover land that would otherwise be used to farming land. Even more importantly, urban expansion is not merely occurring because of urbanization and population growth.

iv. Urbanization and Urban Growth

Tilahun, (2016) described that; urbanization and urban growth are two diverse concepts. The difference between them should be noted that urbanization refers to proportion of the national population living in urban areas. While Urban growth refers to an increase in urban population size, independent of rural population. According to Maria et.al, (2014) urbanization can be observed as a characteristic of the population, as a particular kind of land use and land cover, as well as a characteristic of social and economic processes and interactions affecting both population and land.

2.3. Theories of Urban Expansion

Urban growth could be 'generative' or 'parasitic'. In such case, it is likely that in most developed countries, urban growth is generative in that it inspires economic growth and create 'surplus' in the wider urban area or region, while in developing countries urban growth was parasitic in their development but it is now becoming largely generative (Paul et.al, 2000). Paul et.al, (2000) also added that the generative process of urban expansion, explanations in the developed world were delivered by the central place theory, urban base theory and Keynesian theory while in less developed countries urban expansion is given by the modernization and dependency theory. But in the context of parasitic process an explanation of urban growth is offered by the dependency theory (Lloyd, 1999).

In central place theory, the term "central place" has meant urban center, which are a hierarchical ranking of urban centers and associated market areas and transportation networks (William, 1970). Furthermore central place theory hypothesized that the spreading of centralized services accounts for the spacing, size and functional patterns of urban centers (Christaller, 1993). Paul et.al., (2000) described this theory stood on the assumption that urban settlements locate on a uniform plane, centralized service centers would be distributed regularly within a systematic pattern.

Yet, the central place theory is evaluated as it is dependent upon the evolution of settlement on a uniform plane Christaller ignored variable topography. Unlike the central place theory, which was concerned with the distribution of products from an urban center to its hinterland, the urban base theory involves a consideration of demand from anywhere outside the boundaries of the settlement (Paul et.al., 2000). In addition, the theory further assumes that once the underlying economic, technological and social structure of a country has stabilized, the ratio of basic- to- non- basic activities do not change (Linda, 2005).

According to Linda, (2005) the Keynesian Model basically worried with economic growth of an urban area that is expressed in monetary terms. It comprises the valuation of the effect of circular flow of money upon total income and circular flow of money between producers and consumers, export earnings and import expenditures, investment, savings and public spending and taxation. The theory also assumes that the increase in urban income might or might not be associated with a subsequent increase in urban population but it would perhaps have an effect, possibly substantial on the built urban environment.

The other theory which is appropriate to developing countries as well as to the developed world is Dependency Theory. This theory sustains that under laissez-faire-cities grow parasitically by exploiting and holding back their neighbors or surroundings. Furthermore, Myrdad, (1957) recommended that economic growth follows the standard of cumulative causation, whereby once established in a city economic development endorses further local development the spread effect, but this is only at expense of urban neighbors in general and land owners in particular the back wash effect (Paul et.al., 2000).

With respect to developing countries, dependency theory is very much based on the argument that in relative terms the poor countries of the world are getting poorer and poorer, not so much because of their separation from advanced capitalist countries, but, because of their closer association. Frank, (1967) also stated that this interdependency is attributable to the developing countries joining the global economic system at the bottom and being alleged in a dependent position by cities in the developed world and even within developing countries themselves (Potter & Llyod, 1998).

As an substitute to dependency theory, modernization theory advocates that urban growth is primarily generative rather than parasitic. It is rather based on the opinion that developing countries are characterized by a traditional, indigenous and under developed sector. The innovating, westernized and modernized sector in these countries and urban growth eventually trickles down to poorer regions even though economic activity and wealth are initially concentrated or polarized in major cities (Potter, 1992).

Furthermore, since the Modernization theory implies that urban growth occurs in a hierarchical sequence from the largest urban places to the smallest, Hudson (1969) argued that the trickling down process could be applied to the central place system, whereas Rostow, (1960) saw cities as the ‘engines’ of growth for a country as a whole. Finally, from the cited theories depending on the level of relevance and applicability, this study is closer to the Dependency theory of urban expansion as a base for this study.

2.4. Driving factors and Actors of Urban Expansion

2.4.1. Driving factors of Urban Expansion

Theorists in the field of geography and earth system sciences theorized that LULC changes were caused by the interaction of anthropogenic and biophysical driving factors (Geist et.al., 2006). Accordingly, urban expansion driving factors can be grouped in to three major types and those are, varied agricultural activities, timber removal and development in infrastructure are under direct causes of land use land cover (LULC). While, complexes of economic, technological, demographic, political, institutional and socio-cultural factors are classified as under root causes of land use land cover changes and the third one biophysical factors such as topography, landslides, droughts, and natural fires are referred to as biophysical factors that underpin land use land cover (LULC) conversions (Lambin et.al., 2006, Berhan & Woldeamlak, 2014).

Various scholars and institutions wrote about causes and drivers of urban expansion (Handy, 2003; Batty, 2004; Bhatta, 2010) but the best description is given by the European Environmental Agency, (2006). The research classified major factors into six (6) categories that lead into urban expansion such as demographic factors related with population growth,, economic growth, more space and better housing preference, problems associated with inner city, infrastructure and transportation and factors related to regulatory frameworks. All the factors were indicated below in (Table 2.1) for more understanding.

Table 2.1: Driving factors (Causes) of urban expansion

No.	Driving Factors	Description
1	Demography	Population growth and increase in household formation
2	Economic growth	Investment pressures in industry & manufacturing, agro industry processing, commerce and trade and service
3	Housing preference	Need of more space per person and better housing conditions
4	Inner city problems	Poor air quality, noise, small apartments, unsafe environments, social problems, lack of green open space and poor quality of services
5	Infrastructure and Transportation	Private car ownership, availability of roads, low cost of fuel and poor public transport
6	Regulatory frame works	Weak land use planning, poor enforcement of existing plans lack of horizontal and vertical coordination and collaboration.

(Source: European Environmental Agency (2006)).

Urbanization in worldwide has resulted in cities that are rapidly growing and expanding to be able to host their increasing population and this expansion is termed as urban expansion (UN-Habitat, 2006). Hence, places or sites that are adjacent to urban areas might be needed for social, economic, industrial and communication, road construction and for other infrastructure and investment that may in turn need resettlement and displacement of the adjacent rural farming community. In addition, the natural population growth in the urban area is the largest cause of urban expansion (Todaro, 1997). Accordingly, the major driving factors (causes) for urban expansion such as population size, economic pressure, industrialization, lack of affordable housing, demand of more living space, lack of proper planning policies, land grab etc. has expressed in detail as follows.

i. Population Size

The first and foremost reason of urban growth is increase in urban population. Rapid growth of urban areas is the result of two population growth factors the first is natural increase in population, and the second is migration to urban areas (Handy, 2003).

ii. Economic Pressure

Expansion of economic base (such as higher per capita income, increase in number of working persons) creates demand for new housing or more housing space for individuals (Tilahun, 2016; Bhatta, 2010). This also encourages many developers for rapid construction of new houses. Rapid development of housing and other urban infrastructure often produces a variety of discontinuous uncorrelated developments. Rapid development is also blamed owing to its lack of time for proper planning and coordination among developers, governments and proponents.

iii. Industrialization

Establishment of new industries in countryside increases impervious surfaces rapidly. Industry requires providing housing facilities to its workers in a large area that generally becomes larger than the industry itself. The transition process from agricultural to industrial employment demands more urban housing (Diriba et.al., 2017; Tilahun, 2016).

iv. Lack of affordable housing

It is similar to living and property cost and another reason of urban expansion. Affordable housing is a term used to describe dwelling units whose total housing costs are deemed 'affordable' to those that have a median household income. Lack of affordable housing within the city forces people to set their residences in the countryside (Tilahun, 2016).

v. Demand of more living space

In many developing countries, residents of the core city lack sufficient living space. This encourages countryside development for more living space. People can buy more living space in the countryside than in the inner city, since the cost of property is less in the countryside. However, consumption of more living space not always causes sprawl. Population density is a major concern in this issue. Higher per capita consumption of built-up area (or living space) is desired in many instances. In such cases, higher per capita consumption of living space may indicate better and extended living facilities within the confines of compact urban growth. However, if the demand of more living space forces rapid low-density development in the countryside then it must be an indication of expansion (Tilahun, 2016).

vi. Lack of proper planning policies

Lack of consistent and well-experimented planning policies may also cause urban expansion. A city may be planned with exclusive zoning policies; this means separation of residential, commercial, industrial, office, institutional, or other land uses. Completely separate zoning created isolated islands of each type of development (Bhatta, 2010).

vii. Land Grab

The term ‘land grabbing’ or sometimes called as ‘land grasping’ is generally used to describe the process of government’s acquisition or leasing of large portion of land that is conducted by foreigners, transnational companies or investors especially in the developing countries Land is unfortunately been exploited by the government bodies from top to the bottom level administration for the purpose of investment and national development. It is also clear that land is a source of power if someone comes to the power means it is known by default that he will be among the investors or the rich (Sisay, 2012).

2.4.2. The Role of Actors on Urban Expansion

Actors can be described as those (individuals or bodies) that involve in implementation of some development proposals using their power, interest and strategies. They wish to seek to protect and their further interests related to implementation of policies and projects. The actors have different power to do so. Their power is likely to depend on resources they possess and their willingness to use them for political purposes. The ultimate purpose is to maintain self-interest in a way that the implementation of policies to their advantage. Yirgalem, (2009) and Husen, (2018) listed in an attempt to understand the most important actors such as the state, the grassroots i.e. the poor farmers, businessmen and others are among the core stakeholders who play their own role.

To better understand the factors behind land use land cover (LULC) dynamics from the actors side it is wise to see the role played by the government and its agencies ,the farmers who gave their land, businessmen who bought land, land brokers or property dealers and the developers as shown in (Table 2.2).

Table 2.2: Actors types, roles and powers of influence

No	Actors	Interest and motivations	Roles in land dev't and transitions	Nature of involvement	Degree of influence
1	**Government political leaders (Officials)**	Guide development Make political interactions with business people and make financial benefits/revenues	Policy making and project approval Influence decision making process	Formal and in some cases informal	High
2	**Land sellers (Farmers)**	To get high price of land	Selling land willingly Forced to sell by some political pressures	Formal	Depends on the political pressures
3	**Private developers (Investors)**	Generate financial benefits through speculation	Land developers	Formal	Very significant in their influence to promote or hinder dev't
4	**Land brokers (middlemen)**	Profit maximization from the profit gained by the seller	Enhance transaction in the form of service delivery	Informal	Depends on their number of customers

(Source: Compiled from Yirgalem (2009) and Husen (2018))

2.5. Forms of Urban Expansion

Urban expansion occurs substantially in different forms across countries and even within countries themselves. In any given city, new urban expansion can take place with the same densities (persons per square kilometer) as those prevailing in existing built-up areas, or with increased densities, or with reduced densities. It can also take place through the redevelopment of built-up areas at higher densities, through infill of the remaining open spaces in already built-up areas, or through new "Greenfield" development in areas previously in non-urban use. New Greenfield development can either be contiguous with

existing built-up areas or can “leapfrog” away from them, leaving swaths of undeveloped land that separate it from existing built-up areas (Foeken & Mwangi, 1998; Adell, 1999; cited by Adem, 2010).

The first argument states that compact cities are important features of sustainable urban development in the future. The compact city has dominated many historic European cities and the European Community was the strongest advocate. A compacting city entails higher density development and helps reduce demand for space and travel distance. Urban residents enjoy lower transport expense and power costs. It also reduces potential farmland encroachment by urban uses and makes most effective use of urban land (Jenks & Williams 1996; Hillman, 1996; cited by Adem, 2010).

The second argument rejects the compact city and argues that compact city is unsustainable and unacceptable since the benefits obtained from compaction do not overweigh the losses to the social, economic and natural environment (Stretton, 1996).

Accordingly the solutions lie in reforming transport system rather than imposing compaction to the cities. There are others who favour neither compaction nor expansion of cities rather advocating for elements from both views. This argument promotes urban regeneration strategies and new intra-urban environmental initiatives in line with the compact city argument and favours controlled direction of inevitable expansion to the periphery to support a full range of facilities and to the sites that cause the least environmental damage as for the compaction view of urban expansion (Breheny, 1996).

Compact city concept aims at a high density mixed-use, infill development and intensified urban form. A concept designed to implement sustainable development within the urban environment and to counteract the perceived negative social, economic and environmental impacts of urban expansion (Burton, 2000).

Compact city policies have often been designed primarily to reduce the use of private cars and to minimize the loss of open space. However, proponents of the concept claim more than just environmental benefits can be gained from intensifying urban areas; in fact, ‘higher density settlements are argued to be more socially sustainable because local facilities and services can be maintained, due to high population densities, and therefore accessibility to goods and services is more equitably distributed’. The main goal of the compact city model is to reduce the impact of urban development upon the surrounding natural environment; most future urban growth will need to occur within existing city boundaries (Williams, 1999)).

Compact city development strategy has more recognition and is recently accepted for social and economic utilization of resources although developing countries rarely exercise compaction. Urban Expansion is mostly uncontrolled that one often sees overcrowding (slum and shanties) and extended unplanned settlement with acute shortage of infrastructure in one part and unutilized or partially developed vacant land on the other part.

2.6. Application of GIS and Remote Sensing in Urban Expansion

The modern technology of remote sensing which includes both aerial as well as satellite based systems, allow us to collect a lot of physical data rather easily, with speed and on repetitive basis, and together with GIS helps us to analyze the data spatially, offering possibilities of generating various options/modeling. These information systems also offer interpretation of physical (spatial) data with other socio-economic data, and thereby providing an important linkage in the total planning process and making it more effective and meaningful (Ravindra et.al, 2008).

Recently, remote sensing has been used in combination with Geographical Information Systems and Global Positioning Systems to assess land cover change more effectively than by remote sensing data only (Weng, 2002). It has already proved useful in mapping urban areas, and as data source for the analysis and modelling of urban growth and land use/land cover change.

Urban growth and the physical expansion of cities can be detected, mapped and analyzed using remotely sensed data obtained from mostly Landsat multispectral scanner (MSS) thematic mapper (TM) enhanced thematic mapper plus (ETM+), and SPOT (Ward et al., 2000). Urban areas are complex geographic dimensions with a mixed combination of buildings, roads, gardens, soils, water etc. Such surface cover types, exhibit a unique radiative and thermal moisture properties hence unique spectral signature and the advancement in satellite has helped its application in urban land-use/cover change detection using high spatial resolution sensors (Sewunet, 2017).

According to Sewunet, (2017) one of the most difficult problems we face in studying urban areas in developing countries is lack of reliable data. Most of the data obtained in developing countries are outdated, unreliable or in some cases totally unavailable. On the other hand, urban areas are the most dynamic features on the earth's surface and urban landscapes are the most complex combinations of various built-up and non-built up surface cover types (Melesse et.al., 2007).

Therefore, both GIS and Remote Sensing (RS) have a wide range of applications in solving these problems in urban areas planning, change detection, monitoring, and mapping. Remote sensing is a sound alternative to provide the most valuable and cost effective data from different sources mainly aerial photography and satellite images to assess, monitor and map urban expansion (Sewunet, 2017).

2.6.1. Digital Image Processing

In order to process remote sensing imagery digitally, the data must be recorded and available in a digital form suitable for storage on a computer tape or disk. The other requirement for digital image processing is a computer system, sometimes referred to as an image analysis system, with the appropriate hardware and software to process the data. Several commercially available software systems have been developed specifically for remote sensing image processing and analysis. A digital image is stored as a two-dimensional array (or grid) of small areas called pixels (picture elements), and each pixel corresponds spatially to an area on the earth's surface (Congalton, 1991).

According to Congalton, (1991) There are four (4) most important steps in image processing those are preprocessing (image rectification & restoration), image enhancement, image transformation and image classification & analysis. Preprocessing functions is involves those operations that are normally required prior to the main data analysis and extraction of information. Image enhancement, is solely to improve the appearance of the imagery to assist in visual interpretation and analysis. Image transformations typically involve the manipulation of multiple bands of data, whether from a single image or from two or more images of the same area acquired at different times (Congalton, 1991).

2.6.1.1. Image classification and analysis

Image classification and analysis operations are used to digitally identify and classify pixels in the data. This process assigns each pixel in an image to a particular class or theme based on statistical characteristics of the pixel brightness values. There are a variety of approaches taken to perform digital classification. But the two generic approaches which are used most often, namely unsupervised and supervised classification (Campbell, 1987).

a) Unsupervised Classification

In this classification, the image data are first classified by aggregating them into the “natural” groupings, or clusters present in the scene based on their inherent spectral properties. Classification is based on the Iso data or similar spectral classes in the pixel.

b) Supervised classification

The image analyst "supervises" the pixel categorization process by specifying numerical descriptors of the various land cover types (classes) present in a scene. Representative sample sites of known cover types or training areas are used to compile a numerical "interpretation key" that describes the spectral attributes for each types of interest. The training areas can be selected based on knowledge from previous field work, existing maps, etc.

2.6.1.2. Accuracy Assessment

Accuracy assessment determines the quality of information derived from remotely sensed data. Assessment can be either qualitative or quantitative (Campbell, 1987). Accuracy of image classification is most often reported as a percentage correct and is represented in terms of consumer's accuracy and producer's accuracy (Anupam, 2017).

Accordingly, the consumer's accuracy (CA) is computed using the number of correctly classified pixels to the total number of pixels assigned to a particular category. It takes errors of commission (command error) into account by telling the consumer that, for all areas identified as category X, a certain percentage are actually correct. On the other hand the producer's accuracy (PA) informs the image analyst of the number of pixels correctly classified in a particular category as a percentage of the total number of pixels actually belonging to that category in the image. Producer's accuracy measures errors of omission (processing error).

Accuracy assessment is the final step in the analysis of remote sensing data which help us to verify how accurate our results are. It is carried out once the interpretation/classification has been completed. The accuracy is concerned with the correspondence between class label and 'true' class. A 'true' class is defined as what is observed on the ground during field surveys. In order to perform accuracy assessment correctly, we need to compare two sources of information which include classified image derived from the remote sensing data and reference map high resolution images or ground truth data (Anupam, 2017).

Sample size is an important consideration while assessing the accuracy of remotely sensed data. A minimum of 50 samples for each land class (LC) category in the error matrix. This rule also tends to agree with the results of computing sample size using the multinomial distribution. If the area is especially large or the classification has a large number of LC categories (i.e. more than 12 categories), the minimum number of samples should be increased to 75 to 100 samples per category (Congalton, 1991).

2.6.1.3. Change Detection

Following the supervised classification of imagery post-classification change detection algorithm will be performed to determine changes in land cover. This post-classification approach provides statistical evidence on how land cover has changed and is used to calculate and map land cover changes over time.

2.7. Policies to Contain Rapid Urban Growth and Horizontal Expansion of Cities

Developing countries have adopted specific policies and strategies to control further expansion of their large cities. Some countries have attempted administrative decentralization in order to reduce population pressure. Establishment of green belts around major urban areas has been also used to restrict city expansion and to preserve open land for agriculture.

In 2004, the Ethiopian Government formulated the National Urban Development Policy (NUDP). The NUDP has clearly identified the consequences of rapid urbanization in Ethiopia and designed a program and institution to address the problems. Even if the gap mentioned by the review can be amended, it is doubtful that the policy can generate conditions for self-generated urbanization in Ethiopia (Tilahun, 2016).

The policy finds solutions to the effects of rapid urbanization in Ethiopia (symptoms); it does not address the problem related to the root causes of migration: high rural fertility, increasing food consumption requirements, resource scarcity (particularly land), growth in new entrants in labor force, and lower economic capacity of the urban formal and informal sector to absorb surplus rural labor (Tilahun, 2016).

The strategy of giving primacy to agriculture, on the ground that the majority of the people live in rural areas is a mere simplification of the reality based on ideological orientation. This approach does not work in conditions where people are migrating from one saturated area to another saturated area. Development should occur simultaneously in both rural and urban areas to ensure economic integration and reinforcing expansions for the purpose of absorbing surplus labor. One cannot solve rural problem without the urban and vice versa. Indeed this requires enormous resources and it may be easier said than done. But there is no other option which can help to catch up the race (Tsegaye, 2010).

2.8. Summary of Literatures

The various reviewed literatures are summarized in the (Table 2.3 and 2.4) as followed. This study depended on this summary.

Table 2.3: Summary of urban expansion driving factors used by different authors

Authors and Published year	**Used variables**	**Results of the study**
European Environmental Agency (2006)	demography, economic growth, housing preference, inner city problems, infrastructure and transportation and regulatory frame works	Places or sites that are adjacent to urban areas might be needed for social, economic, industrial and communication, road construction and for other infrastructure and investment that may in turn need resettlement and displacement of the adjacent rural farming community
Kenate, W. (2013)	population size, economic pressure, industrialization, lack of affordable housing, demand of more living space, lack of proper planning policies and land grabbing	Land use land cover (LULC) changes are driven by a combination of underlying drivers such as economic, demographic, biophysical and institutional factors are the key drivers of LULC change in his study area
Berhan, G. and Woldeamlak, B. (2014)	varied agricultural activities, timber removal and development in infrastructure, complexes of economic, technological, demographic, political, institutional and socio-cultural, biophysical factors such as topography, landslides, droughts, and natural fires	Proximate factors (the traditional practices of farming and overgrazing, wood extraction and infrastructure extension), underlying pressures (demographic pressure coupled with poverty, the land tenure system) and biophysical factors (the topography of the watershed) are the key drivers of LULC change in their study area
Diriba, D. et.al., (2016)	industrialization, housing and residential expansion and infrastructure development	Industrialization, residential expansion and infrastructure development were identified as the leading drivers of ALC that negatively affects the size of cultivated land and food crop production in the hinterlands.

(Source: Table generated based on reviewed Literatures)

Table 2.4: Summary of urban expansion driving actors used by different authors

Authors and Published year	**Used variables**	**Results of the study**
Kenate, W. (2013)	private developers, government political leaders, land sellers, community and middlemen	The power of the actor is depend on resources they possess and their willingness to use them for political purposes. The ultimate purpose is to maintain self-interest in a way that the implementation of policies to their advantage and they are the key drivers of LULC change in his study
Yirgalem, D., (2009) and Husen, T. (2018)	officials, farmers, investors and land brokers	Actors who have the part in LULC change, to play either in the demand or supply side of the land market are the government or agencies, the farmers who gave land, investors or communities who bought land, land brokers who property dealers and they are the key drivers of LULC change in their study

(Source: Table generated based on reviewed Literatures)

2.9. The Research Gaps

Most of the studies were carried out in Ethiopia were focuses on assessing urban expansion and its socio-economic impacts on the livelihood of the farming community in the peri urban areas (Ahlam, 2017; Abebe, 2012; Beka, 2016; Adem, 2010; Efa & Gutema, 2017; Firew, 2010; Tamirat, 2016; Kaleb & Samuel, 2017; Leulsegged et al., 2011 and Shishay, 2011). Their focus is mainly on expansion of urban area and its impact on environment and socio-economic impacts on the livelihood of the farming community in the peri urban areas in relation to population growth. Therefore, they didn't show the detail studies about urban expansion trend map and pattern of growth, configuration and growth direction, measurement of spatial change rate and amount of land use land cover (LULC) change and its future growth direction. Generally, in Ethiopia studies made on urban expansion and its impact using GIS and RS techniques particularly for different urban related studies are minimal and due to this there is a limited literature in the area.

There is one study done by Diriba et.al., (2016) This study intended to recognize the major forces of urban sprawl and its impacts on land use conversion in the peri-urban kebeles of the Dukem town and it shown that urban sprawl has caused an intense agricultural land conversion (ALC) that has extremely affected agricultural land and productions. Moreover the study also indicated that industrial expansion, residential growth and development in infrastructure were identified as the leading driving forces of ALC that negatively affects the size of cultivated land and food crop production in the hinterlands of the town. However, integrated discourse regarding the horizontal expansions measurement through spatial analysis functions of GIS and remote sensing techniques to specify the urban expansion characteristics, implications of land use land cover (LULC) changes and major determinants of land management have been limited indicating the need for further studies.

Focusing on this area of field, this study has attempted to contribute to the limited literature in line with the major drivers of land use land cover (LULC) change, horizontal expansions measurement through spatial analysis functions of GIS and RS techniques to specify the urban expansion characteristics in different span of time in the case of Dukem town including what are the factors and who are responsible for the expansion of the town.

Therefore, this study conducted to show those changes happened in Dukem town in the past 15 years. Hence, the study is intended to show how the recent expansion, pattern and composition of the town look like and how much of agricultural, open space and green area is incorporated to the built up area and where the town will reach for the coming ten years.

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1. Introduction

In order to appropriately answer the research question of this study, literatures of different scholars had been assessed in chapter two to come up with a comprehensive methodology. Based on this the section presents description of the study area, materials and methods were used in the study. Specifically, data types, data source, method of data collection, method of data analysis or processing and data collection and analysis tools or software programs used are discussed in detail under this chapter.

3.2. Description of the Study Area

3.2.1. Location of the Study Area

Dukem town is located at 37km South East of Addis Ababa along the main road to Adama as shown in (Figure 3.1). Geographically, the study area located by latitude $8^0$45'25"N-$8^0$50'30"N and longitude $38^0$51'55"E - $38^0$56'5" E covering a total area of 9630.6 hectare. It is located at an average altitude of 2100m above sea level (OUPI, 2017).

Progresses have been seen in the town since a number of houses, manufacturing, service sector and institutions have been constructed. The population number is also rapidly rising because of its closeness to the capital city Addis Ababa and economic importance. Population size growth joined with industrial development has caused in intense competition for land resource.

The town is bounded in the southeast by Bishoftu town but by Gelan town in most parts of north direction. The remaining eastern and western parts of the town are bounded by four neighbouring peasant associations of Akaki district (OUPI, 2017).

The peasant association in the south with the largest common boundary with Dukem town is Wajitu Dibdibe. This is followed by Gogecha peasant association that is found in the northern part of the town. The third largest part of Dukem town is bounded by Tedecha Yatu. The neighbour of Dukem town with the smallest boundary in the northwest is Oda Nabe. In terms of distance of the peasant associations included within the boundary of Dukem town those that are found in the north are located at longest distance from the center of Dukem while the remaining peasant associations in the east and in the south are found closer to Dukem town (OUPI, 2017).

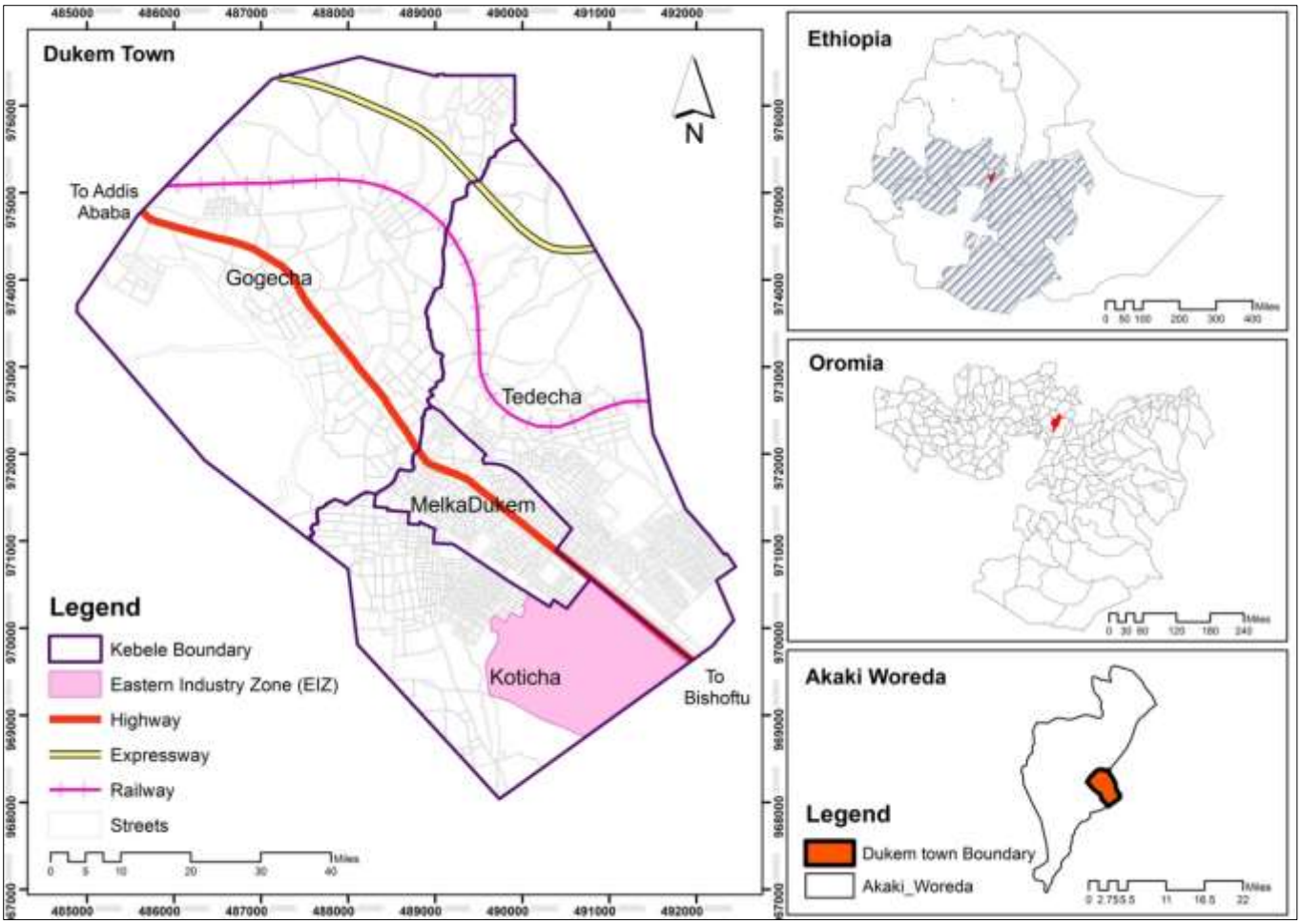


Figure 3.1: Location Map of Dukem town (Source: Organized by the author, using Arc GIS 10.2 Analysis, (2020))

3.2.2. Physical Characteristic of study area

i. Area and Shape

Dukem town is more elongated along the asphalted highway running from Addis Abeba city to Bishoftu town. There is less elongation of the town in areas that do not have better infrastructure development. Area of Dukem town is 9630.6 hectare. Shape analysis of Dukem town implies that it has more south-north extension (OUPI, 2017).

ii. Topography

The elevation of Dukem town ranges from 1890m to 2300m above MSL with an altitudinal range of 410 meters. The north eastern, northern and eastern parts of the town are generally characterized by rugged topography (OUPI, 2017).

On the other hand, the southern and western parts of Dukem have monotonous flat topography. The elevated topography in the north eastern and northern parts of the town is responsible in determining the southwest flow direction of major perennial and seasonal streams. There is also flush water from Eastern Industry Zone (EIZ). The rugged topography in the northern and north eastern parts of Dukem town is inaccessible with stony landscape and steeper gradient that has impact on the infrastructure development (OUPI, 2017).

iii. Slope

The analysis of slope is an important input to link different land uses with topography of an area. The town has slope classes ranging from 0% to over 20%. The different slope classes are found in different parts of the town. The largest slope class (1-2%) covers various parts of the town. It covers a total area of 2691.6 hectares (63.4%) of Dukem town. It covers south-eastern, southern and central parts of Dukem town settlements, commercial activities and institutions are established (OUPI, 2017).

The second largest slope class of Dukem town ranges from 5% to 10%. It is found distributed in different parts of the town especially to west direction of the town. Slope class ranging from 5% to 10% is also found in the north-eastern part of the town (OUPI, 2017).

The third largest slope class covering various parts of Dukem ranges from 0% to 1%. This is extensively found in the southwest. This is the area where flood accumulates due to flow direction of Dukam streams from northeast direction and flush water from Eastern Industry Zone (EIZ). Slope over 15% is found in pocket areas over Gimashe upland and in northeastern areas of Dukem town. These areas are considered as one of the most inaccessible areas of Dukem town. Currently, these areas are used as grazing land because of the presence of grass over these areas. They are covered with scanty natural vegetation and eucalyptus trees (OUPI, 2017).

iv. Climate

According to OUPI, (2017) the agro climatic relationship between altitude and temperature in Ethiopia indicates that the climate of Dukem town falls in the semi temperate agro-climatic zone with temperature range of 15^0C to 20^0C. On the other hand, the metrological station of Akaki which is located at a distance of 15kms is used to analyze the climate of Dukem town as shown in (Table 3.1).

Table 3.1: Climatic data of Dukem town from 1997 to 2017

Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PPT (CM)	13	17	52	80	76	107	228	241	114	22	8	5
Temp ($0_{C)}$	19	20	21	22	22	20	19	19	19	20	19	19

(Source: OUPI, (2017)).

According to OUPI, (2017) the average annual rainfall of Dukem town and its surrounding is 800.3mm. The total average annual rainfall of Dukem town is 963mm. The seasonal distribution of rainfall in Dukem town indicates that the rainy season starts in spring and lasts up to the end of August. On the other hand, the driest season of the town is winter (December to February). The remaining seasons of the year (autumn and spring) are characterized by having moderate amount of rainfall that is below the amount of rainfall occurring during the summer season. Because of this, the growing period of Dukem town starts as early as spring season and lasts in autumn season. As it is shown by the rainfall and temperature graph of Dukem town, the highest temperature within the year occurs during the spring season of the northern hemisphere. In fact, the temperature continuously rises from January to May with the maximum amount of temperature occurring in May. But the temperature of the town falls down during summer and autumn seasons of the northern hemisphere due to the impact of cloud cover as shown in (Figure 3.2).

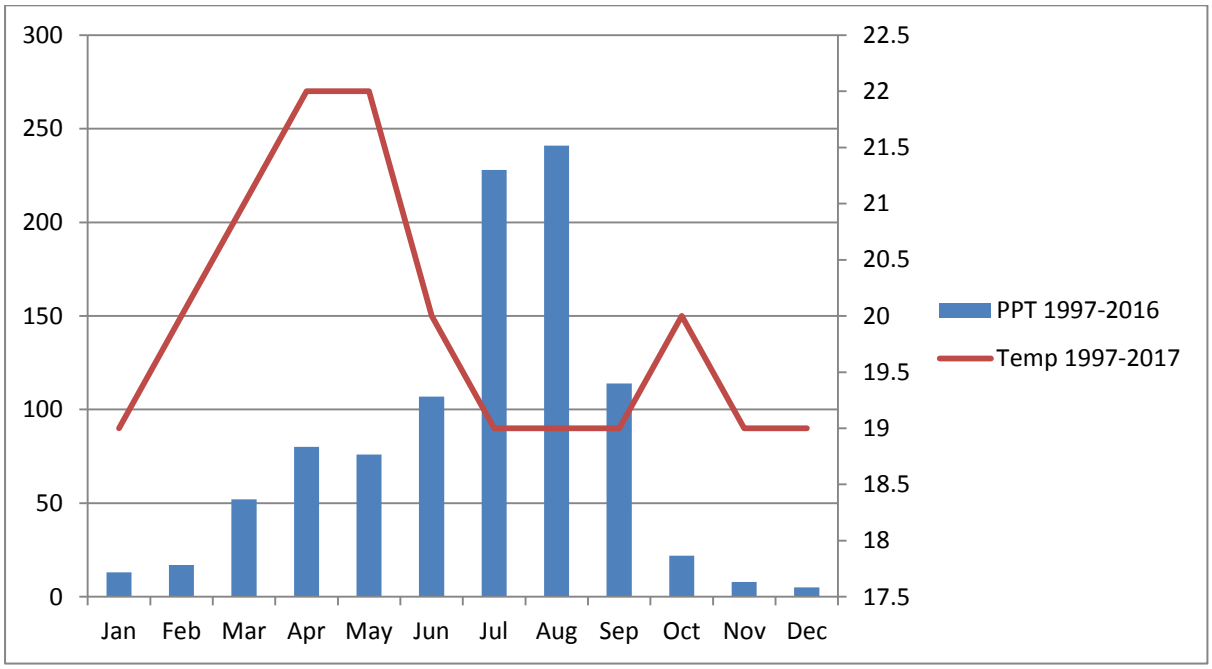


Figure 3.2: Seasonal distribution of Rainfall and temperature of Dukem town (Source: OUPI, (2017)).

3.3. Research Approach

In order to investigate urban expansion trends and its effects on land use land covers (LULC) change in the case of Dukem town an explanatory research type was adopted. The reasons for this approach is that it enabled to clarify urban expansion trends through mapping in different periods of time and also how this had an effect on land use land covers (LULC) change.

In order to address the stated objectives of the study both qualitative and quantitative approach were used and also both primary and secondary data sources were used. The Primary data sources were collected using data collection instruments such as closed-ended and open-ended questionnaires and observations. The secondary data sources were collected using remote sensing technique and processed and analyzed using GIS.

3.4. Research Methods

The researcher had been used spatial analysis method using RS and GIS techniques. Satellite images of Dukem town for 2003, 2008, 2013 and 2019 years to assess urban expansion and changes were accessed using remote sensing; the images are downloaded from Earth Explore USGS website and then finally processed and analyzed using GIS 10.2.2 software. For data management, file reshaping and data documentation as well as to represent the data and findings, percentage, graphs, photographs and tables were used.

The researcher had been also used survey method using close-ended and open-ended questionnaires to identify the perception of officials, experts, kebele administrators and community of the town on the factors and actors that contributed a lot for rapid expansion of Dukem town between 2003 and 2019. In this regard, the sampled respondents rated the listed urban expansion driving factors and actors based on the provided five point Likert scale of strongly agree to strongly disagree while for open ended questionnaire the sampled respondents listed any comments they have related to the factors and actors that contributed a lot for rapid expansion of Dukem town between 2003 and 2019. After the collection of the necessary information, data processing had been performed with SPSS 20 and Excel software. The data were organized and analyzed using descriptive and inferential statistical methods and techniques i.e. mean, mode, median, standard deviation and skewness and the organized data presented in tables, graphs and descriptive analysis.

