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Evaluation of existing slum dwellings in urban settings to meet the UN SDG goals

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Abstract
Over the past two decades, urban environmental quality has declined, and slums are seen as the primary concern. Despite numerous slum upgrading strategies to address urban poverty in developing countries, the issue is only projected to get worse. The lack of sustainable slum redevelopment guidelines in India is a policy gap that needs to be addressed. To make sure that the upcoming LIG housing stocks are sustainable, a logical design and planning approach is required to address climate change and the Sustainable Development Goals. This paper focuses on the study and analysis of existing slum dwellings and their living conditions, and from the observations of the study, it aims to propose recommendations for creating sustainable and sensitive redevelopment. As part of a new approach for slum upgrading projects to meet SDG objectives, it will also investigate the criteria required to construct climate-responsive urban dwellings that are closer to Net-Zero Buildings.
Keywords: Sustainable development, Slum redevelopment, UN SDG, Climate responsive, Urbanization

1. Introduction

For an individual, a House is a physical structure, built for shelter, security, and protection from the environment. It is a place where people feel comfortable, secure, and connected, where people have a sense of belonging. These buildings and built environments play a major role in human life. Housing is one of the most valued sectors for individuals, which is largely dictated by demand and supply. The demand for housing rises in direct proportion to the increase in population and rate of urbanization. It is expected that by the year 2050, the population of India will be almost equally distributed between urban and rural areas. Globally, today, more people live in urban areas than in rural areas. (Habitat, 2014) Considering the high cost of land, materials, labor, etc. most of the housing stock remains unaffordable for the majority of urban dwellers. The poor migrants, who are unable to afford urban housing, find themselves in settlements and slums, developed mostly in vacant plots and open areas along canals, riverbanks, or railway lines. United Nations Human Settlement Program estimated that China (180 million) and India (104 million) had the higher number of slum dwellers in the world in 2012, and these numbers are set to increase in the next decades owing to their urbanization trend. Due to the influx of rural populations into urban areas, slums are continuing to increase, and the quality of housing to decline. As cities grow, so do their slum populations. 1 out of 5 urban dwellers in India currently live in an informal settlement, and 2 out of 5 dwellers live in informal settlements in Maharashtra. It is expected that by the year 2050, 44% of the world's urban population will live in informal settlements. (ourworldindata, 2018; Amen, 2021; Aziz Amen, 2022; Amen et al., 2023; Amen & Nia, 2020). This rapid urbanization has resulted in both benefits and challenges, such as increased economic opportunities and improved access to healthcare and education, as well as issues such as overcrowding, pollution, and social inequality. As a result, addressing these challenges is critical for governments and city planners to create sustainable and livable urban environments for all.

Slums develop and emerge for a variety of reasons around the world. The shift of population from rural regions and small towns to metropolitan areas negatively impacted sustainable development and urban environment quality during the past two decades. Many cities consider slums to be their main challenge, particularly when it comes to issues with population, transportation, health, and safety. (Ghada Ragheba, 2016). With the increased concentration of economic and commercial activity, rapid economic growth, and population influx in Indian cities, the pressure on affordable housing delivery is increasing, resulting in the proliferation of slums. (Gandhi, 2012). livability remains a question in low-income neighborhoods across the world. Insecure housing occupancy and unaffordability difficulties make living conditions unfavorable to the underprivileged society. Poorly built dwelling structures in badly contaminated or disaster-prone areas, as well as a lack of basic services, are examples of such dreadful living situations. This exposes low-income groups substantially to increased physical and social risks. (Thashlin Govender, 2011)

The United Nations Sustainable Development Goals (SDGs) offer a comprehensive framework for addressing the challenges of poverty, inequality, and environmental sustainability. Goal 11, sustainable cities, and Communities of SDG highlight the importance of improving slum conditions in cities by emphasizing an intensified focus on 1 billion

slum dwellers. By focusing on these SDGs, policymakers, and urban planners can design and implement slum redevelopment programs that are tailored to the needs of the people living in the slums.

