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DEPARTMENT OF URBAN AND REGIONAL PLANNING

LOCAL CONSTRUCTION MATERIALS FOR AFFORDABLE HOUSING

IN GEREB GIBA, MEKELLE

A Thesis Submitted in Partial Fulfillment of Bachelor of Science (B.Sc.) Degree in Urban and Regional Planning

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ADVISOR: RISHAN TEKLAY

MEKELLE, ETHIOPIA

JUN//2017

DECLARATION

I, Elshadai Baja, supposed to declare that the thesis entitled "local construction materials for affordable housing in Gereb Giba", submitted to the department of architecture and urban planning literally to urban and regional planning, Mekelle University, Arid campus in possible contentment of the requirement of Bachelor Degree thesis of science in urban planning (urban housing affordability). It is my unique effort, that all sources of materials used for this thesis has been acknowledged and I seriously declared that this thesis may not been obtainable for the prize of any other degree, diploma, communion or other similar titles, in any other university or institution.

ELSHADAI BAJA WELDETSADIK

Signature: _____

Date: _____

Place: Mekelle, Tigray, Ethiopia

CERTIFICATION

As thesis research advisor, I hereby certify that I have read and evaluated this thesis prepared under my guidance, by Elshadai Baja, entitled local construction materials for affordable housing: The Case of Gereb Giba, Mekelle zone, Tigray, Ethiopia. I recommend that it be submitted as fulfilling the Thesis requirement. Certified further, to the best of my knowledge the work reported here in does not form part of any project report or thesis on the basis of which a degree or prize was conferred on an earlier time on this or any candidate.

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ABSTRACT

Housing is a basic need for sophisticated existing from one of those basic social conditions that determine the quality of life and welfare of people and places. Affordability is measured in terms of disposable income and affordable housing is categorized in terms of cost of a house, as a proportion to the total income of a household. For the urban poor, the cost of affordable house should not exceed five times the household gross annual income and the rent should not exceed **30** per cent of the household's gross monthly income. So what if, affordable housing is a basic need but the material cost is very high can result? What solutions should be taken to afford? These are the main questions that we need to answer.

The research is focusing the local construction materials for affordable housing study conducted through questioners, interviews, focus group discussion and site observations. The findings of the study have shown that; there is unaffordability of housing because of the high cost of imported construction materials. It is found out from the respondents and direct observation that the lack of infrastructures is highly seen result in another expense from the household monthly income. Among the respondents, most of them are not satisfied with the quality of materials brought either from different quarry sites or from production areas. Furthermore, the area resembles to have many challenges.

Therefore, this thesis is parted into six chapters dealing with the local materials for affordable housing. The first chapter deals with the proposal writing including introductions, research problem statements, research objectives, research question, significance of the research, scope and limitation of the research and design of the research. The second chapter focuses on the literature review, Basic philosophical ideas on affordable housing and contextual case studies, methods of the research and site selections and the selection criteria's. The third chapter deals with data analysis and major findings. The fourth chapter also focuses on the data analysis result and discussion. The fifth chapter deals with conclusions and recommendations. The sixth chapter focuses of the design proposals of affordable housing.

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CHAPTER ONE
1. INTRODUCTION

1.1. Background

To deal with housing/shelter is one of the basic human needs and addressing its challenge has major significance particularly for the poor or for the low income groups of society. Ethiopia being one of the poorest nations in the world, it is not unusual to find a large portion of its population living in slums and much depleted houses. The main reasons are shortage of land for construction and affordability of construction materials due to ever rising cost of living. (Bekele 2003)

Housing Practices is an ongoing series that documents the experiences of countries who are implementing large-scale affordable housing program which provides authoritative and independent documentation of innovative affordable housing program in countries of the developing world.

The stagnant nature of economic development and rapid population growth of most of the developing countries makes effective and efficient service delivery difficult for governments, to satisfy the need of their residents.

The construction of low efficient houses requires reducing wastage of material. Reducing wastage depends on using components which starts from the smaller parts like the masonry block and repeats themselves of longer scale of the whole housing unit

Locally available construction materials have much smaller environmental impact in contrast to materials such as bricks, concrete and iron mainly because of the lower alive energy.

The importance of locally available materials for affordable housing:-The locally available material is one of the best methods of affording housing as it enables the following aspects: the use of natural materials, renewable materials, and eco-friendly building materials used, using locally available materials and minimizing the resource allocation and innovative methods can implemented to reduce the cost and to achieve affordable, sustainable and Green building (UN-

Habitat 2011). Building materials are defined as materials used in each construction work starting from the underground work until the finishing work.

The affordability of housing has a direct bondage to construction materials. The industrial or international housing construction materials cost very high as low income group cannot afford. The international or industrial materials have also impacts on the environment that may hurt the natural ecosystem. Locally available housing construction materials are materials that we can find out from local area, with low environmental impact, low cost, and highly durable.

Masonry is construction of natural building stone or manufactured units such as brick or concrete block. Masonry consistently ranks among consumers as the first choice in residential covering materials. (Christine Beall, 2004)

1.2. Research problem statement

The construction of low-cost residential buildings in Ethiopia is dominated by the use of labour-intensive technique of construction. There is not much improvement in the management and quality of construction due to the following reasons.

- Old traditional techniques of construction are still on-going as they are thought that they are assumed cheaper and facilitate the contractors:
    - Cheap labour attracts the local contractors as advanced machines are costly
    - Old techniques of construction involve more labour than machines
    - Most of contractors have not undergone civil engineering education
- Also the housing standard of the city is incompatible with the affordability of the majority residents to build their shelter. In other words the majority of the residents have no financial capacity to build their dwelling to fulfill the standard of the regulation, provided that the estimation of construction cost of the units increasing day to day. However this is beyond the current reality since the price of construction materials is rising rapidly.

It is observed that there are problems in the housing provision and affordability. Those problems challenge the living conditions of the society in two approaches of Affordability

1) **"Ability to pay":** this indicates the financial affordability of housing with respect to occupants` income. Therefore, the problems in this wise at the study area are: unaffordability because of high materials costs, low-income level that they may not afford for better housing. Unemployment and poverty hindering their ability to afford.

2) **"Capability and Willingness to spend":** the affordable housing does not enforce the households to spent beyond their **capability (income)** and **willingness (alludes to choice)** to spend. This attitude is more related to locational choice.

1.3. Objective of the research

This study contains the following main and sub objectives.

1.3.1. General/Main objective

The general objective of this thesis is to recommend local construction materials for affordable housing.

1.3.2. Specific objectives

I. To find out the existing challenges of affordable housing
II. To analyze the available local materials and their challenges
III. To assess the existing experiences of masonry of local construction materials
IV. To recommend some possible measures that reduce the challenges of affordable housing by local material technology

1.3.3. Research questions

While undertaking this research, the major research question which considered is:

- What things may alter the affordability of housing?

Also, to answer the major research question, the sub-research questions examined include:

1. What are the specific challenges of affordable housing?
2. What are the locally available housing construction materials and their problems?
3. What the experience of masonry work of local construction material looks like?
4. What kind of design and intervention can help to improve affordable housing?

1.4. Significance of the Research

As been mentioned previously, this research deeply focuses on the local materials for the affordability of housing. First it has significance for the university by aiming to build knowledge upon the existing literature through its realistic findings and fresh understandings by identifying the different factors that influence the affordability of urban housings in the particular area of study. Most significantly, it deals with the existing problems or challenges of the cost-effective affordable housing and strikes on the solutions of the challenges by assessing the local materials. Practically, this research focuses on the construction materials of housing, generally by taking the affordability due the local materials.

Secondly, this research will activate the housing sectors for local materials, local and national governments, nongovernmental organizations measures and intervention programs that promote cost-effective affordable housing by the local materials. This research the "affordable housing by the local materials" mainly focuses on the capacity building for improvement of building materials. These include improved use of local materials, development and use of alternative cost-effective construction materials that each society group can afford by optimizing the available local materials and proper valuation of their land. The purpose of this research is uniquely matures on Gereb Giba is because of the available construction materials and the strong habit of Agricultural activities and cattle breading for their economic level enhancement.

1.5. Scope and Limitation of the Research

The focus of this research in the **general idea of the research topic** is on affordable housing by the local materials. It does not address other areas of study like urban housing accessibility, durability, policy, standards and others. Moreover, its **geographical units** of analysis are also limited to rural household of Gereb Giba, Tigrai, Ethiopia.

For the **time frame**, this research focuses on the housing materials, so if the cost of the materials hires the local material is best option and if not the international materials. But this study area has some external factors that lead us to have local materials. Those factors are Climatic hazards, the construction of Dam, so it is better to use locally available materials. Even though the affordability of construction materials fluctuate, it is still affordable.

Therefore, it should be known that since the research in location specific with unique contexts, it may not lead to generalization for other cities with distinct socio-economic, socio-cultural and/or geographical profile. Furthermore, this research has the following limitations:

- ▶ Limitation of financial resources to undertake the research
- ▶ Time constraints for data collection and analysis
- ▶ Inadequate availability of documented, secondary data particularly for the Gereb Giba
- ▶ Unwillingness of the construction companies and professionals to give information

Thus, under such limitations, though willing to put much effort for the quality of the research not to be compromised, the above limitations mentioned, which would be beyond my efforts may influence the level of detail and completeness of the research.

1.6. Research design/structure
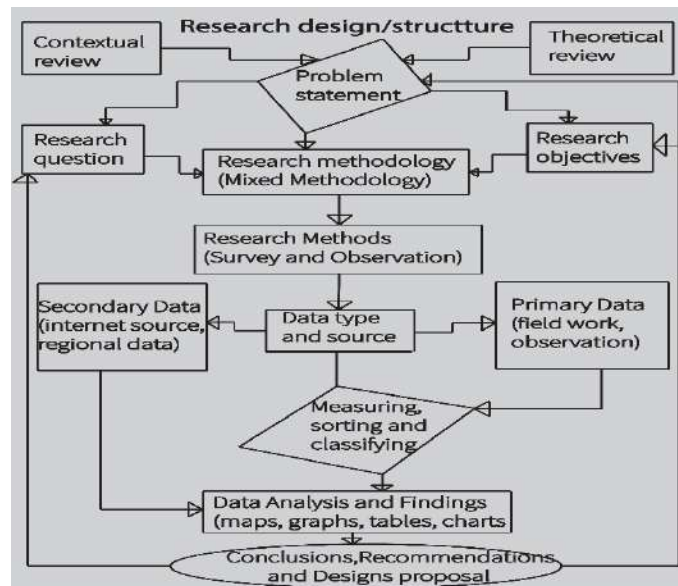
Figure 1: Structure of the research, Source: own design, 2017

The descriptive research design was employed for this study, and cross sectional mixed research methods approach was used. The descriptive research design was used because; it is suitable to describe the degree and nature of problems of affordable housing in the study area. Both qualitative and quantitative research approaches were used for this study. The mixed research approach is useful to capture the best of both qualitative and quantitative approaches. Thus, the study was working both quantitative and qualitative research approach of data collection and

analysis to keep its validity and reliability. Quantitative aspects which focused upon the data with numeric nature was selected to address the research objective that aimed to assess the existing problems and qualitative type also helps to compensate the shortage of quantitative analysis and provide a more explanatory power to it.

CHAPTER TWO
2. LITERATURE REVIEW AND CONTEXTUAL CASE STUDIES

2.1. Introduction

Urban Housing is one of those basic social conditions that determine the quality of life and welfare of people and places. Where homes are located, how well designed and built, and how well they are merged into the environmental, social, cultural and economic fabric of communities. Affordable housing is adequate in quality and location and does not cost so much that it prohibits its occupants meeting other basic living costs or threatens their enjoyment of basic human rights. It is often used to describe a type of housing for low income people, which has a variety of other names for instance social housing, public housing, and low cost housing. (UN-Habitat 2011)

Affordability is measured in terms of disposable income and affordable housing is categorized in terms of cost of a house, as a proportion to the total income of a household. For the urban poor, the cost of affordable house should not exceed five times the household gross annual income and the rent should not exceed **30** per cent of the household's gross monthly income. (UN-Habitat 2011)

Building materials are high in price and of a low quality relative to neighboring countries. For low income housing the most common building materials used are wattle and daub ('chikka') for walls, with roof rafters of round tree lengths (usually Eucalyptus) covered with corrugated iron sheeting, and skim concrete or compacted earth floor. Larger multistory commercial and

residential buildings in urban areas are composed of reinforced concrete frame and slab construction with hollow brick or fired brick infill walls.

Local building materials have been used extensively for building houses at affordable cost. They are easily available locally at little or no cost and local people are conversant with the technology of using them for construction of houses largely through self-help.

2.2. Definition of Key Terms

Housing: - any building or construction which is mainly built to serve a single household or family for residential purpose (Aina, 2005).

Affordable Housing:- adequate in quality and location and does not cost so much that it prohibits its occupants meeting other basic living costs or threatens their enjoyment of basic human rights. (UN-Habitat 2011)

Low-cost Housing: - Housing may granted with low financial expend to afford living condition

Local materials: - Materials that are available and easily accessed locally with low cost

Household: - It is an arrangement made by persons, individually or in groups for providing themselves with food and other essentials of living (UNCHS, 2011.).

Household income:-The total income from all sources of all household members (Manderec, 2010.).

2.3. Basic philosophical ideas on affordable housing

2.3.1. Housing problems in Ethiopia

Housing problems are reflected by housing shortage, which is manifested by overcrowding, homelessness, creation of slum and squatter settlements, inadequate provision of basic housing facilities and public services are mainly presented in Ethiopia. (Taye, 2013)

2.3.2. Factors affecting construction of affordable residential Housing

The housing problem is complicated by its nature in that it comes from diverse causations of socioeconomic, institutional, political and other related policies and priorities (Herrmann, 2008.).

The main factors affecting the affordability of housing are, the low development level of the **Socio economy** of the country, the **lack of saving** institutions and awareness of saving, the **lack of housing finance,** the lack of **Infrastructure** supply The absence of basic infrastructures like: electricity power (100% lack), water (75% lack), and accessibility (75% lack) and others. The percentages are from the direct observation of the study area, Gereb Giba. **Immigration** to a given area, and furthermore, the country's urban population is expected to grow on average by 3.98% and by 2050; about 42.1% of the total population is expected to be inhabited in urban centers (UN-Habitat 2008a). People are migrating from different parts to the study area for the reason of agricultural activity and production cattle. Therefore, the need of housing is increasing through time.

