A Holistic Approach to Large-scale Housing Development in Urban Ethiopia

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December 2013

Submitted towards the fulfillment of the requirements for the Doctor of Architecture Degree.

School of Architecture
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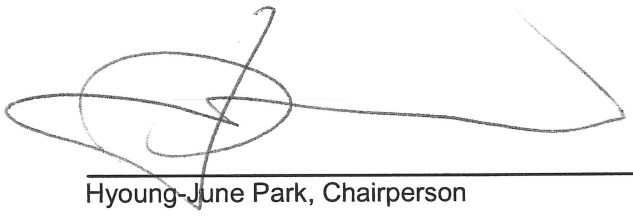
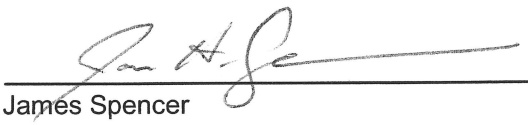
We certify that we have read this Doctorate Project and that, in our opinion, it is satisfactory in scope and quality in fulfillment as a Doctorate Project for the degree of Doctor of Architecture in the School of Architecture, University of Hawai'i at Mānoa.

Doctorate Project Committee



Hyoung-June Park, Chairperson



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Abstract

Due to the rapid urbanization of Ethiopian cities, the growing demand for housing in its urban areas has accelerated the development of large-scale housing projects. This has created a challenge for local authorities responsible for their development in a relatively short period of time. Therefore, current housing development follows the conventional approach where limited building types are developed and replicated with minor modifications to accommodate given site conditions. This strategy has resulted in an environment that is not suitable for the traditional lifestyle of common Ethiopian. Studies show that the lack of social and cultural considerations in the current development has hampered the quality of life of its residents.

The research conducted in this paper proposes a holistic approach to large-scale housing development in order to provide optimized solutions for social mix and multi-generation family life style in Ethiopia. The holistic approach is developed within a parametric modeling environment supported by Rhinoceros 3D & Grasshopper and its plug-ins in order to enhance design feasibility studies. The approach is based upon four major components such as 1) social and cultural factors, 2) a neighborhood model of urban typology, 3) a financial model and 4) a massing study model that delineates the possible building variations.

A research project location in Addis Ababa, Ethiopia is selected as a test site for the proposed development strategy. The site is part of a large informal settlement that was demolished and replaced by a typical low-cost housing development composed of four and seven story towers. The goal is to generate an alternative building typology based on the new holistic approach, which meets the social, cultural and economic needs of tenants. Analysis of informal settlements in Addis Ababa has identified multigenerational living, socially and financially mixed communities as important ingredients for building a sustainable community. It was also discovered that semiprivate spaces, circulation paths and

scalable housing units as key spatial variables that are necessary for the successful cultivation of these communities.

Based upon the analysis of social and cultural factors of given urban district, a neighborhood model is developed from existing site context and defined as a space holder for including various architectural programs such as different unit types (studio, one-bed, two-bed), spatial definitions (private, semi-private, public), and circulation (vertical and horizontal). The financial model is based on the optimization among the three criteria including market value, construction cost, and government incentives in order to provide tangible benefits for encouraging various income groups to participate in this social mix large-scale housing community. The financial model guides the direction of generating massing model variations with the parametric application in the boundary of the neighborhood model in terms of 1) number of units, 2) arrangement of spatial definitions, and 3) configuration of circulation. The direct connection between financial model and massing model within neighborhood boundary condition allows a developer to review design alternatives with changing numbers, at the same time, an architect to understand a financial condition of each alternative with modifying designs.

1 Project Overview

1.1 Problem Statement

Ethiopia's booming economy, which is mostly concentrated in urban areas, has transformed the nation from one of the least urbanized nations in Africa to one of the fastest urbanizing nations in the world. Higher population growth rates and the influx of rural migrants attracted by growing job opportunities in urban centers contribute to the unprecedented rate of urbanization. In 2010 the urban population of Ethiopia accounted for 16.7 per cent of the total population, and by 2050 it is expected to reach 37.5 per cent.[1] As a result, providing basic services such as sanitation, potable water, sustainable housing and electricity has become an enormous challenge to local administrations and the national government. The population growth has also exacerbated existing problems in urban areas that have been building up over decades of neglect, poor planning and administration.

Figure 1.1 A typical informal settlement in Addis Ababa[2]

[1] "Situation Analysis of Informal Settlements in Addis Ababa." Accessed October 7, 2012. *www.unhabitat.org/pmss/ getElectronicVersion.aspx?nr=2332&alt=1*

[2] A typical informal settlement in Addis Ababa. Accessed September 15, 2012. http://www .thechiropra cticjournal.co m/2011/October/ethiopia_slums.jpg

As the largest and fastest growing city in Ethiopia, the capital Addis Ababa is a prime example of urbanization issues exhibited throughout the country. Among many, the lack of affordable and decent housing stands as one of the critical problems plaguing the city. An estimated 70 per cent of the population lives in sub-standard housing found in the cities large informal settlements.[3] The lack of the most basic infrastructure and the level of environmental degradation make these settlements fit for nothing but complete replacement of significant upgrading.

In light of this fact the Ethiopian government has been implementing a large-scale housing development program that is aimed at improving informal settlements while providing decent and affordable housing to low-income urban dwellers. The goal of the program is to completely replace the cities informal settlements by 2020 with 200,000 low-cost housing units that are composed of G+4 to G+7 towers.[4] These are typical apartment units composed of studio, 1 bedroom, 2 bedroom and 3 bedroom types with mixed functions of businesses at ground floors. Since the beginning of the program in 2004 close to 80,000 units have been completed and transferred to tenants.[5]

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[3] "Situation Analysis of Informal Settlements in Addis Ababa." Accessed October 11, 2012. www.unhabitat.org/pmss/ getElectronicVersion.aspx?nr=2332&alt=1

[4] Roman Rollnik, ed. *Condominium Housing in Ethiopia: The Integrated Housing Development Program.* (Kenya: UN-HABITAT, 2011), 15-16.

[5] Rollnik, *Condominium,* 16.

Figure 1.2 Low-cost housing projects in Addis Ababa[6]

Although this program is satisfying some of the immediate need, the fast paced and cost focused development strategy fails to address important design factors necessary for the creation of vibrant and healthy urban communities.[7] In addition, the construction of the new housing developments requires the demolition of large sections of informal settlements, which are home to millions of low-income households, and serve as important commercial centers that provide affordable goods, services and employment opportunities for many.

The premise of this project is the preservation of the essence of communities that are classified as "informal" and are automatically slated for removal and replacement with conventional housing developments. The research conducted in this paper proposes a holistic approach to large-scale housing development in order to provide optimized solutions for social mix and multi-generation family life style in Ethiopia.

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[6] Low-cost housing projects in Addis Ababa. Accessed September 15, 2012 http://addisababaonline.com/wp-ontent/uploads/2012/07/addis-ababa-condominums.jpg

[7] Roman Rollnik, ed. *Condominium Housing in Ethiopia: The Integrated Housing Development Program.* (Kenya: UN-HABITAT, 2011), 15-16.

1.2 Project Objective

The proposed holistic approach to large-scale housing development is realized within a parametric modeling environment supported by Rhinoceros 3D & Grasshopper and its plug-ins in order to enhance design feasibility studies. The approach is based upon four major components such as 1) social and cultural factors, 2) a neighborhood model of urban typology, 3) a financial model and 4) a massing study model that delineates the possible building variations.

The first component deals with the analysis of a typical informal settlement in Addis Ababa and identify the positive and negative qualities that make-up its social and physical components. Based on these findings a set of variables will be developed and quantified. The government's newly developed low-cost housing projects will be used to gage the transformations of the social and physical dynamics of the community and test the validity of variables that makeup informal settlements.

The outcome of the informal settlement analysis will form the bases of a neighborhood model defined as a space holder for including various architectural programs such as different unit types (studio, one-bed, two-bed), spatial definitions (private, semi-private, public), and circulation (vertical and horizontal).

The financial model is based on the optimization among the three criteria including market value, construction cost, and government subsidy in order to provide tangible benefits for encouraging various income groups to participate in this social mix large-scale housing community. The financial model guides the direction of generating massing model variations with the parametric application in the boundary of the neighborhood model in terms of 1) number of units, 2) arrangement of spatial definitions, and 3) configuration of circulation.

The direct connection between financial model and massing model within neighborhood boundary condition allows a developer to review design

alternatives with changing numbers, at the same time, an architect to understand a financial condition of each alternative with modifying designs.

1.3 Project Location

Addis Ababa is chosen as the ideal city for this project because of the severity of the housing problem and its direct relationship and impact on the future of informal settlements, which are the largest components of the city. Among its ten sub-cities one of the oldest and second densest, Lideta, is chosen as the project location.

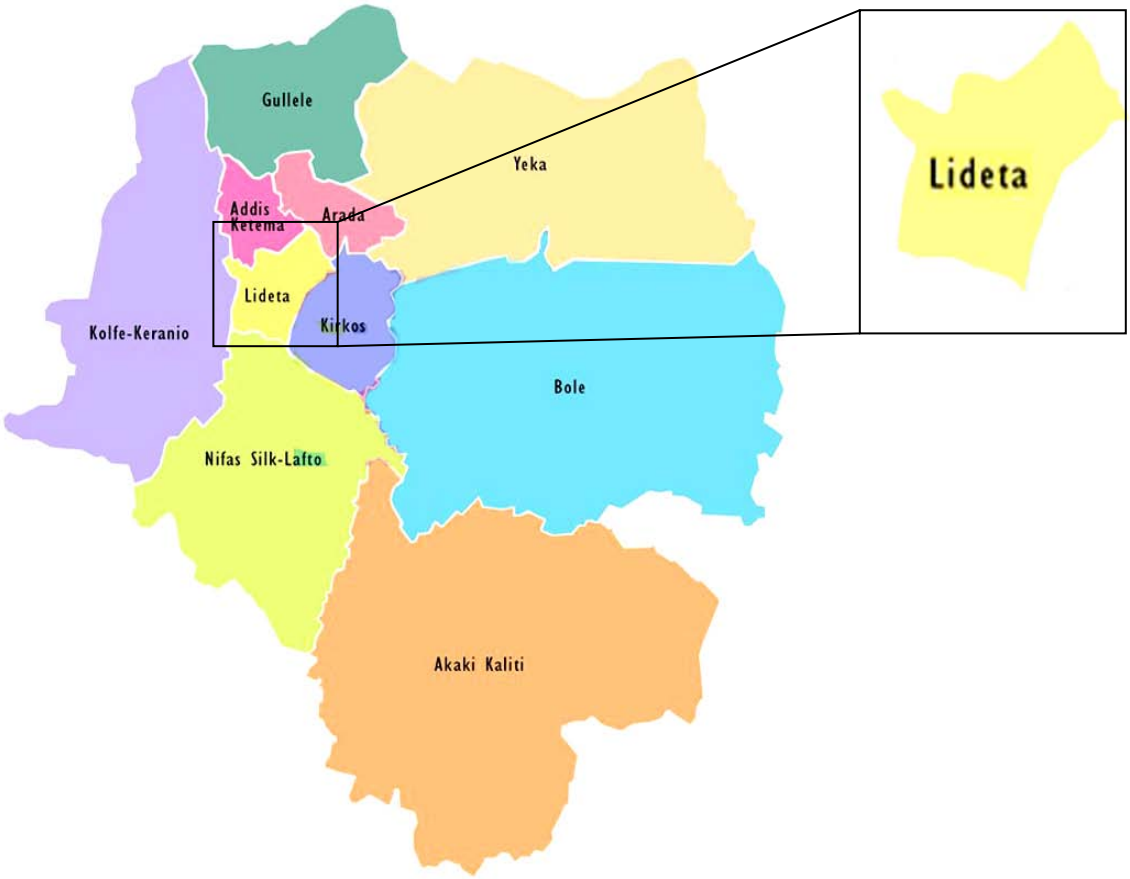

Figure 1.3 Base map of Addis Ababa, Ethiopia and Project Location[8]

[8] Addis Ababa Sub-cities. Accessed August 29, 2012. http://www.addisallaround.com /Portals/0/maps/1038055563.jpg

Lideta sub-city is divided into nine *Kebeles* (neighborhoods) which occupy 11 square kilometers; the sub-city has a population 296,073 people, which are mostly low-income individuals and families (Source). The average family size is 4.5 people which live in a typical one room residence that is on average 20 square meters. Average income of an individual is 400 *Birr* per month which is equivalent to $23.[9]

1.4 Research Methodology

An interpretive historical research of Addis Ababa's 125 year history and its influence on the current urban fabric will set the background for this project. This will be followed by a narration of the current state of informal settlements in the city and major urban upgrading and low-cost housing projects that were attempted in the past few decades. In addition, strategies for urban upgrading projects and two successful examples with distinctly different approaches will be discussed. This methodology will be concluded by setting basic principles for successful urban upgrading projects and steps in how to conduct them.

A quantitative analysis of a typical informal settlement and one of the governments newly developed low-cost housing projects will be conducted. The results from these analyses will be used to establish a set of criteria and variables. The criteria will be derived from the most critical needs exhibited by low-income urban dwellers in the selected project location. Variables will be extracted from anatomical analysis of images, documentary videos and maps of informal settlements in Addis Ababa. The validity of these variables will be tested based on the findings from analysis of the government's newly developed low-cost housing projects and how they transformed the social and physical dynamics of the urban community. The end results from these analyses will set the stage for an experimental project that will conclude this project.

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[9] Roman Rollnik, ed. *Condominium Housing in Ethiopia: The Integrated Housing Development Program.* (Kenya: UN-HABITAT, 2011), 2.

1.5 Project Document Organization

This document is organized in six chapters. Chapter 1 provides an overview of changes occurring in Ethiopia due to the recent and unprecedented economic growth and its impact on urban housing, and associated issues that result from rapid urbanization. The chapter will also look into current efforts exerted by government to address one of the most pressing issues in the capital Addis Ababa, the demand for low-cost housing, and discuss the resulting outcome, which is the premise of this project. Research methodologies and the organization of the doctoral project document are also discussed in this chapter.

Chapter 2 is a literature review that covers issues such as urbanization in Addis Ababa and the formation of informal settlements, followed by urban upgrading efforts conducted in the city in the past few decades. Principles and stages of urban upgrading strategies compiled from literature review and case studies of several upgrading projects in Africa will also be discussed. This chapter will also cover issues regarding mixed-income housing and multigenerational living and its impact in the day-to-day life of ordinary Ethiopian.

Chapter 3 clearly defines the problem area and presents the proposed approach to address the given problem. This chapter also focuses on analysis of informal settlements and identification of positive and negative components that make up their physical and social components. This will be followed by the analysis of the governments low-cost housing projects and identify their success and failures. The findings from these analyses will be used to establish variables that will be the central components of the projects proposal.

Chapter 4 focuses on the definition and analysis of the financial component of large-scale housing developments and specific variables formed based on criteria developed from the analysis of social cultural needs of the target group and neighborhood model that was developed subsequently. In

addition data such as construction and other development costs, market value of housing units in the region is gathered from governmental and non-governmental sources operating in Ethiopia.

Chapter 5 concentrates on the synthesis of the three major components social/cultural, spatial and financial components of the proposed development approach. The proposed holistic approach is developed within a parametric modeling environment supported by Rhinoceros 3D, Grasshopper and its plug-ins in order to enhance design feasibility studies. The financial model guides the direction of generating massing model variations with the parametric application in the boundary of the neighborhood model in terms of 1) number of units, 2) arrangement of spatial definitions, and 3) configuration of circulation. The direct connection between financial model and massing model within neighborhood boundary condition allows a developer to review design alternatives with changing numbers, at the same time, an architect to understand a financial condition of each alternative with modifying designs.

Chapter 6 will provide a conclusion and recommendations for future research possibilities based on lessons learnt from the many facets of this research project, the researcher's personal experiences and discussions with doctoral project committee.

2. LITERATURE REVIEW

2.1 Informal Settlements in Urban Ethiopia

Ethiopia is the least urbanized nation in Africa with only 17% of the population residing in urban areas. Even though, its urban population is currently growing at 6% per year mainly due to rural to urban migration.[1] The new arrivals from rural Ethiopia would mostly end up in informal settlements of large cities like Addis Ababa where the only affordable housing options are available.

The average urban dweller in inner-city Addis Ababa leads a traditional lifestyle very similar to the lifestyle lead by rural dwellers in Ethiopia. The major difference between rural vs. urban life would be how people generate income to support their families; urban dwellers rely less on farming and focus more on commercial activities that are directed at providing basic goods and services to the nearby communities.

Figure 2.1 A typical informal settlement in Addis Ababa.[2]

[1] "Situation Analysis of Informal Settlements in Addis Ababa." Accessed October 11, 2012. www.unhabitat.org/pmss/ getElectronicVersion.aspx?nr=2332&alt=1

[2] "A typical informal settlement in Addis Ababa." Accessed September 15, 2012. http://www.thechiropracticjournal.com /2011/october/ethiopia_slums.jpg

These activities are mostly conducted from their dwellings, which serve as a home at night and place of business during the daytime. The average dwelling is composed of a single room which would be used as a living room, dining room, and an outdoor space used for cooking, washing clothing, bathing and as communal space. The average family size of residents living in informal settlements of Addis Ababa is about 6 persons. The combined income of the residents is estimated to be 800 birr which is equivalent to $47.[3]

Figure 2.2 Traditional cooking.[4]

Traditional cooking is a key aspect of the daily life of Ethiopian that requires the appropriate space to conduct. Firewood, charcoal and kerosene are

[3] Roman Rollnik, ed. *Condominium Housing in Ethiopia: The Integrated Housing Development Program.* (Kenya: UN-HABITAT, 2011), 15-16.

[4] Traditional cooking. Accessed September 15, 2012. http://viajar.elperiodico.com/destinos/africa/etiopia/ciudad-sagrada-de-lalibelen-etiopia/(imagen)/126179/mujer-cocinando-en-una-cocian-tradicional-en-lalibela#mainContent

the most prevalent sources of energy, and also main sources of health hazards in the home. Quite often cooking is done in an outdoor setting due to the lack of properly ventilated kitchens in most units.

Most units have a single indoor space that has multiple purposes. During the daytime it may be used for gathering, food preparation and at night it serves as a sleeping quarter for the whole family. Most families use low quality handmade furniture that may be produced in their own settlement. The variety depends on the resident's financial capacity

Outdoor spaces also serve multiple purposes as a place for community gathering, bathing place for young children, as preparation area for large quantities of food. These spaces also serve as place of commerce. Families may provide food related services, textile, fabrication of products, etc…

Figure 2.3 Typical outdoor spaces[5]

2.1.1 Informal housing

[5] Typical outdoor spaces. Accessed September 17, 2012. http://i1.ytimg.com/vi/0ZszL92K8vs/maxres default.jpg

The urban poor play a major role in providing shelter in urban Ethiopia, and despite the lack of government involvement they manage to provide for themselves. The challenge for urban planners is how to tap into this potential in order to make upgrading projects a success. Understanding the rich diversity of informal settlements should be a fundamental prerequisite for understanding how to deal with the prevalence of slum living conditions.[6]

Informal settlements are composed of entire vibrant local economies, with their own diverse social and cultural groupings. The residents have the best understanding of how these settlements work; the characteristics of their communities, the nature of their needs and priorities. It is important to draw on this knowledge to establish the overall structure of the community which is crucial for planning and policy making.[7]

Four key aspects of informal settlements should be identified in order to determine the way forward. These are housing variety, infrastructure profile, location dynamics, and land tenure. Once there is a clear understanding of these baseline conditions it would be possible to seek the appropriate remedy.[8]

2.1.2 Housing Variety

Informal settlements are filled with a variety of housing ranging from solid concrete structures to shacks made from found material like scrap metal and plastics. Residents of these areas are not all the same. Some have the capacity to generate enough funds to improve their housing units up to middle class standards, while others will continue to live in the most basic shelters that provide protection from the elements. Despite the health and environmental risk, the lack

[6] Quick Guides for Policy Makers. "Housing the Poor in African Cities: Urban Africa." (Kenya: UN-HABITAT, 2011), 20.
[6] Quick Guides, 20.
[7] Quick Guides, 21.
[8] Quick Guides, 20.

of regulations and enforcement allows the residents to build creatively and incrementally.[9]

2.1.3 Infrastructure Profile

Access to potable water is one of the major problems in informal settlements. Government may provide water using tankers, but the availability is not always guarantied. Electrical power is another major issue that could be resolved by government easily but instead residents would end up purchasing through illegally installed lines for much more money than it would cost to get it from the government. Solid waste is generally discarded in dumpsites not far from where residents live hence contributing to the degrading environmental conditions. The reluctance of governments to invest on drainage and sanitation systems only adds to the environmental problem.[10]

2.1.4 Location Dynamics

Income generating areas are the preferred locations of residence for the urban poor. These areas would generally be extremely expensive, and this means the urban poor would have to squat on prime real-estate or settle on the least desirable location which may be prone to environmental disasters. High cost of land in this areas means Informal settlements that develop around would be densely populated. Alternatively some may choose to live in the peripheries of town where it would be easy to settle, but employment and survival may be much more difficult.[11]

2.1.5 Land Tenure

Insecure land tenure is one of the most critical problems that contribute to the many problems that affect informal settlements. In addition to making daily

[9]Roman Rollnik, ed. *Condominium Housing in Ethiopia: The Integrated Housing Development Program.* (Kenya: UN-HABITAT, 2011), 18.

