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Approaching Module based Vertical Mesh System for Green Living in Densely-Populated Zone: A Study on Lower Middle-Income Group, Bangladesh

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Abstract: ***It is a conceptual vision for future Domestic living space that is dreamed and designed in a modular approach conceiving the idea of vertical prototype suiting any location, based on the aim to fulfil daily need of the occupants of a single-family at their single individual module that enables the occupants to engage in effective economic activities employing minimum space, in order to solve the prevailing population problem in Bangladesh and similar dense populated regions in the world. Keeping pace with salient advancement and high-rise culture, the notion of self-sufficient living is being denied and rejected. This vision led to the initial mock-up idea of the metamorphosis of living modules in proportion with population demand. The over-dependency on technology and digitalization is annihilating our Bengali middle-income culture, terminating the intimate bonding of "para" "mohalla" a vibrant neighbourhood, pushing them towards social alienation. The lanes which used to buzz with child cricket matches' excitement are now empty as they are busy with the small screens in their own cubicles. In the aspect of our social stratification, the lower-middle-income people are the most struggle some in terms of compromising their dream and desire, to balance their affordability and to maintain their self-esteem, which lies within the bond they share between the neighbourhood, which is turning to a dead culture. And that is the main reason for the loss of unity, brotherhood, "eyes on the street" culture to ensure safety against crime. The research paper shows the design concept of a housing system from horizontal to vertical where meets the accommodation with balancing social interactions in Bangladesh.***

Keywords: Modular living, development, population, metamorphosis, affordability, architecture, housing, social interaction, culture, future, sustainability, economic development

I. INTRODUCTION

A. Background

The current population of Bangladesh is 164,654,303 as of Wednesday, June 24, 2020, based on World meter elaboration of the latest United Nations data.[1]

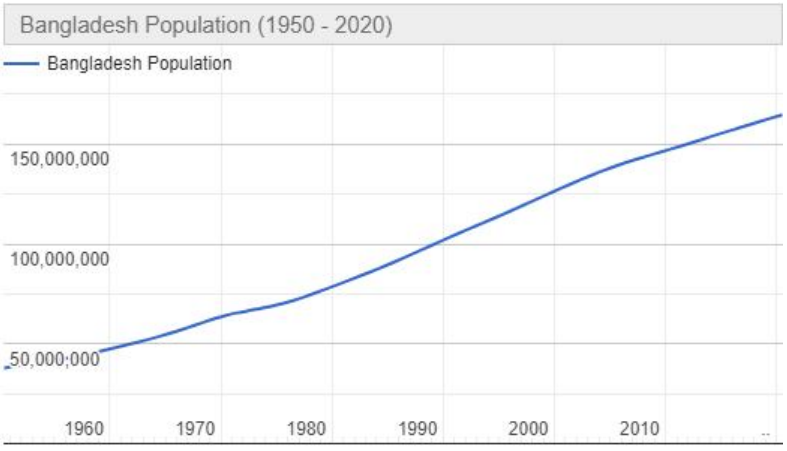

Figure 1 : Population graph (1950-2020)
Source: http://www.worldometers.info/world-population/

The population is equivalent to 2.11% of the total world population with the density of 1265 per Km2 (3,277 people per mi2) in Bangladesh according to UN. Dhaka the capital has the highest number (10,356,500) of population among other cities. People are turning from rural to urban areas daily. The most exceedingly terrible issue looked by the urban populace is the fundamental housing lack. This shortage primarily affects middle-income and low-income groups. Developers within the country's main cities do an excellent job of providing to the housing needs of the affluent sections of the population. They serve customers who can purchase apartments or houses that they need re-sources to pay either within the short term or the long run. But the non-affluent people in the cities certainly need housing finance on particularly easy terms and conditions. During this area, institutions like the govt itself and donor agencies can close to supply an explanation.

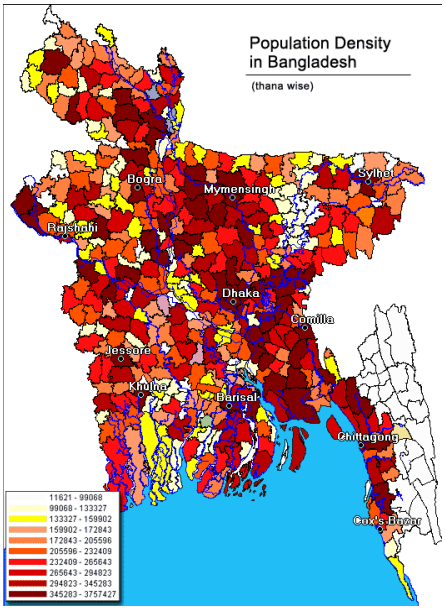

Figure 2: Population density map

Source: https://www.assignmentpoint.com/other/population-of-bangladesh-a-problem-or-prospect.html

B. Present Housing Situation of Bangladesh

Housing is as equally essential as food and clothing. It provides shelter, safety and a way of be-longingness to the owner. It also promotes health and luxury and provides a basis for employment and income generation. Housing is taken under consideration to be a worldwide obstacle all around the world. In many cities of developing countries, up to half of the urban population lives in slums and squatters. Dhaka, being no exception to the present problem, also faces a drag in providing proper shelter at an affordable rate to all or any of its inhabitants since there are three different major income groups living here. Being of more exceptional economic ability and of a minute part of city dwellers a lot of housing options are available to High Income Group (monthly income bracket Tk.82,000- 100,000+) 1. The Middle-Income Group (MIG- Tk.7000- 82,000)1 being a majority, 50% of the total population is considered the driving force for the city ‘s overall development process. In the Middle-Income category, there are two divisions (i) Higher Middle Income, who can manage housing by themselves (ii) Lower-Middle Income (Tk. 7000 – 27,000/ month) 1, who comprises 20%, a majority fraction of Dhaka city ‘s households, have a severe problem in accessing housing at present market price. The Low-Income Group (LIG- Tk.<2,500- 7,000) 1 comprises of Hardcore and Moderate Poor face even worse situations in having access to permanent housing although many NGOs, the Government body, and other housing providers are trying to work for them. [Asma Akter,2013]