2.3.3. Economic Impacts of the Local Materials

Housing is as costly as that the low income group of the society cannot afford. Currently, the cost of building construction material is too exalted or hired and it is beyond the ability of the community to pay for housing. Therefore, this thesis focuses on the local materials which are available and accessible with low cost as that the societies can afford.

2.3.4. Environmental Impacts of the Local Materials

Locally available traditional materials have much smaller environmental impact in contrast to materials such as bricks, concrete and iron mainly because of the lower alive energy. (UN-Habitat 2011)

Locally available materials in the study area that used in this thesis are very mandatory for the protection of the environment from climatic hazards, recharges the ground with cooling emotions, keeping the natural harmonics, enriching with biotic survival, symbiosis housing with the environment, and reuse or reconstruct the materials of the naturally available and cultural.

2.3.5. The importance of locally available materials for affordable housing

As being understood that Housing is one of the basic needs of mankind in terms of safety, security, self-esteem, social status, cultural identity, satisfaction and achievement. But the

affordability of such housing is been very low and not the societies are affording as possible. This is because the cost of building construction is very higher than that they can afford. The locally available material is one of the best methods of affording housing as it enables the following aspects: the use of natural materials, renewable materials, and eco-friendly building materials used, using locally available materials and minimizing the resource allocation and innovative methods can implemented to reduce the cost and to achieve affordable, sustainable and Green building. (UN-Habitat 2011)

2.3.6. Masonry and its basic properties for residential housing construction

Masonry symbolizes strength, durability, and prestige and at the same time adds warmth, color, and scale to a home. Masonry is most visible in building walls, but is also used in foundations, fireplaces, garden walls, retaining walls, floors, sidewalks, patios, and driveways. Masonry consistently ranks among consumers as the first choice in residential covering materials.

2.3.6.1. Characteristics and Performance of masonry

Masonry can be used as a structural system, as a facing, or as a paving system and can be used to build fireplaces and retaining walls. Masonry facings or veneers can be constructed over many types of structural frames and backing walls. It also provides fire resistance, energy efficiency, and durability. (Christine Beall, 2004)

Fire Resistance: Masonry is noncombustible it will not burn. This is a higher level of protection than simple fire resistance.

Durability: Masonry is durable against wear and abrasion and weather well for many years with little or no maintenance.

Energy Efficiency: Large masonry fireplaces used during the day for heating and cooking were centrally located within a structure.

2.3.6.2. Masonry Construction Techniques

Residential masonry construction involves the laying of brick, concrete block, or stone in beds of mortar, the installation of accessory items, and sometimes reinforcement.

The functional and financial successes of a project, however, are often determined before construction begins based on proper planning and estimating. The techniques involved in masonry are, planning and estimating, modular planning, estimating materials, Construction Preparation, Material Delivery, Storage, and Handling, Stone Masonry Construction, Cutting and Shaping Stone, Mortar for Stone Masonry, Setting Stone, Flashing and Weep Holes and Accessories. (Christine Beall, 2004)

2.3.7. Summary

Recognizing masonry, it is a brick or stone from which a building, wall etc. is made, and the skill of building with stone (Longman advanced American Dictionary). To sum up, the masonry work is the local material usage for building construction with a low cost when compared to the industrial material. A naturally found stone masonry is a very important for the construction of affordable housing in that it can minimize cost of materials, rich the environment, accommodate durability of the house. Limestone is relatively durable, easily worked, and widely available in Gereb Giba. This stone is a recommendable local material for housing construction that may afford for the local communities. The techniques of masonry are as easy as it can be done in the local area and community.

2.4. CONTEXTUAL CASE STUDIES

2.4.1. INTERNATIONAL CASE STUDY
PROJECT TITLE: Affordable Housing by Local Building Materials in Nigeria .

2.4.1.1. Challenges of affordable Housing in Nigeria

A number of challenges are influencing against the provision of housing for the urban poor in Nigeria. These challenges include high rates of urbanization and population growth, absence of proper monitoring and evaluation of public housing policies and programs, lack of easy access to land and other housing inputs, cost of imported building materials, among others. As a result, public housing in Nigeria has been criticized for failing to generate tangible and sustainable housing production, distribution and acquisition mechanisms to meet increasing housing demand, particularly by low-income earners.

2.4.1.2. Compressed stabilized earth blocks (CSEB)

The compressed stabilized earth blocks are produced like the compressed interlocking earth blocks. However, the laying procedure is different, with the addition of mortar for jointing. This is the most widely used modern earth walling method in Nigeria and many other countries around the world to provide low cost housing. For example, 2,698 low cost housing units were built in a year time, in 39 villages in India in 2005. The use of compressed stabilized earth blocks proves advantageous in many ways. It is beautiful and can meet any modern standard for house construction. Another advantage is the reduction in cost as it is cheaper than the conventional sand cement made block wall by as much as 20-70% in most construction projects (Adedeji, 2011) CSEB could also be made through 'self-help', that is doing it yourself, gathering materials around at little or no costs (Adedeji, 2011).
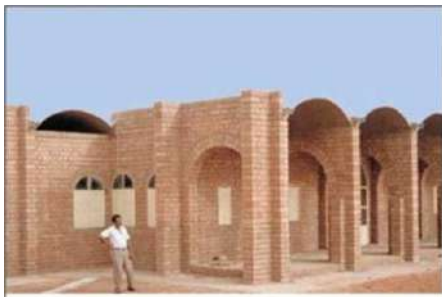
Figure 2: A Building made of Compressed Stabilized

Compressed Earth Blocks

Source: (A. Olotuah, S.A. Bobadoye, 2009)   **Figure 3:** A Building made of **Stabilized Earth Blocks**

Source: (A. Olotuah, S.A. Bobadoye, 2009)

2.4.1.3. Summary

The housing need in Nigeria was found in 2007/2009 was 16-17 million housing units. Having this the Nigeria government had taken a major to build housing with locally available construction material. So having this in mind they started to build low cost housing by local construction materials. For example, in 2010 they targeted to build 10,271 housing units and achieved 64% that means 6540 housing units.

Having the above case study in mind, I can conclude that the available local housing construction materials in Nigeria are used to afford housing deficiency in the area. The very used material is

earth, the clay soil, so as this soil is also available in Gereb Giba it is possible to have an affordable housing in this area. When earth is the dominant walling material, there is limited housing shortage because consumers could easily build their houses according to their capability. Till date earth buildings are still relegated to the background, when used at all it is usually in remote areas that are unnoticeable. Introduction of new, through research on earth as a building material, but accessible construction methods is vital for high output but cheaper requirements to positively compete effectively with the counterpart materials. Noticing, for the most available material in Gereb Giba is the limestone that is very affording local material in housing construction.

The materials hypothesis that taken into account in this project are: cost of building materials influences the housing inadequacy among the lower income earners in the country, Cost of building construction influences the housing inadequacy among the lower income earners in the country, Cost of land influences the housing inadequacy among the lower income earners in the country, Land scarcity influences the housing inadequacy among the lower income earners in the country and Cost of building maintenance influences the housing inadequacy among the lower income earners in the country

The experience that may be shared from this case study is the technical block making skills and the cost minimization processes. The cost minimization of the local building materials and the affordability of housing for low income groups is the best lesson learned.

2.4.2. LOCAL CASE STUDY
Project title: Low-Cost Housing for the Kambaata Region, Ethiopia

A demonstration project for dwelling-houses
Final Project, Construction Engineering Program Spring 2008
By: Ann-Charlotte Johansson, Raffi Wartanian at Halmstad University

2.4.2.1.   The main research project at Halmstad University

For the Kambaata region no major attempt has yet been made to introduce low-cost housing technologies prior to this one. The main research project was initiated in 2007 by Ayeyemi, professor at Halmstad University in Sweden together with two of his colleagues. All three

project members have close connection to Ethiopia and possess great knowledge and experience from the country. Initially the project was more comprehensive than today consisting of five sub-projects; an initial survey; the development and testing of new house building technologies; the erecting of demonstration projects; mapping out the attitudes towards new house building technologies; and the preparation of guide-lines and recommendations for implementation programs. This project mainly belongs within sub-group three in the main project; the erecting of demonstration houses, but also to some extent deals superficially with sub-group four; Attitudes towards new house building technologies.

2.4.2.2.   CSSB – Cement Stabilized Soil Blocks

CSSB, as shown in picture below, can be very nice with the impression of a high quality construction material also based on simple methods. The properties and the looks of the material achieve a high standard but it involves a more complicated production process and increased costs. Different types of blocks are available. Some block types are mason together by lime mortar while some types are directly interlocking with no need for mortar in between. CSSB can be suitable for low income groups if manually produced by the users themselves. The technique requires nevertheless some pre-knowledge about for example soil types, grain size and cement content to attain a successful result.

Figure 4: The appearance of a CSSB wall

This wall is constructed of interlocking CSSB hence no mortar is needed. Most of the advantages and disadvantages listed above are also valid for CSSB.

The components in a CSSB are soil, cement and water. The resulting strength of the block is depending on various things like type of soil and its content of certain clay minerals, the distribution of the grain sizes, cement content and density.

2.4.2.3.   Cost Calculation

The cost calculation consists of a priced bill of quantities, which is prepared based on the drawings made.

A summary of the estimated costs are as follows:

Breakdown:	ETB	SEK
CSSB house	20,138	12,576
Kitchen building	3,833	2,394
Toilet building	1,655	1,034
Total sum:	25626	16004

Note: ETB – Ethiopian Birr (currency)

SEK – Swedish Krona (currency)

2.4.2.4.   Summary

The main conclusion being taken from this project is that the cost-effective low cost housing in Kambaata is very important that the price of the houses really is affordable for the intended end users. As one way to save costs we can recommend to substitute the prescribed foundation made of natural stone and cement to a foundation made of Adobe blocks or CSSB. By bearing in mind it is very educable to have experience to perform the masonry or the local material in Gereb Giba. The very essential potentials in this study area are the presence of limestone, sand and clay soil and other types of stones that have good performance in housing construction.

In the above cost calculation of affordable housing built up in Kambaata, is very good experience of affordability that someone with low income level can afford for housing in the area. They have choice to have one kind of the affordable housing project from the two typology of housing per their ability to pay and willingness to spend for housing. This is cost effective housing or low cost housing at very high level help the community to have affordable housing.

When we compare to the condominium housing cost of 27,000ETB of one bed room, it is very easy for the community to have an adobe house with a cost of 15,227ETB with its toilet and kitchen.

CHAPTER THREE
3. RESEARCH METHODS

3.1. Introduction

In this chapter data sampling techniques, sampling size, methods of data collection, methods of data analysis and site selection criteria will be discussed.

3.1.1. Data sampling technique

Research design and sampling procedures involve the selection of a number of study units from a defined study population. When taking a sample, we will be challenged with the following questions:

     a. What is the group of people from which we want to draw a sample?
     b. How many people do we need in our sample?
     c. How will these people be selected?

(**Source:** Ethiopia Public Health Training Initiative),

There are many sampling methods from these I selected **Cluster sampling:** When a list of grouping of study units is available (e.g. Villages, etc.) or can be easily compiled, a number of these grouping can be randomly selected.

The sample size for this research was determined by using the formula, as indicated in **Bartlett and Higgins (2001),** this study used the following formula to calculate sample size as follows:

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

n: describes the sample size. N: describes total number of population of the area

e: describes maximum variability or margin of Error = 0.09.

1: describes the probability of the event occurring.

3.1.1.1. Sample size determination

The study was conducted with the aim of investigating the problems of Affordable housing in Gereb Giba. To this end, both probability and non-probability sampling methods were applied in order to select respondents. First, the having obtained the sampling frame that constitutes the list of all population of Gereb Giba from the academic sustainable settlement planning and design course or from the direct questionnaire, Second, with regard to simple random sampling technique, the sample of **105** respondents was randomly drawn from the total survey population of **700**. Third, non- probably sampling method was used to conduct the in-depth interview with **5** purposely selected informants among government officials and. On top of this, key-informant interview has been conducted with **5** experts from housing development department of municipalities in order to obtain data that signify the roles of concerned governmental organizations in promoting the access of affordable housing towards own shelter. Therefore, the total respondents are **105+5+5** which is **115** sample sizes is required to be sampled.

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

$$n = \frac{700}{1+700(0.09)^2}$$ = **105** from the actual study area and **10** from officials is **115** respondents

Note: 105 from the **700** population of the study area are **15%.**

The following table shows how the sample frames be gotten from the sample population which I have constructed from the above point of view.

Clusters	Target population	Study population	Study unit	sampling frame
Sampling areas	Gereb Giba population	Around river side	Agricultural areas	Urban agriculture areas
Population to be sampled	700	115 the total sample size	105 the actual study area	**17**, from the percentage of 115 sample size
Geographic areas	80 hectare	15% of 80 hectare 12 hectare	15% of 12 hectare 1.8 hectare	15% of 1.8 hectare **0.27** hectare
Percentage calculation	100%	15% of 100%	2.25% of 100%	**0.34%** of 100%

Table 1: sample size determination, (**Source:** Own production, 2017)

3.1.2. Methods of Data Collection

3.1.2.1.   The data sources

The primary data was collected through interviews of households of the areas, questionnaire of focus group and free hand sketches and observation through transect walk of ongoing housing activities in the data collection time and pictures of the main areas. In addition, personal site observations were also made to assess the provision of affordable housing. The secondary data for this study was the regional map of Tigrai, internet sources and the master plan of the surround areas. These data's were used because; the area had no current (existing) land use map and Arial photography.

3.1.2.2.   Procedures of data collection

The data gathering tools were designed on the bases of review of related literatures, objectives and research questions. Before the questionnaire was managed to the actual respondents, a pre-test (pilot test) was carried out in Gereb Giba academic case of sustainable settlement planning and design.

During the initial stage of questionnaires management, the objectives of the study have been clearly made to the respondents in order to avoid any confusion. Before issuing questionnaires, the time ease for the respondents was considered in order to maximize the rate of return of the questionnaires.

3.1.2.3.   Instruments of data collection

Collecting data through different tools leads to the accurate research findings. Having this in mind, the following data gathering instruments are used: questionnaire, interview and observation.

3.1.2.4.   Questionnaire

Due to resource and time constraint, the research could not entertain large number of people in case studies, in depth interviews and wider focus group discussions. Therefore, questionnaires were used to fill the gap and support the representative sample to address as many individuals as possible to help gather relevant firsthand information. Two different sets of questions were prepared: close-ended and open-ended questions (see Appendix-1).

For those respondents who could not understand English, the questionnaire was prepared and translated in to Amharic while asking them, so that the respondents could easily understand. The items of the questionnaires were classified based on the objectives of the study.