One of the most significant challenges in urban areas is the proliferation of slums. It is estimated that over one billion people live in slums, where they face inadequate housing, overcrowding, and poor access to basic services such as water, sanitation, and healthcare. Slum redevelopment projects aim to address these challenges by improving the quality of housing and infrastructure, and providing basic services to the residents. Sustainable urbanization policies and strategies are viewed as critical instruments for achieving a sustainable future for developing towns and cities. A fundamental problem for sustainable urbanization policies and initiatives is addressing the complexity of urbanization, particularly the continued rise of informal settlements and slums in developing countries. (Jones, 2017).

This paper explores the importance of the UN SDG goals in slum redevelopment projects and how they can be used to improve the lives of people living in slums. This Sustainable Slum redevelopment can bring significant benefits to the people living in the slums, as well as the wider community. Improved housing, infrastructure, and services can improve the health and well-being of the people living in the slums, increase their access to social and economic opportunities, and reduce poverty. In addition, slum redevelopment can contribute to the creation of sustainable cities and communities by reducing greenhouse gas emissions and promoting energy efficiency in housing. The paper will study the projects from the selected city and analyze them based on the various parameters of environmental and social sustainability.

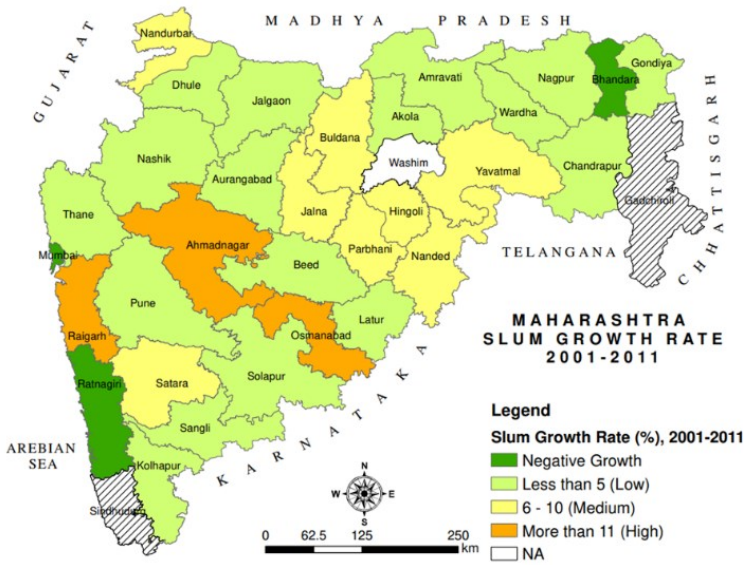


Figure 1: Slum growth rate analysis 2001-2011 (Source: Nitin, 2020)

As per the urban growth rate analysis from 2001 to 2011, Ahmednagar city is facing new developments in the past decades causing urban growth, having a slum growth rate of more than 11% in Maharashtra. Ahmednagar is a city located in the western region of Maharashtra, India. It is known for its rich heritage and diverse culture. The economy of Ahmednagar thrives on agriculture, with sugarcane and cotton being the major crops. The city also has a thriving industrial sector, with manufacturing and small-scale industries contributing to the growth of the local economy. It has the unique identity of connecting and interlinking the greatest number of districts. Further, the city is interconnected by railway as many direct trains pass through this city.

Ahmednagar experiences a semi-arid climate characterized by hot and dry summers and mild winters. In terms of temperature, Ahmednagar sees high summer temperatures reaching up to 40 degrees Celsius (104 degrees Fahrenheit), while winter temperatures range between 10 to 25 degrees Celsius (50 to 77 degrees Fahrenheit). The city receives most of its rainfall during the monsoon season, from June to September, with an average annual precipitation of approximately 600-700 millimeters. The dry climate and limited rainfall necessitate careful consideration of water resources and conservation measures in architectural design.

To study the different types of redevelopment projects currently ongoing in Ahmednagar, two examples with different approaches were selected for the case study. These examples were studied and analyzed based on the environmental and social factors of the project. To analyze the environmental factor, simulations were done for checking the parameters such as daylight, Insolation, shadow footfall during the day, etc. This analysis intends to understand the feasibility of the currently ongoing projects in Ahmednagar and understand the positives and negatives of the projects based on two different types of projects. After studying and understanding the findings from the analysis of the case studies with different design approaches, a New design proposal is proposed for one of the slums present in Ahmednagar.