C. Target Group Analysis (Lower Middle-Income group)

As put by Edward L. Glaeser and Joseph Gyourko, 2003, ‘A housing affordability crisis means that housing is expensive relative to its fundamental costs of production—not that people are poor’.

Research has been conducted to find the means to make housing affordable to the low-income group –moderate and hardcore, (Islam and Shafi, 2008). Still, there are not many records of studies on making housing affordable separately to the low-middle income division of Middle-Income Group of the city. The low middle-income households do not comfortably fit within the middle-income group as their financial capabilities are much less than the other fractions of Middle Income.

Somehow statements are made en-compassing them; 'the low and middle-income families require low-cost flats or plots, and the high and upper-middle-income families are complaining that the cost of a decent plot or a decent flat is going beyond their means (Seraj,2001)'. Educational background of the target group isn't stable. Most of the people in this class are illiterate, and others are less educated. The variation of the profession during this class is significant. Shopkeeper, laundry owner, teamster, an auto-rickshaw driver, small business owner, barber, carpenter, masonry, govt service holder, food court hawker, medical stuff etc. belong during this class. Monthly savings of the target people is extremely little due to their housing and non-housing expenditure.

II. LITERATURE REVIEW

A. Definition of Housing by WHO

World Health Organization (WHO) defined HOUSING as "an enclosed environment in which man finds protection and feels safe and secured from hostile forces and can function with increased comfort and satisfaction as regards to privacy to the individual and his family. The environment must include all necessity, services, facilities, equipment and devices needed for the physical and social well-being of the family or the individual". In the above definition, Housing has been conceived as `an environment'. So, it is seen that in a micro and macro scale, Housing needs to ensure the following:

1) An enclosed environment, protected and Safe
2) Comfort and Privacy
3) Ensures Services, Facilities.

B. Housing Standards

Housing provides psychological support to a person, a sense of security, and wellbeing that relieves one from mental stress, which might be an impediment against an individual's social and personal achievements. As Maslow suggests that —before more sophisticated, higher-order needs can be met, certain primary needs must be satisfied (Maslow, 1970, 1987) and therefore, Maslow's model places —safety, love and belongingness right after physiological needs, i.e., food, water, and sleep, etc.

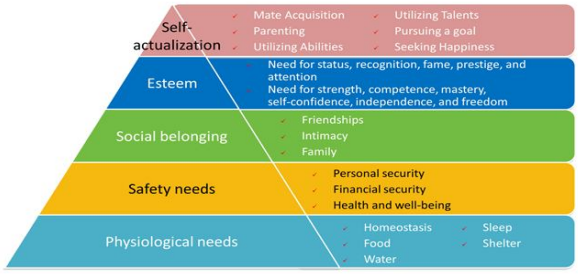

Figure 3 : Maslow's hierarchy needs
Source: https://yourfreetemplates.com/maslows-hierarchy-needs-template/

From this pyramid Fig 3 of human needs, it is proved that these basic physiological and human needs pro-mote higher-order needs. And housing is the individual device to provide this sense of security and belonging-ness since it helps a whole family and its alliances; it is where the members of a family share their sentiments and memories.

Community Facilities	Size of Population									Facility per 1000 Population
	2500	5000	10000	15000	20000	25000	50000	100000	150000	
EDUCATION										
Nursery	0.2	0.4	0.8	1.2	1.6	2.0	4.0	8.0	12.0	0.08
Primary School	0.3	0.6	1.0	1.2	1.6	2.0	4.0	8.0	12.0	0.08
Secondary School			1.2	1.5	2.0	2.5	5.0	10.0	15.0	0.10
College*				1.2	1.6	2.0	4.0	8.0	12.0	0.08
HEALTH										
Small Clinic*				0.6	0.8	1.0	2.0			0.04
Hospital*								4.0	6.0	0.04
COMMUNITY ORGANIZATION										
Community Center/Mosque	0.1	0.2	0.5	0.6	0.8	1.0	2.0	4.0	6.0	0.04
RECRIATION										
Play-Ground/ Play-field	0.5	1.0	1.0	1.2	1.6	2.0	4.0	8.0	12.0	0.08
Park	0.5	1.0	1.5	1.8	2.4	3.0	6.0	12.0	18.0	0.12
COMMERCIAL										
Corner Shop/ Market/Kutcha Bazar*	0.2	0.3	0.5	0.6	0.8	1.0	2.0	4.0	6.0	0.04
ROADS										
Residential Roads**	0.9	1.7	3.5	5.0	6.8	8.5	17.0	34.0	51.0	0.34
Total Area for community Facilities (minimum)	2.7	5.2	10.0	14.90	20.0	25.0	50.0	100.0	150.0	1.00
Net Residential Area	4.44	9.08	18.5	27.93	37.14	46.43	92.85	185.71	278.57	
Gross Residential Area	7.14	14.28	28.57	42.83	57.14	71.43	142.85	285.71	428.57	
Persons per Area	350	350	350	350	350	350	350	350	350	