[10] "Situation Analysis of Informal Settlements in Addis Ababa." Accessed October 11, 2012. www.unhabitat.org/pmss/ getElectronicVersion.aspx?nr=2332&alt=1

[11] Situation Analysis of Informal Settlements, 59.

life uncertain, the potential for eviction at anytime plays a major role in the lack of interest in improving their living conditions. Without the legal recognition, other public organizations would also be reluctant to provide necessary social services that would improve the lives of informal settlers.[12]

2.1.6 Approaches to Informal Settlement Improvement

UN-Habitats quick guide 2 for policy makers recommends five options for dealing with low-cost housing which are on-site upgrading, resettlement on suitable land, government-led new public housing, site-and-services schemes and incremental land development, and city wide housing strategies.[13] On-site upgrading is most appropriate methodology that fits with the objective of this project and will be further discussed.

On-site upgrading requires the improvement of informal settlements without the complete distraction of the existing environment. This means improving the physical, social and economic environment of an existing informal settlement, without displacing the people who live there.[14] Unlike resettlement projects on-site upgrading causes minimal disturbance to the social network of poor communities which is vital to the survival of many.

Most upgrading projects focus on providing technical support for upgrading walkways, drains, water supply lines, street lights, electrical networks, and sanitation and garbage disposal. But a more comprehensive approach will also look into making improvements to individual housing units or rebuilding them, try to resolve land tenure issue, improve income generating tools, improve common areas, and access to public services[15].

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[12] Ministry of Works and Urban Development. *Housing Development Program: 2006 – 2010 Plan Implementation Report.* (Addis Ababa, 2010), 27- 28.

[13] Roman Rollnik, ed. *Condominium Housing in Ethiopia: The Integrated Housing Development Program.* (Kenya: UN-HABITAT, 2011), 21.

[14] Rollnik, *Condominium,* 21.

[15] Rollnik, *Condominium,* 23.

On-site upgrading s considered the best option because it keeps the community together and enhances social stability and builds on existing support mechanisms. It also encourages participation during planning and implementation of project. Having secured land tenure will also encourage residents to invest on improvements to their houses. Overall upgrading projects in poor communities improve morale and encourage the community to build a sense of pride and responsibility to take care of properties and prevent dilapidation of infrastructure.

Having secured land tenure will also improve the financial condition of residents since it gives them more credibility to get credit from financial institutions. Having access to credit means the potential to start a new business or expand an existing one, the potential to move to a better neighborhood, send kids to better schools, etc… which in turn would have a positive effect on the larger community.

2.2 Urban Upgrading Principles

2.2.1 Community Participation

Improving informal settlements should be a participatory process that should focus on the most essential needs of the community as determined by all members. The full participation of the community is an endorsement that would insure the successful completion of the upgrading process. The central aspect of the community participation is the collection of data that would help determine what type of upgrading is needed.[16] The involvement of government and related local authorities should focus on capacity building of local businesses and small scale industries. This will enable the retention of investment funds locally and allow the growth of the local economy.

[16] Quick Guides for Policy Makers. “Housing the Poor in African Cities: Low-income Housing.” (Kenya: UN-HABITAT, 2011), 40.

2.2.2 Partnership between Community and Outside Actors

Strong partnership between the community and local government is key to the successful implementation of upgrading projects. Nongovernmental organization can also play a crucial role in supporting community organizations, as well as providing them with technical support they need in designing housing improvements or developing income generation projects.[17]

2.2.3 Provision of Secure Land Tenure

The fear of eviction discourages resident from maintaining their houses and taking care of their surroundings. Tenure may be granted to individual households in the form of title deeds or lease contracts, after the boundaries have been measured and recorded.[18] It may also be granted to the community as a whole as a means of building a stronger community and protect it from the market forces, insuring the land will always be available for housing.

2.2.4 Contributions from the community

Contribution from the community is an essential part that would insure the successful execution of upgrading projects. It will instill a sense of ownership of the project and its outcome, which will have a long term effect in maintenance and preservation of the community. Contributions may come in the form of fees for construction cost, physical labor to offset the cost of hired workers. A form of supplemental subsidy to the community's contribution is essential, and this may be generated from government or private donors.[19]

2.2.5 Affordable and Sustainable

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[17] Quick Guides for Policy Makers. "Housing the Poor in African Cities: Low-income Housing." (Kenya: UN-HABITAT, 2011), 40.

[18] Roman Rollnik, ed. *Condominium Housing in Ethiopia: The Integrated Housing Development Program.* (Kenya: UN-HABITAT, 2011), 18.

[19] Quick Guides*,* 40*.*

The funding that can be generated from the community should help gauge the size of the upgrading project. If upgrading cost is higher than what the average community member can afford, residents may simply be forced to relocate, which defeats the purpose of the whole project. It also advisable that the funds from several sources be combined, including community contributions, government subsidies and grants from private parties.[20]

2.2.6 Part of larger urban development strategy

Upgrading projects should follow the development strategy of the larger urban and regional development strategy. Projects should not be isolated and be initiated as an emergency response. Convincing the larger community of the definite advantages of the cities upgrading project will generate public support that may possibly translate to political support for the government to do more and also may help generate funding from the private sector.[21]

The seven stages of a typical upgrading project.

1- Selecting the settlement that is to be upgraded

2- Strengthening the community's internal organization

3- Organizing meetings to get stakeholders involved

4- Surveying all aspects of the community

5- Designing all aspects of the upgrading plan

6- Carrying out the actual upgrading work

7- Continue with meetings as a platform for further work

[20] Quick Guides for Policy Makers. "Housing the Poor in African Cities: Low-income Housing." (Kenya: UN-HABITAT, 2011), 40.

[21] Quick Guides, 42.

2.3 Mixed-income Housing

Mixed income housing is a primary mechanism to eliminate neighborhoods of concentrated poverty, combat residential segregation, and avoid the building of public housing that offers all of its housing units to low-income families. Mixed income housing is built through government, state, and local level efforts and through a combination of public-private-non-profit partnerships.[22]

State and local governments use density bonuses, inclusionary zoning policies, and other land use regulations to require and/or encourage housing developers to build a certain percentage of new housing units at a particular level of affordability.[23] For example, inclusionary zoning will require developers to build a certain percentage of new units for low-income families. Density bonuses serve as an incentive, and offer developers the opportunity to build higher density buildings than they would be allowed under normal zoning regulations if they build new units at a certain level of affordability.

Figure 2.4 decay in newly constructed low-income housing[24]

[22] George Galster, "Neighborhood Social Mix as a Goal of Housing Policy." Vol. 7, No. 1, (2007) 19–43.

[23] Galster, "Housing Policy," 19-43.

[24] A typical informal settlement in Addis Ababa." Accessed September 15, 2012. http://www.thechiropracticjournal.com/2011/october/ethiopia_slums.jpg

Housing is seen as a key stabilizing force for those living in poverty, particularly as the challenges of living in neighborhoods of concentrated poverty have become increasingly well documented. Neighborhoods of concentrated poverty suffer from lack of investment in both the physical infrastructure and human resources. Empirical research has shown that living in poor, inner-city neighborhoods results in lower levels of educational attainment, higher participation in criminal activities and other anti-social behavior, more negative health outcomes, more exposure to violence, higher likelihood of teenage pregnancy, and social isolation from good-paying work; in other words – place matters. As the Kirwan Institute highlights, “Neighborhood racial and economic segregation is segregation from opportunities critical to quality of life, financial stability, and social advancement.[25]

This impact of place has come to be known as "neighborhood effects," and scholars continue to grapple with the specific ways that neighborhood impact life outcome. Family, peer, and neighborhood influences are entangled and difficult to empirically analyze in isolation. The following list six mechanisms by which neighborhood influences individual outcomes:

1. Quality of local services

2. Socialization by adults

3. Peer influences

4. Social networks

5. Exposure to crime and violence

6. Physical distance and isolation

[25] George Galster, “Neighborhood Social Mix as a Goal of Housing Policy.” Vol. 7, No. 1, (2007) 19–43.

2.4 Multigenerational Living

Multigenerational households are an important part of the socioeconomic fabric of Ethiopia. Many families around the world live in multigenerational households, which are defined as spanning three or more generations. There are several cultures, particularly in developing countries, that consider multiple generations in the home as the norm, but it is also becoming more common in developed nations, as rising costs of real estate, health care and childcare make more families consider joining forces across generations.[26]

The term “multigenerational household” can be defined in different ways. one that contains three or more parent-child generations or household having two generations consisting of parent and adult children, configured in one of two ways: (1) householder (and spouse), plus parent (or parent-in-law), or (2) householder (and spouse), plus adult child (or child-in-law).

Figure 2.5 multigenerational household[27]

[26] Generations Unite. “Family Matters: Multigenerational Families in a Volatile Economy.” Accessed October 18 2013. http://www.gu.org/LinkClick.as px?fileticket=QW OTaluHxPk=&mid

[27] Multigenerational household. Accessed September 27, 2012. http://www.thechiropracticjournal.com/2011/october/ethiopia_slums.jpg

Life in a multigenerational household has challenges but most say the benefits outweigh them. Financial reasons are often cited as the primary motivator for multigenerational living, as well as care giving needs. While certain members of multigenerational families may face numerous strains on their time and resources, the family member of multiple generations together in one household also serves as a unique support to its members.[28]

The most important thing is for people to be able and willing to communicate what they want, what they're willing to do, and what they're not willing to do," says Dr. Joshua Coleman, a private psychologist who specializes in adult child-parent relationships. There also needs to be joint recognition that when such households are formed, there usually is a power imbalance.[29] The owners of the home tend to have the stronger position of control. "The person who's home is being moved into may be a little bit more set in their ways of how they want the household to run," Coleman says.[30]

If the adult child has lost his or her job, guilt and shame may be brought into the equation. If an older parent has chronic health problems that require substantial care, this can create its own type of imbalance in the relationship. Imbalances also can be a major source of stressful conflict in money issues. Even if respective financial responsibilities have been agreed to in advance, those shouldering most of the financial burden may have, or feel they deserve, a controlling role in the household."Ideally, it's a negotiation among equals where

[28] Generations Unite. “Family Matters: Multigenerational Families in a Volatile Economy.” Accessed October 18 2013. http://www.gu.org/LinkClick.aspx?fticket=QWOTaluHxPk=&mid

[29] “Family Matters”

[30] “Family Matters"

everyone's feelings are taken into consideration," Coleman says. "But that requires people to communicate, and a lot of people aren't very good communicators."[31]

Other situations requiring special attention include conflicts between grandparents and their adult children over grandchildren. Generational parenting attitudes often differ, and grandparents may need to step back and refrain from imposing their own parenting views on their children. Also, grandparents should not be the assumed to be sitters, available on little or no advance notice to care for grandchildren.

Lastly, Coleman notes, sensitivity is required when key family members are not blood relatives of other household occupants. It might be an in-law spouse or even the friend of a teen or young adult grandchild. Do not assume they will have the same attitudes toward multigenerational living as do direct family members.[32]

[31] Generations Unite. “Family Matters: Multigenerational Families in a Volatile Economy.” Accessed October 18 2013. http://www.gu.org/LinkClick.aspx?fticket=QWOTaluHxPk=&mid

[32] “Family Matters”

3. ANALYSIS OF SOCIAL AND SPATIAL COMPONENTS

As the largest and fastest growing city in Ethiopia, the capital Addis Ababa is a prime example of urbanization issues exhibited throughout the country. Among many, the lack of affordable and decent housing stands as one of the critical problems plaguing the city. An estimated 70 per cent of the population lives in sub-standard housing found in the cities large informal settlements.[1] The lack of the most basic infrastructure and the level of environmental degradation make these settlements fit for nothing but complete replacement of significant upgrading.

In light of this fact the Ethiopian government has been implementing a large-scale housing development program that is aimed at improving informal settlements while providing decent and affordable housing to low-income urban dwellers. The goal of the program is to completely replace the cities informal settlements by 2020 with 200,000 low-cost housing units as indicated in location shown in Figure 3.1.[2]

These developments are composed of G+4 to G+7 typical apartment towers composed of studio, 1 bedroom, 2 bedroom and 3 bedroom types with mixed functions of businesses at ground floors. Since the beginning of the program in 2004 close to 80,000 units have been completed and transferred to tenants.[3]

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[1] "Situation Analysis of Informal Settlements in Addis Ababa." *www.unhabitat.org/pmss/getElectronicVersion.aspx?nr=2332&alt=1 (*accessed October 11, 2012)

[2] Roman Rollnik, ed. *Condominium Housing in Ethiopia: The Integrated Housing Development Program.* (Kenya: UN-HABITAT, 2011), 15-16.

[3] Rollnik, *Condominium,* 16.

Figure 3.1 Proposed low-cost housing project locations in Addis Ababa

3.1 Site Selection Criteria

Among Addis Ababa's ten sub-cities one of the oldest and second densest, Lideta, is chosen as the project location. Lideta sub-city is divided into nine *Kebeles* (neighborhoods) which occupy 11 square kilometers; the sub-city has a population 296,073 people, which are mostly low-income individuals and

families.[4] The average family size is 4.5 people which live in a typical one room residence that is on average 20 square meters. Average income of an individual is 400 *Birr* per month which is equivalent to $23.[5]

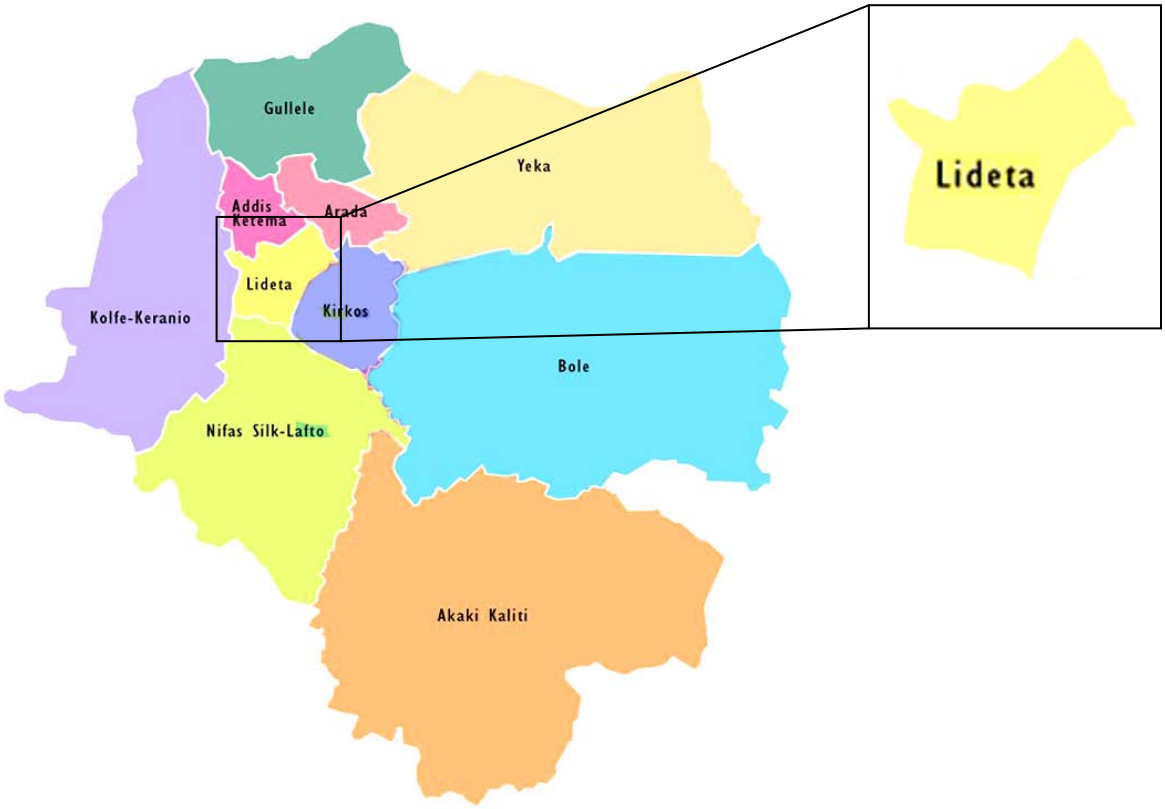


Figure 3.2 Lideta sub-cities of Addis Ababa[6]

3.2 Analysis at Block Level

The project site is located in one of the oldest informal settlements in Lideta sub-city, which is undergoing through major development executed by government and the private sector. The particular block is located at the corner of

[4] Roman Rollnik, ed. *Condominium Housing in Ethiopia: The Integrated Housing Development Program.* (Kenya: UN-HABITAT, 2011), 7.

[5] Rollnik, *Condominium,* 8.

[6] Addis Ababa Sub-cities.http://www.addisallaround.com /Portals/0/maps/1038055563.jpg (Accessed August 29, 2012)

Sao Thome & Principe Street and Liberia Street. Figure 3.3 and 3.4 show the site condition in 2009 and 2011 respectively.

Figure 3.3 Site condition in 2009 [7]

Figure 3.4 Site condition in 2011[8]

[7] Lideta Sub-city, Addis Ababa, Ethiopia https://maps.google.com/maps?hl=en&tab=wl, (accessed October 2, 2012)

[8] Lideta Sub-city, Addis Ababa, Ethiopia https://maps.google.com/maps?hl=en&tab=wl, (accessed October 4, 2012)

Spatial analysis of the site condition in 2009 was conducted Figure 3.5, with the help of an image captured from aerial map of Lideta sub-city. This was then compared to the site condition in 2011 where the entire site is demolished and redeveloped as a low-cost housing project. The areal image was digitized in order to identify main spatial components. These components are then categorized into three major components:

1. Circulation
2. In-between spaces
3. Buildings

Circulation paths are divided into primary, secondary and tertiary paths. Primary paths are generally used by motor vehicles and a large amount of foot traffic. Secondary circulation paths serve mainly as pedestrian paths that connect individual buildings. Tertiary paths are informal paths that may or may not be continues and may also be classified as in-between space.

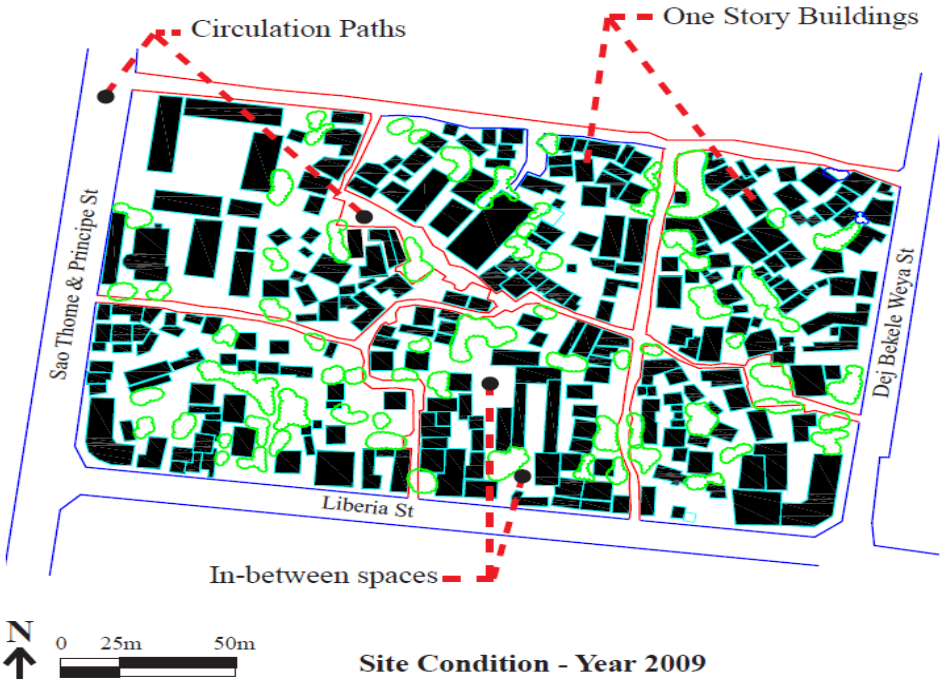


Figure 3.5 study of site condition in 2009

The new development as illustrated in the Figure 3.6 shows a layout with a grid pattern heavily influenced by vehicular circulation, block towers and large public space. Traditional semi-private spaces which generally fall under in-between spaces have been completely taken out of the new layout. These spaces served as outdoor food preparation area, cloth washing space, community gathering area, etc….