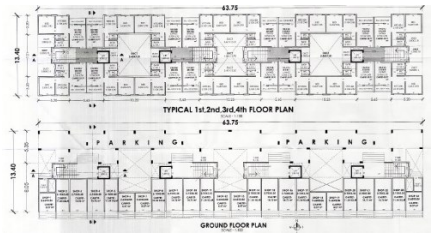
2. Material and Methods

The research methodology for this study involves a qualitative approach using secondary data analysis. This method will be used to analyze the existing literature, including academic publications, government reports, and data sources, to determine the current state of slum dwellings in urban India and the current slum rehabilitated buildings will be analyzed.

1. Literature Review: The literature review will involve collecting data from various sources, including journal articles, reports, and papers published over the last 10 years. The review will focus on studies related to the challenges faced by slum dwellers in India, including poor housing conditions, inadequate access to basic services such as water and sanitation, limited healthcare access, environmental risks, and poverty. Furthermore, the literature review will examine existing slum redevelopment programs in India and their effectiveness in addressing these challenges and aligning with UN SDG goals.
2. Data collection methods: The data collection process will involve conducting an extensive review of existing literature, surveys, and interviews with the slum dwellers and site visits for case study.
3. Data analysis: The data collected through content analysis will be analyzed to identify significant themes related to the research questions. we will analyze current slum rehabilitated buildings through simulations and parameters of UN SDG goals. We will also review and classify the data into different categories based on our research questions, including the current state of slum dwellings in urban India, the challenges of slum redevelopment to meet the UN SDG goals, and potential opportunities and best practices for slum redevelopment.

3. Results

Table 1. Comparison between two types of redevelopment projects

Study case	A. MHADA Project	B. Sanjaynagar Slum Redevelopment
		
Building Height	G+4	G+2
Approach	Conventional (Apartment)	Vernacular (Chawl)
Community Spaces	No	Yes
Utility Space	No	Common per two tenements
Amenities	No	Yes
The scheme under the project is proposed	Public-Private Partnership	U-PMAY + NGO, Architects, AMC, and Community

The design of Building A is the same as what we get to see nowadays everywhere around us. Which is placing the service core in the center and keeping the units on all four sides of the floor plate. This is a 4-story building having shops and parking on the ground floor. These types of buildings are completely in contrast with the lifestyle of the slum dwellers who are used to living on the ground. This type of project disconnects people from social interaction. To see how these individual units are functioning throughout the day, daylight analysis was done. For simulations of daylight analysis, software like Ecotect and Radiance was used.

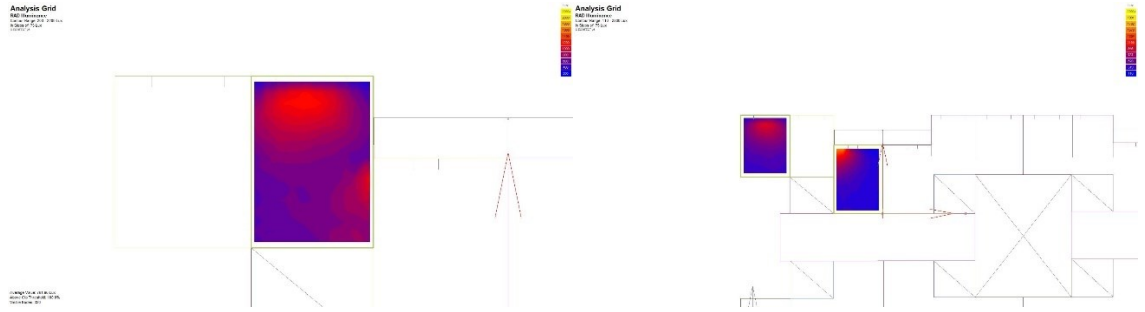


Figure 2: Case A-Unit 1 (Source: Author)

The figure shows the daylight analysis of the units placed toward the north side. The units are getting a good amount of light inside fulfilling the minimum amount required for the specific function to carry out.