3.1.2.5.   Interview

The researcher used semi-structured interview in order to gather data from, administrative bodies or government officials, key informants and experts (see Appendix-2). This was preferred because it is flexible, allowing new questions to be brought up during the interview and also it gives equal chances for both interviewers and interviewees. This was aimed at obtaining background information regarding the affordable housing problem in the study area.

3.1.2.6.   Key informants interview

When the researcher felt doubt about the reliability of information gathered through other techniques or when there is a need to reinforce the data with further information, key informant

interview used as best solution as a tool, which offers the opportunity to acquire, information directly from knowledgeable people. Moreover, the tool also has been instrumental in generating recommendations. Accordingly, key informant interview was used to gather more of qualitative data explains and narrates the study population rather than expressing it in terms of numbers (see Appendix-3).

3.1.2.7. Observation

Among the primary data collection techniques, observation is crucial to understand peoples' activity in the basis of how, what and why they are doing something. This allows developing confidence to speak and analyze what is being said and what is really going on the actual setting. In this case, having observing the living condition of the people, the current situation of the Affordable housing problems with in Gereb Giba and contacted the key persons in the study area. (Appendixes-4) shows us this part of instruments of data collection.

3.1.3. Methods of Data Analysis

In interpretation of the expressive nature of the research, the raw data collected through questionnaires was carefully tallied, tabulated, and organized. Consequently, respondents were categorized; percentages were used to analyze the demographic characteristics of the sample population such as age or sex, educational status, income level, work experience and frequency count and others was hired to analyze various characteristics of sample population and to describe similarities and differences between the respondents or defendants .On the other hand, data collected through interview were presented and analyzed qualitatively by directly reflecting and narrating the interviewees' word. Data obtained from documents of municipality bureau of housing development and other sources (internet, articles) were analyzed by citing and reflecting on issues of affordable housing problem.

All types of computations for the analysis of data was done by using Statistical Package for Social Sciences (SPSS) of different versions, Microsoft office excel and Microsoft office word.

How to interpret data: the data have been collected are changed to software and analyzed to the appropriate way for presentation to the users of the affordable housing. **How to analyze:** to

analyze it has been helped by different software like Adobe Illustrator, Arch CAD, Auto Cad, SPSS, and others.

How to write and triangulation: having using the appropriate skills that are safe for the local users and representing it to different sources in order to give multiple ways of understanding to the validity and reliability of my study on the affordable housing.

Data types		Source of data		Instruments of Data collection		Data analyzing methods	
Spatial data	Socioeconomic data	Primary source	Secondary source	For primary data	For secondary data	Of Primary data	Of Secondary data
Housing condition	Income level	All socioeconomic data and some spatial data	Some spatial data like: environment and topographic data, climatic parameters and soil type	Questionnaires	Internet sources	SPSS	Microsoft word
Infrastructure	Income source			Freehand sketches	Google earth map	Arch CAD	Illustrator
Local materials	Demographic			Pictures	Regional map	Illustrator	Microsoft excel
Environmental and topography	Saving status			Direct observation		Microsoft Excel	
Climatic parameters	Employment			Interviews		Microsoft word	
Soil type	Educational			Focus group discussions		AutoCAD	

Table 2: summary of the research methods   (**Source:** own produce, 2017)

3.2. Site selection and Site selection criteria`s

The current increasing cost of housing materials are the major challenges of affordable housing. The cost of construction materials directly affects the affordability of housing. The cost of industrial or international housing construction materials is the main question and burning issue in housing development. The local housing construction materials are the materials that have been used extensively for building houses at affordable cost. They are easily available locally at little or no cost and local people are familiar with the technology of using them for construction of houses largely through self-help.

But the main challenges in the use of local materials are the unplanned way of housing construction techniques with local materials, the lack financial strength, and low employment level and others.

The selection of the study area mainly regards that the area has very rich local materials and also has very future development opportunity in that it has different potentials to perform housing growth.

These are the criteria that lead me to select the study area by its own characteristics.
- The proximity to Mekelle city, about 17km long
- The natural features like: water body, vegetation coverage, crops and grains, cattle production
- The topographic features suitable for development and construction
- The environmental safety and richness to maximize income of the community
- The multi-productions: agriculture, cattle breading and business activities
- The threshold population more than 700 need better infrastructure
- Crop production:-banana, pineapple, papaya, mango, avocado, lemon and others as income source
- Locally available housing construction materials like, stone, sand, earth/mud, wood, aggregates, grass as a binding materials for low cost housing provision
- The housing demand of the study area, that about 7 house hold size is dwelling in 4m*6m house. And the migration of people from other place for agricultural activities, this increases housing need.

3.3. Conclusion

The performance of the houses built with local building materials is suited to the geo-climatic conditions. However, frequent repairs and reconstruction are required. Moreover, large-scale damage and destruction takes place due to natural disasters like heavy rainfall and floods, earthquakes and landslides, strong winds and cyclones, and fires.

It is, therefore, mandatory on builders to achieve economic optimization in the use of local building materials by application of modern science and technology, so that more durable and

livable houses can be constructed at lowest possible cost. This is also necessary to ensure sustainable development without causing environmental degradation and ecological imbalance, which have become matters of overriding significance. Some notable progress has been made in some developing countries in the improved use of local building materials for low-cost housing and is briefly mentioned above, along with its potential for tackling the massive problem of shelter for the people at affordable cost.

Low- cost housing means housing at low cost for all section of the population, means that from the given physical resources of funds, materials, land, and skills one should able to build the maximum number of houses of good quality at affordable cost i.e. building houses at lower cost as compared to the usual cost level.

CHAPTER FOUR
4. DATA ANALYSIS AND MAJOR FINDINGS

4.1. Introduction

The site first was a cattle settlement area before human settlement approximately in the 1940 E.C. Most part of the site is administered in Tukul kebele. It has the character of some part highly sloped area covered by different types of tree and has a lot of accumulated stones especially in its mountainous area. In the other point its northern part is comfortable for agricultural activity since it have enough amount of water for irrigation purpose, urban agriculture and crop production and its water side slope is also more comfortable for farming production. The flatten part or the gentle slope of the study area is more suitable for building or housing construction because of the locally available materials.

4.2. Study area description- Spatial or physical condition

4.2.1. Location and topography

The study area is located absolutely in Ethiopia, Tigrai in Adi azmera woreda with capital town Tukulu tabia- 6km from Gereb giba qebele. It is found at the northwestern part of Mekelle city at about 17km farther. It is also found relatively at 0540 03' 00''E latitude and 150035'23''N longitude and at 1792m altitude above sea level.

The map below shows the location of the study area done for academic purpose so that everyone can understand easily and access the study area for extra information in this study about the study area. Note that there are no development activities or planning works have done in this area before.
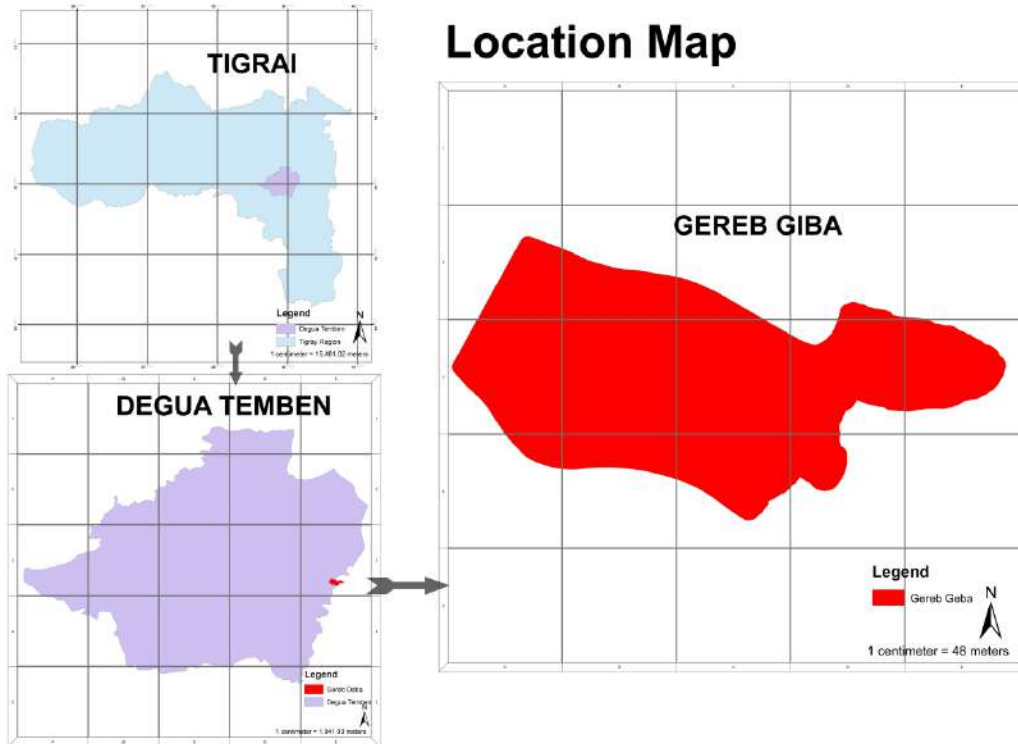
Map 1: Location map of the study area, Gereb Giba**, Source:** field data survey, 2017

4.2.2. Existing Land use and demography

Most part of the study area is covered by agricultural activities about 60%, irrigation about 15%, forest about 10%, residence and service (church) about 5% and the river is about 10%. The study area has no master plan, so this map is done from Google earth photograph
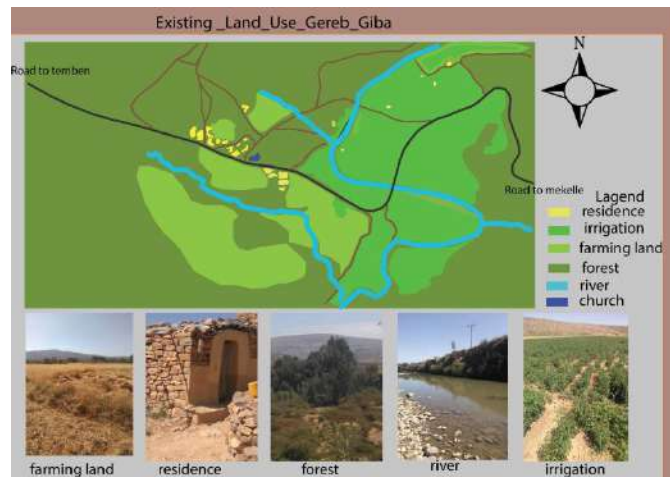
Map 2: Existing land use of Gereb Giba**, Source:** Field data survey, 2017

4.2.3. Environmental analysis

The drainage system of a catchment area is controlled by several factors including geology, structure and topography. In terms of its drainage condition, the study area is part of Tekeze basin where the branches join Giba River then to Tekeze River. The catchment is characterized by spares flow down streams from places of high elevation toward the area with flat topography.

Climatic parameters have a direct implication for urban development and urban planning. The agro climatic zone of the study area is Weyna dega /Mild climatic condition / which is virtually comfortable climatic zone both for habitation and to undertake any developmental activities throughout the year.

4.2.3.1.   Wind Direction

No wind direction has been measured in the metrological stations of Gereb Giba. And the following assessment is made based on the previous document of Mekelle Master Plan. The report indicates that the wind direction is dominated by the Easterlies wind blows from east during the dry season for longer period of the year (September – June). It has high velocity that can blow up the dust and soil easily. On the contrary the westerly wind blows from west during the wet season, July and August, is moist air and has less velocity. Recently a daytime maximum wind speed of 14 m/sec was recorded on 1/6/1996 E.C wind breaking tree plantation is enhanced, the study area will be prone to wind induced hazards. The analysis on wind direction is mandatory to decide the facades or frontage of the housing or building in order to minimize wind pollution.

4.3.   Housing conditions

The physical features and also the functional conditions of the housing in the study area is very poor in that the affordability problems are mainly observed. The building or housing are almost detached with poor waste disposal system, lack electricity but more of them use solar system or energy for lighting, mixed functions in the same room, problems of pollution from the kitchen (they use wood and animal dung for cooking) and from toilet (they use nearby forests and bare

lands), they use very dirty or poor materials for cooking and eating. They suffer off these main problems and other challenges and are losing their health in day to day activities.

Figures 5: Grass kitchen (A)   mixed use room (B)   traditional kitchen (C)

4.3.1. Locally available housing/building construction materials

The locally available building materials, in the sense of the above mentioned information are the basic and essential things that keep the nature in balance in order to bring a sense of Affordability in Housing. Therefore, Gereb Giba is a study area with different locally available building construction materials like: stone (Mesozoic sedimentary rock successions: limestone and dolomite and Igneous rocks: dolerite formation), aggregates, sand, wood, mud, grass for roofing purpose, white stone for cobble stone work and also building foundation work and expansive or clay soil.

4.3.1.1.   Locally available housing construction materials and their uses

The geology of the Mekelle area is mainly related to the rocks of the Mekelle outlier which comprises sedimentary successions formed from Paleozoic to Mesozoic geological time scale. These Mesozoic sedimentary successions include Enticho Sand Stone, Edega Arbi Glacial formation, Adigrat Sandstone Formation, Antalo Limestone Formation, Agulae Shale Formation, which are put according to their age from oldest to youngest formation.

The main lithological units or geological materials used for housing construction by the local people are Limestone which covers the largest area and serves as a backbone for construction of local residential houses. The Dolerite, the younger lithological unit in the study area specifically and in the geological formation of Ethiopia in general is found covering smaller area, but the Hill

top part of the study area above the Gereb Giba River or bridge is dominated by Igneous Rock intrusions.

The plain part of the study area is covered by thickly deposited quaternary sediments which is serving as farm land for the local people. The other available local housing construction material in the study area is Clay soil or expansive soil which is mainly used as wall cementing material and protection of wind entrance to the house. (Source: Wubshet G. 4th year Geology student with direct visit of the study area Gereb Giba with me). Below are some parts of the study area of locally available housing materials

Figures 6: Wubshet at the site (A)   Ato Berhe, resident (B)   Clay soil as Cement (C), **Source:** Field data survey,2017

I.   Limestone

Limestone is one of the common sedimentary rocks which is composed of Calcite (CaCo3). This Lithology covers larger part in the study area which forms thickly bedded sedimentary structure.