Figure 4 : Showing Space Standards for Urban Community Facilities in acres by Population size
Source:https://www.coursehero.com/file/pvd5ls/SPACE-STANDARDS-FOR-URBAN-COMMUNITY-FACILITIES-IN-ACRES-BY-POPULATION-SIZE/

C. Case Study

Correa has designed several houses with a variety of generation method. The forms are mostly basic and the generations can be grouped as linear generations, grouped or clustered generations, and chainlike generations. In some settlements, only a single type of module is used while on the others various modules (units with a variety of fields) can be seen (fig. 5) [2]

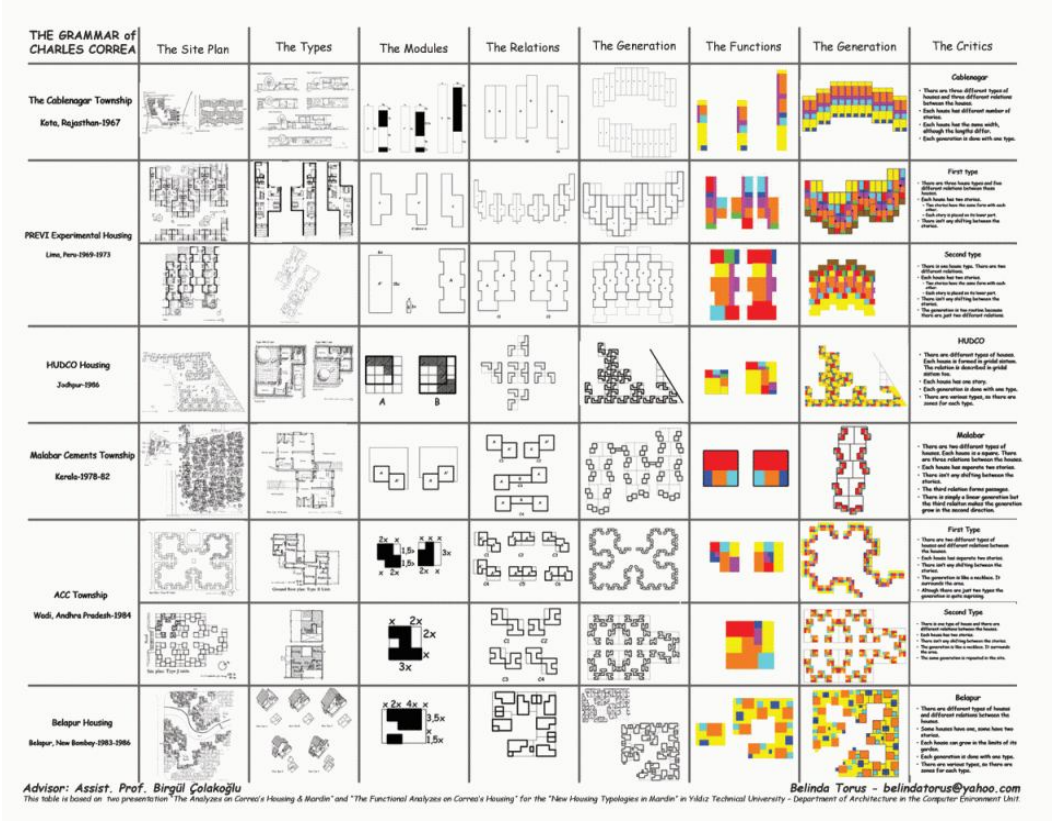

Figure 5 : Charles Correa's housing language

III.PROBLEM DESCRIPTION

The largest countries in the world in terms of population are China and India, with both now having populations of well over a billion.

Table :03 **Income Groups and their Distribution in Dhaka City Corporation (DCC)**

Income Group		Monthly Household Income in Taka	Households Percent	
Low Income Group	Hardcore Poor	<2500	25	40
	Moderate Poor/Low Income	2500-5000	15	
Middle Income Group	**Low Middle Income**	**5000-10,000**	**20**	50
	Middle Middle Income	10,000-25,000	20	
	Upper Middle	25,000-50,000	10	
High Income Group	Lower High	50,000-100,000	7	10
	Upper High	100,000+	3	

Source: Islam and Shafi, 2008 and RAJUK, 2010.

Figure 6 : Income groups and their distribution in Dhaka City Corporation (DCC)

It seems that not having established the high performance of industrialization corresponding to their population, and therefore they lead a medium to the low standard of living. As a developing country, Bangladesh has a housing problem in urban areas. Housing problems in urban-like other developing countries. As a result, serious problems have emerged over the years regarding housing provision and other related ser-vices for the city dwellers, particularly for lower-middle-income people. Due to the enormous population growth in Bangladesh in the past decades, it is almost impossible on the part of the government to ensure housing for all.

As the public sector failed to provide their right, people themselves have taken the initiative to ensure their fundamental need for shelter. In order to meet the ever-increasing demand for residential accommodation in the limited land of Bangladesh the construction of apartment buildings was a natural and viable solution with natural consequences.