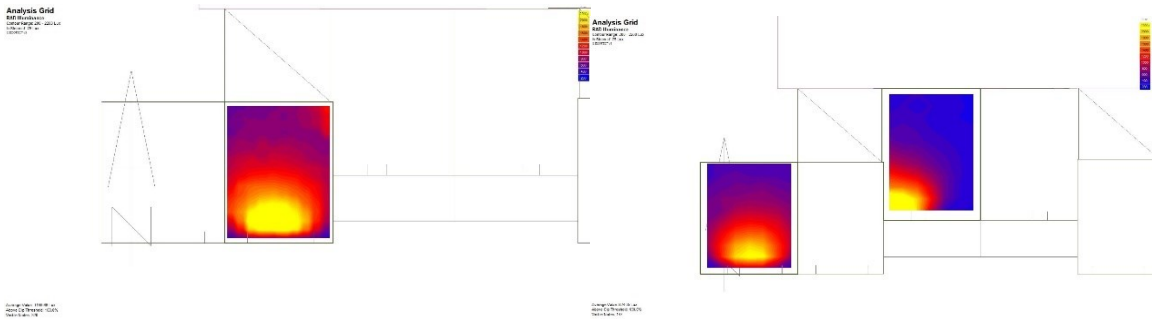


Figure 3: Case A-Unit 2 (Source: Author)

The figure shows the daylight analysis of the units placed toward the south side. The units are getting a good amount of light with extra glare inside. Due to the absence of the required amount of fenestration, the glare can cause discomfort in the indoor spaces causing heating of the space. As this building is designed vertically, keeping the service core surrounded by apartments in one building, there is no mutual shading taking place in the vicinity.
According to the social parameter, this form of structure isolates residents within the vertically stacked structure, destroying their ability to communicate with one another and society as a whole. Also, In the neighborhood, there are no designated open spaces or areas for community interaction.

In the study of case B, there are a total of 298 dwelling units, these units are arranged in 8 clusters forming communal open spaces for that individual clusters. And these units are staggered forming G+2 buildings. To analyze how much of these open spaces are shaded throughout the day, shadow analysis was done. The Ecotect software is used for shadow analysis.

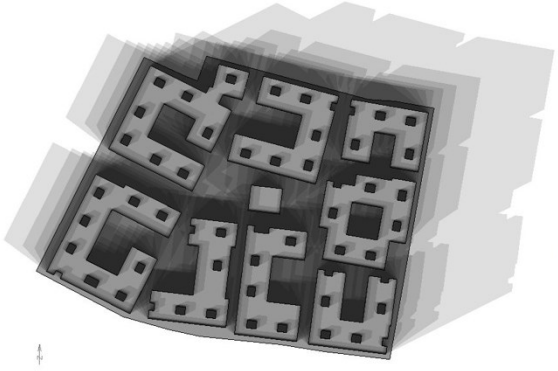


Figure 4: Shadow Analysis (Source: Author)

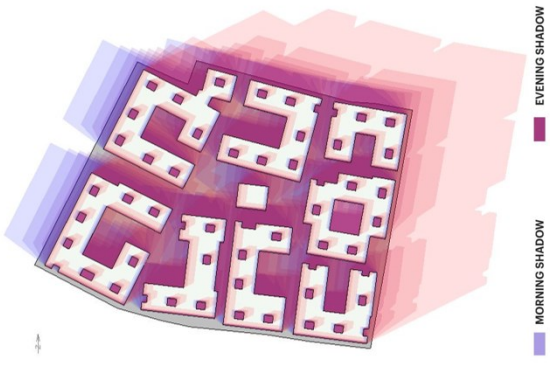


Figure 5: Morning Evening Shadow Analysis (Source: Author)

90% of the site area is shaded by cluster formation of buildings and mutual shading of the same and 10% of the site area receives direct sunlight throughout the day. The 90% of the shaded site area signifies that it solves the issue of

the heat island effect. figure 5 shows the morning and evening shadow pattern on the terrace that helps in both ways like the average shaded area on the terrace will help to inculcate space for communal activities and the area that receives direct sunlight throughout the year gives a designated spot for placing the photovoltaic panels for renewable energy generation.

