



Expertise
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Incremental Housing

Design Approach for Kathmandu

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Bachelor of Engineering

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<p>The purpose of this thesis was to highlight and present a proactive urban strategy of incremental housing. A case study was proposed enlightening the role, design concepts, features and goals of the incremental housing strategy in the densely populated Kathmandu valley. The approach of this thesis provided a deep understanding of current housing demand and suggested incremental housing as a possible approach and solution to counteract the existing situation. This thesis highlighted the step by step theoretical and practical measures underlining the profits, challenges and overall progress of the strategy to the low-income community for improving the quality of living.</p> <p>The thesis studied different existing housing types on the basis of literature, interviews and case studies. The study looked into different topics, such as material cost, energy management, building design modelling and sustainability. Furthermore, as a design approach different prototypes were created with different functions allowing deep investigation of functionality and reliability of various disciplines. The results suggested that incremental housings could be a solution of boosting quality housing for low income people in highly dense cities.</p>	
Keywords	affordable and social housing, incremental housing, sustainability

Contents

List of Abbreviations

1	Introduction	1
1.1	Affordable Housing	2
1.2	Current Situation	4
1.3	Goals and Objectives	4
2	Typology of Affordable Housing- Cases	6
2.1	The Housing First- PAAVO Principle, Finland	6
2.2	Tarragona Social Housing	7
2.3	Monterrey Housing	9
2.4	Incremental Housing in India	10
2.5	Summary	12
3	Incremental Housing in Nepal	13
3.1	Vision	13
3.2	Incremental Housing Strategy	14
3.3	Study and Interpretations	14
3.4	Design Development	16
3.4.1	Design Criteria	18
3.4.2	Conceptual Design Progress	20
3.4.3	Architectural design prototypes	23
3.5	Cluster Plan	25
3.6	Reliability and Cost	26
4	Sustainability	27
4.1	Material Selection and Landscaping	27
4.2	Water Conservation	28
4.3	Passive House Techniques and Green Energy	28
5	Conclusion	31
	References	32

List of Abbreviations

ARA	The Housing Finance and Development Centre of Finland
CBS	Central Bureau of Statistics, Nepal
QOL	Quality of Life
PV	Photovoltaic

1 Introduction

Architecture is a discipline connected with construction that includes the art and technologies of designing a building to provide quality spaces for day to day activities. The practical and theoretical aspects to provide solutions for the user need to have a close relationship to architecture to ensure utilitarian and aesthetic results. [1.] Architecture is mostly well-defined by the shape and the characteristics of a place whilst it finally becomes the marker of civilization. Architects are bound to be very much aware of the fact that the profession must fulfil the basic human needs, as well as match the progress of civilization of society it holds. [2.]

The word affordable indicates inexpensiveness or reasonably priced goods or services. Affordable housing is a similar concept, not too expensive for people with limited sources and incomes. Housing is affordable when choosing between paying rent and shopping is not a dilemma. Housing should be in healthy, secure and open environment with a proper community. However, for low- and middle-income people, finding the right housing can be difficult. That is where the local government and local organizations should work together to create suitable housing for people of different income levels. [3.]

Affordable housing is sustainable, beautiful and professionally managed with all the necessary services and comforts. There are various solutions for making housing affordable. One of the approaches is incremental building design and construction. An incremental approach focuses on the step by step process of construction where gradual changes are made in the layout and the structure of a building according to the needs of the owner or builders upon the availability of resources, funding and time. The main purpose of this architectural strategy is to provide possibilities of affordable living spaces to low-income families. An incremental housing strategy is normally included in social housing programmes where the cost of land must be kept low or the dimensions of the plots small and planned for further expansion or finishing of the homes according to the need of the end users.

Incremental housing is also called as self-help housing, assisted self-help housing or self-managed housing when seen from the perspective of the low-income households. The term 'incremental housing' has been used widely since 2000 where the phenomenon has been found to be of great importance. The developmental procedure engages people and helps to promote local use of resources and promotes the businesses of the communities. [4.]

1.1 Affordable Housing

Among other developing countries, South-East Asia is experiencing a high rate of urbanization. Nepal is one of the countries that faces massive migration from villages to cities resulting in severe conditions in housing demand. In a city like Kathmandu, the demand for individual housing has boosted after the massive earthquake in 2015. This has resulted in an average price increase of land by 40 to 50 percent and that of housing by 20 to 30 percent. This price rise has increased the construction price as well. [5.]

In the meantime, Kathmandu, the capital city of Nepal, is the largest municipality and the only city in the country with a metropolitan municipal status. The population of Kathmandu accounts for 1/12 of Nepal's total population. The population density of the city is 20,228 people per square kilometre with of approximately 50 sq. kilometres of total land area. [6.] For the year 2019, the growth rate of Kathmandu city is 3.94% with 1.5 million people living in the valley. By 2025 growth rate will be 3.28%, and an additional 249,388 residents. [7.]

On the basis of income category, a person with an income of less than around 200 euros per annum is categorized as poor, while a person with an income of 200-500 euros per annum is categorized in the group of lower medium people. Similarly, the population of Nepal is increasing rapidly, increasing the price of buildings and daily costs. This has increased the rate of unemployment, crowdedness and unstable family growth. The people migrating to cities struggle for proper shelter, food and education. This directly effects the quality of life since they must rely on fewer choices on daily food and supplies to make expenses. According to the 2018 Revision of World Urbanization Prospects, the population of the urban area is increasing whereas the population of the rural area is decreasing with a similar proportion (figure 1). [7.]