The uses of Limestone as construction materials: Almost all of the local people in the study area rely on this Rock unit purposely for construction of their residential houses. As depicted by the pictures below the wall of the Building/House is constructed solely using locally available limestone. Another amazing application of this rock unit is used for the construction of traditional furnace for cooking foods. In addition to this, the recent application of this Lithology

is mining the rock for the production of constructional aggregates which may be used for the construction of modern building and advanced road construction.

Beyond the local application, this Lithological unit has a variety of uses such as Mining (using it as a raw materials for cement factory), Mortar (mixed with sand and water), and Glass (heated with sand and soda or sodium carbonate, NaCa3)

Figures 7: Traditional furnace of limestone (A)   limestone house/building (B &C)

II.   Dolerite

Dolerite is an Igneous Rock formed by the cooling of magma. This Lithology covers small area in the study area, however the top of the Hill above Gereb Giba River/Bridge in the site is dominated by igneous intrusion, and due to its inaccessibility and difficulty of excavation (mining) it is not widely used by the local people for house construction. But in small scale with cut or broken from out crop and transported to the plainer area is used as construction materials.

Generally, this rock may be used as building material, concrete aggregate, and paving stones and as an ornamental stones.

Figure 8: dolerite stones (transported)   **Figure 9:** dolerite stone out crop

III. Dolomite

Dolomite stone or dolostone is another group of sedimentary rock which is composed of (CaMg) $_2Co_3$ as a chemical composition. This Lithology is found intercalated with Limestone covering smaller area. Local house construction, road construction, and others are the main uses of this Lithology to the local dwellers.

Figures 10: dolomite stones in the study area found by excavation

IV. Expansive/Clay soil

The plainer part of the study area is covered by thickly deposited Clay rich soil which is very fertile and serves as agricultural farmland for the local people.

Expansive soils or Clay soils are those containing sufficient quantities of clay (montmorillonite, smectite and vermiculite) which tend to swell when they absorb moisture and shrink when they lose moisture.

A pattern of polygonal desiccation, or "shrinkage cracks are the major characteristics of this soil" These soils possess a high plasticity index and cracks travel deep into the ground.

The local people use this soil mixing with cement and water for the purpose of cementing the wall of the house in order to bind the stone each other and to prevent the entrance of wind pollution into the house. They also use as a flooring of the house and for the Traditional furnace work.

Due to the presence of expansive soils/clay soils/ the site not recommended to build modern or international towers unless some engineering treatments is done. This is because of the effects of expansive soil that may happen to the building such as fracturing and cracking on the building,

subsidence, sidewalk and others. In order to construct international or modern buildings in the study area some treatments are recommended to be taken in order to avoid the problems mentioned above. These are:

I. Removal of expansive/clay soil: - the top part of the clay soil has to be removed and replaced with non-expansive soil such as sand-gravel soil.

II. Foundation treatments: - this involves placing a blanket or embankment of non-expansive soil over the expansive soil to resist the uplift pressure of underlying expansive soil.

III. Isolating water from the expansive soil: - sand and gravel are used to break in capillary continuity when ground water is moving upward.

IV. Deep vertical geo-membrane/moisture barrier/:- especially the construction of highway on expansive soil may require this technique. Moisture barriers are constructed in trenches filled with the gravel or resistant membrane (Source: **Wubshet G.** 4th year Geology student with direct visit of the study area Gereb Giba with me).

Figures 11: expansive/Clay soil in the study area

4.3.2. Synchronic and diachronic analysis of the study area

Diachronic analysis is the analysis of the changes taken place on the study area through time. This may be the change on the physical/spatial structures, on the social/cultural life styles, on the environmental aspects, on the economic conditions and others. Whether, the synchronic analysis is the analysis of the currently existing condition of the study area on the above aspects of changes.

In and before the 1960's there were no settlements in the study area. It was simply used for forest some part for grazing and later on it became agricultural or farmland. Following this activities, the farmers started to bread or husbandry of cattle. Consequently, the formers also started to settle on the study area because the far of the work place from their residence (hagere selam, Mekelle and other place). They started to build traditional houses by using the local materials like stone, wood, grass, animal dung and mud.

Having this in mind the government started to give 20m*20m land which is 400m^2 land for each person in 2000 E.C. but there is no housing projects does the study area has. Or no housing is provided for the community by the government in Gereb Giba. They build their houses by using local materials.

For the time being, there is Dolerite stone out crop for construction on the mountainous part of the site, there is also Giba Dam coming, urban agriculture and irrigation activities, and the high way crossing the Gereb Giba and the social service (Orthodox Church) in 2008 E.C.

Currently, Gereb Giba is known by site of locally available construction materials like Sand, Dolerite stone aggregate, and Dolomite stone the whitest stone for coble stone work. Even for the other places like Mekelle, Hagere selam, Temben and others.
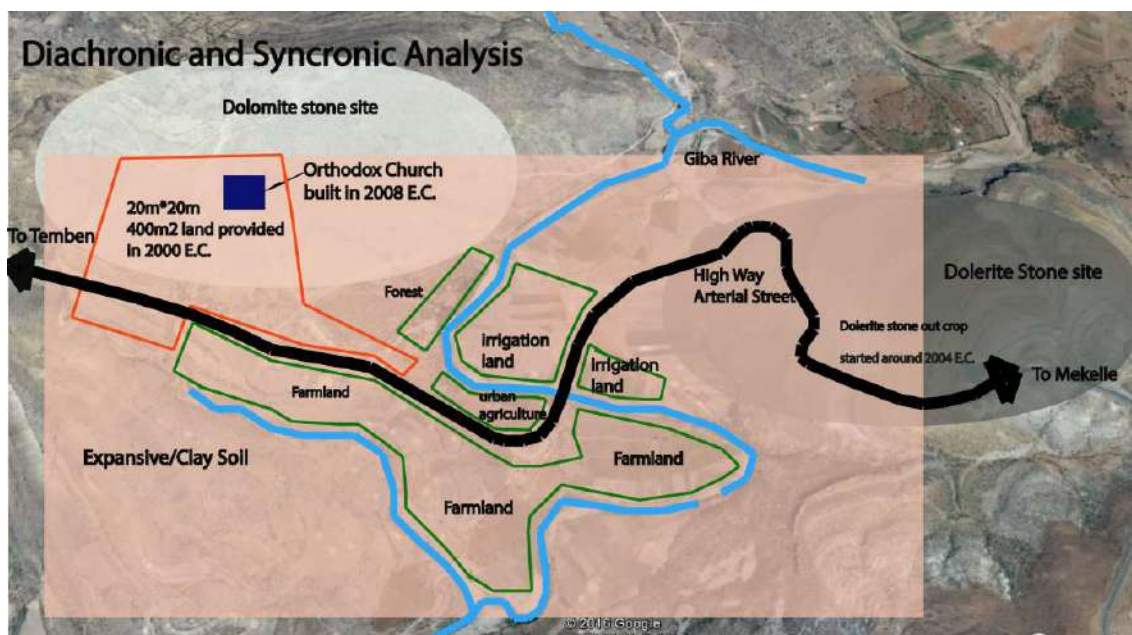
Map 3: Diachronic and Synchronic Analysis map of the study area

4.4. Socio-economic condition

The social and cultural cohesion of the study area is too strong through the existence of cultural way of life and worshiping style, together working or cooperative working habit, very closeness to their work place and at least the same level of living condition. The building materials that the housing is constructed by are more of local materials and these have a cultural benefit to harmonize the society together.

The absence of Social service like schools, health centers, mosque is but creating low social capacity in the study area. There is no school in the site, but the site`s population school from Mayala(1-8 grades) walking 3km from their place and Tukul(6km) and mekelle by walking distances. There are no health centers in the site, but they use from Tukul. Social linkages like idir, equb, mahber are the means of social bondage but there is no bank and microfinance.

4.4.1. Population number and House hold size of Gereb Giba

The total number of population in the study area is about 700 people. There are 144 house hold in the site with male=124 HHs and female=20 HHs. Here we can observe that the population number of male is greater than that of female. Hence males are the most dwellers in this area and positively affect the working habit to increase their income level.

Table 3: Existing population number of Gereb Giba

Gereb Giba	Male	Female	Total
Population	376	324	700
Household	144	124	20

Source: field survey, 2017

4.4.1.1. Income level of the population

There are the three income groups of population presented in the site. Those are when we compare the population of the site with respect each other:

1) Higher income groups: those who can have high income per month. Examples: the owner of cattle, the owner of more agriculture products who can export. Here the numbers of population are about 126 of the total population.

2) Middle income groups: group of populations that can have a middle income per month. Examples are: the less agriculture products and less cattle number, the number of population in this class is 345 of the total population.

3) Low income groups: groups that can have low income per month. Examples are: goat breeders, in this case it is 229 of the total population.

Table 4: Income level of the society, source, field survey, 2017

Income groups	Numbers of population	Percentage (%)	Income per month
Higher	126	18	3000 birr
Middle	345	49.285	2000 birr
Lower	229	32.714	850 birr
Total	700	100	5850 birr

Source: field survey, 2017

4.4.1.2.   Source of income

► Agriculture income: fruit and other product husbandry
► Cattle Market income: cattle husbandry
► Trading and market product exchange (business activities)

Unemployment: as we observed there is a maximum population that don't have work and who are unemployment. This made them to be low income group of population and they have no money freedom and they are also psychologically not free. This is when we compare them to other part of society, so they are suffering of poverty. This idea tells us to provide houses that incorporate more income for the society in order to overcome these situations.

Figures 12**: Income source of the study area**, source: **Field survey, 2017**

4.5. Summary of main Findings

4.5.1. Key potentials in Gereb Giba

▶ The Gerb Giba river: source of construction materials like sand even for Mekelle city, white stone for coble stone work, very essential for agricultural activities, for housing activities, for cattle husbandary and other human life day to day activities

▶ Cattle breading and agriculture and the man power: high hard working habit and increase the level of income and duplicate source of income

▶ Vegetation and tree coverage: for the protection of the environment, source of food and income, minimizes the effect of climate, enhances better life condition for the local community and other animals also

▶ Romanat fall and industrial zone, the Dam coming around the site, irrigation and dolerite stone out crop as a construction materials: these are very essential developments around the study area which encourage the development of the study area.

▶ The local housing construction materials: local materials like stone, sand, clay soil and other construction materials are easily available in the study area

4.5.2. Key problems (main challenges of affordable housing) in Gereb Giba

▶ **High cost of housing construction materials:** this challenges the economy of the community through influencing the annual activities of agriculture by demolishing some part of their farm land. Here there is also Flooding during summer season that harms the society by the increased price of construction materials as they cannot afford for housing.

▶ **Increased cost of transportation**: this also challenges the residents as they cannot even move housing construction materials from other area.

▶ **Lack of infrastructures, the social and physical**: this is the most challenging problems that retard the development of the community.

▶ **Poor Housing conditions:** this problem is mostly seen in the study area even though there is house. This is because of the high cost of building materials and unplanned use of locally available construction materials

- **Lack of financial support:** the local people have no access for financial support from somebody or someplace.
- **Lack of saving:** there is saving habit in the study area that encourages saving and loan system.
- **Absence of governmental housing provision:** there is no governmental housing provision plan for the area.
- **The unemployment and illiteracy:** the very low income level and not educated society have no idea about affordability housing but they have a need of affordable housing.
- **Low income level:** that is the main challenges of the community of housing affordability.

Generally, the study area has opportunities like:

- Mekelle city, hagere selam, Tukul Tabia (like: sugar, vegetation oil, salt, kerosene, solar energy savior, textile products, cloths, and others)
- The river for extraction of resources (sand and white stones even for the Mekelle city)
- High way crossing the site and pedestrian way side of the high way (that provides transportation access to the site)

4.5.3. Needs of the community of Gereb Giba

- Better way of life or planned urban life with better income and income source
- Infrastructure: Electricity, transportation, bus station, social services like: KG, health post, school and others
- Administration- kebele administration, police station for security case
- Affordable housing with their income level and better housing facilities and utilities

4.6. Conclusion

The main conclusion drawn from the analysis section of the thesis is, there are much potential that the study area has like: existing local construction materials, strong habit of agricultural activities, cattle breading and production activities, the big water body for construction and other activities and others.

But because of the main challenges like: lack of experience on how to use local materials, quality of local materials selection for their housing is affected by lack knowledge about the materials, the material that are used for finishing is highly low quality (like grass or weak wood), lack of skilled laborers and Poor workmanship, use of poor construction materials, poor quality production of construction materials by unskilled local peoples, the high cost of industrial materials, lack of basic infrastructures and absence of governmental support.

Therefore, if these challenges continuous to the next generation, the affordability of housing in this area will be the meaningless topic. So what have to be done is using the local potentials by skilled man power in a planned way to construct affordable housing. Overcoming the challenges by the help of planning and design idea is a matchless choice for this area.

CHAPTER FOUR
5. DATA ANALYSIS RESULT AND DISCUSSION

5.1.   Introduction

This chapter deals with the presentation and interpretation of the data collected through questionnaires from the study area from 105 respondents and focus group and interview data from the 10 respondents from the municipality and city administration of Mekelle city as a reference for the study area because not to repeat the same problems in this study area. To emphasize the data collected using questionnaires, the interview obtained from the municipalities' civil servants, and other key informants was incorporated in the body of the analysis and interpretation. The data collected by the two methods: questionnaires and interview were presented in the following sections. Some of the data obtained from the municipality of Mekelle city are presented in appendixes-6.

In this chapter not only the physical data are analyzed but the socio-economic and socio-demographic data are also analyzed. The physical data are more broadly analyzed and focused than that of the socio-economic and demographic data of the study area. As there was no study is taken on the study area before, the data in chapter three are more recent and relevant data so that they can be discussed more flexibly and accurately. It is amazing for me that having most respondents in one place drinking the cultural drink together in the mixed use house of Ameteyesus Hadsh. This opportunity helped me to gather more information about the study area.

5.2.   The Socio-demographic Characteristics of the Respondents

This section deals with the description of the characteristics of all the respondents (105) involved in the study by randomly selection of respondents from the study area. The characteristics of respondents include age, sex, marital status, House hold size, educational level and employment status.

