ABSTRACT

Title of Thesis:	RETHINKING RESIDENCE: HOW TO MASS PRODUCE DIVERISTY?
	Mansoor Ahmed, Master of Architecture, 2020
Thesis Directed By:	Peter Noonan, Professor of the Practice, School of Architecture Planning and Preservation

Due to shortage of housing, Pakistan has launched a project to build five million new dwellings within the next 5 years, through public-private partnerships. Currently, in Pakistan, only 0.3 million units are built in one year and this project would increase that number drastically, greatly impacting the environment and the built fabric.

This thesis looks at an alternative to the simple idea of repeating one house to make many. It is a vision to reimagine Pakistani cities through this expansive development: mass produce dwellings that are responsive to environmental and contextual conditions, minimize the impact on existing infrastructure, energy consumption, and the environment. The proposal is an optimized system of construction that has the ability to mass produce customizable and personalized units. The aim of this thesis is to showcase a balance between mass production and personalization.

RETHINKING RESIDENCE: HOW TO MASS PRODUCE DIVERISTY?

by

Mansoor Ahmed

Thesis submitted to the Faculty of the Graduate School of the
University of Maryland, College Park, in partial fulfillment
of the requirements for the degree of
[Master of Architecture]
[2020]

Advisory Committee:
Peter Noonan, Professor of the Practice, Chair
[Karl Du Puy, Professor Emeritus]
[Matthew Bell, Professor]
[Joseph Williams, Assistant Professor]

Dedication

I would like to dedicate this thesis to my remarkable family that has been a constant source of support and inspiration for me. To my sister, Rabia Ahmed, who has been a mentor and paved the way for me to study architecture and pursue a master's degree; to my brother, Haroon Ahmed, who has supported me throughout my educational and professional career; and to my parents, Farhat Mukhtar and Mukhtar Ahmed, who have spent their lives guiding, nurturing and encouraging me to the best I can be. Thank you for all the love and support.

Acknowledgements

I would like to thank Professor Peter Noonan, my thesis chair, and Professor Karl DuPuy, for their valuable insights and guidance throughout the process. I also appreciate the faculty and students with whom I have had the privilege of interacting with during my time at the University of Maryland. Collectively, they have given me the skills and knowledge to be able to complete this thesis.

Moreover, I would like to express my gratitude to the Fulbright Scholarship Program that has given me the opportunity to take part in the graduate degree program in USA.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

Naya Pakistan Housing Scheme

The government of Pakistan is planning to build 5 Million new housing units through a public-private partnership. The partnership will be such that the pieces of land shall be provided by the government and developers will construct on them. They will be awarded these land holdings if they agree to develop it as per the guidelines provided by the government and maintain a cap of a predetermined affordable selling price.

The project will develop housing in areas all over Pakistan, starting from major cities, Lahore, Karachi, Peshawar and Quetta, where there is a greater shortage of housing and existing infrastructure to support new developments.

Introduction

We can only imagine the impact this radical growth of housing construction would have on the environment, people and cities. Furthermore, this brings to question whether it would even be possible to achieve this growth through the employment of the conventional means of building. Therefore, this project presents an urgent need to reimagine housing. In the context of Pakistan, housing is the most widely built building type and has the biggest contribution to the built fabric.

In what follows, we will start from the scale of a room to a living unit to a building and then test out the idea on a site at a neighborhood scale.

Looking at a new way of constructing and thinking about residential buildings whilst investigating the question of mass producing diversity.

Region Selection for Prototype

For this thesis, the city of Lahore has been selected as the region for the implementation of a prototype development. The reason for this selection is the substantial need for housing in the city, due to population growth and urban migration. Along with this, Lahore has the political, financial and physical infrastructure to support the process of development and serve as a prototype for other cities to follow.

Chapter 2: House

Before we begin to critique and re-invent housing units, we must indulge in the study of housing and the concept of a house.

What is a house?

The first step in discovering a way to design accommodations for people that they may call home, is understanding what it takes for a space to become a house. At its core, it may be argued, that the house is synonymous to shelter; that the earliest houses were a result of man seeking refuge from the hardships of the environment. However, the meaning of a *house* in society, culture and the lives of its inhabitants has proven to be so much more than just that.

Pallasmaa defines home as, "an expression of personality of family and their very unique patterns of life. Consequently, the essence of home is closer to life itself than to artifact" [1]

In the poetics of space, Bachelard says "House we're born in is considered our first universe." [2]Memories engrained from first home continue with us throughout lives- new homes create variations of those primary memories/functions performed. [3]

Another way to look at it would be that the house is firstly a geometric object. However, when the human "plane" is inserted in this geometry, the

[1] Juhani Pallasmaa, "*Identity, Intimacy and Domicile; Notes on the Phenomenology of Home.*" (1994) 3.
[2] Gaston Bachelard and John R Stilgoe, *The Poetics of Space* (Boston, Massachusetts: Beacon Press, 1994) 15.
[3] Ibid. 16.

house becomes a space for intimacy and cheer, without losing its "objectivity"

"*A house that has been experienced is not an inert box. Inhabited space transcends geometrical space*."- Bachelard [4]

Therefore, based on this understanding of the concept of a house, it can be argued that architects cannot design the home itself, but rather a space that allows for the feeling of being at home to emerge.

In light of this understanding of home, the mechanizing of the production of houses potentially leads to the loss of all attributes that make a building a home.

"*If we eliminate from our hearts and minds all dead concepts in regard to the house...we shall arrive at the 'House-Machine,' the mass-production house, healthy (and morally so too) and beautiful in the same way that the working tools and instruments that accompany our existence are beautiful."*-Le Corbusier[5]

The challenge of this thesis is to investigate a type of "house-machine" that is able to evolve into a home/dwelling.

History of Housing in Lahore

The houses of old Lahore were similar to the houses built in the region of Punjab, They were referred to as "Indian houses." The design of these "original" Indian houses was simply based on three activities within the house: Sleeping, Cooking/ Eating and Excretion. The rest of the activities,

[4] Gaston Bachelard and John R Stilgoe, *The Poetics of Space* (Boston, Massachusetts: Beacon Press, 1994) 17

[5] Le Corbusier, *vers une Architecture*. 1923. Quoted in K. Frampton, Modern Architecture (London 1992) p. 153

according to the lifestyle of the time were considered communal activities and hence spaces for them were part of the public domain rather than the interior of the house.

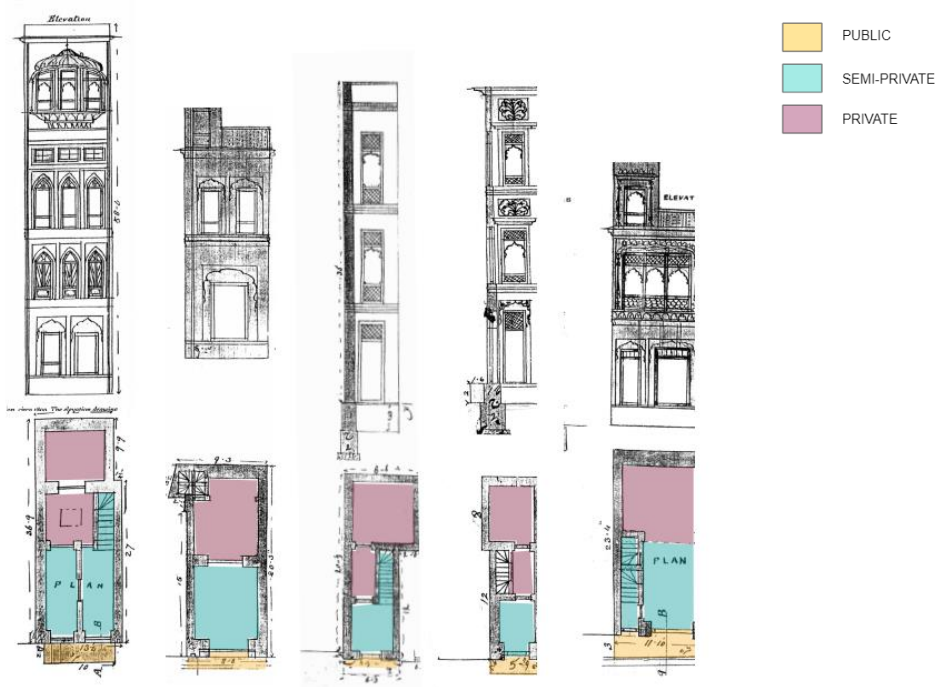


Figure 1 *(Traditional Indian house. Image Source: Glover & author)*

The house then was considered merely a shelter for basic needs. The houses were designed compacted with each other and often neighbors shared their walls. The furniture within the houses was of smaller sizes and therefore the spaces were planned to be smaller than what is known ro be the norm in contemporary times.

Figure 2 *(Transformation of spaces, centered around courtyard. Image Source: Glover & author)*

Later, as the radio came into being and the lifestyle of people changed to become more internalized and the verandah emerged within the dense built environment. Another reason for this was the increase in the average lot size. The open space within the house served as a family communal space and also as the source of light and ventilation for the rooms. Two separate sitting spaces emerged; one for the ladies, one for the men. Privacy remained one of the prime concerns and the bedrooms were placed as far away from the street as possible. Small passages were used as entrance and one squeezed through into an open courtyard (Observable in yellow in the diagram above). The hierarchy of spaces was designed according to their need for privacy.

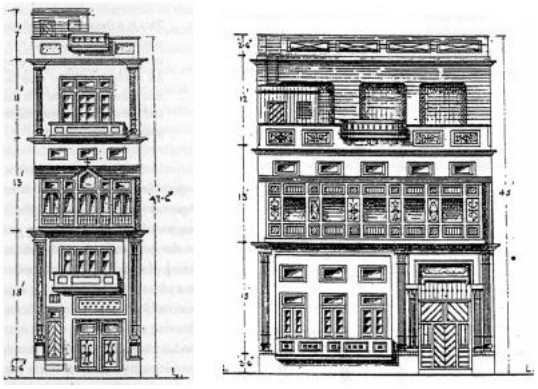


Figure 3 *(Shops on the ground. Image Source: Glover & author)*

Economics were also part of the houses in Lahore. As houses were planned facing streets, the ground floor of the houses were often used as shops. The houses were led up by a narrow staircase that opened into a family sitting space. The sitting space (Highlighted in yellow bellow) faced the street. The concept of the "bhaitak" emerged as a place to sit and interact.

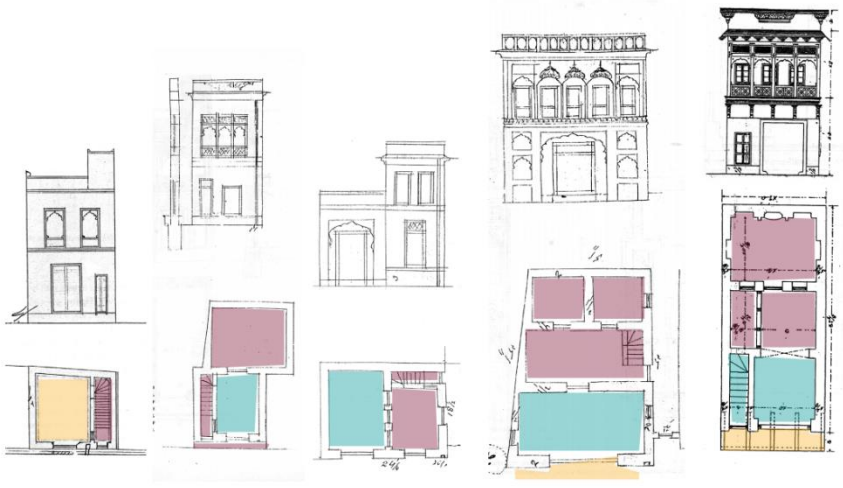


Figure 4 *(The emergence of the "Bhaitak". Image Source: Glover & author)*

Figure 5 *(Typical Colonial Home in Lahore. Image Source: Glover & author)*

When the British arrived in the region they brought with them a new lifestyle. The two large areas that were developed by the British in Lahore were the *Cantonment* and the *Model Town*. The planning of houses reflected the lifestyles of the British. Large drawing rooms and dining rooms came into existence. The bedroom came out from the most private place and was placed nearer to the entrance of the house, closer to the front lawn. Office and reading spaces emerged. Specific spaces for specific activities were built. The idea of shared spaces disappeared. The British brought to Lahore the Bungalow. The availability of the Television also played a major role in making the communal activities, that were once considered to be done outdoors to now become part of the indoors.

Figure 6 *(Colonial home in Lahore: Image Source: Glover & author)*

Housing has evolved greatly in time and has also adapted into multiple variation to accommodate the needs of diverse social and economic groups. Houses in Lahore, hosting more than one, family have a high lot occupancy and less green space. The units are stacked on top. The roof compensates for the deficiency of outdoor space. Public private spaces are clearly distinguishable in the planning, and thresholds begin to define the space within the unit.

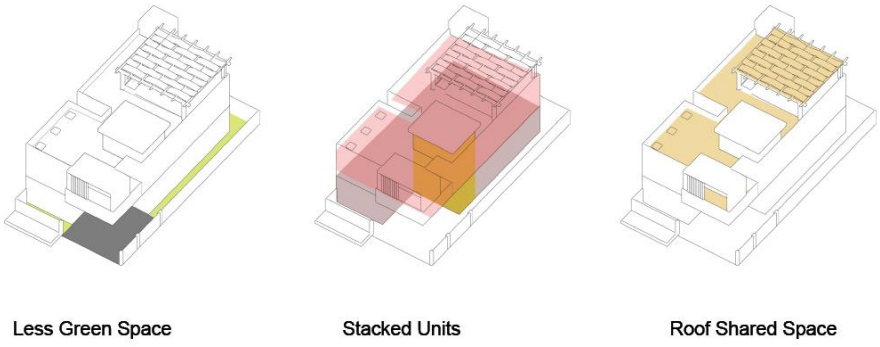


Figure 7 *(Contemporary residential building in Lahore)*

Figure 8 *(Contemporary House in Lahore Image Source: Surblund consultants, Lahore and Author)*

Japanese Home v.s. Western homes

On the contrary to the model brought forward by the British, the Japanese home is designed in a manner where the void is designed to flow through the dwelling and activities are placed inside the void; instead of clearly defined volumes. Activities flow through the space, along with light, ventilation and views enriching the space. As a result of this, the overall unit becomes space efficient.

The small Japanese homes are centered on the idea of shared spaces: multiple functions become shared in one space i.e. functions that do not occur simultaneously have spaces that overlap. This reduces the requirement for area and land. The Japanese philosophy of Zen preaches love and respect for nature and that can be observed profoundly in the design of these tiny dwellings.