Figure 6: Daylight Analysis (Source: Author)

Figure 7: Daylight Analysis

Overall, the cluster formation has helped the buildings to shade the open spaces reducing the heat island effect. The units are getting shaded by passages in front of them working as fenestration as well as community interaction spaces. As per IGBC, the bedroom is getting a good amount of light as compared to other spaces as it is having an external wall on one side. Based on the daylight simulation results, All the units are getting enough daylight except some of the units in which the kitchen and living are getting less amount of light through the duct which is 200 and 110 Lux respectively. Also, as these units are connected by passages, some rooms are getting a minimum amount of light because of the staggering of units creating passages in between them. The ducts connected to the kitchens are not providing enough amount of light inside some of the lower-level units which will in turn cause the use of artificial light inside the spaces.

4. Design Proposal and Recommendations

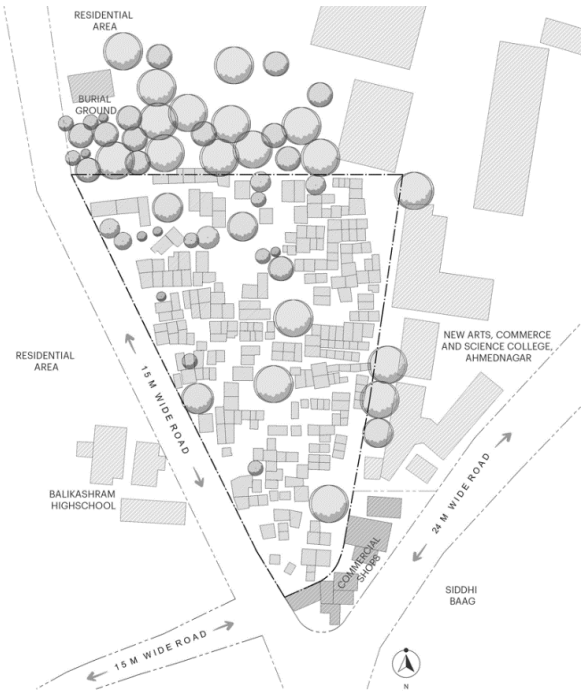


Figure 8: Balikashram slum

Ahmednagar Municipal Corporation has 15% of the total population living in slums. According to Municipal records, there are 17 notified slums and 5 unnotified slums within Ahmednagar Municipal Jurisdiction. The total area under notified slums is 0.18 sq. km. holding nearly 46,500 persons resulting in a density of around 2 lakh persons per sq. km. With about 22 slums in total as per AMC, proper design, construction, and management of the slum development is critical, as it will become a model for the redevelopment of the remaining slums in the city. To understand the current situation of the slums in Ahmednagar, site visits, interviews, and AMC visits were done. After visiting these informal settlements, some things were observed to be common in each of the settlements in the city. Such as the lack of basic infrastructure, no. of public toilets not sufficient for the settlement population, poor management of the waste in these areas, etc.

Based on the location and analysis of the settlements in the city, 3 sites were shortlisted which are located in the heart of the city. After doing the comparative analysis of the shortlisted sites, Balikashram slum was selected for this project proposal based on the criteria such as population, area, context, whether the slum is notified or unnotified, and scope for intervention. Briefing about the Balikashram slum, the total population of the slum is around 1228

people with 213 existing tenements on the 12,500 sqm of land. There are several existing trees present on the site keeping the social ties of the settlement intact. The site is surrounded by schools, colleges, commercial shops, burial ground, garden, and residential areas. The site is facing towards 15 m wide Balikashram road connecting to the main 24 m wide road at the junction. To make this settlement a sustainable community, three important factors affect its long-term sustainability and these factors are considered. As the site is having a lot of existing trees, keeping them as it is and designing around them was a challenge. multiple design options were tried for the project. Based on the case study analysis, forming clusters of the building was found to be a better option which will create a hierarchy of open spaces for the users as well as shade these spaces by surrounding dwellings keeping the existing trees as it is. the formation of a hierarchy of the spaces is done in the design to create various pause points and spaces to strengthen social activities. While designing the units and the clusters, simultaneously the shadow and daylight analysis was done to understand the massing and how it is working in the given context. The shading for the units and open spaces from harsh sunlight was taken into consideration.

Figure 9: Proposed Plan and Elevation

Other massing solutions were looked into after analyzing the preliminary design shadow. The amount that the open areas are shaded by the nearby buildings was taken into consideration when analyzing these massing choices. As per Figure 10, Two massing possibilities for the same were investigated, the first of which was the construction of all G+2 structures. The center open area is not completely shaded in this option. In the second option, buildings on the southwest side were converted to G+3 structures to provide shade for the center open space.