Although the new development shows much improved physical environment, the lack of close connection between the block towers breaks down the most important component of the social fabric that makes these communities unique.

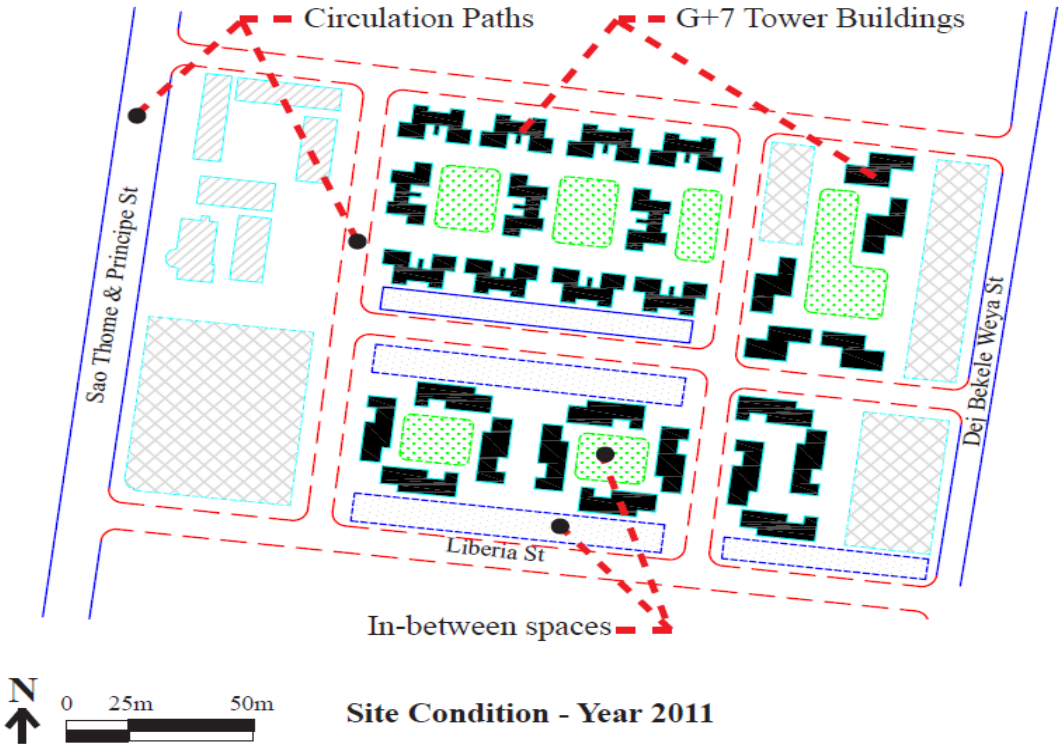


Figure 3.6 study of site condition in 2011

3.3 Definition of Major Variables

Based on the above analysis three major variables are defined. These are circulation, in-between spaces and housing units.

Circulation paths are composed of primary, secondary and tertiary paths. Figure 3.7 show primary paths which is mainly used for vehicular circulation and also serves as a boundary separating main lots. Figure 3.8 show secondary paths which are mainly used for pedestrian circulation and connecting points within lot areas.

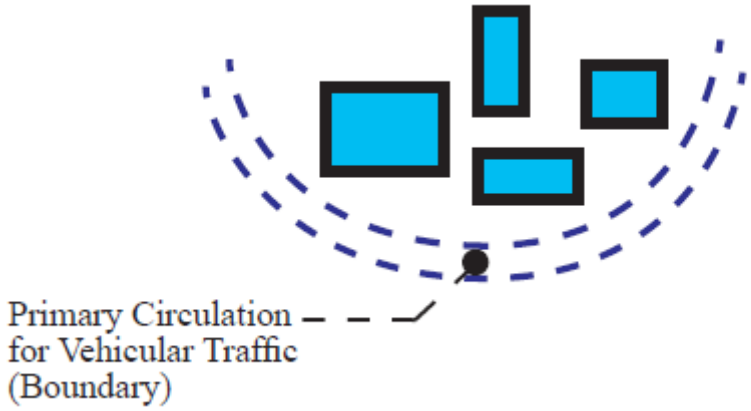


Figure 3.7 Primary circulation

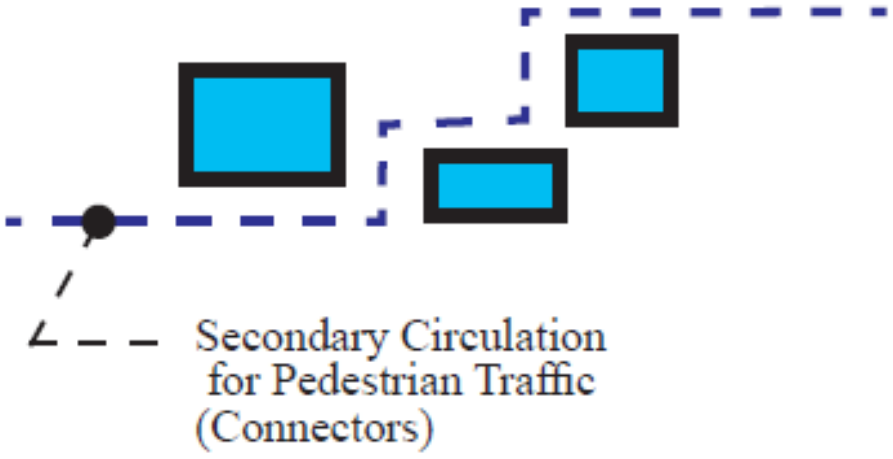


Figure 3.8 Secondary circulation

In-between spaces shown in Figure 3.9 serve as traditional communal spaces found in informal settlements. These spaces can also be considered as tertiary circulation path connecting housing units. Communal spaces supplement the lack of utilitarian spaces within housing units that may be used for storage, washing clothing, gathering, and other communal activities.

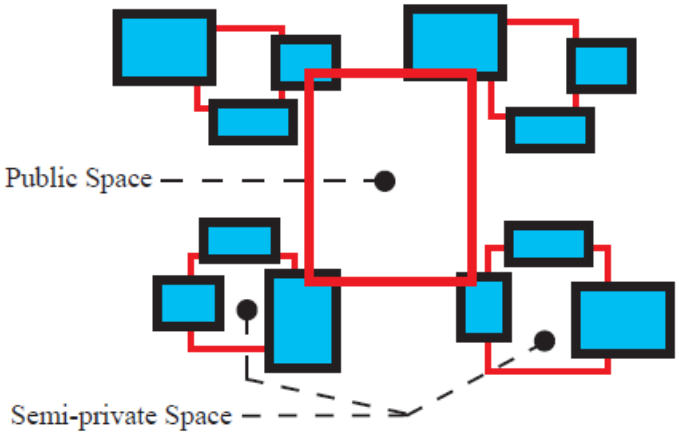


Figure 3.9 Secondary circulation

Housing units, Figure 3.10, are modular components that are scalable depending on the need of the occupant. Units may be combined to create a larger unit for larger family sizes or be reduced to the basic module when family sizes shrink.

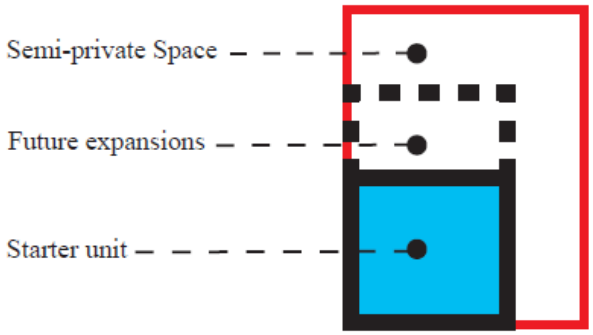


Figure 3.10 Secondary circulation

3.4 Neighborhood Model

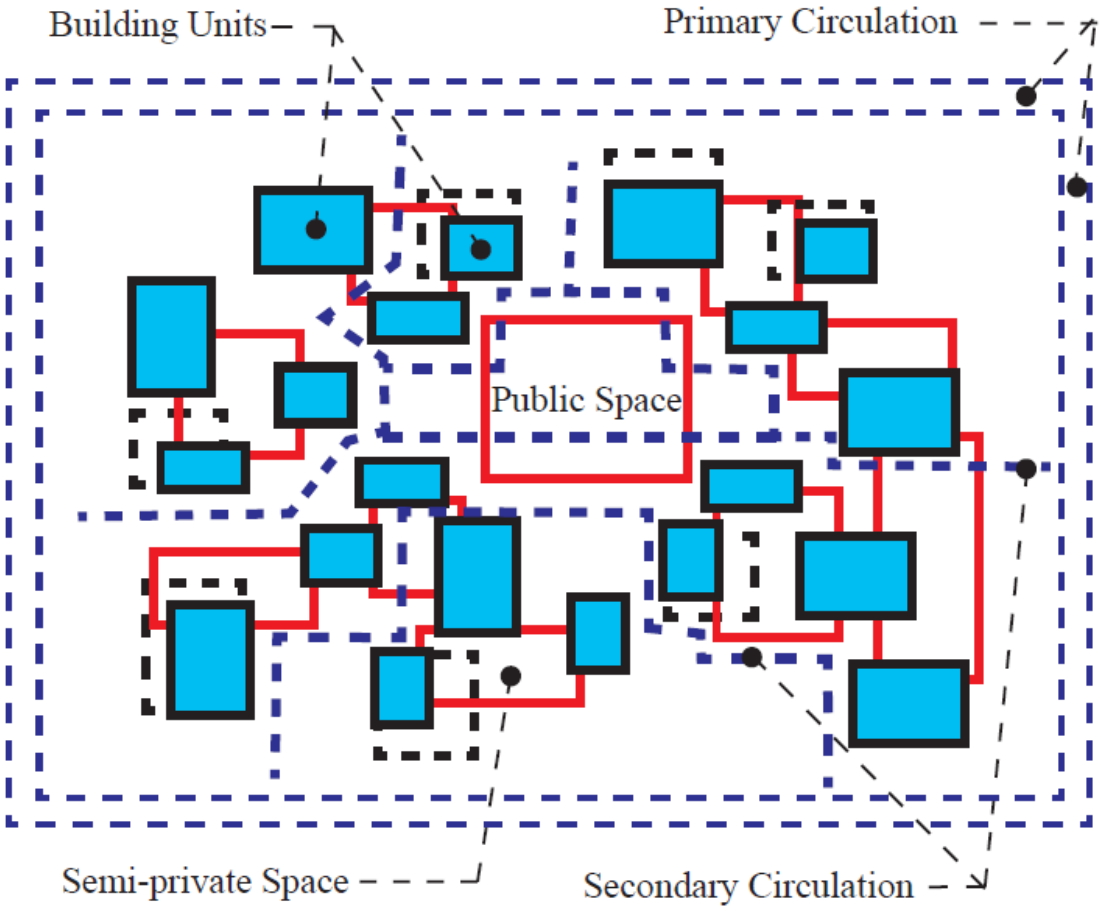


Figure 3.11 Typical neighborhood model

The neighborhood model, Fig 3.11, is a typical model composed of the three special components, buildings, in-between spaces and circulation paths, which are quantified and used to develop preliminary cost estimate and building of massing model for the proposed projects. In-between spaces serve as central components where housing units are organized around. The typical building types are developed based on a modular building system that may be configured

as a studio unit, a one bedroom unit and a two bedroom unit that may be easily modified as the needs of the owners change over time.

3.5 Summery

The study of social and cultural conditions is critical for the successful implementation of a sustainable and appropriate living environment for the target group. The ultimate goal is to preserve the essence of informal settlements by identifying and analyzing important special components that may be applied in future housing projects.

This process was accomplished by doing an analysis of the project site condition before and after its current state. Learning from spacial compositions of project site condition in 2009, Figure 3.5, and project site condition in 2011, Figure 3.6, three special variables were defined and used to establish a typical neighborhood model.

The neighborhood model is then used to establish a preliminary cost estimate and serve as a space holder for a massing model that is used to generate multiple scenarios. The generated scenarios are further analyzed and modified to meet the target group's needs and ultimately generate a refined design that may be further developed into a design development document and a construction document

4. DEFINITION AND ANALYSIS OF FINANCIAL COMPONETS

The financial component of the proposed large-scale housing development is defined and analyzed in the following chapter. The component is formed based on criteria developed from the analysis of the social cultural needs of the target group and neighborhood model that was developed subsequently. In addition, data such as construction and other development costs, market value of housing units in the region is gathered from governmental and non-governmental sources operating in Ethiopia.

The neighborhood model and typical building types, Fig 3.1 and Fig 3.2 respectively, define three special components, buildings/living spaces, in-between spaces/semiprivate areas and circulation, which are quantified and used to develop preliminary cost estimate of proposed projects.

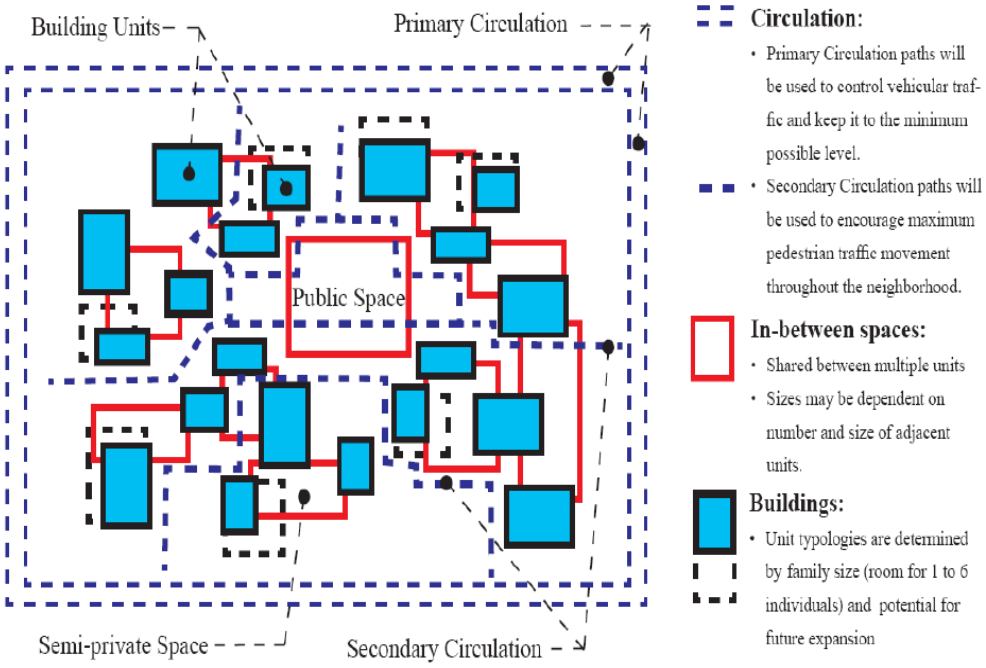


Figure 4.1 Neighborhood model formed based on social and cultural factors

The typical building types are developed based on a modular building system that may be configured as a studio unit, a one bedroom unit and a two bedroom unit that may be easily modified as the needs of the owners change

overtime.

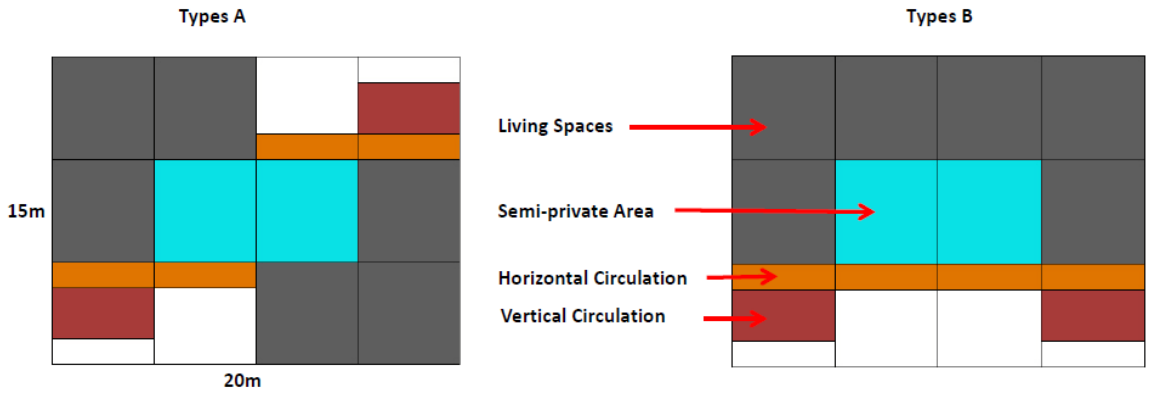


Figure 4.2 Typical building types A and B

4.1 Data Collection Strategy

Data is collected using three major methodologies, which are market study, project site analysis and defined architectural program. The collected data is then analyzed using the proposed financial model.

4.1.1 Market Study

Until recent years the housing industry in Ethiopia was largely run by government. The countries move towards a free market economy coupled with growing demand for commercial and residential real estate has encouraged the formation of private agencies and developers which are starting to take an active role in the industry. Market data such as construction costs, labor cost, and market value of housing units is gathered from governmental and non-governmental sources operating in Ethiopia.

Currently the state controls the majority of rental accommodation and influences the supply of new housing through active involvement in material production and importation, land supply, and housing finance.[1] Very few private

[1] "Situation Analysis of Informal Settlements in Addis Ababa." accessed October 11, 2012. www.unhabitat.org/pmss/getElectronicVersion.aspx?nr=2332&alt=1

housing developers exist. The private construction industry is very small and it is complicated and time consuming to start a company, register it, and conduct business. Those that do exist operate only for high-income groups as there is little incentive to construct low-income housing (source).

In conformity with a master plan or guidelines of a city, urban land is permitted to be held by lease on auction or negotiation. Minimum price of urban land will be determined on auction or through negotiation. The duration of urban land - lease holdings by region and different investment activities are shown in Table 4.1 bellow.[2]

Region/ Name of City	Area of activity	Period of lease
Addis Ababa City Administration and other towns designated as Addis Ababa City	• Housing(Personal & Leasable)	Up to 99 Years
	• Science, technology, research & study • Government offices • Non-profit making philanthropist organization • Religious institution	Up to 90 years
	• Industry	Up to 60 years
	• Commerce	Up to 50 years
	• Others	Up to 50 years
Other towns which are not designated as of grade of Addis Ababa	• Education Health, culture, sports, etc	Up to 99 years
	• Industry	Up to 80 years
	• Commerce	Up to 70 years
	• Others	Up to 70 years
Amhara National Regional State *(Bahir Dar, Gonder, Dessie)*	• Housing (personal and leasable)	Up to 99 years
	• Education, Health, Culture, Sport	Up to 99 years
	• Industry	Up to 80 years
	• Trade and commerce	Up to 70 years
	• Urban Agriculture	Up to 15 years
	• Others	Up to 70 years
Oromiya National Regional State	• Private dwelling houses	Up to 99 years
	• Rental dwelling houses	Up to 60 to 99 years based on the grade of towns
	• Industrial activities	Up to70 to 95 years based on grade of towns
	• Educational, Scientific, Technological, Cultural, Health and Sporting activities	Up to 95 years
	• Others	Up to 60 to 99 years based on the grade of towns

Table 4.1 Duration of urban- land lease holdings by region and activity[3]

[2] Ethiopian investment Agency. "Factor Costs" Addis Ababa. Accessed October 19, 2013. *http://www.eia.gov.et/English*

[3] "Ethiopian investment Agency"

Lease - price payment may be made wholly at the signing of the lease contract or periodically with bank compound interest on the unpaid balance. The periods of payment of urban land - lease prices vary from region to region and on the type of investment activity as shown in Table 4.2 bellow.[4]

Region /Name of City	Area of activity	Period of payment
Addis Ababa City Administration	• Private dwelling houses	Within 99 years
	• Industry	Within 30 years
	• Business	Within 15 years
	• Culture, Sport and education	Within 20 years
	• Rental Dwelling houses	Within 30 years
Amhara National Regional State (Bahir Dar, Dessie, Gonder)	• Private dwelling house	Within 99 years
	• Private housing through auction or negotiation	Within 50 years
	• Social development and cultural undertakings (Health, Education ...)	Within 40 years
	• Industry	Within 40 years
	• Commerce	Within 30 years
	• House for rent	Within 40 years
	• land with 15 years lease period	Within 10 years
Oromiya National Regional State	Residential house Industry Trade and other services Education ,science and technology , Health , culture, sports and others	The maximum land holding period is 80 to 99 years with a minimum holding period of 30 years. Payment for lease holding is effected within 40 years; and within 30 years for holding less than 40 years.
Tigray National Regional State	Residential house Industry Trade and other services Education ,science and technology , Health ,culture , sports and others	15 to 99 years depending on the sector of development

Table 4.2 Periods of payment of urban land lease prices[5]

[4] Ethiopian investment Agency. "Factor Costs" Addis Ababa. Accessed October 19, 2013. *http://www.eia.gov.et/English*

[5] "Ethiopian investment Agency"

The minimum price of urban land is determined prior to its possession on auction or through negotiation. The minimum lease and rental prices of urban land in some regions of the country are shown in Table 4.3 bellow (source).