3.5. Research Design

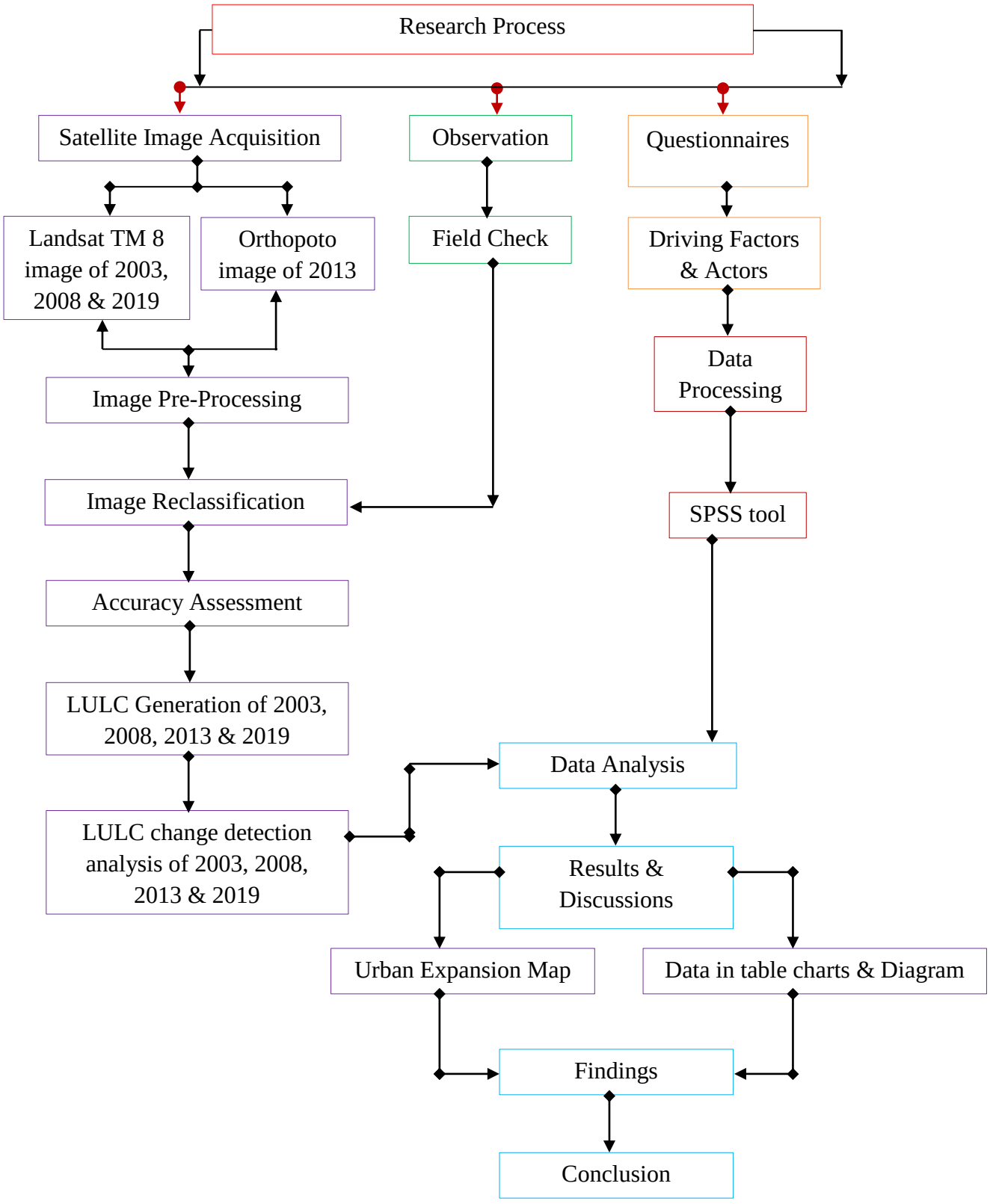


Figure 3.3: Showing Research process diagram (Source: Organized by the author, (2020))

3.6. Data Type and Source

The study is based on both Quantitative or numerical data type and Qualitative or descriptive data type required for the study were collected from both Primary data and Secondary data sources to achieve the aim of the study.

Reliable data is used to effectively achieve the designed objectives of the study. Accordingly, there are two types of data sources primary and secondary.

3.6.1. Primary Data Sources

The Primary data sources were collected using frequent observations of the town and closed-ended and open-ended questionnaires for officials and experts of Dukem town Land Development and Management office, Community and each Kebele administrators (Melka Dukem, Tedecha, Koticha and Gogecha Kebeles).

3.6.2. Secondary Data Sources

The secondary sources of data for this study were collected from books, journals, official reports, websites, legal documents, satellite images, previous study documents, population data and Orthopoto from Dukem town Land Development and Management Office data's were widely used. Generally the detail of satellite image, data types used in the study and data sources from which they were obtained are summarized in (Table 3.2).

Table 3.2: Data types and Data sources from which they were obtained

No.	Data	Year	Platform	Source	Data Type
1	Satellite Image	2003	Landsat TM	USGS web.	Secondary
2	Satellite Image	2008	Landsat TM	USGS web.	Secondary
3	Satellite Image	2013	Orthopoto	DTLDMO	Secondary
4	Satellite Image	2019	Landsat TM	USGS web.	Secondary
5	Demographic Data			CSA/DTSAO	Secondary
6	Annual Reports			DTLDMO	Secondary
7	Administrative Boundaries and Shapefiles			DTLDMO	Secondary
8	Dukem Town Structure Plan			OUPI	Secondary

(Source: Organized by the author, (2020)).

3.7. Data Collection Methods

3.7.1. Data Collection Instruments

Data collection instruments applied in this study is GIS and Remote sensing technique, questionnaires and observations. Measurement of spatial expansion from categorical maps generated from satellite images to quantify the expansion trends of the town in different periods of time and its effects on land use land covers (LULC) change using spatial analysis of GIS and Remote sensing techniques.

The land cover change detection characteristics are used for assessing the spatial and temporal land use land cover (LULC) change in the study area. It is the identification of variations in land cover types by observing a specified area at different times using multi-temporal data sets from satellite images. Spatial temporal satellite images of a specified geographic area were processed and classified to produce thematic maps for 2003, 2008, 2013 and 2019 then the classified maps were compared and overlaid to visualize the changes on the area in the span of time. It is also possible to compute the amount of increase and/or decrease of each category and see the change in percent in each year.

3.7.1.1. Justification of Data Collection Instruments

Remote sensing provides spatially consistent data sets that cover large areas with both high spatial detail and high temporal frequency. Remote sensing can also provide consistent historical time series data, spatial and temporal dynamics of the processes in urban growth and land use change (Herold et al., 2003). Recently, remote sensing has been used in combination with Geographical Information Systems (GIS) and Global Positioning Systems (GPS) to assess land cover change more effectively than by remote sensing data only (Weng, 2002). Therefore, the method has already proved useful in mapping urban areas, and as data source for the analysis and modelling of urban growth and land use/land cover change.

GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps. These abilities distinguish GIS from other information systems and make it valuable to a wide range of public and private enterprises for explaining events, predicting outcomes, and planning strategies. Generally, GIS provides facilities for data capture, data management, data manipulation and analysis and the presentation of results in both graphic and report form, with a particular emphasis upon preserving and utilizing inherent characteristics of spatial data (Tilahun, 2016).

There are many advantages of spatial analysis of GIS and Remote sensing methods. Because urban areas are dynamic and complex in nature, conventional methods of data collection are unable to cope with the many changes that take place over very short time periods. Collecting and processing the data can also take a long time and there was an urgent need for a better data source. Therefore, both GIS and Remote Sensing (RS) have a wide range of applications in solving these problems in urban areas planning, change detection, monitoring, and mapping. Remote sensing is a sound alternative to provide the most valuable and cost effective data from different sources mainly aerial photography and satellite images to assess, monitor and map urban expansion.

3.7.2. Primary Data Collection Instruments

In order to generate information regarding the major driving factors and key actors, important data collection instruments used are questionnaires and observations.

3.7.2.1. Questionnaires

The researcher was prepared both items of questionnaires closed-ended and open-ended questions for officials, experts, community and kebele administration (Melka Dukem, Tedecha, Koticha and Gogecha Kebeles). Because experts and office head who are directly working on the issue believed to have rich data than the others. In addition, it helps to get required information from community could describe changes resulted over time. Thus, an investigator was used similar questions for all respondents of the selected sample.

Open-ended questionnaires were included into the survey in order to provide a chance for the respondents to list any unlisted their concern on the factors and actors that contributed a lot for rapid expansion of Dukem town between 2003 and 2019. Also, it believed that, the open-ended question helps to compare the answer of close-ended question.

To identify the perception of officials, experts, Kebele Administrators and community of the town on the factors and actors that contributed a lot for rapid expansion of Dukem town between 2003 and 2019, five Likert scales of strongly agree to strongly disagree were used. Because since the data collected was based on personal perception which may vary accordingly it was based on Likert scale to grasp the perception level of respondents.

The survey questionnaire was primarily prepared in English languages and then translated into the local language Afaan Oromo and Amharic. The researcher used similar questionnaire for all respondents of the selected sample.

3.7.2.2. Observations

Ground truth data's on the field were collected by direct observation in the study area. The researcher was observed and collected the necessary visual information with the help of camera on the existence of urban expansion.

3.7.3. Secondary Data Collection Instruments

3.7.3.1. Satellite Imageries

The United States Geological Survey (USGS) is a gold mine of information and the known source of satellite image free of charge that covers wide areas (Sewunet, 2017). In order to investigate urban expansion trends of Dukem town, Landsat imagery/Landsat Thematic Mapper (TM) for the years 2003, 2008 and 2019 were used as a source of data and acquired from earth explorer website. However, for a year of 2013 Orthopoto was used due to the availability of this material from Dukem town land development and management office. Orthopoto is high resolution image and for the years 2003, 2008 and 2019 high quality cloud free images were selected from row 54 and path 168, full scenes. The January season of the year is preferred to get cloud free images for ease of classification and facilitate comparison in classification activities. These data's are used to produce the historical land use/ land cover maps of the study area and urban expansion changes.

3.8. Sampling Techniques

3.8.1. Sampling Method

In order to generate information regarding the major driving factors and actors responsible for Dukem town expansion a purposive (judgmental or expert sample) sampling technique was employed as a non-random sampling to select the representativeness of target group from officials, experts of Dukem town Land Development and Management office and Kebele Administrators (Melka Dukem, Tedecha, Koticha and Gogecha Kebeles) because there was a variety in service year so that priority given to service seniority.

Another target group is representativeness from communities, also a purposive sampling technique was applied because the communities selected were those who lived for 15 years and above in Dukem town, the reason is that they could describe changes resulted over time and believed to have rich information than other existing new settlers in the town.

3.8.2. Sampling Frame

Sampling frame is the population of interest from which sample is selected. Accordingly, the respondents of this study were Dukem town land development and management office experts, officials, kebele administrators and community in the town.

To select the sample size from the total informant data regarding Dukem town land development and management office experts, officials, kebele administrators and communities in the town data were collected from the municipality and kebele offices as specified in detail (Table 3.3 and 3.4). Based on this, the data regarding the total study population samples of experts, officials and kebele administrators were acquired and decided under the sample size determination.

Table 3.3: Sampling frame data used to identify office employees

No.	**Target Population**	**Kebele**	**Gender**		**Total number of employees**
			Male	Female	
1	Dukem town land development and management office Experts	-	46	21	67
2	Dukem town land development and management office Experts at kebele level	Melka Dukem	2	1	10
		Tedecha	2	1	
		Koticha	1	1	
		Gogecha	1	1	
3	Dukem town land development and management office Officials	-	2	-	2
4	Kebele administrators	Melka Dukem	2	-	8
		Tedecha	2	-	
		Koticha	1	1	
		Gogecha	2	-	
		Total			87

(Source: Dukem town Land Development and Management Office & Kebele Administration (Melka Dukem, Tedecha, Koticha and Gogecha Kebeles), (2020)).

Table 3.4: Sampling frame data used to identify communities (Hh CSA-2007 data)

No.	Target Population	Kebele	Households
5	Community	Melka Dukem	1925
		Tedecha	1299
		Koticha	2487
		Gogecha	1540
		Total	7251

(Source: (OUPI, (2017): Dukem town structure plan study report, (2020)).

3.8.3. Sample Size Determination

Determining sample size is affected by different factors such as the purpose of the study and population size of the study (Glenn, 2003). Furthermore in addition to the purpose of the study and population size, three criteria usually will need to be specified to determine the appropriate sample size, those are the level of precision, the level of confidence and the degree of variability in the attributes being measured (Miaoulis & Michener, 1976).

There are several strategies to determining the sample size. These include using a census for small populations, imitating a sample size of similar studies and applying formulas to calculate a sample size. Using a sample size of a similar study is to use the same sample size as those of studies similar to the one you plan. Using formulas to calculate a sample size is the application of one of several formulas that a need to calculate the necessary sample size for a different combination of levels of precision, confidence, and variability.

In the process of the sample size selection, purposively selection for the informants was used. Therefore, the first step is calculating the sample size of the total respondents (experts, officials, kebele administrators and communities in the town).

The strategies used for determining the sample size of this study was using a simplified formula to calculate a sample size because of small populations. The Yamane formula is used to determine the sample size. Yamane, (1967:886) provides a simplified formula to calculate sample sizes (Glenn, 2003).

Accordingly, the sample size for office employees and communities in the town at 95% confidence interval and ±5% precision were 66 and 379 respectively as computed and shown below.

$$n = \frac{N}{1 + N(e)^2}$$

Where:

n = required sample size

N = Study Population

e = level of precision = 95% confidence i.e. e = **0.05%**

Office Employees

$$n = \frac{N}{1 + N(e)^2} \quad \mathbf{n} = \left[\frac{87}{1 + 87(0.05)^2}\right] \quad \mathbf{n} = \left[\frac{87}{1.3175}\right] = \mathbf{66}$$

Community

$$n = \frac{N}{1 + N(e)^2} \quad \mathbf{n} = \left[\frac{7251}{1 + 7251\ (0.05)^2}\right] \quad \mathbf{n} = \left[\frac{7251}{19.1275}\right] = \mathbf{379}$$

The details about the sample proportional respondents were computed as the total study population of each sampling frame divided to the total study population and then multiplied by a total calculated sample using the above formula and the results are summarized as shown in (Table 3.5 and 3.6).

Table 3.5: Proportional sample size determination for Office employees

No.	Target Population	Kebele	Total Number	Sample Size
1	Dukem town land development and management office Experts	-	67	55
2	Dukem town land development and management office Experts at kebele level	Melka Dukem	3	2
		Tedecha	3	2
		Koticha	2	1
		Gogecha	2	1
3	DTLDMO Officials	-	2	1
4	Kebele administrators	Melka Dukem	2	1
		Tedecha	2	1
		Koticha	2	1
		Gogecha	2	1
		Total	**87**	**66**

(Source: Organized by the author, (2020).

Table 3.6: Proportional sample size determination for communities (Hh CSA-2007 data)

No	Target Population	Kebele	Total Household	Sample Size
5	Community	Melka Dukem	1925	101
		Tedecha	1299	68
		Koticha	2487	130
		Gogecha	1540	80
		Total	**7251**	**379**

(Source: Organized by the author, (2020).

Table 3.7: Total sample size of survey from each target population

No	Target Population	Sample Size	Selection Method
1	Dukem town land development and management office Experts	55	Purposive (Priority for service seniority)
2	Dukem town land development and management office Experts at kebele	6	Purposive (Priority for service seniority)
3	Dukem town land development and management office Officials	1	Purposive (Priority for service seniority)
4	Kebele administrators	4	Purposive (Priority for service seniority)
5	Community	379	Purposive (lived for 15 years and above in Dukem town)
	Total	**445**	

(Source: Organized by the author, (2020).

Therefore, 445 respondents were considered for the survey from each kebele administrators, officials, experts of Dukem town land development and management office and communities in the town as indicated in the above (Table 3.7).

A purposive non-random sampling technique was used because there is a variety in service year so that priority was given to seniority and the communities selected were those who lived for 15 years and above in Dukem town, the reason is that they could describe changes resulted over time and believed to have rich information than other existing new settlers in the town.

3.8.4. Sample Years for Trend Analysis

In order to map urban expansion trends and measure its effects on LULC change of Dukem town, four periods of years 2003, 2008, 2013 and 2019 selected because during those periods the town expansion was very high and those years are critical boom period of change, for more clarification major reasons considered are specified in detail (Table 3.8).

Table 3.8: Criteria for the selection of years

No	Sample Year (Gc)	Selection Criteria/Reason
1	2003	To measure and show the level of urban expansion and land use land covers change before the town designation as an 'Industrial Hub' or 'Eastern Industry Zone (EIZ)' of the country in 2005.
2	2008	To measure and show the level of urban expansion and land use land covers (LULC) change within the development of various industries and manufacturing sectors in the town, following the development in industries the number of population rise due to employment opportunities.
3	2013	To measure and show the level of urban expansion and land use land covers (LULC) change within the development of Addis-Adama expressway and Ethio-Djibouti (HRT) heavy railway crossing the town constructed in 2011/2012, thus the town expanded along and towards these infrastructure development during this period.
4	2019	To measure and show the level of urban expansion and land use land covers (LULC) change after a massive residential land delivery undertaken by a town municipality in 2017/2018 especially for farmer household and their families who lose their agriculture land due to the development of huge industries and manufacturing. Accordingly, 227 farmer household earn 500m^2 and 635 farmer families above 18 years old earn 140 m^2 a total of 20.24 ha land was delivered. During this period Dukem town land development and management office also deliver land for public servants in cooperatives (Teachers, Municipal workers and others) 140m^2 lot of land.

(Source: Organized by the author, (2020)).

High resolution image and high quality cloud free images were selected and also the January season of the year is preferred to get cloud free images for ease of classification and facilitate comparison in classification activities.

3.9. Study Variables

In order to meet the aim of the study, to investigate urban expansion trends & its effects on land use land covers (LULC) change in the case of Dukem town, study variables such as background of respondents, urban expansion driving factors and actors, land use land cover (LULC) characteristics and rate of change were used.

The status or background of town community and government office employees (experts and officials) variables such as address, gender, age, place of birth, level of educations, qualification background, occupation, work place, work position and year of services in this position were studied.

The driving factors were considered in this study as determinants of urban expansion of Dukem town take different forms but the most obvious forces include nine (9) variables such as increase in population size, investment pressure in commerce and service, housing preference (demand of more living space and better housing condition, informal access to land, establishment of industries & manufacturing, development in road infrastructure & transportation, the prepared plans of the town, location of the town and topography of the town.

The key actors who contribute a lot for the expansion of Dukem town include six (6) variables such as Private Investors, Government officials, Experts (Workers), Community, Local Farmers and Land brokers

The land cover change detection characteristics were used for assessing the spatial and temporal land use land cover (LULC) change in the study area. Five (5) land use land cover (LULC) variables were selected for the purpose: built-up area, agricultural area, green area, bare land/open space and forest. The total areas covered by each class in each study year were calculated and the amount and rate of change for each land cover classes analyzed.

3.9.1. Types of Variables and Measuring Techniques

The types of variables were used for this study along with their analysis and measurement techniques are specified and presented in detail as shown in (Table 3.9).

Table 3.9: Description of the study Variables

No	Variables	Types of variables	Measuring Techniques
1	Address, Gender, Age, Birth place, Level of educations, Qualification background, Occupation, Work place, Work position and Year of services	Independent	Descriptive statistics graphs were used
2	-Increase in population size -Investment pressure in commerce & service -Establishment of industries & manufacturing -Dev't of road infrastructure & transportation -Housing preference -Informal access to land -The prepared plans -Location of the town -Topography of the town	Independent	Ranked data were five points of Likert scales from strongly agree to strongly disagree used and Descriptive statistics were used to describe their results
3	-Private Investors, -Government officials, -Experts, -Community, -Local Farmers and -Land brokers	Independent	Ranked data were five points of Likert scales from strongly agree to strongly disagree used and Descriptive statistics were used to describe their results
4	LULC characteristics: Built-up area, Agricultural land, Green area, Bare land and Forest	Dependent	Map, graphs and charts were used
5	Rate of change	Dependent	Graphs and charts were used

(Source: Organized by the author, (2020))

3.10. Data Processing Method

The activities were conducted under this portion include acquisition of satellite images for four years 2003, 2008, 2013 and 2019, image preprocessing, image classification and categorical map generation, accuracy assessment, LULC change detection and spatial expansion analysis.

3.10.1. Image Preprocessing

In Preprocessing, Satellite images were downloaded from Earth Explorer website USGS Landsat archive website and layers tacked after extracting the compiled file. Image collection and favorite of seasons are based on data availability and free from cloud coverage. After data acquisition, image to image geometric rectification done using satellite image acquired in 2003, 2008, 2013 & 2019 and using ArcGIS 10.2 images were re-projected and calibrated using Projection UTM Zone 37N, Datum WGS 1984 to make it fit with Landsat images and the study area.

Geometric rectifications, re-projection and clipping by the study area were performed for all images and Strip line removal analysis was performed repeatedly until the lines are removed and a clear image obtained. Study area image extraction or clipping the images using boundary shapefiles to get an image fit to the study area done to all images using ArcGIS 10.2 software.

3.10.2. Image Classification

After all the image preprocessing activities, one of the actual tasks of the study is image classification which is the basis for change detection activity. There are two methods for image classification. The first is Supervised image classification comprises picking pixels that characterizes land cover classes that are accepted by the specialist. The second is Unsupervised image classification which is more computer automated. It supports the specialist to specify some factors that the computer uses to reveal statistical patterns that are essential in the data (Tadesse et.al., 2001).

Due to related spectral features the application of unsupervised classification may not give decent consequences. As a result, supervised image classification was employed for this study. Supervised classification needs the selection of training areas to get precise classification output. It is strongly based on the quality and quantity of training samples to create decent quality classification results (Ahlam, 2017).

3.10.3. Accuracy Assessment

Previously, different image classification methods such as supervised and unsupervised classification were discussed. Accuracy assessment is a necessary activity after any satellite image classification investigation to know whether or not the classification process met its purposes. It refers to assessing the accuracy level of the final categorical map generated by image classification (Levin, 1999).

After classification of satellite images, Accuracy assessment is the final step in the analysis of remote sensing data which help us to verify how accurate our results are. It is carried out once the interpretation/classification has been completed. One such method is a contingency table (confusion matrix) which is produced from a random sample of individual pixels or clusters compared to "known" cover conditions over the same pixel areas. This can give us a percentage of 'correctness' of the classification result (Campbell, 1996).

On error matrix, the rows correspond to classes in the ground truth map, columns correspond to classes in the classification result and diagonal elements in the matrix represent the number of correctly classified pixels of each class. Off-diagonal elements represent misclassified pixels or the classification errors, i.e. the number of ground truth pixels that ended up in another class during classification. Off-diagonal row elements represent ground truth pixels of a certain class which were excluded from that class during classification. Such errors are also known as errors of omission or exclusion. Off-diagonal column elements represent ground truth pixels of other classes that were included in a certain classification class. Such errors are also known as errors of commission or inclusion (Anupam, 2017).

The most usually applied procedures of accuracy assessment include producer's accuracy, user's accuracy, overall accuracy and Kappa coefficient (Anupam, 2017). All of these procedures were applied to crisscross the performance of classification activities for the years from 2003 to 2019. The equations are adopted from Anupam, (2017) & Congalton, (1991).

i. Accuracy or Producer's Accuracy

Producer's accuracy is defined as the probability that any pixel in that category has been correctly classified (Anupam, 2017). It is calculated as shown in (Equation 1).

$$\textbf{Producer's Accuracy \%} = \left[\frac{\text{Total number of correct pixels in a category}}{\text{Total number of pixels of that category derived from the reference data (i.e., row total)}} \right] 100 \quad \text{...Eq. (1)}$$

ii. Reliability or User's Accuracy

User's accuracy is defined as the probability that a pixel classified on the image actually represents that category on the ground (Anupam, 2017). It is calculated as shown in (Equation 2).

$$\textbf{User's Accuracy \%} = \left[\frac{\text{Total number of correct pixels in a category}}{\text{Total number of pixels of that category derived from the classified data (i.e., column total)}}\right] 100\ \%\text{.....Eq. (2)}$$

iii. Overall Accuracy

The collective accuracy of map for all the classes can be described using overall accuracy, which calculates the proportion of pixels correctly classified (Anupam, 2017). The overall accuracy is calculated as shown in (Equation 3).

$$\textbf{Overall Accuracy \%} = \left[\frac{\text{Sum of the diagonal elements (true samples)}}{\text{Total number of accuracy sample pixels}}\right] 100\ \%\text{...Eq. (3)}$$

iv. KAPPA Coefficient

Overall accuracy is a measure of accuracy for the entire image across all classes; it ignores off-diagonal elements such as errors of omission and commission. Further, it is difficult to compare different overall accuracy values if different number of accuracy sites were used. This paves way for use of other accuracy assessment methods which is more commonly used method known as Kappa analysis, in which off-diagonal elements are incorporated as a product of the row and column marginal totals (Anupam, 2017).

Kappa analysis generates a kappa coefficient or K_{hat} statistics, the values of which range between 0 and 1. Kappa coefficient (K_{hat}) is a measure of the agreement between two maps taking into account all elements of error matrix (Anupam, 2017). It is defined in terms of error matrix as shown in (Equation 4).

K_{hat} = (Obs – exp) / (1 – Exp)…….....Eq. (4)

Where, Obs = Observed correct, it represents accuracy reported in error matrix (overall accuracy) Exp = Expected correct, it represents correct classification.

3.10.4. Land Use Land Cover (LULC) Classes

During the classification process, it is rare to find clearly defined classes that one would like. Before collecting training samples, the land cover classes should be known so as to make the classification easier. This study has been established its own classification scheme based on visual interpretation of satellite images. Therefore, as the main objective of the study is change detection of land-use/ Land cover and measuring urban expansion of Dukem town, five (5) LULC main categories were selected for the purpose: built-up area, agricultural area, green area, bare land/open space and forest as shown in (Table 3.10).

Table 3.10: Land-use land-cover (LULC) categories applied for classification in the study

No.	Landuse Category	Description
1	Built-up Area	Areas covered by include all developed areas roads, buildings, housing units, commercial and resident areas, under construction areas, industries and manufacturing etc.
2	Agricultural Area	Areas covered by include all areas employed for agricultural activities farmland and crop (grazing).
3	Green Area	Areas covered by vegetation of any type, including vegetation and other pockets of green areas.
4	Bare land	Areas covered by open spaces with little or no vegetation, sands, rocky areas and fenced land for investment purpose i.e., not built
5	Forest	Areas covered by trees forming closed or nearly closed canopies

(Source: Organized by the author, (2020))

3.11. Data Analysis Methods

Data analysis methods such as trend analysis, LULC change detection analysis, spatial expansion rate analysis and qualitative data analysis of analysis were used.

3.11.1. Trend Analysis

In order to map urban expansion trends and measure its effects on land use land covers (LULC) change of Dukem town, four periods of years 2003, 2008, 2013 and 2019 were selected because during those periods the town expansion was very high and those years were critical boom period of change. The urban expansion maps of the study area was created using ArcGIS 10.2.2 analysis tools. Using Georeferencing techniques, Landsat TM was Georeferenced and finally clipped with the existing shape file of the study area. Different land use categories are dictating from the satellite imageries.

In the process of screen digitizing some features in the imageries may not properly identified, so to solve such problem images of the study area were processed based on the visual elements or characteristics of satellite image interpretation techniques of the, i.e. patterns, tones, textures, shapes, shadow, association and aspect of the features to derive information about LULC features. The acquired land use statistics data were presented and analyzed by using tables, figures, charts and reports.

3.11.2. LULC Change Detection Analysis

After determining the land cover features in the image processing, image classification and categorical map generation, reclassification section, the next step is land cover change detection (LULC) change detection and spatial expansion analysis. Land cover change detection is the process of assessing the spatial and temporal land use/ land cover change in the study area (Ahlam, 2017).

It is the identification of variations in land cover types by observing a specified area at different times using multi-temporal data sets from satellite images (Sewunet, 2017). Spatial-temporal satellite images of a specified geographic area were processed and classified to produce thematic maps for 2003, 2008, 2013 and 2019 then the classified maps were compared and overlaid to visualize the changes on the area in the span of time.

It is also possible to compute the amount of increase or decrease of each category and see the change in percent in each year using the following formula (Sewunet, 2017) as shown in (Equation 5).

$$\textbf{Change in \%} = \left[\frac{\text{Total Area in } T_2 - \text{Total Area in } T_1}{\text{Total Area in } T_1}\right] 100\ \% \quad \text{……...….Eq. (5)}$$

Where T_1 is earlier point of time and T_2 is the later or recent point of time in the series.

3.11.3. Spatial Expansion Rate Analysis

The dynamic degree of spatial structure is an indicator that can reflect rate of spatial expansions and were calculated using the formula (Sewunet, 2017) as shown in (Equation 6).

$$\textbf{DC} = \left[\frac{BA_2 - BA_1}{BA_1} \quad X \quad \frac{1}{T2 - T1}\right] 100\ \% \quad \text{…….…….Eq. (6)}$$

Where DC is the dynamic change rate of urban expansion for a period, T1 and T2 are specific years, BA_1 is total built-up area at time T_1, and BA_2 is total built-up area at T_2.

The total areas covered by each class in each study year will be calculated and the amount and rate of change for each land cover classes should be analyzed.

3.11.4. Future Built-up Area Computation

Exponential Growth Model (EGM) is used to make future predictions of urban built areas (Dean, 2013). Accordingly, In order to compute the future built up area growth of Dukem town, it is compulsory to calculate average growth rate. So based on the urban expansion of town form 2003-2019 years the average growth rate of the expansion has been calculated using exponential growth model formula as shown in (Equation 7 and 8).

$Bf = Bo\ e^{rt}$ -------> $r = \frac{1}{t} * \ln\left(\frac{Bf}{B_0}\right)$ ……..…….Eq. (7)

Where: Bf = current built up, Bo = initial built up, r = growth rate and t = Time (year)

$Bf = Bo * (1+\%/100)^{t\,(f-o)}$ ……...…….Eq. (8)

Where: B = Built-up area, f = future year, o = initial/base year, % (r) = average growth rate per year and t = time in year

3.11.5. Future Population Size Forecast

Exponential growth population model is possible to construct an exponential growth model of population, which begins with the assumption that the rate of population growth is proportional to the current population (Dean, 2013). To calculate population size of an area ought to known population an exponential growth rate model was applied as shown in (Equation 9).

$Pt = Po*(1+r/100)^{t}$ ……..…….…….Eq. (9)

Where: Pt = population at time required, Po = Current population, r = Rate of population growth and t = Projection time

3.11.6. Qualitative Data Analysis

Open-ended questions for respondents to express their concerns, or comments which are not included in the closed-ended questions related to the driving factor and key actor's contributed a lot for the rapid expansion of Dukem town. Accordingly, the questionnaires were distributed purposively for all the sample respondents along with close-ended questionnaires.

On the other hand, it is also believed that, it helps to triangulate the response provided by close-ended question concerned to the driving factor and key actor's contributed a lot for the rapid expansion of Dukem town with their responses of open-ended question. For the analysis of these data, the response was grouped and coded according to their concern into major themes. These themes identified were analyzed along with the result of close-ended questionnaires based on the relationships of their concern.

3.12. Tools and Software Programs

The character of this study is analyzing of urban expansion trends & its effects on land use land covers (LULC) change detection, so mainly ArcGIS 10.2 software program was used for data processing and urban expansion trends measurement in this study and the details of tools and software programs were used are shown in (Table 3.11).

Table 3.11: Tools and Software programs were used for the study

No.	Software & Tools	Function
1	ArcGIS 10.2.2	To create shape file, identify path and row of the study area, data analysis, management, geo-referencing, image processing, enhancement, transformation, classification, delineation and clipping and make layout for final mapping.
2	Remote Sensing Techniques (RST)	To detection of land use land covers (LULC) change in different period of time
3	USGS website	The source of satellite image free of charge
4	SPSS	To process, manage and analyze the statistical data's collected
5	Camera	To capture ground images
6	Micro-soft excel	To perform different statistical calculations.
7	Micro-soft word	To write the study paper
8	Adobe-Illustrator	To illustrate graphics

(Source: Organized by the author, (2020))

3.13. Validity of Methods and Materials

The validity of the methods, materials and an outcome of the thesis result are ensured by taking the following safeguards. The results were obtained from the combined use of both quantitative and qualitative methods simultaneously increase the value of the conclusion.

Referring other researchers work and discussion with advisors and experts on issues that require expertise and also crosschecking information's and data's were carried out through survey questionnaires with information gathered from the concerned offices and community of the town, also different composed Dukem town profiles, prepared and published materials on the subject matter. Almost all of office respondents are professionals or experts in their specific program they are more close to the issue, so this help the researcher for the reliability and validity of information generated.

Furthermore, remote sensing provides consistent historical time series data; spatial and temporal dynamics of the processes in urban growth and land use change (Herold et.al., 2003). Recently, remote sensing has been used in combination with Geographical Information Systems (GIS) to assess land cover change more effectively (Weng, 2002). Therefore, the method has been already proved by different scholar's, in which its useful in mapping urban areas, and as data source for the analysis and modelling of urban growth and land use land cover (LULC) changes.

Additionally, Assessing accuracy for each category as well as for the whole image is essential to compare the results of various classification techniques and quality and reliability of the results obtained. Sampling size is also an important consideration for accuracy assessment and sufficient numbers of samples were taken which ranges between 35 and 105 pixel samples for each class. Moreover, for accuracy assessment of the classified images ground truth (physical survey) and high resolution Orthopoto were used for further clarity and validity of the data.

CHAPTER FOUR

4. RESULT AND DISCUSSION

4.1. Introduction

This chapter discussed the main findings of the study concerning urban expansion trends & its effects on land use land covers (LULC) change. The results were discussed in the aim to achieve objective of the study, which is mapping urban expansion trends and measuring its effects on LULC change of Dukem town using Remote Sensing & GIS techniques between 2003 and 2019.

Dukem is rapidly expanding since its delineation to industrial zone. In this study, an attempt has been made to compute the built up expansion of the town from 2003 to 2019. To quantify the magnitude of urban area expansion satellite images were used. The study is focused on the delineated Dukem town boundary. This covers a total area of about 4,245 hectare. The study is also estimated the future growth direction of the town for the coming year 2030.

Furthermore, this chapter discusses the status of sample respondents and then data's were presented, analyzed, interpreted which collected from Dukem town land development and management office, kebele administration, municipality of the town and OUPI. The respondents surveyed and interviewed such as Dukem town land development and management office experts and officials, kebele administrators and community of the town through conducting closed-ended and open-ended questionnaires.

Accordingly, out of the planned 445 (66 from office employees and 379 from communities) 388 (61 from office employees and 327 from communities) were surveyed face to face from all four kebeles in the town**.** Among the 388 respondents all of them attempted all the close-ended survey questionnaires properly, and 82 (39 from office employees and 43 from communities) of them also attempted the open-ended questionnaires of the survey. While data collection the researcher had made a strong effort to normalize data quality through giving priority for service seniority, level of educations, educational qualification background, place of work, work position and year of services in the position.

4.2. Historical Background of Dukem town

Urban settlements usually emerge as the result of people's permanent settlements around religious, political centers, trade and other economic activities. As such the emergence of Dukem, as an urban center, owes to the construction of railway line from Dijoubuti to Addis Ababa in the late ninetieth century.

Accordingly, Dukem began to mushroom in the beginning from 1914 but as the site was under the land lords tenancy, not either parceled into formal urban settlement under the municipal administration, such cases as issuance of trade license, taxation and other related matters were conducted and managed under Bishoftu town municipality. Those people who wanted to get land for different development purposes in Dukem urban settlement were provided from the land lords, as tenants. Houses in the town also belonged to the absentee landlords (OUPI, 2017).

Then, the 1974 popular revolution had changed the land tenure system in the country at large and thus changed the land tenure in Dukem and its surroundings. Although there were some progress in urban development during the revolutionary Derg period no fundamental transformation has taken place in this regard until the fall of the socialist military rule in 1991. Dukem has emerged as one of an industrial urban center in the region and the country at large since the beginning of 2000s and known as the Eastern Industrial Zone (EIZ). It is one of the urban centers under reform by virtue of the proclamation 65/1995 EC (2003). The town is expanding to a large extent encompassing the rural villages of Waajitu and Dibdibbe, Yaatu and Oda Nabe in the present plan boundary. The name Dukem is derived from the Oromo term ‘deeme or Sokke’ (went out) or Duukaa deemuu, Duukaa kaachu (OUPI, 2017).

4.3. Trend Detection Mapping

The results were discussed in the aim to achieve objective of the study, which is mapping urban expansion trends and measuring its effects on LULC change of Dukem town. To quantify the magnitude of urban area expansion satellite images were used. Accordingly, trend or change detection has been done first by image preprocessing (un-supervised) and then image processing (supervised).

4.3.1. Un-Supervised Change Detection

Image preprocessing or un-supervised land use land covers (LULC) change of Dukem town maps were produced for the periods of year 2003, 2008, 2013 and 2019 as presented in (Figure 4.1). Un-supervised satellite images of Dukem town at different years to assess urban expansion and changes were obtained using remote sensing from Earth Explore USGS Landsat web site. Accordingly, Landsat-7 images of 2003 & 2008 and Landsat-8 images of 2013 & 2019 were used based on its availability. Image selection and preference of seasons was based on, one for its free availability of the data and the other it was free from cloud coverage. Activities such as image clipping by the study area, re-projection, and image resolution merge were done for all images.

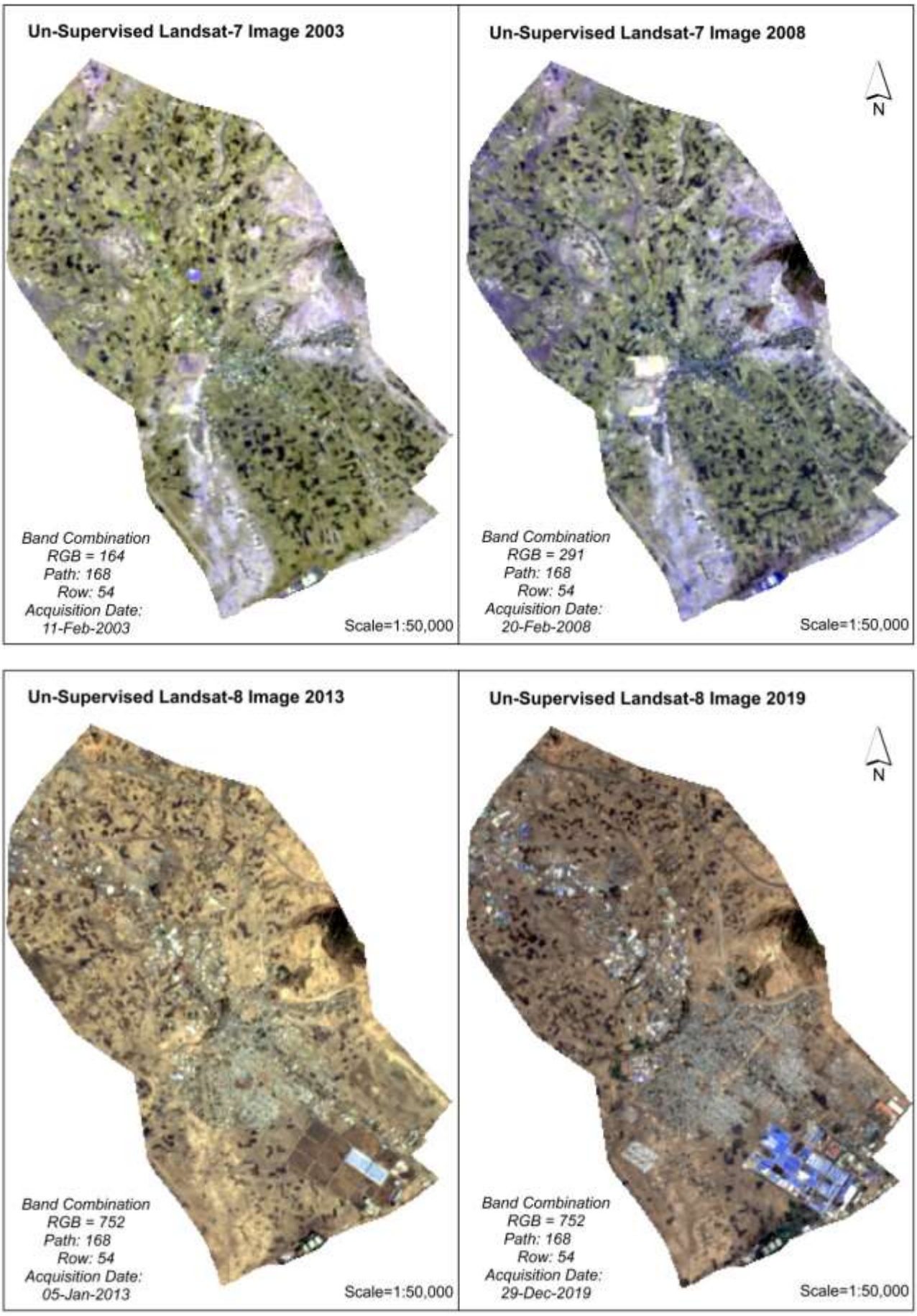


Figure 4.1: Showing Un-Supervised Landsat-7 images of 2003 & 2008 and Landsat-8 images of 2013 & 2019 (Source: Organized by the author (2020)).