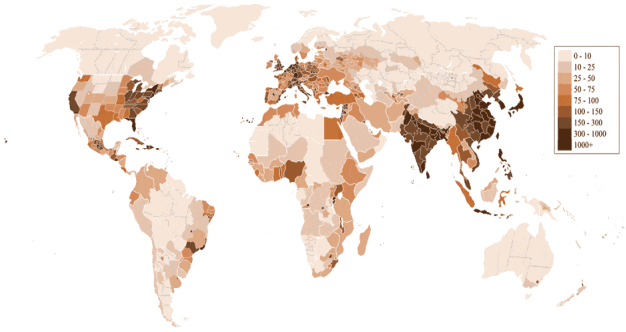

Figure 7 : World map of population density

At the beginning most of the developers aimed to cater the upper income group of the society. But recently the private housing companies also started to construct apartment for the middle-income people who are the larg-est segment of population (about 50 percent) of Bangladesh.Another Problem that we face in our society is Interaction among all group of people as well as all the generation.People becoming socially more introvert nowadays. They hardly know each other even who's living to the next door. Designing the space to interact people with each other was another consideration of this project.

The major focuses of this research are:

1) To investigate the issues related with housing standard expected by the lower middle-income group.
2) To study the affordability of the lower middle-income group to meet the housing cost
3) Accommodate a dense population into a delineated space while ensuring the social interaction.

IV. RESEARCH OBJECTIVES

While seeking a solution to reside a great number of populations underlining the parameters of affordability, compact yet a healthy living situation, sustainability, this research conducted a goal to create a universal platform for the unprivileged through a balance of an eco-friendly environment introducing them with advanced technology. It is A modular approach where self-sufficient and autonomous living modules are comprised into a framing system that can be varied according to the population demand by addition and subtraction of living modules. There was also an attempt to solve the psychological crisis of lower middle-income group, they are not solvent enough like upper income group to fulfil their every dream and desire, neither allowed to expose their financial crisis and subjected to the vulnerability of maintaining a certain social status like lower income ones. So, the aim was to providing the maximum facility and comfort within an economic budget for the lower middle-income people, the additional subsidy required to provide the facility would be generated from an autonomous green cycle of activity by the dwellers themselves. Thus, the method-ology was derived to run an interactive and active living system. Now a days with prosper of technology, social alienation is growing as an alarming problem, people are consorted in their cubicle rather than committing to nature, society and the environment. The living system would contain hierarchy of breathing spaces leading to a "Central Hub" that contains recreational (clubs, museum, café, libraries), economical (bank, market, office, shopping mall), religious (mosque, church etc), health (hospital, day care etc), educational (school, college etc) concentrating around a vibrant public space. This coherent plug-in system can be incorporated in a city level platform to ensure a better standard of living, balancing the social stratification and an initiation of green architecture and technology. We expect the system to deliver a vivid neighbourhood coexisting with its pristine culture, participating in the change of their economical predicament.

V. METHODOLOGY

The methodology is or any sort of exploration or undertaking to hold the objective of the work and methodical acquire the entire technique a nutshell. The Data assortment and examination of this diary depended on subjective information. This approach of design is conceptual. Various data collected by online survey and study. Problem is deducted by present situation. This approach is a solution for a better living and accommodation for lower middle-income group in Bangladesh.

VI. DESIGN PROCESS

A. Modular Container Settlement-Where the Story Begins

A modular approach is an attempt to looking at the problem from a functional approach, studying the basic ergonomics to determine the optimum space required for a family of target group to function (sleeping, working, cooking) moderately to ascertain the minimum wastage of space.

In the 1920s, master architect Le Corbusier published his own influential book, Toward an Architecture, in which he famously wrote “Une maison est une machine-à-habiter” (“A house is a machine for living in”). It reflects the functionalist vision of modern architecture that can also effectively solve the space and resource shortage crisis. Being settled to conduct the research in a modular approach, the challenge was to selecting the material to suit the design, that would allow us the flexibility to alter the modules, consist of low self-weight to permit volumetric expansion, minimal thickness of facades providing maximum clear spans and aids to the assembling and dismantling operation.

Table 1 Comparison of cost with a typical 800sft apartment with a container made apartment

Material type	Estimated building cost (taka)	Remarks
Typical studio apartment	1,60,000/-	Cost reduced by 33%
Container apartment	1,20,000/-	

A typical second hand container of 40’ costs 70,000taka [3]
and cement would cost around 1.6 lac taka.
So, beside flexibility, container home can reduce the cost therefore rent up to 33%. [4]

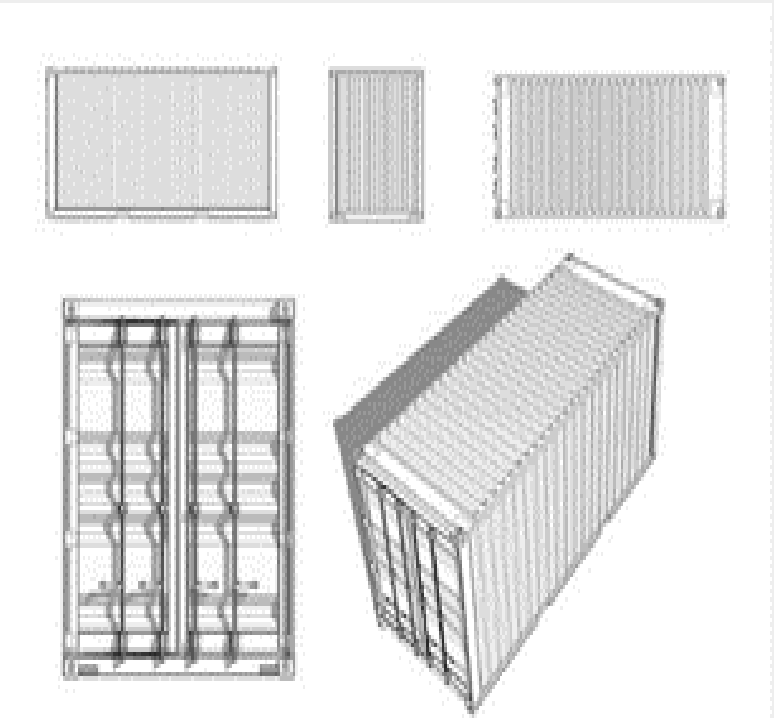

Figure 8 :Typical Container module
Source :https://www.yumpu.com/en/document/view/51242729/shipping-container-technical-drawings-20gp-spatial-design-