No.	Zone	Grade of Lease Land	Minimum price (Birr /M2)	Multipliers to determine negotiable prices by width of roads (meter)			
				No road	Less than 10	10 up to 20	Above 20
1	Central Business Zone	1	1686	1.2	1.5	1.7	1.9
		2	1535	1.2	1.5	1.7	1.9
		3	1323	1.2	1.5	1.7	1.9
		4	1085	1.2	1.5	1.7	1.9
		5	894	1.2	1.5	1.7	1.9
2	Transitional Business Zone	1	1035	1.2	1.3	1.4	1.5
		2	935	1.2	1.3	1.4	1.5
		3	809	1.2	1.3	1.4	1.5
		4	685	1.2	1.3	1.4	1.5
		5	555	1.2	1.3	1.4	1.5
3	Expansion Zone	1	355	1	1.2	1.3	1.4
		2	299	1	1.2	1.3	1.4
		3	217	1	1.2	1.3	1.4
		4	191	1	1.2	1.3	1.4

Table 4.3 Minimum urban land - lease prices in Addis Ababa[6]

4.1.2 Project Site

Addis Ababa is chosen as the ideal city for this project because of the severity of the housing problem and its direct relationship and impact on the future of informal settlements, which are the largest components of the city. Among its ten sub-cities one of the oldest and second densest, Lideta, is chosen as the project location.

The project site is a 43,103 m^2 parcel divided into six lots as shown in Figure 4.3. Based on Addis Ababa administration criteria on Table 4.3 above, the selected project site is valued at roughly 1686 ETB/M^2. A multiplier 1.9 is added based on the adjacent road size which is larger than 20 meters.

Existing circulation paths within the property are retained and improved to meet municipal code. The six lots will be developed with FAR of 2 and maximum site coverage of 50%. Zoning regulations in the area allow for up to seven story

[6] Ethiopian investment Agency. “Factor Costs” Addis Ababa. Accessed October 19, 2013. *http://www.eia.gov.et/English*

towers that may be used for housing and commercial activities to support the newly developed community.

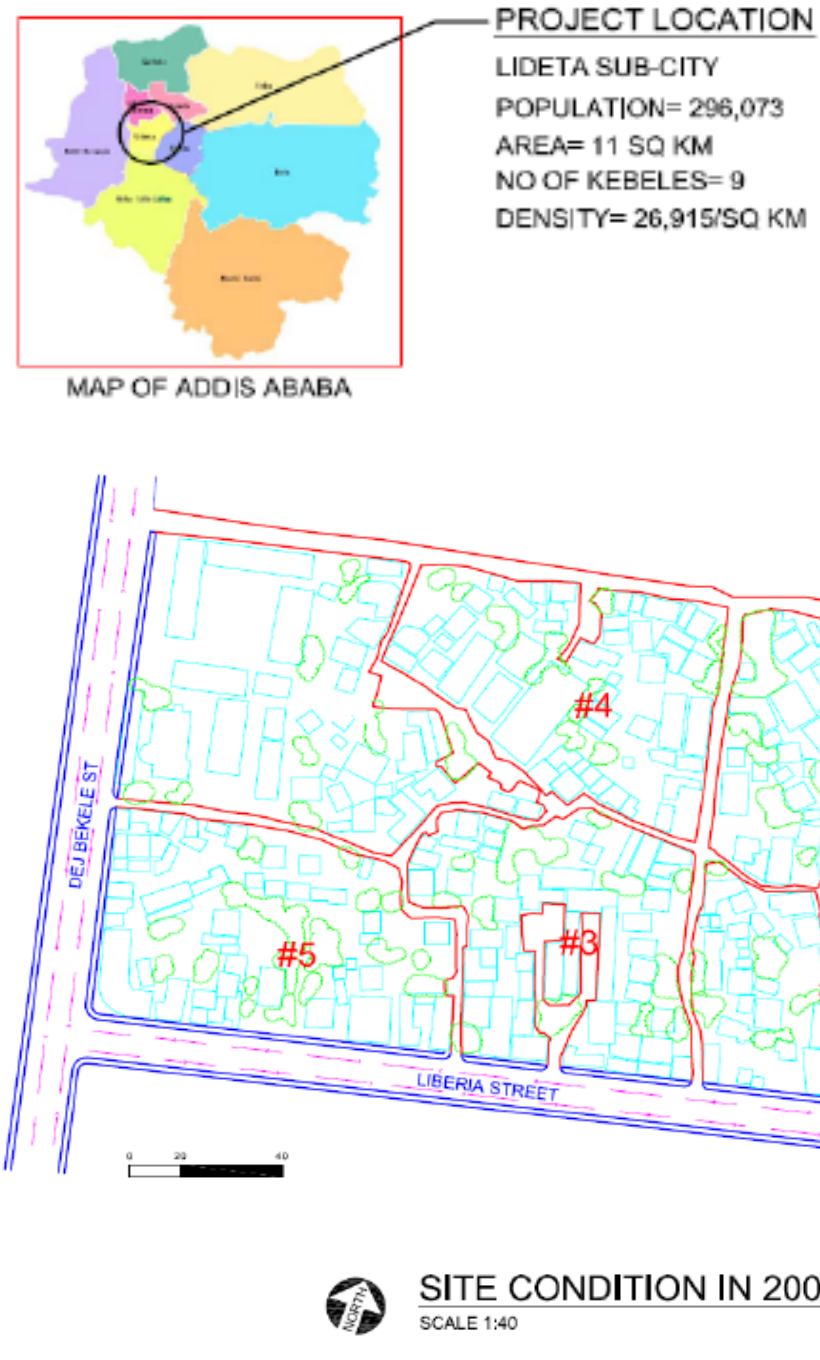


Figure 4.3 Project site located in Lideta sub-city

4.1.3 Architectural Program

The architectural program defines requirements for living units categorized as studio, one bedroom and two bedroom that are based on a 5 meter square grid. Studio units are 25m^2 in size, one bedrooms constitute two studios which form a 50m^2 unit and two bedrooms which are made up of three studio units which form a 75m$^{2.}$ unit.

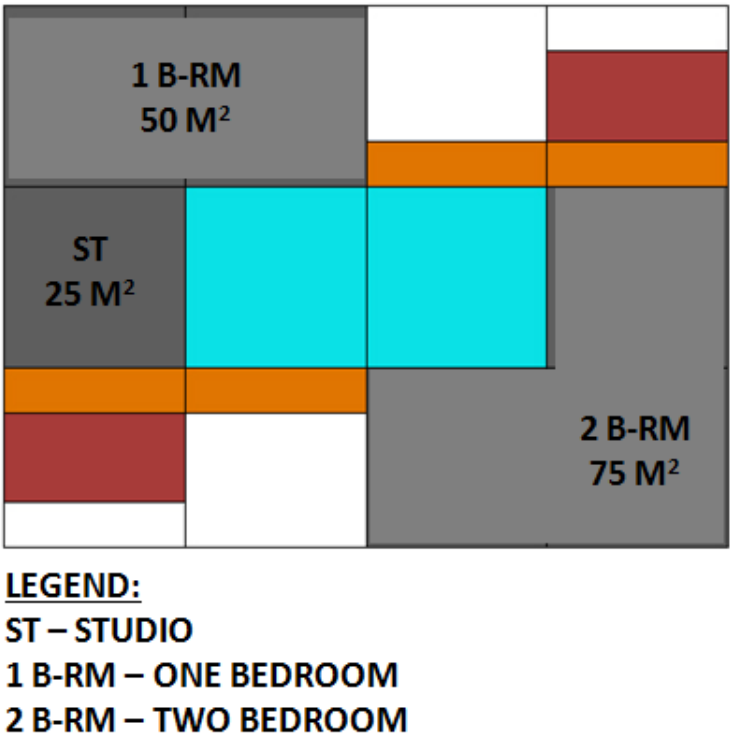


Figure 4.4.1 A typical building type consisting of the three types of units

Based on the given FAR of 2, 80,000m^2 living space is required. Accounting for 50% site coverage and roughly 300m^2 building foot print 66 four story towers are proposed. The floor spaces within these towers will be will be divided using a unit mix percentage specified by the planner. For this exercise 40%, 30% and 30% percent mix is recommended. This would result in 1280 studios, 480 one bedrooms and 320 two bedrooms.

4.2 Financial Model

The financial model is based on the optimization among the three criteria including market value, construction cost, and government subsidy (incentives) in order to provide tangible benefits for encouraging various income groups to participate in this social mix large-scale housing community. The financial model guides the direction of generating massing model variations with the parametric application in the boundary of the neighborhood model in terms of 1) number of units, 2) arrangement of spatial definitions, and 3) configuration of circulation.

4.2.1 Definition of variables

The following list defines major variables that are used to analyze the financial component associated with the project. Data is gathered from market study project site analysis and architectural program. This information is then formulated to produce a cost estimate of the project. Subscripts x, y and z indicate studio, one bedroom and two bedroom units respectively.

Nomenclature

Project Data

A = Total unit area

V = Project value

C = Construction cost

L = Land cost

Standard unit size defined by research

S_x= Studio unit size

S_y= One Bedroom unit size

S_z= Two Bedroom unit size

Sales value of units defined by research

M_x= Studio unit Sales value

M_y= One Bedroom unit Sales value

M_z= Two Bedroom unit Sales value

Ration among different unit types (R)

R_x= Studio unit ratio

R_y= One Bedroom unit ratio

R_z= Two Bedroom unit ratio

Number of each unit

U_x= Number of Studio unit

U_y= Number of One Bedroom unit

U_z=Number of Two Bedroom unit

Individual unit area

A_x= Studio unit area

A_y= One Bedroom unit area

A_z=Two Bedroom unit area

Individual unit height

H_x= Studio unit height

H_y= One Bedroom unit height

H_z=Two Bedroom unit height

Cost of units per m^2 (subsidized)

C_x= Studio unit cost

C_y= One Bedroom unit cost

C_z=Two Bedroom unit cost

Individual unit price

P_x= Studio unit price

P_y= One Bedroom unit price

P_z=Two Bedroom unit price

Semi-private space defined by research

S_a= Semi-private area

4.2.2 Analysis of variables

The following flowchart (diagram) illustrates formulation of the definitions listed above. The collected data is first calculated, and depending on the project goal incentives are introduced in order to make adjustments to the outcomes of the calculations. Figure 4.4 shows a flowchart that illustrates the basic configuration of the financial model.

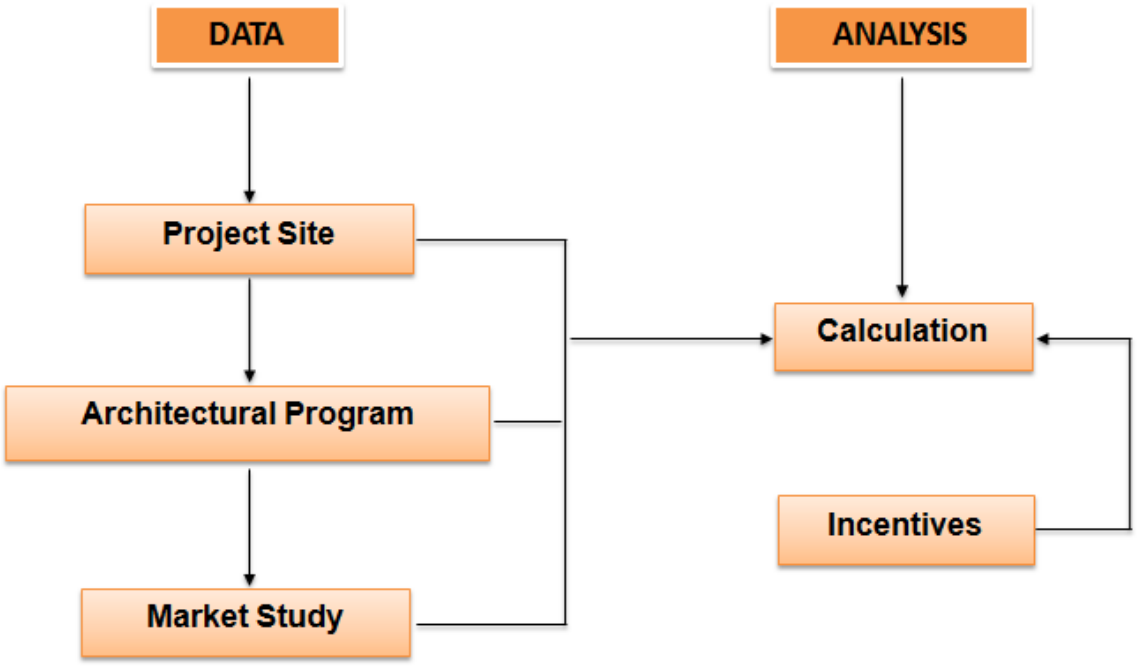


Figure 4.4 Financial model flowchart

The project site is one source of information which is used to define variables that are essential in the formation of the financial model. As shown in Figure 4.5 total site area, floor area ratio (FAR), site coverage, and other pertinent municipal codes are collected using this component and later used, in combination with data from architectural program, market study, in the analysis process.

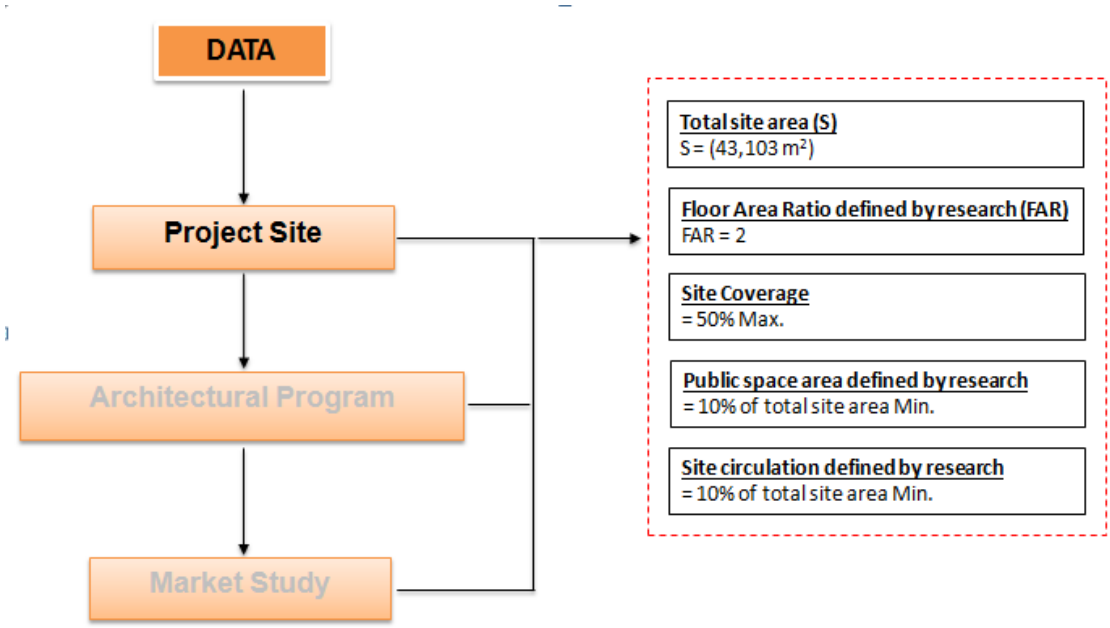


Figure 4.5 Financial model - data from project site

Architectural program defines total unit area requirements, the proposed percentage of unit mix, semi-private area and circulation as shown in Figure 4.6.

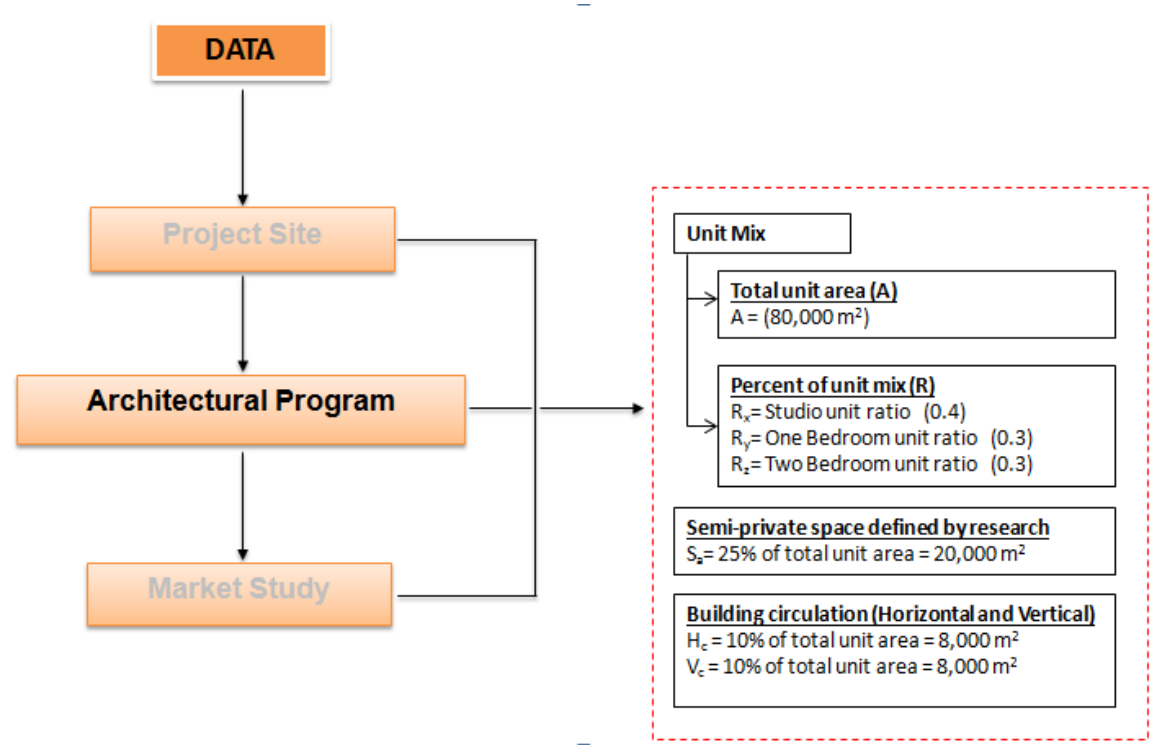


Figure 4.6 Financial model - data from architectural program

Market study data shown in Figure 4.7 is compiled from information generated by government agencies and real estate brokers operating in Addis Ababa.