4.3.2. Supervised Change Detection

Image processing or supervised land use land covers (LULC) change of Dukem town maps were produced for the periods of year 2003, 2008, 2013 and 2019 as presented in (Figure 4.2). These maps show built-up area with gray color, the light yellow is agricultural area, the purple color is barren land, the green color shows green areas and the dark green color shows forest area.

The change in areal coverage for each periods of year from 2003 to 2019 is clearly presented on the maps. At the beginning in 2003, Dukem town occupied only small area at the center of the town. The result also shows that there was no much change in years between 2003 and 2008 but the town began to expand a little bit towards the north to Addis Ababa city and to the south Bishoftu town following the major asphalt road of eastern corridor.

The growth of the town dramatically changed between the years 2008 and 2013 following the development of Eastern Industry Zone (EIZ) and Ethio Djibouti Heavy Railway line pass in the town was a major development activity that contributed a lot for the growth of Dukem town during those periods.

The growth of the town continued between the years 2013 and 2019 particularly infill developments in terms of residential development. Generally, as shown in (Figure 4.2) the town has been grown intensely in all directions between the years 2008 and 2019. Built-up area were increased dramatically from 698.06 hectares (16.45%) in 2003 to 3,091.67 hectares (72.81%) in 2019 this indicated that built areas consuming a considerable amount of other land use land cover (LULC) types while agricultural land extremely decreased in all years from 2,764.37 hectares (65.12%) in 2003 to 999.05 hectares (23.53%) in 2019 which indicating its highest contribution to built-up areas. The trend of other categories varies increasing and decreasing at various times particularly a lot in the past eleven (11) years.

Furthermore, The increase in barren land in 2013 was the result of land taken by investors but not developed yet and due to the existence of areas like rock and gully areas which area unsuitable for agricultural areas, but this decreased later dramatically in 2019 showing the utilization of these areas for agricultural land and its conversion into built-up areas.

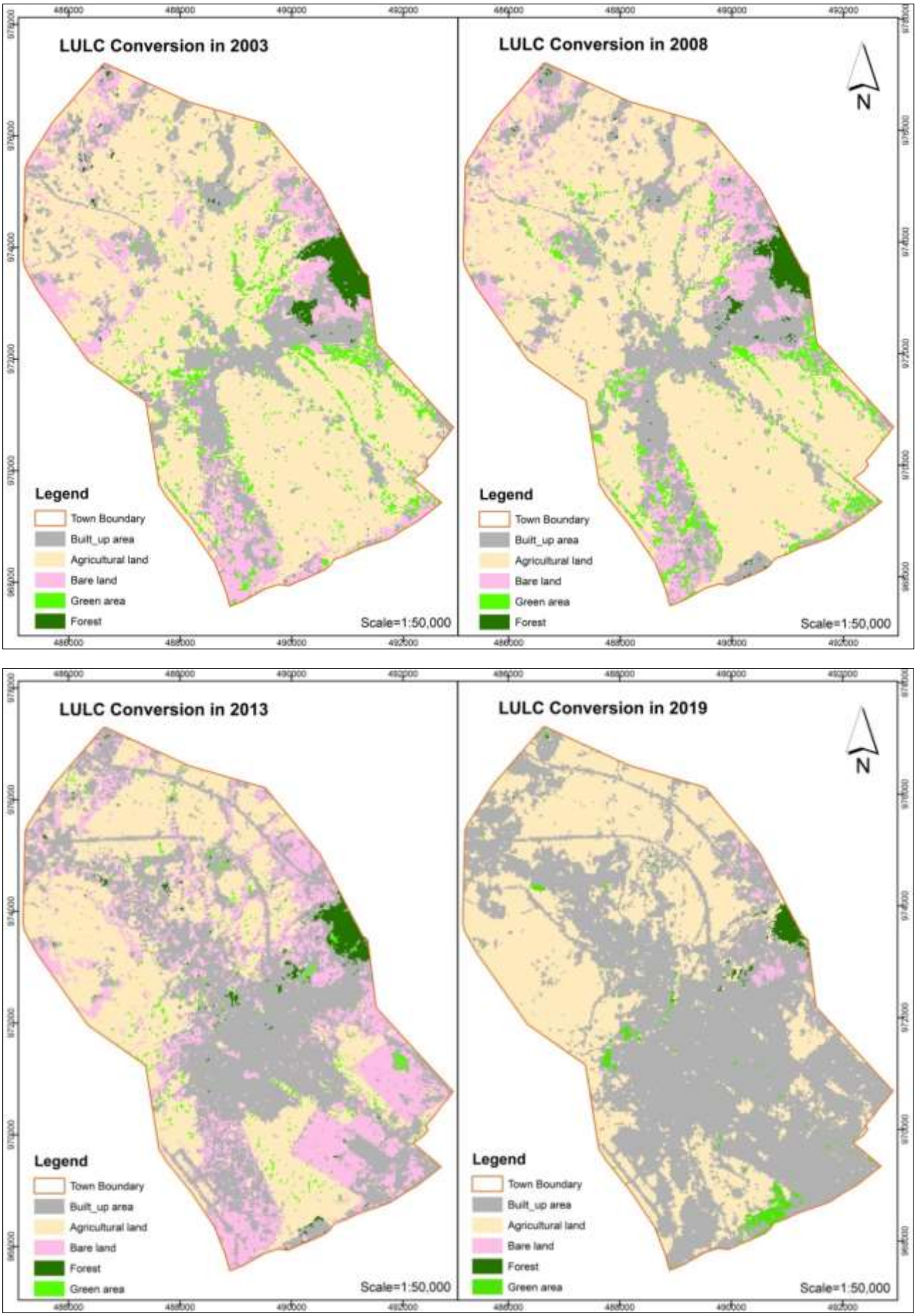


Figure 4.2: Showing Supervised LULC Conversion in 2003, 2008, 2013 and 2019 (Source: Organized by the author (2020))

4.3.3. Accuracy Assessment

A map using remotely sensed or other spatial data cannot be regarded as the final product without taking necessary steps towards assessing accuracy or validity of that map (Congalton, 1991). Assessing accuracy for each category as well as for the whole image is essential to compare the results of various classification techniques and quality and reliability of the results obtained. Sampling size is an important consideration for accuracy assessment and sufficient number of samples was taken which ranges between 35 and 105 pixel samples for each classes. Moreover, for accuracy assessment of the classified images ground truth (physical survey) and high resolution Orthopoto were used for further validity of the data.

To compute accuracy, an error matrix is created to show the difference between classified categorical maps and their conforming actual reference maps. The error matrix or confusion metrics is an array of values allocated to a specific category in the reference data and the classified map to be assessed in the table. The rows in the table represent the categories of reference image or data while columns represent for the categories of classified image or map in the error matrix as presented in (Tables 4.1 - 4.4).

The values along the diagonal represent the number of correctly classified points or true sample pixels. All non-zero values off the diagonal show discrepancy of the classified image and reference image which is error of omission (processing error) and commission (command error). Commission errors are incorrect inclusions and specify number of points whose pixels incorrectly included to column categories but omission errors are incorrectly excluded pixels from row categories. Next calculation for producer's accuracy, user's accuracy, overall accuracy and kappa statistics were discussed in detail.

i. Producer's Accuracy

The producer's accuracy informs the image analyst of the number of pixels correctly classified in a particular category as a percentage of the total number of pixels actually belonging to that category in the image and calculated by using (Equation 1). Accordingly, the results showed the minimum producer's accuracy result for the study was showed that 84.40%, 88.40%, 86.84% and 89.28% for the year 2003, 2008, 2013 and 2019 classification maps or results respectively. The producer's accuracy for other categories varies between 84.40% and 97.00% for all years which indicates that the classification performances were reliable and the results are acceptable (sees also Tables 4.1 - 4.4).

ii. User's Accuracy

The user's accuracy is computed using the number of correctly classified pixels to the total number of pixels assigned to a particular category. It is the probability that a pixel classified on the image actually represents that category on the ground and calculated by using (Equation 2). Accordingly, the results showed that user's accuracy varies between 84.26% and 93.47% for the year 2003, 83.56% and 96.15% for the year 2008, 85.45% and 95.74% for the year 2013 and 90.90% and 95.45% for the year 2019. Therefore, the results in both producer's and user's accuracy indicated that the performance of image and its classification was achieved very well and the error margins are within acceptable accuracy (sees also Tables 4.1 - 4.4).

Table 4.1: Accuracy assessment results of the year 2003

		Classified Image						
		Agri. land	**Barren land**	**Built-up area**	**Forest**	**Green area**	**Row Total**	**Producer's Accuracy (%)**
Reference Image	**Agri. land**	**92**	9	5	2	1	**109**	**84.40**
	Barren land	1	**104**	1	0	7	**113**	**92.03**
	Built-up area	0	7	**86**	0	0	**93**	**92.47**
	Forest	5	0	0	**63**	6	**74**	**85.13**
	Green area	1	0	0	5	**75**	**81**	**92.59**
	Column Total	**99**	**120**	**92**	**70**	**89**	**470**	
	User's Accuracy (%)	**92.92**	**86.66**	**93.47**	**90.00**	**84.26**		

(Source: Satellite image analysis of 2003 using GIS (2020))

Table 4.2: Accuracy assessment results of the year 2008

		Classified Image						
		Agri. land	**Barren land**	**Built-up area**	**Forest**	**Green area**	**Row Total**	**Producer's Accuracy (%)**
Reference Image	**Agri. land**	**75**	4	1	0	2	**82**	**91.46**
	Barren land	2	**61**	5	0	1	**69**	**88.40**
	Built-up area	0	7	**102**	0	0	**109**	**93.57**
	Forest	2	0	0	**50**	2	**54**	**92.60**
	Green area	1	1	0	2	**35**	**39**	**89.74**
	Column Total	**80**	**73**	**108**	**52**	**40**	**353**	
	User's Accuracy (%)	**93.75**	**83.56**	**94.44**	**96.15**	**87.50**		

(Source: Satellite image analysis of 2008 using GIS (2020))

Table 4.3: Accuracy assessment results of the year 2013

		Classified Image						
		Agri. land	**Barren land**	**Built-up area**	**Forest**	**Green area**	**Row Total**	**Producer's Accuracy (%)**
Reference Image	**Agri. land**	**56**	1	0	2	1	**60**	**93.33**
	Barren land	2	**90**	5	0	1	**98**	**91.84**
	Built-up area	0	3	**82**	0	0	**85**	**96.47**
	Forest	1	0	0	**47**	2	**50**	**94.00**
	Green area	4	0	0	6	**66**	**76**	**86.84**
	Column Total	**63**	**94**	**87**	**55**	**70**	**369**	
	User's Accuracy (%)	**88.88**	**95.74**	**94.25**	**85.45**	**94.28**		

(Source: Satellite image analysis of 2013 using GIS (2020))

Table 4.4: Accuracy assessment results of the year 2019

		Classified Image						
		Agri. land	**Barren land**	**Built-up area**	**Forest**	**Green area**	**Row Total**	**Producer's Accuracy (%)**
Reference Image	**Agri. land**	**97**	2	0	1	0	**100**	**97.00**
	Barren land	3	**88**	4	0	1	**96**	**91.66**
	Built-up area	1	6	**105**	1	1	**114**	**92.10**
	Forest	1	0	0	**77**	3	**81**	**95.06**
	Green area	3	0	1	2	**50**	**56**	**89.28**
	Column Total	**105**	**96**	**110**	**81**	**55**	**447**	
	User's Accuracy (%)	**92.38**	**91.66**	**95.45**	**95.06**	**90.90**		

(Source: Satellite image analysis of 2019 using GIS (2020))

iii. Overall Accuracy

The combined accuracy of map for all the classes can be described using overall accuracy, which calculates the proportion of pixels correctly classified (Anupam, 2017). Accordingly, an overall accuracy was calculated using (Equation 3) and the results showed that 89.36%, 91.50%, 92.41% and 93.28% for the year 2003, 2008, 2013 and 2019 classified maps respectively.

iv. Kappa Analysis

Kappa analysis generates a kappa coefficient or statistics. It is a measure of the agreement between two maps taking into account all elements of error matrix. The values are varies between 0 and 1 and thus the results converging to 1 show excellent conformation between

the classified map and reference image. Accordingly, It was calculated using (Equation 4), an overall kappa statistics results indicated 0.87, 0.89, 0.9 and 0.91 for the year 2003, 2008, 2013 and 2019 classification maps respectively. Therefore, Kappa coefficient of 0.87, 0.89, 0.9 and 0.91 implies that the classification process was avoiding 87%, 89%, 90% and 91% of the error that a completely random classification would generate.

4.3.4. Land use Land covers (LULC) Analysis

4.3.4.1. Land use Land cover (LULC) in 2003

As presented in (Table 4.5) and (Figure 4.2), land use/land cover (LULC) of Dukem town in quantity and map respectively. In this year (2003) agricultural land cover was the highest coverage 2764.37ha (65.12%) of the total area in the town boundary. Also, a relatively considerable amount of the area was covered by built-up areas 698.06ha (16.45%) followed by barren land 502.27ha (11.83%), green 189.92ha (4.47%) and forest 90.56ha (2.13%).

Table 4.5: Area and percentage coverage land use land cover (LULC) of 2003

No.	**LULC (Land use land cover type)**	**Area coverage in hectare & Percentage**	
		Area coverage in Ha	Area coverage in %
1	Built-up area	698.06	16.45
2	Agricultural land	2764.37	65.12
3	Barren land	502.27	11.83
4	Green area	189.92	4.47
5	Forest	90.56	2.13
	Total	4245.18	100

(Source: Satellite image analysis of 2003 using GIS (2020))

4.3.4.2. Land use Land cover (LULC) in 2008

In this year (2008), the settlement of Dukem town was slowly expanded since many industries were on the process of establishment in the town. Similar to the year 2003 the land use land cover classes that covered the highest share of total area were agricultural land which was about 2578.43ha (60.73%) of the total area in the town boundary. Likewise, a relatively considerable amount of the area was covered by built-up areas 998.09ha (23.51%) followed by barren land 481.02ha (11.34%), green 104.01ha (2.45%) and forest 83.83ha (1.97%) see also (Table 4.6 and Figure 4.2).

Table 4.6: Area and percentage coverage land use land cover (LULC) of 2008

No.	LULC (Land use land cover type)	Area coverage in hectare & Percentage	
		Area coverage in Ha	Area coverage in %
1	Built-up area	998.09	23.51
2	Agricultural land	2578.43	60.73
3	Barren land	481.02	11.34
4	Green area	104.01	2.45
5	Forest	83.83	1.97
	Total	4245.38	100

(Source: Satellite image analysis of 2008 using GIS (2020))

4.3.4.3. Land use Land cover (LULC) in 2013

After 10 years in 2013 the land use land cover (LULC) of the study area was intensely changed. Built-up area during this period covered the highest share of total area which was about 1600.15ha (37.69%), followed by agricultural land and barren land which was 1577.14ha (37.14%) and 936.29ha (22.05%) respectively. The increase in barren land in this year (2013) was the result of land taken by investors but not developed yet and due to the existence of areas like rock and gully areas which area unsuitable for agricultural areas. Others, forest and green land constitute the smallest portion of the total area in the town boundary which was 69.48ha (1.64%) and 62.74ha (1.48%) respectively.

During this period (2013) the town was highly expanded to the surrounding rural areas since many industries were established in the western and southern part of the town and numerous constructional activities were taking place, those was a factor responsible for the built up area expansion of Dukem town during this period. Economically in search of job high number of population were migrating from different part of the country to the town. Thus, rapid population growth for economic purpose to employ in industries was the major. Furthermore, the emergences of strong transport linkage are new National Railway Line (HRT) crossing the town, Express way and Highway line passing through Dukem and its region was one of the factors for the expansion of the town to its surrounding region in 2013.

When it was compared with the year 2008 land use land cover (LULC), the town has undergone significant alterations and changes because an agricultural land were converted in to other land use land cover (LULC) classes. In general in this year, the remain land use land cover classes showed considerable decreased, while built-up area showed increased compared to the land use land cover (LULC).

Table 4.7: Area and percentage coverage land use land cover (LULC) of 2013

No.	LULC (Land use land cover type)	Area coverage in hectare & Percentage	
		Area coverage in Ha	Area coverage in %
1	Built-up area	1600.15	37.69
2	Agricultural land	1577.14	37.14
3	Barren land	936.29	22.05
4	Green area	62.74	1.48
5	Forest	69.48	1.64
	Total	4245.80	100

(Source: Satellite image analysis of 2013 using GIS (2020))

4.3.4.4. Land use Land cover (LULC) in 2019

During this year (2019), the land use land cover (LULC) change of the town was dramatically changed. Built-up area was the dominant land use land cover (LULC) constituted about 3091.67ha (72.81%). The remaining portion of the area in the town boundary was covered by other LULC classes agricultural land, barren land, green area and forest which was 999.05ha (23.53%), 77.01ha (1.82%), 49.27ha (1.16%) and 28.91ha (0.68%) respectively. It was the year at which extensive land use land cover change dynamics was experienced in the town. Agricultural land strictly declined to 999.05ha (23.53%). On other hand, built-up area indicated the peak rate of increased by 3091.67ha (72.81%). The remain land use land cover classes showed dramatically declined and changed in to built-up areas over these 16 years. The accelerated increment of built-up area at the expense of other land use land covers (LULC) was attributed to the alarming rate growth of the town.

Table 4.8: Area and percentage coverage land use land cover (LULC) of 2019

No.	LULC (Land use land cover type)	Area coverage in hectare & Percentage	
		Area coverage in Ha	Area coverage in %
1	Built-up area	3091.67	72.81
2	Agricultural land	999.05	23.53
3	Barren land	77.01	1.82
4	Green area	49.27	1.16
5	Forest	28.91	0.68
	Total	4245.91	100

(Source: Satellite image analysis of 2019 using GIS (2020))

4.3.5. Change Comparison from 2003-2019

Furthermore, to compare and contrast the difference in each land use land cover (LULC) dynamics between the years 2003 and 2019, the total area in hectare (ha) covered by each land use land cover (LULC) change and its percentage in the land were also considered and performed using GIS in through calculating the area each category covered on the earth to quantify the amount of change as shown in (Table 4.9). The total area of each category calculated in hectares and in percentage for each year.

Table 4.9: Total amount of land in hectares for each category from 2003-2019

	LULC (Land use land cover type)	Years and Area coverage in hectare & Percentage							
		2003		2008		2013		2019	
		Area	%	Area	%	Area	%	Area	%
1	Built-up area	698.06	16.45	998.09	23.51	1600.15	37.69	3091.67	72.81
2	Agricultural land	2764.37	65.12	2578.43	60.73	1577.14	37.14	999.05	23.53
3	Barren land	502.27	11.83	481.02	11.34	936.29	22.05	77.01	1.82
4	Green area	189.92	4.47	104.01	2.45	62.74	1.48	49.27	1.16
5	Forest	90.56	2.13	83.83	1.97	69.48	1.64	28.91	0.68
	Total	4245.18	100	4245.38	100	4245.80	100	4245.91	100

(Source: Analysis of satellite imageries of 2003, 2008, 2013 and 2019 using GIS (2020))

As presented in the above (Table 4.9) the total area of built-up class increased dramatically from 698.06 hectares (16.45%) in 2003 to 3,091.67 hectares (72.81%) in 2019 while agricultural land extremely decreased in all years from 2,764.37 hectares (65.12%) in 2003 to 999.05 hectares (23.53%) in 2019 which indicating its highest contribution to built-up areas. The trend of other categories varies increasing and decreasing at various times. The increase in barren land in 2013 was the result of land taken by investors but not developed yet and due to the existence of areas like rock and gully areas which area unsuitable for agricultural areas, but this decreased later dramatically in 2019 showing the utilization of these areas for agricultural land and its conversion into built-up areas. This is presented graphically so that the trend of all categories can be seen more clearly as shown in (Figure 4.3) in line graph.

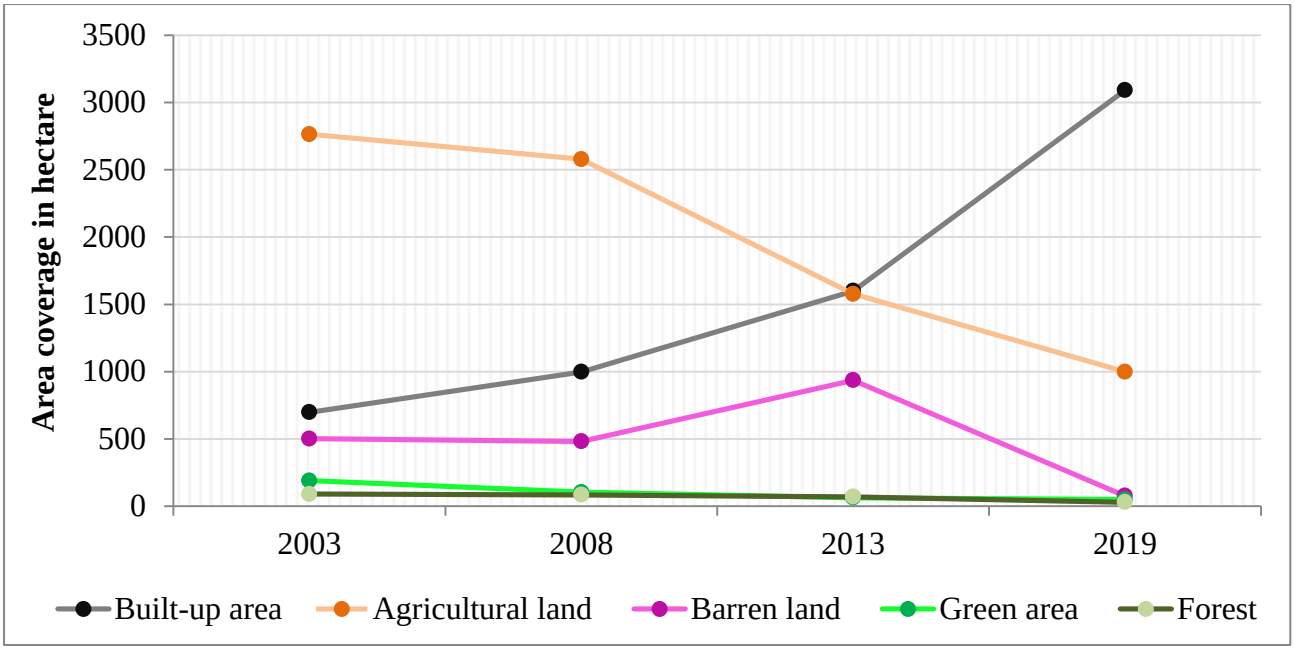


Figure 4.3: Graph of total area for all land use land cover classes from 2003–2019

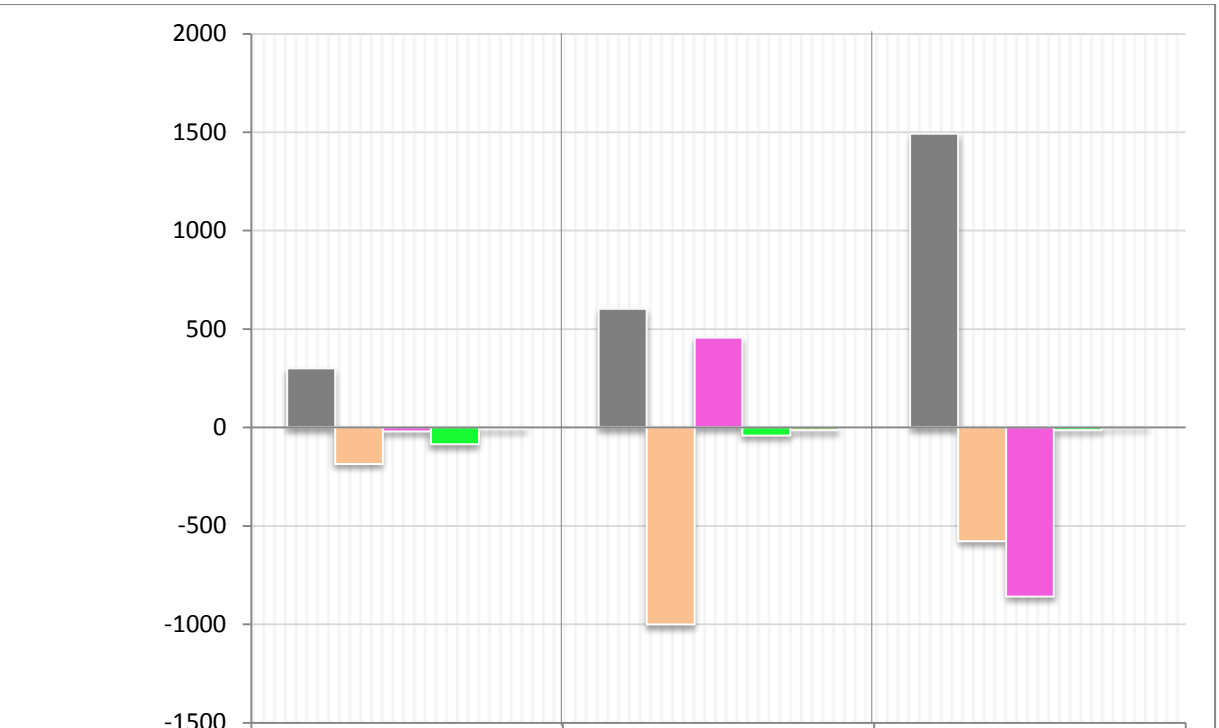
Figure 4.4: Showing conversion of agricultural land in to built-up areas in Tedecha kebele (Source: Own photo, 2020)

The change in percent, the amount of increase (positive) and decrease (negative) in each year were also computed. As presented in the below (Table 4.10 and Figure 4.5) shows the result of change in percent for each categories as calculated using (Equation 5).

Table 4.10: Change in percent in time series analysis from 2003-2019

	LULC (Land use land cover type)	Change (2003-2008)		Change (2008-2013)		Change (2013-2019)	
		Area (ha)	%	Area (ha)	%	Area (ha)	%
1	Built-up area	300.03	42.98	602.06	60.32	1491.52	93.21
2	Agricultural land	-185.94	- 6.73	-1001.29	-38.83	-578.09	-36.65
3	Barren land	-21.25	-4.23	455.27	94.65	-859.28	-91.77
4	Green area	-85.91	-45.23	-41.27	-39.68	-13.47	-21.47
5	Forest	-6.73	-7.43	-14.35	-17.12	-40.57	-58.39

(Source: Own computation using Equation 5 (2020))



	Change (2003-2008)	Change (2008-2013)	Change (2013-2019)
Built-up area	300.03	602.06	1491.52
Agricultural land	-185.94	-1001.29	-578.09
Barren land	-21.25	455.27	-859.28
Green area	-85.91	-41.27	-13.47
Forest	-6.73	-14.35	1.64

Figure 4.5: Change in percent in time series analysis from 2003-2019

The above result shows that built up area were increased by 300.03 hectare (42.98%) from 2003–2008, 602.06 hectare (60.32%) from 2008–2013 and 1491.52 hectare (93.21%) from 2013–2019. While agricultural land declined by 185.94 hectare (6.73%) from 2003–2008, 1001.29 hectare (38.83%) from 2008–2013 and 578.09 hectare (36.65%) from 2013–2019. Predominantly, the major change took place in the past eleven year's shows that highest expansion of the town. On the other hand, other categories mainly barren land, green areas and forest showed a slightest decrease. This indicated that an agricultural land was the main contributor to the built up area (see also Table 4.10 and Figure 4.5).

4.3.6. Change in Built-up Area (2003-2019)

The change in built-up area between the year 2003 and 2019 were mapped and compared to find the changes by visualizing all the classification results separately in single map to show the expansion of built-up area in each year. The change in each year were shown on the map with the green color representing the built-up area for 2003, the red color for 2008, the yellow color represents the growth of built-up area in 2013 and the orange color represents the profound expansion of built-up area in 2019.

The expansion of built-up area from 2013 to 2019 was very special in that it covered almost double growth of the town and increased by a large amount of land which indicated rapid and unprecedented urban growth of the town consuming the surrounding non-built-up areas (see Figure 4.7).

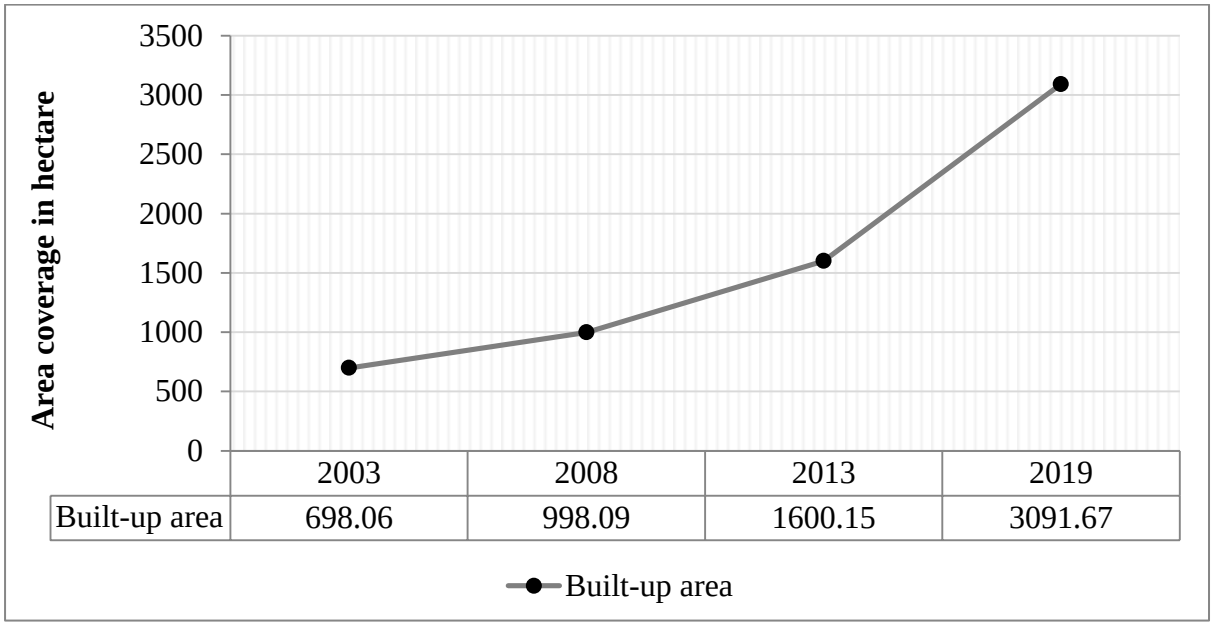


Figure 4.6: Built up area (2003, 2008, 2013 and 2019)

Table 4.11: Change in percent in time series analysis from 2003-2019

No	Year	Built-up Area (Ha)	Urban Expansion (HA)	Urban Expansion (%)
1	2003	698.06	-	-
2	2008	998.09	300.03	42.98
3	2013	1600.15	602.06	60.32
4	2019	3091.67	1491.52	93.21

(Source: Own computation using Equation 5 (2020))

As showed in the above (Figure 4.5 and Table 4.11), The built up area expansion of Dukem town between 2003 and 2008 was 300.03ha which was 42.98% expansion, between 2008 and 2013 was 602.06ha which was 60.32% expansion and again also the built-up area expansion of the town between 2013 and 2019 was 1491.52ha which was 93.21% expansion.

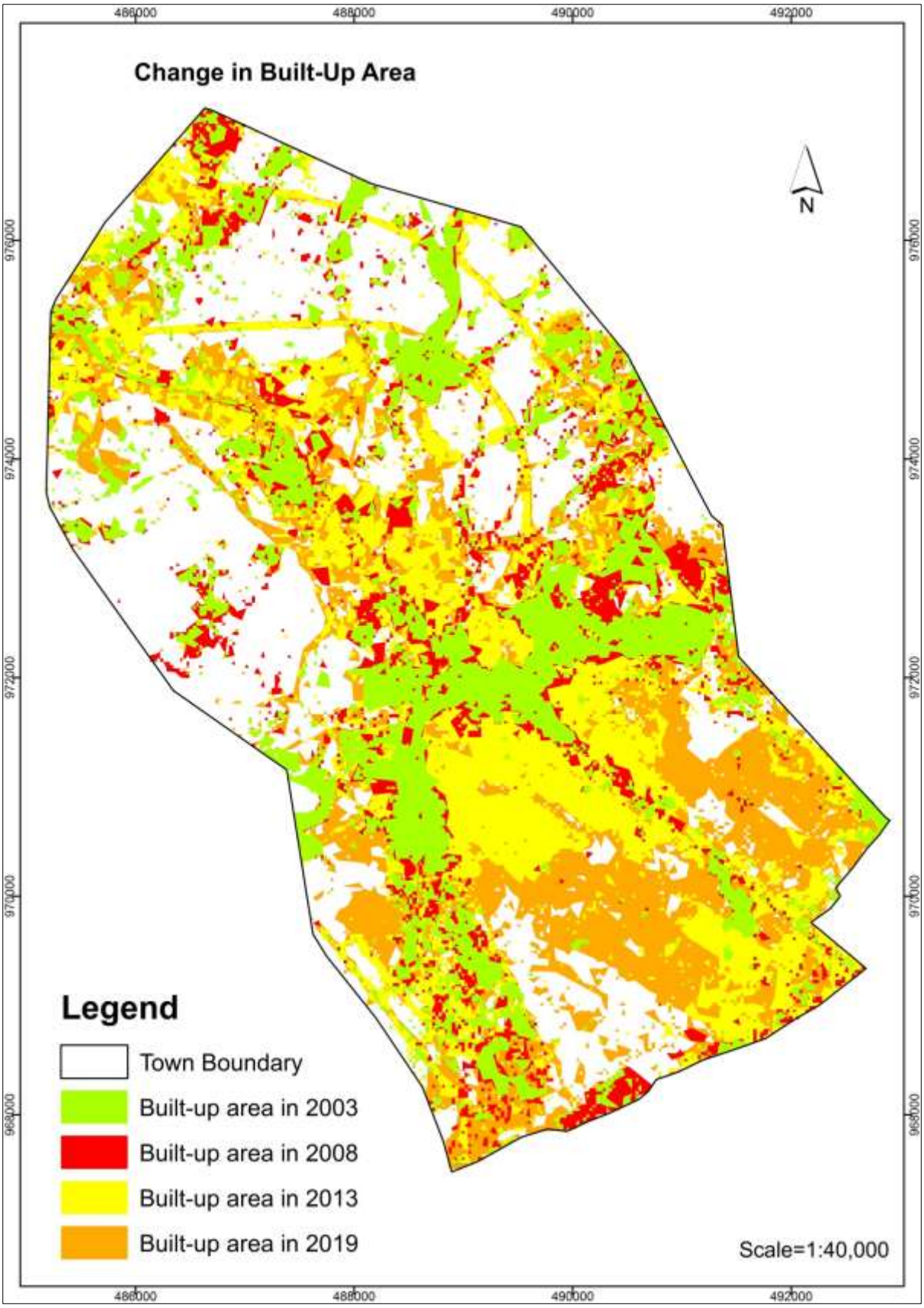


Figure 4.7: Showing Overlaid built-up area of Dukem town from 2003–2019 (Source: Organized by the author (2020)).

4.3.7. Dynamic Change Detection

The rate of change or rate of spatial expansion is used to compute built up area in between two time periods. Therefore, the dynamic change of built-up area between the years 2003-2008, 2008-2013 and 2013-2019 were calculated as follows using (Equation 6).

$$\textbf{DC}\ (2003\text{-}2008) = \left[\frac{998.09 - 698.06}{698.06} \times \frac{1}{2008 - 2003}\right] 100\ \% = \underline{\textbf{8.6\%}}$$

$$\textbf{DC}\ (2008\text{-}2013) = \left[\frac{1600.15 - 998.09}{998.09} \times \frac{1}{2013 - 2008}\right] 100\ \% = \underline{\textbf{12.1\%}}$$

$$\textbf{DC}\ (2013\text{-}2019) = \left[\frac{3091.67 - 1600.15}{1600.15} \times \frac{1}{2019 - 2013}\right] 100\ \% = \underline{\textbf{15.5\%}}$$

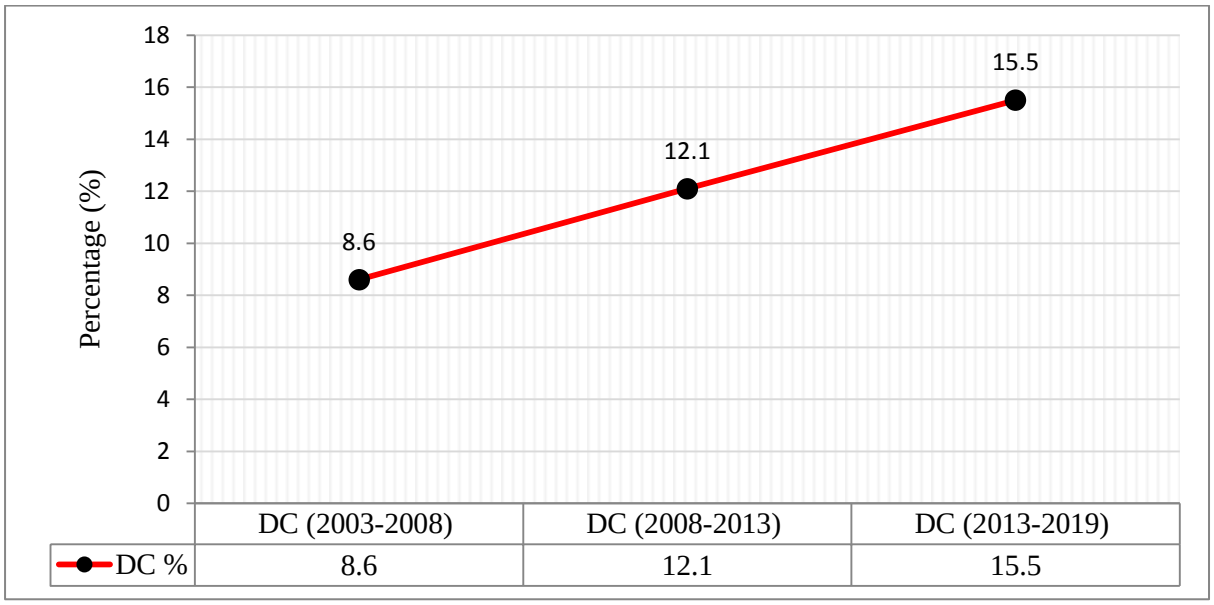


Figure 4.8: The rate of change in built up area from 2003–2019

As calculated and presented in the above (Figure 4.7) the built-up area of Dukem town increases in its spatial extent by 8.6% from 2003–2008, 12.1% from 2008–2013 and 15.5% from 2013–2019 per year. The dynamic change between 2003 and 2008 was lower than other periods. The rate of change for the two periods from 2008 to 2013 and 2013 to 2019 was among the highest and indicates that the trend of urban expansion was more and more increasing, particularly in the past eleven years. It means that an agricultural land around the town was incorporated into urban areas and became much more valuable land for new housing and industrial zones.

4.4. Description of Respondents

Out of the scheduled 445 (66 from office employees and 379 from communities) samples of respondents for the survey from each kebele administrators, officials, experts of Dukem town land development and management office and communities in the town, 388 (61 from office employees and 327 from communities) were surveyed face to face from all four kebeles in the town**.** While data collection the researcher had made a strong effort to normalize data quality through giving priority for service seniority level of educations, educational qualification background, place of work, work position and year of services in the position.

Therefore, among the 388 respondents all of them attempted all the close-ended survey questionnaires properly, and 82 (39 from office employees and 43 from communities) of them also attempted the open-ended questionnaires of the survey.