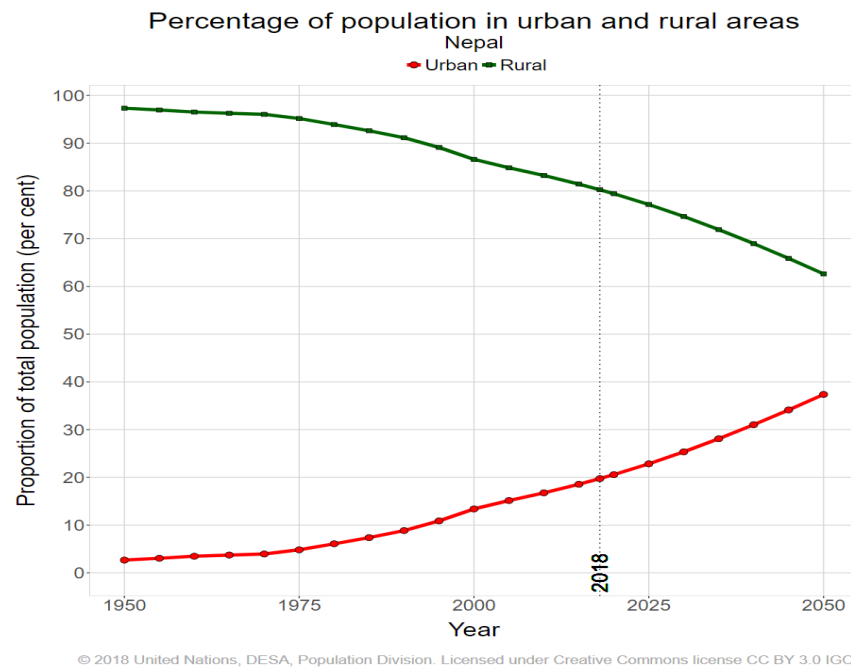


Figure 1. Percentage of total population in urban and rural areas in Nepal from 1950 to 2050 [7].

There are also wide differences in the average per capita income among various geographical areas in Nepal. The per capita income in urban areas is higher than that of rural areas. According to the report of the Central Bureau of Strategies of Nepal, 25.16 % of the population lived under the national poverty line in 2010. The proportion of urban poverty was 15.46% and that of rural areas 27.43%. [8.] An old estimation for 1995/96 to 2009/10 predicted a decline in poverty. Unfortunately, the increase in population and migration to the city also suggested that the poverty in urban areas is going to increase eventually over time. [9.]

The annual average housing demand in whole Nepal is 140,000 residential units and 42 percent of the demand is in the capital city. On average, the housing associations are only able to build 25,000 units. The supply and demand are not proportionate, which makes housing valuable and rises the prices of housing. In the meantime, the government lacks planning for homelessness and fails to come up with an effective strategy that would help to shift the focus more on the proper settlement of unwanted migration. [10.]

As mentioned above, the last decades have led to various problems of housing, especially in a city like Kathmandu that bears a huge amount of migration every year. Many people are suffering from a housing shortage because of unaffordability. The problem of poverty formation of slums can be prevented from a good housing solution. The location, design, material efficiency, services and community along with economic assistance are some of the parameters which are very important factors to be considered when making housing affordable and sustainable. [6.]

1.2 Current Situation

Strategic thinking is very important when planning construction projects. All aspects that affect the building outcome, like social, economic and physical outlook, should be examined and considered. The social aspect includes for example the study of family living, culture, size of family and age group. The economic aspects are policies, developmental processes and materials that affect the pattern of life. The physical aspects should relate to the selection, site analysis, typology and the location. [11.]

The quality of life (QOL) in slums is a very important viewpoint. It should examine and conclude how well the people manage their everyday life themselves. Since the late 1950s, the slums had been established along the rivers Bagmati and Vishnumati. The Balkhu region was studied by a research team from Dianoia University of Applied Science (UAS) and Turku University of Applied Science (UAS). The Balkhu settlement with approximately 1650 people in 350 households is located along the Bagmati river with an access to natural water, but the river is extremely polluted making sanitation a challenge. Furthermore, the study showed that the dwellings were at a risk of flooding and earthquakes. In addition, the settlement was illegal, so the community was under a threat of government evacuation and demolition. [12.]

1.3 Goals and Objectives

The goal of this final year project is to create a self-manageable, green and affordable construction where poor people from low income families can enjoy the quality of life, get a healthy dwelling, fulfil their basic needs, and thrive. The project also aims at finding

ways to reduce problems related to planning and execution, increasing housing ownership and creating self-sufficient sustainable planning that incorporates the community. The project focuses on lowering the cost of building and suggests various design techniques from which a user can profit when building independently.

Economical Objective

The selection of land is crucial since the economic factor plays a vital role when designing. The construction site should be suitable for the users and easily reachable, expressing financial capabilities and basic needs. The building costs should be as small as possible and energy should be saved using various energy efficient tools and techniques. [11.]

Social Objective

An incremental building project should allow the locals to interact with each other and create harmony between them. The design should be easy and understandable for the users. People from different ethnic groups should get involved in activities enhancing cultural sharing and security. The basic independent retail services, health facilities and primary accessibility should be assured. [11.]

Ecological Objective

A typological analysis and site evaluation techniques are studied in such a way that they should help to reduce the material cost and time. This should lead to an increase of job opportunities in the community and erudite people about the design quality and get themselves involved. The material used for construction should be energy efficient, and the whole process of construction should be sustainable. [11.]

2 Typology of Affordable Housing

The chapter presents various case studies focusing on different scenarios to achieve a proper, well-managed dwelling. The core principles and strategies are very important to the establishment and procurement of a project. The case studies in this chapter emphasize sustainability, affordability and a well-managed system to reduce the homelessness of people.

2.1 The Housing First- PAAVO Principle, Finland

Most of the countries in Europe face a massive problem of homelessness. Due to higher rental living cost, there is an enormous increase in homeless people. In London, nearly 9000 people sleep on streets, struggling for their daily life and searching for work. [13.] However, Finland has successfully decreased the amount of homelessness by their Housing First programme called by PAAVO. In 1987, there were almost 19,000 homeless people in the country; since then, the country has been very successful in eradicating the problem of homelessness. The programme was well managed and coordinated decreasing the amount of homeless people by 33.3 percent by 2015. [15.]