Differences between Western and Japanese homes:

Figure 9 *(Relationship of public to private space: Image Source: Shelton)*

Relationship of public to private space:

The solid walls of the western homes create a fine distinction between the outside and the inside. However, the Japanese home is enclosed in screens that creates a boundary that is much more permeable and translucent.[6]

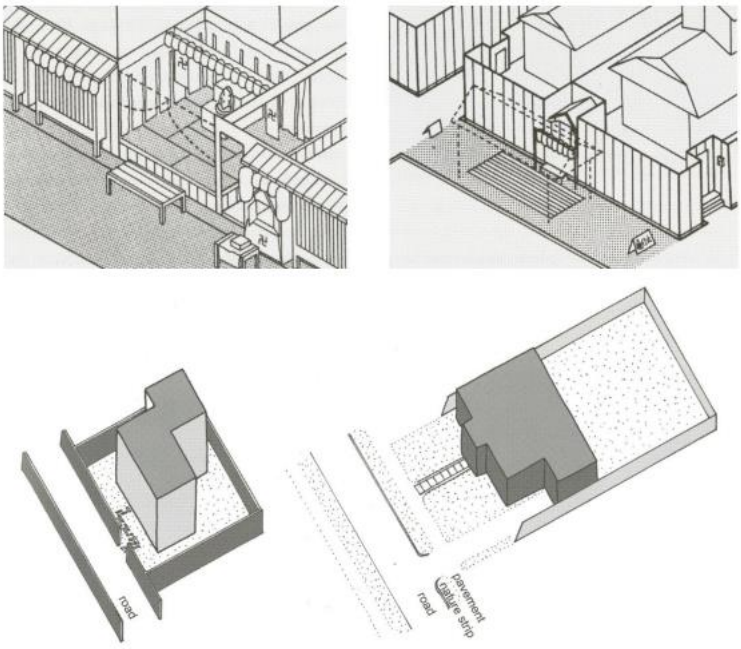


Figure 10 (Relationship of building to the street. Image Source: Shelton)

Relationship of buildings to street:

The lack of boundary walls allows for connection from the private to the public. The relationship of the building to the street is permeable. However, level and texture changes create a distinction between both these realms. [7]

[6] Barrie Shelton, *Learning from the Japanese City : West Meets East in Urban Design*. (London: E & FN Spon, 1999) 25
[7] Ibid. 27

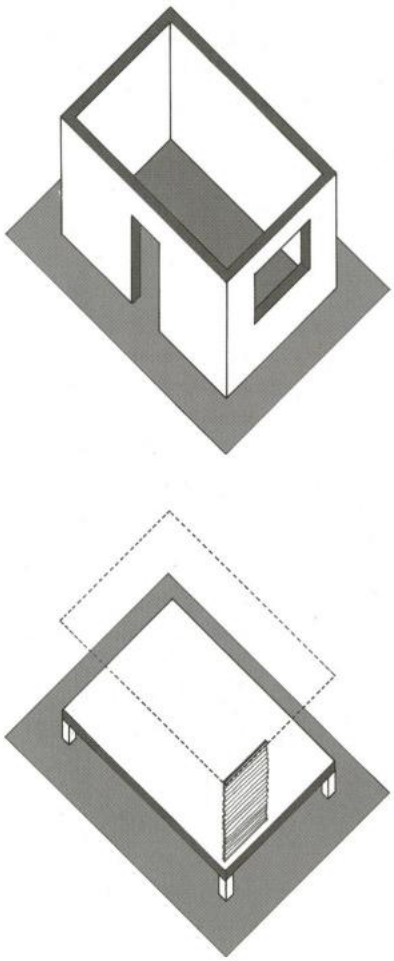


Figure 11 *(Definition of Enclosure. Image Source: Shelton)*

Defining elements of enclosure:

The floor in the Japanese space versus the wall in the western space. Both these elements are used to define being “inside”. In Japanese homes the floor is the most solid element, the roof floats on top and screen or blinds are suspended to create a barrier between the outside and the inside. [8]

[8] Barrie Shelton, *Learning from the Japanese City : West Meets East in Urban Design*. (London: E & FN Spon, 1999) 26.

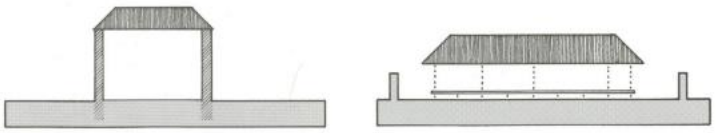


Figure 12 *(Definition of Enclosure. Image Source: Shelton)*

Chapter 3: Prefabrication

What is Prefabrication?

Prefabrication refers to the processing of raw materials into a useable product before being used for its final purpose. The idea of processed raw materials allowing for ease of construction has been present since a long time. [9]

A.M. Watkins, in his book, mentioned a house as early as 1670 to have used prefabricated construction components. As well as in 1849 when pre-fabricated homes were being shipped from California form New York. [10] This confirms that prefabrication in construction is not a completely new idea, but rather an age old phenomenon.

As defined by the Cambridge dictionary, being prefabricated means being built from parts that have been made in a factory beforehand and can be put together quickly. [11] In this sense, it may be argued that buildings have been prefabricated since quite some time. Windows, doors, hardware, fixtures, many of components that are used in the building construction process are manufactured beforehand in a factory. This mass production of components is done to increase the quality, reduce cost and save time [12] During conventional construction, the time and cost are in direct relation to the quality and scale of the project. Prefabrication has the ability to offer greater quality with lesser cost. Kieran and Timberlake uses the

[9] LaRusso, Adam Nicholas, "Disaster Relief: A System for Recovery" Master of Architecture Thesis, University of Maryland (College Park, Md.), 2011, (2012-02-17T07:16:48Z). 11
[10] A.M. Watkins, *The Complete Guide to Factory-Made Houses* (Chicago: Longman Financial Services Publishing, Inc., 1988) 9.
[11] "*Prefabricated: Definition in the Cambridge English Dictionary*." Accessed May 15, 2020. https://dictionary.cambridge.org/us/dictionary/english/prefabricated.
[12] Stephen Kieran, and James Timberlake. *Refabricating Architecture : How Manufacturing Methodologies Are Poised to Transform Building Construction*. (New York: McGraw-Hill, 2004) 9.

mathematical relationship Quality x Scope > Cost x Time to describe this idea. [13] Kaufmann claims that manufacturing in the factory is faster than conventional on-site construction. [14]

Prefabrication and factory-based production is being used in other industries extensively. The automobile industry was transformed by Henry Ford when he designed an assembly line where specialized and specific stations performed the same tasks repeatedly on each of the cars as it moved along. This created efficiency and resulted in a better-quality product that cost less. As cars became more complex, the fabrication methods have also evolved. Instead of the liner assembly line, production is now done parallel to one another. [15] Different suppliers and manufactures work on various components separately and simultaneously before they are all brought together and assembled. The ship and airplane manufacturing industries make use of prefabrication extensively as well. The ship is prefabricated in large modules known as the grand blocks which are brought to the dry dock ready to be assembled into the ship. [16] The airplane manufacturing process follows a similar formula; small components are assembled into larger modules, that are later brought to the assembling plant to be put together to make the airplane.[17]

---

[13] Ibid. 10.
[14] Michelle Kaufmann, and Catherine Remick. *Prefab Green. 1st ed* (Layton, UT: Gibbs Smith, 2009) 70.
[15] LaRusso, Adam Nicholas, "*Disaster Relief: A System for Recovery*" Master of Architecture Thesis, University of Maryland (College Park, Md.), 2011, (2012-02-17T07:16:48Z). 4
[16] Ibid. 5
[17] Stephen Kieran, and James Timberlake. *Refabricating Architecture: How Manufacturing Methodologies Are Poised to Transform Building Construction*. (New York: McGraw-Hill, 2004) 79.

Types of Prefabrication

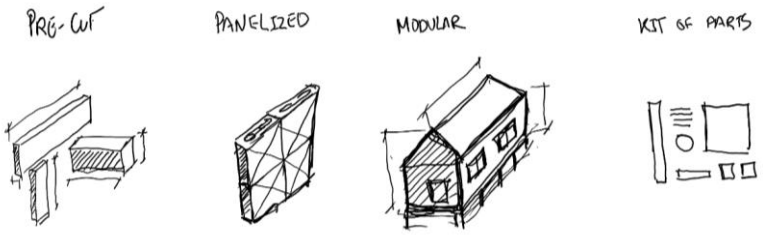


Figure 13 *(Types of Prefabrication)*

Prefabrication can be of varying degrees and in various methods. Adam LaRusso, in his thesis, groups the different types as Precut. Panelized, Modular and Kit of Parts. [18]

Precut

The components that make up the building are pre-cut to their required sizes to save cost and time. This method usually requires the largest on-site construction time in comparison to other prefabrication methods. An example of this is a typical wood frame house where the timber members are previously sized and cut elsewhere. [19]

Panelized

This method is not so different from precut. However, the components instead of only being sized appropriately are integrated into larger sections [20] (panels) that can be used in the construction process. The size of the panel is important as these panels become the building blocks of the

[18] LaRusso, Adam Nicholas, "*Disaster Relief: A System for Recovery*" Master of Architecture Thesis, University of Maryland (College Park, Md.), 2011, (2012-02-17T07:16:48Z). 15-20
[19] A.M. Watkins. *The Complete Guide to Factory-Made Houses* (Chicago: Longman Financial Services Publishing, Inc., 1988), 51.
[20] LaRusso, Adam Nicholas, "*Disaster Relief: A System for Recovery*" Master of Architecture Thesis, University of Maryland (College Park, Md.), 2011, (2012-02-17T07:16:48Z). 16

building and in turn guide the sizing of the structure. A closed panel is one that has wiring and insulation within it, further reducing the need for on-site work.[21]

Modular

These are built in factories as a complete module that can be transported to site to be placed in relation to other modules. This reduces the need for on-site work to the highest degree. These modules are built in factories that ensure top quality controls and ideal conditions for construction, as compared to being built on site. However, due to their large size, they need heavy equipment to be transported and placed on site. [22]

The sizes of these modules are often limited by the means of transportation and the capacity to be able to move them around on site.

Kit of Parts (Precut or Panelized):

This method allows for prefabrication, along with customization. A kit of parts that has been manufactured in the factory can be configured in different ways to produce different iterations. Potentially the kit of parts is designed to allow for multiple variations of spatial planning or material options. [23] A contemporary example of this is Ikea.[24]

[21] A.M. Watkins. *The Complete Guide to Factory-Made Houses* (Chicago: Longman Financial Services Publishing, Inc., 1988) 48.
[22] LaRusso, Adam Nicholas, "*Disaster Relief: A System for Recovery*" Master of Architecture Thesis, University of Maryland (College Park, Md.), 2011, (2012-02-17T07:16:48Z). 17
[23] Joanna Wissinger, and Philip Lief Group. *The Best Kit Homes : Save Time and Money on Your Customized Dream House.* (Emmaus, Pa.: Rodale Press, 1987) 10.
[24] Ibid. 7.

Prefabrication Through Time

Many famous architects in the past have found interest in modular housing. Le Corbusier advocated the idea of "machine for living" [25]and anticipated that in the future, buildings would come much closer to machines (like cars and airplanes). In theory, buildings could be built in a matter of days as compared to conventional long durations of construction.[26] Le Corbusier's philosophy saw houses as "tools" that help existence as compared to an act of dwelling.[27] His conception of the Citrohan House and the Domino House reflect these ideas. [28]

Walter Gropius said that "we want an architecture adapted to our world of machines," [29]showing his inclination towards prefabrication. He was keen on exploring the potential to use mass, factory production of housing to reduce the number of hours workers spent on construction sites.

[25] LaRusso, Adam Nicholas, *"Disaster Relief: A System for Recovery*" Master of Architecture Thesis, University of Maryland (College Park, Md.), 2011, (2012-02-17T07:16:48Z). 23
[26] Ibid. 23
[27] Le Corbusier, *Towards a New Architecture* (New York: Praeger, 1970). 211
[28] LaRusso, Adam Nicholas, "*Disaster Relief: A System for Recovery*" Master of Architecture Thesis, University of Maryland (College Park, Md.), 2011, (2012-02-17T07:16:48Z). 32
[29] Ibid. 23

Figure 14 *(Toerten houses. Image source: https://www.bauhaus-dessau.de)*

Gropuis built his Toerten houses by implementing the idea of an assembly line. His enthusiasm for prefabrication was exhibited later through the deign of the Copper Houses in 1931.

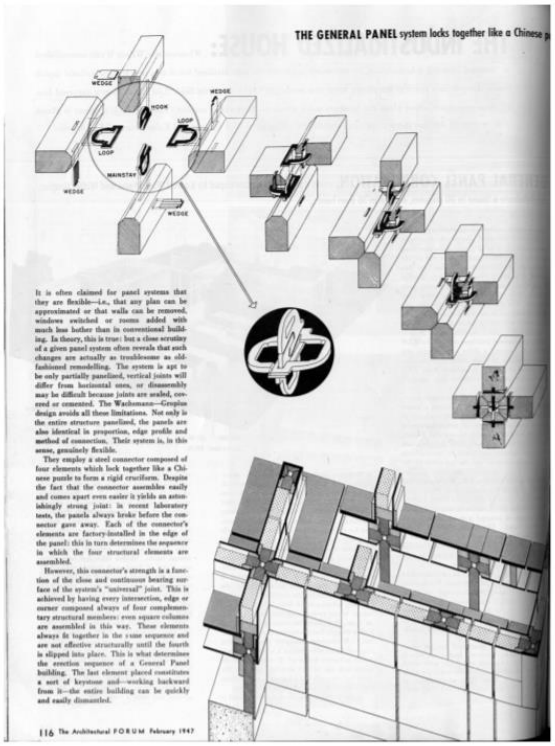


Figure 15 *(The general panel system locks together like a Chinese puzzle. Image Source: Architectural Forum, February, 1947: 116.)*

Konrad Wachsmann and Walter designed the Packaged House System (1942-52) that was made up of modules that were interchangeable and flexible in terms of their joinery. The modules could be used for walls, ceilings or floors and varied through the use of panels. [30]

Another prefabrication enthusiast was Buckminster Fuller. His writing titled "4D" claimed traditional construction to be primitive. [31]

He argued that houses should be built more like cars or airplanes and delivery should be made through air transportation. By doing so, the limitations of truck sizes and ground transportation would be eliminated.

[30] LaRusso, Adam Nicholas, "*Disaster Relief: A System for Recovery*" Master of Architecture Thesis, University of Maryland (College Park, Md.), 2011, (2012-02-17T07:16:48Z). 24
[31] Michael John Gorman, *Buckminster Fuller: Designing for Mobility*. (Italy:Milan 2005) 23.

[32]Representation of this idea can be seen in his proposal for the lightful towers.

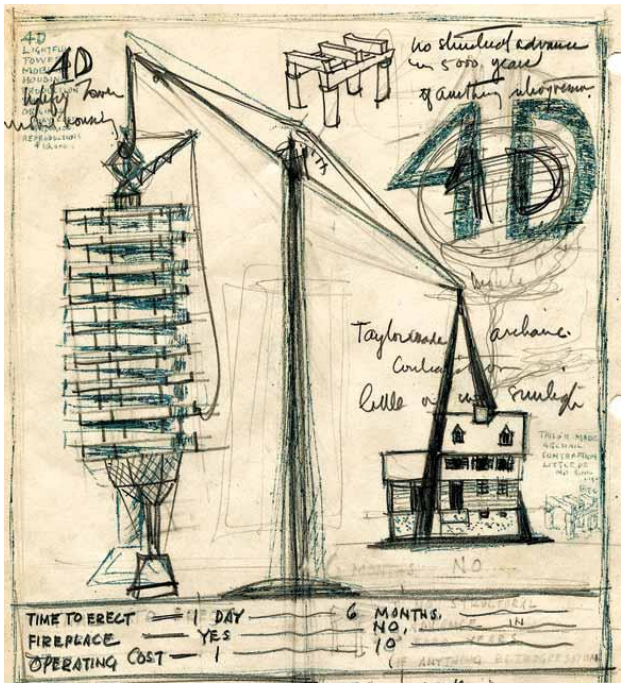


Figure 16 *(Lightful towers. Image Source: https://blogs.uoregon.edu/dymaxionhouse/4d-becomes-dymaxion/)*

Buckminster Fuller's design for the Dymaxion house was also pushing the boundaries of using technology in the creation of a house.[33] The Dymaxion house was more of a machine that could be mass produced through prefabrication. [34]

[32] LaRusso, Adam Nicholas, "*Disaster Relief: A System for Recovery*" Master of Architecture Thesis, University of Maryland (College Park, Md.), 2011, (2012-02-17T07:16:48Z). 36
[33] Ibid. 25
[34] Michael John Gorman, *Buckminster Fuller: Designing for Mobility*. (Italy:Milan 2005) 41.