4.4.1. Backgrounds of office employees

The backgrounds of the office employees (Government officials, Kebele administrators and Experts) such as gender, age, level of educations, educational qualification background, place of work, work position and year of services in the position were collected and the results are presented as follows.

Gender of the respondents is an important variable influencing equity and participation. Accordingly, as presented in (Figure 4.9), the results showed that among the collected 61 sampled respondents 72.7% of them were males on the other hand 27.3% of them were females. Also as presented in (Figure 4.10), the ages of the respondents, it varies from lower group of 3% for the age group 61-70 years followed by 51-60 years age groups which was 6.1%, 18-30 years age groups which was 21.2%, 41-50 years age groups which was 33.3% and 31-40 years age groups which was 36.4% and this indicated that about the half of the sampled office workers are matured and experienced.

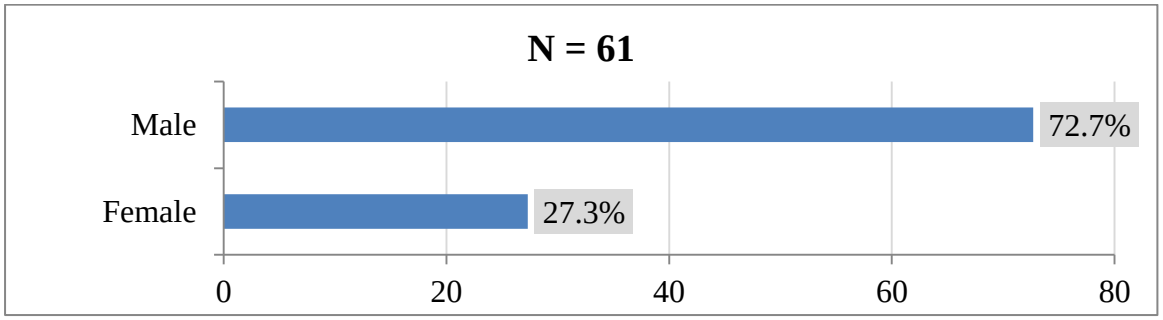


Figure 4.9: Gender character of office employees

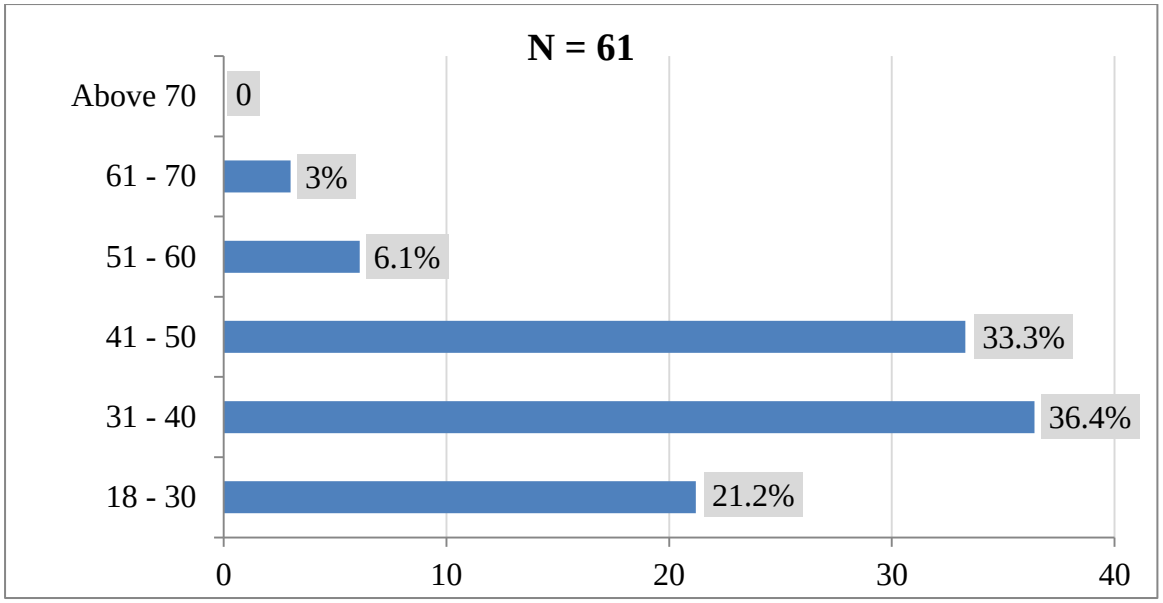


Figure 4.10: Age character of office employees

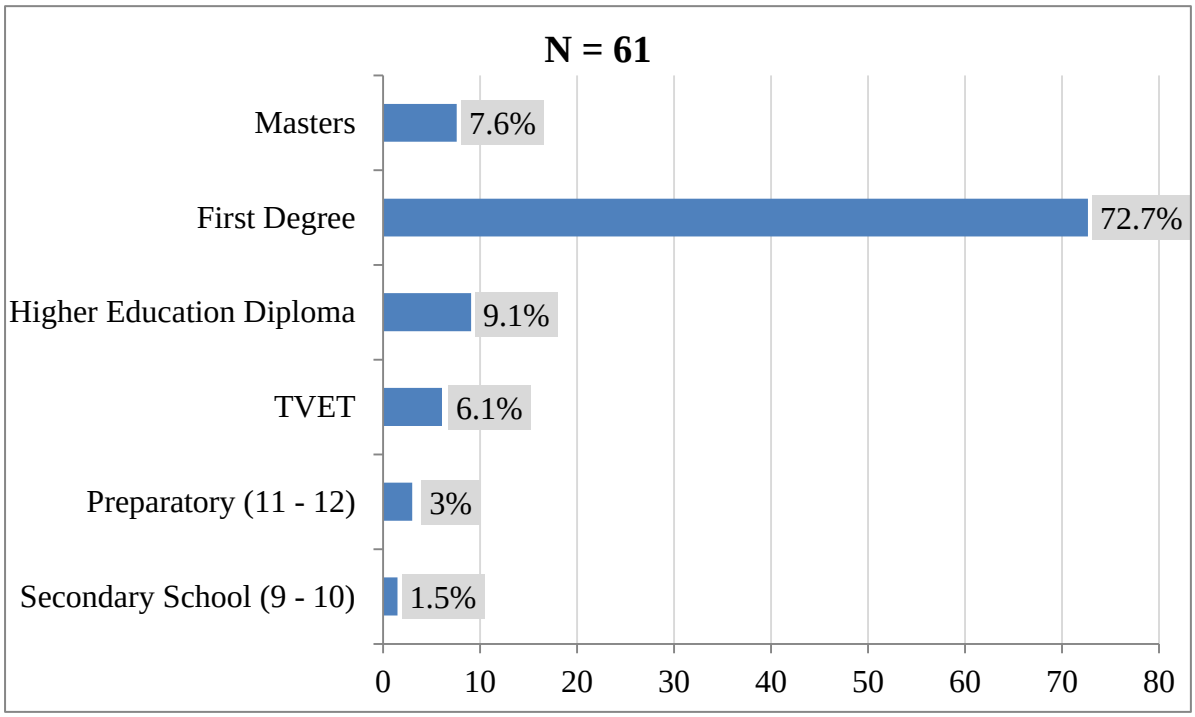


Figure 4.11: Level of Education of office employees

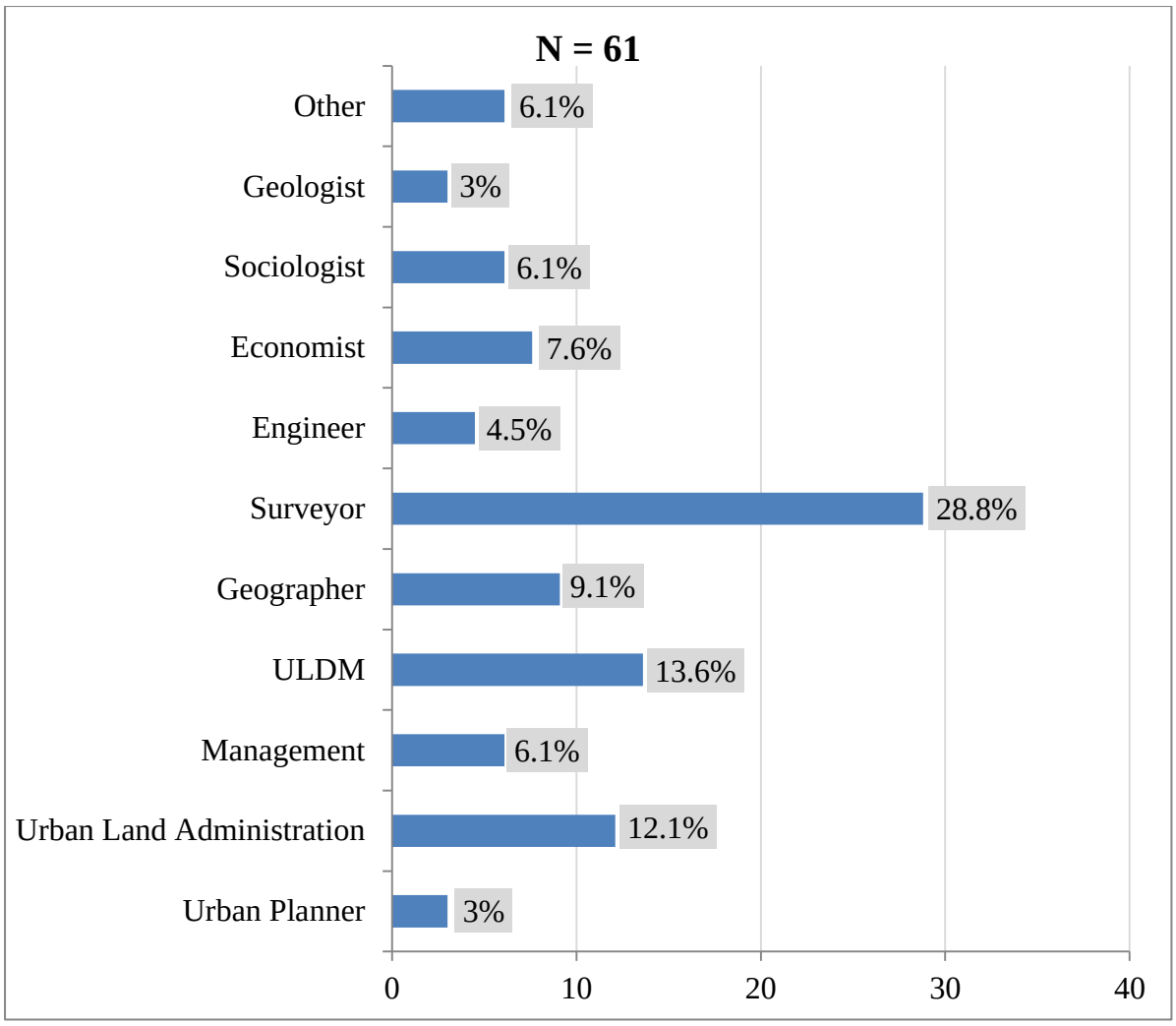


Figure 4.12: Educational qualification background of office employees

From the sampled office employees most of them were attended first degree program which was about 72.7% followed by higher education diploma which was about 9.1%, masters 7.6%, TVET 6.1% and by who attended preparatory 3% and secondary school 1.5% (see Figure 4.11) and as presented in (Figure 4.12), most of the sampled office employees educational qualification background was surveyor program which was about 28.8% followed by urban land development and management (ULDM) which was about 13.6%, urban land administration 12.1%, geographers 9.1%, economists 7.6%, sociologists 6.1%, management 6.1%, engineers 4.5%, urban planners 3%, geologists 3% and others from different educational qualification background constitutes about 6.1%. Therefore, this indicated that almost all of them are professionals or experts in their specific program they are more close to the issue, so this help the researcher for the reliability and validity of information generated.

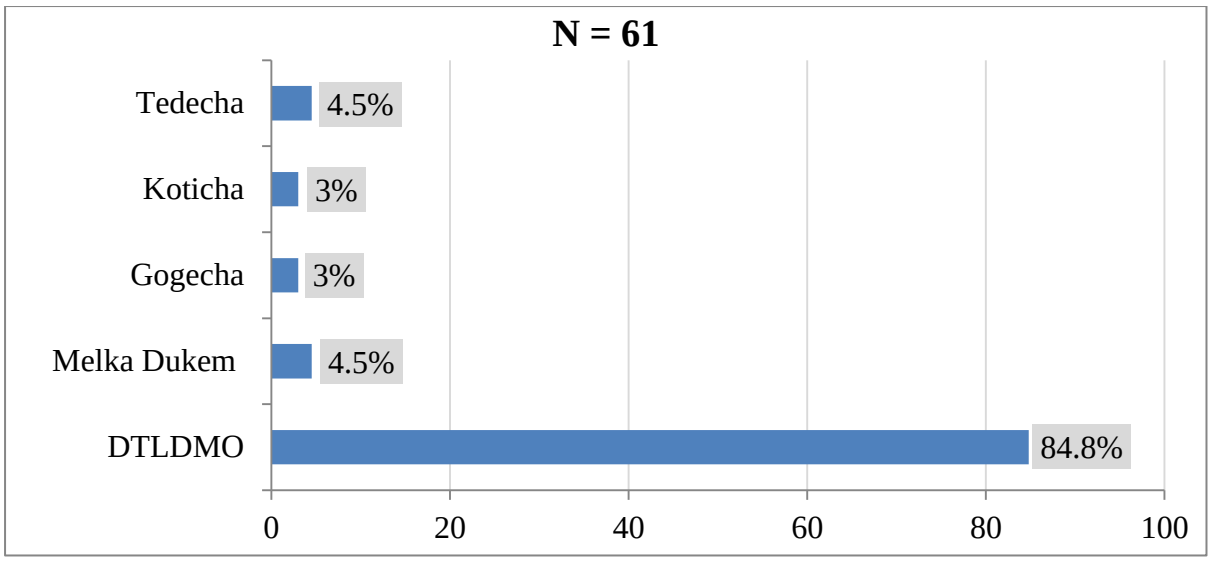


Figure 4.13: Work place of office employees

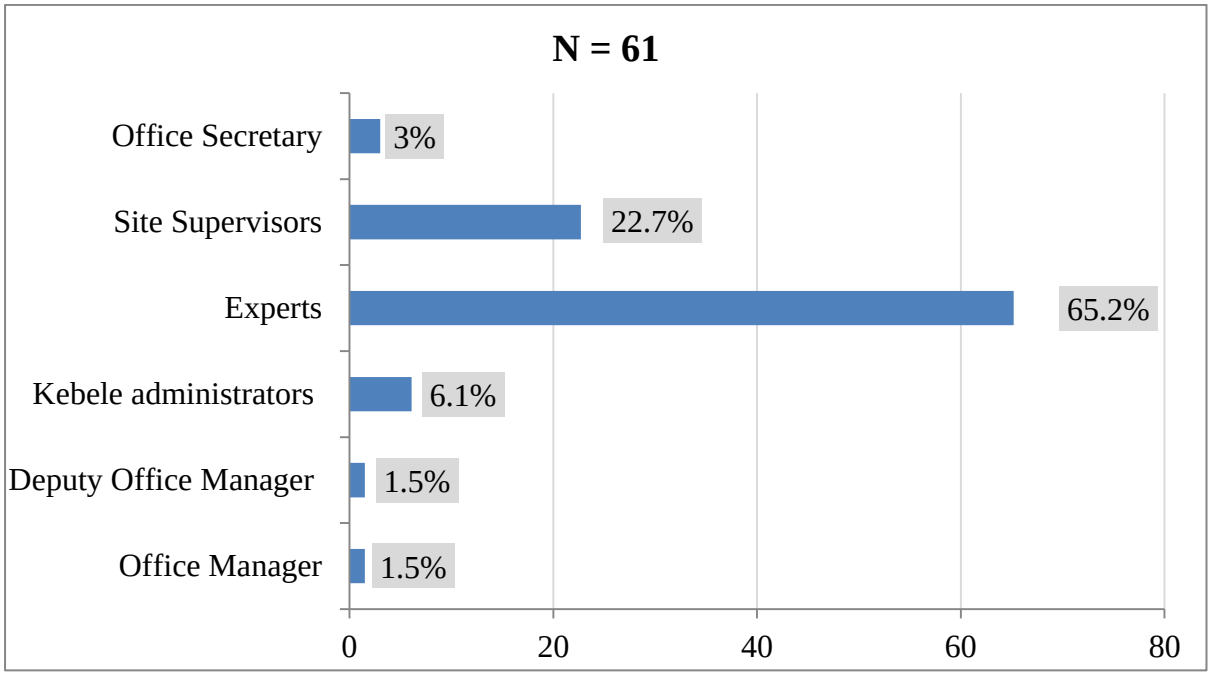


Figure 4.14: Work position of office employees

Most of the sampled office employees were from Dukem town land development and management office (DTLDMO) which was about 84.8% followed by from the four kebele administration in the town Melka Dukem 4.5%, Tedecha 4.5%, Koticha 3% and Gogecha 3% (see Figure 4.13). Also as presented in (Figure 4.14), Most of the sampled office employees in their work position were experts which constitute about 65.2% followed by site supervisors 22.7%, kebele administrators 6.1%, office secretary 3%, office manager 1.5% and deputy office manager 1.5%. Therefore, this showed that the study tried to assess the information's and data's from whole parts of the town in terms of participation and also where the data's collected and the study was done with almost all experts in their specific program they are more close to the issue.

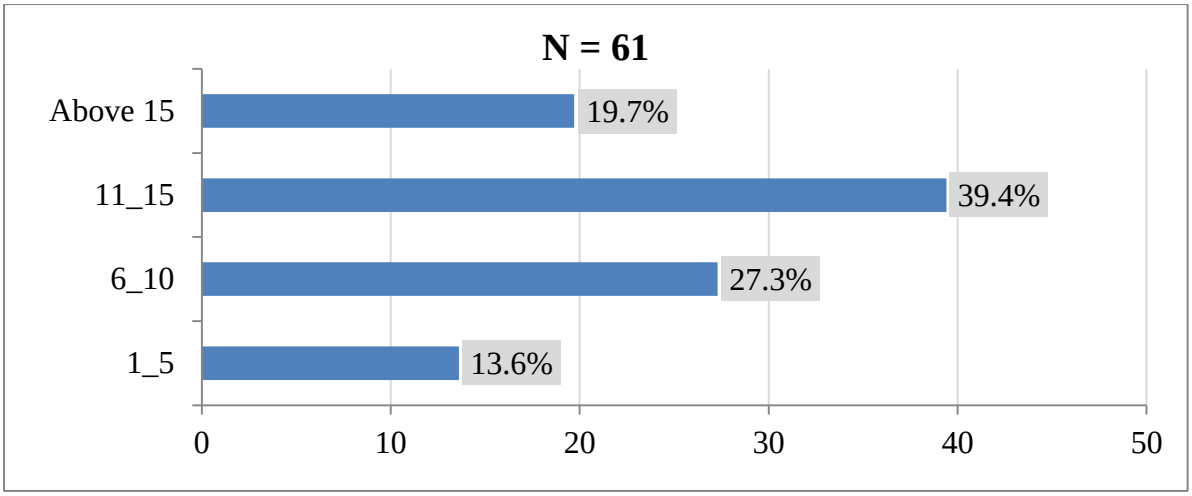


Figure 4.15: Year of services in the work position of office employees

As presented in above (Figure 4.15), Most of the sampled office employees were served for 11-15 years which was about 39.4% followed by 6-10 years 27.3%, above 15 years 19.7% and 1-5 years 13.6%. This indicated that more than half of respondents were senior in their work duration and position. So almost all of them could describe changes resulted over time and believed to have rich information than other new employers.

4.4.2. Backgrounds of the Community

The background of Dukem town communities such as address (kebele), gender, age, place of birth, level of educations and occupation were collected and the results are presented as follows.

Address or kebeles of the community is an important variable influencing proportionality and participation. Accordingly, as presented in (Figure 4.16), the results show among the collected 327 of sampled respondents 34.3%, 26.6%, 21.1% and 17.9% of them were from Koticha, Melka Dukem, Gogecha and Tedecha kebeles respectively.

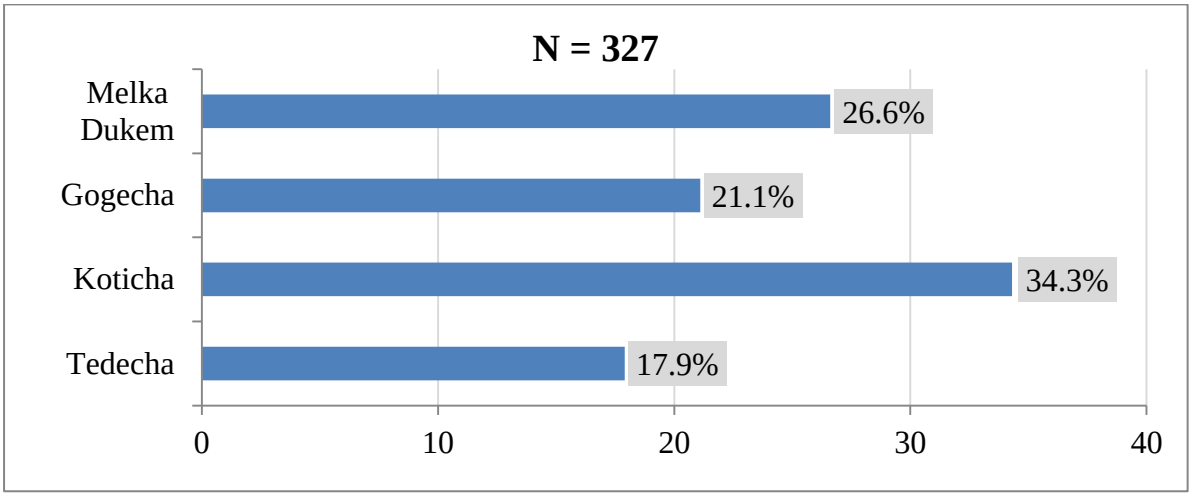


Figure 4.16: Address or kebeles of the communities

Gender of the respondents is an important variable influencing equity and participation. Accordingly, as presented in (Figure 4.17), the results show among the collected 327 of sampled respondents 68.3% of them were males and while 31.7% of them were females.

Also as presented in (Figure 4.18), the ages of the sampled communities, varies from lower group of 2.9% for the age group above 70 years followed by 18-30 years age groups which was 5.3%, 61-70 years age groups which was 10.6%, 51-60 years age groups which was 20.6%, 31-40 years age groups which was 23.7%, and 41-50 years age groups which was 36.9% and this indicated that more than half of the scheduled sampled communities were older and experienced one in their age.

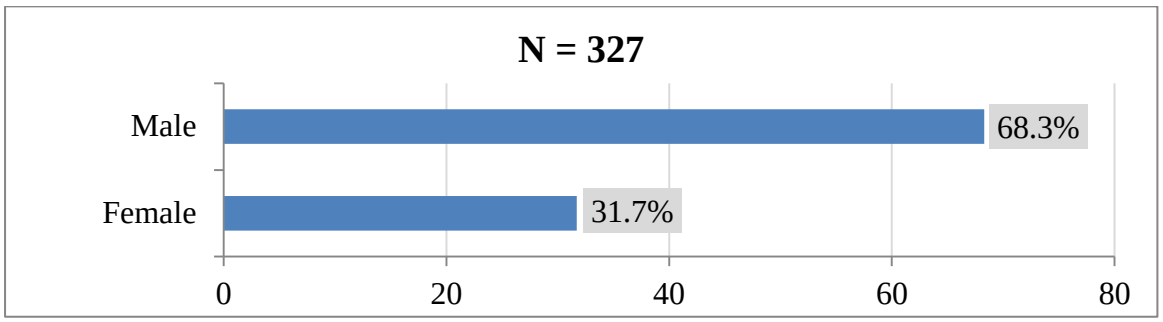


Figure 4.17: Gender of the communities

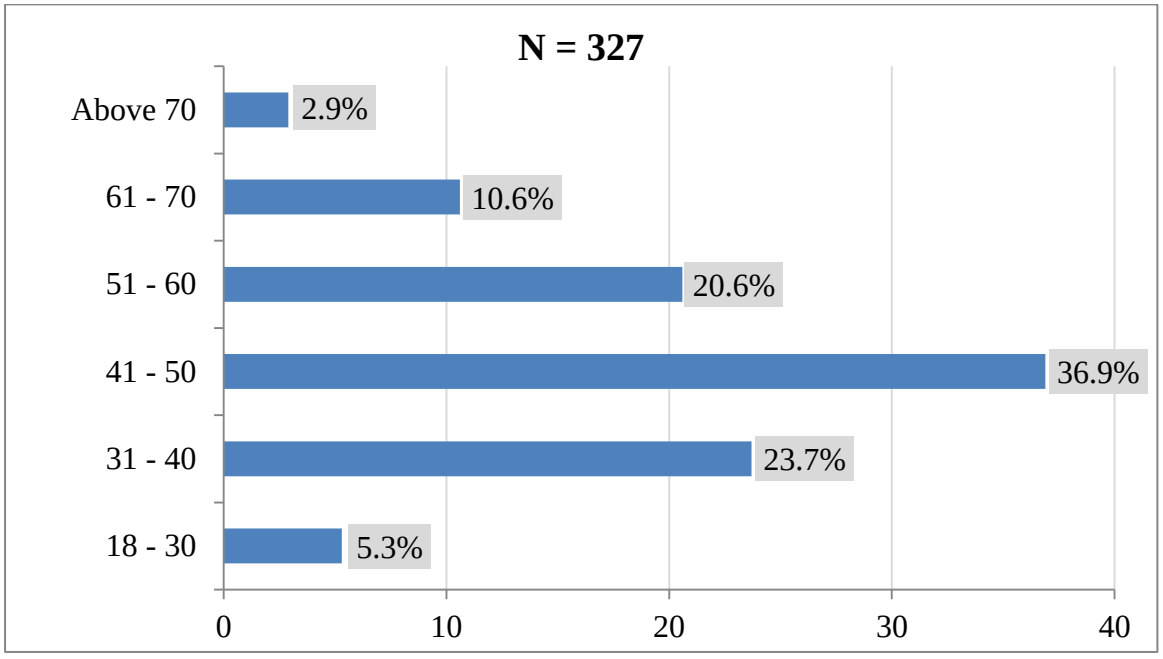


Figure 4.18: Age character of the communities

As presented in (Figure 4.19), Most of the planned sampled communities migrated ones which was about 59.8% and only 40.2% of sampled communities were born in Dukem town. This indicated that there were rapid population growth through migration to the town due to the establishment of many industries and also its geographical proximity to Addis Ababa

made the town increased population and economic importance, a number of commuters per day those who preferred to live in the town and work in Addis Ababa was a major reason according to the informants during survey.

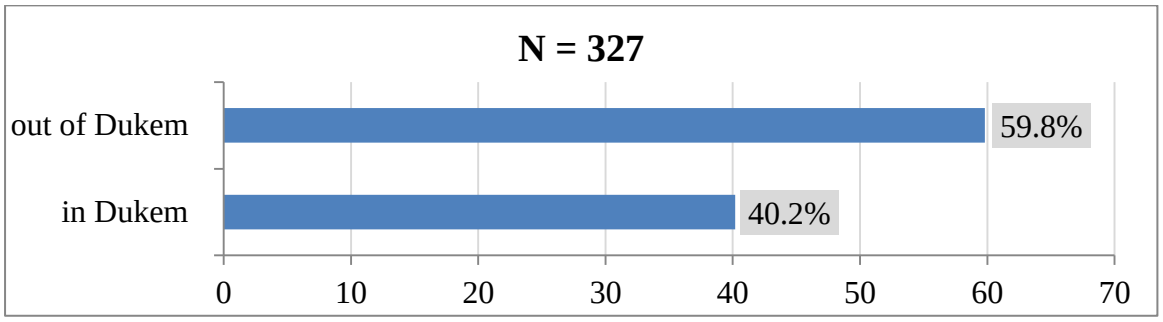


Figure 4.19: Communities place of birth

From the scheduled sampled communities most of them attended first degree program which was about 36.4% followed by TVET which was about 12.4%, higher education diploma 11.3%, secondary school 10.6%, read and write 8.7%, elementary school 7.7%, preparatory school 5.8%, illiterate 4.2% and masters 2.9% (see Figure 4.20). This indicated that more than half of the planned sampled respondents were professionals in their specific program. So they were more close to the issue due to their knowledge and this support the conclusion of the study with an information generated.

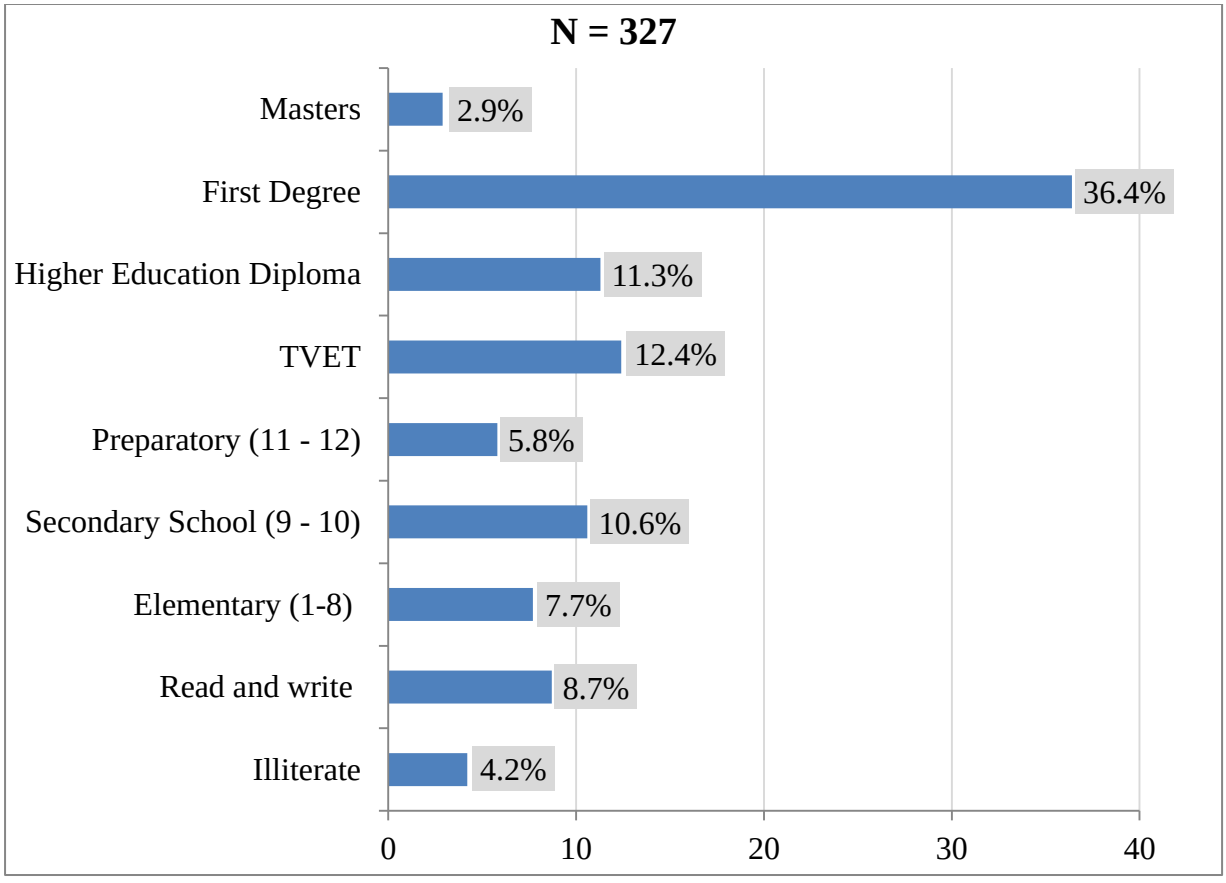


Figure 4.20: Communities level of education

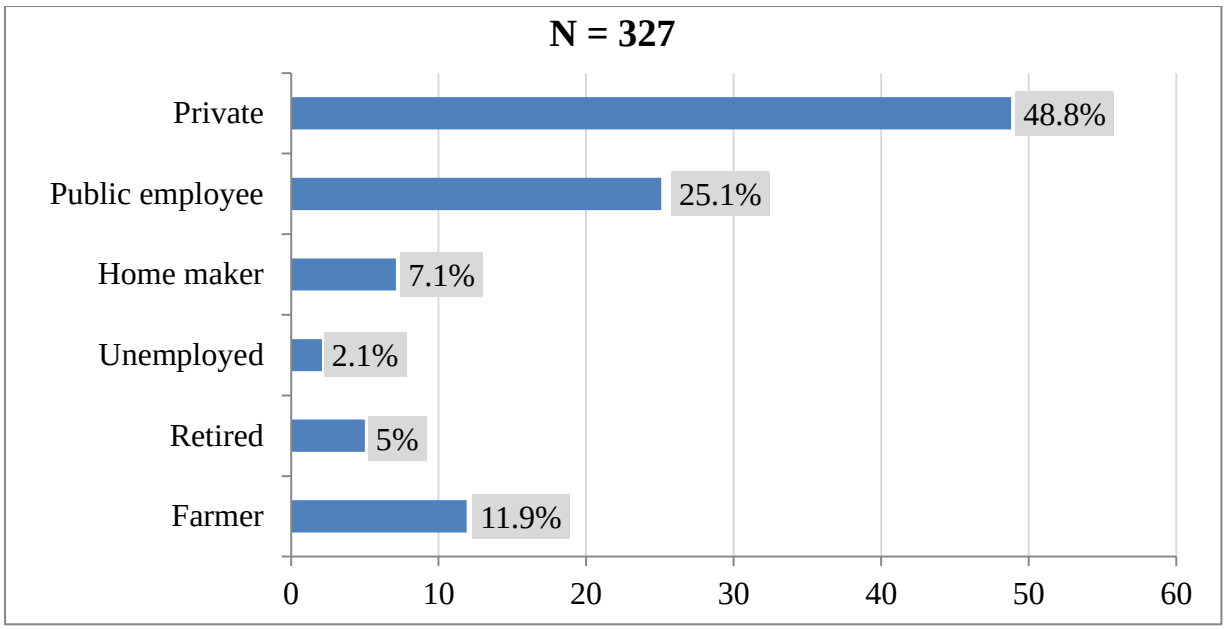


Figure 4.21: Occupation of communities

As presented in (Figure 4.21), when the samples described by their occupation, it was found that most of communities were confined in running their own private business which was about 48.8% followed by public employees which was about 25.1%, farmers 11.9%, homemakers 7.1%, retired 5% and unemployed 2.1%.

4.5. The Driving Factors

The driving factors, were considered in this study as determinants of urban expansion take different forms but the most obvious forces being assumed such as increase in population size, investment pressure in commerce & service, establishment of industries & manufacturing, development of road infrastructure & transportation, housing preference, informal access to land, the prepared plans of the town, location and topography of the town.

The proximity to Addis Ababa made the town increased population and economic importance, a number of commuters per day those who preferred to live in the town and work in Addis Ababa. Population growth, coupled with industrial and commercial expansion has resulted in intense competition for resources like housing and other basic resources. The town is characterized by one of those towns with high concentration of industries. According to OUPI (2017), proximity to Addis Ababa, transport facility, the highway and expressway to southern and eastern part of the country pass through Dukem town, surrounded by agricultural productive areas and poor policy implementation tools which results in squatter settlements were the major driving factors for the rapid expansion of the town.

4.5.1. Perceptions of Office Employee's on Driving Factors

In order to measure the perception of office employees on the factors that contributed a lot for the rapid expansion of Dukem town between the year 2003 and 2019, Nine (9) urban expansion driving factors or forces such as increase in population size, investment pressure in commerce & service, establishment of industries & manufacturing, development of road infrastructure & transportation, housing preference, informal access to land, the prepared plans, location and topography of the town were included in the survey questionnaire for the respondents (office employees) using five (5) point Likert scale measurement.

The survey result showed that most of the respondents (office employees) were agreed with listed urban expansion driving factors such as increase in population size, location of the town, establishment of industries & manufacturing, development in road infrastructures & transportation, housing preference, informal access to land, investment pressure in commerce & service, the prepared plans of the town and topography of the town by 94%, 92.4%, 90.9%, 90.9%, 89.4%, 81.9%, 81.8%, 66.7% and 60.7% respectively (see also Figure 4.22).

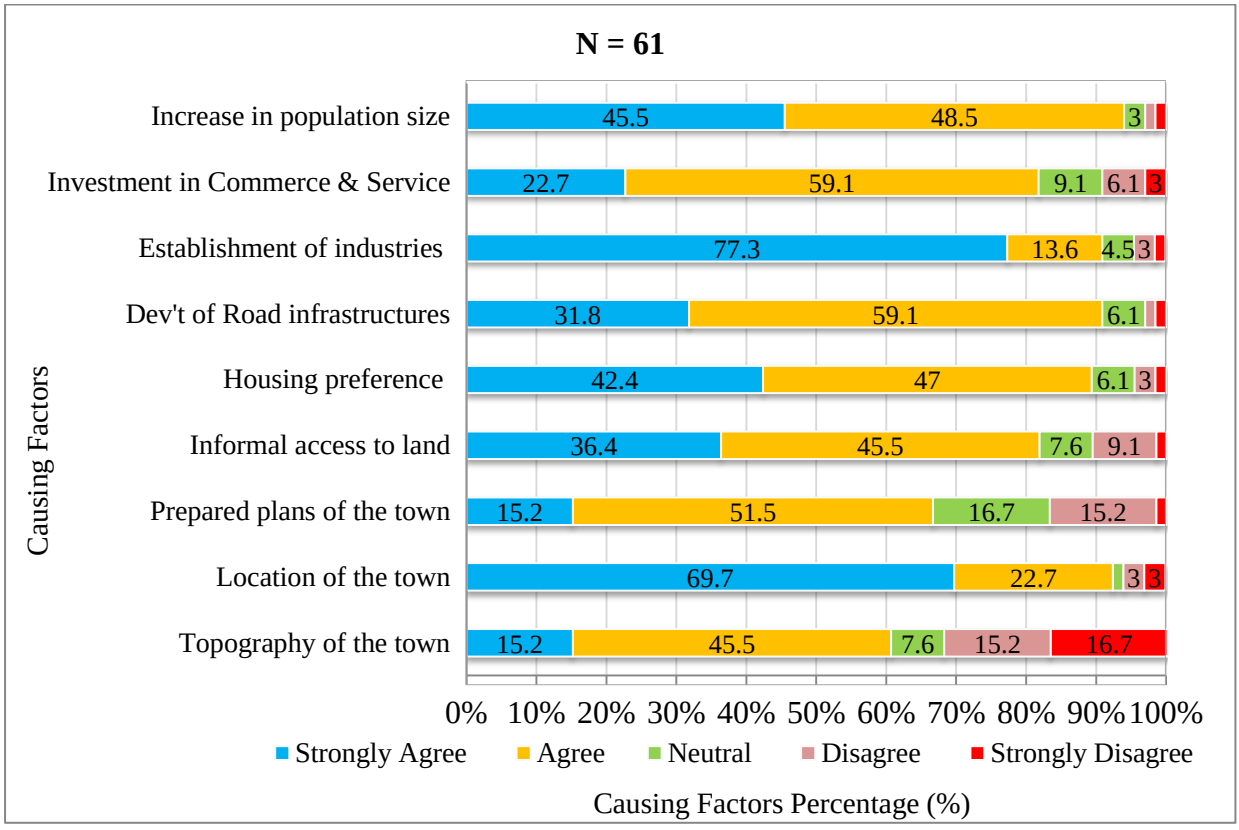


Figure 4.22: Showing expansion factors rating according to office employees

The next ration of the survey provided open-ended questions for office employees to express unlisted concerns in their own insights on the urban expansion driving factors. While, this was also believed to see the relationships of respondents responses by close-ended questions

concerned to additional factors that contributed a lot for the rapid expansion of Dukem town between 2003 and 2019 with open-ended questions. Accordingly, from 61 surveys there were 23 responses from office employees forwarded to additional driving factors on the open-ended question. Therefore, the listed additional response by office employees on urban expansion driving factors generally categorized under three (3) major themes such as 'land grabbing' with (12), 'A massive parcel delivery for farmer hh families in 2018/2019' with (9), 'Land provided for the nation confiscated from Oromia-Somale region in 2018' with (2) number of response and each of them were discussed in corresponding sections of analyses. Most of them were belongs to the housing preference or residential category.