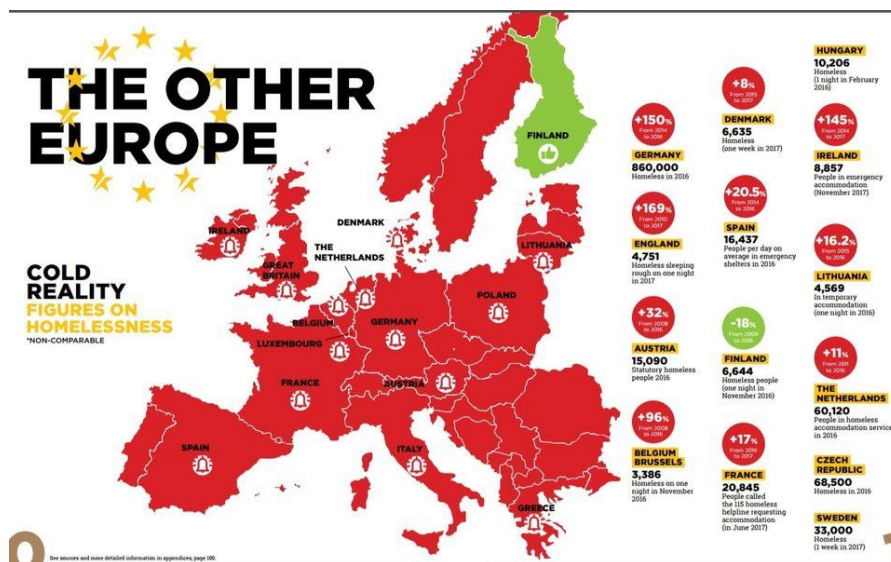


Figure 2. Homelessness in Europe [14].

Figure 2 illustrates the growing homelessness in Europe and the amount of homeless people in 2016. For instance, Germany faces a 150 % of increase in homeless people, with 860,000 people living in the streets without proper shelter. Meanwhile, within Finland the population of homeless people is decreased by 18 % in general. [14.]

The programme PAAVO which followed a principle called Housing First by the government of Finland in 2008-2011, covered ten growing cities of Finland. The execution and coordination of the programme were handed to different state administrations and housing finance companies. The target of the programme was to eliminate homelessness in a long-term manner. Both sustainable and social values were considered. The Housing First principle meant that a homeless person owns the lease of the dwelling on the basis of the act on residential leases and the self-support housing facilities. The target was to build 1,250 new dwellings, either for self-supported tenants or as service housing. The programme was funded by the state and various local authorities. In total, the programme cost 170 million of Euros and built for 1,500 long term dwellings for homeless people. [15.]

After the success of PAAVO I (2008-2011), the second PAAVO (2012-2015) was initiated with a goal of preventing homelessness in any foreseeable future. By the end of 2011, homelessness in Finland had declined by 28 percent and by 2012 the decrease was almost 40 percent. The number of dwellings reached 2,500 and the employment also escalated. The quality of shelter has improved and social rehabilitation services for them have been recovered. The Finnish achievement in the housing sector was a huge success and a lesson for other countries which morals to implement a strategy base on providing housing first eradicate homelessness. [16.]

2.2 Tarragona Social Housing

Tarragona Social housing was built on 4,706 m² on the northern side of Tarragona, Spain. The site was analysed to ensure sustainability of construction and equal distribution of dwellings. The designers, a company called Aguilera Guerrer Arquitectos intended to reach balance between the natural world and the planning policy.



Figure 3. The perspective view of Social Housing of Tarragona [17].

They hoped to offer the inhabitant a home that aimed to give security, shared spaces and privacy. There were various challenges especially because of the irregular slope compared to the horizontal plan layout. Every house was designed to have two floors with common living space and kitchen on the first floor and a sleeping area on the second floor. The housing areas were small, but the designers succeeded in giving the proper dimensions and developing social housing. The houses are of block structure with various voids and balconies that facilitate the privacy and assure proper natural lightning. [17.]

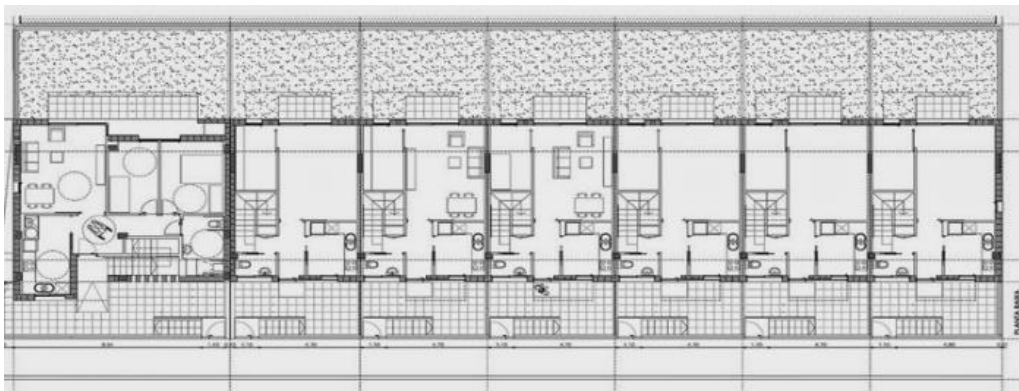


Figure 4. The layout plan of the houses of Tarragona [16].

The layout plan included a toilet and a kitchen with an attached living room on the first floor and bedrooms on the upper floor. Such planning helps both to minimize dead space and, especially, to build a house with limited area.

2.3 Monterrey Housing

The project in Elemental Monterrey in Mexico was funded by the state government of Nuevo Leon. This project designed by Alejandro Aravena of Elemental architectural studio was awarded as Brit Insurance Architectural Award in 2010. There is a total of 70 homes. The housings are an incremental complex with three stories with single houses of 40 m². The houses were built for low income households. Meanwhile, the cheapest houses cost about 30,000 dollars. [18.]



Figure 5. The incremental housing by Elemental in Monterrey [19].

The project come up with reduced initial cost of 20,000 dollars, making it clearly cheaper. Initially, the building contains a continuous floor cover and a space between each building, but the open system lets the families to upgrade and expand their dwellings. [18.]



Figure 6. The planning conceptual design and the site location of the project [19].

The floor layout of the development was made to leave an option for self-building choice since the building is porous. It gives more options for users to expand the spaces according to their needs and also with respect to the urban development. [19.] For instance, the expanding options can be a singular duplex with spaces between buildings as in figure 5. This increases privacy and security and gives freedom to expand the space.

2.4 Incremental Housing in India

The project commenced by Filipe Balestra and Sara Göransson proves that the incremental housing strategy can be implemented anywhere. Balestra and Göransson collaborated with SPARC and Mahila Milan, along with a group of other international architects, urban planners and designers to set up a project. The Indian government provided a grant of 4,500 euros per family for the growth of their homes because the prototype also needs the participation of the community as they must pay 10% of the house costs. Workshops were held with local people to explore possibilities, to ensure proper communication and to understand the real needs and demands of the people. [20.]