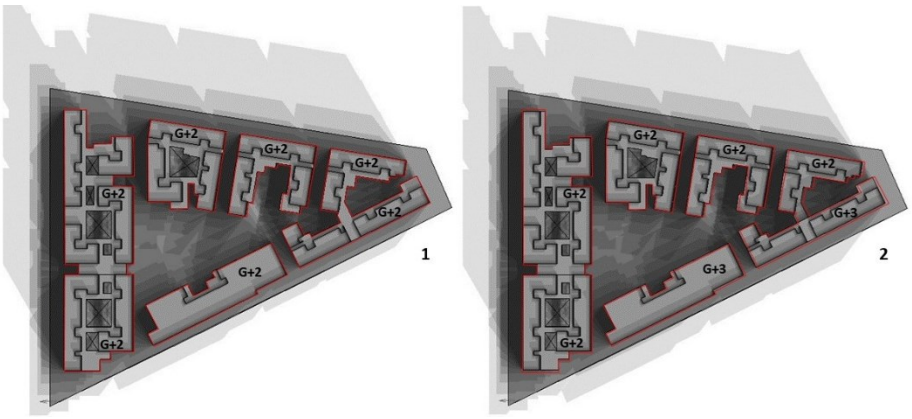


Figure 10: Shadow analysis of massing.

A daylight analysis is carried out to determine how much light is received by individual dwellings. It allows us to determine if the areas are getting enough daylight or not. For the simulation, units at various locations were chosen to determine how much light (lux) each area receives. The simulation is carried out in two stages. Specifically, for Living Rooms and Kitchens, According to the minimal amount of lux value necessary for that space.