4.5.1.1. Descriptive Analysis of Office Employee's on Driving Factors

In order to measure the perception of office employees on the factors that contributed a lot for the rapid expansion of Dukem town between the year 2003 and 2019, Nine (9) urban expansion driving factors or forces were used. Accordingly, to analysis and measure these perception descriptive analysis methods were used as follows. To further describe and analyses the characteristics of perceptions a measure of central tendency (mean, median and mode), measure of dispersion (standard deviation and variance) and measure of distribution (Skewness) were discussed as follows in the (Table 4.12). The results in the table are directed based on Likert scales measurement from 0-4 values, whereas strongly disagree (0), disagree (1) neutral (2), agree (3) and strongly agree (4). The outputs in the table were based on the value which means the results near to 4 showed strong agreement of office employees with the respective listed urban expansion driving factors or forces.

Accordingly, most of driving factors have perception value around positive attitude strongly agree which mean more agreed to the listed urban expansion driving factors. As presented in the above (Table 4.12) establishment of industries & manufacturing and location of the town are the driving factors which office employees rated as strongly agreed with an average score mean of 3.62 and 3.53 respectively. The driving such as increase in population size, housing preference, development in road infrastructures & transportation, informal access to land, investment pressure in commerce & service and the prepared structure plan of the town were the most office employees perceived agreed with average mean 3.35, 3.26, 3.18, 3.14, 2.92 and 2.64 respectively. While, topography of the town is driving factor that office employees rated with an average score mean of 2.27 neither negative nor positive attitude with a value around two or average neutral perception. With topography of the town average perceived value is around two which is neutral in its mean value of 2.27 approximately 2 with the most frequently rated value of 'agree' i.e. 3 mode value. However, since some respondents

perceived ‘topography of the town’ by rating as ‘disagree' it makes the average value less the most frequently rated value by skewing the perception of office employees toward the ‘neutral' (see Table 4.12).

Table 4.12: Descriptive analysis result of office employees on driving factors

Causing Factors	**N**	**Mean**	**Median**	**Mode**	**Std. Deviation**	**Variance**	**Skewness**
Increase in Population size	61	**3.35****	3	**3**	.754	.569	-1.791
Investment pressure in Commerce & Service	61	**2.92****	3	**3**	.917	.840	-1.330
Establishment of Industries & Manufacturing	61	**3.62*****	4	**4**	.837	.700	-2.589
Dev’t in Road Infra. & Transportation	61	**3.18****	3	**3**	.742	.551	-1.471
Housing preference	61	**3.26****	3	**3**	.829	.686	-1.523
Informal access to land	61	**3.14****	3	**3**	.975	.950	-1.152
The prepared plans	61	**2.64****	3	**3**	.971	.943	-.658
Location of the town	61	**3.53*****	4	**4**	.915	.838	-2.514
Topography of the town	61	**2.27***	3	**3**	1.354	1.832	-.555

*neither negative nor positive attitude with a value around two or neutral average, **positive attitude with a value around three which as agree to the factors and ***positive attitude with a value around four which as more agree to the factors

4.5.2. Perceptions of Communities on Driving Factors

Similarly, In order to measure the perception of communities on the factors that contributed a lot for the rapid expansion of Dukem town between 2003 and 2019, Nine (9) urban expansion driving factors or forces such as increase in population size, investment pressure in commerce & service, establishment of industries & manufacturing, development in road infrastructure & transportation, housing preference, informal access to land, the prepared plans of the town, location of the town and topography of the town were included in the survey questionnaire for the respondents (communities) using five point Likert scale measurement. Accordingly, The survey result shown that most of the communities were agreed with listed urban expansion factors such as establishment of industries & manufacturing, location of the town, informal access to land, increase in population size and investment pressure in commerce and service by 81.8%, 76.6%, 74.4%, 73% and 65.7% respectively. And almost more than half of communities agreed on the prepared plans of the town (53.1%). While considerably less than half of the communities are agreed (i.e. more than half not agreed) on topography of the town (40.7%), housing preference (40.3%), development in road infrastructures & transportation (34.8%) which contributed a lot for the rapid expansion of Dukem town between 2003 and 2019 (see Figure 4.23).

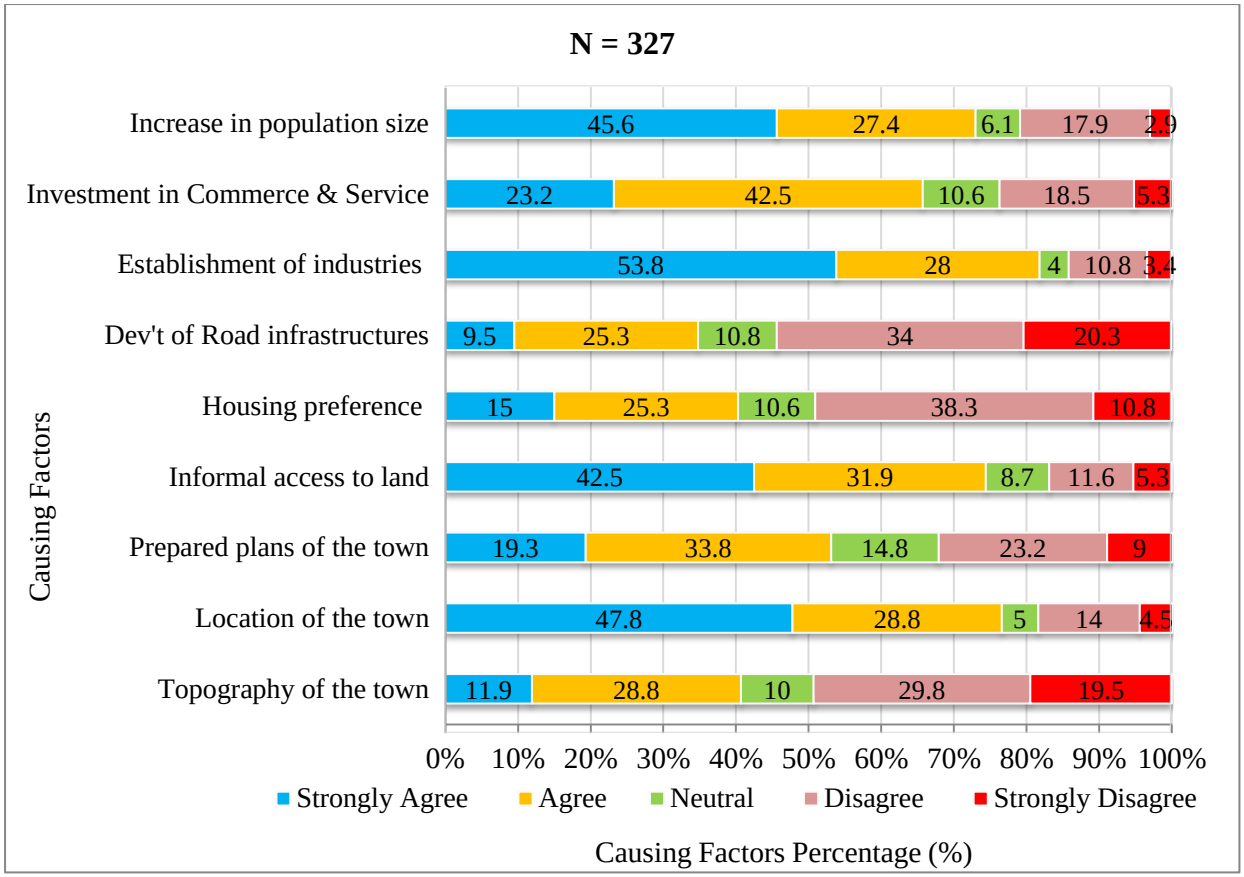


Figure 4.23: Showing expansion factors rating according to communities

The last portion of the survey provided open-ended questions for communities to express their own perceptions. On the other hand, it is also believed to see the relationships of respondents responses by close-ended questions concerned to additional factors that contributed a lot for the rapid expansion of Dukem town between 2003 and 2019 with open-ended questions. Accordingly, from 327 surveys there were 29 responses from communities forwarded to additional driving factors on the open-ended question. Therefore, the listed additional response by communities on urban expansion driving factors generally categorized under four (4) major themes such as ‘land grabbing’ with (13), ‘housing shortage’ with (11) ‘economic interest’ with (3) and ‘suitable climate condition’ with (2) number of response and each of them were discussed in corresponding sections of analyses.

4.5.2.1. Descriptive Analysis of Communities on Driving Factors

In similar manner in order to grasp the perception of communities on the factors that contributed a lot for the rapid expansion of Dukem town between the year 2003 and 2019, Nine (9) urban expansion driving factors or forces were used. Accordingly, to analysis and measure these perception descriptive analysis methods were used as follows. To further describe and analyses the characteristics of perceptions a measure of central tendency (mean, median and mode), measure of dispersion (standard deviation and variance) and measure of

distribution (Skewness) were discussed as follows in the (Table 4.13). The results in the table are directed based on Likert scales measurement from 0-4 values, whereas strongly disagree (0), disagree (1) neutral (2), agree (3) and strongly agree (4). The outputs in the table were based on the value which means the results near to 4 showed strong agreement of communities with the respective listed urban expansion driving factors or forces.

Table 4.13: Descriptive analysis result of communities on driving factors

Causing Factors	**N**	**Mean**	**Median**	**Mode**	**Std. Deviation**	**Variance**	**Skewness**
Increase in Population size	327	**2.95*** **	3	**4**	1.224	1.497	-.879
Investment pressure in Commerce & Service	327	**2.60*** **	3	**3**	1.181	1.394	-.636
Establishment of Industries & Manufacturing	327	**3.17*** **	4	**4**	1.141	1.301	-1.351
Dev't in Road Infra. & Transportation	327	**1.30***	1	**1**	1.303	1.699	.281
Housing preference	327	**1.97****	2	**1**	1.300	1.690	-.185
Informal access to land	327	**3.01*** **	3	**4**	1.205	1.452	-1.029
The prepared plans	327	**2.31****	3	**3**	1.267	1.607	-.296
Location of the town	327	**3.02*** **	3	**4**	1.219	1.486	-1.097
Topography of the town	327	**1.84****	2	**1**	1.348	1.818	.107

*negative perceptions with a value around one which as disagree to the factors, **neither negative nor positive attitude with a value around two or neutral average, ***positive attitude with a value around three which as more agree to the factors

Accordingly, Most of driving forces such as establishment of industries & manufacturing, location of the town, informal access to land, increase in population size and investment pressure in commerce & service were the most communities perceived agreed with average mean 3.17, 3.02, 3.01, 2.95 and 2.60 respectively. However, factors such as 'establishment of industries & manufacturing', 'location of the town', 'informal access to land' and 'increase in population size' average perceived value is around three which as agree to the actors in its mean value of 3.17, 3.02, 3.01 and 2.95 respectively, with the most frequently rated value of 'strongly agree' i.e. 4 mode value. However, since some communities perceived by rating as 'disagree' it makes the average value less the most frequently rated value by skewing the perception of communities toward the 'agreed'. On the other hand, driving factors such as the prepared plans of the town, housing preference and topography of the town were the most communities' perceived neutral with average mean of 2.31, 1.97 and 1.84 respectively. While development in road infrastructures & transportation was the only driving factor that showed the most disagreed with average mean around 1.30 (see Table 4.13).

4.5.3. Driving Factors Analysis

In order to generate information regarding the major driving factors responsible for Dukem town expansion between 2003 and 2019, five Likert scales of strongly agree to strongly disagree were used. Because since the data collected was based on personal perception which varied accordingly based on the attitude toward the factors and actors that contributed a lot for rapid expansion of the town.

The driving factors, as determinants of urban expansion take different forms but the most obvious forces being considered in this study such as increase in population size, investment growth in commerce & service, establishment of industries & manufacturing, development in road infrastructures & transportation, housing preference, the prepared plans of the town, location of the town and topography of the town each of them discussed. Particularly, comparison task has been done between office employees and communities attitude on the listed factors also cross checking task analysis undertaken using different materials prepared for Dukem town (Structure plan of the town by OUPI, Dukem town profile, sector reports etc.) were discussed in detail in the following section.

4.5.3.1. Increase in Population Size

The rapid increase in population has led to the establishment and expansion of urban centers. In this study office employees and the community assumed in providing reliable information that they could describe changes resulted over time and believed to have rich information. Accordingly, the survey result for increase in population size indicated that most of office employees and communities were strongly agreed with 94% and 73% respectively (see Figure 4.22 and 4.23). On the other hand, in terms of descriptive analysis data were most of office employees and communities perceived strongly agreed with an average mean of 3.35 and 2.95 respectively (see Table 4.12 and 4.13). The survey result showed that there is a little bit difference between the two respondents (office employees and communities), were most of office employees as a most agreed or ‘strongly agreed’ while communities as a more agreed or ‘agreed’ to this driving factor. Therefore, this indicated that both office employees and communities perceived an average of ‘strongly agreed’ with the increase in population size that contributed a lot for the expansion of the town between the year 2003 and 2019.

Moreover, to see the population profile of the town for the purpose of crosschecking, Dukem town would not have exact population data in each year to show the growth of population number depending on the time sequence, so to solve the problem the researcher computed or forecasted the population growth size of the town in each year taken into account

consideration of the Central Statistical Agency census result in both years (1994 and 2007). Both year CSA survey results are illustrated as in (Table 4.14) below.

Table 4.14: Population size of Dukem town in 1994 and 2007 CSA

No	CSA Year	Male	Female	Total
1	1994	6644	6698	**13,342**
2	2007	14,702	14,127	**28,829**

(Source: Dukem town structure plan by OUPI, 2017)

Therefore, the researcher used the above two CSA population data for projection of each year. Though, CSA, 1994 census results taken as base year. To calculate population size of an area ought to known population growth rate of the area. Thus, exponential growth rate model applied as follow using (Equation 9).

$Pt = Po\ e^{rt}$

Where

Pt = Current population (2007)

Po = Base Year population (1994)

r = Growth rate

t = Time (13 year)

$$r = \frac{1}{t} * \ln\left(\frac{P_t}{P_0}\right) = \frac{1}{13} * \ln\left(\frac{28829}{13342}\right) = 0.1 * \ln(2.16) = \mathbf{0.0593}$$

Annual population growth rate of the area under consideration calculated 5.93% through the above formula which is higher than average annual growth of Oromia urban area 4.13%, (CSA, 1994-2007). However, a growth rate calculation has three variants such as High, Medium and Low variant based on the situation of vital population growth factors. According to this study, high variant accounted 6.93%, medium variant accounted 5.93% and low variant accounted 4.93%, then the researcher employed an average medium variant (growth rate = 5.93%), due to the existence of high migration rate because the town has many industries. This is calling many job seekers from different areas. The Eastern Industry Zone (EIZ) which observes huge human force make Dukem town special of other towns in the region.

Thus,

$Pt = Po*(1+r/100)^t$

Where:

Pt = population at time required

Po = Current population

r = Rate of population growth

t = Projection time

If the population of Dukem town according to CSA in 1994 estimated 13,342 with 4.13% average annual growth rate of Oromia urban area %, (CSA, 1994-2007) then,

$Pt = Po*(1+r/100)^t$

$P\text{-}2003 = 13{,}342*(1+4.13/100)^9 = 13{,}342 * 1.4394 =$ **19,204**

If the population of Dukem town according to CSA in 2007 estimated 28,829 with 5.93% rate of growth then,

$Pt = Po*(1+r/100)^t$

$P\text{-}2008 = 28{,}829*(1+5.93/100)^1 = 28{,}829 * 1.0593 =$ **30, 539**

$P\text{-}2013 = 28{,}829*(1+5.93/100)^6 = 28{,}829 * 1.4129 =$ **40,732**

According to OUPI planning team during Dukem town structure plan preparation in 2017 they projected population through cross-checking the data from CSA (57,650) and the data obtained from the town administration (114,027). Thus, they were used the average of the two which is about 85,839 number of population in 2017.

P-2017 = **85,839**

$P\text{-}2019 = 85839 *(1+5.93/100)^2 = 85839 * 1.1221 =$ **96,320**

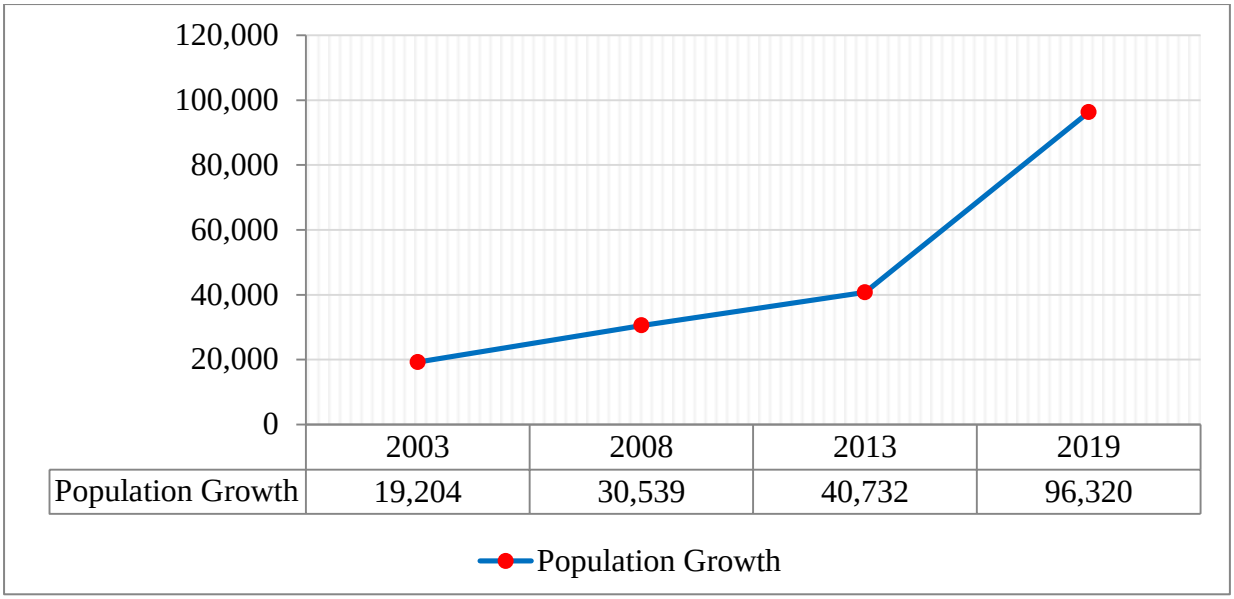


Figure 4.24: Population growth trend from 2003-20019 (Source: Own computation using CSA and OUPI projection in 2017)

Population growth determined through population dynamics factors, such as fertility, mortality and migration. According to, different studies inflow of people from rural and surrounding small towns into the medium and large town increases from time to time. Of the large town in the region Dukem accounted, which practicing booming migration rate (OUPI, 2017). Depending on the direction of movement the event of migration can be classified into in and out migration but not any data about out migration in the town. However, as information from the town profile and simple personal judgment there is extremely in migration due to the existence of many industries. This is calling many job seekers from different areas. The Eastern Industry Zone (EIZ) which observes huge human force make Dukem town special of other towns in the region.

According to Dukem town profile report (2019), the town has significant economic importance because of the industrial expansion and over 22,000 employees are engaged in the Eastern Industry Zone (EIZ) only and many, more including the rest of the factories. This causes many to migrate to this area searching for livelihood. The negative aspect of this condition is highly crowding the town, increasing competition for resource including housing and other basic resources. Therefore, the town currently practicing extremely high migration rate and this situation results that Dukem town population growth rate categorize under high variant rate.

4.5.3.2. Investment Pressures in Commerce and Services

Dukem town is growing and getting expanded in all direction due to geographical proximity to Addis Ababa made the town increased population and economic importance, a number of commuters per day those who preferred to live in the town and work in Addis Ababa, Gelan, Akaki, Bishoftu, Modjo, Adama etc.. Industrial and commercial expansion has resulted in intense competition for resources like housing and other basic resources.

The rise in investment in terms of economic growth has led to the rapid expansion of the town. According to the survey result from office employees and communities on the factor that investment growth contributed a lot for the expansion of the town shown that were agreed with 81.8% and 65.7% respectively (see Figure 4.22 and 4.23). On the other hand, in terms of descriptive analysis data were most of office employees and communities perceived agreed with an average mean of 2.92 and 2.60 respectively (see Table 4.12 and 4.13). The survey result showed that office employees more agreed to investment growth while the communities relatively less agreed. Therefore, this indicated that both office employees and communities perceived an average value of 'agreed' with investment growth that contributed a lot for the expansion of the town between the year 2003 and 2019.

Furthermore, the major economic activity of the town is trade and service and it is likely that the industry and urban agriculture development (OUPI, 2017). Existence of active commerce and business and associated services owe it a business economic activity. Many businesses (hotels, restaurants and shops) are located in the center dominantly following the main asphalt road to Addis Ababa and Adama. The town is characterized by one of those towns with high concentration of investment activities most profoundly in industrial and manufacturing sectors as shown in (Table 4.15) below.

Table 4.15: Type of Investment by Employment and Capital

No	Type	Number	Capital	Employment
1	Industry & Manufacturing	423	17,811,954,354	22,221
2	Agro Industry processing	46	315,768,407	1711
3	Commerce	120	686,427,910	3,484
4	Service	19	38,343,331	608
	Total	**608**	**18,852,494,002**	**28,024**

(Source: Dukem town Investment Office, 2020)

As presented in (Table 4.15), there were a number of investment activities in the town such as industry & manufacturing, agro-industry, urban agriculture, commerce or trade and services within a total number of 423, 46, 4, 120 and 15 respectively. Dukem town currently has a total of 608 investment activities where running with a total capital 18,852,494,002. This showed that as the investment expanding and attracts further investors in to the town, the economic sector growing due to the contribution of investment to the local, national economy in many ways import substitution and saving foreign currency, tax contribution and employment generation and where by this situation contributed a lot for further expansion of the town.

4.5.3.3. Establishment of Industries and Manufacturing

The government of Ethiopia has given due consideration to private investment that involved foreign investment. Hence, the private sector participation in development has increased significantly. Dukem town is characterized by one of those towns with high concentration of industries due to its high proximity to the national market of capital Addis Ababa city.

According to the survey result from office employees and communities on the factor that establishment of industries and manufacturing contributed a lot for the expansion of the town shown that were the most strongly agreed factor with 90.9% and 81.8% respectively (see Figure 4.22 and 4.23). On the other hand, in terms of descriptive analysis data were most of office employees and communities perceived strongly agreed with an average mean of 3.62 and 3.17 respectively (see Table 4.12 and 4.13). Therefore, the survey result indicated that both office employees and communities perceived a value of 'strongly agreed' with the establishment of industries and manufacturing contributed a lot for the expansion of the town between the year 2003 and 2019.

Dukem is preferred as suitable corridor to promote investment owing to the best opportunities available i.e. proximity to the national market and location on the national highway road and railway line, the existence of suitable and accessible land. The existence of cheap labor and land fee is another opportunity that makes the area feasible for private sector involvement. Currently, there are many types and stages of manufacturing activities in the town with other small scale industries. Dukem hosts more than 500 domestic and foreign private investors engaged in various investment activities like; manufacturing industries, hotel and tourism, real estates and services (Dukem profile, 2019). According to the same source, this sector generates an employment opportunity for more than 23,932 (see Table 4.16) populations from different parts of the country.

According to 2008 land use plan (LUP) and 2017 structure plan (SP) prepared by OUPI, industry cover 186.2ha of land i.e. 4.39% in 2008 and this changed to 510.5ha of land i.e. 12.02% in 2017 (see also Table 4.21). More than 18 billion ETB is invested and more than 600 hectare farmland is converted. Eastern Industry Zone (EIZ) is one amongst and the largest holding more than 500 hectare land. This industry zone is in operation comprising more than 80 factories (Dukam town profile, 2019). At present, industry is densely concentrated in the Western and North Eastern area of the town; in reference to the preceding Dukem town boundary locally named Tedecha and Gogecha areas.

Figure 4.25: Showing Eastern Industry Zone (EIZ) (Source: Own photo, 2020)

Table 4.16: Number of Industry, Capital and employment Creation

No	Activity	Number	Capital (ETB)	Employment
1	Chemical industry	5	2,036,776,318	98
2	Garment	1	2,011,920,000	190
3	Manufacturing	233	6,984,105,608	13,395
4	Light Industry	10	3,079,100,000	725
5	Steel and Metal	11	2,367,382,780	1,718
6	Tannery and Leather	3	35,000,000	120
7	Textile and Garment	20	254,130,000	1,592
8	Agro industry	1	1,000,000	71
9	Agro processing	45	314,768,407	1,640
10	Mining and Energy	1	3,000,000	14
11	Others	139	724,771,241	4,369
	Total	**469**	**17,811,954,354**	**23,932**

(Source: Dukem Town Municipality, 2019)

As presented in the above (Table.16), Dukem town currently has a total of 469 industries and manufacturing were running with a total capital 17,811,954,354. This indicated that the industry sector has contribution to the local, national economy in many ways import substitution and saving foreign currency, tax contribution and employment generation and where by contributed a lot for the dramatic expansion of Dukem town particularly in the past ten years.

Besides, the investment economic contribution is remarkable; it also enables the country to earn notable foreign currency by way of exporting finished and intermediate/semi processed product oversea. However, this esteemed industry expansion and urbanization in the region of Oromia is not without difficulty and condemnation. The industry expansion is also is feared and denounced for evicting the poor, marginalizing and putting small farmers in to livelihood insecurity. The undesirable incidence succeeding industry expansion are unemployment of the farming family and household, loss of livelihood asset land, family disintegration and loss of farmer's household life at large. Diriba (2016) stresses the negative consequences that in spite of the catalytic role that industries play in the processes of realizing rapid economic growth, this sector, incur heavy costs on the part of the livelihood of agricultural communities.

Figure 4.26: Showing the established industries and manufacturing in Koticha Kebele (Source: Own photo, 2020)

4.5.3.4. Development in Road Infrastructure and Transportation

Dukem town is located on the National Trade Route (NTR) line, bisected by the National highway road from Addis Ababa to Djibouti making transportation access to all national, regional and district urban centers. Another infrastructure contributing to the existence of strong transport linkage is National Railway Line (NRL) crossing the town and Addis-Adama expressway passing through Dukem town.

Figure 4.27: Showing National Railway Line (NRL) crossing the town (Source: Own photo, 2020)

Figure 4.28: Showing Addis-Adama expressway passing through the town (Source: Own photo, 2020)

Transport routes open the access of the town to the region and countryside and responsible for linear development and expansion. Roads are the major catalyst for urban expansion (Handy, 2003; Batty, 2004; Bhatta, 2010). In the two major outlets there are a number of commuters per day with high mobility between Addis Ababa and Dukem along a line to Bishoftu, Modjo, Adama, Djibouti and other eastern regions of the country. According to Ahmed (2011) in the main outlets where most of the expansions were related with housing,

services and recreational functions and those factors attract other contingent activities and open a door for further urban expansion. A number of passengers and long distance voyagers are passing through the town taking good to and from Djibouti port most of the time the truck drivers prefers Dukem as a resting place.

The town expanded highly on the either sides of the road along the main infrastructure (highway and expressway roads) to the western and eastern part of the region highly and converges to surrounding rural villages like Gebi in the eastern part, Mendelo in the western part, Waajitu and Dibdibbe in the southern part and Tedecha in the northern part. Furthermore, industries that are already established in the town contributed a lot for further infrastructure development and this brought horizontal expansion of the town.

According to the survey result from office employees and communities on the factor that 'development in infrastructure and transportation' contributed a lot for the expansion of the town shown that were most of office employees agreed to this factor with 90.9% while less than half of communities agreed (most of them not agreed i.e. 'disagreed') with 34.8% (see Figure 4.22 and 4.23). On the other hand, in terms of descriptive analysis data were most of office employee's perceived agreed with the average mean of 3.18 while the communities perceived disagreed with the average mean of 1.30 (see Table 4.12 and 4.13). The survey result showed that there is a huge difference between the two were most of office employees as average agreed while communities as average disagreed to this driving factor.

Therefore, this indicated that office employees has positive attitude with most 'agreed' value to the factors while the communities negative perceptions with most 'disagreed' value with the factor 'development in infrastructure and transportation' that contributed a lot for the expansion of the town between the year 2003 and 2019. On the other hand this result implied that the communities were not satisfied with the existing infrastructure development in the town. For instance one of the respondents from the community said that "Our town Dukem is endowed with high concentration of investment activities most profoundly in industrial and manufacturing, a lot of both local and foreign investors invest in the town, but their contribution to the development particularly in terms of social service and infrastructure provision also keeping environment safe with greenery still now I'm not seen yet".

4.5.3.5. Prepared Plans of the Town

Oromia Urban Planning Institute (OUPI) is a governmental institution established under Oromia National Regional Government to prepare urban plan of different kind. Accordingly, in 2008 and 2017 the institute prepared a land use plan (LUP) and structure plan (SP)

respectively for Dukem town. Those studies attempt to draw important existing planning issues and forward remedial measures at all particularly on land use plan. Hence, those prepared planning frameworks land use plan (LUP) in 2008 and structure plan (SP) in 2017 had their own contributions and implications for the dramatic expansion of the town.

Dukem town within its present boundaries, comprise two urban clusters, the old (LUP) and new (SP). The old part of Dukem is the area totally covered 4245.89 hectare land, where the town was originally founded and which used to serve as the major administrative and commercial center of the town. The new prepared structure plan demarcated a total area of 9630.3 hectare of land in the coming year 2027 (OUPI, 2017) this had its own implications for the future dramatic expansion of the town **(**see Table 4.21). Currently, the major function such as governmental offices, financial institutions and main commercial areas such as shops and hotels are concentrated in the center of the town. The main growth direction of the town is only to the Southern and Northern directions. But in the other two directions western and eastern the town already land locked with Gelan and Bishoftu towns respectively.

According to the survey result from office employees and communities on the factor that the prepared plans (land use plan and structure plan) of the town contributed a lot for the expansion of the town shown that were more than half of them agreed to this factor with 66.7% and 53.1% respectively (see Figure 4.22 and 4.23).

On the other hand, in terms of descriptive analysis data were most of office employees and communities perceived average agreed with mean of 2.64 and neutral with mean 2.31 respectively (see Table 4.12 and 4.13). The survey result showed that there is a little bit difference between the two respondents (office employees and communities), were most of office employees as agreed while communities as a neutral to this driving factor. Therefore, this indicated that office employees were agreed the prepared plans (land use plan and structure plan) of the town that contributed a lot for the expansion of the town between the year 2003 and 2019. While the communities neither negative nor positive attitude with a value neutral average with this driving factor.

Furthermore, rapid industrialization and urbanization process in Dukem town has brought dynamic economic and demographic changes. This dynamism caused urban land expansion that led to the conversion of considerable size of the farming land in the urban fringe. Accordingly, within very short period of time the agricultural land changed in to varies category of built up area, especially to the residential and industrial functional uses as presented (Table 4.17) in the following.

Table 4.17: Comparison between 2008 and 2017 Existing Land use

No	Land use Type	Existing LUP (2008)		Proposed LUP (2008)		Existing SP (2017)		Proposed SP (2017)	
		Area (Ha)	Area (%)	Area (Ha)	Area (%)	Area (Ha)	Area (%)	Area (Ha)	Area (%)
1	Administration	3.6	0.08	11.2	0.26	4.57	0.12	20.8	0.2
2	Residence	452.8	10.66	1308.6	30.82	1128.1	26.57	3612.2	37.5
3	Commerce	30.3	0.72	215.3	5.07	121.8	2.87	204.8	2.1
4	Service	21.7	0.51	63.4	1.49	61.3	1.44	246.3	2.6
5	Industry	186.2	4.39	658.9	15.52	510.5	12.02	1735.7	18.0
6	Agriculture	3311.49	77.99	1244.86	29.32	1589.32	37.43	1698.0	17.6
7	Road & Transport	153.9	3.63	542.5	12.78	777.1	18.30	1926.9	20.0
8	Others	85.9	2.02	201.47	4.74	53.2	1.25	185.5	1.9
	Total	4245.89	100	4245.89	100	4245.89	100	9630.3	100

(Source: 2008 Land Use Plan (LUP) and 2017 Structure Plan (SP) prepared by OUPI)

As presented in the above (Table 4.17), The general urban land use of the town comprises different categories such as administration, residence, commerce, service, industry, agriculture, road & transport and others (special function, reserved, water body, recreation, quarry and gorge). The comparison between 2008 Land use plan (LUP) and 2017 structure plan (SP) existing land use prepared by OUPI indicated that due to horizontal expansion of the town fertile agricultural land changed into different land use classes. Among these, residence was exceeded by about three times increased from 452.8ha (10.66%) to 1128.1ha (26.57%) which was taken as the largest portion between 2008 and 2017, which accounts about 15.91% from the total share of agricultural land. Road and Transport (Infrastructure) was next to residence land use in portion of land use changed from 153.9ha (3.63%) to 777.1ha (18.3%), which accounts about 14.61%, then Industry changed from 186.2ha (4.39%) to 510.5ha (12.02%), which accounts about 7.63%, Commerce, Service and Administration about 2.15%, 0.93% and 0.04% respectively from the total agricultural land use changed into different categories. On the other hand within the time span of nine (9) year the share of agricultural land was declined from 3311.49ha (77.99%) to 1589.32ha (37.43%) by 40.56% difference between the year 2008 and 2017. Therefore, the result showed that after the approval of the LUP, the total area of existing land use for both residence and industry in 2008 was exceeded by about three times between 2008 and 2017 (Figure 4.29).

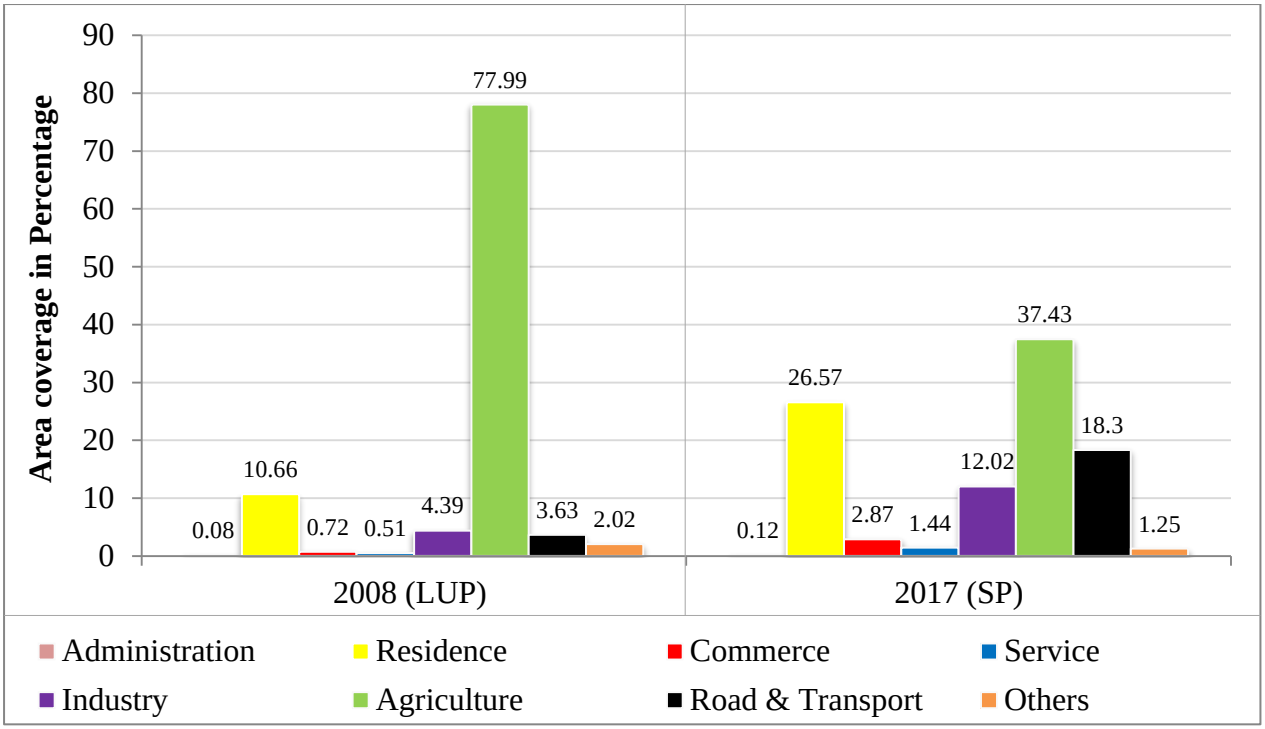


Figure 4.29: Percentage of Landuse categories in 2008 LUP & 2017 SP (Source: OUPI, 2017)

Figure 4.30: Showing rapid expansion of residence in Tedecha kebele (Source: Own photo, 2020)

Moreover, the town has two plans, land use plan (LUP) in 2008 and structure plan (SP) in 2017 prepared by OUPI. However, those plans were not properly implemented on the ground. There were a mismatch between the LUP prepared by OUPI in 2008 and the current land use of Dukem town. For instance, in Koticha kebele a local name called 'Meto Arba' neighborhood there was a surprising case, based on the data generated from Dukem town existing block and parcellation map and field survey cross-checking found that more than half of land allocated to green area and social services in LUP 2008 were currently converted in to residential use and houses constructed on it. Furthermore, the data generated from Dukem town current existing block and parcellation were presented in detail both in map (Figure 4.31) and (Table 4.18) in the following.