Figure 7: Incremented houses from three prototypes building [21.]

The first prototype allows the house owner to extend the house vertically without any structural risk. The house is two-storeyed but structured as to be three-storeyed houses.

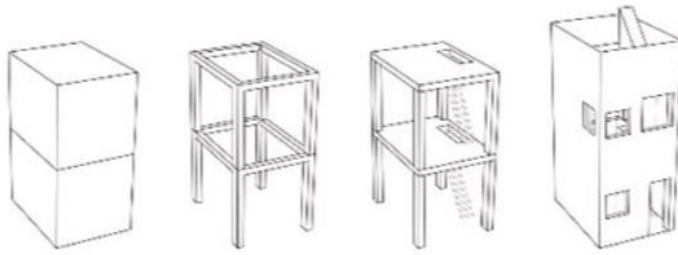


Figure 8. Prototype 1 [21].

The second prototype was designed with a space in the bottom floor allowing the owner for parking or to advance it to shop or living room.

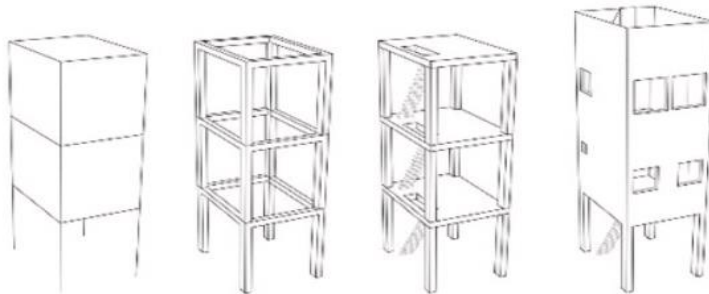


Figure 9. Prototype 2 [21].

The third prototype contains a void in between two storeys that can be used as a balcony or living space or even for basic workspace.

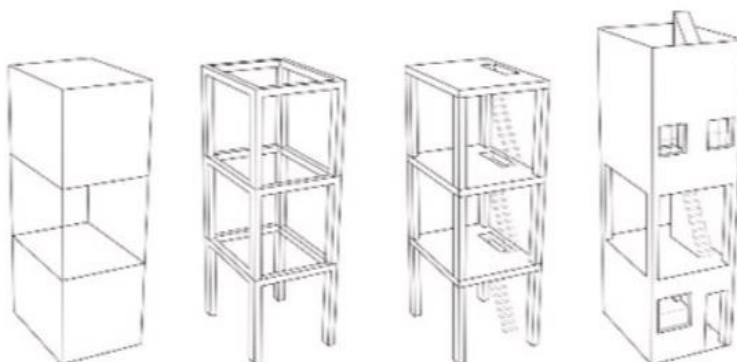


Figure 10. Prototype 3 [21].

All the prototypes were well built and established. The zoning was very flexible that helped the local people to settle fast and also helped them to carry out daily task more efficiently.

2.5 Summary

There are always much to learn from the past and improve for future as a designer and an architect. The case studies are a lesson from which a designer can point out the concrete and decisive outcome and blend them on behalf of better environment.

The table 1 below shows the comparison of different case studies and their outcomes.

Table 1. Comparison of the cases

Cases		Accomplishment
Housing First Principle	A self-serviced or lease base supported housing.	The number of homeless people down from 19,000 people to 7,000, and further to 5,000 people in last three decades.
Tarragona Social Housing	Social Affordable Housing	The building featured social bond to nature following passive house design techniques such as day-light saving, and natural ventilation.
Monterrey Housing	Incremental Housing Strategy	Allows room for expansion, resident interaction and reduction of price rate.
Incremental Housing India	Incremental Housing Strategy	Gradual development of buildings without demolition, reducing price with simple frame structure, letting users to take part in design process. Raised the living standards, leaving organized patterns in place.

Successfully planned and designed affordable housing shows that a well-planned and managed building helps to reduce costs and thus promotes sustainability. Most of the cases in this chapter used locally available materials. Hence, the cost of materials was reduced by improved design. Some major aspects tried in the cases were the reduced thinner wall concept, the use of solid concrete thick block wall and replacement of wooden frames by concrete mechanics. These provided economic benefits. Moreover, the layout of the units promotes the quality of living. Proper orientation planned with passive design techniques and construction methods is achieved in the buildings. The family structure, as well as the age and gender of the residents play a huge role as a social aspect of a building. The importance of hospitality and privacy are equally important while designing buildings. For instance, construction costs can be divided into two factors: the material cost and the labour cost. By implementations of incremental housing techniques, the local people can be involved in constructing their own home and the risk of losses can be diminished. [22.]

3 Incremental Housing in Nepal

3.1 Vision

The basic needs of human being are food, clothes and healthy shelter. There should be a chance for all human beings to prosper and fulfil their basic needs. This final year project aims at exploring the incremental housing method as a possible solution to provide affordable housing for low-income families of Nepal. Nepalese construction industry faces a major challenge. The struggle people face every day to find a proper shelter is a problem in the current situation. To overcome the current difficulty, this thesis studies looks into incremental housing as a strategy that could provide numerous benefits in providing houses for low income people. It would also help to solve the problem of homelessness.

3.2 Incremental Housing Strategy

Incremental housing concept allows for the house owner to make design decisions on their own. The housing units are flexible, and the layout of the house allows the users to expand of the liveable spaces according to their future needs. Also, the demand and affordability meet the current housing need and help the users to carry out the project whenever it sensible from their perspective. Incremental housing gives an opportunity to a low-income family to build their own place and take care of it. The problem of homelessness can be addressed positively through incremental housing. The incremental housing gives owner to choose the type of the building they prefer, making the housing services reliable and supporting the participation of users in designing process. [23.]

In incremental housing units, internal improvements, such as partition walls, floor finishing, roof joints, can be changed with no damage to the structure. This strategy has different advantage depending on aspects of further expansion of the building. Moreover, the strategy promotes the use of local resources and skills. This creates job opportunities for people and educates them by involving them in the design phase of a project. The design can be sustainable. The construction process can involve the end users and allow for the use of local materials, focusing on energy efficient materials like concrete blocks instead of burnt bricks, the use of doors and windows frames instead of wooden ones. [24.]