Architecture using steel intermodal containers (shipping containers) as structural element. Using steel intermodal containers (shipping containers) as structural element. The use of containers as a building material has grown in popularity over the past several years due to their inherent strength, wide availability, and relatively low expense. Homes have also been built with containers because they are seen as more eco-friendly than traditional building materials such as brick and cement.

Containers being available in 3 different sizes, provides the advantage to oscillate the spaces for whether it is a single person living module or multiple family living module claiming different space requirements.

Figure 9 : Available container sizes
Source : https://portshippingcontainers.com.au/shipping-container-dimensions.html)

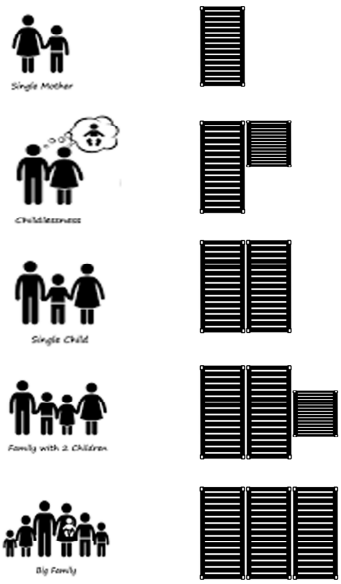

Figure 10 : metamorphosis of container modules for different family

Figure 11 : Inside view
Source: Internet

This housing modules were stacked and studied to achieve the maximum green roof spaces so that the vertical settlement can accommodate all means of a village life serving the subdued class, labors and farmers by generating income and providing community space to enrich them both economically and culturally.

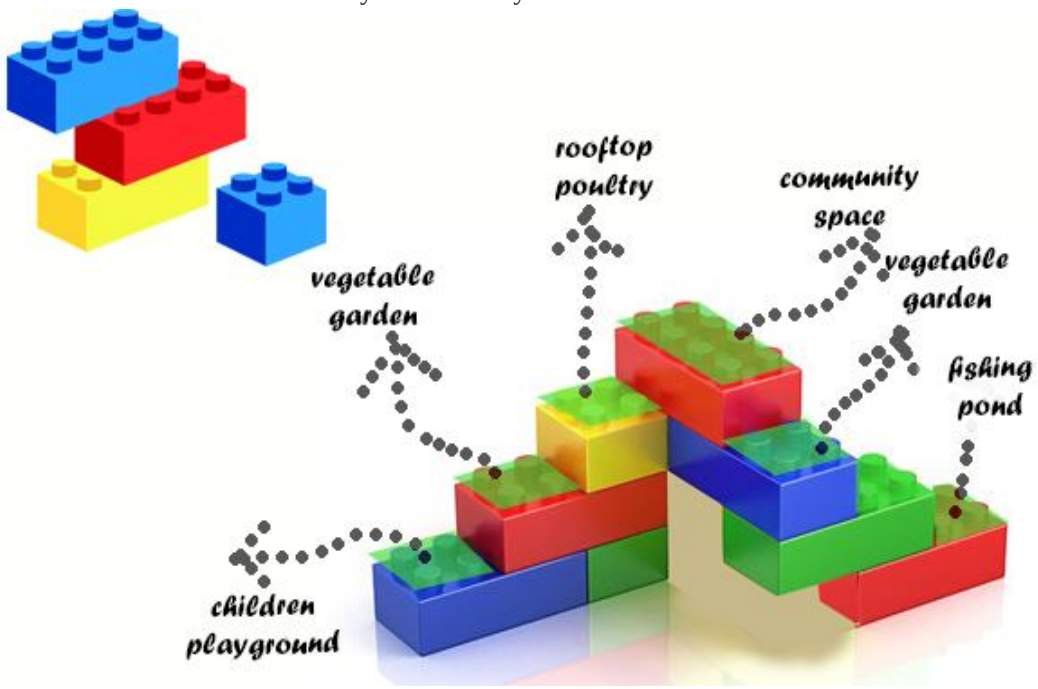

Figure 12 : Modules as 'Lego pieces'

We considered the container living modules as “Lego pieces” and stacked them vertically which automatically generated the usable rooftop spaces as the top surface of a module served the terrace for the module located in upper level due to the stacking effect.

B. Design Phase

A framing system will be established for every cluster of housing at the initial stage. Living modules will be inserted into this framing structure as per requirement of the number of settlers to be accommodated. When the population density is at initial state, adequate number of modules will be posted in the precast framing system, while the supplementary voids of frame can contribute as playful station for children, cultivated as vertical green blending with the residences or even host clubs, programs or cultural spaces subscribing the urban fabric. We have studied with some physical models to show the different permutations with container modules possible in a building cluster.