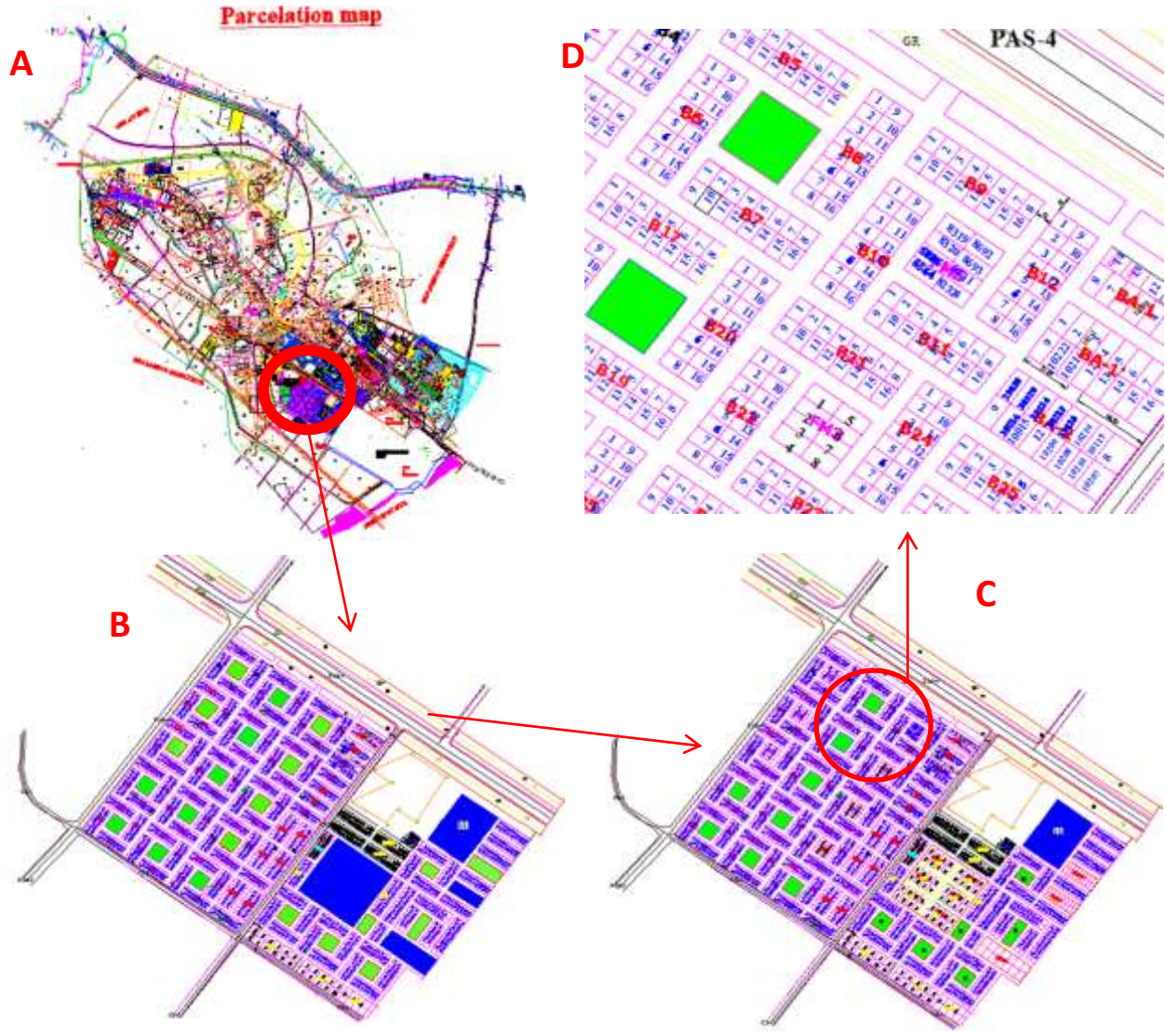


Figure 4.31: Dukem town current parcellation showing a mismatch between the LUP in 2008 and the current land use in locality 'Meto Arba' neighborhood (Source: DTLDMO, 2020). Showing Dukem town block and parcellation (A), Proposed LUP in 2008 (B) and implemented or converted green and service functional uses in residence parcel (C) & (D)

Table 4.18: Parcels converted from Green & Service to residence in the locality 'Meto Arba'

Parcel (m^2)	Total Number of parcel	Area (m^2)	Area (ha)	Conversion
160	18	2880	0.288	Service to residence
175	18	3150	0.315	Green area to residence
200	56	11200	1.12	Green area to residence
500	62	31000	3.1	Service to residence
Total	**154**	**48230**	**4.823**	

(Source: Compiled from Dukem town current parcellation map DTLDMO (2020))

As presented in the (Table 4.18) a total area of 3.388 hectare and 1.435 hectare were converted from service and green area to residence in its current functional use respectively. On other hand a total area of 4.823 hectare (48230m^2) amount of land grabbed with the involvement of different actors. During field survey, I tried to asked experts in the office and officials why such case happened and most of them said that, "it was happened by a group of previous wealth collectors (corrupted politicians/officials, investors and experts) in the town and It is a serious issue currently under investigation handled by Anti-Corruption Commission".

Therefore, Land is inappropriately been exploited together in cooperation of different actors like the government officials or authorities, experts, brokers, investors and residents of the town. Particularly, the Government officials were played a great role in land grabbing because they are the major motivator goes to policy makers who are accountable to manipulate, who are responsible to develop government policy and promulgate urban planning regulations and also They are the decision makers for the whole thing due to this power they can easily grab land or public resource in the town and whereby contributed a lot for the rapid expansion of Dukem town. Moreover Husen Tura (2018) in his study indicated similar cases that corruption, lack of transparency and injustice regarding land administration system and distribution has created a group of wealth collectors.

4.5.3.6. Housing Preference

The unprecedented growth of urban population was causing an exceptionally rapid increase in the demand for housing in the town. Several people commute between Addis Ababa, Adama and Bishoftu for job and many are preferred residing in Dukem town. This indicates the demand for residence purpose was higher in the town. Expansion of massive single family house due to living in apartment and multi-family high rise building not exist except condominium housing came in to being very recently in the town.

Thus, privately built single family residential home were perceived in the town and this excessive demand for the land has also initiated the spreading of investments and settlements on the outskirts into farming lands.

Accordingly, the survey result from office employees and communities on the factor that 'housing preference' contributed a lot for the expansion of the town shown that were most of office employees agreed to this factor with 89.4% while less than half of communities agreed with 40.3% (see Figure 4.22 and 4.23). On the other hand, in terms of descriptive analysis data were most of office employee's perceived agreed with the average mean of 3.26 while the communities perceived neutral with the average mean of 1.97 (see Table 4.12 and 4.13). The survey result showed that there is a contradiction between the two were most of office employees as average agreed while communities as a neutral to this driving factor. Therefore, this indicated that office employees has positive attitude with most 'agreed' value to the factors while the communities neither negative nor positive attitude with a value neutral perceptions with the factor 'housing preference' that contributed a lot for the expansion of the town between the year 2003 and 2019.

Moreover, a massive residential land delivery was undertaken by a town municipality in 2017/2018 especially for farmer household and their families who lose their agriculture land due to the development of huge industries and manufacturing. Accordingly, 227 farmer household earn 500m^2 and 635 farmer families above 18 years old earn 140 m^2 a total of 20.24 ha land was delivered (DTLDMO, 2020).

Figure 4.32: Showing a massive residential land delivery 140 m^2 in 2017/2018 in Tedecha kebele (Source: Own photo, 2020)

4.5.3.7. Informal Access to Land

Dukem town land development and management office administration registered about 1,866 exact numbers of informal housing units in the year 2018. The informal access to land also indicated during survey as major factor that contributed a lot for the expansion of the town between the year 2003 and 2019 by office employees and communities. Accordingly, the survey result from office employees and communities on the factor that 'informal access to land' contributed a lot for the expansion of the town shown that were the most strongly agreed factor with 81.9% and 74.4% respectively (see Figure 4.22 and 4.23). On the other hand, in terms of descriptive analysis data were most of office employees and communities perceived strongly agreed with an average mean of 3.14 and 3.01 respectively (see Table 4.12 and 4.13). Therefore, survey result showed that both office employees and communities perceived an average of 'agreed' with the 'informal access to land' that contributed a lot for the expansion of the town between the year 2003 and 2019.

Figure 4.33: Showing informal settlement along the newly constructed national railway line in Tedecha kebele (Source: Own photo, 2020)

During field survey, a number of informal settlers on the periphery of the town were observed. According to some informants during survey, there was illegal land market going in Tedecha and Gogecha kebeles, where there were farmers parceling and selling their agricultural land in fear of the government's land expropriation. A lot of speculative buyers drive within the informal land market in Dukem town. As described by Shodhganga (2013), the process of 'informal access to land' was just like, new plot of land come on to the market

through an informal system without any planning or documentation. The exchange is usually among personal networks and a simple sales dealing by the local administration officials, brokers, local farmers and community of the town. Those people buying the land are illegally accessing the land. Then, they construct a small hut on the purchased parcel till they are ready to be regularized in the future and build the main residential or resell it for profit in the future.

Moreover according to ascertains that deficiencies of the public land management system particularly the land allocation process have led to the evolution of informal land markets (Tendayi, 2009; as cited by Shodhganga, 2013). Also Husen Tura (2018) added that the inefficiencies of formal land supply have consequently seen the occurrence of informality.

4.5.3.8. Location of the Town

Geographical location is one of the factors for the rapid expansion of urban centers. Accordingly, Dukem town is located at 37km South East of Addis Ababa along the main road to Adama. In spite of its location the town is preferred for different urban functions particularly for industries & manufacturing and residential uses.

According to the survey result from office employees and communities on the factor that 'location of the town' contributed a lot for the expansion of the town shown that were the most strongly agreed factor with 92.4% and 76.6% respectively (see Figure 4.22 and 4.23). On the other hand, in terms of descriptive analysis data were most of office employees and communities perceived strongly agreed with an average mean of 3.53 and 3.02 respectively (see Table 4.12 and 4.13). The survey result showed that almost both office employees and communities were most agreed with the location of the town contributed a lot for the expansion of the town between the year 2003 and 2019.

Moreover, the town has strong transport linkage with Addis Ababa and the neighboring urban centers due to a number of commuters per day those who preferred to live in the town and work in Addis Ababa. Dukem is favored as suitable corridor to promote investment owing to the best opportunities available i.e. proximity to the national market and location on the national highway road and railway line, the existence of suitable and accessible land.

4.5.3.9. Topography and Slope of the Town

Topography is also another important factor which contributes for the expansion of the town. Dukem town is characterized by large flat and gentle slope which is suitable for development and expansion of the town. Accordingly, the largest slope class (1-2%) covers various parts of the town with a total area of 2691.6 hectares (63.4%) particularly south-eastern, southern

and central parts of town. The elevation of the town ranges from 1890m to 2300m above MSL with an altitudinal range of 410 meters and different slope classes are found in different parts of the town (OUPI, 2017). The main reason could be the flat topography that attracts residence since flat area created conductive condition for construction purpose and facilitates easy movement.

Accordingly, the survey result from office employees and communities on the factor that 'topography or slope of the town' contributed a lot for the expansion of the town shown that were more than half of office employees agreed to this factor with 60.7% while less than half of communities agreed 40.7% (see Figure 4.22 and 4.23). On the other hand, in terms of descriptive analysis data were most of office employees and communities perceived average neutral with mean of 2.27 and 1.84 respectively (see Table 4.12 and 4.13). The survey result showed that there is a little bit difference between the two were most of office employees as average agreed while communities as a neutral to this driving factor. Therefore, this indicated that both office employees and communities neither negative nor positive attitude with a value neutral average with 'topography or slope of the town' that contributed a lot for the expansion of the town between the year 2003 and 2019.

4.5.3.10. Land Grabbing

Land grabbing (attitude of government officials) acquisition is generally defined as the process of governments of large lot of land that were leaded by foreigners, transnational companies or investors particularly in the developing countries (Kenate, 2013).

According to Kenate, (2013) in his study drivers (determinants) of expansion of Addis Ababa and the role of actors specified that land is unfortunately been exploited by the government bodies from top to the bottom level administration for the purpose of investment and national development. He also further described that, land is a source of power if someone comes to the power means it is known by default that he will be among the investors or the rich. Moreover, Husen, (2018) in his study land rights and land grabbing in Oromia concluded that 'government cadres in order to get political reward and credit were doing a number of problems to the innocent poor people'.

According to the information from office employees during survey, Through Land grab huge hectares of land is always prepared by displacing the farmers from their agricultural land and kept in a land bank then massive amount of land is given to investors for housing and industrial establishments in the town. Yirgalem, (2009) in his study the situation of informal actors in urban land management concluded that 'in most cases the direct beneficiaries from

the land sell to the foreign companies and to the local investors were the government officials'. Kenate, (2013) in his study also indicated that, land lease policy has created the chance to the officials and other actors being engaged in corruption and he concluded his study by saying that, corruptions related to land lease holding and land grabs by government authorities in Addis Ababa and the surrounding Oromia special zone towns there were a lot of developments perceived. Likewise, Corruption, lack of transparency and injustice regarding land administration system and distribution not an exceptional case in Dukem town, which has created a group of wealth collectors, land speculators, and brokers upon the public land and whereby contributed a lot for the rapid expansion of the town.

4.6. The Driving Actors

Actors can be defined as those individuals or bodies that involve or contribute on the expansion of the town. The actors have diverse power to do so. Their power is likely to depend on resources they own and their interest. In the process of expansion or development, roles are played by different actors. According to Ahmed, (2011) one of the most important approaches in the study of the driving forces of urban expansion is enumerating the major stakeholders or decision makers in the existing phenomena. The most important actors as grassroots i.e. investors, government bodies, communities, farmers and others are among the core stakeholders who play their own role in driving urban expansion of the town.

The driving factors behind land use land cover (LULC) change from the actors side it is wise to saw the role played by the government bodies or agencies, the farmers who gave their land, investors or communities who bought land, land brokers who property dealers with the major focus on land market. The driving actors were considered in this study such as private developers (investors), government officials, experts, community of the town, local farmers and land brokers.

4.6.1. Perceptions of Office Employee's on Key Actors

In order to measure the perception of office employees on the key actors who contributed a lot for the rapid expansion of Dukem town between 2003 and 2019, Six (6) actors such as private developers (investors), government officials, experts, community of the town, local farmers and land brokers were included in the survey questionnaire for the respondents (office employees) using five point Likert scale measurement. Accordingly, most of the respondents (office employees) were agreed with listed actors such as private developers/investors (93.9%), community of the town (89.4%), government officials (86.4%), experts (78.8%) and almost more than half of office employees agreed on local

farmers (57.6%). While considerably less than half of the office employees are agreed (i.e. more than half not agreed) to land brokers (33.4%) who contributed a lot for the rapid expansion of Dukem town between 2003 and 2019 (see Figure 4.34).

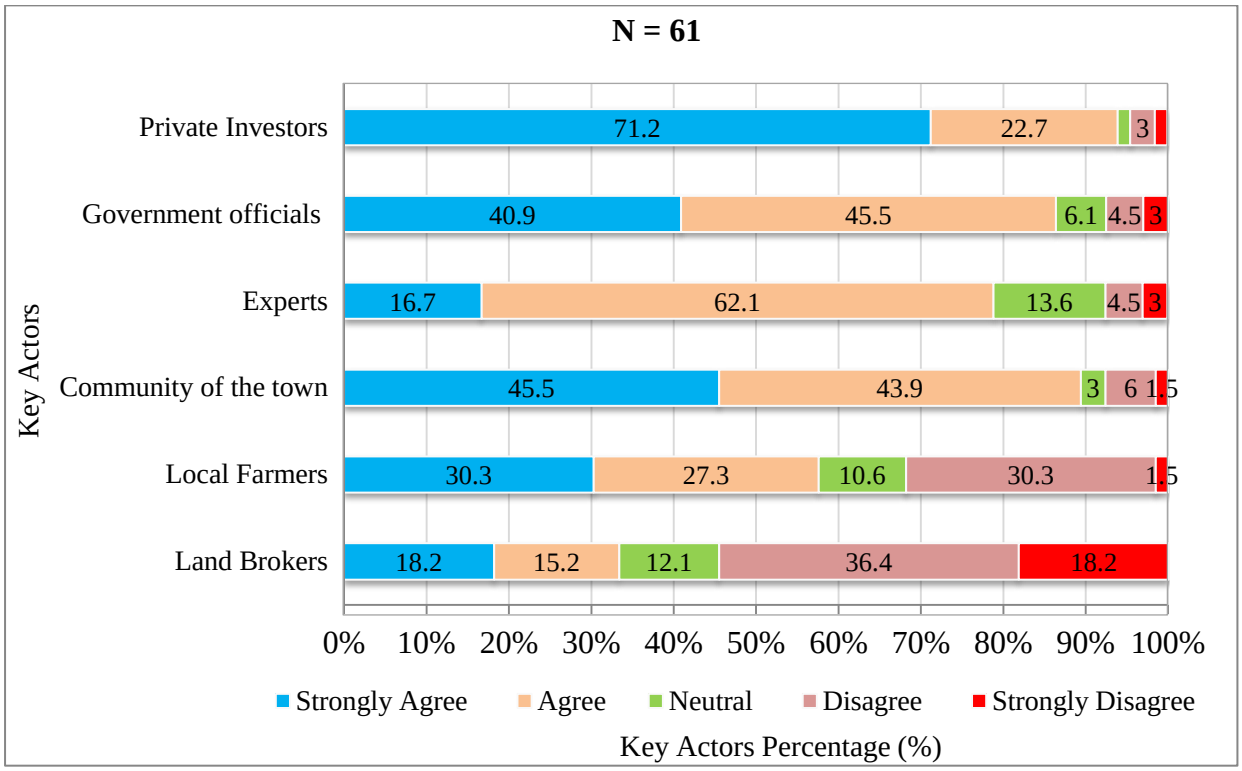


Figure 4.34: Showing key actors rating according to office employees

In similar way the survey provided open-ended questions for office employees to express their own perceptions on additional key actors who contributed a lot for the rapid expansion of Dukem town between 2003 and 2019 with open-ended questions. Accordingly, from 61 surveys there were 16 responses from office employees forwarded to the key actors on the open-ended question. Therefore, there are three (3) raised additional major response by office employees on urban expansion driving actors such as Diaspora with eleven (8) responses, Land Graber's (former as well as current corrupted official, investors, experts and communities) with five (5) responses and land speculators with five (3) responses. All of them were discussed in corresponding sections of analyses.

4.6.1.1. Descriptive Analysis of Office Employee's on Key Actors

In order to assess the perception of office employees on the key actors who contributed a lot for the rapid expansion of Dukem town between 2003 and 2019, Six (6) urban expansion driving actors were included in the survey questionnaire. Accordingly, to analysis and measure these perception descriptive analysis methods were used the average attitude of 61 surveys and the most rated frequency of each as shown in (Table 4.19).

The results were interpreted to further describe and analyses the characteristics of perceptions, a measure of central tendency (mean, median and mode), measure of dispersion (standard deviation and variance) and measure of distribution (Skewness) were discussed. The results in the table are directed based on Likert scales measurement from 0-4 values, whereas strongly disagree (0), disagree (1) neutral (2), agree (3) and strongly agree (4). The outputs in the table were based on the value which means the results near to 4 showed strong agreement of communities with the respective listed urban expansion driving forces.

Table 4.19: Descriptive analysis result of office employees on driving actor's

Key Actor's	**N**	**Mean**	**Median**	**Mode**	**Std. Deviation**	**Variance**	**Skewness**
Private Investors	61	**3.59*** **	4	4	.803	.645	-2.600
Government officials	61	**3.17** **	3	3	.954	.910	-1.551
Experts	61	**2.85** **	3	3	.864	.746	-1.323
Community of the town	61	**3.26** **	3	4	.900	.810	-1.585
Local Farmers	61	**2.55** **	3	1	1.255	1.575	-.227
Land brokers	61	**1.79***	1	1	1.398	1.954	.392

*neither negative nor positive attitude with a value around two or neutral average, **positive attitude with a value around three which as agree to the actors and ***positive attitude with a value around four which as more agree to the actors

As presented in the above (Table 4.19) private developers or investors is the actor which office employees rated as strongly agreed with an average score mean of 3.59. The key actors who driving expansion of the town such as community of the town, government officials, experts, and local farmers were the actors which office employees 'agreed' with an average score of 3.26, 3.17, 2.85 and 2.55 respectively. However, when compared in terms of office employees rating frequency for the private developers or investors and community of the town actors are the most frequently rated as strongly agreed with, While government officials and experts has rated as agreed which the most frequently rated value by office employees. On the other hand, land brokers are driving actors that office employees rated as disagreed with an average score mean of 1.79. And when compared in terms of the most frequently rated value by office employees, the scored value is neither negative nor positive attitude with a value around two or average neutral perception.

4.6.2. Perceptions of Communities' on Key Actors

In the same way, to measure the perception of communities on the key actors who contributed a lot for the rapid expansion of Dukem town between 2003 and 2019, Six (6) variables

(actors) such as private developers (investors), government officials, experts, community of the town, local farmers and land brokers were included in the survey questionnaire for the respondents (office employees) using five point Likert scale measurement.

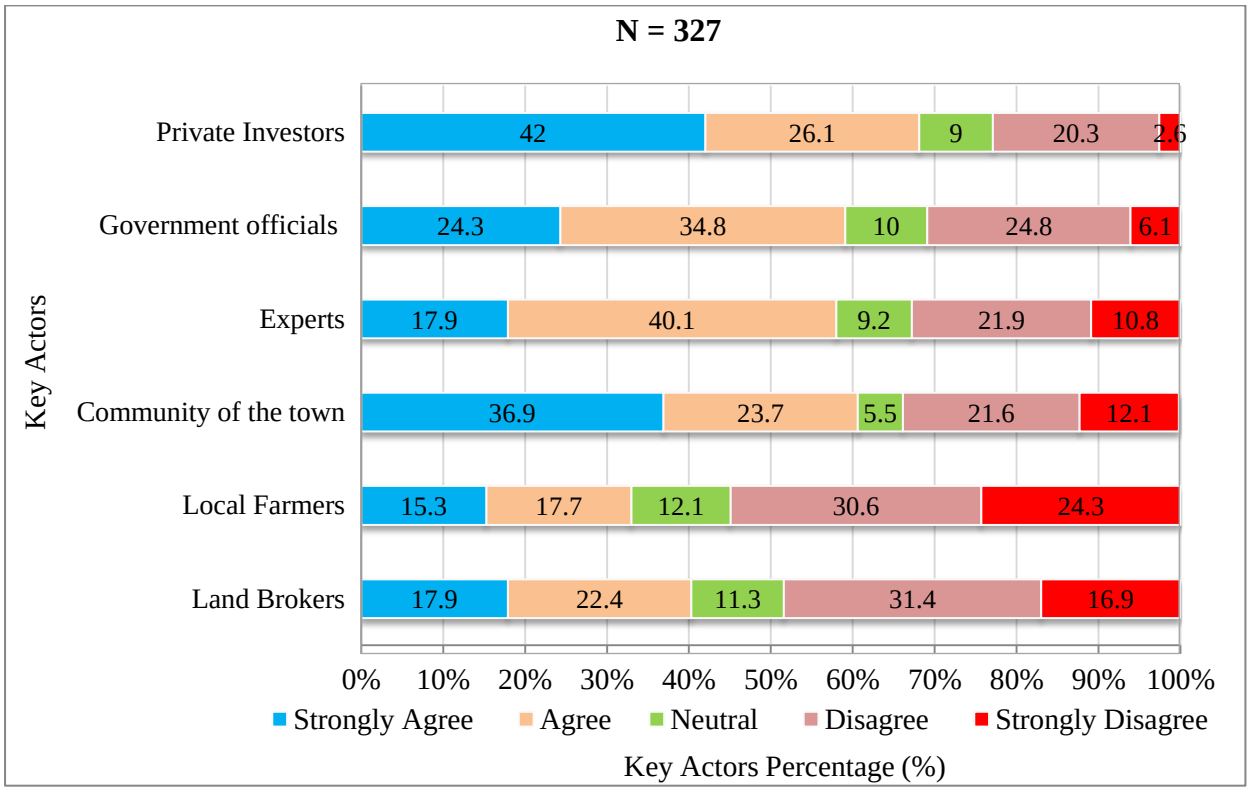


Figure 4.35: Showing key actors rating according to communities

As shown in the above (Figure 4.35), most of the communities were agreed with private developers/investors (68.1%) and community of the town (60.6%), almost more than half of communities agreed on government officials (59.1%) and experts (58%). While considerably less than half of the communities are agreed (i.e. more than half not agreed) to land brokers (40.3%) and local farmers (33%) who contributed a lot for the rapid expansion of Dukem town between 2003 and 2019.

In similar way, the survey provided open-ended questions for communities to express their own perceptions on additional key actors who contributed a lot for the rapid expansion of Dukem town between 2003 and 2019 with open-ended questions. Accordingly, from 327 surveys there were 14 responses from communities forwarded to the key actors on the open-ended question. Therefore, there are two (2) raised additional major response by communities on urban expansion driving actors such as Diaspora with two (2) responses and Land Graber's (former as well as current corrupted official, investors, experts and communities) with twelve (12) responses. All of them were discussed in corresponding sections of analyses.

4.6.2.1. Descriptive Analysis of Communities' on Key Actors

Similarly, In order to assess the perception of communities on the key actors who contributed a lot for the rapid expansion of Dukem town between 2003 and 2019, Six (6) urban expansion driving actors were included in the survey questionnaire. Accordingly, to analysis and measure these perception descriptive analysis methods were used the average attitude of 327 surveys and the most rated frequency of each as shown in (Table 4.20).

The results were interpreted to further describe and analyses the characteristics of perceptions, a measure of central tendency (mean, median and mode), measure of dispersion (standard deviation and variance) and measure of distribution (Skewness) were discussed. The results in the table are directed based on Likert scales measurement from 0-4 values, whereas strongly disagree (0), disagree (1) neutral (2), agree (3) and strongly agree (4). The outputs in the table were based on the value which means the results near to 4 showed strong agreement of communities with the respective listed urban expansion driving factors.

Table 4.20: Descriptive analysis result of communities on driving actor's

Key Actor's	**N**	**Mean**	**Median**	**Mode**	**Std. Deviation**	**Variance**	**Skewness**
Private Investors	327	**2.84****	3	4	1.241	1.539	-.679
Government officials	327	**2.76****	3	3	1.264	1.599	-.381
Experts	327	**2.32***	3	3	1.292	1.670	-.422
Community of the town	327	**2.52****	3	4	1.468	2.155	-.468
Local Farmers	327	**1.69***	1	1	1.406	1.976	.366
Land brokers	327	**1.93***	2	1	1.390	1.932	.147

*neither negative nor positive attitude with a value around two or neutral average,
**positive attitude with a value around three which as agree to the actors

As indicted in the above (Table 4.20) Private developers or investors, government officials and community of the town were the actors in which communities rated as agreed with an average score mean of 2.84, 2.76 and 2.52 respectively. However, both actors 'private developers or investors' and 'community of the town' average perceived value is around three which as agree to the actors in its mean value of 2.84 and 2.52 respectively, with the most frequently rated value of 'strongly agree' i.e. 4 mode value. However, since some communities perceived private developers or investors and community of the town by rating as 'disagree' it makes the average value less the most frequently rated value by skewing the perception of office employees toward the 'agreed'. While actors who driving expansion of the town such as experts, land brokers and local farmers were the actors in which perceived

most ‘neutral’ with an average score between 2.32, 1.93 and 1.69 respectively. However, when compared in terms of office employees rating frequency for the government officials and experts actors are the most frequently rated as ‘agreed’ with, While local farmers and land brokers has rated as disagreed which the most frequently rated value by communities.

4.6.3. Driving Actor’s Analysis

The driving key actors who contributed a lot for the rapid expansion of Dukem town between 2003 and 2019, which are considered in this study such as private investors, government officials, experts, community of the town, local farmers and land brokers were discussed in respective sections of analyzed in the following.

4.6.3.1. Private Investor’s

Husen, (2018) & Kenate, (2013) in their study the role of actors indicated that among the various actors who have the part to play in the demand side of the land market were the investors. Private sector players are actually not only the investors alone but also brokers and property dealers, the farmers themselves, different entrepreneurs and speculators. The private developers can also be diaspora’s and categorized into foreign and local investors or developers. The local developers include those investors who are willing to establish real estate developments for local purchases to accommodate the spill-over population and the people who need the highest quality residential houses. On the other hand foreign developers who got support from the government to invest in a various big developments. Yirgalem, (2009) concluded that, local investors or developers are people with strong economic basis and political connections with the government in authority. Further he noted that with exception of very few investors, the majority are indirectly owned by the government officials and their agents. They are the decision makers for the whole thing and can easily own land for their investment projects. They grab land from other investors who have no political power. These groups of investors are also among the top speculators of public resource (Kenate, 2013).

According to the survey result from office employees and communities on the actor that ‘private investors or developers’ contributed a lot for the expansion of the town shown that were the most strongly agreed actor with 93.9% and 68.1% respectively (see Figure 4.34 and 4.35). On the other hand, in terms of descriptive analysis data were most of office employee’s perceived strongly agreed with the average mean of 3.59 while the communities perceived agreed with the average mean of 2.84 (see Table 4.19 and 4.20). The survey result showed that there is a little bit difference between the two were most of office employees as average

strongly agreed while communities as an average agreed to this actor. Therefore, this indicated that both office employees and communities has positive attitude with most 'agreed' value to the driving actor 'private investors or developers' that contributed a lot for the expansion of the town between the year 2003 and 2019.

4.6.3.2. Government Official's

Government officials are the other major interest bodies and in fact the major motivator goes to policy makers who are accountable to manipulate the government and who are responsible to develop government policy and promulgate urban planning regulations (Yirgalem, 2009). Kenate, (2013) also noted that government officials or authorities were responsible to regulate project development, evaluation and approval and follow up the policies designed and development schemes planned and overall decisions. According to some informants during survey, The interest of authorities do not only vary according to the role they have as an government institution but also many times reflect their individual interest, depending on many personal programs for instance the role played by political officials which finally opens the door for informal actors who are powerful to act by manipulating government administration.

According to the survey result from office employees and communities on the actor that 'government official's' contributed a lot for the expansion of the town shown that were the most agreed actor with 86.4% and 59.1% respectively (see Figure 4.34 and 4.35). On the other hand, in terms of descriptive analysis data were most of both office employee's and communities perceived agreed with the average mean of 3.17 and 2.76 (see Table 4.19 and 4.20). Therefore, this showed that both office employees and communities has positive attitude with most 'agreed' value to the driving actor 'government official's' that contributed a lot for the expansion of the town between the year 2003 and 2019.

4.6.3.3. Experts

The experts or office workers are actor who involved in facilitating both the supply and demand in the land market and who assist the speed of land conversion (Husen, 2018; Kenate, 2013). According to some information from office employees and communities during survey, many speculative buyers operate within the illegal land market in the town with cooperation with experts or workers. Sales agreements are validated by experts at Dukem town land development and management office and at kebele level and local kebele administration officials. Participants in such case transactions particularly a larger group of rich people and middle-income earners.

According to the survey result from office employees and communities on the actor that 'expert's' contributed a lot for the expansion of the town shown that were the most agreed actor with 78.8% and 58% respectively (see Figure 4.34 and 4.35).

On the other hand, in terms of descriptive analysis data were most of office employee's perceived agreed with the average mean of 2.85 while the communities perceived neutral with the average mean of 2.32 (see Table 4.19 and 4.20). Therefore, survey result indicated that there is a little bit difference between the two were most of office employees as average agreed while communities as an average neutral to the driving actor 'expert's' that contributed a lot for the expansion of the town between the year 2003 and 2019.

4.6.3.4. Community of the town

The demand for housing in the town is increasing through time since several people commuters working in Addis Ababa and preferred residing in the town. According to some information from office employees and communities during survey, the town communities buy land either from farmers informally or through lease agreement formally construct a house. Thus, privately built single family residential home were perceived in the town.

According to the survey result from office employees and communities on the actor that 'communities of the town' contributed a lot for the expansion of the town shown that were the most agreed actor with 89.4% and 60.6% respectively (see Figure 4.34 and 4.35).

On the other hand, in terms of descriptive analysis data were most of both office employee's and communities perceived agreed with the average mean of 3.26 and 2.52 (see Table 4.19 and 4.20). Therefore, this showed that both office employees and communities has positive attitude with most 'agreed' value to the driving actor 'communities of the town' that contributed a lot for the expansion of the town between the year 2003 and 2019.

4.6.3.5. Local Farmer's

The local farmers are private interested actor who involved in especially in the supply side of the land market (Husen, 2018; Kenate, 2013). According to some information from office employees, communities and simple personal observation during field survey, there were illegal land markets going in Tedecha and Gogecha kebeles, where there are a lot of farmers parceling and selling their agricultural land in fear of the government's land expropriation. In such a case huge hectares of land is converted in to non-agricultural activities, particularly in to residential housing in the town.

According to the survey result from office employees and communities on the actor that 'local farmer's' contributed a lot for the expansion of the town shown that were more than half of office employees agreed to this factor with 57.6% while less than half of communities agreed (most of them not agreed i.e. 'disagreed') with 33% (see Figure 4.34 and 4.35).

On the other hand, in terms of descriptive analysis data were most of office employee's perceived agreed with the average mean of 2.55 while the communities perceived disagreed with the average mean of 1.69 (see Table 4.19 and 4.20). The survey result showed that there is a huge difference between the two were most of office employees as average agreed while communities as average disagreed to this driving actor. Therefore, this indicated that office employees has positive attitude with most 'agreed' value to this actor while the communities negative perceptions with most 'disagreed' value with the actor 'local farmer's' that contributed a lot for the expansion of the town between the year 2003 and 2019.

4.6.3.6. Land Broker's

The land brokers or property dealers are private interested actor who involved in both the supply and demand in the land market and who facilitate the pace of land conversion (Husen, 2018). According to some information from office employees and communities during survey, there is partnership between brokers, local authorities and local residents or communities who drive the farmers to sell their land informally to them and for some time the brokers hold the land for profit maximization. Land brokers or property dealers have the local authorities and experts for information provision regarding what the government is scheduling to do. Some land brokers actually negotiate the transaction with the farmers by keeping the authorities and then after getting adequate information they sell the land for those people who need for residential housing and whereby rapid urban expansion of the town.

Moreover Husen, (2018) & Kenate, (2013) described that land brokers are the one who have richer access to the most detailed local information on the legal status, ownership, prices and the person who interested either to sell or buy land. In this case even the local authorities do not have such detailed information as much as the brokers do.

According to the survey result from office employees and communities on the actor that 'land broker's' contributed a lot for the expansion of the town shown that less than half of both office employees and communities agreed (most of them not agreed i.e. 'disagreed') with 33.4% and 40.3% respectively (see Figure 4.34 and 4.35).

On the other hand, in terms of descriptive analysis both office employee's and communities' perceived neutral with the average mean of 1.79 and 1.93 (see Table 4.19 and 4.20). Therefore, this indicated that both office employees and communities neither negative nor positive attitude with a value neutral average with actor 'land broker's' that contributed a lot for the expansion of the town between the year 2003 and 2019.

4.7. Future Expansion of Dukem Town

4.7.1. Estimation of Population for the year 2030

To estimate population size ought to known population growth rate of the town computed. A growth rate calculation has three variants such as High, Medium and Low variant based on the situation of vital population growth factors. Annual Growth Rate of Dukam town and area included under the town is calculated 5.93% (CSA, 1994-2007) through the above formula which is greater than to Oromia urban area annual growth 4.13%, (CSA, 1994-2007).

According to this study, alternative growth rate such as high variant 6.93%, medium variant 5.93% and low variant 4.93% were assumed during 2019-2030. See the three alternative variants in (Table 6.7) below which are computed using (Equation 9).

Table 4.21: Estimated Population size of Dukem Town for 2030

No	Projection Variants	Growth Rates	Base Year Population	Estimated Population
			2019	**2030**
	High	6.93	96,320	201,285
	Medium	5.93	96,320	181,520
	Low	4.93	96,320	163,536

(Source: Own Computation from projected population, 2020)

As presented in the above (Table 4.21), in 2030 the population of the town will be varying between 163,536 and 201,285 when the population growth rate varies from the lower to highest variants respectively. Therefore, the population of the town assumed to grow at the average (medium variant) growth rate per annum during 2019-2030 because the town has huge industries that reason for high in migration rate. In the view, Dukem town will be expected to reach about an average of 181,520 populations by the year 2030. Thus, the population size is became almost close to double of 2019 (96,320) in 2030 (181,520).

The doubling time of the town is the time needed for the town to double itself and can be calculated as 70 per the annual growth rate of the town (OUPI, 2017).

Doubling time = 70/ Annual Growth rate.

=70/6.93%

=10.1Years

This indicates that, nearly after 10 years the population of Dukem will be double. This is a fast doubling time when compared with the doubling time of Ethiopia, which is 23 years (OUPI, 2017). The fast doubling time is due to high influx of people from rural area and other part of the country to Dukem because of seeking for job opportunity. Therefore, all policy and planning issue should consider the expected population size. See also the population growth trend from 2003-2030 in (Figure 4.36).

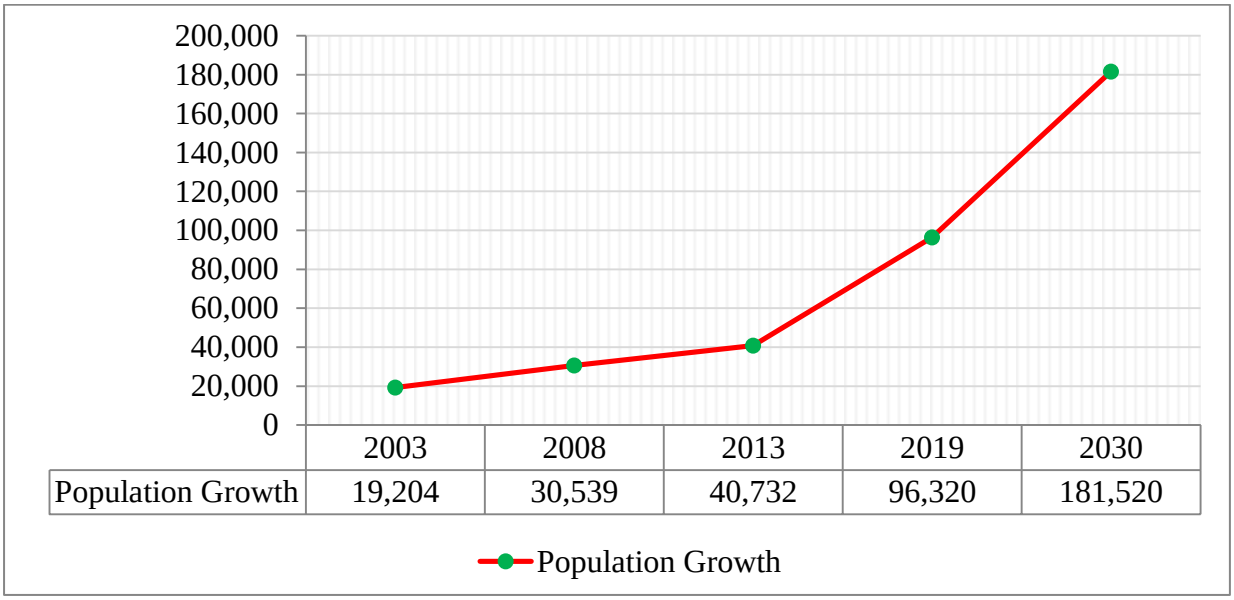


Figure 4.36: Population growth trend from 2003-2030 (Source: Own computation using CSA and OUPI projection in 2017

4.7.2. Estimation of Built up Area for the year 2030

In order to compute the future built up area growth of the town, it's compulsory to calculate average growth rate. Accordingly, based on the urban expansion of town for the last 16 years the average growth rate of the expansion has been calculated. The researcher used an average change percent in built-up area of 2003-2019 to compute an average growth rate based on exponential growth model as follows using (Equation 7).

To find the growth rate of built up area, it needs driving the formula from exponential growth formula. Thus,

Bf = Bo e^{rt} -------> $r = \frac{1}{t} * \ln\left(\frac{Bf}{B_0}\right)$

Bf = Final Built up

Bo = Initial Built up

r = Growth rate

t = Time (5 year)

$r = \frac{1}{t} * \ln\left(\frac{Bf}{B_0}\right) = \frac{1}{5} * \ln\left(\frac{998.09}{698.06}\right) = 0.2 * \ln(1.43)$ = 0.0715 (7.15%) built up area growth rate

The average growth rate of the expansion is calculated as 7.15%. Therefore urban expansion of the town is estimated for 2030 by using the exponential growth formula. Thus, exponential growth rate model applied as follow using (Equation 8).

Bf = Bo * $(1+\%/100)^{t\,(f-o)}$

Where B = Built up area

f = future year

o = initial/base year

% (r) = average growth rate per year

t = time in year

Bf = Bo * $(1+\%/100)^{t\,(f-o)}$

Where

Bo = 3091.67 Ha (built up area in 2019)

f = 2030

o = 2019

% (r) = 7.15

t = 11

Bf = 3091.67 $(1+7.15/100)^{11}$

Bf = 6,608.56 hectare **(**built up area in 2030)

Therefore, the urban expansion of the town is estimated as 6,608.56 hectare in the coming 2030 it is increased by 3516.89 hectare from 2019 which means 113.75% expansion. A trend of the expansion from 2003-2030 it is presented as line graph in (figure 4.37) below.