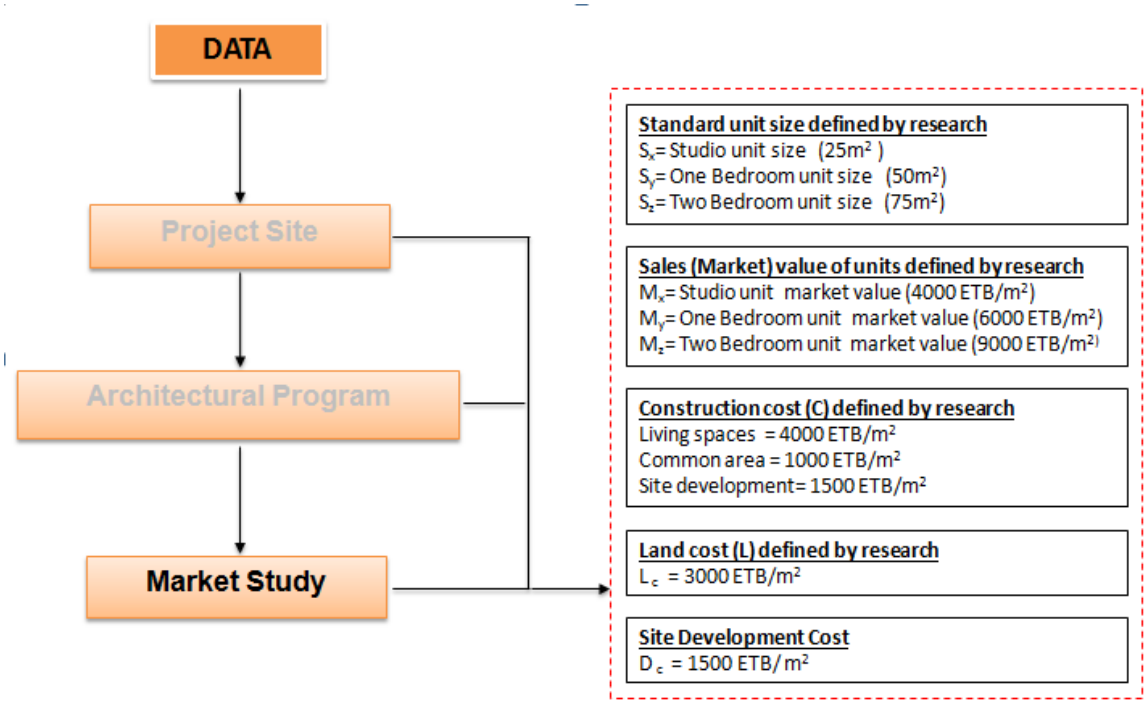


Figure 4.7 Financial model - data from market study

Calculations shown in Figure 4.8 indicate the difference between the project value (V) and construction cost (C). In order for the project to be financially feasible the project value need to be at a minimum equal to the construction cost or more. The objective here is to introduce incentives that are focused on reducing the cost of construction. Incentives indicated in Figure 4.9 are applied to offset the cost of construction. Some of the main incentives include the cost of land and site development cost. Incentives are generally provided by local government in order to make public projects a reality.

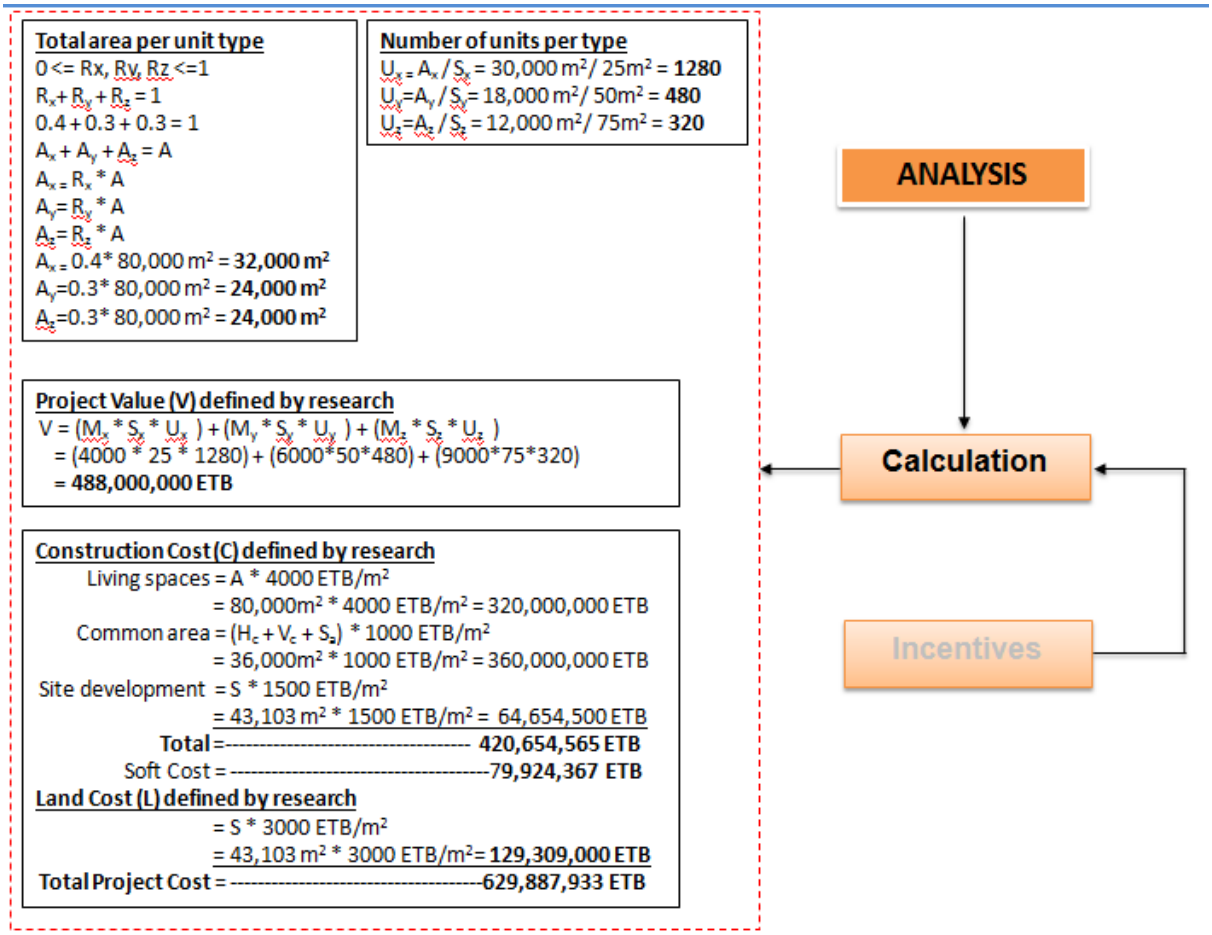


Figure 4.8 Financial model - Calculations

After incentives are applied the numbers are recalculated in order to reflect the impact of the applied incentives described as “Options”.

Depending on the project type a variety of incentives may be applied. This may range from tax incentives in construction equipment, labor cost offsets by involving prospective residents in the construction project, technical assistance by government agencies that would help build the capacity of local builders, etc…

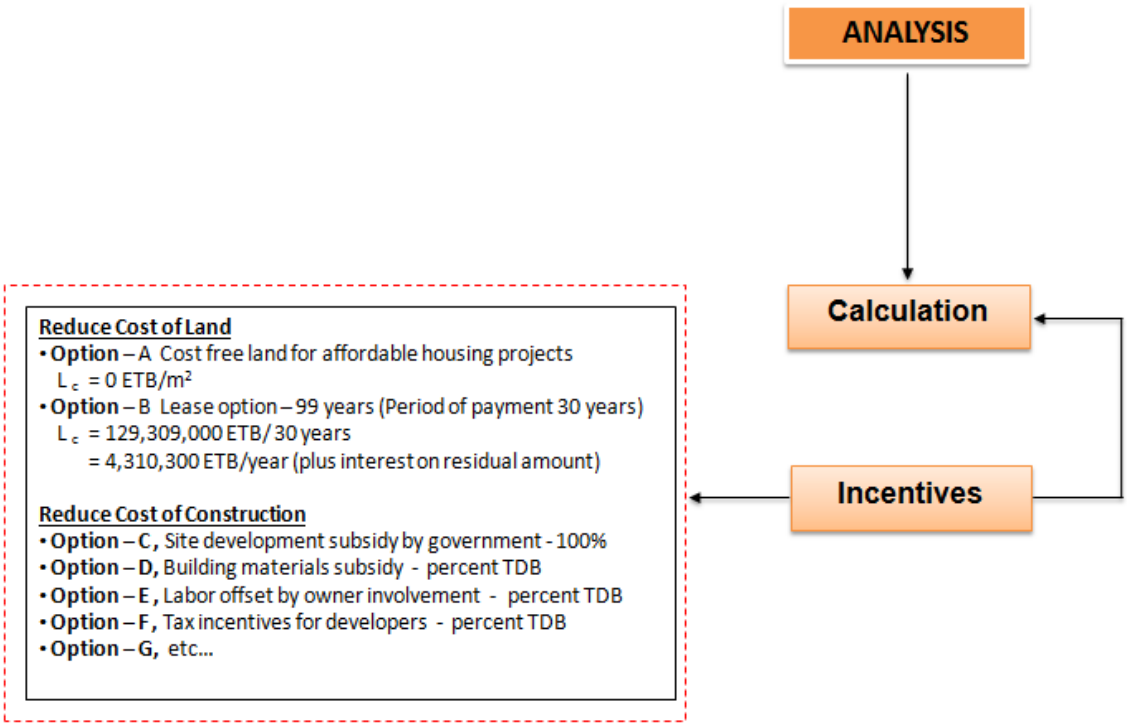


Figure 4.9 Financial model - incentives

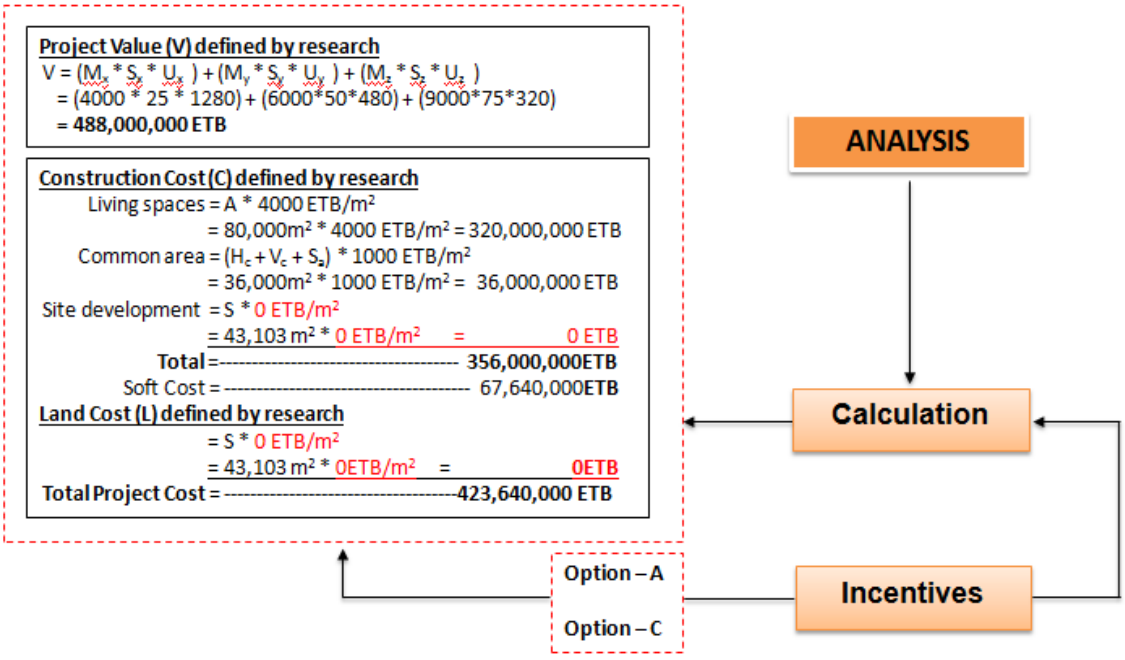


Figure 4.10 Financial model - calculation with incentives

4.3 Summery

The financial component of the proposed large-scale housing development is formed based on criteria developed from the analysis of social and cultural needs of the target group and neighborhood model that was developed subsequently. In addition data such as construction and other development costs, market value of housing units in the region is gathered from governmental and non-governmental sources operating in Ethiopia.

Data is collected using three major methodologies, which are market study, project site analysis and architectural program. The collected data is then analyzed using the proposed financial model. The typical building types are developed based on a modular building system that may be configured as a studio unit, a one bedroom unit and a two bedroom unit that may be easily modified as the needs of the owners change over time.

The neighborhood model and typical building types, Fig 3.1 and Fig 3.2 respectively, define three special components, buildings/living spaces, in-between spaces/semiprivate areas and circulation, which are quantified and used to develop preliminary cost estimate of proposed projects.

The financial feasibility of the project is justified by the introduction of government incentives. In this exercise cost of land and site development cost are introduced as the key government contributions, which made the project financially sustainable.

5. SYNTHESIS OF SOCIAL, SPATIAL AND FINANCIAL COMPONENTS

5.1 Parametric Modeling Environment

The proposed holistic approach is developed within a parametric modeling environment, Figure 5.1, supported by Rhinoceros 3D, Grasshopper and its plug-ins in order to enhance design feasibility studies. The approach is based on four major components such as 1) social and cultural factors, 2) a neighborhood model of urban typology, 3) a financial model and 4) a massing study model that delineates the possible building variations.

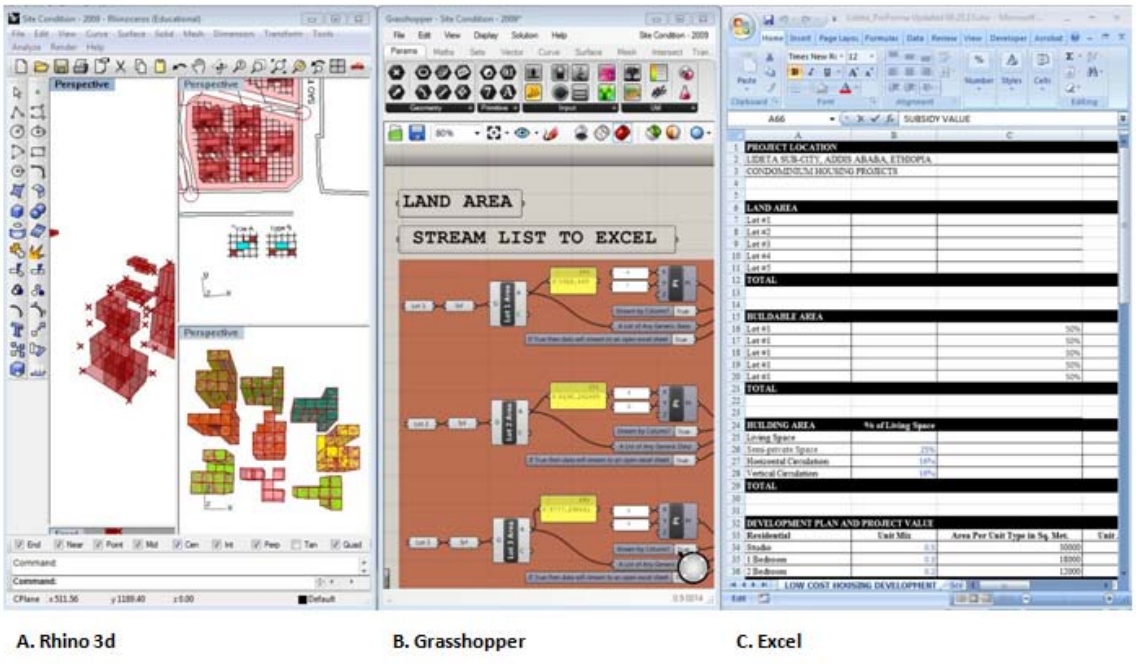


Figure 5.1 parametric modeling environment supported by Rhinoceros 3D, Grasshopper and MS Excel

The financial model guides the direction of generating massing model variations with the parametric application in the boundary of the neighborhood model in terms of 1) number of units, 2) arrangement of spatial definitions, and 3) configuration of circulation. The direct connection between financial model and massing model within neighborhood boundary condition allows a developer to

review design alternatives with changing numbers, at the same time, an architect to understand a financial condition of each alternative with modifying designs.

5.2 Data Transference from Rhinoceros 3d to Excel

Information is generated from the digital site model created in Rhinoceros 3d and grasshopper and translated into area values that may be manipulated in an excel spreadsheet figure 5.2 and Figure 5.3 respectively. Figure 5.4 shows grasshopper script used to capture geometry in Rhino and translate information into an Excel spreadsheet.

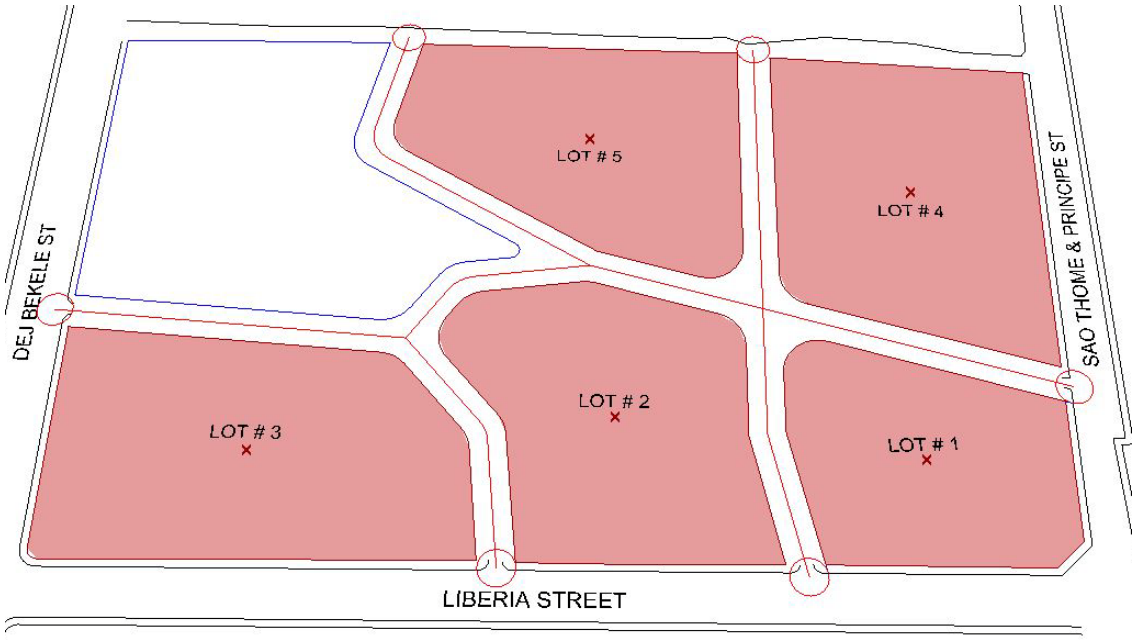


Figure 5.2 Lot areas generated in Rhinoceros 3d and Grasshopper

LAND AREA			Square Meter
Lot #1			5,919
Lot #2			8,196
Lot #3			9,777
Lot #4			10,021
Lot #5			9,190
TOTAL			43,103

Figure 5.3 Area values of lots captured in Excel spreadsheet

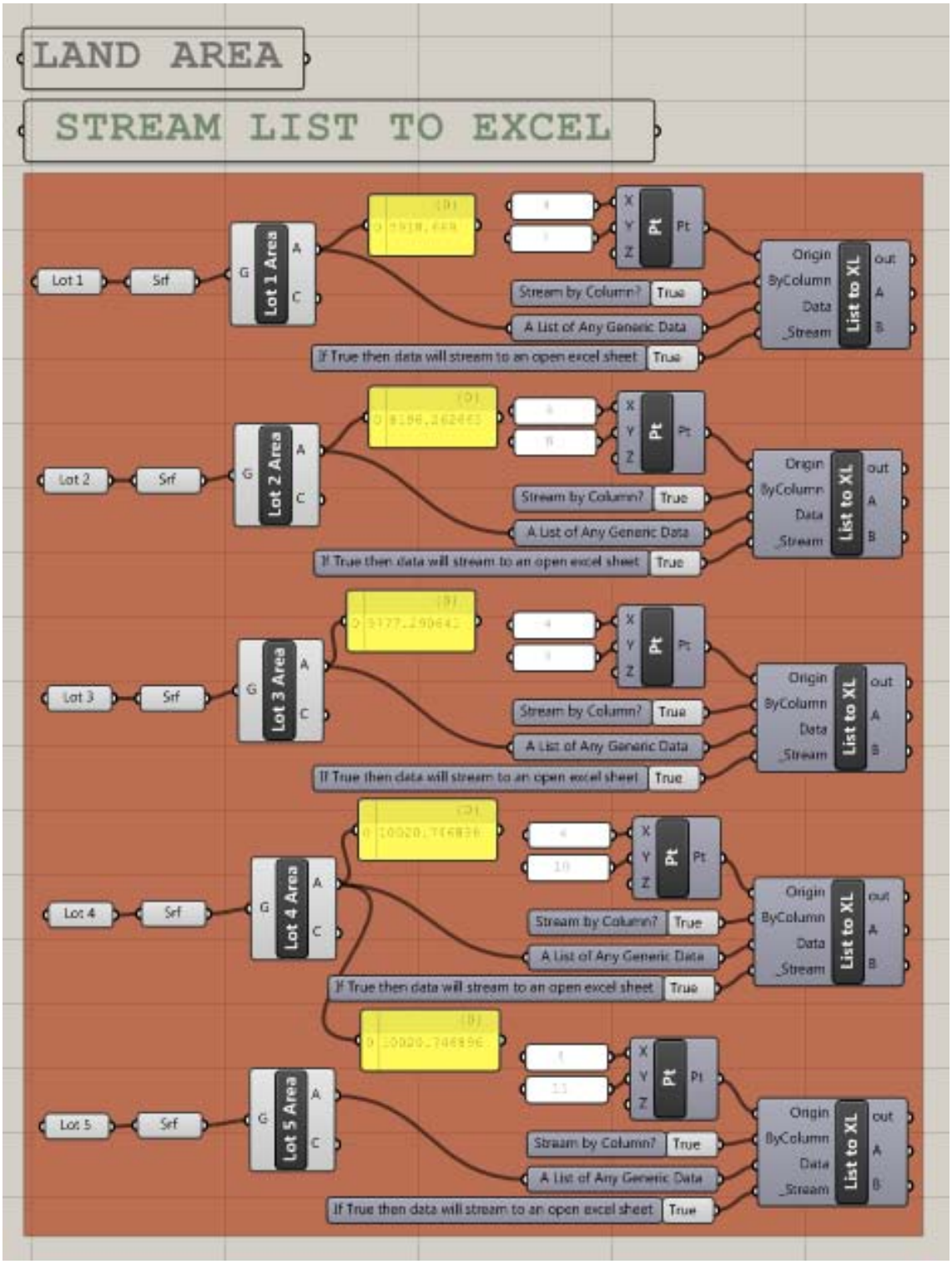


Figure 5.4 Grasshopper script used to generate area values [1]

[1] Grasshopper script used to generate area values. adapted from work by Damian Alamar. Accessed October 09, 2013. www.liquidtectonics.com

5.3 Site planning strategy

The project site is a 43,103 m^2 parcel divided into six lots as shown in Figure 5.5. Based on Addis Ababa administration criteria on Table 4.3, the selected project site is valued at roughly 1686 ETB/M^2. A multiplier 1.9 is added based on the adjacent road size which is larger than 20 meters.