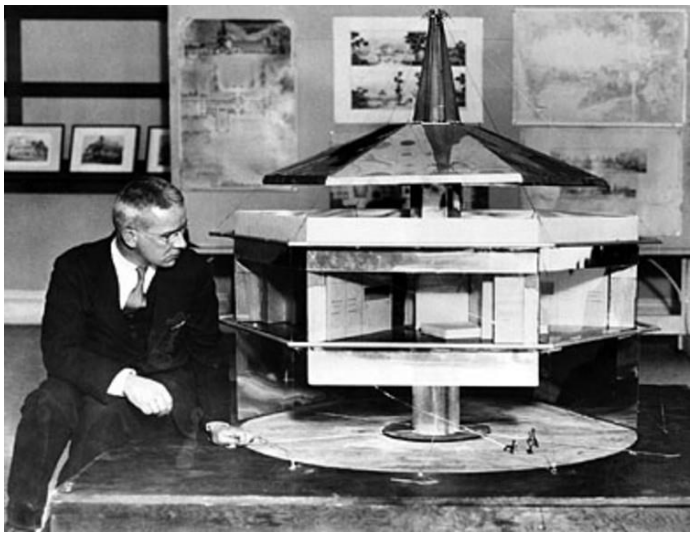


Figure 17 *(Dymaxion house. Image Source: Archdaily)*

Jean Prouve is another name that has pushed the idea of prefabricated homes. [35] He used his background as an ironworker to create structures that were built out of prefabricated steel. These structures could be assembled by as few as five men in a time duration of a few hours. His house showcased this portability by moving through exhibits from France to Africa. Jean had kept the number of parts to a minimum and allowed it to be light in weight. [36]

Trailer parks can also be considered an example of prefabricated homes. It was at the time of and after the World War II that these trailers became a solution to the housing problem. [37]Trailers were being used to house refugees and serve as aid stations.[38]

[35] LaRusso, Adam Nicholas, "*Disaster Relief: A System for Recovery*" Master of Architecture Thesis, University of Maryland (College Park, Md.), 2011, (2012-02-17T07:16:48Z).26
[36] Peter Sulzer and Erika Sulzer-Kleinemeier. *Jean Prouvé, Highlights: 1917-1944.* (Basel ; Boston: Birkhäuser, 2002)
[37] Walis, Allan D. "*House Trailers: Innovation And Accommodation in Vernacular Housing*." Perspectives in Vernacular Architecture 3. 1989. p. 29-30
[38] LaRusso. 27

From the houses that were delivered during the war, most ended up in college campuses with students, or were inhabited by returning veterans, due their low cost, even though they were designed as temporary houses. [39]

As a result of this, World War II caused a shift in the perception of trailers from being vacation residences to year-round houses. [40] Prior to the war, seventy-five percent of commercially sold trailers were used for vacationing. [41] However, after the war, about ninety percent of the trailers manufactured ended up being used for housing year round.[42]

In time, these trailer houses began to be looked down upon and received criticism. [43]The Tennessee Valley Authority introduced the Sectional House as a response. They adopted the idea of a prefabricated houses that was delivered to the site in two halves and then assembled. [44]

After WWII, the shortage of housing lead to the adoption of mass production and prefabrication.[45] In the 1950's Levittown was developed through modular houses produced through an assembly line. [46]

Katrina Cottages are another example of a prefabricated housing type that emerged after the 2005 hurricane.

---

[39] Hart, John Fraser., Michelle J. Rhodes, and John Morgan. *The Unknown World of the Mobile Home.* (Baltimore: Johns Hopkins UP, 2002.) 12

[40] Sarah Colvin, "*Manufactured homes and their communities: mobility of an American vernacular*" Master of Architecture Thesis, University of Maryland (College Park, Md.), 2011, (2012-02-17T07:16:22Z).2

[41] Ibid. 2

[42] Walis, Allan D. "*House Trailers: Innovation And Accommodation in Vernacular Housing*." Perspectives in Vernacular Architecture 3. 1989. p. 34

[43] LaRusso, Adam Nicholas, "Disaster Relief: A System for Recovery" Master of Architecture Thesis, University of Maryland (College Park, Md.), 2011, (2012-02-17T07:16:48Z). 27

[44] Rudolph, 3.3.

[45] LaRusso, Adam Nicholas, "Disaster Relief: A System for Recovery" Master of Architecture Thesis, University of Maryland (College Park, Md.), 2011, (2012-02-17T07:16:48Z). 27

[46] Bryan Burkhart and Allison Arieff. Prefab. (United States: Gibbs Smith, 2002) 27

Benefits of Prefabrication

A prefabricated modular system has multiple benefits including: less wastage of materials;[47] better quality assurance; protection from weather conditions during the construction process; health and safety of construction workers; energy efficiency and reduction of the overall time of construction[48]

[47] L. Jaillon, *Quantifying the waste reduction potential of using prefabrication in building construction*. (Waste management. Volume 29 issue 1. January 2009) p 309-320.
[48] Y. Luo, D. R. Riley, M. J. Horman and G. O. Kremer, *Decision Support Methodology for Prefabrication Decisions on Green Building Projects,* (Salford, United Kingdom: Symposium on sustainability and value through construction procurement, 2006) 370.

Examples of Prefabricated Building Structures

Modular Unit Technologies

Figure 18 *(Kullman Bathroom Pods. Image source: http://www.modular.org/images/Bathroom%20Pods%20Whitepaper%20Dec16.pdf)*

Kullman Bathroom Pods are manufactured in a factory based off the specification of the architect and shipped to site where they are slipped into place (by cranes) in between semi-finished walls. They are often used for multifamily housing projects and allow for speed for construction and reduction of cost; the greater the quantity of units ordered, the cheaper the price. Finishes on the modules can be customized and once they are plugged into place, it is difficult to notice that they were built off-site. [49]

[49] Victoria Kathleen Kraushar-Plantholt, "*Rethinking the American house: expandable-life-cycle houses in suburban context*" Master of Architecture Thesis, University of Maryland (College Park, Md.), 2011, (2011-10-08T06:31:40Z). 34

Flat Packed Technologies

Flat pack is another name for the “kit of parts” prefabrication system. Lazof Office offers a fully customizable floor plan than can be seen in its variations in a catalogue or designed or modified with the help of a designer. [50]

The house is designed in a eight foot high single floor structure with structural supports at every eight feet. The panels that fill the space within the structural frame come in a variety of options along with the bathroom and kitchen modules. [51]

Cellophane House

Figure 19 *(Kieran & Timberlake Associates’ Cellophane house. Image Source: https://kierantimberlake.com/pages/view/14/)*

[50] “FlatPak” Aceessed on May 17, 2020. https://www.flatpakhouse.com/
[51] KrausharPlantholt. 40

Kieran & Timberlake Associates' Cellophane house is a simple steel structure with beams bracketed together. It can be easily assembled and disassembled.[52]

Conclusion

Prefabrication and modular buildings have been subject to exploration and investigation throughout time and history. They have been implemented in multiple forms and by some of the greatest architects of their times. There is definite potential in the concept and the benefits it offers make it worth of implementation in the context of the Naya Pakistan Housing development.

[52] KrausharPlantholt. 37

Chapter 4: Community

What is a Community?

A community can be described as a group of people that is recognizable as a group. [53] It is also argued that community also means people who engage in regular social interactions and have certain aspects in common. It means people who reside in an area and other than sharing the place, also have common ties and social engagement.

A sense of community is a phenomenon described by psychologists as the sensation of belonging to a group. It is the reason why people behave in manners resultant of a community. Building upon that idea, it is discovered that people who have a greater and stronger "sense of community" engage more in neighborhoods and shared activities. They are also more likely to take part in caretaking and supporting their community through individual effort and community organizations. [54]

The creation and the loss of this "sense of community" can be attributed to the design of the areas that these people reside in. For example, in areas with lower densities and pedestrian unfriendly environments, the chances of casual and spontaneous interactions among neighbors falls. [55]

However, there are certain tools and techniques that can allow for encouragement of human interactions and result in a better sense of community. Some of these tools are described by Sidney Brower as

[53] Sidney N Brower, *Neighbors and Neighborhoods: Elements of Successful Community Design* (Chicago, IL: APA Planners Press, 2011) 3
[54] Ibid. 4.
[55] Ibid. 6.

homogeneity, physical traits of the area, amenities, community organizations and community rituals and traditions. [56]

What is the Size of a Community?

The scale and nature of the community varies and is dependent on its area and the number of individuals that associate themselves with it. [57] Research has revealed that residents that have shared values and shared beliefs are more likely to form homogeneous communities. [58]

"when we look at the most beautiful towns and cities of the past we are always impressed by a feeling that they are somehow organic…each of these towns grew as a whole…under its own laws of wholeness… and we feel this wholeness in every detail" - Christopher Alexander [59]

A homogenous physical design can create a place that is recognizable and attracts like-minded people to relocate to this region. They will also feel the need to behave in a particular manner and new comers would be motivated to follow the existing culture. Sidney Brower questions the authority of designers to give a place its identity even before anyone has begun to inhabit the area. [60]

One possible solution to this concern is to involve potential residents in the design of the community. The role of the designer would become limited to the proposition of a theme and residents guide the rest of the design process. An example provided by Sidney Brower is that of *Carmel*

[56] Sidney N Brower, *Neighbors and Neighborhoods: Elements of Successful Community Design* (Chicago, IL: APA Planners Press, 2011.) 7.
[57] Ibid. 3
[58] Ibid. 23
[59] Ibid. 95
[60] Ibid. 39

by the sea in California where residents where involved in the design process. Another method is that the residents re-create and re-define the theme of the area as mentioned by Sidney Brower was the came in Mounty Airy.

Particular attention must be given not to confuse the real identity of the community with only the appearance of the community. The appearance is merely a backdrop that allows for the community to develop itself. It encourages collective action and interactions. Therefore, the appearance of the community should go together with community gathering traits; similar people, community organization and traditions. [61]

It is expected of designers to use both intuition and knowledge to design effective neighborhoods that are in line with the interest and concerns of a population that the designers would not be able to relate to directly; due to differences in age, gender, race, culture etc. [62]

Extending the question further to look into what is it that actually makes a good community design. Some argue that mixed income communities result in less interaction among residents. A simple example of a corner store may result in easing that tension, which leads to the conclusion that it is not only common interests of the people that lead to interactions but design can play a vital role in bringing about such a result. [63]

Cities are attractive to people because they present the chance for personal and professional advancements and employment. However, in current times, merchants do not live on top of their shops, traders need not travel

[61] Sidney N Brower, *Neighbors and Neighborhoods: Elements of Successful Community Design* (Chicago, IL: APA Planners Press, 2011.) 79
[62] Ibid. 113
[63] Ibid. 115

down to the docks to learn about incoming cargo, to hear public news, and people need not gather in squares. In today's world, people can use technological advancements instead, making it possible to be connected without actually having to be there. [64] In this sense the entire country becomes urbanized.

It is interesting to note, that people tend to identify themselves based on the place that they live in. This may not be the same place that they work in or recreate in. Further to that, people have varied opinions about what is a good place to live in; it becomes a very subjective matter.

There has been a shift in looking at focusing investigations from differences between a city and a rural setting to creating a contrast between city centers and suburban areas. The differences, in some studies, have led to a conclusion that suburban lives are more family centric and community oriented; people tend to be move involved in the community and more neighborly. [65]

However, these claims are widely disputed as well and have argued that high density can have a positive and enjoyable effect. [66]

Some have argued that it is neither the size nor the density of the community that effects the social framework of the residents. Instead, it is dependent on "residential mobility" which means the degree to which

[64] Sidney N Brower, *Good Neighborhoods : A Study of In-Town & Suburban Residential Environments* (Westport, Conn.: Praeger, 1996) 18
[65] Ibid. 111
[66] Friedman, John and John Miller Jr. *The urban field*, Journal of the American Institute of Planners. 31 November 1965. p. 312-320

residents relocate or continue to stay in one place. The longer that people stayed in one place, the stronger their social ties and sense of belonging. [67] Neighborhoods can be considered as the building block of settlements and become reflections of the purpose of that community, for example, to strengthen the community, improve productivity, enhance health, etc. Residential functions remain consistent to a degree throughout different settlements. So in a way, housing anywhere would have to satisfy these basic residential functions; shelter (be available, accessible affordable), housekeeping (conducive to regular life routine and necessities; easy to sustain life) , accommodation (ability to host domestic functions), connection (to associated functions like employment, interactions etc.), meaning (reflect the values of the residents) and recreation (provide opportunities for relaxation and enjoyment). [68]

What makes a good neighborhood has always been changing throughout time. A good neighborhood should satisfy the residential functions based on the lifestyle of the people at that time and place and should be adaptable to change through their life into the future.

Sidney Brower classifies communities intro three broad categories; market place residents (that interact with diverse people and functions), The club (interactions occur among a smaller circle) and The Refuge (closed off, protected and only interact amongst themselves or invited guests) [69]

[67] Sidney N Brower, *Good Neighborhoods: A Study of In-Town & Suburban Residential Environments* (Westport, Conn.: Praeger, 1996). 61
[68] Ibid. 97
[69] Ibid. 61-76

Conclusion

There can be many ways to look at communities and begin to classify them as good or bad. Lessons applicable from this research to the project are that communities that instill a sense of belonging are: sensitive to the culture of the people, showcase some form of homogeneity, offer appropriate amenities and allow for human interaction to occur with ease and comfort. These would become the guiding principles for the Naya Pakistan Housing developments.

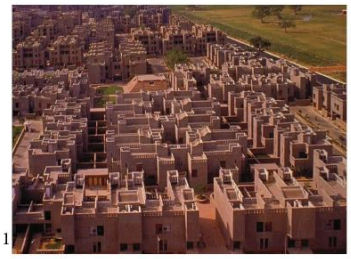
Chapter 5: Community & Housing

Housing Precedents

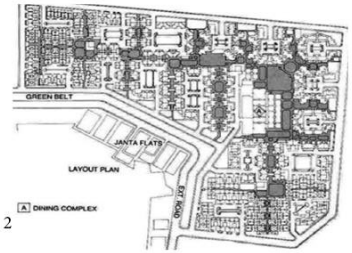
Housing is one of the most widely built building type in Pakistan. In this chapter, some of the successful housing projects have been investigated. The focus of this investigation is to not only look at the individual unit of habitation, but to explore how the units interact with one another, the variety of units available, their areas, amenities available for inhabitants and the overall verticality and average density of the development. Along with exploring the basic materiality of the project. Thirteen projects have been selected from different geographic regions and from varying time periods to discover underlining similarities.

Figure 20 (Precedent Housing Analysis)

15 unit/acre — ASIAN GAMES, NEW DELHI

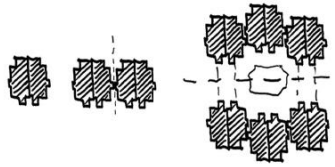


1



2

MASTER PLAN



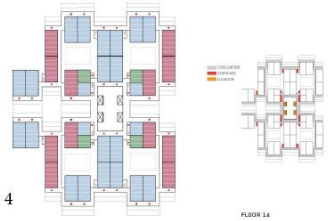
AGGREGATION PLAN

NO. OF UNITS	500
TOTAL SITE AREA	1,524,600
TOTAL NO. OF FLOORS	2 TO 4

1 & 2. Image Source: Asian Games Village, by Raj Rewal, at New Delhi, India, 1980 to 1982. Photo by courtesy of the architect. http://www.greatbuildings.com/. Accessed May 17 2020.

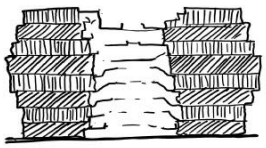
46 unit/acre — WALDEN 7, BARCELONA

3



4

MASTER PLAN



AGGREGATION PLAN

NO. OF UNITS	446
TOTAL PROJECT AREA	430,556
TOTAL NO. OF FLOORS	14

3. Image Source: Denis Esakov, https://www.denis-esakov.com/walden-7-bofill. Accessed May 17, 2020.
4. Image Source: alzbetadvorakova, WALDEN 7 – Ricardo Boffil. https://habitatgecollectiu.wordpress.com/2015/12/04/walden-7-ricardo-boffil/ Accessed May 17, 2020.