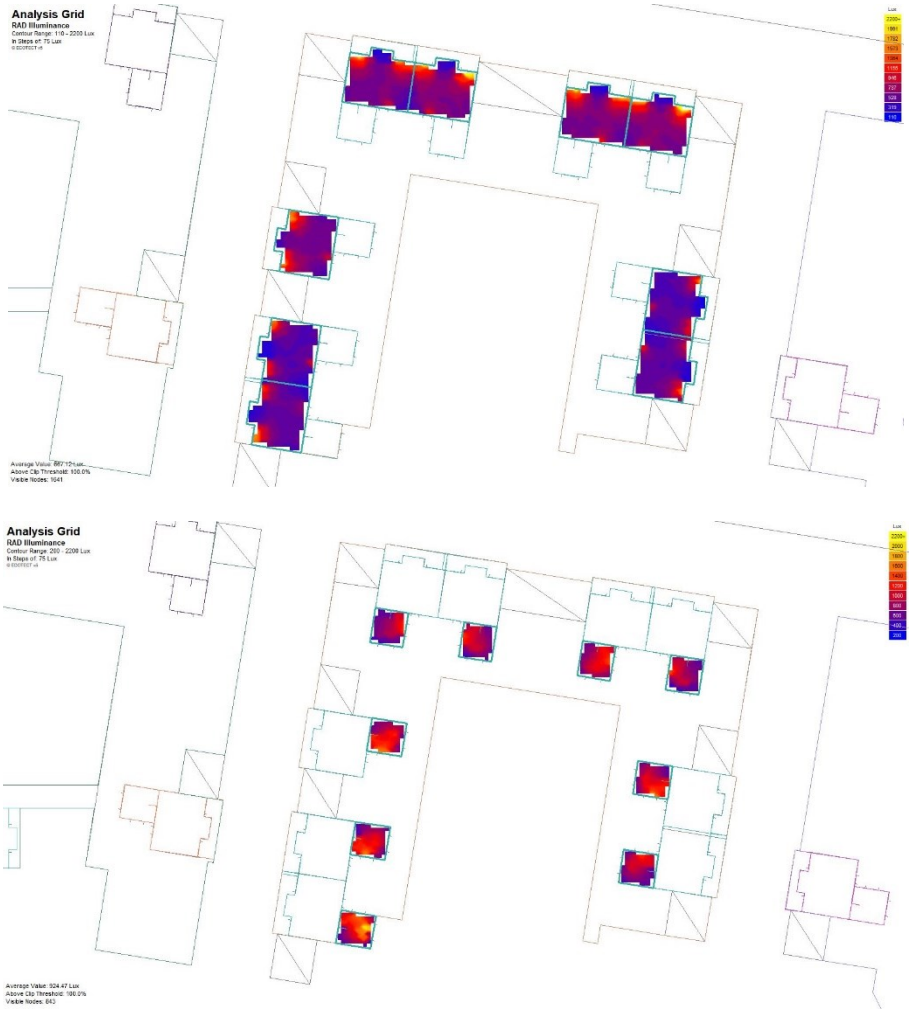


Figure 11: Daylight Analysis

The simulation findings show that dwellings receive a sufficient amount of daylight, which will greatly minimize the usage of electricity throughout the daytime. As Ahmednagar comes under the hot and dry climatic conditions where

summer temperatures go up to 40 degree C, The shading for the units and open spaces from harsh sunlight was taken into consideration by designing fenestrations and overhangs.