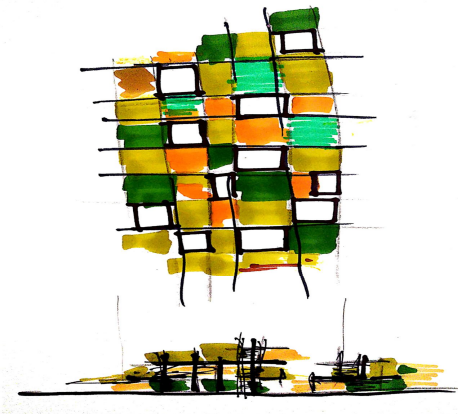

Figure 13 : Conceptual Sketch

According to design, modular container will be set one by in to the base structure. Modular can be design regarding the needs of a family. According to family member this modular can be modified.

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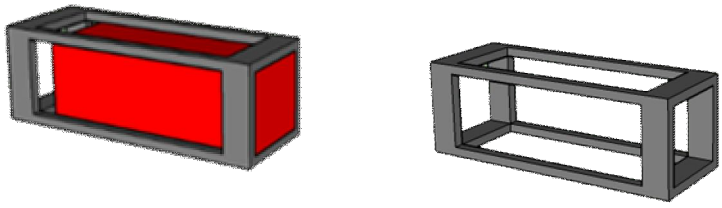