64 unit/acre — HABITAT 67, CANADA

5

MASTER PLAN

AGGREGATION PLAN

NO. OF UNITS	354
TOTAL PROJECT AREA	238,500
TOTAL NO. OF FLOORS	12

5. Image Source: Gaétan, https://www.flickr.com/photos/le_grand_marcheur/12279127303. Accessed May 17, 2020

267 unit/acre — BRAWERY SQUARE, LONDON

6

MASTER PLAN

AGGREGATION PLAN

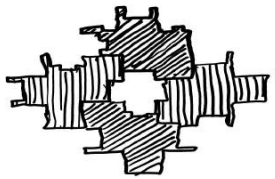
NO. OF UNITS	380
TOTAL PROJECT AREA	32,291
TOTAL NO. OF FLOORS	8

6. Image Source: Dennis Gilbert, archdaily. https://www.archdaily.com/35639/brewery-square-hamiltons-architects. Accessed May 17, 2020

Figure 21 *(Precedent Housing Analysis)*

4 unit/acre LA MURALLA ROJA, CALP

MASTER PLAN



AGGREGATION DIAGRAM

NO. OF UNITS	50
TOTAL PROJECT AREA	532813
TOTAL NO. OF FLOORS	10 to 15

50 unit/acre TIMBER-YARD HOUSING,DUBLIN

7

8

MASTER PLAN

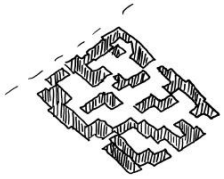
AGGREGATION DIAGRAM

NO. OF UNITS	47
TOTAL PROJECT AREA	40,902
TOTAL NO. OF FLOORS	4 to 6

92 unit/acre ODHAMS WALK, LONDON

9

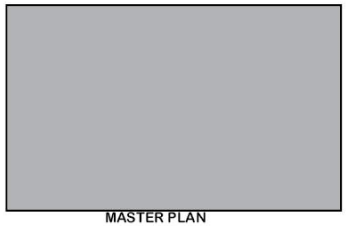
MASTER PLAN



AGGREGATION DIAGRAM

NO. OF UNITS	102
TOTAL PROJECT AREA	48,746
TOTAL NO. OF FLOORS	6

296 unit/acre KANCHANJUNGA, MUMBAI



MASTER PLAN

AGGREGATION DIAGRAM

NO. OF UNITS	32
TOTAL PROJECT AREA	4746
TOTAL NO. OF FLOORS	28

7. Image Source: O'Donnell + Tuomey, https://www.totallydublin.ie/more/nice-gaff-timber-yard-housing/. Accessed May 17, 2020

8. Image Source: O'Donnell + Tuomey, https://mie-sarch.com/work/1568. Accessed May 17, 2020

9. Image Source: Chestertons Estate Agents, https://www.rightmove.co.uk/property-for-sale/property-57049908.html. Accessed May 17, 2020

Programmatic Comparison

	Unit Type	Unit Area /sq. ft	Total No. of units	Total area of project/sft	Total area of site /sq. ft.	Total No. of floors	Basic amenities	Material specification	Building type
Habitat 67	**1 Bed**	346	354	238,500	Nill	12	Living room, bedroom bathroom, suspended terraces, dining, storage, kitchen	Prefabricated stacked concrete module	Multi-leveled residential modules
	2 bed	1110							
Asian games	**1 bed**	1334	500	Nill	1,524,600	2 to 4	Living room, dining, bedroom, bath, courtyard, kitchen, storage	Concrete	Family housing
	2 Bed	1002							
Kanchanjuga apartments	**1 Bed**	2566	32	4746	Nill	28	Living, bedroom, dining, bathroom, kitchen, terrace garden, study	Concrete	Skyscraper multi-family housing
	2 Bed	2347							
Byker wall	**1 bed**	490	628	8,712,000	Nill	6	Roof terrace, living room, bedroom, kitchen, bath, veranda	Concrete, brick	Multi-family housing
	2 bed								
Brewery square	**1 bed**	380	198 dwellings, 6 towns	32,291	Nill	8	Living room, bedroom bathroom, kitchen, shops, cinemas		Residential units
Walden 7	**1 bed**	612	446	430,556	Nill	14	exterior & interior courtyard, living room, bedroom, kitchen, bath, swimming pool	Red ceramic tiles	Residential units
	2 bed	1104							
Linked hybrid	**1 bed**		750	2,368,060	Nill	21	living room, bedroom, bath, mini salon, café auditorium	Steel	Multi-purpose complex
	2 bed								

Table 1 *(Comparison of Housing Precedents)*

	Unit Type	Unit Area /sq. ft	Total No. of units	Total area of project/sft	Total area of site /sq. ft.	Total No. of floors	Basic amenities	Material specification	Building type
Timber-yard social housing	**1 bed**	1478	47	40,902	Nill	4 to 6	living room, bedroom, bath, kitchen, study, dining, terrace	Insitu concrete structure with a brick skin	Residential social housing
	2 bed	850							
Madrid housing	**2 bed**	799	141	236,800	Nill	14	open and private courtyard, kitchen, living room, utility rooms, bedroom		Multi-family living
	3 bed	1120							
Quinta monroy	**2 bed**	2400	30	53,819	387500	2 to 4	Roof terrace, living room, bedroom, kitchen, bath, veranda	Paint with tiles	Residential units
Mountain dwellings	**1 bed**	1126	80	355,209	Nill	10	Roof garden, living, laundry, bedroom, bath, dining	Concrete	Residential parking garage
	2 bed	758							
Odhams walk	1 bed	556	102	48,746	Nill	6	Living room, open kitchen, bedroom, tv room, terrace	Brick	Residential units
	2 bed	886							
La muraLla roja	**1 bed**	645	50	532,813	Nill	10 to 15	Living room, bedroom, bath,roof terraces, solaria, swimming pool, sauna	Paint finish	Residential use
	2 bed	861							
Kingo houses	**1 bed**	650	60	Nill		single	Living room, bedroom, bath, roof terraces	brick	residential units

Table 2 *([Continued] Comparison of Housing Precedents)*

Summary of Aggregation Analysis

Looking at the housing developments from a standpoint of the individual unit to a combination of units reveals that the craft of the designer and the individuality of each project really exists within the realm of the repetition. Housing may happen within the individual unit itself, but the functions of housing extend beyond those that can be fulfilled by the unit. They exist in the spaces that result through the interactions of these units. The above study of successful housing projects showcases that the difference in aggregation of units brings about differences in the housing complex entirely.

Housing in Lahore

A similar study is carried out with housing in the city of Lahore. As a result of the study, housing typologies in Lahore can be classified into three sections: detached/semi-detached, multifamily and row homes. Another finding of the study is that contemporary developments in Lahore are up to four floors with the average dwelling being two floors. The densities of these new developments range from seven units per acre to thirteen units per acre.

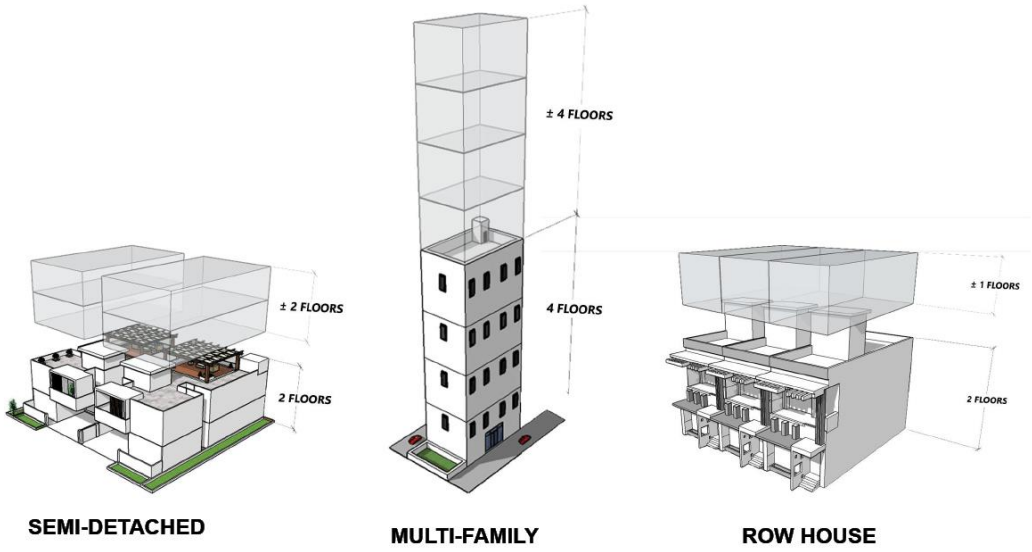
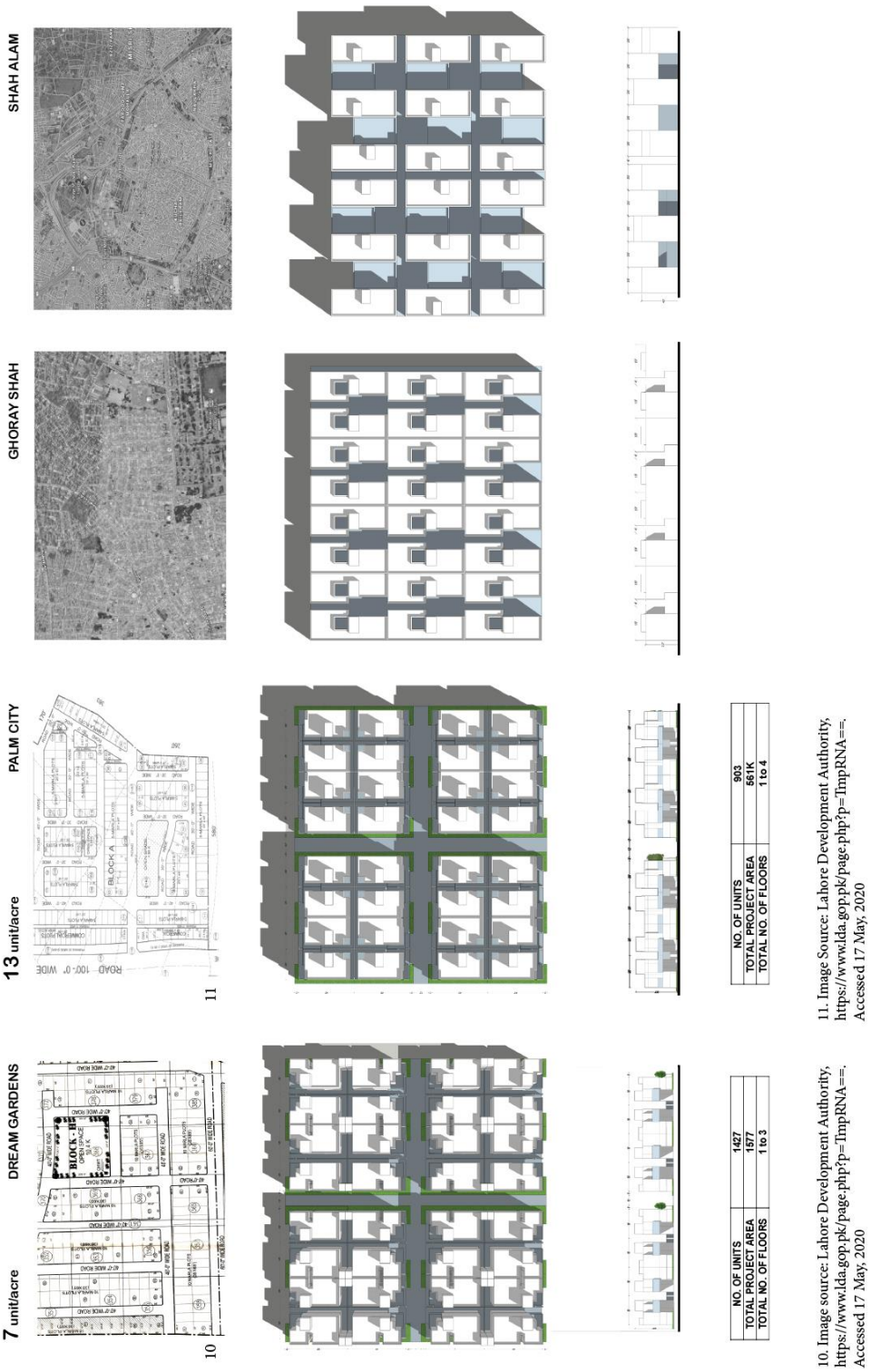


Figure 22 *(Three types of housing in Lahore – Detached/Semi-Detached, Stacked Mid Rise, Row homes)*

Contemporary Housing Developments in Lahore



11. Image Source: Lahore Development Authority, https://www.lda.gop.pk/page.php?p=TmpRNA==. Accessed 17 May, 2020

10. Image source: Lahore Development Authority, https://www.lda.gop.pk/page.php?p=TmpRNA==. Accessed 17 May, 2020

Figure 23 *(Analysis of Contemporary Housing in Lahore)*

Chapter 6: Site

What is Lahore?

Lahore is geographically located between 31°15′—31°45′ N and 74°01′—74°39′ E. It is in the country of Pakistan and the city serves as the seat of the provincial capital for the province of Punjab.

Lahore has gone through different eras under different rulers following varying ideas about the city. The significant "Lahori" buildings were built during the Mughal era that lasted for about two hundred years. This was followed by a fifty year period of the Sikh rule. Followed by the British, who managed to maintain control of the region for almost a century.[70] The British planners and builders were not keen on interacting with the historic city and placed their developments at the periphery of the old city, creating their own little city. After the partition of the subcontinent to create Pakistan, Lahore has expanded into a vast metropolis with multiple layers of development and characteristics. This expansion has majority occurred to the south of the old city; a pattern that was set in place by the British. [71]

[70] William J. Glover, *Making Lahore Modern : Constructing and Imagining a Colonial City*. (Minneapolis: University of Minnesota Press, 2008.) p.1-27

[71] Rabia Ahmed Qureshi, "*The traditional courtyard house of Lahore: an analysis with respect to Deep Beauty and sustainability*" Master of Science Thesis, Kansas State University (Manhattan), 2015 (2015-04-27T15:33:50Z). p.14

Expansion Map

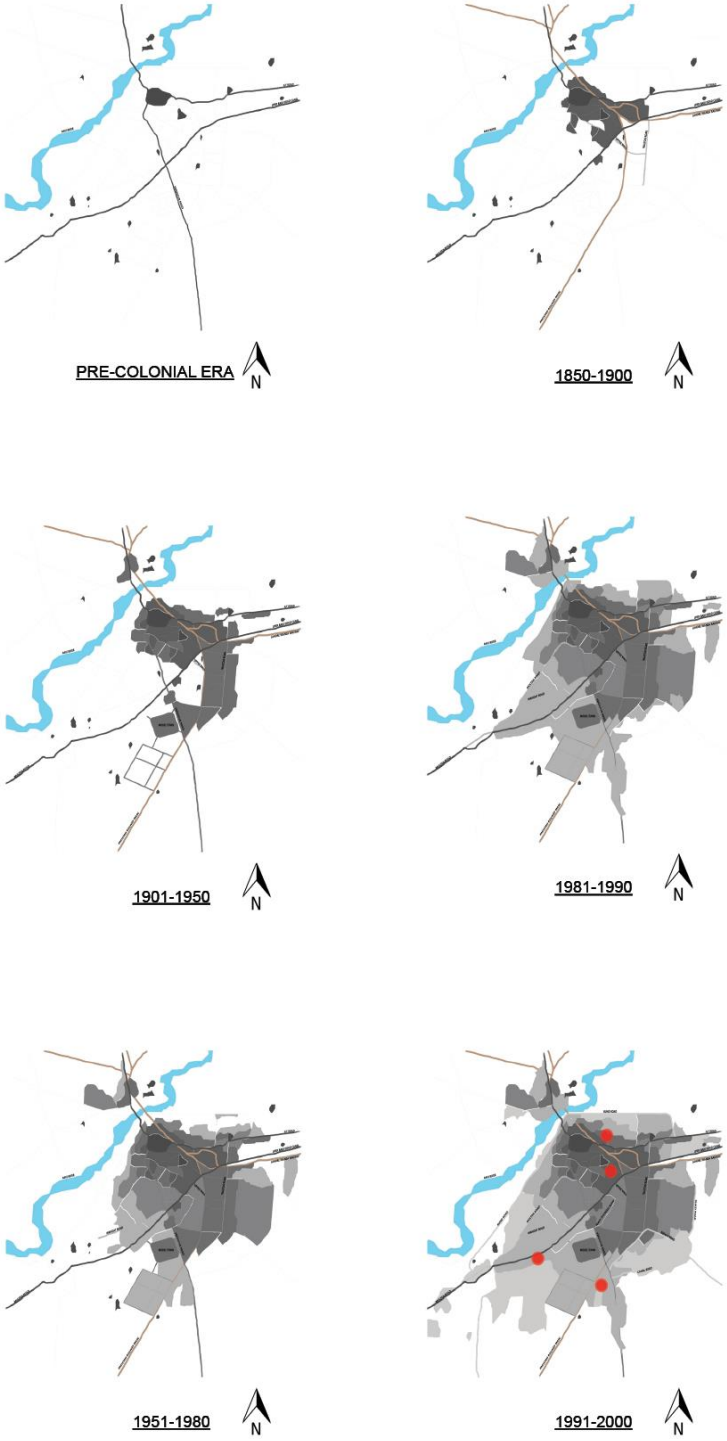


Figure 24 *(Expansion of Lahore 1600 – 2000)*

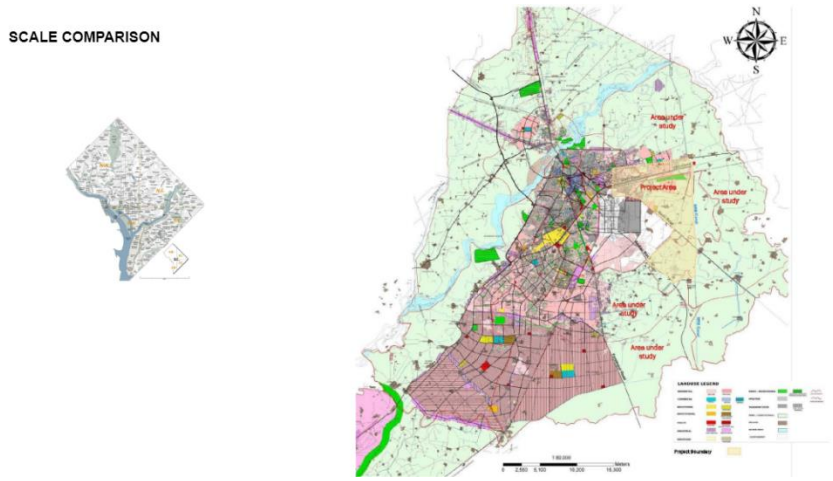


Figure 25 *(Scale comparison of Washington DC with the city of Lahore 2025. Image Source: Author, Lahore Development Authority and The Washington Post Company)*