Table 5: Age, Sex and Marital Status composition of the respondents

Variable Name	Categories	Frequencies	Percentages	Total	
	≤20	10.5 which is 11	10%	Respondents	%
	21-30	16.5 which is 17	16%		
Age	31-40	63	60%	105	100
	41-50	11.55 which is 12	11%		
	51-60 and ≥ 61	3.15 which is 3	3%		
Sex	Male	84	80%	105	100
	Female	21	20%		
Marital Status	Married	89	85%	105	100
	Single	14	13%		
	Divorce	2	2%		

(**Source:** Field Survey, 2017)

5.2.1. Age

The age structure is one of the most important demographic indicators. Because, it helps to detect the level of fertility, mortality and human resource potential of the study area for any investment purpose in one hand and the socio-economic development level of the study area on the other hand. So, it can be concluded from the finding that the high proportion of the young and adult age population in the study area reveal that, there is high fertility and high population growth rate which directly contribute to the existing housing problem on the affordability. On the other hand, few of the respondents were in the old age category. And the 10% childhood age group is also a very anticipating age group for the next future development who needs affordable housing. Low proportion of old age population on the other hand is an indicator for low life expectancy which may not alter the affordability of housing.
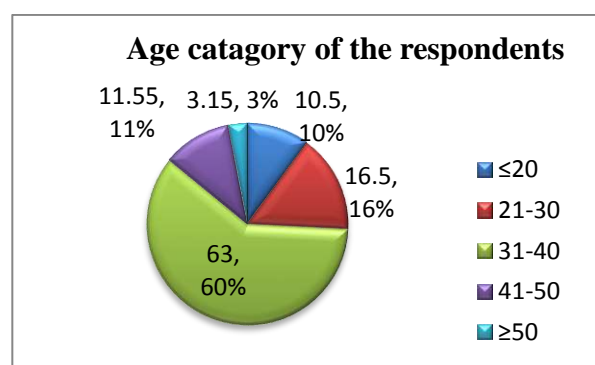
Chart 1: Age category of the respondents, source: Field survey, 2017

Here the demand or need of affordable housing is very crucial and high, because the adult and more productive age group in the study area needs better way of life in nature and as responded they need quality housing at the cost they can afford in their income aspect.

5.2.2. Sex

Sex is also one of the important variables in the demographic and socio-economic studies because many social and economic conditions are a function of sex (Tamirat, 2008). Sex distribution of the respondents in Gereb Giba as illustrated in table below is largely dominated by males, which accounted for 84 (80%) respondents of the sampled population.

On the other hand, female respondents accounted for 21 (20%) only. These show that most of the Gereb Giba populations were males. This may be associated with the high exposure of males to education in comparison with females and got access to be employed. As employment directly affects the affordability of housing sex also affects.

5.2.3. Marital status of the respondents in Gereb Giba

As observed and interviewed, some of the respondents in the study area married were adults and majorities of them were family heads. Whereas those of singled were unmarried man and reported as they intended to marry late in their life. The absence of widowed and widower implies that the fertility rate of the study area is high; therefore the demand or need of affordable housing will increase correspondingly.

Marital status of the respondents

2, 2%

14, 13%

89, 85%

- Married
- Single
- Divorced
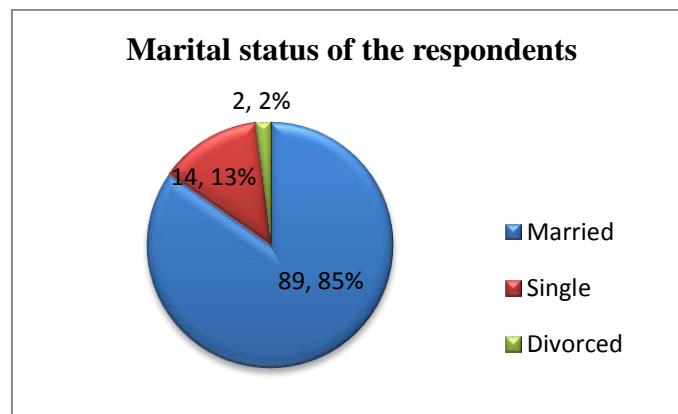
Chart 2: Marital status of the respondents   **Source:** Field Survey, 2017

5.2.4. Educational status of the respondents in Gereb Giba

Education is one of the important factors that can determine the house hold income, which in turn affects the affordable housing construction capacity of the community of the study area (Habitamu, 2013). Considering this, as the field survey and the observational result of the study area, Gereb Giba indicates that almost all of the respondents have no educational qualification and hence they no income from education. Most of them about 101 (96%) of the respondents are below grade 5 and 4 (4%) of the respondents have finished grade 10. This implies that there shall be social service like, schools and others in order to encourage this community. Even they do not have the idea of housing affordability, so they are under challenges financial shortage.

5.2.5. House hold of the respondents

As it is shown in table below, among the total respondents, 52 (50%) had 4-5 members in their families. Next, 38 (36%) of respondents had 2-3 members. Also 15 (14%) of the respondents had 6-8 members in their family. Finally, it is possible to deduce from the survey result that the family size is highly linked with some ones' monthly saving and this in turn affects the capacity of a family to lead normal life. As the respondents experience shows that when the size of the family increases, small amount or nothing remains from their monthly earning to save. On the other hand, individuals with small family size may save some amount of money left from consumption in traditional institution and micro finance. This implies that those respondents who have large family size may spend a lot of money to fulfill the basic necessities of their families like food, clothes, and other social obligation. In this manner, it is very difficult for the family with large members to save and construct or possess their own residential house even it is not affordable.

Table 6: House hold of the respondents

House hold size	Frequency	Percentage
2-3 HH	38	36%
4-5 HH	52	50%
6-8 HH	15	14%
Total	105	100%

Source: Field Survey, 2017
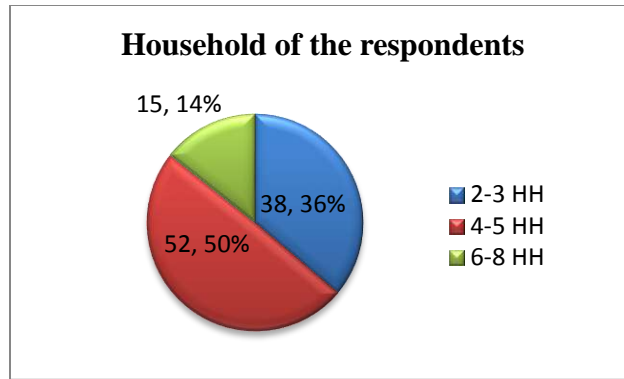
Chart 3: Household of the respondents, **Source:** Field Survey, 2017

5.2.6. Employment status of the respondents in Gereb Giba

As mentioned in the educational status of the respondents, almost all of the respondents are not educated and are farmers. The respondents are all self-employed, farmers and cattle producers at the same time. The employment status of the community at the same time also challenges the affordability of housing in this study area. Therefore, employment creation is may be the best way to manage the employment status of this society. As been observed, many of the adult aged society group was simply sitting in some area throughout the day without any work performing.

Thus, one can conclude from the survey result that, majority of the respondents in the study area are low income societies and suffering from the affordable residential housing shortage. According to (Aina, 2005), the low income earner is a relative term and to identify the low income person, one needs to take awareness of the location, cost of living, employment status of individuals, educational qualifications and their expenditure characteristics within a free market economy. In this respect, the low income individual is seen as a person whose income is low and cannot meet most of his/her basic needs and affordable housing. The high level of unemployment indicates the failure of the area`s economy to use its labour resource effectively.

5.3. Factors Affecting Access to Residential Housing in Gereb Giba

5.3.1. Income related factors that discourage Gereb Giba communities from gaining affordable residential housing

5.3.1.1. Monthly income of the respondents

According to the table below, majority of the respondents 92 (87.62%) monthly income that they gain from their current work (agriculture and cattle production) is 801-1200 ETB. 9 (8.57%) of the respondents monthly income is 1201-1600 ETB. And 3(2.86%) of the respondents monthly income is from 1601-200ETB. Lastly, 1(0.95%) of the respondents monthly income is >2401ETB, this respondent`s is grossary a mixed use house. Thus, the overall monthly income distribution of the respondent's ranges from 801 to ≥ 2400 ETB.

As the survey result shows that from the limited amount of monthly income, expenditure on basic necessities like food, cloth and other social services take greater share. This in turn reduces the effective demand of housing, affordable housing.

The findings from the study (survey and interview) indicate that the monthly income of the respondents was not enough to fulfill their basic necessities including residential housing.

Therefore, the amount of income limits the performance of the majorities of Gereb Giba residents to construct affordable housing and forced them to live in poor housing. As the result, it can be concluded from the finding that as it is very difficult to them to construct affordable residential housing. So, it is imperative to the communities to develop the habit of saving, through which the study problem may be solved in the long run.

Table 7: The monthly income of the respondents

Monthly income in ETB	Frequency	Percentage	Source of income
801-1200	92	87.62%	Agriculture, cattle production
1201-1600	9	8.57%	Agriculture, cattle production
1601-2000	3	2.86%	Agriculture, cattle production
>2401	1	0.95%	Grossary, agriculture, cattle production
Total	105	100%	

Source: Field Survey, 2017
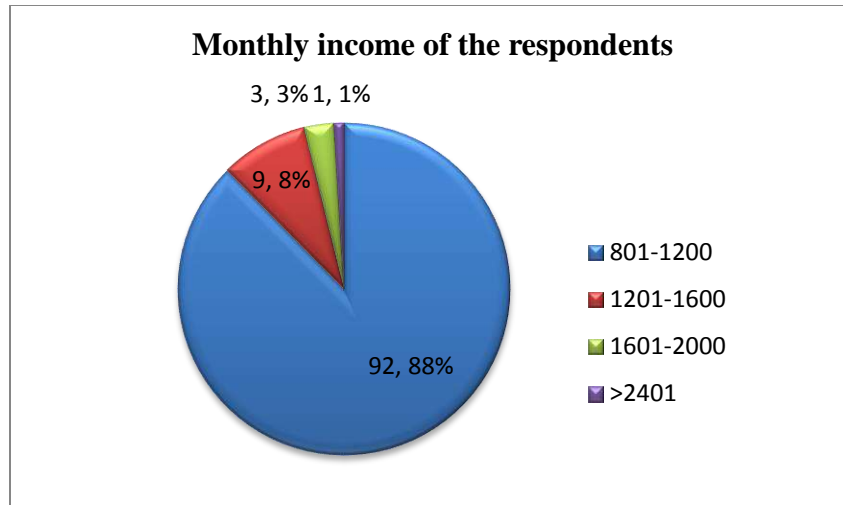
Chart 4: Monthly income of the respondents, **source:** Field survey, 2017

With face to face interview administered to some selected respondents in the study area, one farmer states the situation as follows:

In my family, both my wife and I are farmers. We have three children. Our total monthly income is about 900 ETB. With this monthly income, life is very difficult to survive in Gereb Giba. We all have our wants and needs to be fulfilled. I believe that, first I have to give priority to my family's needs. But, we have a residential housing built with wood, so we are trying to have a 4*4, 20m2 residential housing in a near future built from local stone. Even they have this housing, they will not afford because in a 20m2 house it is difficult to dwell for five household size.

5.3.1.2. Saving habit of the respondents in Gereb Giba

5.3.1.2.1. Monthly saving of the respondents

Majority of the respondents, 102 (97.14%) were not able to save. The respondents have forwarded different reasons like increasing cost of food and other different goods for their failure to save. On one hand, 3 (2.86%) of the respondents were saving monthly 50-1000 ETB.

One of the in depths interview participants affirmed the above survey result by explaining the situation by his mouth as follows:

Now, due to increasing cost of life in the Mekelle city, it is very difficult to communities to save from monthly income. As one farmer in depth interview reported that, for him a little money left behind from his monthly income of 830 ETB. As he said, the life in his family is a process from hand to mouth. Even this is so; this respondent saves 50 ETB 6% of his monthly income per month in traditional saving institute (Iqub).this means that his expense per month is 94%. In order to afford for housing the expense must not be greater than 30% for housing facilities. This respondent borrowed 19,500 ETB from microfinance for the purpose of irrigation work. Therefore, by this saving mechanism and amount he cannot afford for the Housing.

Therefore, one can draw a conclusion from the above finding that the saving habit of the respondents in the study area was very poor. This may be due to lack of developing the habit of saving and the increasing cost of living and the absence of modern saving institution like bank. Saving is the means to attain our future needs including affordable residential housing. To save, you need not be an investor or a millionaire, billionaires. It is a way of putting aside whatever left behind our consumption and expenses.

NOTE: There is no modern saving institution in the study area. And there is no rental houses in the study area that means everybody live in his/her own house even it is not affordable. There is no residential housing supply by the government in the study area. From this findings what I can conclude is that there shall be the presence of these things in the study area if not the affordability of housing is again under comma, that means the community may not afford by any means for low-cost effective housing.

5.3.1.3. Respondents' duration of Residence in Gereb Giba

According to table below, very few sampled respondents, 15 (14.28%) have been lived in Gereb Giba for one year to five year. Also, 32 (30.47%) of the sampled respondents have lived for 6-10 years in the area. Other respondents, 58 (55.24%) lived for ≥10 years in the study area. Majority, 58 (55.24%) of the respondents have lived for ten and above ten years in the area. The survey result reveals that majority of the respondents have lived for long years in Gereb Giba. Accordingly, they had a lot of experience about the housing problem and the increasing cost of life in general. So, they can provide enough information for problems related with lack of access to affordable residential housing by the community. Knowing this information is also very

essential to estimate the duration of the age of the housing built up by the locally available materials.

Table 8: Respondents' duration of residence in Gereb Giba

Duration of stay in Gereb Giba	Frequency	Percentage
1-5 years	15	14.28%
6-10 years	32	30.47%
≥10 years	58	55.24%
Total	105	100.00%

Source: Field Survey, 2017
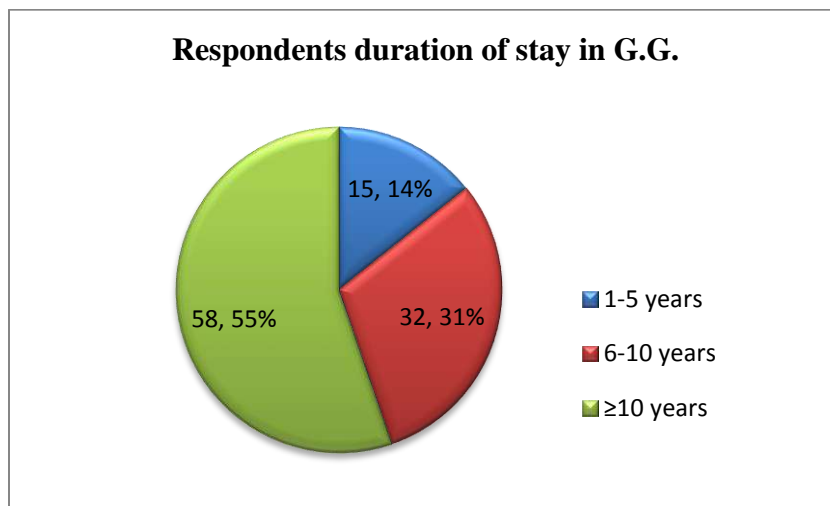
Chart 5: Respondents duration of stay in Gereb Giba**, source:** Field survey, 2017

5.4. Supply Related factors that Prevent communities from Gaining Access to Affordable Residential Housing

These factors may contain the land supply and the housing supply in the study area either by his/her ability to pay and willingness to spend and by the government provision.