3.3 Study and Interpretations

The final year project site is situated in Goldhunga, 8 km from the city centre of Kathmandu, Nepal. The total built up area for the project is currently 3886.01 m² an agricultural field filled partly with temporary houses.

The average maximum temperature in Kathmandu is 27°C, the minimum 11°C. The average precipitation is of 1,343 mm with the number of wet days annually 110 days. The average sunlight hours per day are 7 hours and daylight hours 12 hours. The site analysis based on accessibility can be seen in table 2. [26.]

Table 2. Site evaluation based on accessibility [25].

Evaluation Aspects	Measures
Accessibility to Work-place	8 km away from the heart of city
Site entrance	Joined to Trisuli Highway
Transportation	Multiple access with public transportation with buses and micro-buses every 30 minutes
Education	Educational institutions for primary, intermediate and secondary level are available within 2 kilometres.

The physical evaluation aspects include slope, soil type and the natural limits in the neighbourhood. In Goldhunga, the land has slope of 17 percent. As mentioned above, the soil type is agricultural, making construction easier because there is no need for demolition and, thus, no debris and waste. There are very few natural constraints. [25.]

The infrastructural and urbanization aspects are represented by the table 3 below:

Table 3. Site Evaluation for Infrastructure and other aspects.

Evaluation Aspects	Measures
Water networks and Sewage System	Present
Electricity	Present
Urban Connection	The site far from urbanized area
Community	Employees, local residence, farmers

The site is irregular and narrow in shape making it suitable for making row houses. There is a two-lane highway to the south and another two-lane road to the north. The road in the north acts as a main entrance to the site. The neighbourhood buildings are of residential type and there are other agricultural fields nearby. The neighbourhood people are mostly farmers and include people of different income classes. [25.]

3.4 Design Development

On the master plan, a general layout plan, the buildings are grouped to face each other with access to a public communal space. The design suggested in this thesis is row house typology where buildings are attached, sharing a common wall. Row house typology with a public recreational area encourages social interaction between people through social spaces. The apartment layout is done in such a way that gives flexibility for users to change it and allows potential daylight and natural ventilation. The front face of the

houses is faced either west or east allowing the users to endorse the morning and evening sunlight. There is a total of 14 houses which, with families of 5, makes a total of 70 people living in the development. As the project expands over time, the family size grows up to a total of 9 people per house, place of sheltering more than 130 people in a foreseeable future.

After a thorough site analysis and research on different affordable housing typologies, the project has different pros such as using of land very efficiently, safe outdoors, shared communal space and possibility for rich interaction between residents. Since there is always a shared wall between the row house units, there is a disadvantage of reduced privacy. Also, the fire risk in such apartment types is extreme. [28.] However, the zoning was done according to the site activity. The two-lane road in the north acts as a major entry to the site. The shape of the plot is narrow. Therefore, the houses might not have the same distance to the road.

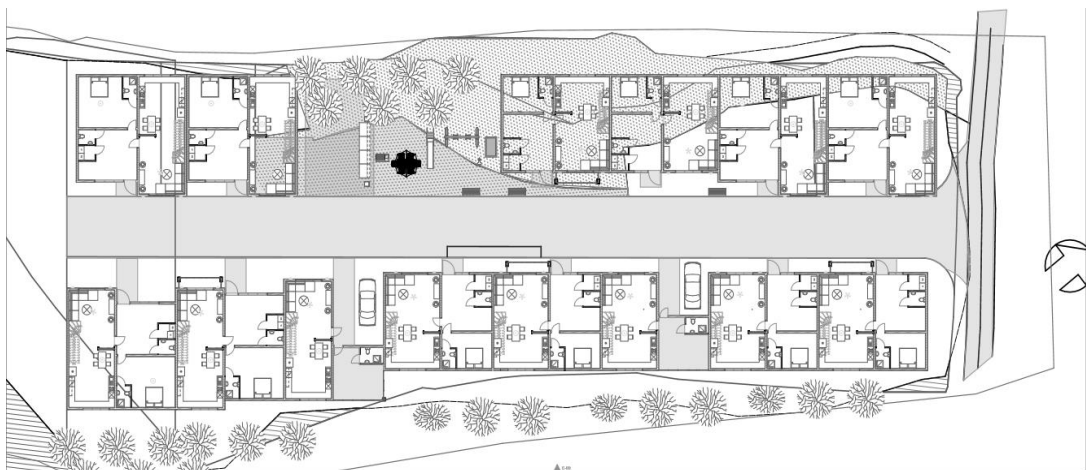


Figure 11. The general plan layout of the project site (Row housing Typology).

The existing trees are to be well preserved so that the freshness can be harnessed, and the exquisiteness of the neighbourhood can be unharmed. The government has a provision of a sewage system. So, the project will have access for a sewage line easily. Considering the noise from the highway from south, the building is positioned further away where there are enough trees and plantations reducing the noise. The site is situated among other residential buildings, which allows the community to get involved in the local ceremonies like festivals and gatherings. This will fill the void between the participation

of people and increase the interaction between different income people. There will be an equal opportunity for people that raises the level of awareness and interest social welfare in them. The 6 m wide road facilitates people by improving traffic flow and promotes safety issues with separate walking lanes.

3.4.1 Design Criteria

The built-up area plays important role on planning the number of dwellings. The process of reducing the amount of built area is possible and allowed only if it follows the building regulation and standards. Increasing the number of dwellings certainly reduces the cost per unit. In the project suggested in this thesis, there are two proposals with two types of building layout and design. Since the area is a crucial factor for building, it is important to follow the same pattern for each building. Here, there are two types of buildings, (figure12) with different design on the basis of the orientation and position accordingly to the site constraints. [28.]



Figure 12. Type 1 and Type 2 homes.

The first stage of the incremental concept created in the thesis is to design a basic floor plan. Figure 9 is a representation of the floor plan of the Type 1 building with a basic area of 54,8 m² on the ground floor and 58,2 m² on the first floor. The primitive design has a kitchen and a living room on the ground floor, an L-shaped staircase leading to the first floor. The first floor has a master bedroom with a big window giving the whole view of the street and neighbourhood. There are two more small rooms with single beds. The toilet with an attached shower is situated on the first floor. The building has very little dead space. In the beginning, the building design is suitable for a family of four. As the

family grows and when there is need of more space, the building is designed in a such a way that the family can expand the living space safely and successfully according to the standard building design codes.