Existing circulation paths within the property are retained and improved to meet municipal code. The six lots will be developed with FAR of 2 and maximum site coverage of 50%. Zoning regulations in the area allow for up to seven story towers that may be used for housing and commercial activities to support the newly developed community.

Lot 3 is selected to illustrate how the foundation of the massing model is intended to work. Existing circulation paths are identified and used as a starting point for laying building footprints that may be adjusted subsequently to meet local code.

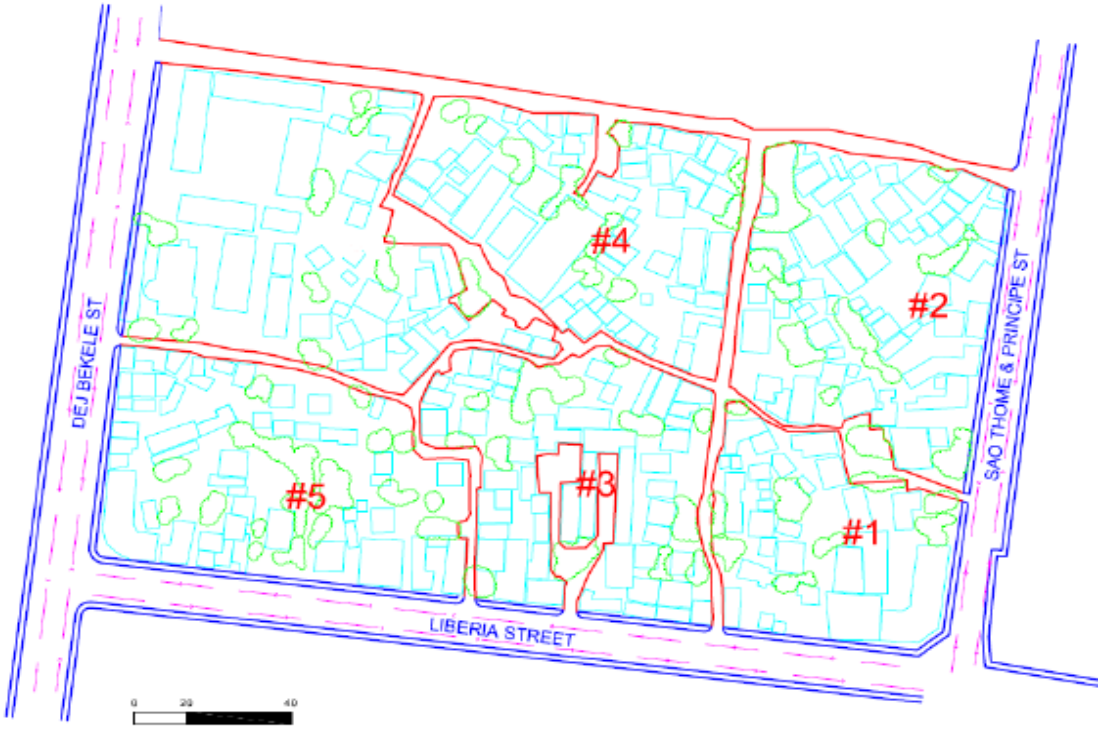


Figure 5.5 Project site

Existing path are identified and categorized as primary, secondary and tertiary circulation paths. Depending on the importance of their service to the community, critical paths are identified and used to create sub plots that would be used to lay a foundation grid for building footprints. Figure 5.6 illustrated the initial step that was taken to establish critical paths.

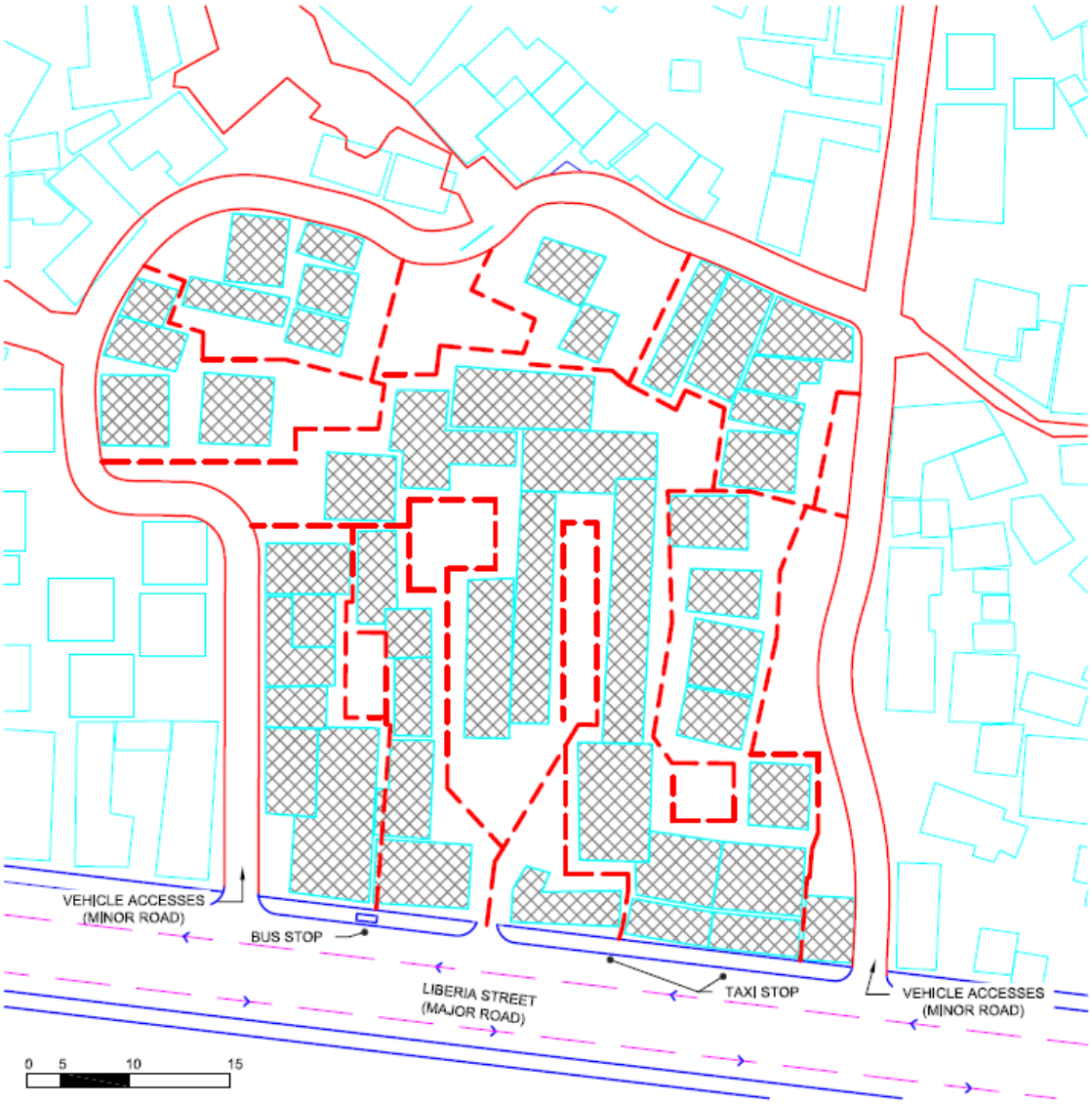


Figure 5.6 Lot #3 showing selected paths

Figure 5.7 illustrated improved circulation paths that were developed from existing paths that were most frequently used by the original settlers of the community. These paths serve as a boundary for the 5x5 grids that lay the foundation for building foot prints.

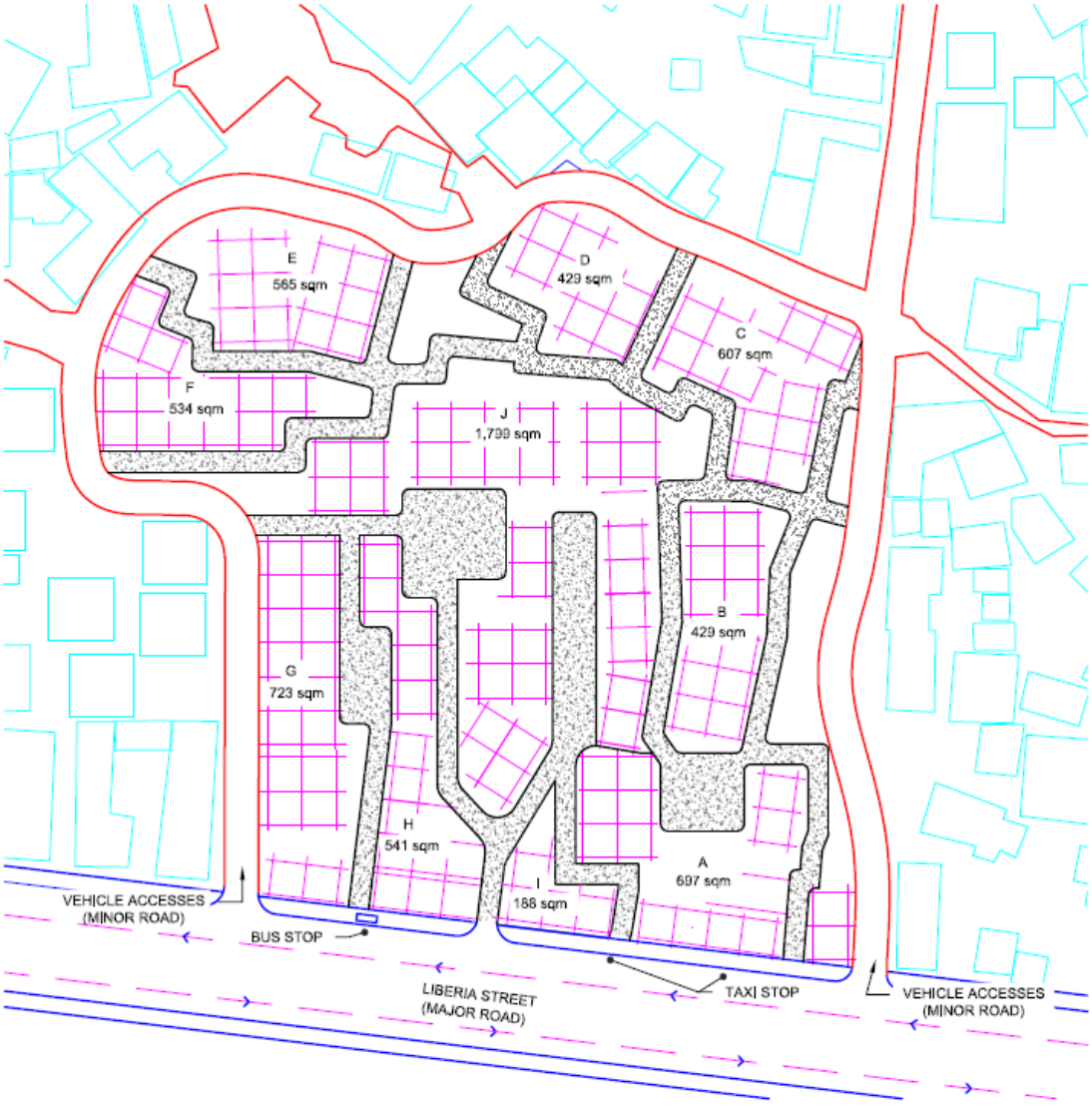


Figure 5.7 Lot #3 showing improvements of selected paths

Figure 5.8 Lot #3 showing improvements of selected paths and building footprint

Figure 5.9 close-ups of selected buildings from Lot #3

Figure 5.10 illustrates the potential for a combination of four and seven story buildings that may be developed following the steps illustrated in Figures 5.6, 5.7 and 5.8.

The ultimate goal is to use a computational modeling tool to automatically create a similar massing model that may be used to make studies and test potential development possibilities of a given site.

Figure 5.10 G+4 and G+7 buildings developed based on the 5x5 grid

Figure 5.11 identifies several points on the study model that require further study in order to verify code compliance issues and overall physical conditions in regards to circulation and appropriateness as a living environment.

Figures 5.12 to 5.20 show close-up perspective views that correspond to the points indicated on Figure 5.11.