Climate

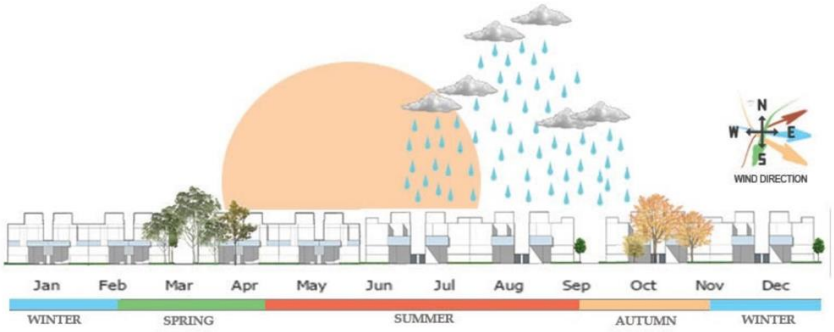


Figure 26 *(Lahore Seasons Diagram)*

The city of Lahore experiences all four seasons and has heavy rainfall during the monsoon period. The climate is hot and arid with average daily temperatures ranging from 22 degree Celsius in the winters to 35 degree Celsius in summers.[72]

Urban Issues of Lahore

The city of Lahore has been expanding uncontrollably outwards in the past decade. Urbanization of agricultural land has led to great environmental and economic concerns. The massive infrastructural developments have led to the degradation of the environment and the public transit system has failed to cope up with the urban sprawl leading to long travel distances on independent vehicles.

Energy consumption of cities has also become an imminent concern. Pakistan as a country faces a deficit of power production leading to load shedding (absence of power at certain times of the day) to make up for the

[72] Rabia Ahmed Qureshi, "*The traditional courtyard house of Lahore: an analysis with respect to Deep Beauty and sustainability*" Master of Science Thesis, Kansas State University (Manhattan), 2015 (2015-04-27T15:33:50Z). p.15

shortage of power. Alarmingly, the increase in energy demand has exceeded the growth in population. This means that not only have cities expanded but they have become more energy inefficient. LESCO, (Lahore Electric Supply cooperation) declared that 40% of all electricity consumed in the city is done in the residential sector. [73]This means that there is potential to create substantial impact on the energy consumption of the city by re thinking the residential component of cities.

Lack of green spaces and pedestrian infrastructure has also become a great urban issue for the city. In recent times, Lahore's air quality index was considered to be among the unhealthiest in the world.[74] It reached such high level of contaminants that schools and public parks had to be closed down, because it was no longer safe to be outside. [75]

These are potentials for improvements and points of concerns that the Naya Pakistan housing scheme can help address and present a model that can be replicated to bring about a bigger change.

Regional Building Technologies

Regional building construction technologies can be seen as illustrated in figure below. Brick and concrete are the main building construction materials. However, wood is also used in certain application. Residential buildings are built on site with load bearing masonry walls and reinforced

[73] Lahore Electric Supply Company, *Electricity demand forecast based on power market survey, period 2014-2024.* 24th issue. LESCO and NTDC. May 2015. 3

[74] *Lahore air remains 'hazardous' as Air Quality Index hits 447*, Dawn.com. Updated: November 13, 2019. Accessed 17 May, 2020

[75] Mubasher Bukhari, *Schools shut in Lahore as city chokes in toxic smog*, Reuters. updated: November 22, 2019. Accessed 17 May, 2020

cement concrete roofs. Nevertheless, variations do exist in certain locations and among specific economic classes based on the cost of construction

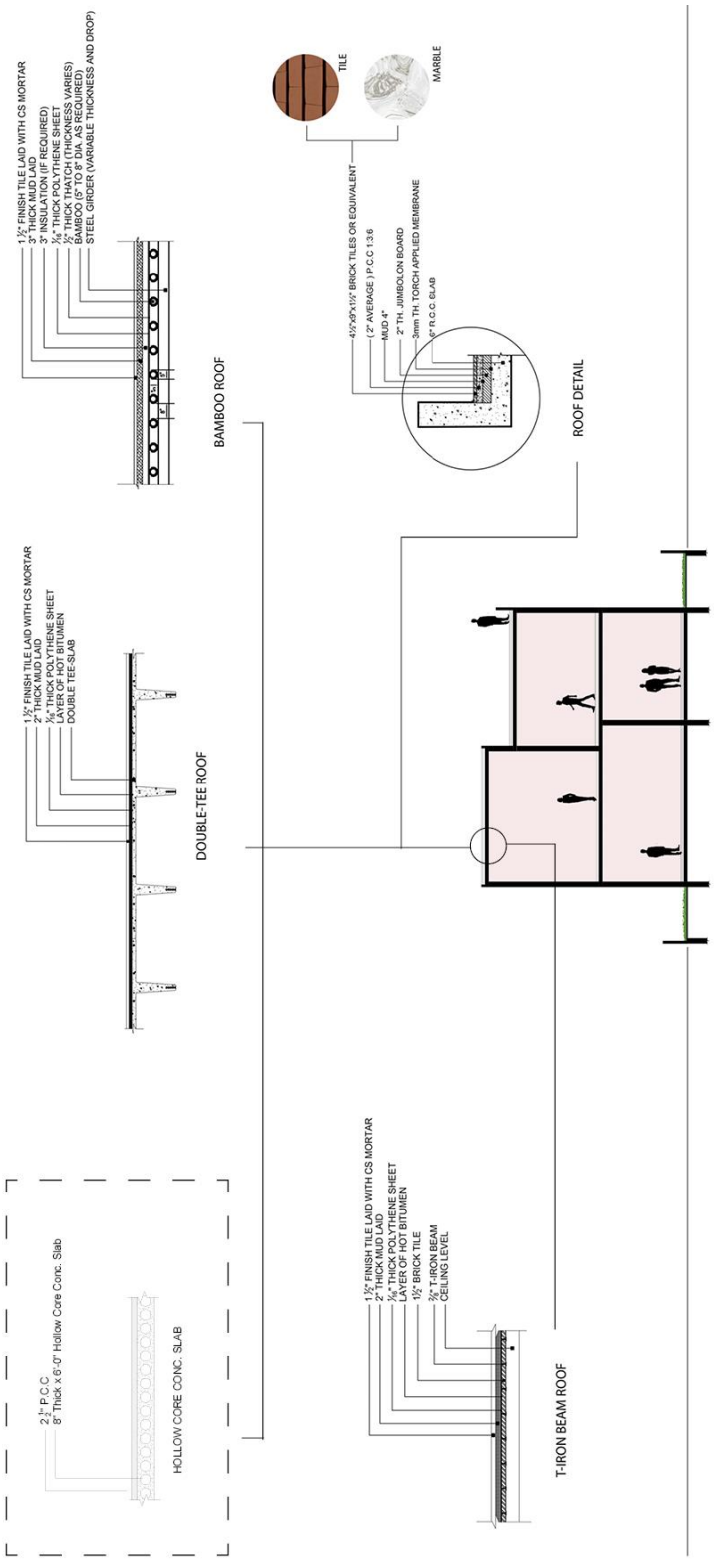


Figure 27 *(Building construction materials and techniques for each component of the building.)*

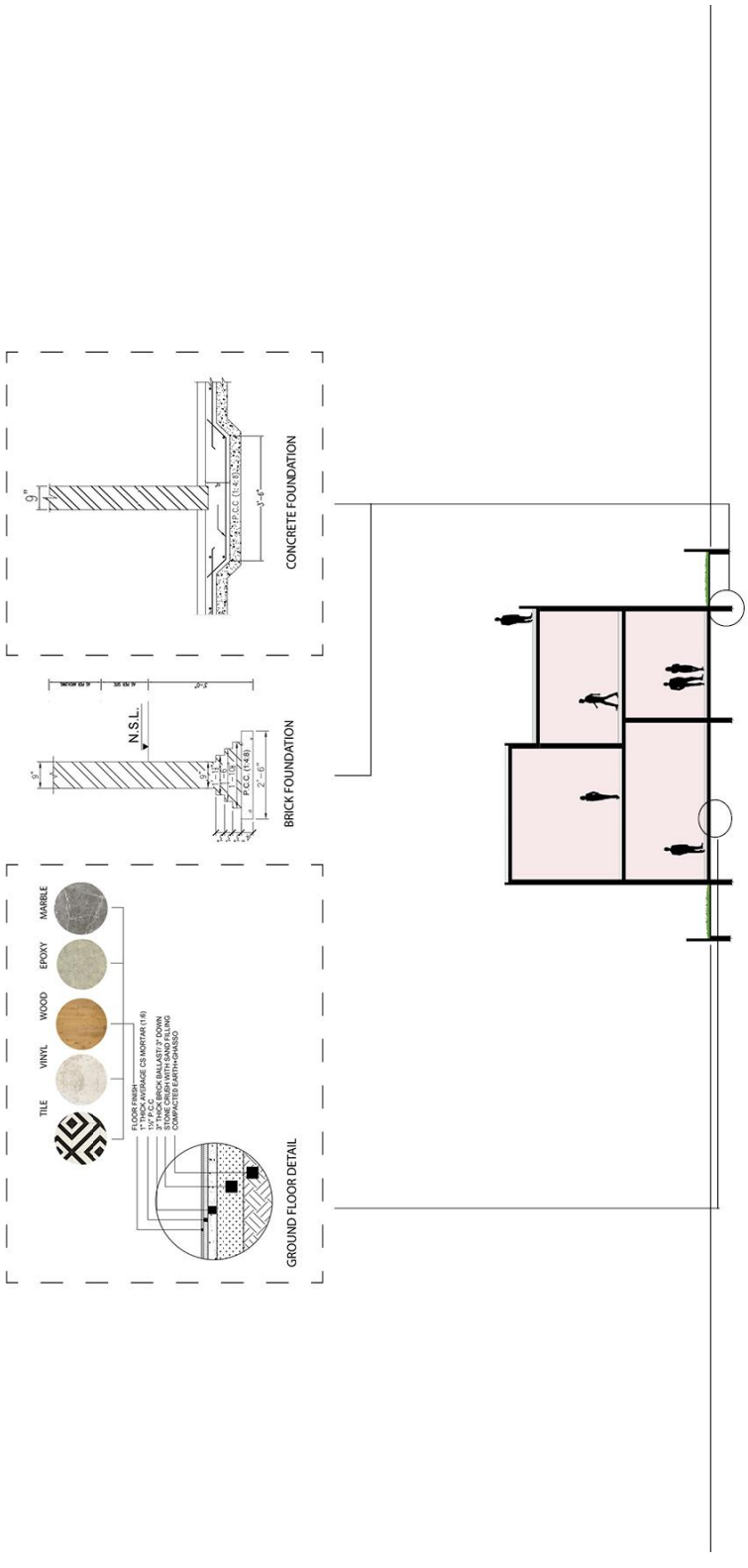


Figure 28 *(Building construction materials and techniques for each component of the building.)*

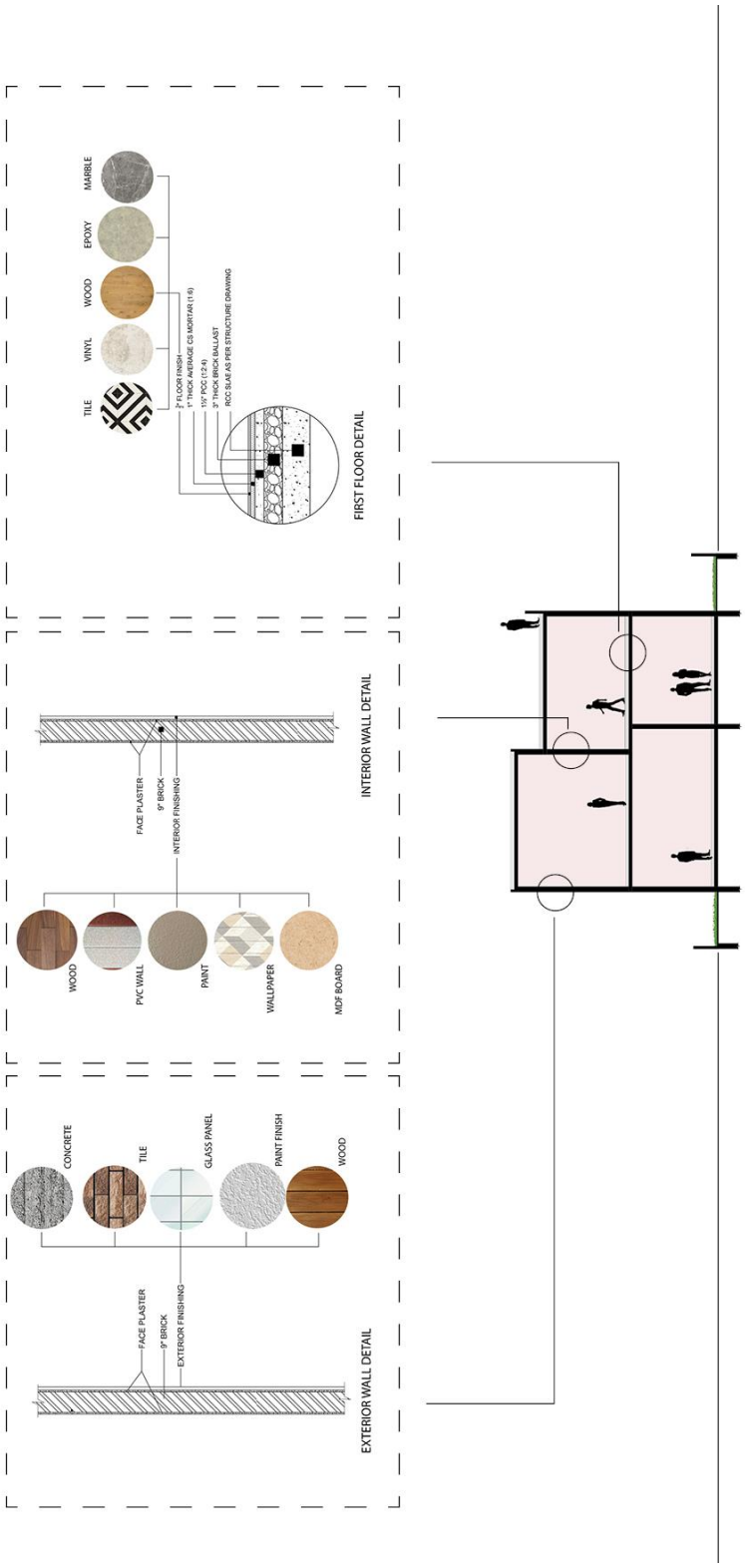


Figure 29 *(Building construction materials and techniques for each component of the building.)*

Regional Construction Process

A typical house in Lahore starts its journey like this: A contractor and his team of 3 to 4 trusted workers start putting the building together. Excavating, building up walls, putting up shuttering, pouring, including services and utilities, adding finishes, cladding, fittings and fixtures and eventually a year has gone by till the time come when one can actually begin residing in the house.