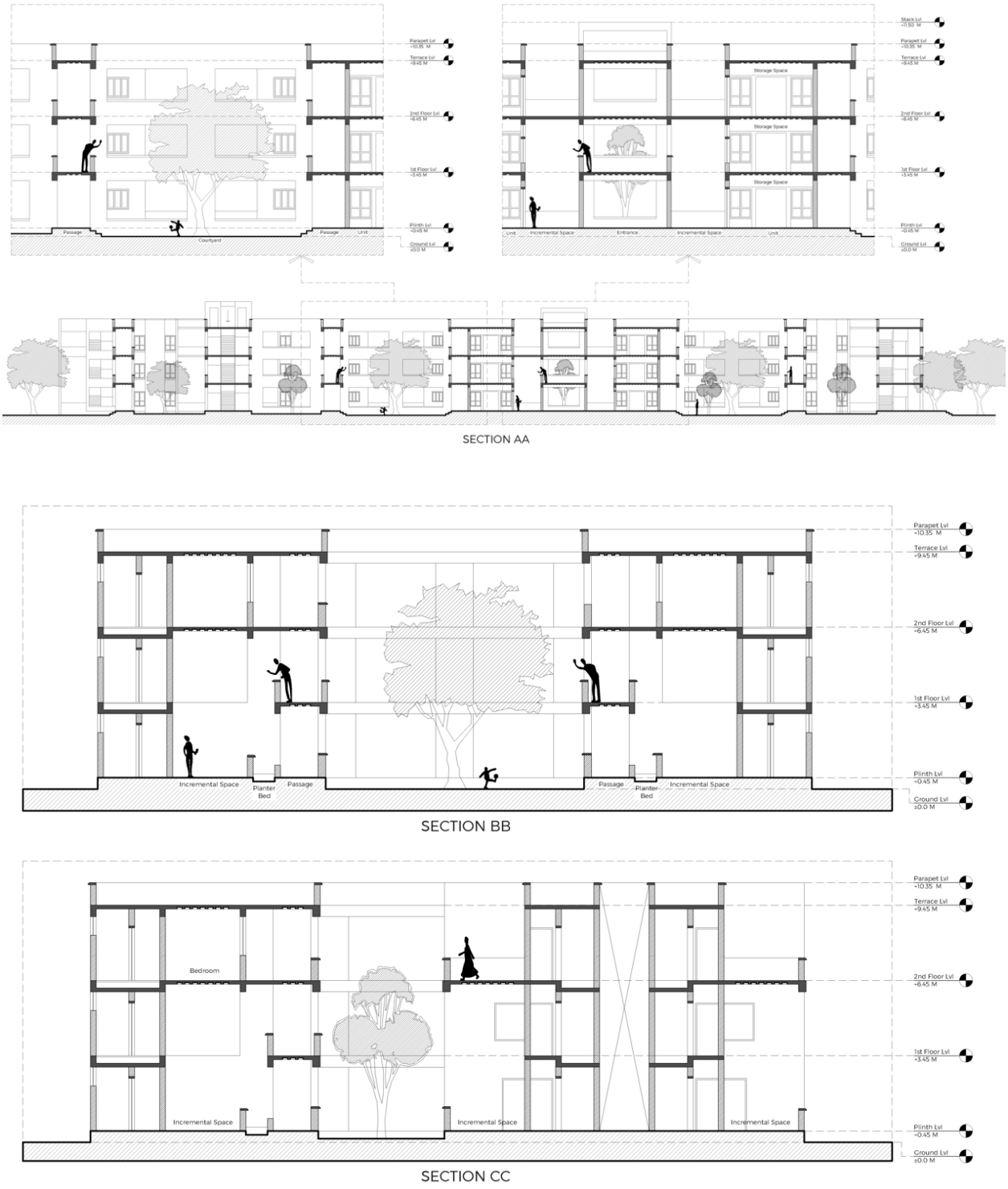


Figure 12: Sections showing hierarchy of spaces

The consideration of Rat-trap bond masonry is done for load-bearing structures in design for better thermal efficiency than conventional masonry walls, without compromising the strength of the wall as well as to reduce the number of bricks and mortar required because of the cavity formed in the wall. Also, the use of CSEB filler block is done in the slab as it is more cost effective than traditional RCC slab and also it provides a great thermal insulation layer because of the air pocket formed by blocks. There is consideration of extra storage spaces in the units. Also,

structural stability point of view, the staggering of the wall to create storage spaces, add extra strength to the wall to support the roof and floors. The future needs of the dwellers are taken into consideration by providing incremental spaces in the design.

Figure 13: Conceptual views of the proposed design

5. Discussion

When going for slum redevelopment, according to SRA laws, the standard practice is built on a public-private partnership, where a developer participates in the project and provides 25 square meters of each tenement for free in exchange for a free sale component that allows him to profit from the project.

The disadvantage of this approach is that the developer alone determines the project's quality and character. He strives to fit as many units as he can on the allotted land to make the most money feasible after providing free tenements to the current slum inhabitants. The consequence of this sort of project is therefore a tall building with claustrophobic living space for slum dwellers. By incorporating the commercial component/sale component by the developer, the community loses its essence, leaving slum inhabitants feeling disassociated.

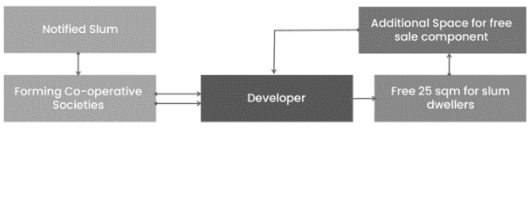


Figure 14: Conventional practice carried out by SRA

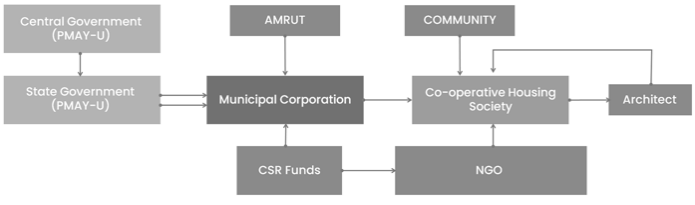


Figure 15: Proposed scheme for redevelopment

The author proposes a new framework as an alternative to current practice. In this proposal, the community forms a housing society in which they decide for themselves under the guidance of a local NGO, an architect, and a municipal corporation. The funds will be obtained through CSR funds (Corporate Social Responsibility). CSR is the financing and grant procedure through which non-profit organizations (NGOs) can get financial and other help from the corporate sector to better the lives of the underprivileged.

6. Conclusions

The paper concludes that slum redevelopment in India is crucial for achieving the UN SDG goals related to decent housing, poverty reduction, access to education and healthcare, and creating sustainable cities and communities. For redevelopment programs to succeed, there needs to be active community involvement, a comprehensive integrated approach, efficient governance, and regulatory frameworks, and the programs should be scalable and replicable with the dwelling units having consideration of future expansion and affordability.

In architectural design and planning for the Ahmednagar context, it is important to consider the climatic conditions and the need for energy-efficient strategies. Design elements such as proper orientation, shading devices, natural ventilation, and the use of locally available materials can help mitigate the heat and maximize thermal comfort. Rainwater harvesting techniques, efficient water management systems, and solar energy utilization can contribute to sustainable development in the region.

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Conflict of Interests

The authors declare no conflict of interest.

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