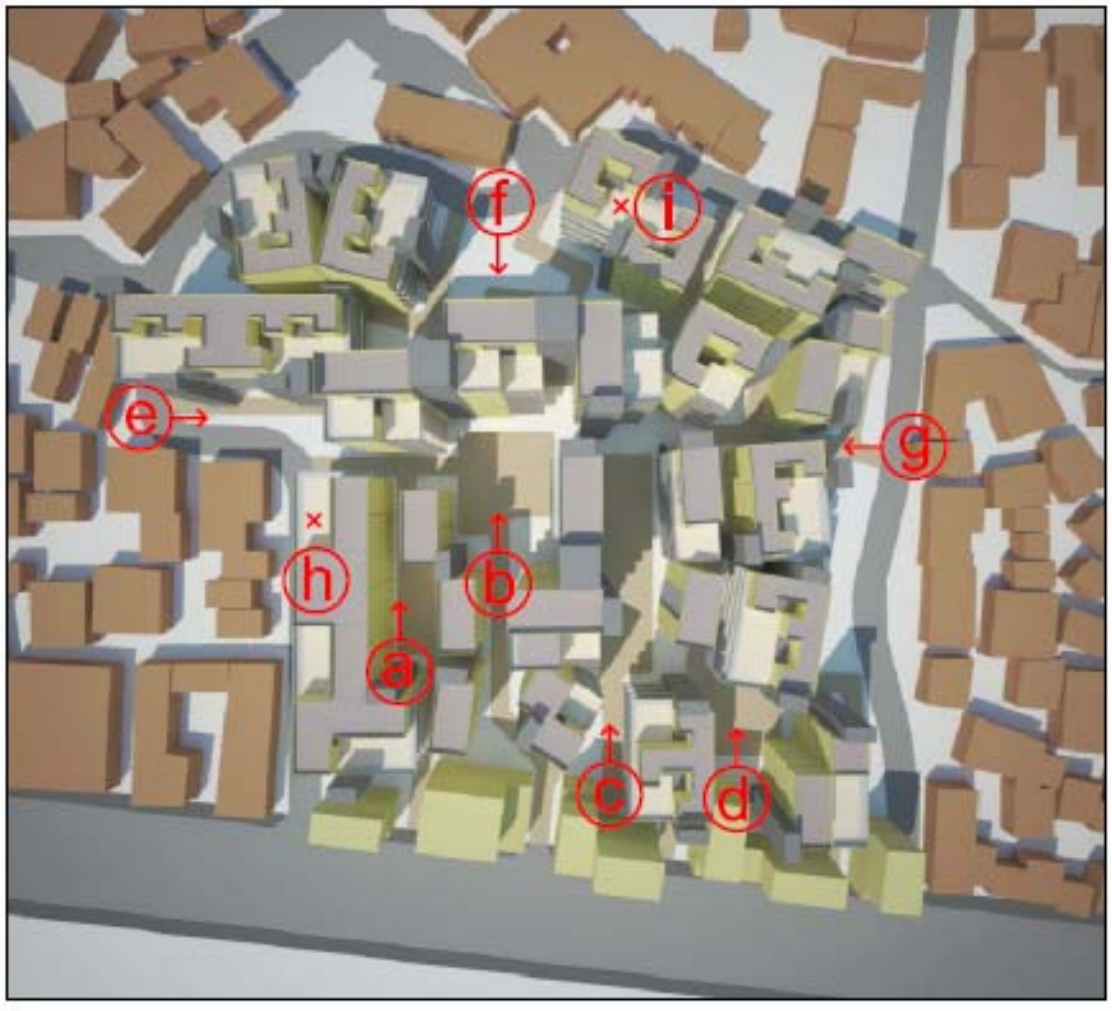


Figure 5.11 Lot areas generated in Rhinoceros 3d and Grasshopper

Figure 5.12 View from point A

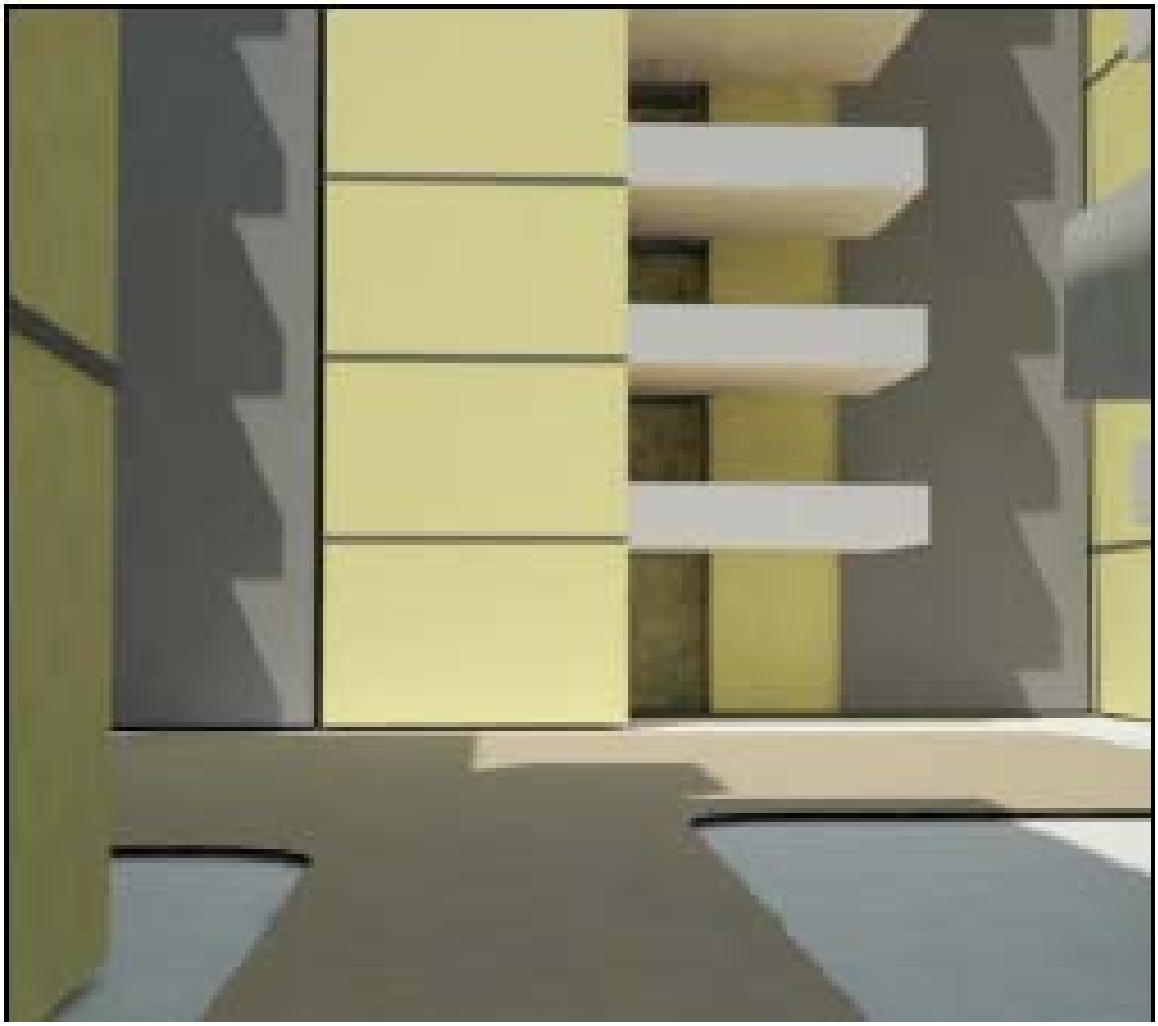


Figure 5.13 View from point B

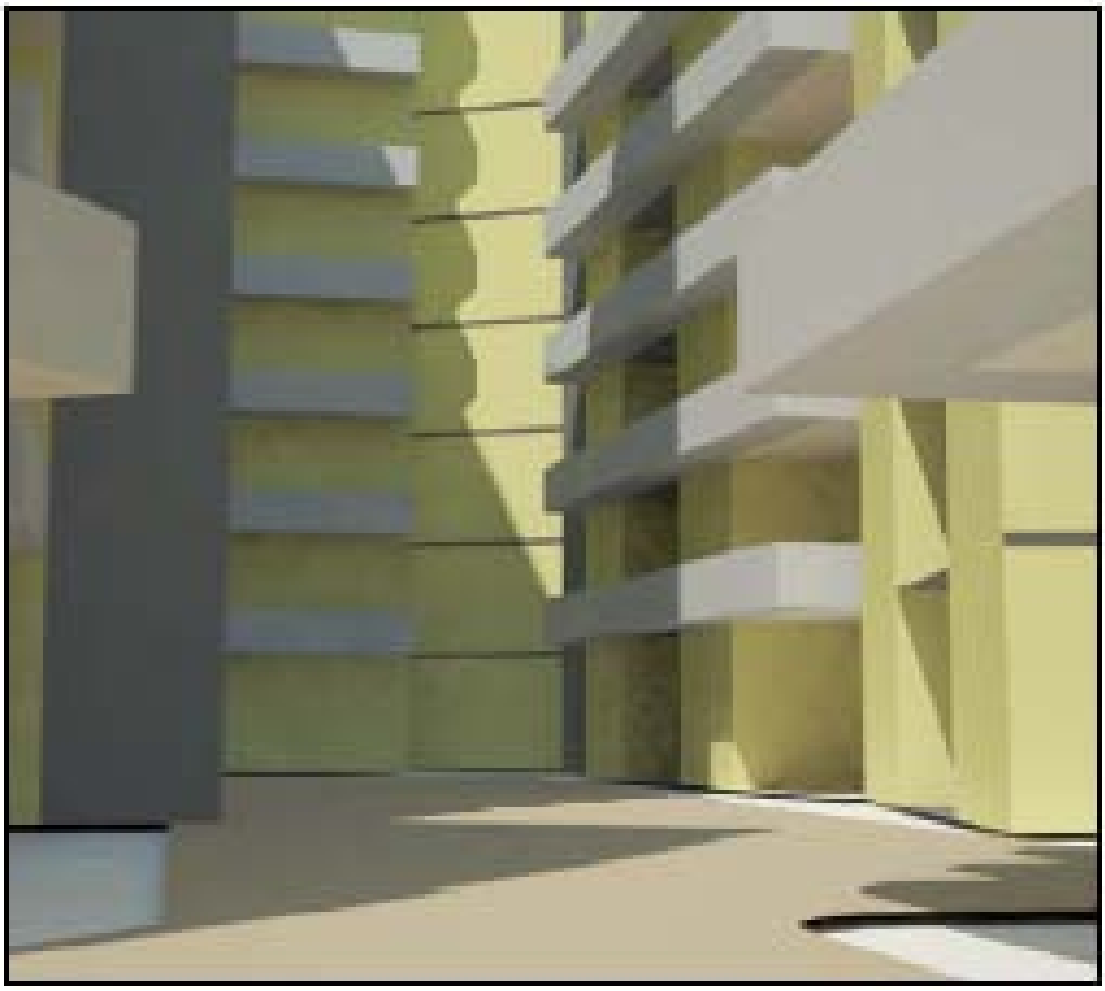


Figure 5.14 View from point C

Figure 5.15 View from point D

Figure 5.16 View from point E

Figure 5.17 View from point F

Figure 5.18 View from point G

Figure 5.19 View from point H

Figure 5.20 View from point I

5.4 Building Typology

The proposed building type is based on a 5m x 5m grid, which may be configured in many combinations. The following diagrams show two possible building types that are configured in all possible unit types: studio, one bedroom and two bedroom types. Depending on the architectural program and unit mix percentage a combination of some or all of the types specified below maybe used in a particular project.