Figure 30 *(Typical residential construction site in Lahore. Image Source: Surblund Consultants, Lahore)*

There is wastage of materials on site and excessive water consumption in the building process. Both can be prevented by the employment of prefabricated construction techniques.

Site Selection

The site needs to be located in a developed city, facing a housing deficit and lack of affordable house. The site needs to be next to public transportation and offer multimodal connections to the rest of the city. It needs to be at the edge between different social classes communities to allow for a connection between this disconnection. It must be a vacant lot, offering little or no value to the neighboring community. It must have available amenities like schools, hospitals, mosques within proximity to mitigate the need to build such services on site.

Site Selection Matrix

KEY:
1 = Least Suited
4 = Best Suied
Most Significant
↓
Least Significant

Criteria				
Vacant brownfield land with-out current use:	2	4	3	1
Area	1	1	1	1
Proximity to multimodal transportation:	3	2	4	1
Walkability:	2	4	3	1
Within existing urban fabric:	1	3	4	2
Proximity to multiple social classes:	2	1	3	4
Proximity to amenities:	4	3	2	1
Interesting opportunities on site	1	1	1	1
Total	17	20	22	13

Figure 31 *(Site Selection Matrix)*

The four sites chosen are listed above. From the list the site located in Johar town at the intersection of the Canal Bank road and Yaseen Khan

Watoo road is the most viable site for intervention and the demonstration of the new housing concept.

Chapter 7: Design Development

Existing Design Proposal

Since this massive housing project is coming to fruition, the government is proposing a simple repetition of what is already being done; a repetition of one house, to make many. However, this cannot be as simple as that. The housing types that are currently being suggested look like as shown in figure 35.

The Government's Proposal

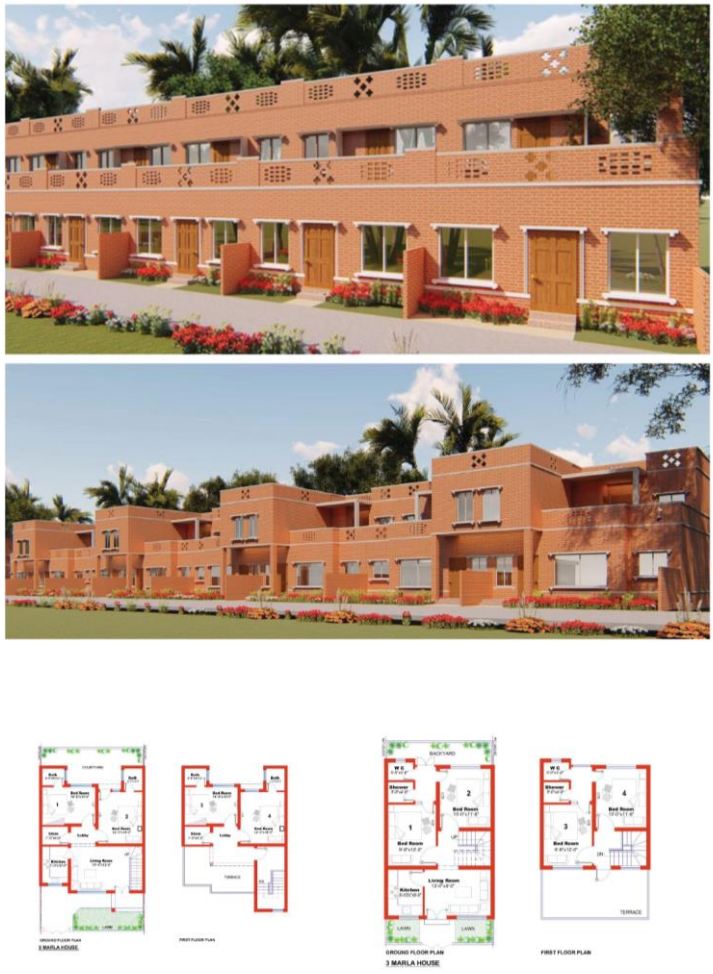


Figure 32 *(Naya Pakistan Housing Proposal by the Government. Image Source: http://www.fgeha.gov.pk/naya-pakistan-housing-scheme/)*

Issues with the Government's Proposal

There are a few points of attention about the government's proposal.

The first point is that since the method of construction will be the same as usual, there would be substantial wastage of material, water, resources and time. A typical house takes about a year to build and uses over thousands of gallons of water along with producing waste, noise, and pollution. Multiplying that with five million would not be feasible.

The second point is that these developments would be low density housing. Due to low density developments, cities are expanding drastically. The city of Lahore alone has expanded to more than about one and a half times of its original size in the last decade. Agricultural land is being consumed at an alarming rate, causing grave environmental concern, travel distances have increased, dependency on cars has become substantial and the social implications of moving from living in a dense walled city, to low density neighborhoods have also impacted communities.

The third point is that the houses will all be the same. Lahore has prided itself as city of colors; of cultures; of people. There are about 60 languages spoken in the country[76] among a rich variety of social groups and a diverse range of economic groups. Factoring in age, gender, education, and the list goes on, it can argued that all individuals are unique; they have different needs; they live differently, and express themselves differently. Then how can their houses be all the same? Apart

[76] Muhammad Akram and Anser Mahmoos, *The Status of teaching in Pakistan, Language in India*, Volume 7: 12 Dec 2007. p.2

from absence of variety, there will also be no room for flexibility and adaptability through time. Furthermore, a simple repetition of one house, to make many would end up completely ignoring contextual conditions of the site i.e these would not be responsive to site conditions.

Therefore, it is imperative to rethink the proposal currently being suggested and look at a new way of thinking about the Naya Pakistan Housing development. The first step to the endeavor would be establish a scalable construction system and the second would be to ensure inbuilt variety, flexibility and adaptability in the mass produced unit.

Proposed Modular System

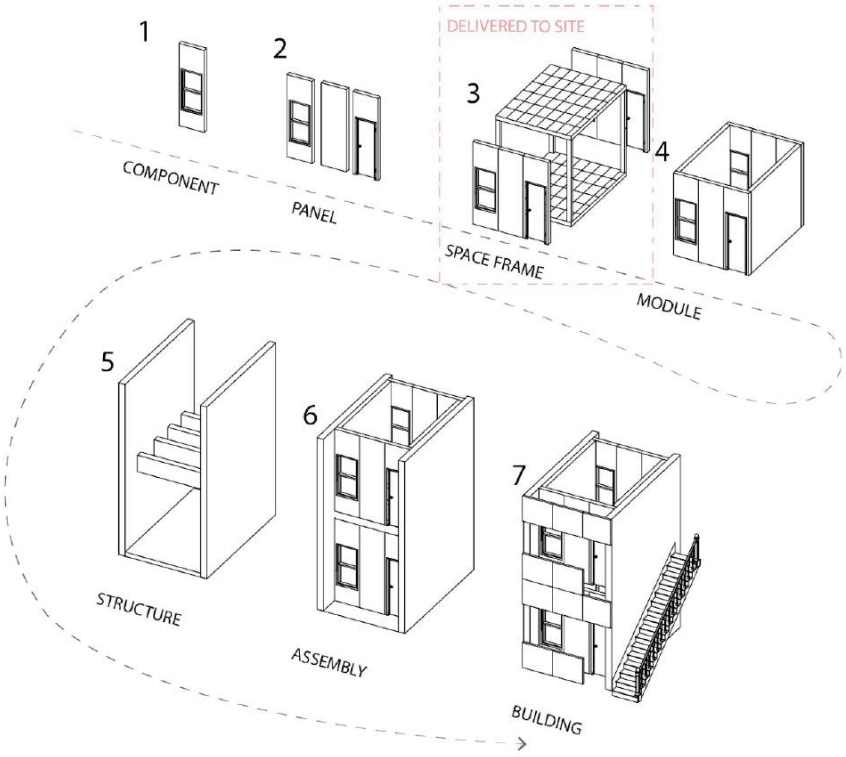


Figure 33 *(Proposed modular system)*

This thesis advocates the use of a modular, prefabricated construction system. The modular system being proposed consists of a component that makes the panels, then panels then come together to make a module. These modules are placed inside the structure, and adding on cladding and accessory components makes the building. The core of this assembly is the idea the building envelope can be seen as “structure” and “interior space” and that interior spaces can act as items of furniture placed inside the structural envelope.

Unit Assembly

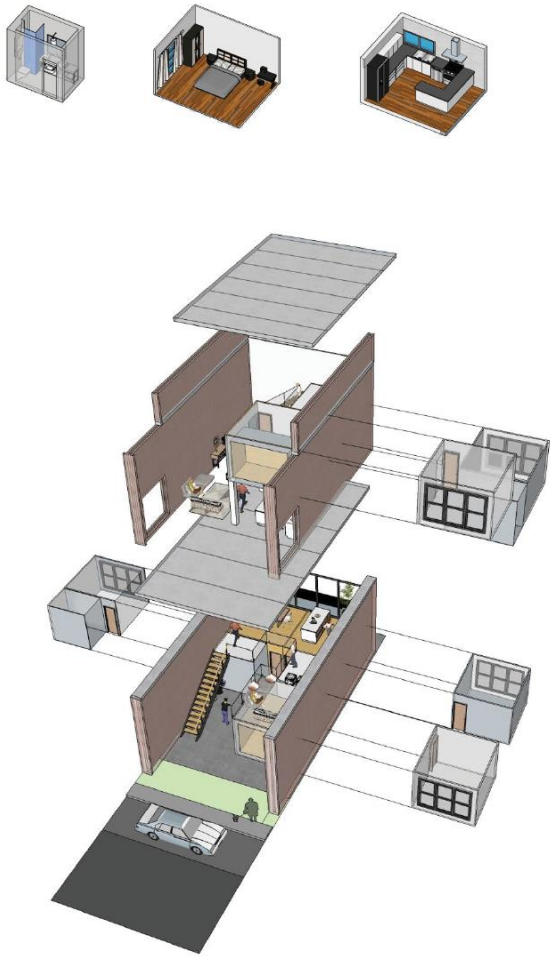


Figure 34 *(Proposed unit assembly)*

The scheme is to build the structure on site and then place interior space modules to define space and make it functional.

Structural System

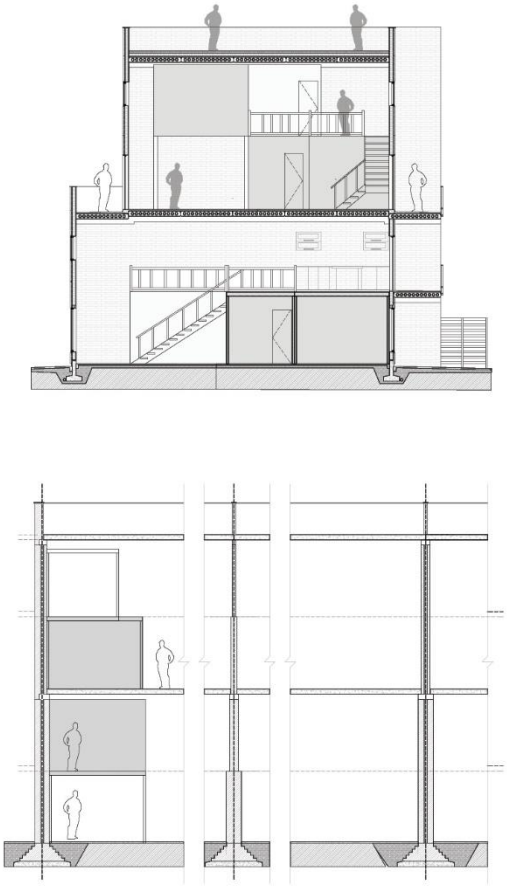


Figure 35 *(Proposed structural system)*

The assembly is such that brick masonry cavity walls hold the system and services. Hollow core concrete slabs placed on the load bearing masonry walls. This creates a double height interior enclosure that is considered as one dwelling. Once the structure is built on site, the modules are simply transported to the location and placed inside creating a living unit.

Module Construction

Within these living units, modules can exist in three conditions. Stacked, raised up, or placed on spanning members.

The modules are built from locally sourced wood – partal and kale. These are readily available wood types in the region. These timber members will be built up in a factory as illustrated in the diagram before being transported to the site.

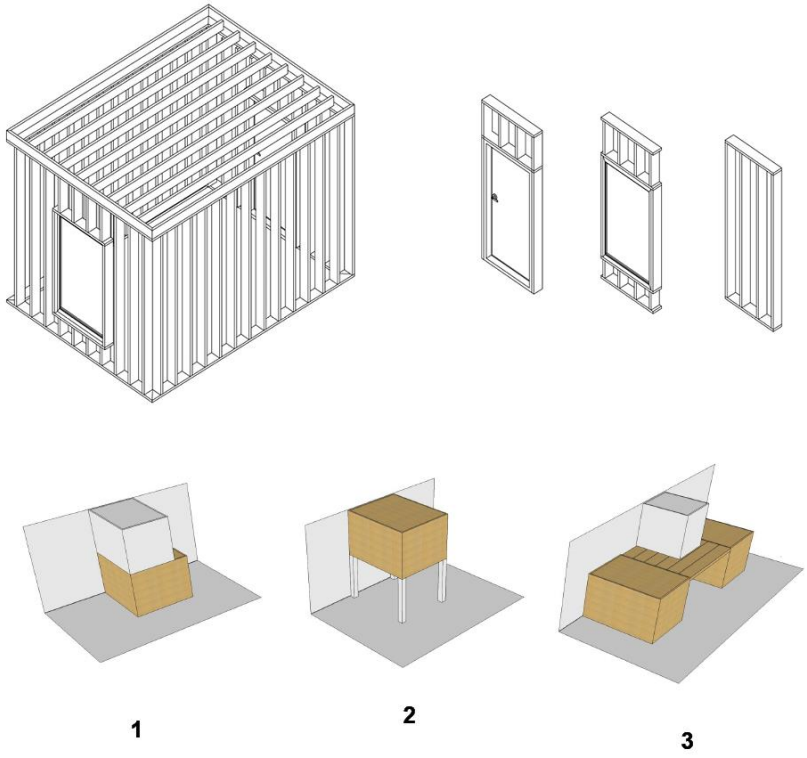


Figure 36 *(Proposed living module)*

Variety of Configurations

This framework allows for a large variety of unit configurations ranging from one bed to three bed units. The footprints of the units is twenty four feet by fifty four feet. This is based on the structural system being used, the area requirements suggested in chapter five and the ability for the units to allow multiple configurations of interior pace. Unit type two has a longer footprint of twenty four feet by sixty feet. Naming these unit types based on their spatial configurations helps clarify the increased level of variety achievable through this concept.

Unit Type 1 Configurations

The terrace is a one bed unit where the living space exists on top of sleeping spaces, viewing into the double height space and the outside. *Inverter Railcar* is a similar concept where one sleeps at the lower level and lives at the upper level with circulation to the side. This is a two bed, two bath unit. *The passageway* is similar configuration that showcases a void that runs all the way from the front to the back with the modules stacked against the wet wall. In the *Playground* arrangement, the entire lower level becomes a Playground. This allows for multiple configurations of furniture based on the needs of the occupants. The private spaces raised up on the upper level. The *Four Corners* arrangement divides the space into implied zones. In the *Courtyard* unit creates a central void with the spaces arranged around it. Therefore, as described above, the modules can be staggered to create a composition of volumes and space.

Ample light and air is brought in from both ends. The double height space and high windows allow for the hot air to escape creating a pleasant environment inside the space. Visual connections are created, whist allowing for spatial hierarchy that define the overall spaces.