5.4.1. An attempt by the respondents to obtain land for residential house construction

Majority, 90 (64.5%) of the respondents did not attempt to obtain land in the study area. Those respondents who didn't attempt to obtain land, forwarded different reasons for their failure to

attempt. Shortage of money, the absence of concerned municipality in the area, lack awareness of land policy, plenty of land for agricultural activity and others are mentioned as major reasons.

The rest 10 (10%) of the respondents attempted to obtain land for residential housing, the reasons behind these respondents are distance of work place from their living residence, to have other land for their children, in order to build house and for the home/shelter of their cattle.

Accordingly, the government had provided land for residential purpose in the area around 1999 E.C. The provision system is known as "Metekeya". The provided land for housing construction is 20m*20m which is 400m2.

Even though there is a provided land for residence, the community is unable to build affordable housing because of different reasons like, due to financial shortage, due to absence of loan or advance and due to rising in the cost of construction materials. These reasons are the reasons of the whole respondents in the study area. The land ownership/acquisition in the study area is by the provision of land and by inheritance from their families and relatives.

Note that: these challenges are also the problems that prohibit the society not to build or construct affordable residential housing in the study area.

5.4.2. Major Effects of lack of access to affordable residential housing

Regarding the effects of lack of access to affordable residential housing, everybody faces the same challenges in the study area. These challenges are:

- ► Lack of infrastructures and housing facilities: as been put in the analysis section of this thesis, there is lack of infrastructures like electricity.
- ► High cost of building construction materials: as one respondent said that it is very difficult to me to construct affordable housing with high cost of materials. He indicated that for example the cost of one single still corrugate of 3rd level is 120 ETB and wood for roofing with 90 ETB for single wood. This respondent is excavating to construct a 4m*4m which is $16m^2$ houses for five house hold size, so this is not even affordable due to functional benefits of the house. But he can gain stone, clay soil and other materials

from local area without payment. He simply collects them, with only consumption of labor force.

▶ Inability to resist the increasing life cost: as there are no local markets and other places from where they get goods easily, they import from Mekelle city. So that they face a problem of great cost of transportation, high cost of goods/items and utilities. This indirectly and directly minimizes the habit and ability of saving.

5.4.3. Ways to alleviate the problem of affordable residential housing

Almost all of the respondents are attempted to give the same solutions for how they can solve the problems of affordable residential housing in Gereb Giba. The ways they suggest are:

▶ Saving regularly and constructing their own affordable house
▶ Getting loan or advance from financial institutions and constructing their own house
▶ Hard working and minimizing the rate of expenditure
▶ The help of the government for his own people, governmental provision of housing

Further, the respondents were asked in open-ended questionnaire to forward their suggestion about their contribution in order to alleviate the housing problem in Gereb Giba.

Accordingly, most of them reported that developing the habit of saving regularly and working hard as the major ways to solve the problem of the affordable residential housing. The habit of saving could be developed in the following ways. First, by avoiding extravagance practices and wastage during production and consumption and by the provision of saving institutions, Second, by consuming locally produced goods and planning owns life and finally, by avoiding spontaneous purchasing.

▶ Therefore, one can drive conclusion from the above finding that saving regularly, working hard and living in one's own means are the ways to alleviate the housing problem of the community.

5.5. Existing physical conditions of housing in Gereb Giba

The existing physical housing condition in the study area is poor and not affordable. Almost all of the houses are constructed by locally available construction material. There is one building built with local and international materials. The constructed houses are not affordable for the community in two different aspects. These are:

- Not used in a planned and right architectural manner: this relates to the function parts of the houses, the façade or frontage of the building, exposed for some pollutions like vehicle and dusts.
- High cost of housing commodities: even though they got housing construction materials in the local, the lack of infrastructures are the main challenges that lead to expend most.

5.5.1. The local materials used for housing construction in Gereb Giba

The survey result reveals that the larger numbers of housing units floor finishing are earth or soil i.e. 93(87.57%) housing units floor finishing are earth and 12(12.43%) housing units are stone concrete. The construction materials of wall from which the study area houses wall were constructed, 104(99%) have limestone wall and small amount of clay soil for cementing, 1(1%) were constructed from wood. The construction materials of roof of the study area 104 (99%) made up of corrugated iron sheet and 1 (1%) made up of wood. Also it can be seen from the table below that the majority of the houses were built from temporary material which can be rotten in short period of time. Thus; construction of wall should be from hollow block and other permanent construction material. Soiled floor is not good for dwellers health while it is not easily cleanable and may dispersed with wind causing contamination to food and drink. In line with this, soiled floor should be discouraged and the house should have cemented or if not stone concreted floor. Based on the above analysis result anybody can conclude that the housing condition of the study area is somewhat sub-standard.

NO	Construction materials	Number of housing Constructed	Percentage (%)
1	Flooring		

	Earthen	93	87.57
	Stone	12	12.43
2	Walling		
	Limestone	104	99
	Wood	1	1
3	Roofing		
	Corrugated iron sheet	104	99
	Wood	1	1

Table 9: Construction materials of the houses   **Source:** Field survey, 2017
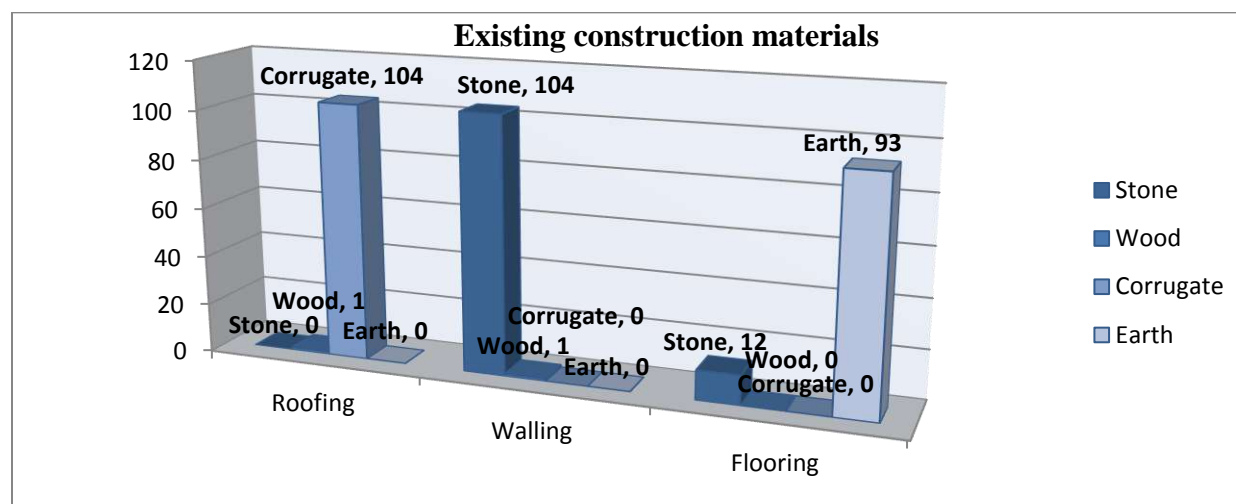
Chart 6: Existing construction materials of the house, **source:** Field survey, 2017

5.5.2. The housing utilities and infrastructure facilities in Gereb Giba

For the quality and presence of utilities in the study area that are surveyed by direct observation are tabulated as follow. The absence of infrastructures are the main challenges of this area, so the communities are suffering of many different problems like communicative disease, high cost of life, high transportation cost, lack of electricity, and others. Therefore, having this in mind the conclusion is driven as the absence leads to lose of life directly and indirectly. According the literature review, the housing problem is complicated by its nature in that it comes from diverse causations of socioeconomic, institutional, political and other related policies and priorities (Herrmann, 2008.). All these factors influences the quality of housing, so regarding this idea the

housing condition was to be bad. The low quality of the housing condition and the lack of utilities indicate that the housing in the study area is unaffordable.

Table 10: Construction materials of the houses

NO	Attributes	Number of household	Percentage (%)
1	Housing condition		
	Poor/bad	100	95.24
	Good & moderate	5	4.76
2	Housing typology		
	Detached	105	100
	Attached	0	0
	Semi-detached	0	0
3	Waste management system		
	Poor disposal	95	90.48
	Burning	10	9.52
4	Housing energy source		
	Wood	62	59
	Wood & animal dung	43	41
5	Housing light		
	Solar system	37	32.24
	Kuraz	68	64.76
6	Housing water supply		
	Pumping tape water	105	100
7	Housing toilet facility		
	Bare land	43	41
	Forest	56	53

	Pit private	6	6
8	Housing kitchen facility		
	Kitchen private	9	8.57
	Kitchen in the house	54	51.43
	Traditional furnace	42	40

Source: field survey, 2017

5.6. Affordability summarization due to the existing housing typology, condominium housing and local material

5.6.1. Existing housing typology, sample from Gereb Giba

In the study area, lot of household contain about 5 - 8HH size in a 4m*6m=24m^2 building. This is not affordable by the standard of Mekelle city, 4HH size in single house. Below is the local housing typology in the area with an area of 24m^2 for 8HH size as been direct observed.
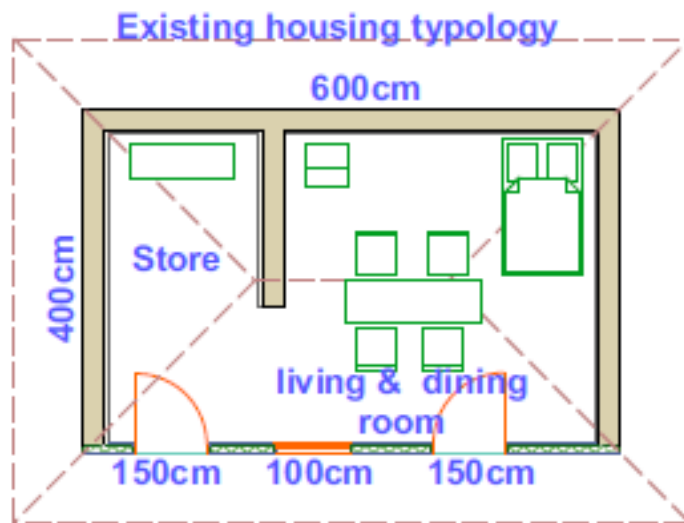
Figure 13: Ground Plan of existing housing typology   **Figure 14:** 3D of the house

This housing typology is unaffordable due to the lack of infrastructures, high density of people, problem in the functional use of the building (living, dining, bed room, and other different activities) in the same room, causes disease because of the ground material, low income of the residence, low quality of life and others.

The above sample house is taken from the study area. The owner of this house is Ato Gebremedhin Gebru. He has a monthly income of 950 ETB and he save 5% of his income which is 50 ETB. Even though he did he was unable to afford his housing.

There is no governmental support or supply of housing in this area, lack of modern saving institution, lack of financial support, and low income level are the main challenges of affordable housing in the area. For these reasons the societies could not afford for housing in Gereb Giba.

Therefore, there should be the availability of the needs in the area so that to afford housing for the community.

5.6.2. Housing cost summary of condominium housing

Condominium housing is a name given to the form of housing tenure where each resident household owns their individual unit, but equally shares ownership and responsibility for the communal areas and facilities of the building, such as hallways, heating systems, and elevators. There is no individual ownership over plots of land. All of the land on a condominium site is owned by all homeowners. (UN-Habitat 2011)

Table 11: Initial financial structure for beneficiaries according to unit type

Unit type	Down-payment	Interest rate	Grace period	Repayment period
Studio	10%	0%	6 months	20 years
1-Bed	10%	2%	3 months	10 years
2-Bed	30%	7.5%	-	15 years
3-Bed	30%	7.5%	-	10 years
Commercial	100%	-	-	-

Table 12: Breakdown of unit typologies in each condominium block

Unit type	Floor area (m^2)	Percentage in each block
Studio	<20	20
1-bed	20-30	40
2-bed	30-45	20
3-bed	>45	20

Table 13: Unit type and beneficiary income level

Unit type	Monthly income in ETB (USD)	Average price (m2) in ETB (USD)	Selling price in ETB (USD)
Studio	300 (23)	800 (62)	16,000 (1,230)
1 Bedroom	600 (46)	900 (69)	18-27,000 (1,380-2,070)
2 Bedroom	1,200 (92)	1,100 (85)	33-50,000 (2,530-16,660)
3 bedroom	1,800 (138)	1,200 (92)	>50,000 (16,660)

Note that, the construction cost of a condominium housing unit on the private market is estimated to be ETB **2,000/m²** (USD 154/m²). (UN-Habitat 2011)

Therefore, some body to own condominium housing should have the following costs:

Case 1: **To own studio**

$20m^2$ x 2000 ETB is equal to **40,000ETB**

Case 2: To own one bed room

$30m^2$ x 2000ETB is equal to **60,000 ETB**

Case 3: To own two bed room

$45m^2$ x 2000 ETB is equal to **90,000ETB**

Case 4: To own three bed room

$60m^2$ x 2000 ETB is equal to **120,000 ETB**

Therefore, by no means the community of the area is affording for condominium housing in the site for each of the housing unit type. This is because; the very low income level of the society and even the condominium housing typology is not popular for the rural community to have.

5.6.3. Local building material cost summarization

Table 14: Cost of local materials in Mekelle city

No.	Local materials	unit	With transport cost in Mekelle (ETB)	Direct cost in Mekelle (ETB)	Transport cost (ETB)	K/m from Mekelle
1	Sand	m^3	333.98	329.35	4.63	1.00
2	Water	m^3	115.50	110.87	4.63	1.00
3	Gravel	m^3	330.72	326.09	4.63	1.00
4	Stone	m^3	173.33	168.70	4.63	1.00
5	Cement sand mortar	m^3	1.85	0.00	0.37	1.00
6	Soil Brick	m^3	126.37	121.74	4.63	1.00

| 7 | Others | m^3 | 11927.63 | 11702.807 | 147.76 | Conditional |
| 8 | Summation | m^3 | **12836.05** | **12759.557** | **171.28** | Conditional |

Having this in mind and that of the distance of the study area from Mekelle is about 17km conclusion is drawn out from the above table. In the other local materials the cost of transportation depends on the weight of materials. In order to calculate the cost of transportation for the study area we simply take the total transportation cost => 171.28 ETB x 17km = **2911.76ETB.**

Therefore, the total cost of local materials in order to have housing in Gereb Giba is **12759.557 ETB + 2911.76ETB = 15,671.317 ETB**

Most of the above mentioned materials are available at the study area, so they can easily get without extra transport cost. But they only need some other materials from other place by transportation cost.