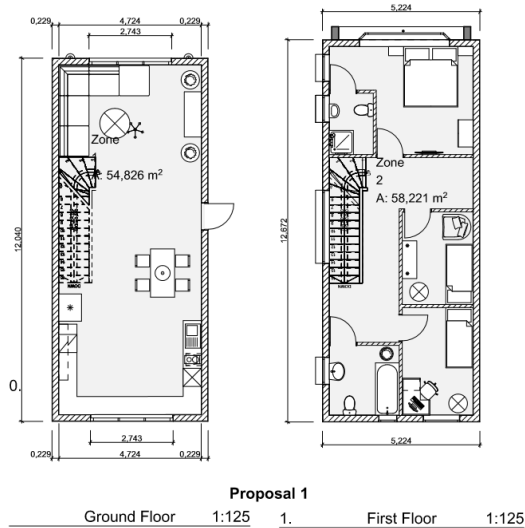


Figure 13. Initial floor plan for the design of the house type 1.

In the beginning, the building design is suitable for a family of four. As the family grows and when there is need of more space, the building is designed in a such a way that the family can expand the living space safely and successfully according to the standard building design codes.

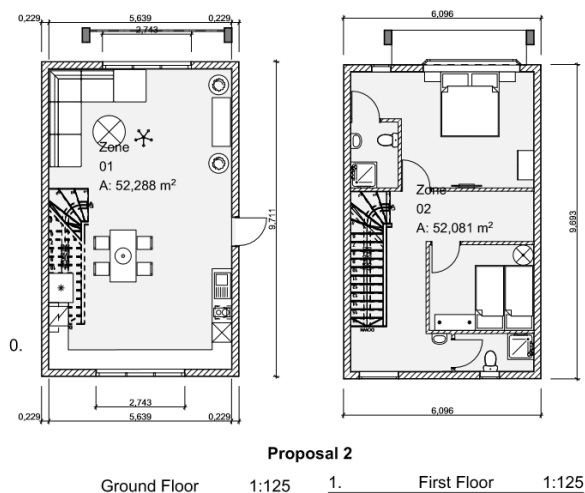


Figure 14. Initial floor plan for the design of the house type 2

Compared to Type 1, the Type 2 building has only a minor change, in dimension. The building follows a similar layout with the kitchen and living room on the first floor, the bedrooms and a toilet on the second floor. The type 2 building is wider but has smaller area. The Type 2 building is also designed for a family of four with a total of 104 m².

3.4.2 Conceptual Design Progress

The housing plan consists seven houses of both types, a total of 14 providing homes for fourteen families. There are three types of architectural outlooks, allowing the users to choose the design based on the resource's availability and usability. The prototypes are for a family of four to five. The conceptual design phases show how the family demand develops and the expansion of the housing units as per the need of the house users.

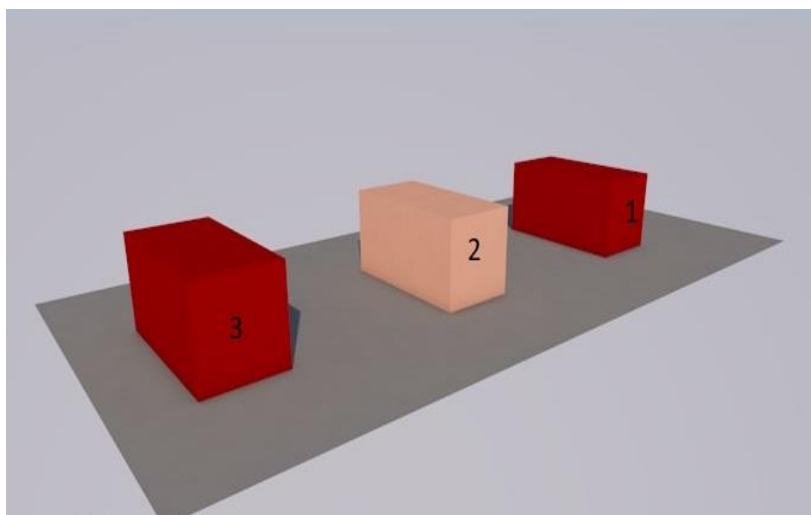


Figure 15. Primitive Design for both Type 1 and 2 buildings.

The initial designs are regular free-standing houses placed in a row with a space between. The space is allocated for the future expansion of the building. Until the time being, the user can use the space for the other purpose, like as a garden or for other use like for drying clothes or vegetable farming.

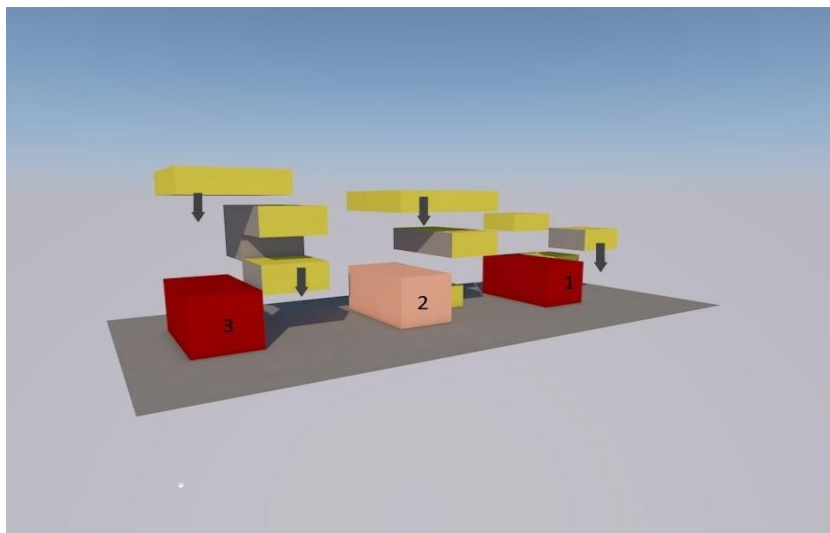


Figure 16. Expansion Phase.

The expansion phase is a decision made by the users according to their needs, family size and purposes. For instance, the expansion phase gives freedom to the users to modify the architectural outlook of building where they can decide whether they want a parking space on the ground floor or a housing unit.