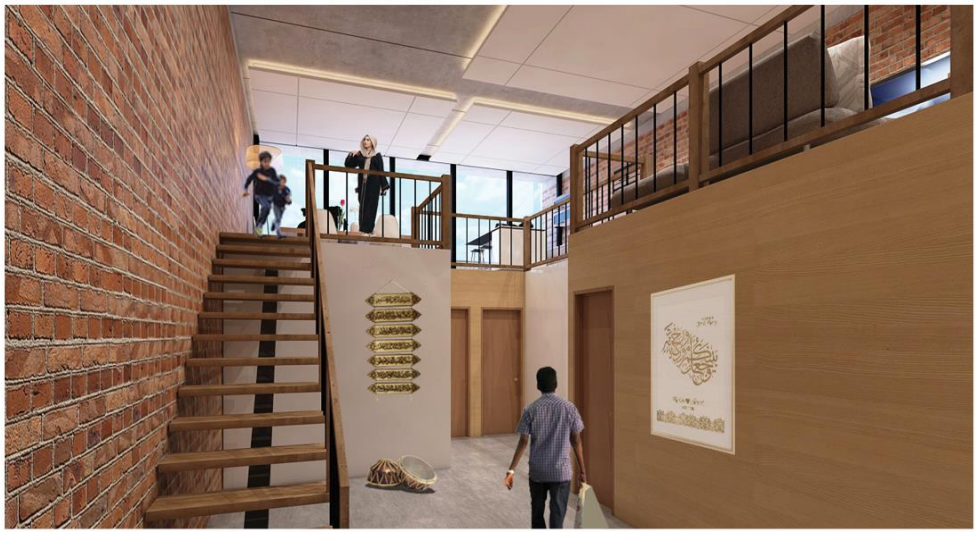


Figure 37 *(Typical interior view of one unit)*

Figure 38 *(Interior view of residential unit)*

Unit Type 2 Configurations

To further enhance the presence of variety, a similar assembly system is applied to a slightly longer unit footprint. This allows for the outdoor space to penetrate into the units and for voids to flow through the structure bringing in light and ventilation. The interaction of these longer units with the street is also different. This brings a variation in the urban experience throughout the development

Figure 39 *(Street view: Unit Type 1 (top) versus Unit Type 2 (Bottom))*

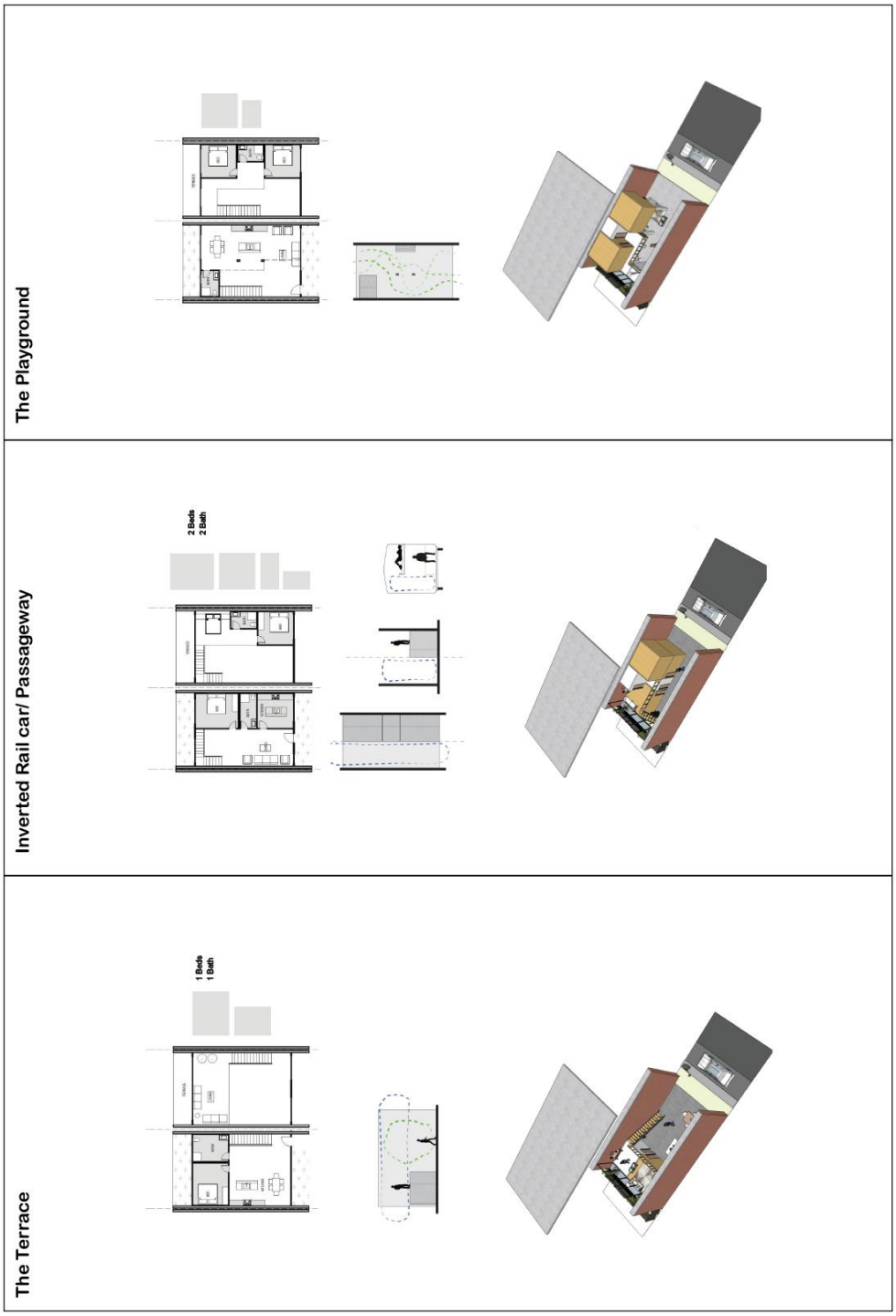


Figure 40 *(Unit Type 1 – Configurations 1)*

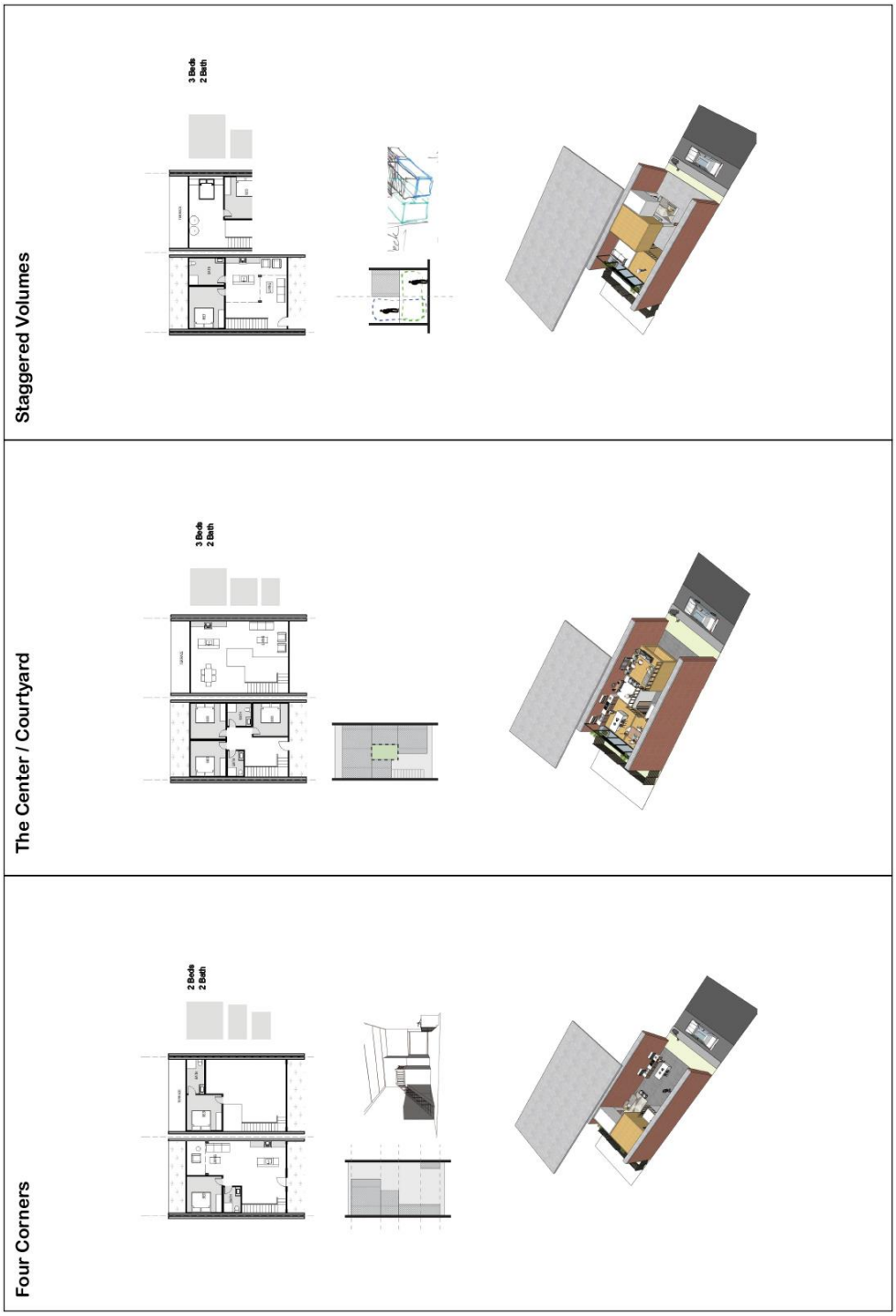


Figure 41 *(Unit Type 1 – Configurations 2)*

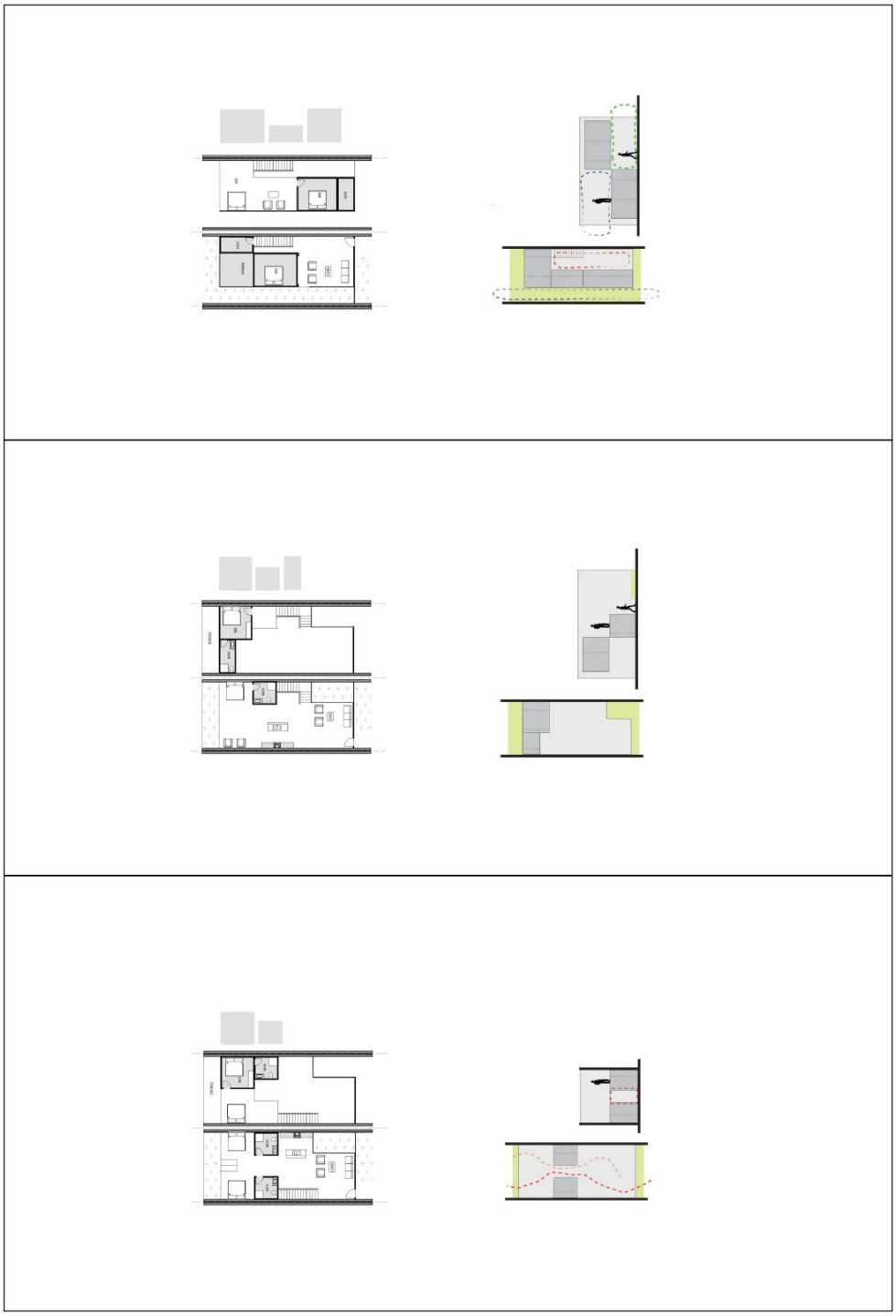


Figure 42 *(Unit Type 2 – Configurations 1)*

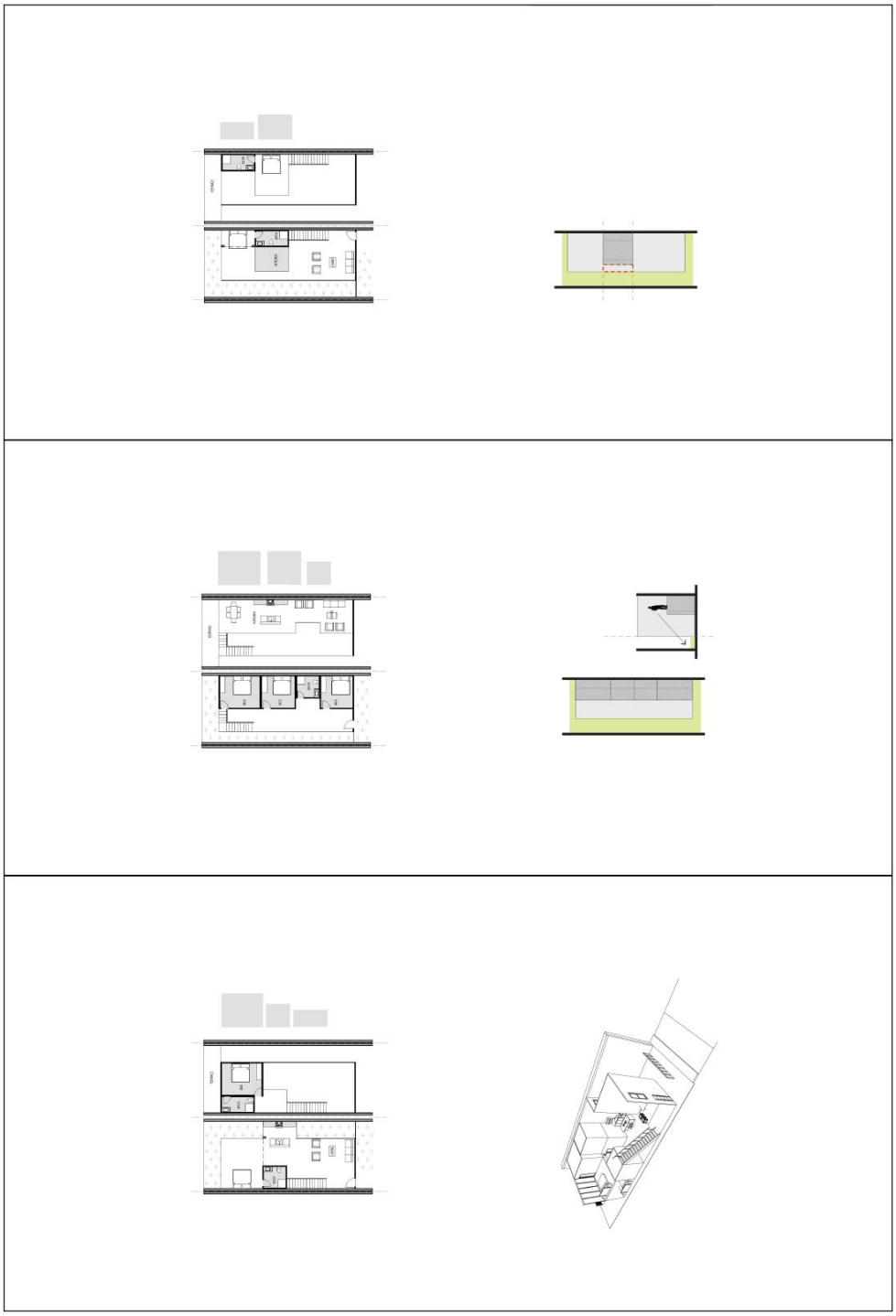


Figure 43 *(Unit Type 2 – Configurations 2)*

Typical Building

Figure 44 *(Proposed typical building floor plans)*

After looking at the units, how they come together to make a building must be explored. These units are stacked on top of one another. Each unit is accessed from the street side and exposed to the outside at the rear as well. The roof functions as a shared public space. A typical building is has a footprint of six building units connected with two circulation cores. The ground level units have walk up access and the ones above are accessed through the outdoor gallery. The circulation core of the building houses a garbage chute that is accessible from the rear for collection and a electric/utilities rooms and overhead water tanks at the top level.