Therefore, when we compare the cost of housing build by local material with the cost of condominium housing it is a difference of sky and earth. The community can afford housing with very low cost by optimizing the locally available materials in a modern way of construction.

5.6.4. What progressive unaffordability can result?

The study area has a population of 700 residents, 144 housing units and 140 households. But about 8 household sizes are dwelling in a single 24m^2 houses. This implies that there is a need of housing in the study area. Therefore, if we can estimate for the next 5 years we will have the following population and housing units should be built.

i.   **Population estimation, by the linear progression method**

Pt. = Po (1+rn), where Pt. is final population to be estimated. Po is initial population, r is growth rate of the population and n is difference of year between final and initial. The growth rate of population for rural Mekelle is 5.07% or 0.0507 and the difference in time is 5. Therefore,

Pt. = Po (1+rn),

Pt. = P2009 (1+0.0507*5)

P2014 = 700 (1+0.2535)

P2014 = 700 (1.2535)

P2014 = **877.45**, this is the population number after five years later. Therefore, the housing demand of the population will be calculated by the formula of:

ii. Housing demand projection for the next five years

Housing demand = back log + new housing formation + houses to be demolished + contingency

Housing demand = BL + NF + HD + CG

There is no house to be demolished, **HD = 0** and the BL = 144 − 140 = **4 HUs**

The new housing formation is equal to:

NF = 877.45/HHs per house, 5 HHs as Mekelle standard

NF = 877.45/5

NF = **215.4 HUs** are needed to be built for the remaining population

Contingency is the houses to emerge eventually, it is considered as 10%

CG = (BL + NF + HD)*10%

CG = (4 + 0 + 215.4)*0.1

CG = **21.94 HUs** are going to be emerged eventually.

Therefore, the demand of housing for the next five years will be:

Housing demand = BL + NF + HD + CG

Housing demand = 4 + 215.4 + 0 + 21.94

Housing demand = **241.34 HUs** will be needed for the next five years

Conclusions are easily drawn from this calculation that the following five years are very challenging years if there is no provisions of affordable housing as per the estimated housing units. The main solutions for this will be the local material for housing construction in order to save the financial wastage for the government and other stakeholders.

CHAPTER SIX
6. CONCLUSIONS AND RECOMMENDATIONS
6.1. CONCLUSIONS

Having the literature review in mind and findings on the study area the following conclusions are drawn out from the study. When coming to the conclusions, the objective aspects of this study are considered. Those are: the existing challenges of affordable housing, the local construction materials available, experiences of masonry and possible measures of affordability of housing accordingly.

- Challenges of affordable housing
    - International manufactured construction materials are very high cost that are not affordable for housing with its transport cost
    - The increased cost of transportation is the head ach in affording housing
    - Lack of basic infrastructure is considered as a burning issue that pulls affordable housing not to be practical
    - The low income level, lack of financial support and lack of saving create additional load not to afford housing
    - Absence of governmental housing provision, unemployment and illiteracy are caused the fast absence of affordability and encouraged low quality housing
- Local materials available
    - Manufactured material shortage is not being given immediate solution and hence resulting in suspension of project activity because of its high cost.
    - Local Materials produced and delivered by production sites are not considerably reaching the need of affordable housing
    - The unplanned and not designed use of local construction materials for housing construction by the local people is minimizing the affordability of housing
    - The very rich availability of local construction materials are mandatory to have affordable housing when produced in a planned manner
    - The housing development sector seems to be very slow in searching for alternative cost effective local construction materials for affordable housing

- o Local materials are cost effective, affordable and environmentally sound in that the manufacturing techniques and transportation pollutions are minimized
- o Using locally produced building materials shortens transport distances, thus reducing air pollution produced by vehicles.

- Experiences from masonry
  - o Masonry is a local construction materials work for affordable housing construction
  - o Fire resistance, durability and energy efficiency are the essential characteristics of masonry in affordable housing
  - o Naturally existing materials are cost minimizing local materials which enhance affordable housing by encouraging functional and financial success
  - o Local material selection in masonry should be taken a great concern in introducing new local cost effective and minimized finishing work materials.

- Measure of affordability of housing
  - o When the ability to pay and willingness to spent of the society at every income group are kept in an affordability sense for housing construction
  - o The housing expenditure cost affordable house of the society should not exceed 30% of their total monthly income, but the study area population is costing about 95% for their housing. Therefore, it is not affordable.
  - o There is no design intervention for affordability of housing taken in the area by using the local materials.
  - o Affordability of housing is missing because of the absence of basic infrastructures, increasing cost of life and lack of governmental mechanism to solve the problems

In general, the costs of imported international construction materials are very high and affordability of housing is directly related to the cost of materials, it is impossible to afford for housing in Gereb Giba. The necessary choice to afford housing in this area is the local construction material so that we can find them in the local area without much money delay for transportation. Natural stone is an available material in this area in different types and forms. Masonry is the work of these stones for housing construction in a local area and the techniques are easier to build affordable housing. Even the Clay or expansive soil in Gereb Giba is very essential in a work of compressed interlocking earth block (It is a more advanced type of

compressed earth blocks and it is capable of being laid without mortar or any other jointing material. Its minor setback is that it can only be produced by a specialized machine, which may not be advantageously acquired by an individual builder for a single project). But the components in a (cement stabilized soil block) CSSB are soil, cement and water. The resulting strength of the block is depending on various things like type of soil and its content of certain clay minerals, the distribution of the grain sizes, cement content and density. The preparations for the producing of CSSB require accuracy. After the soil has been dug out it has to be crushed and then screened to separate the different fractions. When the soil is crushed and mixed into suitable proportions of grain sizes right amount of cement should be evenly spread over the loose soil and dry mixed before water is added. The cement rate is normally recommended within the span of 5% to 10%. Obviously, clay soil is available in Gereb Giba but the only thing is to take experimental work on the capacity of the soil.

Note that clay soil, sand, limestone, water (Giba River) and other construction materials are available in Gereb Giba.

6.2. RECOMMENDATIONS

First of all I am supposed to recommend starting with the appreciations of the good parts which should be reserved up by the people of the area such as;

- o The hard working custom of the people like irrigation, cattle production and the internal devotion to have better life and planned activity and the need of affordable housing should be encouraged for a betterment of their income level.
- o The strong and harmonious relationship or interaction of the society is a basic criterion for affordable housing implementation.
- o The strong habit of using local materials for housing construction of the community is very essential to make easy the work of masonry and local materials than that of imported materials so that it makes the techniques of local construction materials easy to take place
- o The availability of local construction materials are important that minimize the cost of housing materials, so facilitates affordable housing with low cost housing

The next recommendation resembles to the constraints of affordable housing and challenges of the area;

- The low income level and unemployment are considerably affects the affordable housing development directly, hence the life quality of the society in the area was very low and resulted to the huge presence of poverty
- The lack of infrastructures and housing utilities were affecting at maximum percentage and the affordability sense had been lost and become simple idea as only a shelter: so that housing should be beyond the concept of shelter only
- The cost of imported materials becoming hired and burning issue as no low income group society can afford enhances the use of local construction materials with low cost and to keep the environment sustainable
- The lack of transportation for the area and the lack of local materials production sites in the area are minimizing the ability to use the local materials in a modern design and planning

The general recommendations drawn from the study are as follows. They are drawn from experiences from the case study, literature, and finding and from the interpretation of findings and by taking into consideration the needs of the community in the study area.

- First of all affordable housing is an obligatory requirement of society to have as a human right with their level of income
- Local materials are the best choice to provide affordable housing, so the housing sectors should take measures and recognize these materials while the allocation of housing
- For the demand of housing in the study area the next five years exceeding 241HUs, by any means may not the government can afford for the society because of the economic insufficiency of the country, so it is better to optimize the local housing construction materials with very low cost of housing.
- The cost of local materials for a single residential housing with two bed rooms is more affordable than that of condominium housing typology so that recommendation can be cropped out to introduce local masonry and small enterprises as construction industry

- The lack of saving habit awareness and saving institution are majorly retards the people from having affordable housing. Therefore, there should be saving institution that enhances their economic level, because they work hard but no money they save for housing purpose

- The study area has much potential like sand even distributed for Mekelle city, large river, and good habit of irrigation system, cattle production and crop production. The only lack in here is the assistance of the government to develop their income source through a planned aspect. Therefore, the government should concern for this area to afford their housing through their ability to pay for housing.

- There is a need of community to have management organization to improve the working methodology and urban way of life for their business system, so the connection to other areas should be kept in balance

- I recommend that the government shall provide different infrastructures for example electricity, transportation, clean water, and others that majorly affects the affordability of housing.

- The concerned body of the government, the housing sector should encourage the income level of the community by increasing the productivity of irrigation and agricultural activity through modern system by recycling the animal waste to the agriculture land

- In a very real ways Mekelle city is expanding. Therefore, it is essential to optimize the Giba River and it's out crops like sand and stone even water in this area. Recommendation is the city management should take this in to consideration to afford for housing.

CHAPTER SEVEN
7. DESIGNS AND STANDARDS

7.1. Norms and standards of Addis Ababa structure plan

7.1.1. Household sanitation standards

o   A housing unit should have a septic tank or a connection to a public sewer system

o   Size of septic tank (clear space) should correspond to family size and within a range of 8-27 centimeter for economical and efficient usage

o   Setback standards of septic tanks stipulated in the building permit document should be respected.

7.1.2. Greenery and Environmental norms and standards

o   One plot one tree for plots of area up to 150 m sq. and 1 tree for every additional 100 m sq. plot area.

o   12-25 % of a plot area should be unsealed (for greenery and natural open space so that rain water should percolate to the ground, decrease water discharge and reduce runoff).

o   Green areas of different standards (Neighborhood-city level) should be provided and developed according to the norms and standards provided in the Social Facilities component.

o   In any case an average of 0.5-1m sq./person should be reserved for green spaces

7.1.3. Housing area standard

Table 15: Housing area standards of minimum habitat

Income group	Minimum habitat housing standard (m^2)	
Low income	20	It consists of a multi-purpose room (13 m2), toilet (3 m2) and kitchen (4 m2) will be built at the first phase and an additional bedroom of 10 m2 at the final stage.
Middle income	30	It consists of a living room (13 m2), toilet (3 m2) and kitchen (4 m2) and 10 m2 bedroom at the first phase and

		an additional bedroom of 10 at the final stage.
High income	-	

Source: Addis Ababa norms and standards

7.1.4. Site Occupancy Ratio Standards

Table 16: Site occupancy ratio standards stories

N0	Plot size	Site Occupancy Ratio (SOR) Number of stories.
1	<150	o Single story detached Max. 75% o Single story attached Max 65% o Two and three story detached Max 60% (rental or condominium)
2	150-175	o Single story detached middle-income- Max 65% o Single story semi-detached - Max 60% o Single story attached - Max 55% o Two and three story detached - Max 60% o Two and three story semi-detached -55% o Two and three story attached - Max 50%
3	**175-250**	**G+1-G+2- Min 65 %**
4	250-400	G+0, G+1 Min 65 and 50% respectively
5	400-600	For G+2, G+1-and G+0 Min 45, 50 and 65 Respectively.
6	>600	G+0, G+1, G+2 Min 40% and above shall be allowed. In doing so proposed facilities and building elements shall be considered.

Source: Addis Ababa norms and standards

o In allocating land for high-income, minimum Site Occupancy Ratio should not be lower than 40 per cent for G+2 housing units and the maximum not more than 65 per cent for G+0 residential complexes

o Maximum SOR for low and middle-income housing in expansion areas should be 75 and 65% respectively.

To sum up, the standards, as the provided land by the government is 400m^2 and when we take 65% of this coverage 260m^2 land for housing construction. The proposed height of building is G+1 to keep the standard. Two types of housing units are proposed one bed room with an area of 20m^2 and two bed rooms with an area of 30m^2. Shopping is proposed to encourage their economic level.

GROUND FLOOR PLAN, (one bed room)

Dimensions: 30.00m overall width, 9.00m, 1.00m, 20.00m sections, 8.00m height, 2.30m

Room labels:
- bed room
- bath room
- Toilet
- stair case
- kitchen
- living and dining room
- Shopping

2.20 3.01 0.15 2.10 2.58 6.44 E-06 2.94 0.15 3.23 7.46

S-02

31.000

+3.100

2.43

child bed room

master bath room

closet

Staire Case

child bed room

master bath room

closet

child bed room

master bath room

closet

child bed room

master bath room

closet

3.25

master bed room

master bed room

master bed room

Maid`s Room

Maid`s Room

Maid`s Room

master bed room

S-01

9.000

1.50

corridor

Maid`s Room

Kitchen

8.85 9.55

2.99

Kitchen

Kitchen

Kitchen

Living and Dining Room

Living and Dining Room

0.75

toilet

toilet

Toilet

Living and Dining Room

Living and Dining Room

S-01

7.81 2.58 1.76

toilet toilet

verenda1 verenda2

8.000 0.400 8.000

S-02

FIRST FLOOR PLAN (two bed room)

DETAILS DESIGNS

The detail housing typology below has 4 HH in the Ground floor and other 4 HH in the First floor. This typology more encourages the income level through incremental system by providing shoping at the Group floor and also increases the recycle of animal waste for irrigation activities and also increases social interaction. The housing materials are localmaterials that shrinks cost and increases environmental safety. It is more affordable than condominium housing in that it minimizes.