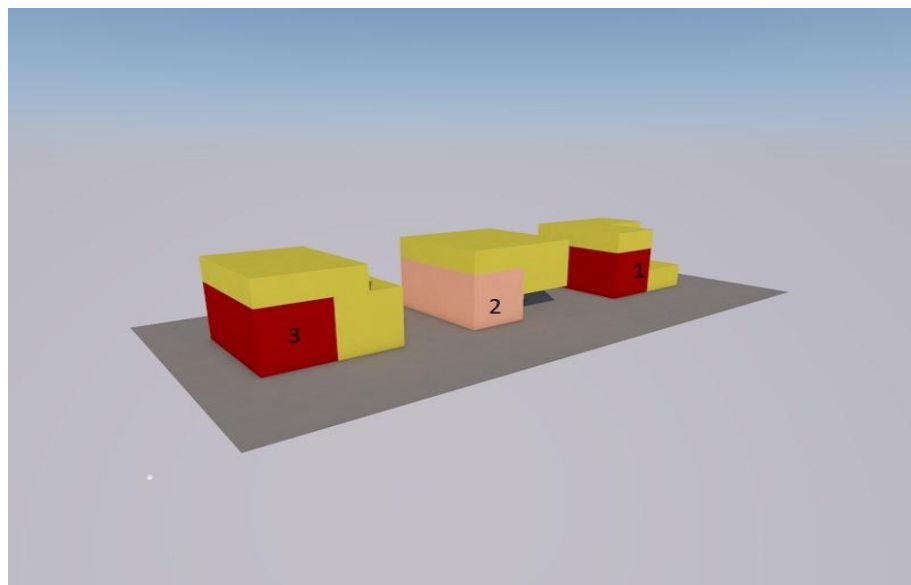


Figure 17: Final Phase

Structurally, the building is allowed three storeys. The users can decide to finalize their home according to their income, needs and goals. The finished houses were designed with basic three architectural design prototypes. Each has different appearances and characteristics.

3.4.3 Architectural design prototypes

There are three different prototypes that a user can choose. The prototypes have different facilities, layout, design, appearance and features. For instance, the first prototype has a balcony where the user can find themselves open to the local environment, whereas the second prototype does not have any open space on the first floor, allowing for more enclosed space for living. The third prototype has an open ground floor for uses like parking or gardening.

The first prototype allows the user to have a balcony on the second floor. It gives opportunity for people to socialize, gives a good impression of space and independence. The balconies are versatile. They can be used to grow plants or for dining and entertainment, offering more privacy.



Figure 18. Prototype 1.

The second prototype has a void on the ground floor allowing the user to have their own parking space, or also to an outdoor garden and an outdoor terrace. This building type is for people who at some time can afford a car and allows them to have own parking zone in their own house. They can also divide the void to outer balcony or garden where they can make outdoor dining, recreational activities and so on.



Figure 19. Prototype 2.

The third prototype is a simple house with no outdoor spaces. The house is mostly targeted for larger families. There are more bedrooms and inner living space. In addition, there is a terrace on the third floor allowing the users to get sunlight and use open space for basic use.



Figure 20. Prototype 3.

The idea of various prototypes is to facilitate people and provide comfort regarding their basic requirement. The sustainable factors are implemented increasing the quality air movement, reduced energy demand and environmental comfort.

3.5 Cluster Plan

Row housing helps to reduce the construction budget, has a construction time and an efficient layout. This typology allows construction in a very large scale in very little time compared to other housing options. [28.] The plan follows the city skyline around the built environment since the other buildings nearby are not more than four storeys high. The plan grants enough empty space before the family expansion and allows the user to luxuriate empty unused space. Every family wants to socialize and get out; therefore, the planning is focused on maintaining an open communal space with a shared seating area and a children's park. There are different kinds of recreational outdoor activities available such as a common barbeque place, playground for kids and a community garden.



Figure 21. Communal Space.

The families always tend to reduce their household costs. For this reason, the open space in the primitive stage can be helpful as people can use it as a garden to grow various vegetables and save their expenses. This way people can also socialize and share their common interests.

3.6 Reliability and Cost

The process of construction is vital because even small details play a key role to avoid costs and prevent the risk of accidents. The list of details regarding construction materials, quantity, prices, and mapping suggest the process time and durability of construction. The normal construction cost for a finished house is up to approximately 80,000 euros. The average cost per m² is around 400 euros per buildings. [29.] Thus, the types of building discussed in this thesis would amount to:

- Type 1 with 113 m², the approximate cost will be around 39,000 euros.
- Type 2 with 104 m², the approximate cost will be around 36,000 euros.

The costs for a low-income family is still, however, high. Therefore, there can be different incentives from the government involving a provision of lease base agreement or a grant of a certain amount that aids in the expenses of housing. Also, financing companies, including the private sector, should run alongside the government for a successful completion of the approach.

The government can, for instance, plan serviced housing that includes the full funding of the project where the land is still governmental property. Meanwhile, partly funding a project is also a probable tactic, with a self-supporting housing agreement where the government implements a very low interest rate after 10 years of use. Nowadays, the financial companies in Nepal are emerging vigorously. The financing companies can also work with the rest of the private sector to lend with a very low interest rate and help people in need.

4 Sustainability

The global need demands a building that is sustainable and promotes durability. It is about bringing change in neighbourhood area, making an impact in the daily life and ensuring quality of life. The energy use, material selection, efficiency, accessibility, water preservation and so on are some of the factors that should be taken into account. Similarly, this project promotes ecological design, follows passive house design techniques and certainly helps to reduce unemployment locally. There are different factors that affect sustainability. For instance, a strong effort for ensuring the participation of people will benefit maintaining the social sustainability. Likewise, financial viability allows the user to achieve stability and sense of balance in their economic status. Making the communal space and plantation of trees around, leaving greenery surpluses to prevent negative environmental effects along with environmentally friendly materials in construction diminish the impact of the dwellings on the environment. Moreover, the promotion of sustainable living with integrated systems of rainwater harvesting, use of natural energy, and energy efficient products in the houses will contribute to sustainability.