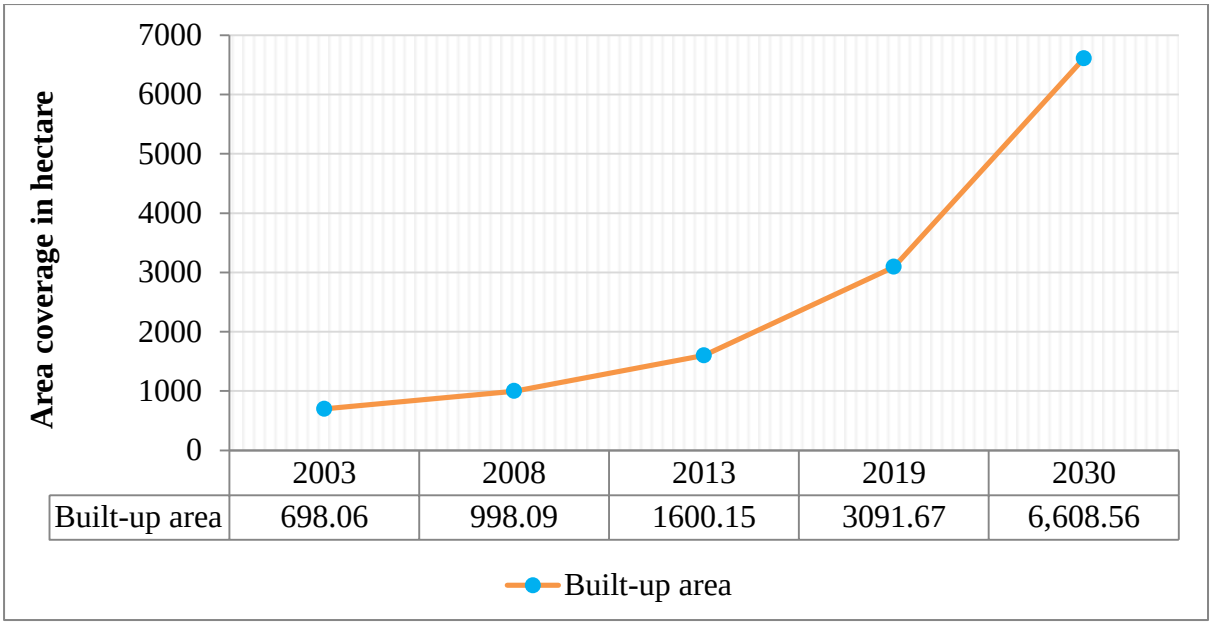


Figure 4.37: Urban expansion/ Built-up area estimation for 2030

4.7.3. Comparison of Population Size and Built-up Area

It is clear that population growth size has a direct impact on urban expansion. Accordingly, when the population of Dukem town in 2003 was 19,204, the built up area of the town was 698.06 hectare of the total land. The population size was stretched to 30,539 in 2008 at the same the built up area was expanded to 998.09 hectare of the total land. In 2013 the population became 40,732 and the built area was expanding to 1600.15 hectare of the total land. In 2019 the population size became 96,320 while the built area was expanding to 3091.67 hectare of the total land.

Finally, an estimated growth size in 2030, the population size will be reached 181,520 while the built area will be expanded to 6,608.56 hectare of the total land. Therefore, from 2003-2008, the population size of Dukem town was increased by 11,335 which were 59.02% then from 2008-2013 it was increased by 10,193 which were 33.38% and from 2013-2019, the population number of the town was up rise by 55,588 which was 136.47%. Finally, the estimated number of population from 2019-2030 will be increased by 85,200 which will be 88.25%.

On the other hand, the built up area of Dukem town was increased by 300.03 ha which was 42.98% of the total land from 2003-2008, then the built up area of the town was increased by 602.06 hectare which was 60.32% of the total land from 2008-2013 and it was expanded to 1491.52 ha which was 93.21% of the total land from 2013-2019 and the estimated expansion of built up area from 2019-2030 will be increased by 3516.89 ha which will be 113.75% of the total land (see Table 4.22 & Figure 4.38).

Table 4.22: Built-up area and Population size change comparison from 2003-2019 & 2030

No	Year	Built-up Area (Ha)	Population	Built-up Growth (%)	Population Growth (%)
1	2003	698.06	19,204	-	
2	2008	998.09	30,539	42.98	59.02
3	2013	1,600.15	40,732	60.32	33.38
4	2019	3,091.67	96,320	93.21	136.47
5	2030	6,608.56	181,520	113.75	88.25

(Source: Own computation using Equation 1 (2020))

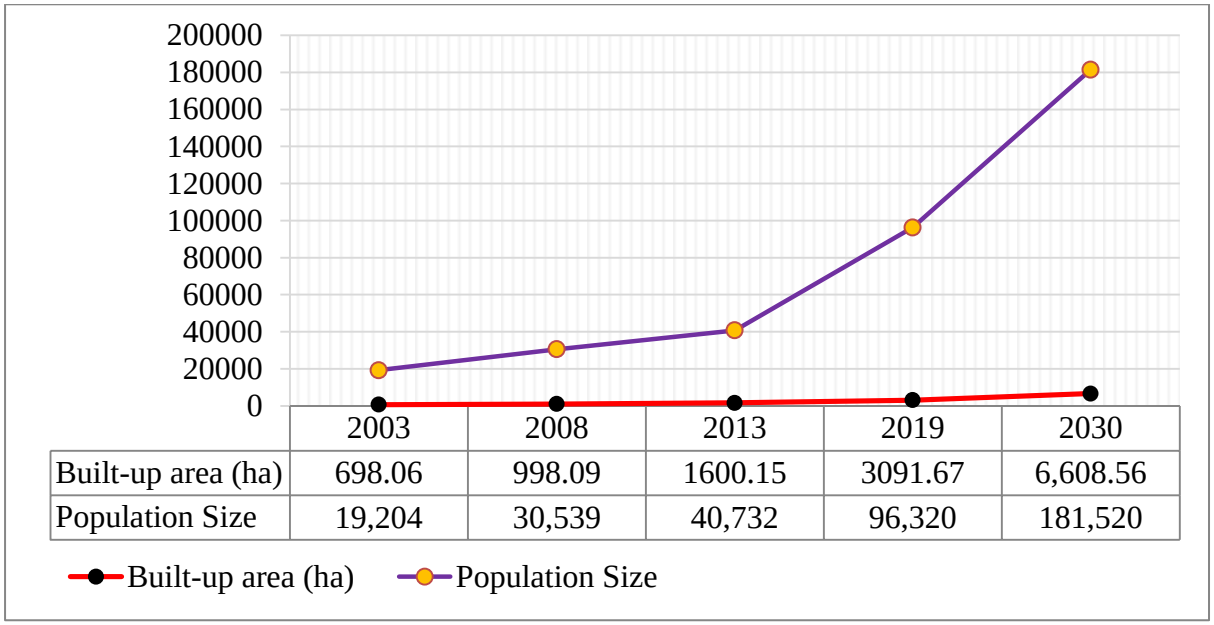


Figure 4.38: Built-up area and Population size change comparison from 2003-2019 and 2030

4.7.4. Future Expansion Direction of the town

As the historical trends clearly specified that the foundation of Dukem town was linked with the railway terminal at the center of the town. Once established as an urban center the town growth is similar with development of urban centers in developing countries unplanned settlement and following the available infrastructure etc. The town stretch from the center to Medhanialem Orthodox Church to the North and to Koticha to the southern area and to Addis Ababa and Bishoftu direction. In addition to this the establishment of industries, infrastructure, government and other institutions far away from the center farther stretches the town to the surrounding agricultural land.

The other major factors that helps to decide the size of expansion area and direction is the population size. The expected increase in number of population accounts the future needs of housing the number of people of Dukem increased highly because four peasant associations

totally merged to the town. These are two from Adea wereda and two from Akaki wereda (Oda Nabe and Gimashe from Akaki and Tedecha Yatu and Dibdibe from Adea).

Using satellite images of 2003, 2008, 2013 and 2019 trends it is possible to identify the direction of expansion of the town for the coming ten years. Dukem town is located at south east of Addis Ababa along the main road to Adama. The Addis Ababa Adama road is the most influential one. In addition to this infrastructure influence, the development of different services has also important contribution in the overall growth directions of the town. The furthest built up area in the year 2003 was towards following the main road and rail way and in the year 2013 more towards south and south western the main possible reason could be the flat topography that attracts residence since flat area created conductive condition for construction purpose and facilitates easy movement. Currently built-up area increased in all direction but it was more pronounced along the major roads north to south, southwestern and southeastern part of the town.

Furthermore, OUPI was prepared a structure plan for Dukem town in 2017 for ten years. The new prepared structure plan demarcated a total 9630.3 hectare of land for the coming year 2027 this had its own implications for the future dramatic expansion of the town. Currently, the major function such as governmental offices, financial institutions and main commercial areas such as shops and hotels are concentrated in the center of the town. The main growth direction of the town is only to the eastern and western directions. But in the northern and southern directions the town already land locked with Gelan and Bishoftu towns respectively.

Figure 4.39: Showing future expansion direction to the eastern direction (Source: Own photo, 2020)

4.7.5. Future Expansion Constraints

The horizontal expansion of any urban area is mainly dependent on topographic constraints such as steeper slopes, flood prone areas and gorges. This is not an exception to Dukem town because the eastward and northwest ward expansion directions of the town are mainly affected by the steeper gradients and stony land scape. Because of this, the future expansion of Dukem town is mainly affected by steeper gradient of Gimashe upland in the northern parts of the town. There are also manmade constraints that control the future expansion of Dukem town. These includes the presence of rail way and express way both of which are physically separating the eastern part of the town to be easily accessed except at few pathways and bridges. On the other hand, the common boundaries that Dukem town has with Bishoftu town and Gelan town has restricted the future expansion of the town towards the south and north directions. Because of this, the future expansion direction of Dukem town is towards west and east direction.

4.8. Discussion of the Results

4.8.1. Trend of Expansion and Land use land covers (LULC) Change

Urban settlements usually emerge as the result of people's permanent settlements around religious, political centers, trade and other economic activities (G/Hiwot, 2006; Marshall et.al., 2009; Aburas et.al., 2017). As the historical trends clearly specified that the foundation of Dukem town is connected with the construction of railway line from Dijoubuti to Addis Ababa in the late ninetieth century. Accordingly, Dukem began to mushroom beginning from 1914 (OUPI, 2017). The trend analysis of the study has shown that, the town stretch from the center to the northern Addis Ababa and to the southern Bishoftu direction along the main road to the eastern region corridor. Dukem has emerged as one of an industrial urban center in the region and the country at large since the beginning of 2000s and known as the Eastern Industrial Zone (EIZ). The town is expanding to a large extent encompassing the rural villages of Waajitu, Dibdibbe, Yaatu and Oda Nabe in the present plan boundary.

In order to achieve objective of the study, the results were discussed, accordingly land use land covers (LULC) change trends in areal coverage for each year 2003, 2008, 2013 and 2019 were produced. At the beginning in 2003, Dukem town occupied only small area at the center of the town. The result also shows that there was no much change in years between 2003 and 2008 but the town began to expand a little bit towards the north to Addis Ababa city and to the south Bishoftu town following the major asphalt road of eastern corridor. Then the growth of the town dramatically changed between the years 2008 and 2013 following the

development of Eastern Industry Zone (EIZ) and this continued between the years 2013 and 2019 particularly infill developments in terms of residential development.

The town has grown intensely in all directions between the years 2008 and 2019 in built-up areas expansion. Similarly, studies revealed that land use and land cover (LULC) change analysis results were shown the rapid increase in built-up areas expansions characterized by horizontal physical expansion led to dramatic changes against fertile agricultural land and sensitive environment (Leulsegged et.al., 2011; Diriba et.al., 2015; Parvaiz et.al., 2017; Sewunet, 2017). This study similarly showed that built-up area increased dramatically from 698.06 ha (16.45%) in 2003 to 3,091.67 ha (72.81%) in 2019 this indicated that built areas consuming a considerable amount of other land use land cover (LULC) types while agricultural land extremely decreased in all years from 2,764.37 ha (65.12%) in 2003 to 999.05 ha (23.53%) in 2019 which indicating its highest contribution to built-up areas.

The trend of other categories varies increasing and decreasing at various times particularly a lot in the past ten years. Furthermore, The increase in barren land in 2013 was the result of land taken by investors but not developed yet and due to the existence of areas like rock and gully areas which area unsuitable for agricultural areas, but this decreased later dramatically in 2019 showing the utilization of these areas for agricultural land and its conversion into built-up areas. Similarly, studies indicated that the rapid industrialization and manufacturing accompanied with rapid urban population growth and urban sprawling, leading to the incorporation of the fringe areas and significantly affect the size of fertile agricultural land and most of the converted lands for industrial establishments are underdeveloped or not even developed at all (Diriba et.al., 2015; Parvaiz et.al., 2017).

Moreover, the built-up areas of Dukem town was increases in its spatial extent by 8.6% from 2003-2008, 12.1% from 2008-2013 and 15.5% from 2013-2019 per year. The dynamic change between 2003 and 2008 was lower than other periods. The rate of change for the two periods from 2008 to 2013 and 2013 to 2019 was among the highest and this indicated that the trend of urban expansion was more and more increasing, particularly in the past eleven years. It means that an agricultural land around the town was incorporated into urban areas and became much more valuable land for new housing and industrial uses.

Studies revealed that population growth has a direct impact on urban expansion (Handy, 2003; Tilahun, 2016). Accordingly, comparison of population size and built-up area has been made. Therefore, from 2003-2008, the population size of Dukem town was increased by 11,335 which are 59.02% then from 2008-2013 it was increased by 10,193 which are 33.38%

and from 2013-2019, the population number of the town was up rise by 55,588 which is 136.47%. Finally, the estimated number of population from 2019-2030 will be increased by 85,200 which will be 88.25%. On the other hand, the built up area of Dukem town was increased by 300.03 hectare which was 42.98% of the total land from 2003-2008, then the built up area of the town was increased by 602.06 hectare which was 60.32% of the total land from 2008-2013 and it was expanded to 1491.52 hectare which was 93.21% of the total land from 2013-2019 and the estimated expansion of built up area from 2019-2030 will be increased by 3516.89 hectare which will be 113.75% of the total land.

4.8.2. Characteristics of Sampled Respondents

Out of 61 surveyed office employees (Government officials, Kebele administrators and Experts) were attended first degree program which was about 72.7% followed by higher education diploma which was about 9.1%. While most of them were surveyor program which was about 28.8% followed by urban land development and management (ULDM) which was about 13.6%, urban land administration 12.1%, geographers 9.1% and etc., this indicated that almost all of them are professionals or experts in their specific program they are more close to the issue. Most of them were served for 11-15 years which was about 39.4% followed by 6-10 years 27.3% and this indicated that more than half of respondents are senior in their work duration and position. So almost all of them could describe changes resulted over time and believed to have rich information than other new employers.

On the other hand, Out of 327 surveyed communities were most of them matured by age group 41-50 (36.9%) followed by age group 31- 40 (23.7%) and age group 51- 60 (20.6%). Most of them were migrated ones which was about 59.8% while 40.2% were born in Dukem town. This indicated that there were rapid population growth through migration to the town due to the establishment of many industries and also its geographical proximity to Addis Ababa made the town increased population and economic importance, a number of commuters per day those who preferred to live in the town and work in Addis Ababa was a major reason according to the informants during survey. In terms of level of education most of them were attended first degree program which was about 36.4% followed by TVET which was about 12.4% and higher education diploma 11.3% and this result indicated that more than half of the planned sampled respondents were professionals in their specific program.

4.8.3. Driving Factors that contribute a lot for the expansion of Dukem town

Dukem town is characterized by one of those towns with high concentration of industries. A lot of commuters per day those who preferred to live in the town and work in Addis Ababa, population growth, coupled with industrial and commercial expansion has resulted in intense competition for resources like housing in the town. According to Diriba et.al., (2016) proximity to Addis Ababa, transport facility, the highway and expressway to southern and eastern part of the country pass through Dukem town, surrounded by agricultural productive areas and poor policy implementation tools which results in squatter settlements were the major driving factors for the rapid expansion of the town.

The driving factors, were considered in this study as determinants of urban expansion take different forms but the most obvious forces being assumed such as increase in population size, investment pressure in commerce and service, establishment of industries & manufacturing, development in road infrastructure & transportation, housing preference, informal access to land, the prepared plans, location and topography of the town.

The survey result of 'office employees' showed that 'establishment of industries & manufacturing' and 'location of the town' were the major driving factors which rated as 'strongly agreed' with an average score mean of 3.62 and 3.53 respectively. The driving factor such as 'increase in population size', 'housing preference', 'development in road infrastructures & transportation', 'informal access to land' 'investment pressure in commerce & service' and 'the prepared plans of the town' were the most office employees perceived 'agreed' with average mean 3.35, 3.26, 3.18, 3.14, 2.92 and 2.64 respectively. While, 'topography of the town' was a driving factor that office employees rated with an average score mean of 2.27 neither negative nor positive attitudes with 'neutral' perception. On the other hand, the survey result of 'communities' showed that 'establishment of industries & manufacturing', 'location of the town', 'informal access to land', 'increase in population size' and 'investment pressure in commerce & service' were the most communities perceived 'agreed' with average mean 3.17, 3.02, 3.01, 2.95 and 2.60 respectively. Other driving factors such as 'the prepared plans of the town', 'housing preference' and 'topography of the town' were the most communities' perceived 'neutral' with average mean of 2.31, 1.97 and 1.84 respectively. While 'development in road infrastructures & transportation' was the only driving factor that showed the most disagreed with average mean around 1.30.

Therefore, when compared the survey results of 'office employees' and 'communities' on the driving factors that contributed a lot for the expansion of Dukem between the year 2003 and

2019, both of them were perceived an average of ‘strongly agreed’ with the ‘establishment of industries and manufacturing’, ‘location of the town’ and ‘increase in population size’, and also both of them were perceived an average value of ‘agreed’ with ‘informal access to land’ and ‘investment pressure in commerce & service’. However, with factors ‘the prepared plans of the town’ and ‘housing preference’ office employees has positive attitude with most ‘agreed’ while the communities were neither negative nor positive attitude with a value ‘neutral’ perceptions and both of them were neither negative nor positive attitude with a value ‘neutral’ average with ‘topography or slope of the town’. Regarding the factor ‘development in infrastructure and transportation’ there was huge differences between the two were most of office employees as average ‘agreed’ while communities as average ‘disagreed’ to this driving factor. On the other hand the result implied that the communities were not satisfied with the existing infrastructure development in the town.

4.8.4. Driving Actor’s that contribute a lot for the expansion of Dukem town

The most important actors those individuals or bodies who involve in the process of town expansion were as a grassroots i.e. investors, government bodies, communities, farmers and others are among the core stakeholders who play their own role in driving urban expansion (Yirgalem, 2009; Kenate, 2013; Husen, 2018). The driving actors were considered in this study such as private developers (investors), government officials, experts, community of the town, local farmers and land brokers. The role played by the government bodies or agencies, the farmers who gave their land, investors or communities who bought land, land brokers who property dealers with the major focus on land market.

The survey result of ‘office employees’ showed that ‘private developers or investors’ were the major driving actor which rated as ‘strongly agreed’ with an average score mean of 3.59. The key actors who driving expansion of the town such as ‘community of the town’, ‘government officials’, ‘experts’, and ‘local farmers’ were most ‘agreed’ with an average score of 3.26, 3.17, 2.85 and 2.55 respectively, While ‘land brokers’ was the only driving actor that office employees rated as ‘disagreed’ with an average score mean of 1.79. On the other hand, the survey result of ‘communities’ showed that ‘private developers or investors’, ‘government officials’ and ‘community of the town’ were rated as most ‘agreed’ with an average score mean of 2.84, 2.76 and 2.52 respectively, While actors who driving expansion of the town such as ‘experts’, ‘land brokers’ and ‘local farmers’ were the actors in which perceived most ‘neutral’ with an average score between 2.32, 1.93 and 1.69 respectively.

Therefore, when compared the survey results of 'office employees' and 'communities' on the driving actors that contributed a lot for the expansion of Dukem between the year 2003 and 2019, both of them were perceived an average of most 'agreed' with the 'private investors or developers', 'government official's' and 'communities of the town'. While, with actor 'expert's' office employees has positive attitude with most 'agreed' while the communities were neither negative nor positive attitude with a value 'neutral' perceptions and both of them were neither negative nor positive attitude towards a value 'neutral' average with the actor 'land broker's'. Regarding the actor 'local farmer's' office employees has positive attitude with most 'agreed' while the communities negative perceptions with most 'disagreed'.

4.8.5. Future Expansion of Dukem town

Dukem town confronted high rapid increase in population due to establishment of industries (EIZ) and manufacturing and commuters to Addis Ababa city. Studies revealed that population growth has a direct impact on urban expansion (Handy, 2003; Tilahun, 2016). According to the population projections made on this study for the coming ten year, Dukem town will be expected to reach about an average of 181,520 populations by the year 2030. Thus, the population size is became almost close to double of 96,320 (2019) 181,520 in (2030). Similarly, studies by OUPI, (2017) population projection indicated that Dukem town will be expected to reach about 171,653 populations by the year 2027.

The rapid expansion of built-up area of Dukem town increased in all direction but it is more pronounced along the major roads north to south, southwestern and southeastern part of the town. According to the built-up area estimation made on this study for the coming ten years, Dukem town will be expected to reach about an average of 6,608.56 ha built area in the coming 2030 it is increased by 3516.89 ha from 2019 which means 113.75% expansion. Moreover, OUPI was prepared a structure plan for Dukem town in 2017 for ten years. The new prepared structure plan demarcated a total 9630.3 hectare of land in the coming year 2027 this had its own implications for the future dramatic expansion of Dukem town.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

The study is conducted on mapping urban expansion trends and measuring its effects on LULC dynamics using RS & GIS techniques with also identifying the major driving factors and actors that contribute a lot for the expansion of Dukem town between the year 2003 and 2019. The concluding remarks of the study are defined based on the research questions.

The foundation of Dukem town is connected with the railway line from Dijoubuti to Addis Ababa in the late 19th century and the town began to mushroom in beginning from 1914 (OUPI, 2017). In beginning of the year 2000 Dukem has been emerged as one of an industrial urban center known as the Eastern Industrial Zone (EIZ). The town has grown intensely in all directions particularly between the years 2008 and 2019.

Accordingly, The trend analysis of LULC dynamics has shown that, built-up area increased dramatically from 698.06 hectares (16.45%) in 2003 to 3,091.67 hectares (72.81%) in 2019 this indicated that built-up areas consuming a considerable amount of other LULC types while agricultural land extremely decreased in all years from 2,764.37 ha (65.12%) in 2003 to 999.05 ha (23.53%) in 2019 which indicating its highest contribution to built-up areas.

Moreover, the built-up area increases its spatial extent by 8.6% from 2003-2008, 12.1% from 2008-2013 and 15.5% from 2013-2019 per year. The rate of change for the two periods from 2008 to 2013 and 2013 to 2019 is among the highest and this indicated that the trend of urban expansion is more and more increasing, particularly in the past eleven years. It means that an agricultural land around the town is incorporated into urban areas and became much more valuable land for new housing and industrial uses. Similarly, studies revealed that land use and land cover change analysis results were shown the rapid increase in built-up areas expansions characterized by horizontal physical expansion led to dramatic changes against fertile agricultural land and sensitive environment (Leulsegged et.al., 2011; Diriba et.al., 2015; Parvaiz et.al., 2017). Studies revealed that population growth has a direct impact on urban expansion (Handy, 2003; Tilahun, 2016). Accordingly, when the population of Dukem town in 2003 was 19,204, the built up area was 698.06 ha, population size was stretched to 30,539 in 2008 at the same the built up area was expanded to 998.09 ha, in 2013 the population became 40,732 and the built area was 1600.15 ha and in 2019 the population size became 96,320 while the built area was expanding to 3091.67 ha of the total land.

Studies were shown that pressures in investments for the industrial and residential expansions persisted as main driver force of agricultural land conversions (Diriba & Feyera, 2016; Hossein et.al., 2017). Moreover, the rapid industrialization and manufacturing accompanied with rapid urban population growth and urban sprawling, leading to the incorporation of the fringe areas and significantly affect the size of fertile agricultural land even most of the converted lands for industrial establishments were underdeveloped or were not even developed at all (Diriba et.al., 2015; Selam, 2017).

This study also concluded that, the driving factors such as establishment of industries and manufacturing, location of the town and increase in population size were the top forces that contribute a lot for the dramatic expansion of Dukem town between the year 2003 and 2019. While the driving factors such as informal access to land, investment pressure in commerce & service, the prepared plans of the town and housing preference were moderate relatively. However, relatively less agreed with the driving factors such as topography of the town and development in infrastructure and transportation.

Studies indicated that, among the various actors who have the part in LULC change, to play either in the demand or supply side of the land market are the government or agencies, the farmers who gave land, investors or communities who bought land, land brokers who property dealers (Yirgalem, 2009; Kenate, 2013; Husen, 2018). Similarly this study concluded that, the driving actors such as private investors, government officials and communities of the town are the top actors that contribute a lot for the dramatic expansion of Dukem town between the year 2003 and 2019. While with actor experts both office employees and communities are neither negative nor positive attitude. On the other hand relatively less agreed with the actors such as land brokers and local farmers.

Finally, future expansion forecast indicated that, if the growth of the town continued with similar expansion pace, Dukem town will be expected to reach about an average of 6,608.56 ha built area for the coming ten years it is increased by 3516.89 ha from 2019 which means 113.75% expansion. And also the town will be expected to reach about an average of 181,520 populations by the year 2030. The new prepared SP demarcated a total 9630.3 ha of land in the coming 2027 this had its own implications for the future expansion of the town. The main growth direction of the town is only to the eastern and western, while in the northern with Gelan and in the southern with Bishoftu the town already land locked. Therefore, all policy and planning issue should consider the expected future expansion of the town.

5.2. Recommendations

Based on the research questions and findings of the study, in addressing the challenges resulting from urban expansion and manage land use conversion the following recommendations has been forwarded.

- The results of the study were indicated that, the pace of urban expansion in Dukem town is very rapid, particularly in the last six years with a growth rate of 15.5% and this will continue in the coming decades. The study also showed that the LUP and SP prepared by OUPI so far to guide development activities were not properly implemented on the ground. So as to bring the required balanced development government officials, experts and communities expected to plan ahead for sustainable utilization of natural resources and cope up with the pace of urban expansion.

- Applying strong efficient land management and monitoring tools through implementing and applying GIS and satellite images (RST) in supervision of urban land use change and its proper implementation according to the prepared plan.

- Dukem town is endowed in its location that proximity to Addis Ababa made the town increased population and economic importance as preferred for different urban functions especially, industries and residential. That is why the actors, private investors or developers increasingly showed their investment interest in the town. However the town is not developed yet, so those investors should participated in community service in such a way that they can create attractive and green public spaces and whereby contribute to the promotion of green agendas due to presence of numerous industries and manufacturing in the town.

- Corruption, lack of transparency and injustice regarding land administration system and distribution has created a group of wealth collectors, land speculators, and brokers upon the public land and whereby contributed a lot for the rapid expansion of the town so such land grabbing issues should be handled by Anti-Corruption Commission with the enhancement of communities participation and of other stakeholders in order to avoid or minimize the wastage of public land.

- Its indicated that in the study, living in apartment and multi-family high rise building not exist except condominium housing came in to being very recently in Dukem town. Privately built single family home and the huge heaters of land allocated for industries and

manufacturing for the investment purpose labeling as the word ‘development’ was perceived as the major contributor for the dramatic expansion of the town, As such a considerable amount of agricultural and green areas were declined in the past sixteen years. Therefore, attainable planning strategies which consider the upcoming future growth of the town should be prepared and implemented which can integrate both the urban areas and its surrounding rural villages for the holistic mutual developments.

- The town is expanding from year to year because of various reasons .Hence the expanding areas are suffering from in adequate urban infrastructure and the burden of the provision of these urban infrastructure falls on the municipality. It is recommended that the municipality should form partnership between sectors to alleviate the problem

- The trends of urban expansion program implemented so far indicated that the communities were not given awareness and participated in planning and implementation of the process. However, ensuring sustainable development to cope up with the effects of urban expansion and dislocation, all actors of development particularly the involvement of neighboring farming communities is indispensable. Thus, priorities should be given to the consent, awareness and participation of the farming community in the forgoing programs and decision making process before actual implementation of the program.

- Further preparations is necessary looking for planning concepts of smart growth, compact city high density mixed-use and infill development for safeguarding the fertile agricultural land and natural environments and ensure balanced horizontal expansion of the town.

- The growth of capital Addis Ababa outwards and the existence of Oromia Special Zone surrounding the city necessitated integrated planning as developments of the city and regions. However the two regions have independent plans so such independent or uncooperative decisions will result in conflicts like the conflicts happened between the residents of the two regions over land and which brought political and socioeconomic frustration in the country. Therefore, the government should respond to integrated regional development plan with a coordination of developments and cooperation between the capital Addis Ababa city and Oromia Special Zone (OSZ) in general and specifically Dukem town. Further rethink the values, symbols, social profits associated with the consequences of its overall development policies and outcomes of integrated regional development plan and the beneficiaries of its developments in terms of national economic, social, political, cultural aspects.

REFERENCES

Adem, K. (2010). Urban Expansion and the Neighbourhoods: The Case of Bishoftu Town, East Shewa Zone, Oromia Regional State, Public Administration and Development Management.

Afera, H., Asirat, T. and Ermias, S. (2018). 'Applications of Remote Sensing and GIS in Land Use/Land Cover Change Detection: A Case Study of Woreta Zuria Watershed, Ethiopia', Applied Research Journal of Geographic Information System, 1: 1-9.

Ahlam, Y. (2017). Urban Expansion and Its Impact on the Livelihood of Peripheral Farming Communities: The Case of Kutaber Town, Amhara Region, Ethiopia.

Alsharif, A., Pradhan, B., Mansor, S. and Shafri, H. (2015). 'Urban Expansion Assessment by Using Remotely Sensed Data and the Relative Shannon Entropy Model in GIS: A Case Study of Tripoli, Libya', Theoretical and Empirical Researches in Urban Management, 10: 123-138.

Antos, S. E., Lall, S. V. and Gracia, N. L. (2016). The Morphology of African Cities. Social, Urban, Rural and Resilience Global Practice Group, World Bank, 51 pp.

Anupam, A. (2017). Unit 14-Accuracy Assessment, https://www.researchgate.net/publication

Ambaye, A. (2012). Assessment of Urban Expansion and Its Impact on the Livelihood of Peripheral Farming Communities in The Case of Dukem Town.

Amaha, G. (2007). Urbanization, Urban Sprawl Pattern Recognition and Modeling of Hawasa-Shashemene: Addis Ababa University School of Graduate Studies GIS and Remote Sensing Program.

Ariana, B.V., (2016). The Impact of Roads on Land-Use Change in Ethiopia: Evidence from Satellite Data.

Bahiru, Z. (1991). A History of Modern Ethiopia, 1855-1974: Addis Ababa University Press, Addis Ababa.

Balchin, P.N., et al. (2000). Urban Economics: A Global Perspective. Great Britain Macmillan Press Ltd.

Basel, M. and Hana, O. (2019). 'Population Projection Model using Exponential Growth Function with a Birth and Death Diffusion Growth Rate Processes', European Journal of Scientific Research, 15: 271-276.

Batty, M. (2004). What is Urban Sprawl? Concepts and Perceptions, Final Seminar of the Scatter Project Brussels.

Beka, G. (January, 2016), Urban Expansion and Its Socio-Economic Impacts on the Livelihood of the Farming Community in Sululta

Bekure, W. (1999). 'For men urbanized Ethiopia', Migration and Urbanization in Ethiopia: Proceedings of the Second Annual Conference. Addis Ababa: Association of Ethiopian Geographers.

Berhan, G. and Woldeamlak, B. (2014). Drivers and Implications of Land Use and Land Cover Change in the Central Highlands of Ethiopia: Evidence from Remote Sensing and Socio-demographic Data Integration, Vol. X, No.2.

Bhatta, B.(2010). Analysis of Urban Growth and Sprawl from Remote Sensing Data, 17 Advances in Geographic Information Science, Springer-Verlag Berlin Heidelberg.

Burton, E. (2000). 'The Compact City: Just or just compact', A preliminary analysis' Urban Studies, 37(11): 1969-2007.

Campbell, J. B. (1987). Introduction to Remote Sensing, The Guilford Press, New York.

Campbell, J. B. (1996). Introduction to Remote Sensing, Taylor and Francis, London.

Ciparisse, G. (2003). Multilingual Thesaurus on Land Tenure, English Version. Rome: Food and Agricultural Organization of the United Nations, (FAO).

Congalton, R. G. (1991). 'A review of assessing the accuracy of classifications of remotely sensed data', Remote Sensing of Environment, 3: 35-46.

Dean, H. (2013). Modeling Population Growth: Exponential and Hyperbolic Modeling. (http://www.scirp.org/journal/am).

Dejene, N. (2011). Rapid Urban Expansion and Its Implications on Livelihood of Farming Communities on Peri-Urban Area: Addis Ababa, Ethiopia.

Diriba, D., Azadib, H., Feyera, S., Ketema, A., Taherif, F. and Stellmacher, T. (2016). 'Urban sprawl and its impacts on land use change in Central Ethiopia', Journal of Urban Forestry & Urban Greening, 16: 132-141.

Diriba, D., Stellmacher, T., Azadib, H., Ketema, A. and Feyera, S. (2017). The Impact of Industrialization on Land Use and Livelihoods in Ethiopia: Agricultural Land Conversion around Gelan and Dukem Town, Oromia Region: https://www.researchgate.net

Efa, T. and Gutema, I. (2017). 'Prospects and Challenges of Urbanization on the Livelihood of Farming Community Surrounding Finfinne', American Research Journal of Humanities and Social Sciences, 315: 2378-7031.

Eyasu, S. (2007). The Impact of Urban Expansion on the Livelihood of Peri-Urban Farming Communities in Alemgena Town: Addis Ababa University Schools of Graduate Studies Regional and Local Development Studies (RLDS).

European Environment Agency, (2006). Urban Sprawl in Europe the Ignored Challenge. Copenhagen, Luxembourg, 60 pp.

Fevera, A. (2005). Urban Expansion and the Livelihood of the Peri-Urban Agricultural Community: The Case of Addis Ababa, Addis Ababa University Master of Arts in Regional and Local Development Studies.

Firew, B. (2010). The Impact of Horizontal Urban Expansion on Sub-Urban Agricultural Community Livelihood: The Case of Tabor Sub-City, Hawassa city, Ethiopia.

Gao, J. (2002). 'Integration of GPS with remote sensing and GIS: Reality and prospect', Photogrammetric Engineering & Remote Sensing, 68:5 447–453.

G/Hiwot, B. (2006). Urban growth and its impact on land use, the case of Mekelle, M.A. thesis, Ethiopian civil service college, Addis Ababa.

Geist, H., McConnell, W., Lambin, E. F., Moran, E., Alves, D. and Rudel, T. (2006). "Causes and trajectories of land-use/cover change", Local processes and global impact, Berlin: Springer, 41-70.

Glenn, D. I. (2003). Determining Sample Size 1: Department of Agricultural Education and Communication, and extension specialist, Program Evaluation and Organizational Development, Institute of Food and Agricultural Sciences (lFAS), University of Florida, Gainesville 32611 http://edis.ifas.ufl.edu.

Handy, S., Paterson, R., Song, J. Rajamani, J., Jung, J., Bhat, C. and Kockelman, K. (2003). Techniques for Mitigating Urban Sprawl: Goals, Characteristics, and Suitability Factors. University of Texas, Austin, USA, 120 pp.

Haregewoin, B. (2005). Urbanization and Urban Sprawl.

Herold, M. Goldstein, C.N. and Clarke, C.K. (2003). 'The spatiotemporal form of urban growth: measurement, analysis and modelling', Journal of Remote Sensing Environment, 86: 286-302.

Husen, T. (2018). Land Rights and Land Grabbing in Oromia, Ethiopia, VL-70, Journal Land Use Policy: https://www.researchgate.net/publication/321020098.

Kafi, M., Shafri, H. Z. and Shariff, M. (2014). An analysis of LULC change detection using remotely sensed data; A Case study of Bauchi City, Department of Civil Engineering, Selangor Malaysia IOP Conf. Series: Earth and Environmental Science.

Kaleb, M. and Samuel, G. (2017). Investigation of Urban Sprawl Trends and its Impact on Socio-economy of Peri-urban Community in Addis Ababa: The Case of Akaki Kality Sub-city

Kenate, W. (2013). Land use cover dynamic socio economic and environmental transformations and implications a geographical study of the fringe of finfinne Addis Ababa city Ethiopia

Kothari, C. R. (2004). Research methodology: Methods and techniques. New Age International.

Lambin, E. F., Geist, H. and Rindfuss, R.R. (2006). "Introduction: Local processes with global impacts" In E. F. Lambin and H. Geist, editors. Land-use and land-cover change: Local processes and global impact, Berlin: Springer, 1–7.

Leulsegged, K., Gete, Z., Dawit, A., Fitsum, H. and Heinimann, A. (2011). Impact of Urbanization of Addis Abeba City on Peri-Urban Environment and Livelihoods.

Levin, N. (1999). Fundamentals of Remote Sensing: Tel Aviv University, Tel Aviv, 225 pp.

Linda, L. (1996). A sociology of Periphery Versus A periphery of Sociology: Rural Sociology and the Dimensions of space, in Journal of Sociology, Vol.61, pp: 77-99

Lo, L. P. and Yeung, K. W. (2005). Concepts and Techniques of Geographic Information System: Prentice-Hall of India Private Limited, New Delhi, 492 pp.

Maher, M., Sabrina, H., Mohammad, F. and Zulfa, H. (2017). 'Measuring and Mapping Urban Growth Patterns Using Remote Sensing and GIS Techniques', Pertanika Journal of Scholarly Research Reviews, 3: 55-69.

Maria, E. F., Somik, L. and Danny, L. (2014). Africa's Urbanization Challenges and Opportunities Africa's Urbanization.

Marshall, F., Waldman, L., MacGregor, H., Mehta, L.and Randhawa, P. (2009). On the Edge of Sustainability. Perspectives on Peri-urban Dynamics, STEPS Working Paper 35, Brighton: STEPS Centre

Mathias, T. A. (2016). Remote Sensing and Geographic Information System Based Suitability Analysis of Urban Green Space Development in Addis Ababa: A case Study of Bole Sub-city. Addis Ababa University Addis Ababa, Ethiopia

Melesse, A. M., Weng, Q., Thenkabail, P. S. and Senay G. B. (2007). Remote sensing sensors and applications in environmental resources mapping and modelling, 7: 3209-3241.

Miaoulis, G. and R. D. Michener (1976). An Introduction to Sampling. Dubuque, Iowa: Kendall/Hunt Publishing Company.

Nasir, J. and Saleem, A. (2018). Exponential Growth Model for Forecasting of Area and Production of Potato Crop in Pakistan. https://www.researchgate.net

Negasa, J. (2017). Monitoring Urban Expansion and Suitability Analysis for Residential Housing by Using Geographic Information System and Remote Sensing; the Case of Sululta Town; Oromia Regional State of Ethiopia. Addis Ababa University, Department of Geography and Environmental Studies.

Oromia National Regional State Urban Planning Institute (2008). Revision of Dukem town Development plan, 2008 Addis Ababa.

Oromia National Regional State Urban Planning Institute (2017). Dukem town structure plan Study report, 2017 Addis Ababa.