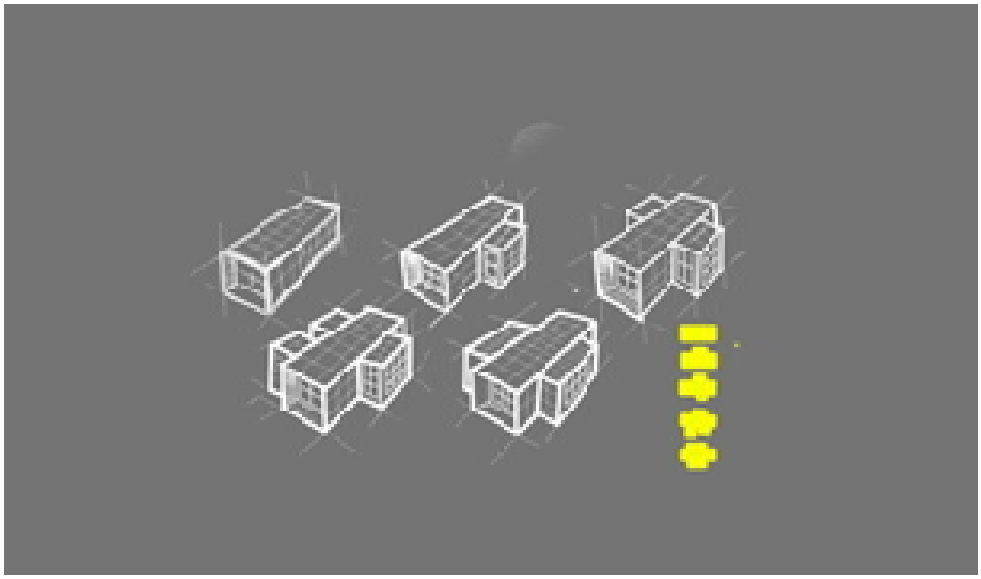

Figure 14 : Module Design as per need

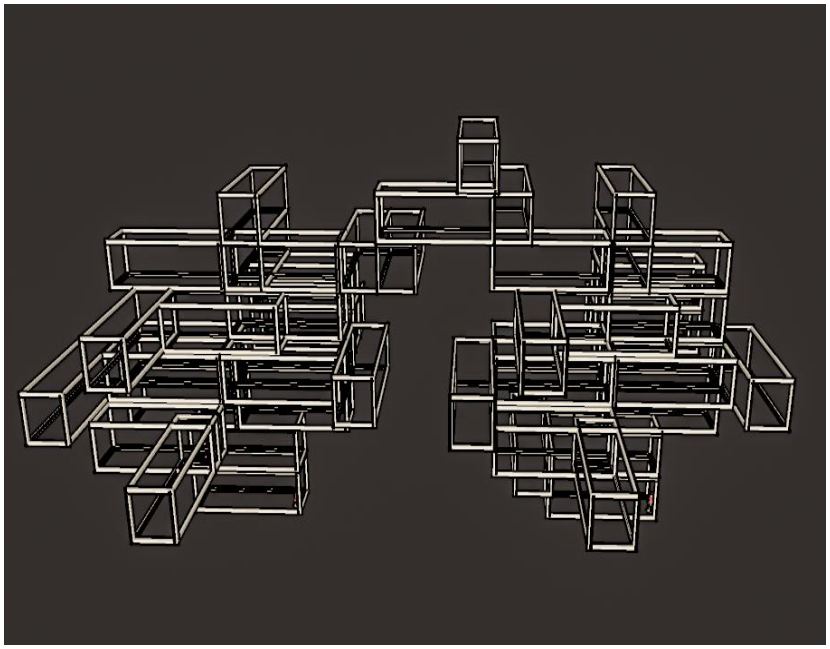

Figure 15 : Initial Structural Frame

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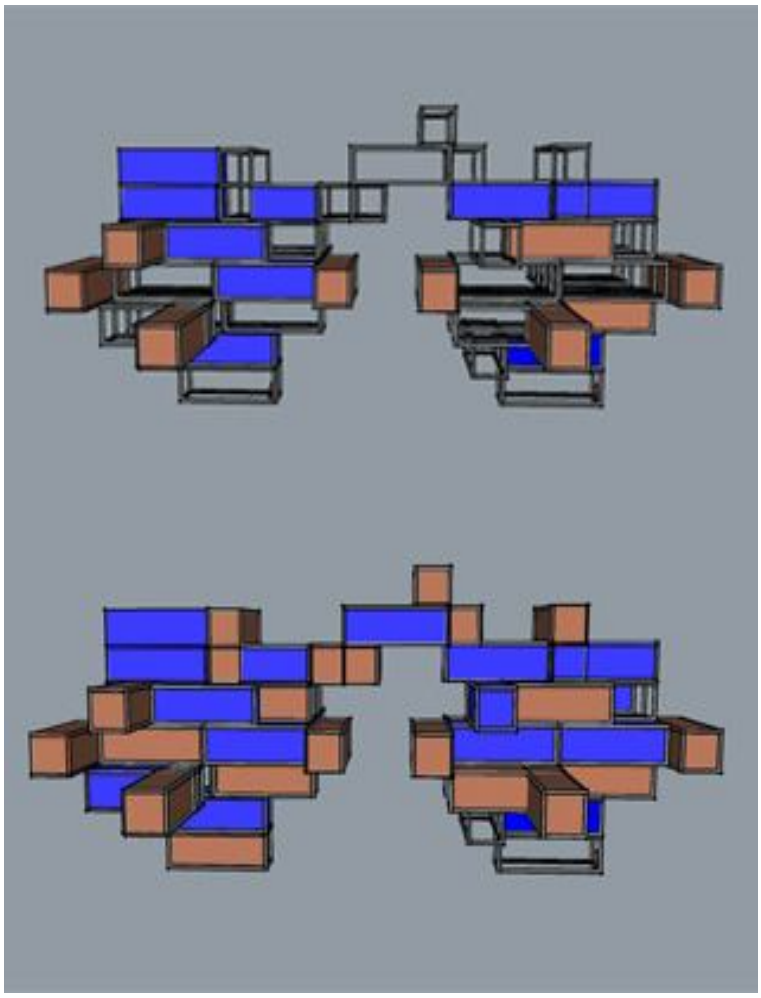

Figure 16 : Showing module installation during (i) the population is sparse (ii) the population is dense
Source :Authors (conceptual study)

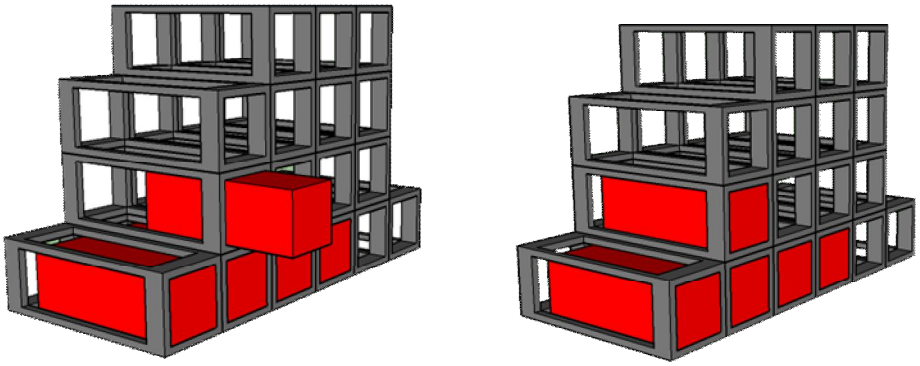

Figure 17 : Add or extract Module
Source :Authors (conceptual study)

The problems facing the world now, and soon it will grow day by day, it will be problematic to provide places, specifically in urban centers. This design will to input containers if needed in future due to demand.

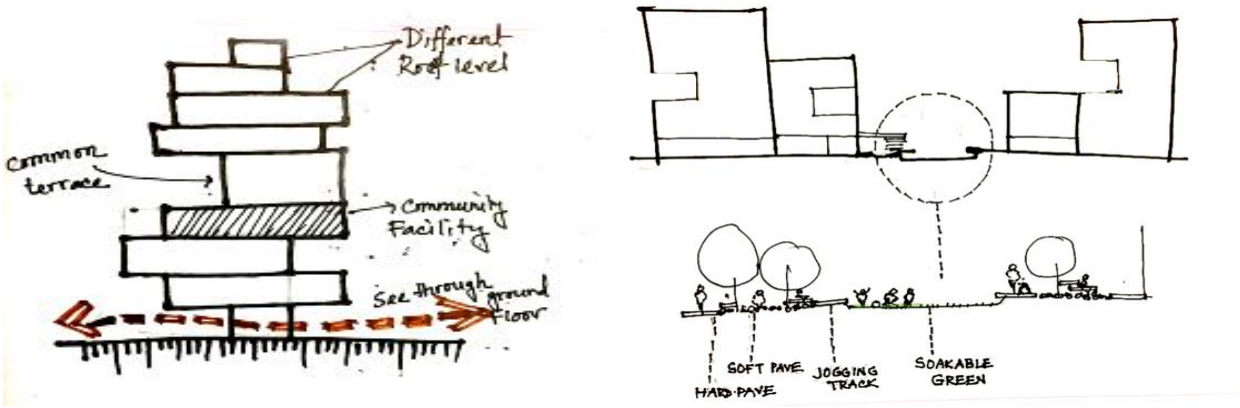

Figure 18: Conceptual sketches
Source :Authors (conceptual study)

Only providing 8" earth filled elevated terrace which is a common practice is not rather making people alienated, detached from each other, so we wanted to bring people to a central hub to meet the daily needs and both recreational purposes, so that meeting people once a while enhance the interact.