Units closer to the gallery have public spaces towards the street side as a response to pedestrian traffic on the gallery level.

Figure 45 *(Building section showcasing unit stacking)*

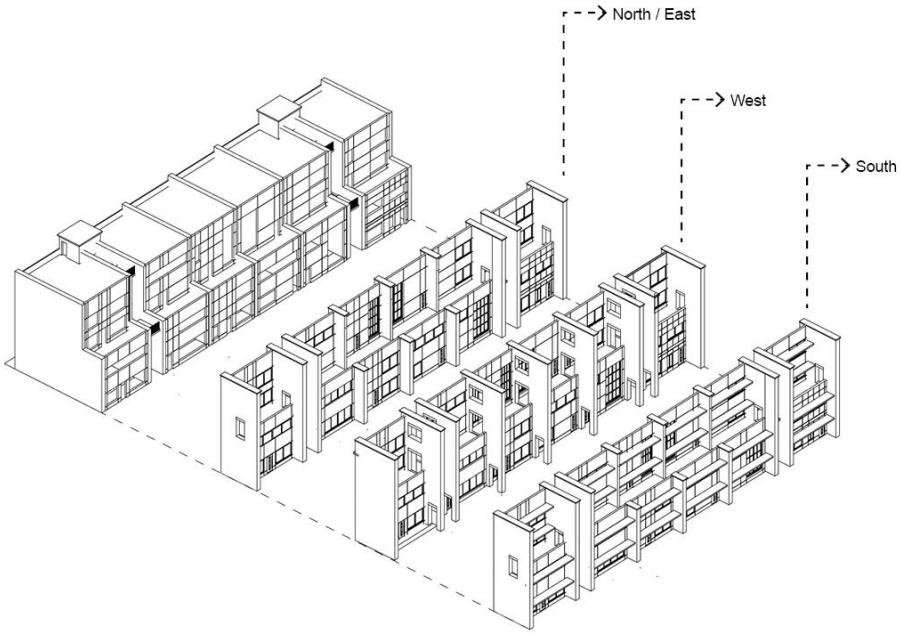


Figure 46 *(Façades respond to orientation)*

As units adapt to their positions within the building and the needs of the occupants, the overall building facades also change with respect to their orientation and changes in the interior space. Looking at the south facing façade, horizontal shading elements can be observed. They come about as a response to the sun's position in summer and winters.

The west façade is where the vertical walls protrude outwards, casting shadows on to the openings, shielding them from the evening sun.

The north and the east sides are more open to let light into the building.

Each building façade has a unique response to its orientation with respect to the sun. Three examples of facades adapting to their position in relation to the sun can be seen in the figure above,

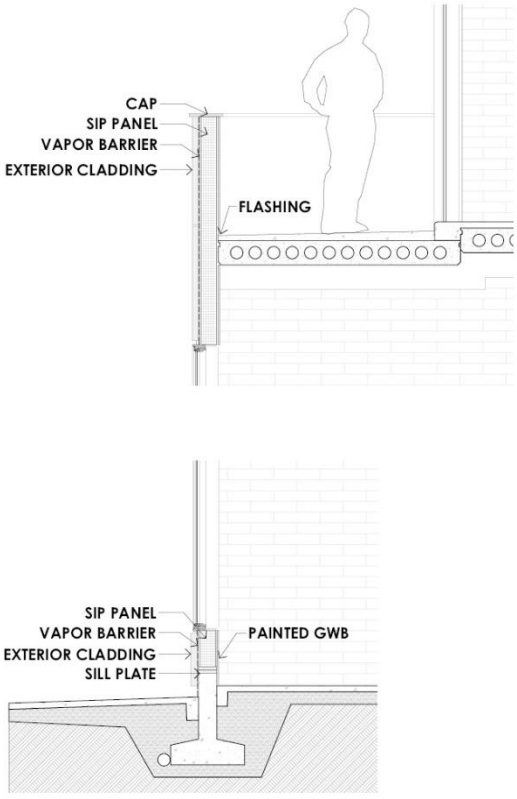


Figure 47 *(Proposed typical façade system)*

This in built responsiveness is made possible by designing the façade in a modular fashion with Structurally Insulated Panels (SIP). Theses SIPs sit on a concrete footing, with an applied skin of waterproofing membrane and cladding panels on the outside. The modularity of the façade allows for diversity. The integration with the overall assembly makes the facade responsive to the site. The cohesion of the building language and individuality of the units create for a sense of community and belonging. Diversity can be observed, where each unit is able to adapt to the needs of its occupants and its position in the context, while the assembly and the unit remain as a repeated concept creating consistency, solidarity and homogeneity.

Figure 48 *(Typical west facing façade)*

Figure 49 *(Typical Neighbourhood)*

Site Design

Responding to the Site

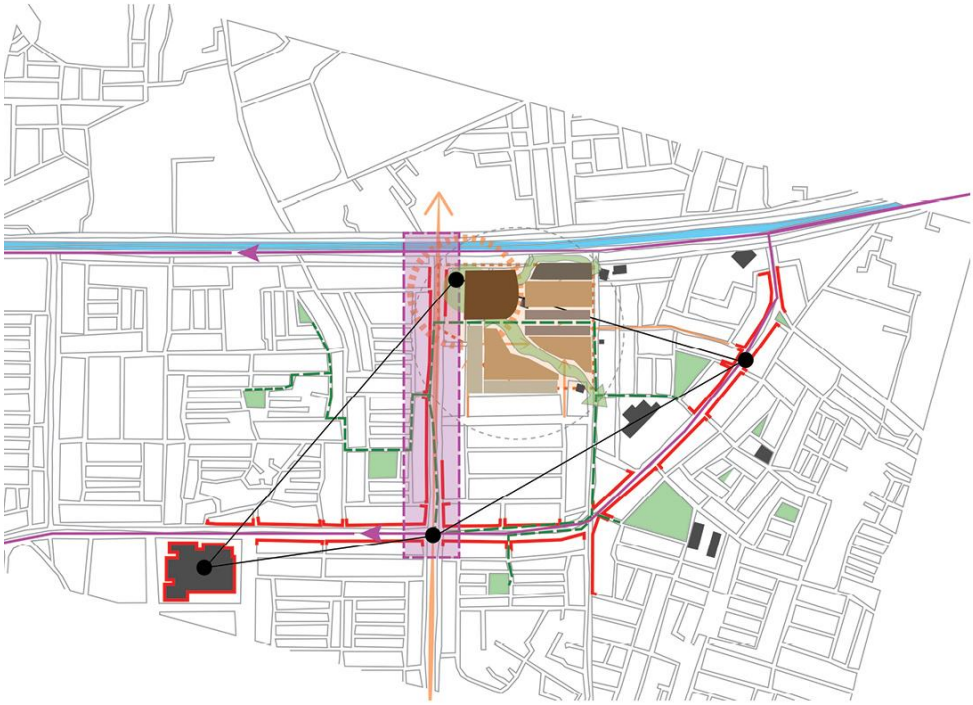


Figure 50 *(Master plan responding to site)*

The boundary of the site is marked with the dotted line. The black highlighted shapes are some of the important buildings in the context, including schools, mosque, a hospital and shopping malls. An active retail corridor (shown in red) exists on the periphery the site. A network of outdoor communal spaces is littered around the site (shown in green). Public transit routes (shown in purple) flow on both ends of the retail street, enhancing the importance of the north-west corner of the site. The big idea is to bring in the existing fabric of the context and establishing the north-west corner as a central public transit node for the region. Followed by connecting the green infrastructure on site and creating a walkway through the site, connecting the public transit node to the

context. Following that, the densities are programmed to flow from high density at the north and west edges to low density at the south and east to meet the density existing on site.

Proposed Master Plan

Figure 51 *(Proposed master plan)*

The proposed master plan showcases the green connections and the creation of neighborhood squares through the positioning of the building units discussed previously. The green connection is integrated into the grid of the fabric. The series of residential squares becomes the highlight of this community. Retail and service locations exist in central positions lining up the main street of the development that leads to the existing retail corridor. The wide corridors hold mixed use buildings with services and retail that facilitate the housing development. Looking at the location of the type one and type two units showcases the variety of housing types on an urban level just as it is on the unit level. The variation of building types and grouping of zones and the scale of the public spaces begin to define the experience of this neighborhood. A sense of community is

encouraged, through the residential squares, as building fronts on these square is optimized.

Figure 52 *(Proposed Street Views)*

Chapter 8: Conclusion

Vision for the Future

All of these features combined make this development truly a vision for a New Pakistan: where houses can be manufactured in controlled environments efficiently, then brought to site to be assembled easily and quickly; where mass produced houses have the inbuilt ability to adapt and change and allow for a healthy mix of personal expression and communal consistency.

The prefabricated system brings together the benefits and efficiency of mass production with the need for variety on an individual level whilst maintaining cohesion on the level the community.

Figure 53 *(Typical Residential Square)*

Bibliography

Bachelard, Gaston, and John R Stilgoe. *The Poetics of Space*. Translated by M Jolas. 1994th ed. Boston, Massachusetts: Beacon Press, 1994.

Akram, Muhammad and Anser Mahmoos. *The Status of teaching in Pakistan, Language in India*, Volume 7: 12 Dec 2007.

Archdaily, *Dymaxion house*. Retrieved from: https://www.archdaily.com/401528/ad-classics-the-dymaxion-house-buckminster-fuller

Bachelard, Gaston and John R Stilgoe. *The Poetics of Space*. Boston, Massachusetts: Beacon Press, 1994.

Brower, Sidney N. *Good Neighborhoods: A Study of In-Town & Suburban Residential Environments*. Westport, Conn.: Praeger, 1996.

Brower, Sidney N. *Neighbors and Neighborhoods: Elements of Successful Community Design*. Chicago, IL: APA Planners Press, 2011.

Bukhari, Mubasher. *Schools shut in Lahore as city chokes in toxic smog*, Reuters. updated: November 22, 2019. Accessed 17 May, 2020.

Burkhart, Bryan and Allison Arieff. *Prefab*. United States: Gibbs Smith, 2002

Colvin, Sarah. "*Manufactured homes and their communities: mobility of an American vernacular*" Master of Architecture Thesis, University of Maryland (College Park, Md.), 2011, (2012-02-17T07:16:22Z)

"FlatPak" Aceessed on May 17, 2020. https://www.flatpakhouse.com/

Friedman, John and John Miller Jr. *The urban field.* Journal of the American Institute of Planners. 31 November 1965.

Fuller, Buckminster. *Lightful towers.* Retrieved from: https://blogs.uoregon.edu/dymaxionhouse/4d-becomes-dymaxion/

Glover, William J. *Making Lahore Modern : Constructing and Imagining a Colonial City*. Minneapolis: University of Minnesota Press, 2008.

Gorman, Michael John. *Buckminster Fuller: Designing for Mobility*. Italy:Milan 2005.

Gropius, Walter. *Toerten houses*. Retrieved from: https://www.bauhaus-dessau.de

Hart, John Fraser. Michelle J. Rhodes, and John Morgan. *The Unknown World of the Mobile Home.* Baltimore: Johns Hopkins UP, 2002.

Kaufmann, Michelle, and Catherine Remick. *Prefab Green. 1st ed*. Layton, UT: Gibbs Smith, 2009.

Kieran, Stephen, and James Timberlake. *Refabricating Architecture : How Manufacturing Methodologies Are Poised to Transform Building Construction*. New York: McGraw-Hill, 2004.

Kieran & Timberlake Associates' *Cellophane house*. Retrieved from: https://kierantimberlake.com/pages/view/14/

Kraushar-Plantholt, Victoria Kathleen. "*Rethinking the American house: expandable-life-cycle houses in suburban context*" Master of Architecture Thesis, University of Maryland (College Park, Md.), 2011, (2011-10-08T06:31:40Z).

Kullman Bathroom Pods. Retrieved from: http://www.modular.org/images/Bathroom%20Pods%20Whitepaper%20Dec16.pdf

Lahore Electric Supply Company, *Electricity demand forecast based on power market survey, period 2014-2024.* 24th issue. LESCO and NTDC. May 2015.

Lahore air remains 'hazardous' as Air Quality Index hits 447, Dawn.com. Updated: November 13, 2019. Accessed 17 May, 2020

Lahore Development Authority, Lahore 2025. Retrieved from: https://www.lda.gop.pk/page.php?p=TWpjeQ==

LaRusso, Adam Nicholas. "Disaster Relief: A System for Recovery" Master of Architecture Thesis, University of Maryland (College Park, Md.), 2011, (2012-02-17T07:16:48Z).

Le Corbusier, *vers une Architecture*. 1923. Quoted in K. Frampton, Modern Architecture. London 1992.

Le Corbusier, *Towards a New Architecture*. New York: Praeger, 1970.

L. Jaillon, *Quantifying the waste reduction potential of using prefabrication in building construction*. Waste management. Volume 29 issue 1. January 2009.

Naya Pakistan Housing Proposal by the Government. Retrieved from: http://www.fgeha.gov.pk/naya-pakistan-housing-scheme/

Pallasmaa, Juhani "*Identity, Intimacy and Domicile; Notes on the Phenomenology of Home.*" 1994.

"*Prefabricated: Definition in the Cambridge English Dictionary*." Accessed May 15, 2020. https://dictionary.cambridge.org/us/dictionary/english/prefabricated.

Qureshi, Rabia Ahmed. "*The traditional courtyard house of Lahore: an analysis with respect to Deep Beauty and sustainability*" Master of Science Thesis, Kansas State University (Manhattan), 2015 (2015-04-27T15:33:50Z).

Shelton, Barrie. *Learning from the Japanese City: West Meets East in Urban Design*. London: E & FN Spon, 1999.

Sulzer, Peter and Erika Sulzer-Kleinemeier. *Jean Prouvé, Highlights: 1917-1944.* Basel, Boston: Birkhäuser, 2002.

The general panel system locks together like a Chinese puzzle. Image Source: Architectural Forum, February, 1947.

The Washington Post Company, Washington DC Map, Retrieved from: https://www.washingtonpost.com/wp-srv/metro/specials/theguide/maps05/dc_anc.html

Watkins, A.M. *The Complete Guide to Factory-Made Houses*. Chicago: Longman Financial Services Publishing, Inc., 1988.

Wissinger, Joanna, and Philip Lief Group. *The Best Kit Homes : Save Time and Money on Your Customized Dream House.* Emmaus, Pa.: Rodale Press, 1987.

Walis, Allan D. "*House Trailers: Innovation And Accommodation in Vernacular Housing*." Perspectives in Vernacular Architecture 3. 1989.

Walis, Allan D. "*House Trailers: Innovation And Accommodation in Vernacular Housing*." Perspectives in Vernacular Architecture 3. 1989.

Y. Luo, D. R. Riley, M. J. Horman and G. O. Kremer, *Decision Support Methodology for Prefabrication Decisions on Green Building Projects.* Salford, United Kingdom: Symposium on sustainability and value through construction procurement, 2006.