Parvaiz, A.B., Miftaul, S., Abaas, A.M and Pervez, A. (2017). 'Urban Sprawl and its Impact on Landuse /Land Cover Dynamics of Dehradun City, India', Gulf Organization for Research and Development International Journal of Sustainable Built Environment, International Journal of Sustainable Built Environment, 6: 513-521.

Paul, N. (2000). Urban Economics: a Global Perspective, Great Britain Creative Print and Design (Wales) Ebb Vale.

Pickett, S., Cadenasso, M.L., Grove, J.M., Nilon, C.H., Pouyat, R.V., Zipperer, W.C. and Costanza, R. (2001). 'Urban ecological systems: linking terrestrial ecological, physical, and socioeconomic components of metropolitan areas', 32:127–157.

Potter, R. (1992). Urbanization in the Third World, Oxford, Oxford University Press

Potter, R.B. and Lloyd-Evans, S. (1998). The City in the Developing World, Harlow: Longman.

Ravindra, K.V., Sangeeta, K. and Tiwary, R. K. (2008). Application of Remote Sensing and GIS Technique for Efficient Urban Planning in India.

Reis, J. P., Silva, E. A. and Pinho, P. (2015). 'Spatial metrics to study urban patterns in growing and shrinking cities', Urban Geography, 1938–2847.

Selam, G. (2017). The Challenges and Contributions of Industrial Park Development (IPD) in Ethiopia: The Case of Eastern Industry Zone (EIZ) PLC, Dukem town, Oromia.

Sekela, T. and Manfred, F. B. (2019). Land-Use and Land-Cover (LULC) Change Detection in Wami River Basin, Tanzania, Land 2019, 8, 136.

Seid, Y. (2007). Urban Expansion and Suitability Analysis for Housing of Adama City Using Remote Sensing and Geographic Information Systems Techniques, Department of Earth Sciences Faculty of Science Addis Ababa University.

Sewunet, S. (2017). Urban Sprawl Mapping and Landuse Change Detection Using Spatial Metrics Method: A Case Study of Addis Ababa City and Its Surrounding Areas, Ethiopia

Shishay, M. (2011). The Impacts of Urban Built-Up Area Expansion on the Livelihood of Farm Households, in the Peri-Urban Areas of Mekelle City: The Capital of Tigray Regional State.

Solomon, E. (2018). 'Mapping urban expansion and its effect on the surrounding land uses using GIS and remote sensing. A case study in Debre Tabor Town, Ethiopia', Journal of Degraded and Mining Lands Management, Volume 6, Number 1.

Tadesse, W., Tsegaye, T. D. and Coleman, T.L. (2001). Land use/cover change detection of the city of Addis Ababa, Ethiopia using remote sensing and GIS technology.

Tamirat, M. (2016). 'Horizontal Urban Expansion and Livelihood Adjustment Problem among Ex-Farmers in the Kebeles Surrounding Jimma Town: The Case of Derba Kebele', European Scientific Journal, 14: 1857-7881.

Tegegne, G/E. (2002). 'Urban poverty and the environmental: illustration from Addis Ababa, in Ethiopia', Ethiopian Development forum, Vol. No. 1: 76-84.

Teshome, E. (2014). The Transforming Power of Urbanization: Changes and Uncertainties among the Farming Community in Laga Xafo-Laga Dadhi Town, Ethiopia. Addis Ababa University Department of Social Anthropology.

Tilahun, S. (2016). RS & GIS Integrated Study on Urban Sprawl with its Effects on Surrounding Farming Communities.

Todaro, M.P. (1997). Economic Development (6th ed.), London: Addison Wesley

Tsegaye, T. (2010). Urbanization in Ethiopia: Study on Growth, Patterns, Functions and Alternative Policy Strategy Stockholm University 2010

Ward, D., Phinn, S.R. and Murray, A.T. (2000). 'Monitoring growth in rapidly urbanizing area using remotely sensed data', Association of American Geographers, 52:371-386.

Weng, Q.H. (2002). 'Land use change analysis in the Zhujiang Delta of China using satellite remote sensing, GIS and stochastic modelling', Journal of Environment Management, 64: 273-284.

William, H. (1970). Urban Economics: Theory, Development and Planning, New York Macmillan Publishing Co., Inc.

Williams, K. (1999). 'Urban intensification policies in England: problems and contradictions', Land Use Policy, 16(3): 167-178.

UN-Habitat (2000). Strategies to combat homelessness. Kenya, Nairobi.

UN-Habitat (2006). State of the worlds; the millennium development goals and urban Sustainability. 30 years of shaping the habitat agenda.

United Nations (2001). World urbanization prospects. The 1999 revision. New York: United Nations.

Yamane, T. (1967). Statistics, An Introductory Analysis, 2nd Ed., New York: Harper and Row.

Yanping, Q. and Zhen, W. (2019). Study on Urban Expansion Using the Spatial and Temporal Dynamic Changes in the Impervious Surface in Nanjing

Yirgalem, D. (2009). The situation of informal actors in urban land management in one of the Sub-cities of Addis Ababa, the Kolfe-Keranio sub-city.

ANNEX

Annex I: Questionnaires for Government officials, Kebele administrators and Experts

Survey date_____ Survey place_____ Who collected the survey_____

Dear Respondent:

The main aim of this questionnaire is to collect data as input for the study titled *"An Investigation of Urban Expansion Land Use Land Covers Dynamics: The Case of Dukem Town, Oromia Special Zone".* The purpose is to qualify the requirement for awarding the Master of Science (MSc.) in Urban Planning at EiABC Addis Ababa University. Therefore, you are expected to provide genuine and accurate information with respect to the factors that contributed a lot for rapid expansion of Dukem town.

Thank you!

Part I: Background of Respondents

1. **Address (Kebele):** □ Melka Dukem (1) □ Gogecha (2) □ Koticha (3) □ Tedecha (4)
2. **Gender:** □ Male (1) □ Female (2)
3. **Age:** □ 18-30 (1) □ 31-40 (2) □ 41-50 (3) □51-60 (4) □61-70(5) □above 70 (6)
4. **Level of educations:** □ Elementary (1-8) (1) □ Secondary School (9-10) (2) □ Preparatory school (11-12) (3) □TVET (4) □Higher Educational Diploma (5) □ First Degree (6) □Masters (7)
5. **Qualification background:** □Urban Planner (1) □Urban Land Administration (2) □Management (3) □Urban Land Development and Management (4) □Geographer (5) □Surveyor (6) □Engineer (7) □Economist (8) □Sociologist (9) □Geologist(10) □Other_____(11)
6. **Work place:** □Dukem town land development and management office (1) □ Melka Dukem (2) □ Gogecha (3) □ Koticha (4) □ Tedecha (5)
7. **Work position:** □ Office Manager(1) □ Deputy Office Manager (2) □Kebele administrators (3) □ Deputy Kebele administrators (4) □Experts (5 □Site Supervisors (6) □Secretary (7) □Other _____(8)
8. **Year of services in this position:** □ 1-5 (1) □ 6-10 (2) □11-15 (3) □above 15 (4)

Part II: Factors that contributed for the expansion of Dukem Town

9. What do you think on the following factors that contributed a lot for the rapid expansion of Dukem town between 2003 and 2019?

Key Factors	Strongly agree (4)	Agree (3)	Neutral (2)	Disagree (1)	Strongly disagree (0)
Increase in population size					
Investment pressure in commerce & service					
Establishment of industries & manufacturing					
Dev't of road infrastructure & transportation					
Housing preference					
Informal access to land					
The prepared plans of the town					
Location of the town					
Topography of the town					

10. What do you think on the following key actors who contributed a lot for the rapid expansion of Dukem town between 2003 and 2019?

_____

_____

Part III: Key Actors who contributed for the expansion of Dukem Town

11. What do you think on the following key actors who contributed a lot for the rapid expansion of Dukem town between 2003 and 2019?

Key Actors	Strongly agree (4)	Agree (3)	Neutral (2)	Disagree (1)	Strongly disagree (0)
Private investor's					
Government official's					
Expert's					
Community of the town					
Local farmer's					
Land broker's					

12. Do you have any other comments on the key actors who contributed a lot for the rapid expansion of Dukem town between 2003 and 2019?

_____

_____

Annex II: Questionnaires for Community

Survey date_____ Survey place_____ Who collected the survey_____

Dear Respondent:

The main aim of this questionnaire is to collect data as input for the study titled *"An Investigation of Urban Expansion Land Use Land Covers Dynamics: The Case of Dukem Town, Oromia Special Zone".* The purpose is to qualify the requirement for awarding the Master of Science (MSc.) in Urban Planning at EiABC Addis Ababa University. Therefore, you are expected to provide genuine and accurate information with respect to the factors that contributed a lot for rapid expansion of Dukem town.

Thank you!

Part I: Background of Respondents

1. **Address (Kebele):** □ Melka Dukem (1) □ Gogecha (2) □ Koticha (3) □ Tedecha (4)
2. **Gender:** □ Male (1) □ Female (2)
3. **Age:** □ 18-30 (1) □ 31-40 (2) □ 41-50 (3) □51-60 (4) □61-70(5) □above 70 (6)
4. **Place of Birth:** □ In Dukem (1) □ Out of Dukem (2)
5. **Level of educations:** □Illiterate (1) □Read and write (2) □ Elementary (1-8) (3) □ Secondary School (9-10) (4) □ Preparatory school (11-12) (5) □ TVET (6) □ Higher Educational Diploma (7) □ First Degree (8) □ Masters (9)
6. **Occupation:** □ Private (1) □ Public employee (2) □ Home maker (3) □Unemployed (4) □Retired (5) □Farmer (6) □ If other specify_____(7)

Part II: Factors that contributed for the expansion of Dukem Town

7. What do you think on the following factors that contributed a lot for the rapid expansion of Dukem town between 2003 and 2019?

Key Factors	Strongly agree (4)	Agree (3)	Neutral (2)	Disagree (1)	Strongly disagree (0)
Increase in population size					
Investment pressure in commerce & service					
Establishment of industries & manufacturing					
Dev't of road infrastructure & transportation					
Housing preference					
Informal access to land					
The prepared plans of the town					
Location of the town					
Topography of the town					

8. Do you have any other comments on the factors that contributed a lot for the rapid expansion of Dukem town between 2003 and 2019?

_____

_____

Part III: Key Actors who contributed for the expansion of Dukem Town

9. What do you think on the following key actors who contributed a lot for the rapid expansion of Dukem town between 2003 and 2019?

Key Actors	Strongly agree (4)	Agree (3)	Neutral (2)	Disagree (1)	Strongly disagree (0)
Private investor's					
Government official's					
Expert's					
Community of the town					
Local farmer's					
Land broker's					

10. Do you have any other comments on the key actors who contributed a lot for the rapid expansion of Dukem town between 2003 and 2019?

_____

_____

Annex III: Questionnaires for Office Employees in Afan Oromo Language

ADDIS ABABA UNIVERSITY

Ethiopian Institute of Architecture, Building

Construction and City Development (EiABC)

Gaaffilee Hojjettota Mootummaa, Bulchitoota Gandaa fi Ogeessotaa Magaalaa Dukamiif

Guyyaa gaaffii_____ Bakka gaaffii_____ Gaafataa _____

Kabajamtoota Yaada Laatan Hundaaf:

Dhimmi ijoon gaaffii kanaa qorannoo mata dureen isaa *"An Investigation of Urban Expansion Land Use Land Covers Dynamics: The Case of Dukem Town, Oromia Special Zone"* jedhuuf odeffannoo fayyadu funaanuufiidha. Sababni inni barbaachiseefis barumsa digrii lammaffaa (Maastersii) Yuunivarsiitii Finfinnerraa gosa barnootaa Pilaanii Magalaatiin (Urban Planning) eebbifamuuf ta'uu isaa isin beeksisa. Kanaafuu, deebiin isin laattan dhimma barumsaa qofaaf waan barbaadameef, Sababoota babal'ina magaalaa dukamiif gumaacha taasisan irratti, deebii haqaa fi qabatamaa ta'e akka laattan kabajaan isin gaafadha.

Galatoomaa!!

Qajeelcha 1ffaa: Odeffannoo Namoota Yaada kennanii

1. **Teessoo (Ganda):** □ Malkaa Dukam □ Gogeechaa □ Kootichaa □ Xaddachaa
2. **Saala:** □ Dhi □ Dha
3. **Umurii:** □ 18-30 □ 31-40 □ 41-50 □51-60 □61-70 □70 fi isaa ol
4. **Sadarkaa Barnotaa:** □ Sadarkaa 1ffaa (1-8) □ Sadarkaa 2ffaa (9-10) □Qophaa'ina (11-12) □ BLTO □ Diploomaa □ Digirii Jalqabaa □ Digirii Lammaffaa (Maastersii)
5. **Ogummaa:** □Pilaanara Magaalaa □Bulchiinsaa Lafa Magaalaa □ Maanaajimentii □ Misoomaa fi Maanaajimentii Lafa Magaalaa □Ji'oogiraafara □Surveeyara □Injiinara □Ikoonomistii □Sooshiyooloojistii □Jiyooloojistii □Kan biroo_____
6. **Bakka Hojii:** □ Waajjira Bulchiinsaa fi Itti Fayyadama Lafa Magaalaa Duukam □Malkaa Dukam □ Gogeechaa □ Kootichaa □ Xaddachaa
7. **Sadarkaa Hojii:** □I/G Waajjira □ I/A Waajjira □Bulchaa Gandaa □I/A Bulchaa Gandaa □Ekispertii / Ogeessa □To'ataa dirree □Bareessaa /ituu □Kan biroo_____
8. **Waggaa Tajaajilaa** □ 1-5 □ 6-10 □ 11-15 □15 fi isaa ol

Qajeelcha 2ffaa: Sababoota Babal'ina Magaalaa Dukamiif Gumaacha Taasisan

9. Sababoota babal'ina magaalaa dukamiif gumaacha taasisan keessattuu, bara 1995 kaasee hanga bara 2012 tti tarreeffaman armaan gadii keessaa isa kamtu irra caalaatti sababa ta'a jette yaadda?

Sababota Ijoo	Eeyyeen Sirriitti	Eeyyeen	Hin Murteessine	Miti	Gonkumaa Miti
Dabaluu Baay'ina Ummataa					
Guddina Investimentii Daldala fi Tejaajilaa					
Hundeeffama Warshaalee fi Industirii					
Babal'ina Dandii fi Geejiba					
Filannoo Bakka Jireenyaa					
Babal'ina ijaarsa Seeranalaa					
Qophaa'uu Pilaaanii Magaalaa					
Finfinneef Dhiheynaairrati Argamu					
Haala Teessuuma Lafaa					

10. Yaada dabalataa yoo qabaatteef bakka duwwaa arman gadii irrati barreesi.

_____

_____

_____

Qajeelcha 3ffaa: Qaamota Ijoo Babal'ina Magaalaa Dukamiif Gumaacha Taasisan

11. Qaamota Ijoo babal'ina magaalaa dukamiif gumaacha taasisan keessattuu, bara 1995 kaasee hanga bara 2012 tti tarreeffaman armaan gadii keessaa isa kamtu irra caalaatti ga'ee guddaa taphate jette yaadda?

Qaamota Ijoo	Eeyyeen Sirriitti	Eeyyeen	Hin Murteessine	Miti	Gonkumaa Miti
Abbootii Qabeenyaa					
Qondaaltota Mootummaa					
Ogeessota					
Hawaasa Magaalaa					
Qonnaan Bultoota					
Dallaalaa Lafaa					

12. Yaada dabalataa yoo qabaatteef bakka duwwaa arman gadii irrati barreesi

_____

_____

_____

Annex IV: Questionnaires for Communities in Amharic Language

ADDIS ABABA UNIVERSITY

Ethiopian Institute of Architecture, Building Construction and City Development (EiABC)

<u>ለዱከም ከተማ ነዋሪዎች የተዘጋጀ መጠይቅ</u>

መጠይቁ የተሰበሰበበት ቀን _____የተሰበሰበበት ቦታ _____የሰበሰበዉ ሰዉ ስም _____

ለተከበራችሁ ሀሳብ ሰጪዎች በሙሉ:

የዚህ ቃለ መጠይቅ ዋና አላማ ለጥናታዊ ጽሁፍ የሚረዳ ሀሣብ ለመሰብሰብ ታስቦ የተዘጋጀ ሲሆን የጥናታዊ ፅሁፉ ርእስም *"An Investigation of Urban Expansion Land Use Land Covers Dynamics: The Case of Dukem Town, Oromia Special Zone"* የሚል ይሆናል፡፡ ይህ ጥናታዊ ጽሁፍ ያስፈለገበት ዋና ምክኒያት የድህረ ምረቃ ትምህርት ማስተርስ በከተማ ፕላን የት/ክፍል በአዲስ አበባ ዩኒቨርሲቲ ለመስራት ነዉ፡፡ ስለዚህ የምትሰጡት ሀሳብ ለትምህርት የተፈለገ መሆኑን ተረድታችሁ ለዱከም ከተማ መስፋፋት ምክኒያት ናቸዉ የምትሏቸዉን ሀሳብ በቅንነትና በታማኝነት ተገቢ ምላሽ እንድትሰጡን ስንል በትህትና እንጠይቃለን፡፡

እናመሰግናለን!!

<u>መመሪያ አንድ፡ የሀሳብ ሰጪዎች መረጃ</u>

1. **አድራሻ (ቀበሌ)፡** □ መልካ ዱከም □ ጎፌቻ □ ኮቲቻ □ ጠዴቻ
2. **ፆታ:** □ ወንድ □ ሴት
3. **እድሜ:** □ 18-30 □ 31-40 □ 41-50 □51-60 □61-70 □ከ70 ዓመት በላይ
4. **የትዉልድ ቦታ፡** □ ዱከም ከተማ □ ሌላ ቦታ
5. **የትምህርት ደረጃ፡** □ያልተማረ □ማንበብና መፃፍ፣ □የመጀመሪ ደረጃ(1-8) □የሁለተኛ ደረጃ (9-10)
   □ መሰናዶ (11-12) □ ቴክኒክና ሙያ □ የከፍተኛ ትምህርት ዲፕሎማ □ የከፍተኛ ትምህርት ድግሪ
   □ ድህረ ምረቃ ትምህርት ማስተርስ
6. **ስራ:** □የግል ሰራተኛ □የመንግስት ሰራተኛ □የቤት እመቤት □ስራ አጥ □ጡረተኛ
   □ ከላይ ከተጠቀሱት የተለየ_____

<u>መመሪያ ሁለት፡ ለዱከም ከተማ መስፋፋት አስተዋፅኦ ያደረጉ ምክኒያቶች/ነገሮች</u>

7. ለዱከም ከተማ መስፋፋት አስተዋፅኦ ካደረጉ ምክኒያቶች ወይም ነገሮች መካከል በተለይም ከ1995 ዓ.ም አንስቶ እስከ 2012 ዓ.ም ድረስ ከዚህ በታች ከተዘረዘሩት ምክኒያቶች ዉስጥ የትኛዉ ይበልጥ አስተዋፅኦ አድርጓል ትላለህ/ሽ?

ዋና ምክኒያቶች	መለኪያ				
	እጅግ በጣም እስማማለሁ	በጣም እስማማለሁ	በጥቂቱ እስማማለሁ	ያንያህል አልስማማም	ፈጽሞ አልስማማም
የህዝብ ቁጥር መጨመር					
የእንቨስትመንት እድገት በንግድ እና በአገልግሎት					
የኢንዱስትሪዎች መስፋፋት					
የመንገድ መሰረተ ልማት እና ትራንስፖርት መስፋፋት					
አማራጭ የመኖሪያ ስፍራ					
ህገ ወጥ የመሬት ወረራ					
የከተማዉ ፕላን መዘጋጀት					
ለአ/አ ከተማ በቅርብ ርቀት ላይ መገኘት					
የከተማዉ መሬት አቀማመጥ					

8. ተጨማሪ ሀሳብ ከሎዎት ከታች ባለዉ ባዶ ቦታ ላይ ያስፍሩ።

_____

_____

_____

<u>መመሪያ ሶስት፡ ለዱከም ከተማ መስፋፋት አስተዋፅኦ ያደረጉ አካላት</u>

9. ለዱከም ከተማ መስፋፋት አስተዋፅኦ ካደረጉ አካላት መካከል በተለየም ከ1995 ዓ.ም አንስቶ እስከ 2012 ዓ.ም ድረስ ከዚህ በታች ከተዘረዘሩት ዉስጥ የትኛዉ ይበልጥ አስተዋፅኦ አድርጓል ትላለህ/ሽ?

ዋና አካላት	መለኪያ				
	እጅግ በጣም እስማማለሁ	በጣም እስማማለሁ	በጥቂቱ እስማማለሁ	ያንያህል አልስማማም	ፈጽሞ አልስማማም
ባለ ሀብት					
የመንግስት አካላት					
ባለ ሙያው					
የከተማ ነዋሪ ማህበረሰብ					
አርሶ አደሩ					
የመሬት ደላላ					

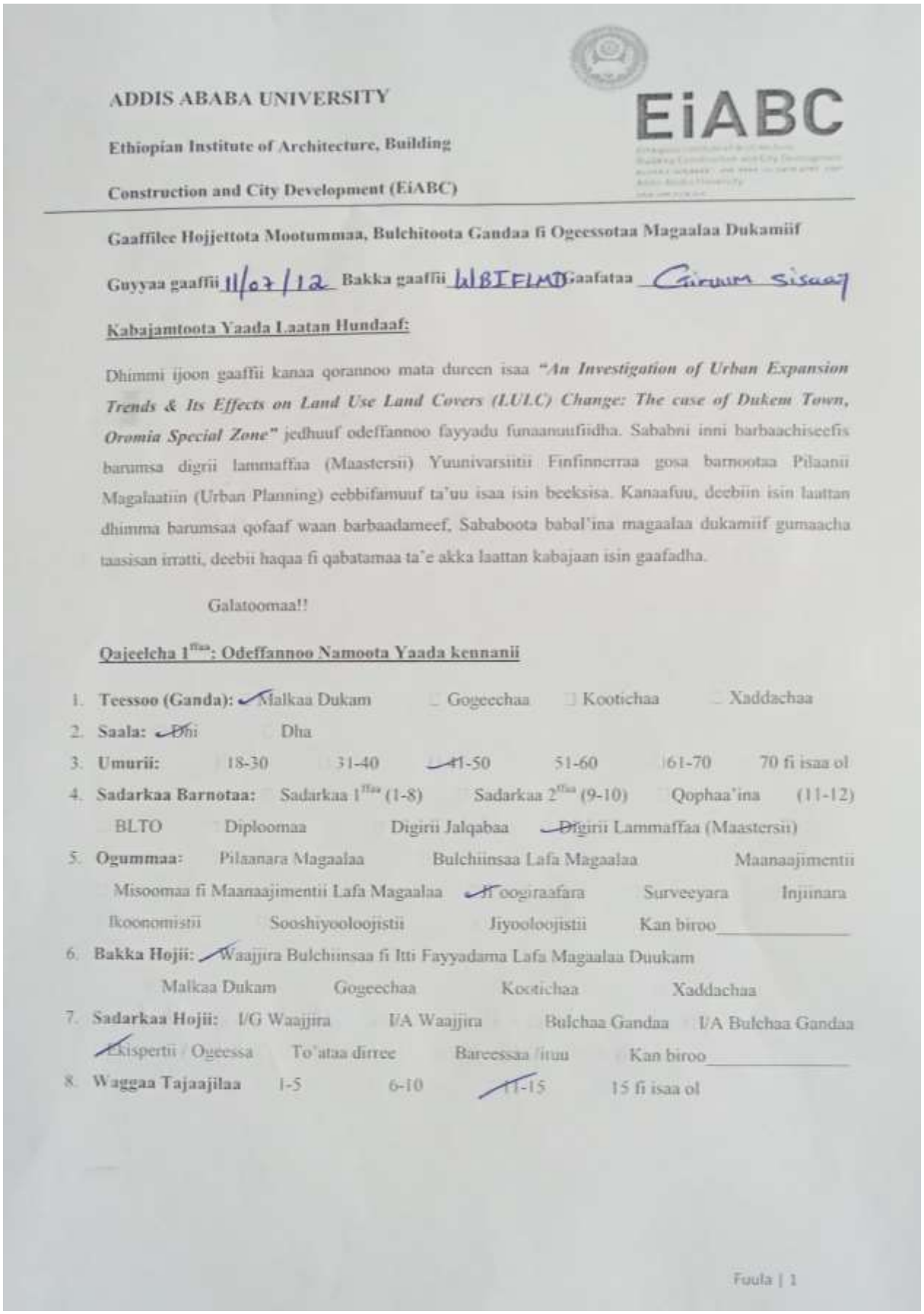
10. ተጨማሪ ሀሳብ ከሎዎት ከታች ባለዉ ባዶ ቦታ ላይ ያስፍሩ።

_____

_____

_____

Annex V: Example of properly attempted survey questionnaire in Afan Oromo Language



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EiABC

Gaaffilee Hojjettota Mootummaa, Bulchitoota Gandaa fi Ogeessotaa Magaalaa Dukamiif

Guyyaa gaaffii 11/07/12 **Bakka gaaffii** WBIFLMD **Gaafataa** Girmm sisaay

Kabajamtoota Yaada Laatan Hundaaf:

Dhimmi ijoon gaaffii kanaa qorannoo mata dureen isaa ***"An Investigation of Urban Expansion Trends & Its Effects on Land Use Land Covers (LULC) Change: The case of Dukem Town, Oromia Special Zone"*** jedhuuf odeffannoo fayyadu funaanuufiidha. Sababni inni barbaachiseefis barumsa digrii lammaffaa (Maastersii) Yuunivarsiitii Finfinnerraa gosa barnootaa Pilaanii Magalaatiin (Urban Planning) eebbifamuuf ta'uu isaa isin beeksisa. Kanaafuu, deebiin isin laattan dhimma barumsaa qofaaf waan barbaadameef, Sababoota babal'ina magaalaa dukamiif gumaacha taasisan irratti, deebii haqaa fi qabatamaa ta'e akka laattan kabajaan isin gaafadha.

Galatoomaa!!

Qajeelcha 1ffaa: Odeffannoo Namoota Yaada kennanii

1. **Teessoo (Ganda):** ✓Malkaa Dukam Gogeechaa Kootichaa Xaddachaa
2. **Saala:** ✓Dhi Dha
3. **Umurii:** 18-30 31-40 ✓41-50 51-60 61-70 70 fi isaa ol
4. **Sadarkaa Barnotaa:** Sadarkaa 1ffaa (1-8) Sadarkaa 2ffaa (9-10) Qophaa'ina (11-12) BLTO Diploomaa Digirii Jalqabaa ✓Digirii Lammaffaa (Maastersii)
5. **Ogummaa:** Pilaanara Magaalaa Bulchiinsaa Lafa Magaalaa Maanaajimentii Misoomaa fi Maanaajimentii Lafa Magaalaa ✓Hoogiraafara Surveeyara Injiinara Ikoonomistii Sooshiyoolooojistii Jiyoolooojistii Kan biroo_____
6. **Bakka Hojii:** ✓Waajjira Bulchiinsaa fi Itti Fayyadama Lafa Magaalaa Duukam Malkaa Dukam Gogeechaa Kootichaa Xaddachaa
7. **Sadarkaa Hojii:** I/G Waajjira I/A Waajjira Bulchaa Gandaa I/A Bulchaa Gandaa ✓Ekispertii / Ogeessa To'ataa dirree Bareessaa /tuu Kan biroo_____
8. **Waggaa Tajaajilaa** 1-5 6-10 ✓11-15 15 fi isaa ol

Fuula | 1

Qajeelcha 2^{ffaa}: Sababoota Babal'ina Magaalaa Dukamiif Gumaacha Taasisan

9. Sababoota babal'ina magaalaa dukamiif gumaacha taasisan keessattuu, bara 1995 kaasee hanga bara 2012 tti tarreeffaman armaan gadii keessaa isa kamtu irra caalaatti sababa ta'a jette yaadda?

Sababota Ijoo	Eeyyeen Sirriitti	Eeyyeen	Hin Murteessine	Miti	Gonkumaa Miti
Dabaluu Baay'ina Ummataa		✓			
Guddina Investimentii Daldala fi Tejaajilaa		✓			
Hundeeffama Warshaalee fi Industirii	✓				
Babal'ina Dandii fi Geejiba			✓		
Filannoo Bakka Jireenyaa	✓				
Babal'ina ijaarsa Seeranalaa	✓				
Qophaa'uu Pilaanii Magaalaa		✓			
Finfinneef Dhiheynaairrati Argamu	✓				
Haala Teessuuma Lafaa		✓			

10. Yaada dabalataa yoo qabaatteef bakka duwwaa arman gadii irrati barreesi.

Sababoota kan biroo keessa Iddoon manaa jireenyaatiif qonnaan bultootaaf kennameefi akkasumas lafaa mallaqaan seeraan alaa wareguun akka dabalataatti kaasuun ni danda'ama.

Qajeelcha 3^{ffaa}: Qaamota Ijoo Babal'ina Magaalaa Dukamiif Gumaacha Taasisan

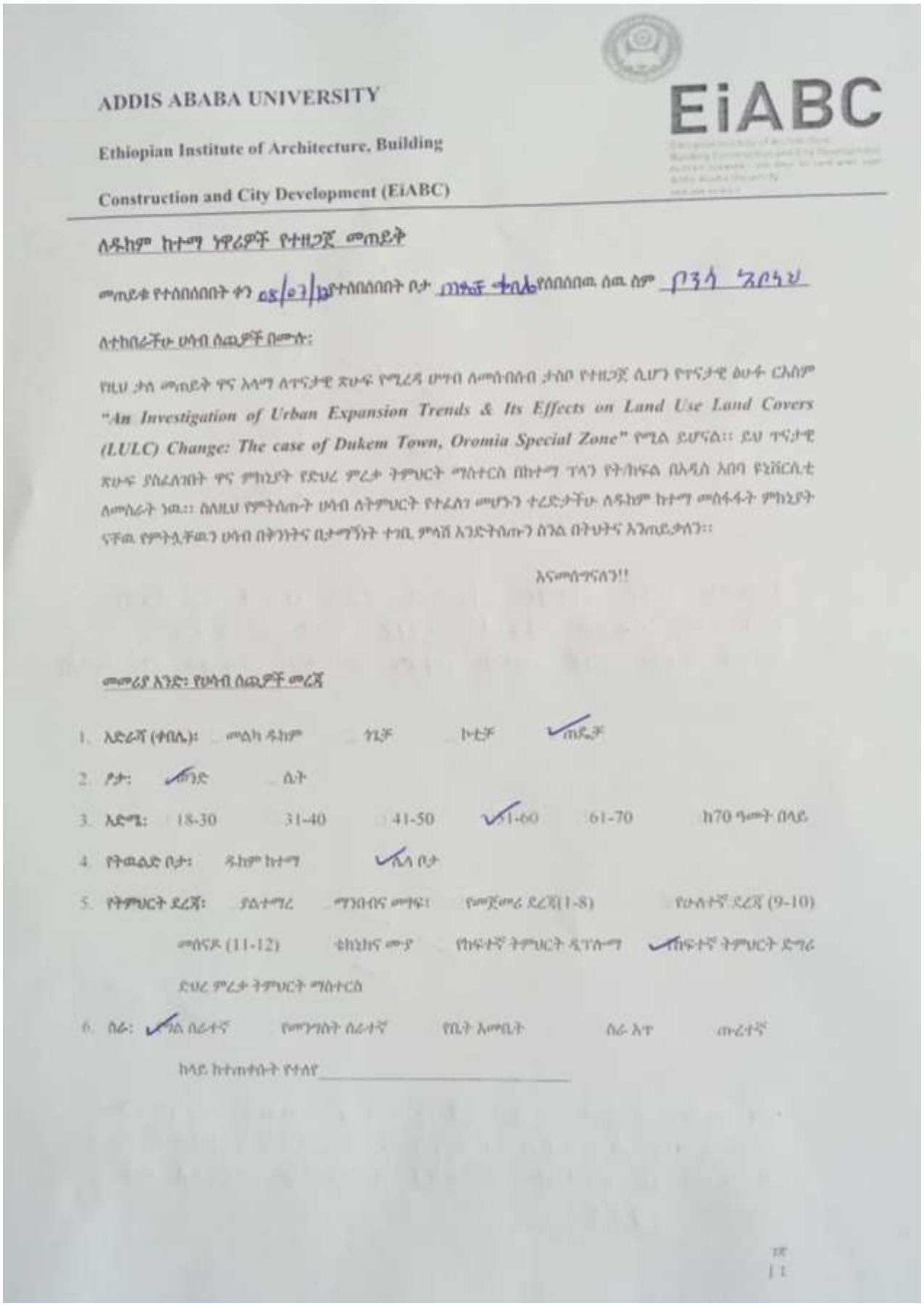
11. Qaamota Ijoo babal'ina magaalaa dukamiif gumaacha taasisan keessattuu, bara 1995 kaasee hanga bara 2012 tti tarreeffaman armaan gadii keessaa isa kamtu irra caalaatti ga'ee guddaa taphate jette yaadda?

Qaamota Ijoo	Eeyyeen Sirriitti	Eeyyeen	Hin Murteessine	Miti	Gonkumaa Miti
Abbootii Qabeenyaa	✓				
Qondaaltota Mootummaa		✓			
Ogeessota			✓		
Hawaasa Magaalaa		✓			
Qonnaan Bultoota					✓
Dallaalaa Lafaa					✓

12. Yaada dabalataa yoo qabaatteef bakka duwwaa arman gadii irrati barreesi

Dii'aspooraan biyyattiin adda addaa irra dhufaan gahee guddaa taphataan jedheen yaadaa.

Annex VI: Example of properly attempted survey questionnaire in Amharic Language



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EiABC

ለዱከም ከተማ ነዋሪዎች የተዘጋጀ መጠይቅ

መጠይቁ የተሰበሰበበት ቀን 05/07/13 የተሰበሰበበት ቦታ ጋንቱፎ ቀበሌ የሰበሰበው ሰዉ ስም ቦንሳ ጎርጎሪ

ለተከበራችሁ ሀሳብ ሰጪዎች በሙሉ፡

የዚህ ታስ መጠይቅ ዋና አላማ ለጥናታዊ ጽሁፍ የሚረዳ ሀሳብ ለመሰብሰብ ታስቦ የተዘጋጀ ሲሆን የጥናታዊ ፅሁፉ ርእስም *"An Investigation of Urban Expansion Trends & Its Effects on Land Use Land Covers (LULC) Change: The case of Dukem Town, Oromia Special Zone"* የሚል ይሆናል:: ይህ ጥናታዊ ጽሁፍ ያስፈለገበት ዋና ምክንያት የድህረ ምረቃ ትምህርት ማስተርስ በከተማ ፕላን የትስከፍል በአዲስ አበባ የኒቨርሲቲ ለመስራት ነዉ:: ስለዚህ የምትሰጡት ሀሳብ ለትምህርት የተፈለገ መሆኑን ተረድታችሁ ለዱከም ከተማ መስፋፋት ምክኒያት ናቸዉ የምትሏቸዉን ሀሳብ በቅንነትና ቢታማኝነት ተገቢ ምላሽ እንድትሰጡን ስንል በትህትና እንጠይቃለን::

እናመሰግናለን!!

መመሪያ አንድ፡ የሀሳብ ሰጪዎች መረጃ

1. እድራሻ (ቀበሌ)፡ መልካ ዱከም ጎጊቻ ኮቲቻ ጠጅቻ
2. ፆታ: ወንድ ሴት
3. እድሜ: 18-30 31-40 41-50 51-60 61-70 ከ70 ዓመት በላይ
4. የትዉልድ ቦታ፡ ዱከም ከተማ ሌላ ቦታ
5. የትምህርት ደረጃ: ያልተማረ ማንበብና መፃፍ፡ የመጀመሪ ደረጃ(1-8) የሁለተኛ ደረጃ (9-10) መሰናዶ (11-12) ቴክኒክና ሙያ የከፍተኛ ትምህርት ዲፕሎማ የከፍተኛ ትምህርት ድግሪ ደህረ ምረቃ ትምህርት ማስተርስ
6. ስራ: ግል ስራተኛ የመንግስት ሰራተኛ የቤት እመቤት ስራ አጥ ጡረተኛ ከላይ ከተጠቀሱት የተለየ _____

መመሪያ ሁለት፡ ለዱከም ከተማ መስፋፋት አስተዋፅኦ ያደረጉ ምክንያቶች/ነገሮች

7. ለዱከም ከተማ መስፋፋት አስተዋፅኦ ካደረጉ ምክንያቶች ወይም ነገሮች መካከል በተለይም ከ1995 ዓ.ም አንስቶ እስከ 2012 ዓ.ም ድረስ ከዚህ በታች ከተዘረዘሩት ምክንያቶች ውስጥ የትኛው ይበልጥ አስተዋፅኦ አድርጓል ትላለህ/ሽ?

ዋና ምክንያቶች	መለኪያ				
	እጅግ በጣም እስማማለሁ	በጣም እስማማለሁ	በጥቂቱ እስማማለሁ	ምንም አልስማማም	ፈጽሞ አልስማማም
የህዝብ ቁጥር መጨመር		✓			
የኢንቨስትመንት እድገት በንግድ እና በአገልግሎት		✓			
የኢንዱስትሪዎች መስፋፋት	✓				
የመንገድ መሰረተ ልማት እና ትራንስፖርት መስፋፋት			✓		
አማራጭ የመኖሪያ ስፍራ		✓			
ህገ ወጥ የመሬት ወረራ	✓				
የከተማዉ ፕላን መዘጋጀት			✓		
ለአ/አ ከተማ በቅርብ ርቀት ላይ መገኘት	✓				
የከተማዉ መሬት አቀማመጥ			✓		

8. ተጨማሪ ሀሳብ ካለዎት ከታች ባለዉ ባዶ ቦታ ላይ ያስፍሩ፡፡

ተጨማሪ ሀሳብ ለምትሰጠው ተጠቃሚ የሆኑ ሁኔታ እና ለአዲስ
አበባ ከተማ በቅርብ ርቀት ላይ መገኘት እንደዚሁም ህገ ወጥ
የመሬት ወረራ [illegible] ቤቶችን መገንባት ይቻላል [illegible]::

መመሪያ ሶስት፡ ለዱከም ከተማ መስፋፋት አስተዋፅኦ ያደረጉ አካላት

9. ለዱከም ከተማ መስፋፋት አስተዋፅኦ ካደረጉ አካላት መካከል በተለየም ከ1995 ዓ.ም አንስቶ እስከ 2012 ዓ.ም ድረስ ከዚህ በታች ከተዘረዘሩት ዉስጥ የትኛዉ ይበልጥ አስተዋፅኦ አድርጓል ትላለህ/ሽ?

ዋና አካላት	መለኪያ				
	እጅግ በጣም እስማማለሁ	በጣም እስማማለሁ	በጥቂቱ እስማማለሁ	ምንም አልስማማም	ፈጽሞ አልስማማም
ባለ ሀብት	✓				
የመንግስት አካላት		✓			
ባለ ሙያው	✓				
የከተማ ነዋሪ ማህበረሰብ		✓			
አርሶ አደሩ					✓
የመሬት ደላላ				✓	

10. ተጨማሪ ሀሳብ ካለዎት ከታች ባለዉ ባዶ ቦታ ላይ ያስፍሩ፡፡

ህገ-ወጥ የመሬት [illegible]
[illegible] ለመጠቀም የመንግስት ሠራተኞችና በባለሀብቶች
እንደተጨማሪ የከተማው መስፋፋት አስተዋፅኦ እያደረገ ነው
[illegible] ይቻላል::

Annex VII: Trends of Eastern Industry Zone between 20013 and 2019

Orthopoto of the year 2013

Eastern Industry Zone (EIZ) in 2019

Annex VIII: Partial View of Dukem Town