4.1 Material Selection and Landscaping

All the material used for the construction of the housing development proposed in this thesis are going to be produced and made available locally for example stairs from local marble, internal flooring from locally made tiles and ceramics for kitchens and bathrooms. The landscaping is focused on the plantation of various gardening plants and deciduous trees. The deciduous trees allow to pass sunlight in the winter and prevent excessive sunlight in the summer. Evergreen trees can be planted alongside the common road to maintain freshness and increase the greenery of the area. In addition, the type of construction of the building structure varies according to the price rate. For instance, modular houses are cheap compared to houses built on site. The time of construction is shorter, and the expenses of building construction smaller.

4.2 Water Conservation

The water conserving techniques like grey-water recycling, rainwater harvesting, and rational use of groundwater are imposed in the project planning. Each building will have a storage water tank in the basement where they can harvest rainwater directly. Also, the grey water from sinks is lead to the toilet so that every flushing uses grey water. Furthermore, grey water can be used for watering the gardens as well. This reduces water consumption significantly and helps to reduce costs.



Figure 22. Wastewater Treatment.

4.3 Passive House Techniques and Green Energy

The project suggested in this thesis includes some techniques that increase the comfort of living and helps in achieving low energy demand. The structural orientation and external shading help the building to get the right amount of sunlight and prevent overheating. The buildings are box-like rowhouses which shades itself. For instance, the elevation and projection of the balcony helps to reduce the excessive sunlight during the daytime. A building form with open space like balconies and terraces assists cooling and articulation of sound. Big windows facilitate the sunlight into open space increasing the natural illumination. Constant airflow in the built-up area allows the natural ventilation.



Figure 24. White model render showing passive design techniques like shading, projections, big windows

Techniques that can reduce the energy demand and promote sustainability are solar photovoltaic systems, geothermal power, cavity walls and natural mixed mode ventilation, discussed below.

Solar Photovoltaic System

The average annual sunlight in Nepal is seven hours. [26.] This suggests that the solar PV cells can cover roughly 50% of the total electricity supply in a year. There will be overproduction of energy from the panels which can be also used for domestic hot water supply. When the building is south oriented, it catches the sunlight from morning to evening. Therefore, a photovoltaic system is very useful for collecting green energy.

Geothermal Power

Since the total built area of the project suggested in the thesis is about 3,880 m², there is a potential for geothermal power production. The Nepalese government can initiate a plan of providing electricity from geothermal energy to the 4 houses and their neighbourhood. This will help to reduce energy costs, promoting green and sustainable living.

Cavity Walls

A cavity wall is a technique that can be introduced in this project as cavity walls have much lower U values compared to regular walls, and they assist in maintaining the temperature inside the house. A cavity wall consists of two separate layers, separated by a hollow space. The thermal resistance of brick is very high compared to that of air. Therefore, the use of cavity walls helps to reduce the U and the thermal conductivity of a wall, resulting in the prevention of energy loss through envelopes. [30.]

Natural Mixed mode Ventilation

Natural ventilation from windows helps to maintain a flow of fresh air in a building and helps to cool the space. Apart from natural ventilation, a mixed mode ventilation system can be used. The mixed mode system combines natural air from windows and mechanical ventilation allowing placid distribution. This type of ventilation helps to save energy and allows comfort in a house in a way that the user can operate the ventilation system as needed with the natural ventilation still working. [31.]

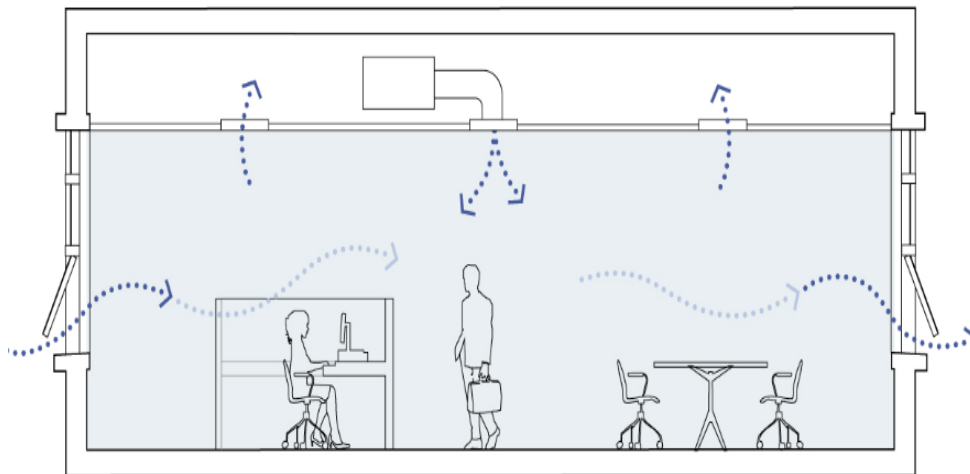


Figure 23. Concurrent mixed – mode operation [31].

As in figure 23, the natural air flows through the windows and the intake and exhaust pipes operate when necessary to maintain the stability of temperature, and quality of air.

5 Conclusion

The case studies about and a case approach to incremental housing suggest that for housing to succeed there should be various model propositions and approaches regarding affordability. The coherent intellect of incremental housing is a key to affordability. The financing schemes, design procedures, sustainability and social establishment are some of the propositions for and passageways to for incremental housing. The population is increasing rapidly. This has resulted in serious homelessness in people and decreased the quality of life. There are different possibilities for incremental housing to prove that the strategy is one of the ways that helps to eradicate homelessness because of affordability. The houses discussed in the thesis are sustainably built with various design techniques and energy saving plans that surely help to attain quality of living and stability.

From different case studies it can be concluded that incremental housing helps to promote sustainability and helps to reduce the total cost of construction. The total lifetime period is long and various factors, including social, economic and ecological aspects can help affordability and positively change the quality of living. In the design case project, various approaches were proposed to make a community social and sustainable. For instance, shared communal space, rainwater harvesting, solar PV cells, geothermal heat extraction, and proper material selection are some of the most influencing factors. However, the housing cost was still high for the people with low income. But with the help of sustainable approaches for energy saving, minimalism in expenses and governmental financial plans, the project could be a boon for people living under severe conditions. With the help from different administrations including the government or NGOs or the financial private sector giving financial support, the project could become successful. Incremental housing strategies can possibly support the current construction sector to provide affordable housing without compromising the business strategies. Thus, low-income families can find themselves in a healthy living environment and be enriched with substantiality and prosperity as well as the construction organizations with a new business model and perspectives.

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