GROUND FLOOR PLAN, (one bed room)

FIRST FLOOR PLAN (two bed room)

Front Elevation

Section A-A

Rear Elevation

Section B-B

GROUND FLOOR PLAN, (one bed room)

OVER ALL 3D

FIRST FLOOR PLAN (two bed room)
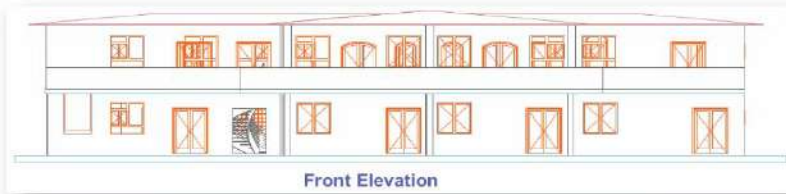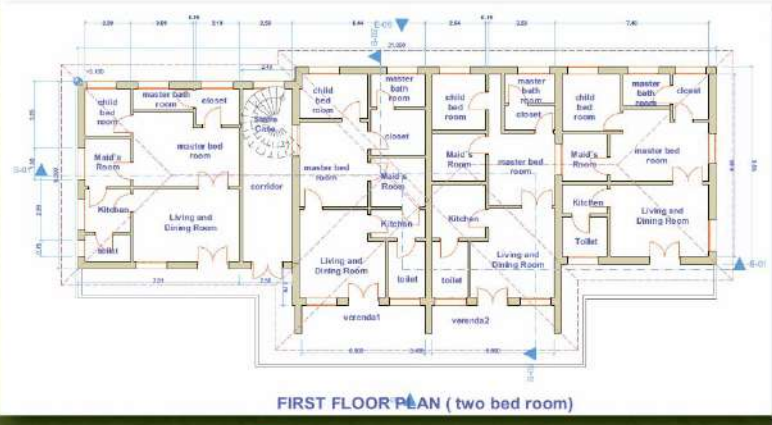
Cattle house

Roofing material corrugate

Open space-greenery

Walling and Flooring material Limestone Masonry

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APPENDIXES

<u>**Appendixes- 1**</u>

Questionnaire development

The purpose of this questionnaire is to gather information on the title; **Placed-Based affordable housing: the case of Gereb Giba, Mekelle zone, Tigrai Region, Ethiopia**. Thus, you are kindly requested to respond in a free, accurate and sincere manner. This will maximize the trustworthiness of the research work. Be sure that the information you provide will be kept confidential and used only for the research propose.

Direction:

▶ There is no need of writing your name.
▶ For multiple choice items, you can choose more than one answers if you believe two or more alternatives are important.
▶ In case of questions where alternatives are given, please mark an ''X'' in the box in front of your choice. But kindly write your opinion briefly for short answer questions on the space provided.
▶ Please try your best to provide an accurate response as possible to the questions.
▶ There is no right or wrong answer. Relevant answers should be indicated with cross ''X'' in the box provided.
▶ Please do not leave the question not answered.
▶ I apologize for the inconvenience I may have created due to taking your time in filling out this questionnaire.

Part One: Information related to the Socio-Demographic Characteristics of respondents

Direction: Indicate your response by using (X) mark in the box provided.

1. Age:

A) ≥20 ☐   B) 21- 30 ☐   C) 31-40 ☐   D) 41-50 ☐   E) 51-60 ☐
F) ≥61 ☐

2. Sex: A) Male ☐   B) Female ☐

3. Marital status:
A) Single ☐   B) Married ☐   C) Divorced ☐   D) Widowed ☐   E) Widower ☐

4. House hold size   A) 2   B) 3   C) 4   D) 5   E) >5

5. Educational level:
A) 5-8 ☐   B) 9-12 ☐   C) Certificate ☐   D) Diploma ☐   E) B.A/B.Sc./B.Ed. ☐
F) M.A/M.Sc./M.Ed. ☐   G) Ph.D. ☐
H) Other (Please Specify) _____

6. What is your employment
A) Governmental ☐   B) NGOs ☐   C) Self-employed ☐   D) Unemployed ☐

E) Pensioner ☐   F) Others ☐

Part Two: Questions related to current status of housing and factors affecting access to affordable housing by the society.

7. What is your monthly income in ETB?
A) 801- 1200 ☐   B) 1201 -1600 ☐   C) 1601-2000 ☐

D) 2001-2400 ☐   E) >2401 ☐

8. What are your other sources of income? A) Animal husbandry B) Business
C) Vocational activity ☐   D) Agriculture ☐   C) Others ☐
9. How much do you save per month in percentage per your income?
A) Nothing ☐   B) 5% ☐   C) 10% ☐   D) 20% ☐   E) 30% ☐

F) 50% ☐   G) >50% ☐

10. Your monthly expenditure from your monthly income
A) 100% ☐   B) 95% ☐   C) 90% ☐   D) 80% ☐   E) 70% ☐

F) 50% ☐   G) <50% ☐

11. Where do you save your money?
A) Traditional saving institution (equb, edir, mahber) ☐   B) Bank ☐
C) Micro finances institutions ☐
D) Other (Please Specify) _____

12. Have you ever borrowed some amount of money from the above mentioned?
Saving institutions? A) Yes ☐   B) No ☐
13. If your answer for question number 14 is yes, how much birr have you borrowed?
_____

For what purpose have you borrowed? Please specify your reason.

_____

14. How long have you lived in Gereb Giba so far?
A) Below 1year ☐   B) 1 -5 years ☐   C) 6-10 years ☐   D) Above 11 years ☐
15. The house that you are now living is: A) Private owned ☐
B) Rented from private persons ☐   C) Rented from municipality ☐
D) Kebele House ☐   E) Others ☐
16. If your answer for question number 18 is rented, what is the amount that you are paying for the house per month ETB?
17. A) ≤100 ☐   B) 101 – 300 ☐   C) 301 – 600 ☐   D) Above 601 ☐
18. How do you explain the effects of paying such amount of money per month for the rental house in your living standard? _____

19. Why are you living in a rented house?

A) It is due to lack of my own house ☐   B) It is to be close to the place of work ☐

C) It is to be close to friends ☐

D) Other (please specify) _____

20. Have you ever attempted to obtain land for residential house construction in Gereb Giba?

A) Attempted ☐   B) Not attempted ☐

21. If your answer for the question 22 is yes, why didn't you construct your own residential house?

A) Due to financial shortage ☐   B) Due to absence of loan ☐

C) Due to rising in the cost of construction materials ☐   D) Due to lack of interest to construct ☐

E) Due to lack of planning in my life ☐

F) Other (Please specify) _____

22. Is there any residential housing supply by government for the society?

A) Yes ☐   B) No ☐

23. If your answer for question 24 is "Yes ", what type of residential house has been supplied?

A) Kebele house ☐   B) Condominium house ☐   C) Habitat for humanity house ☐

D) Saving houses built by municipality ☐

E) Other (Please Specify) _____

Part Three: Questions related with Effects of lack of access to affordable residential housing.

24. What are the effects of lack of access to the affordable residential housing in Gereb Giba?

A) Lack of different infrastructures and housing utilities

   i. Electricity ☐   ii. Water ☐   iii. Others _____

B) High cost of Building Materials ☐

C) Dependent life in some one's rental compound ☐

D) Lack of freedom in the rent house when getting out and in ☐

E) Lack of freedom to use water and electricity in the rental house ☐

F) Inability to resist the increasing life cost ☐

G) Being exposed to the arbitrary increment of cost of rent house ☐

H) Being in able to get rent house for large size family ☐

I) Other (Please Specify) _____

25. Land ownership/Acquisition

A) Land provision ☐   B) Housing unit ☐   C) Fixed Lease ☐

D) Inheritance ☐   E) Gift (Private) ☐

Part Four: Questionnaires related with available local materials in the study area and their current benefits for the Affordable housing construction

26. What type of materials are you using for Residential building construction?

A) International materials ☐   B) Local materials ☐   C) Others ☐

27. Are the materials affordable for the community   A) Yes ☐   B) No ☐

If yes, (Please specify)   _____

If no, (Please specify)   _____

28. What are the Local Materials available in Gereb Giba?

A) Stone ☐   B) Bamboo ☐   C) Sand ☐   D) Wood ☐   E) Grass ☐

F) Mud/Earth ☐   G) others, (Please specify) _____

29. Housing materials for Roofing

A) Corrugate ☐   B) Concrete ☐   C) Wood and Grass ☐   D) bamboo ☐

F) Mud/Earth ☐ G) others, (Please specify) _____

30. Housing materials for Walling

A) Brick ☐   B) Stone concrete ☐   C) Wood and Grass ☐   D) bamboo ☐

F) Mud/Earth ☐   G) others, (Please specify) _____

31. Housing materials for Flooring

A) Earth mud ☐   B) Cement concrete ☐   C) Wood tile ☐   D) Stone ☐

D) Cement tile ☐   F) Mud/Earth ☐   G) others, (Please specify) _____

Appendixes-2

Interview

Part Five: Interview guide for experts working in municipalities and Housing development and government offices also

32. Do you believe that there is problem of affordable residential housing in Gereb Giba currently?
33. Do you have information about the current status of affordable residential housing problems in Gereb Giba?
34. What do you think are the major causes for such affordable residential housing problems in Gereb Giba?
35. Is there any action that has been taken to solve the affordable residential housing problem in Gereb Giba?
36. Is there any plan which is designed by government to solve the current affordability residential housing problem in Gereb Giba?
37. What is the government plan to increase housing ownership in Gereb Giba?

Appendixes-3

Key informants/focus group interview

Part Six: Questionnaires related with the ways to alleviate the problem of affordable housing.

38. What do you think are the ways to solve the affordable housing problems?
A) Saving regularly and constructing their own houses ☐
B) Getting loan from financial institutions and constructing their own house ☐
C) Buying constructed saving houses ☐
D) Buying constructed condominium housing ☐
E) Other (Please Specify) _____
39. What do you think are the role of government in alleviating the existing housing Problem (please Specify) _____

40. What do you generally suggest to improve the situation? (Please specify)

Observation

Part seven: Questionnaires answered by direct observation

41. Housing condition

A) Good ☐   B) Moderate ☐   C) Bad/poor ☐

42. Housing typology

A) Attached ☐   B) Detached ☐   C) Semi-detached ☐

43. Waste management system

A) poor disposal ☐   B) Septic tank ☐   C) Open ditch ☐

D) Burning ☐   E) municipal collection ☐

44. Housing energy source

A) Electricity ☐   B) Wood ☐   C) Animal Dung ☐

D) Gas ☐

45. Household Water supply

A) Tape in the house ☐   B) Tape in the compound ☐   C) Public Tape ☐

D) Tape outside ☐   E) Common Tape ☐   F) Pumping ☐

46. Toilet Facility

A) Flush common ☐   B) Flush Private ☐   C) Pit private ☐

D) Pit shared ☐   E) In the Bare land ☐   F) In the Forest ☐

G) No toilet ☐

47. Kitchen Facility

A) Kitchen private ☐   B) Kitchen shared ☐   C) Kitchen in House ☐

D) No kitchen ☐

Sample Transcription of Respondents' from the residents of the study area

Respondent sample: Mr. Berhe Heshie, Mr. Araya Heshie, Mr. GebreAzgi brhanu, Ms. Ameteyesus Hadsh, Mr. GebreMedhin Gebru and others responses' are summarized below out of 105 respondents.

Appendix table 1: Field observation checklist and questionnaire result of factors of affordable housing in the study area, generalized form of the questions above (x)

No.	List of questionnaire statements	Yes	F	%	No	F	%
1	Respondent save regularly to afford housing				x	105	100
2	Government provide land for residence	x	5	5	x	100	95
3	The cost of materials challenges the housing affordability	x	105	100			
4	Government has provided finance for housing construction				X	105	100
5	Government has planned to construct residential housing				x	105	100
6	Respondents can afford for international housing construction materials				x	105	100
7	Lack of infrastructure impacts the affordability of housing	x	105	100			
8	Use of Local materials can afford for housing-(low-cost housing)	x	80	76	x	25	24
9	Income level and source influence housing affordability	x	105	100			
10	Most of the people are unable to pay for affordable housing by international housing materials	x	105	100			

Source: Field Survey, 2009 direct site observation and interview of the residents

%= percentage F= frequency *Out of 105 randomly selected respondents from the study area

Appendixes-6

Sample Transcription of Respondents' Interview/focus group/

Interview guide for experts working in municipalities of Mekelle and Housing development and government offices

Having these focus group discussions on Mekelle city administration civil servant, it is possibly enables me to have a referenced idea from this city to study the actual study area, Gereb Giba.

Researcher: Do you believe that there is problem of affordable residential housing in Mekelle city?

Respondent A: Tsahaye WeldeGirma, Planner in Mekelle City Administration

Definitely, the problem of residential housing is one of the burning issues in Mekelle City.

The problem is the problem of majorities of the residents in the city. Government employees are one of them. Currently, as the result of increasing cost of life in city, it is very difficult to government employees including me to construct their own residential housing. The cost of construction materials is sky rocketed. It is increasing from time to time. My gross monthly salary is 5541 birr. After spending on basic needs, no more money left behind to save from my salary. If I do not save I know that, I couldn't construct my own residential house. Even sometimes, I take some amount of money in advance from my salary to be deducted at the end of the month when I collect my salary. So, I left with small amount of money. For me constructing my own house with in my current capacity is unthinkable. My big worry is survival in all costs. I do not worry for the presence of my own house, but I do not hate if I had it. There are other problems that the city facing. These are: the high lease cost of land 1300 birr per $1m^2$ land this is very difficult for low income group of people, high urbanization rate of the city, fast growth of the population of the city, migration from rural to urban and high cost of rental houses.

There are some mechanisms the government has taken to solve the shortage of housing in the city by cooperating with stakeholders. These are the Self-helping cooperative housing system ($84m^2$ G+1 building for 20households which is $168m^2$ with 2m setback and green area for 4 blocks in the compound by the policy of 30 for infrastructure, 30 for green area and 40 for building of the city wide) provision by

facilitating saving and borrowing loans from bank by giving contracts for construction by bidding activities, and by provision of apartment and condominium housing.

Researcher: Do you believe that there is problem of affordable residential housing in Mekelle city?
Respondent B: Mebratom GebreMedhin, Infrastructure exporter in Mekelle City Administration
Yes of course, I believe that there is serious problem of residential housing for government employees in Mekelle city. The current challenges of affordable housing mekelle city are: high cost of construction materials, higher labour cost, low income of resident individuals, high standards of building and zoning regulation, and higher cost of professionals. My monthly salary is 4867 ETB and I have no residential house to live in.

There are some mechanisms the government has taken to solve the challenges of affordable housing in the city by cooperating with stakeholders. These are the Self-helping cooperative housing system (84m^2 G+1 building for 20households which is 168m^2 with 2m setback and green area for 4 blocks in the compound by the policy of 30 for infrastructure, 30 for green area and 40 for building of the city wide) provision by facilitating saving and borrowing loans from bank by giving contracts for construction by bidding activities this mechanism of housing provision do not consider or include the low income group of the people, and by provision of apartment and condominium housing but this includes the low income groups of society.
The government is planning to supply land through lease frequently and providing land for cooperatives as well as introducing condominium programs.