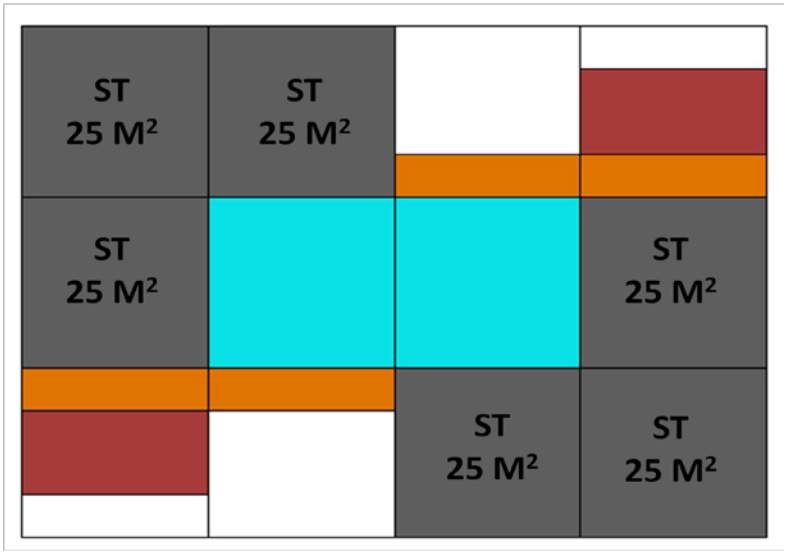


Figure 5.21 Type A - Studio combination

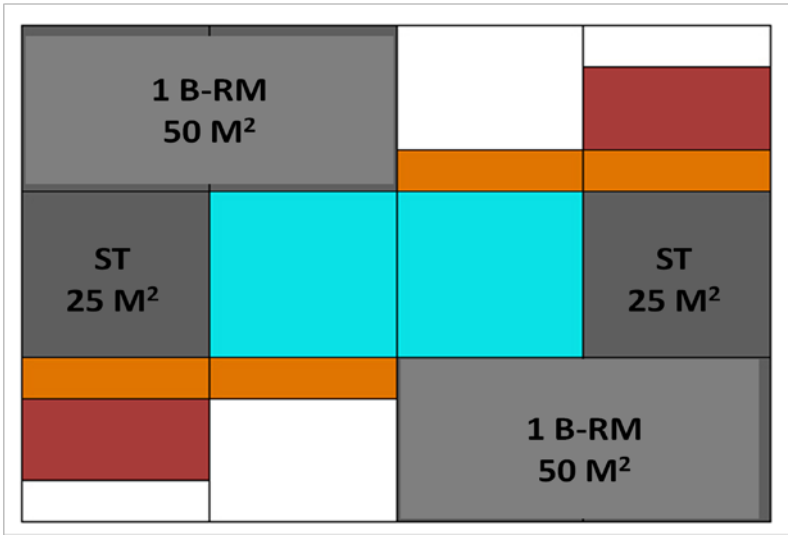


Figure 5.22 Type A - studio, one bedroom combination

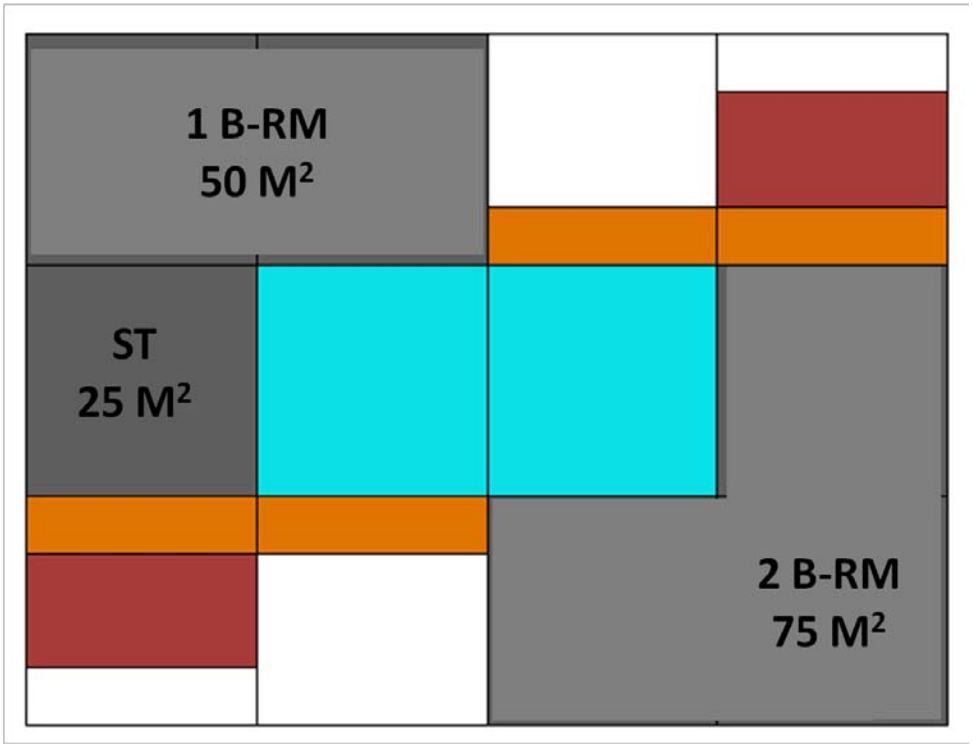


Figure 5.23 Type A - studio, one bedroom, and two bedroom combination

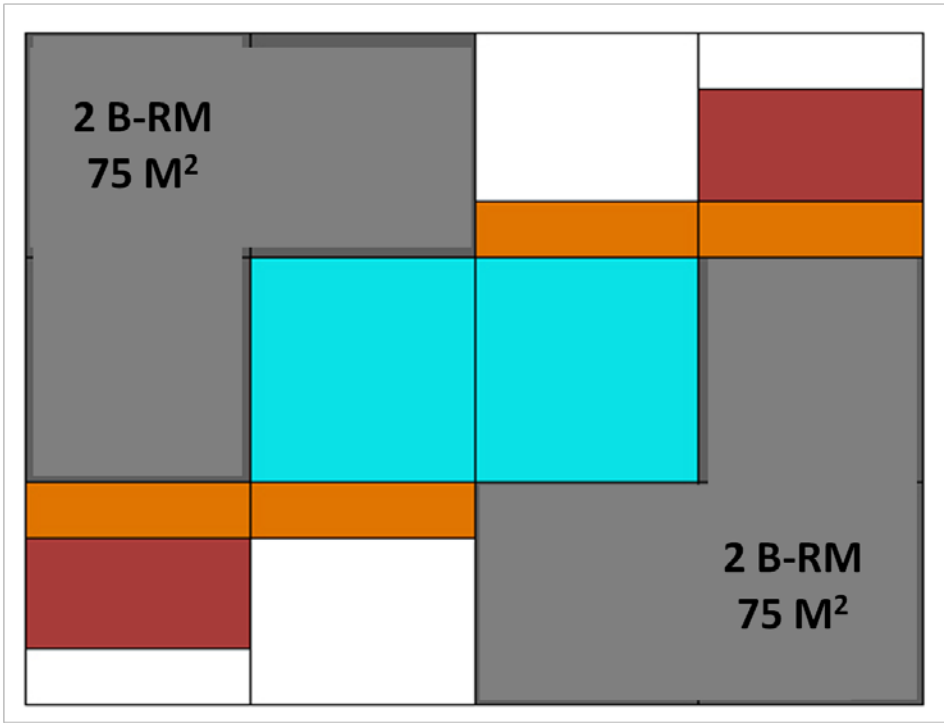


Figure 5.24 Type A - Two bedroom combination

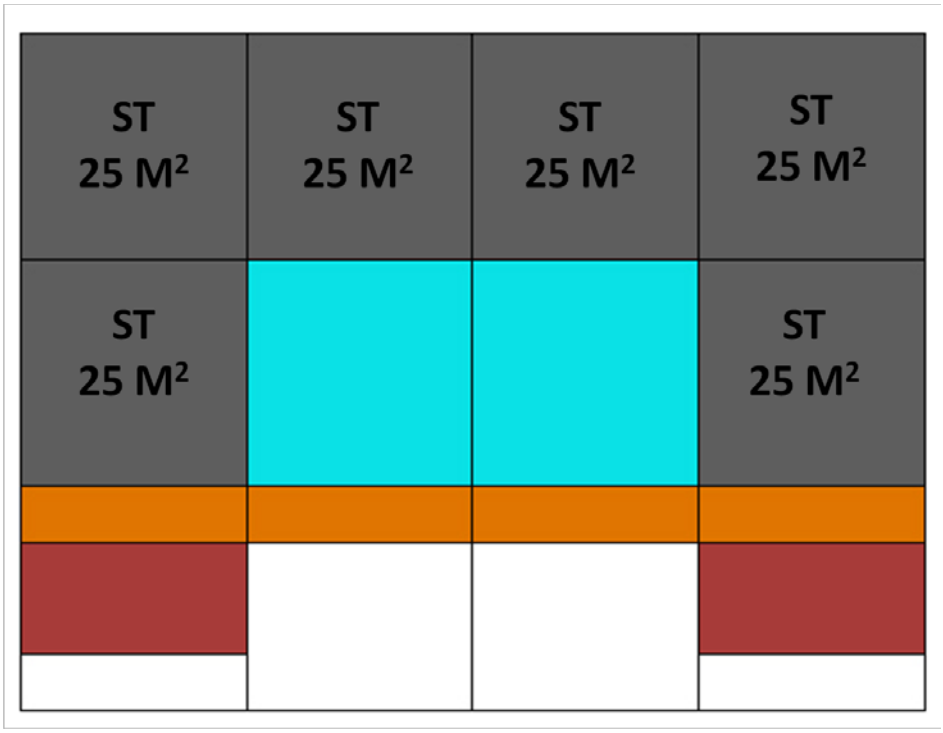


Figure 5.25 Type B - Studio combination

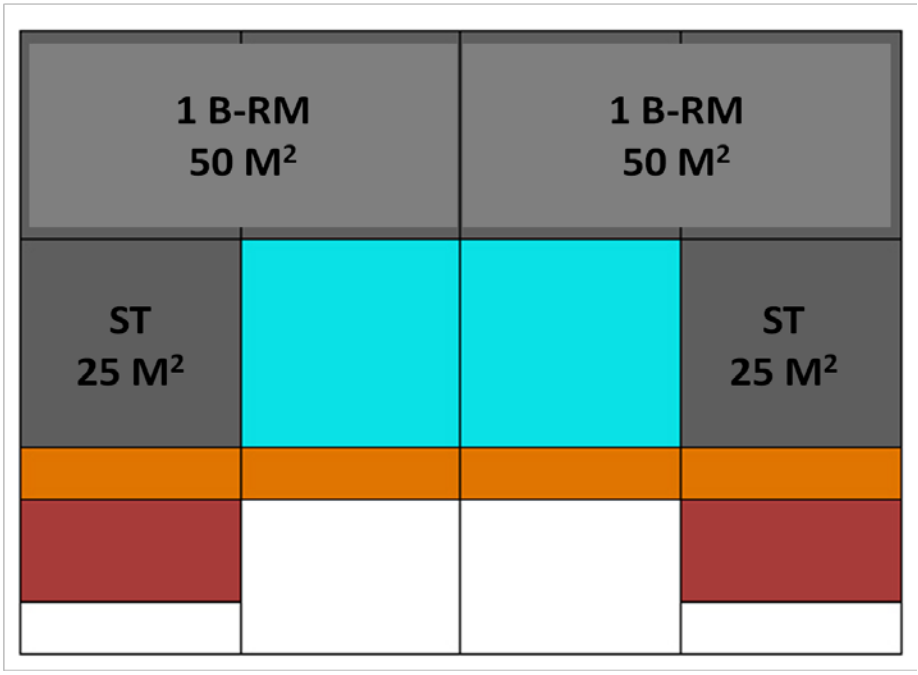


Figure 5.26 Type B - studio, one bedroom combination

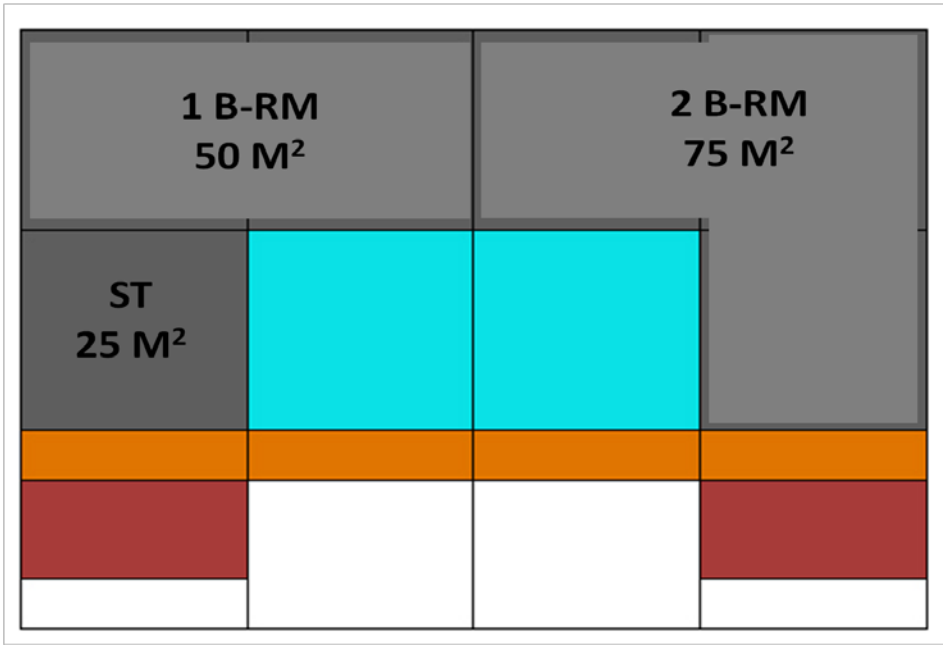


Figure 5.27 Type B - studio, one bedroom, and two bedroom combination

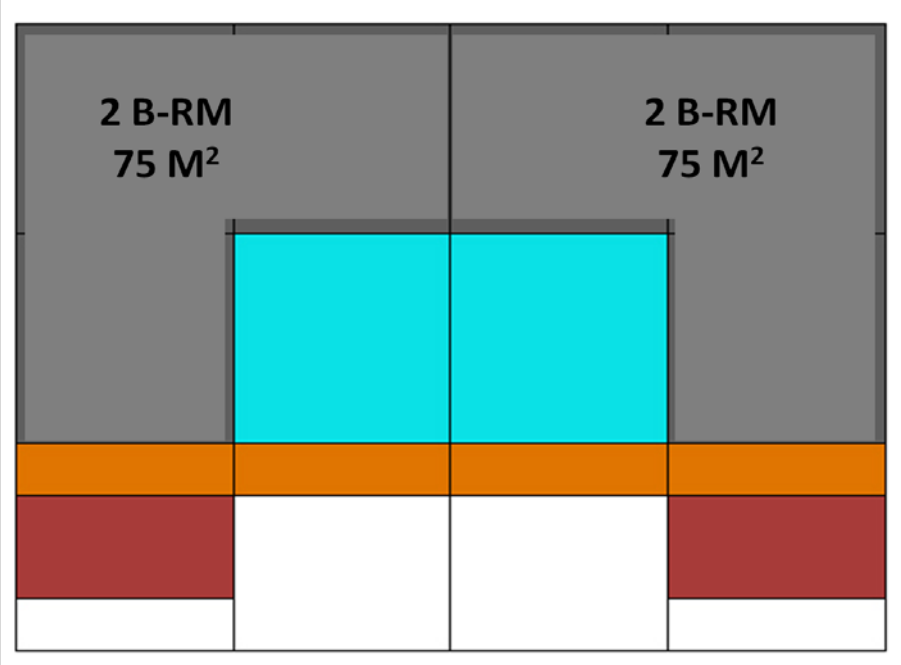


Figure 5.28 Type B - Two bedroom combination

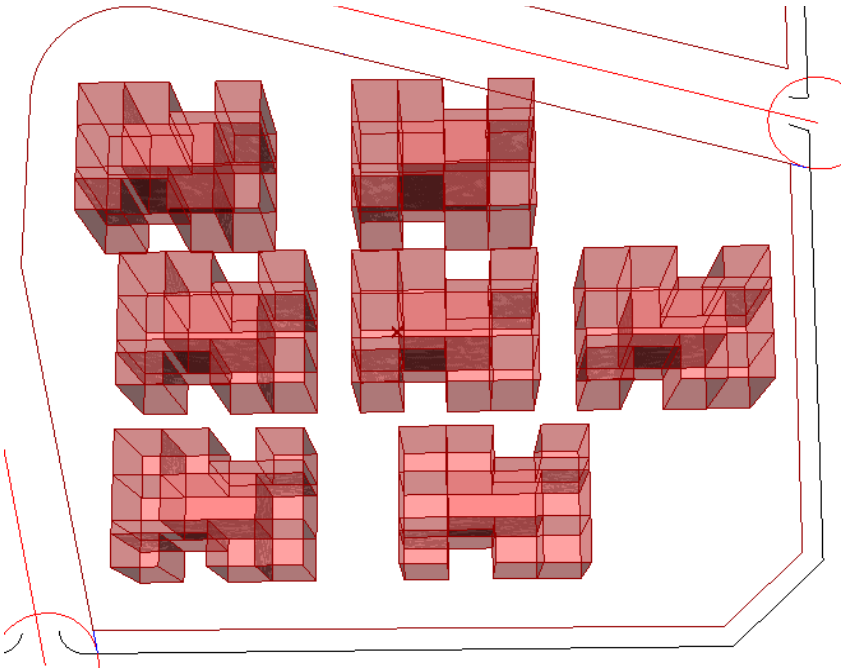


Figure 5.29 Type A on Lot #1

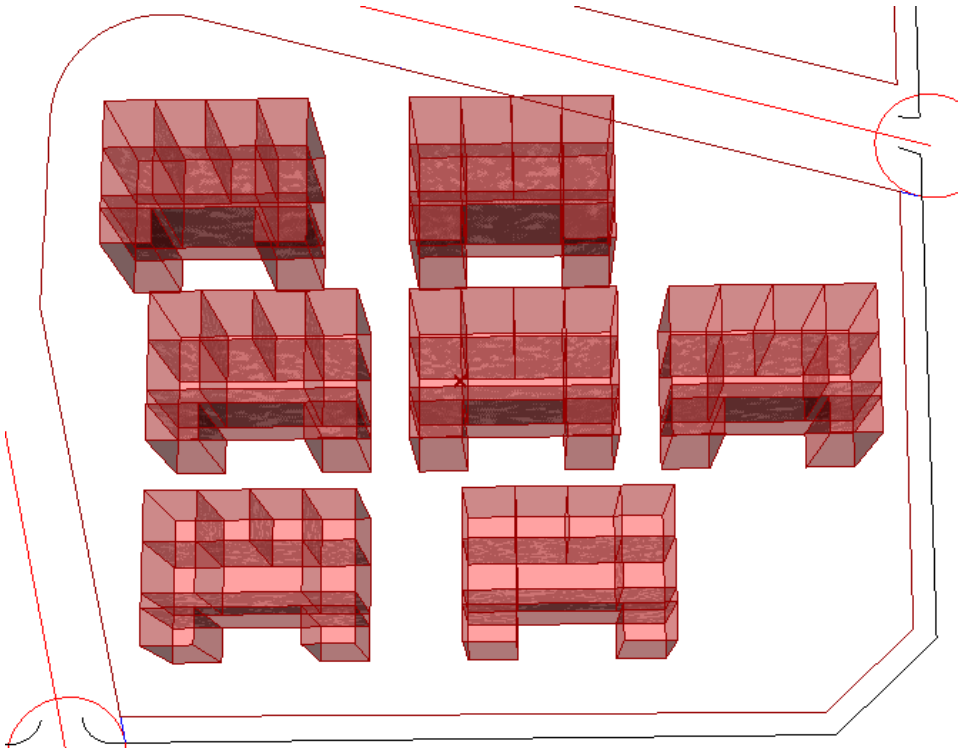


Figure 5.30 Type B on Lot #1

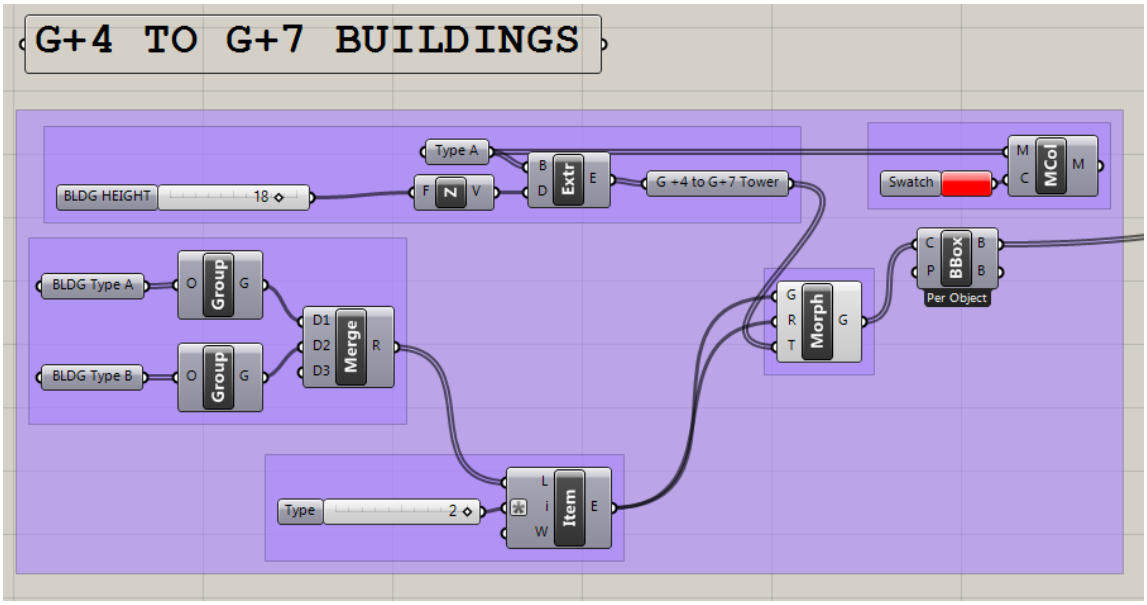
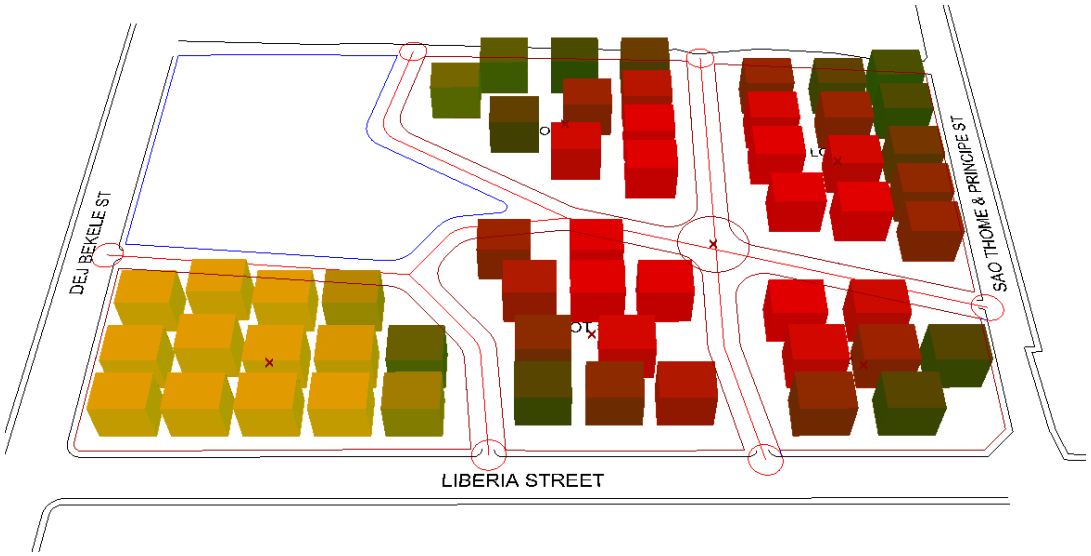


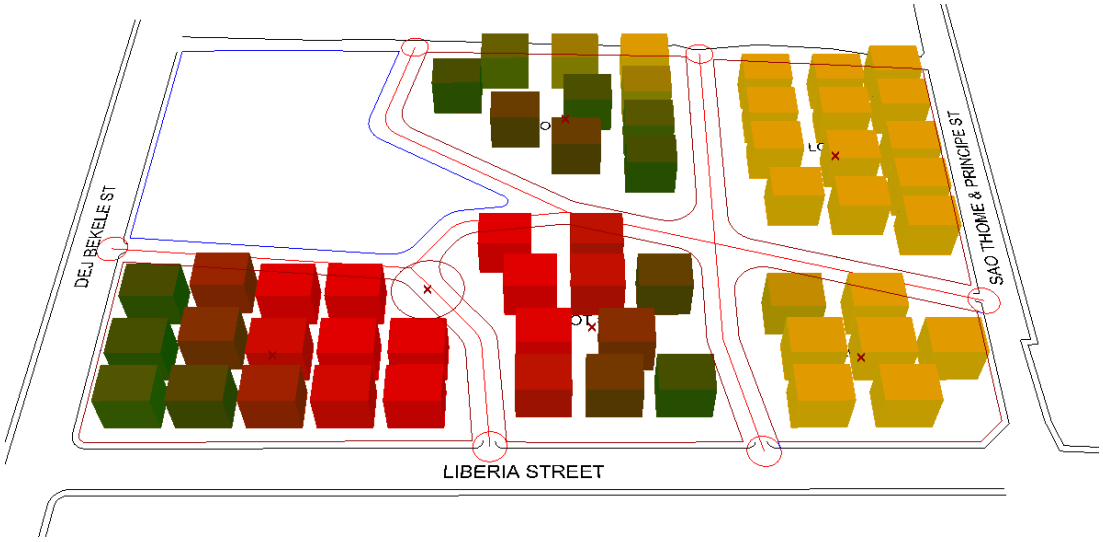
Figure 5.31 Grasshopper script used to determine building type combination and building height

5.5 Unit Mix

Providing a mixed income community may be achieved in many ways. The parametric modeling tool allows the designer to specify the percentage of unit mix and the distribution of units. Specific unit types may be distributed within a single building or the distribution may be specific to a group of buildings which will be classified as low-income, middle-income and high-income areas. Figure 5.15 shows options A and B which illustrate possible iterations that are controlled by adjusting percentages and the particular zone of unit mix.



Option A



Option B

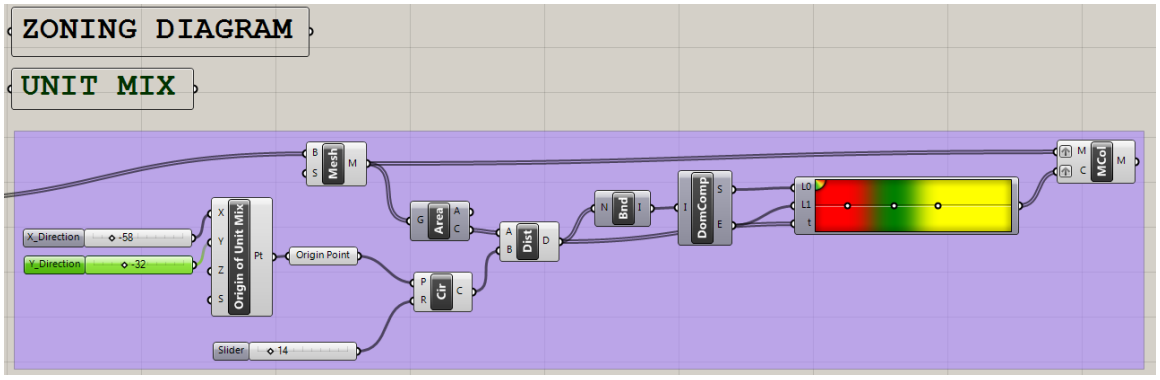


Figure 5.32 Unit mix script

Sliders X and Y shown in Figure 5.6 control the origin of the unit mix. Depending on municipal codes, site conditions and developers intentions these coordinate points may be adjusted to change the origin point of the unit mix. Figure 5.6 show the percent composition between the various unit types: red-2 bedroom, green 1 bedroom, yellow studio.

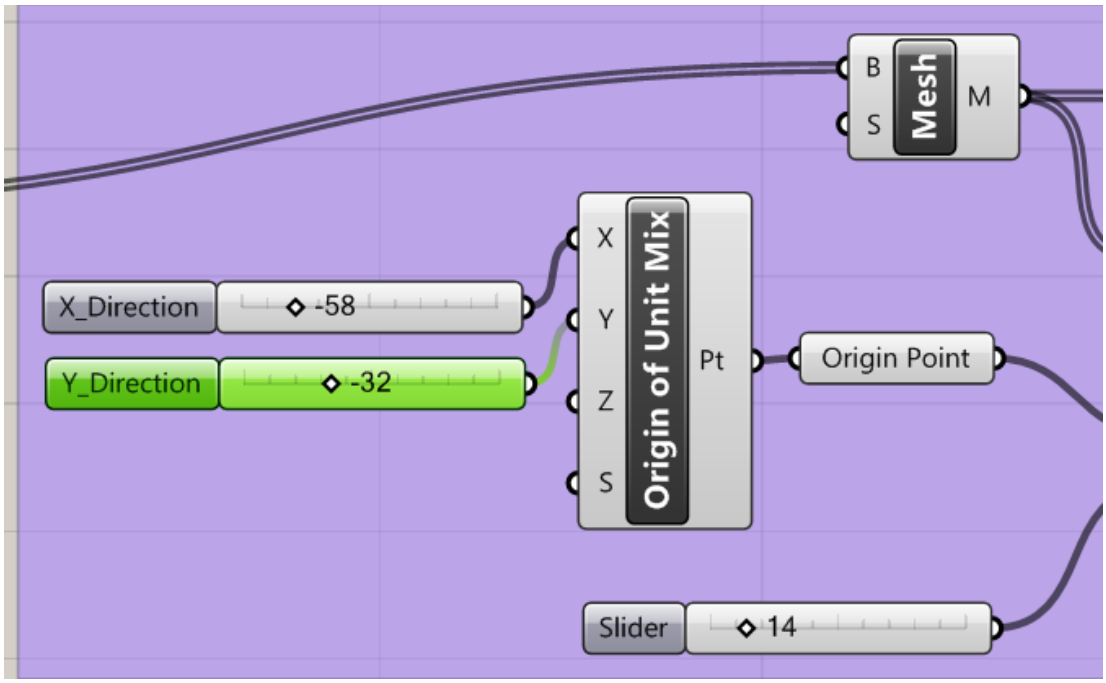


Figure 5.33 Origin point of unit mix

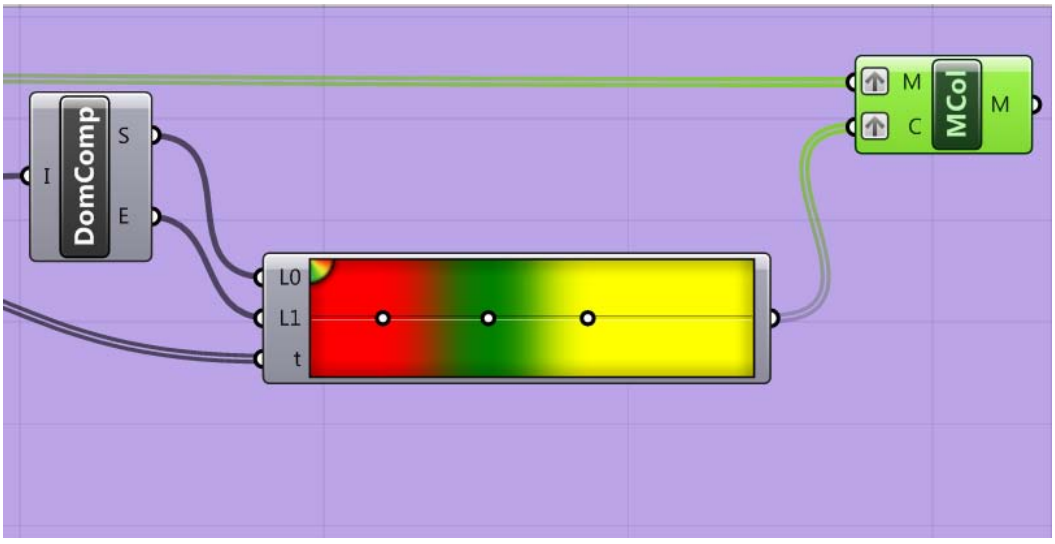


Figure 5.34 Unit mix percentage

5.6 Summery

The proposed holistic approach is developed within a parametric modeling environment, supported by Rhinoceros 3D, Grasshopper and its plug-ins in order to enhance design feasibility studies.

The approach is based on four major components such as 1) social and cultural factors, 2) a neighborhood model of urban typology, 3) a financial model and 4) a massing study model that delineates the possible building variations.

The financial model guides the direction of generating massing model variations with the parametric application in the boundary of the neighborhood model in terms of 1) number of units, 2) arrangement of spatial definitions, and 3) configuration of circulation.

The direct connection between financial model and massing model within neighborhood boundary condition allows a developer to review design alternatives with changing numbers, at the same time, an architect to understand a financial condition of each alternative with modifying designs.

6_CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

As the demand for housing in urban Ethiopia continues to grow rapidly, local authorities are striving to address the issue in a timely manner. Current housing development follows the conventional approach where limited building types are developed and replicated with minor modifications to accommodate given site conditions. This strategy has resulted in an environment that is not suitable for the traditional lifestyle of common Ethiopian. Studies show that the lack of social and cultural considerations in the current development has hampered the quality of life of its residents.

The research conducted in this paper proposes a holistic approach to large-scale housing development in order to provide optimized solutions for social mix and multi-generation family life style in Ethiopia. A research project location in Addis Ababa, Ethiopia is selected as a test site for the proposed development strategy. The site is part of a large informal settlement that was demolished and replaced by a typical low-cost housing development composed of four and seven story towers.

The goal is to generate an alternative building typology based on the new holistic approach, which meets the social, cultural and economic needs of tenants. Analysis of informal settlements in Addis Ababa has identified

multigenerational living, socially and financially mixed communities as important ingredients for building a sustainable community. It was also discovered that semiprivate spaces, circulation paths and scalable housing units as key spatial variables that are necessary for the successful cultivation of these communities.

Based upon the analysis of social and cultural factors of given urban district, a neighborhood model is developed from existing site context and defined as a space holder for including various architectural programs such as different unit types (studio, one-bed, two-bed), spatial definitions (private, semi-private, public), and circulation (vertical and horizontal). The financial model is based on the optimization among the three criteria including market value, construction cost, and government incentives in order to provide tangible benefits for encouraging various income groups to participate in this social mix large-scale housing community.

The financial model guides the direction of generating massing model variations with the parametric application in the boundary of the neighborhood model in terms of 1) number of units, 2) arrangement of spatial definitions, and 3) configuration of circulation. The direct connection between financial model and massing model within neighborhood boundary condition allows a developer to review design alternatives with changing numbers, at the same time, an architect to understand a financial condition of each alternative with modifying designs.

6.2 Recommendations

The many facets of this project have identified potential research topics that may be undertaken by future doctoral project students. The following list is categorized in three major areas. 1) Informal settlements 2) Financial feasibility studies and 3) Computational modeling.

1. Informal settlements

- The evolution of informal settlements and lessons that are learnt from their formation, which may be applicable in future housing development projects.
- Study of the anatomy of informal settlements and its impact on the daily life of its residents.
- The effect of social and cultural norms and how they shape our living environments.
- The importance of circulation paths and in-between spaces in regards to connecting communities and augmenting living spaces.
- The role of multifunctional spaces: gathering areas, outdoor cooking spaces, out-door laundry areas, etc…
- Life in a single room living space for multiple family members.

2 - Financial feasibility studies

- What is the ideal percent mix in a mixed income community? This particular project identified a 30,30,40 combination for high, middle and low income housing units respectively, which was intended at reducing the impact of high concentration of low-income residents.
- What is the optimum ratio of subsidy money distribution? What are the appropriate criteria that would allow as in determining this ratio?

3 - Computational modeling

- This research has shown the potential for computational modeling tools in driving architectural design. Further studies are required in determining how to generate and transfer basic planning data from project sites into a computational modeling tool in a simple and efficient way. This would allow planners and designer save several hours of manual work required in the schematic design phase of projects.

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