VII. FUTURE SCOPE

The research study aims to continue with the concept of zero waste smart city into reality. By fulfilling the needs of zero waste smart city, there should be a particular way that has given thought to prepare pre-formal work by phasing small areas refers to clusters, from City vision to community, and then to the community to unit scale. It will show this future vision of domestic spaces, which can effort the daily needs through an established technological cycle that would automate the cycle of production and income generation to add value to the traditional style of design. The vision will provide the analytical data indicating the ratio of the population this system would accommodate comparing to the conventional approach ensuring the social interaction, cultural integrity, and affordability of Middle-Income Group.

VIII. CONCLUSIONS

As a result, the population problem has a great impact on the housing sector. The requirement of houses depends on the population of a country. The more the number of people, the greater will be the requirement for houses. But when the demands cannot mobilize, people have to compromise with the standard of living. Every Government of every nation is trying to provide the highest possible facilities for the betterment of living standards. But almost every country, especially the undeveloped and developing countries, are failing to make adequate preparation due to lack of proper planning, population growth, budget shortage, insufficient use of construction technologies. The city planning should be accumulating with the functional zoning with different zone like Residential, Industrial, Educational, Parks, Forests, Playground, etc. Which is actually will create an individual hub. These modules can be constructed with the help of advanced construction technology. To establish this modular planning, it is necessary to standardize the system of modular housing worldwide. It can be changed as per the convenience essential like Transportation (both underground and over ground), Structural needs (foundation works underground and building structures over ground), Infrastructures (playgrounds, ponds, forests, etc.)It's like a framing system where modules can be added or subtracted from the frame structure very easily as per need due to population growth rate.

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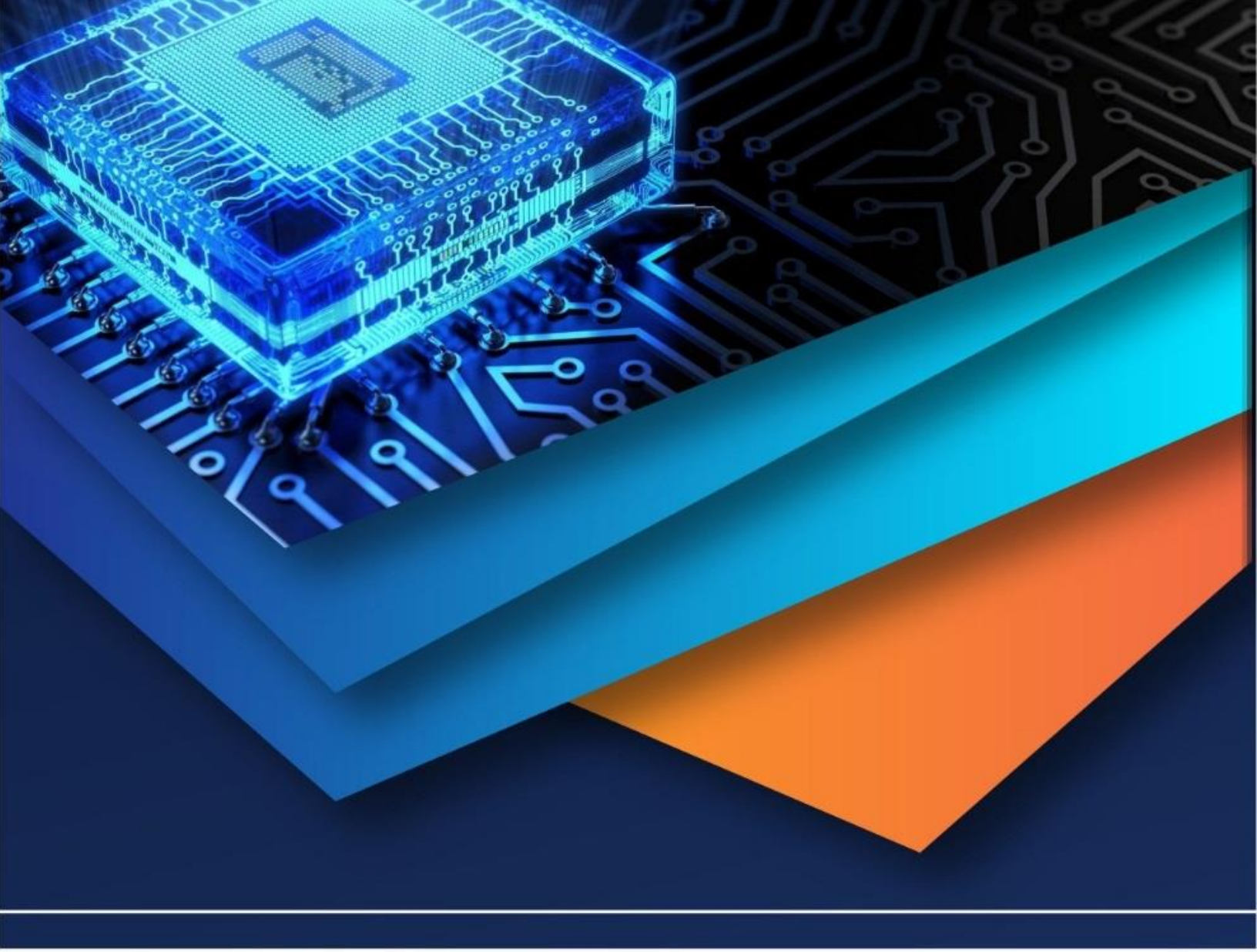

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