HOME RECONFIGURED:

Adaptable housing as a solution in Mumbai to help people stay in place

by

Nupur Garg

A thesis

presented to the University of Waterloo

in fulfillment of the

thesis requirement for the degree of

Master of Architecture

Waterloo, Ontario, Canada, 2021

AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

ABSTRACT

With the continuously rising employment, businesses, investments, and consequently migration, the housing prices of Mumbai have skyrocketed over the past few decades. The house bought on a mortgage, or rented at cheap rates back in the day, is passed down for generations to grow into due to the inability to afford/shift in a new home. This leads to people compromising on their needs, in a rigid home, throughout their life. We need a solution to allow the residents to take agency over the design of their apartments while still maintaining the benefits of typical housing. The research, therefore, questions how can our existing housing typologies undergo adjustment as people's lives change? Can we design mass housing apartments in dense urban cities, like Mumbai, India, that provides the residents' autonomy over their spatial layouts? What are the ways people can change the spatial layout of their apartments to better suit their changing requirements and expectations? To incorporate the multifunctionality, adaptability theories present in the housing industry are researched to help incorporate time as a design variable and help people stay in place. A lot of research has been done individually for different adaptable elements and systems in a residential building like open building plans, movable partitions, home kits, and incremental housing, but previous work has failed to address an approach that combines the advantages of each and apply the system in the cultural context of Mumbai. To achieve this goal, the thesis investigates the opportunity of providing a better home for the residents by reimagining a new typology that changes with time and supports the residents' ability to stay in place without making the building redundant in the future years. Residents of housing development in Mumbai are interviewed to understand the problems they face while living in a standardized apartment. These findings, combined with the present theories and case studies, are used to design an apartment prototype with a new adaptable system that provides residents agency over their space and configure the spatial layout that works best for them. This thesis helps in reducing the rigidness of a housing design while also giving the residents' decision-making power in the design of their homes and allows them to stay in place comfortably.

ACKNOWLEDGEMENTS

Firstly, I would like to thank my thesis supervisor, John Mcminn for his optimism, support, and guidance throughout this process. Without his time and expertise, I would not have arrived at this thesis.

I would also like to thank my committee member, Rick Andrighetti for his belief in the importance of this work and in my ability to pursue it. Your enthusiasm and suggestions were incredibly valuable.

Thank you to Prateek, Shreya, and Tushar, for guiding me throughout the process, checking up on me, and keeping me sane.

Thank you to my parents and friends for your encouragement and support.

TABLE OF CONTENTS

AUTHOR'S DECLARATION iii

ABSTRACT v

ACKNOWLEDGEMENTS vii

LIST OF FIGURES x

CHAPTER 1 – INTRODUCTION 1

CHAPTER 2 – PROBLEM OF AFFORDABILITY IN MUMBAI 7

MUMBAI – ABOUT THE CITY 7

MIGRATION AND HOUSING 8

RENTAL POLICIES 9

CHAPTER 3 – STANDARDIZATION AND RIGIDITY 15

DIFFERENT NEEDS 15

STANDARDIZATION AND RIGIDITY 19

CHAPTER 4 – MUMBAI HOUSING INDUSTRY 29

ABOUT THE GOVERNMENT STRUCTURE 29

HISTORY OF HOUSING DEVELOPMENT 29

HOUSEHOLD COMPOSITION 35

TYPICAL HOUSING ELEMENTS 35

TYPICAL HOUSING AGGREGATIONS 44

CONSTRUCTION AND MATERIALITY 46

INTERVIEWS CONDUCTED 48

CHAPTER 5 – ADAPTABILITY AS A POTENTIAL SOLUTION 61

ADAPTABILITY 62

OPEN BUILDING MOVEMENT (OBM) 63

GOVERNMENT POLICIES 66

END USERS 66

SYSTEM STUDIES 69

STATIC INCREMENTAL 70

OPEN BUILDING PLAN AND SUPPORT / INFILL 70

MOVABLE SYSTEMS 74

KIT OF PARTS 76

CHAPTER 6 – DESIGNING A PROTOTYPE 84

DESIGN ELEMENTS 84

TYPICAL TRADITIONAL AND CULTURAL ELEMENTS 85

ADAPTABILITY ELEMENTS 87

DESIGN GOALS 88

UNIT DESIGN 90

ELEMENTS IN THE UNIT 92

DESIGN INTERVENTION 92

SCHEMATIC DEMOUNTABLE WALL DESIGN 92

WALL MOVEMENT 98

DESIGN IMPLEMENTATION 106

RENTAL POSSIBILITIES 133

CHAPTER 7 – IMPACTS OF ADAPTABILITY 146

IMPACTS 146

LIMITATIONS 147

FUTURE POSSIBILITIES 148

BIBLIOGRAPHY 150

APPENDIX 154

INTERVIEW QUESTIONNAIRE 154

LIST OF FIGURES

Fig. 1.01. Traditional vs Proposed design process diagram

By author

Fig. 2.01. Location map of Mumbai

By author

Fig. 2.02. Population graph of Mumbai

By author. Data retrieved from Census of India, 2011

Fig. 2.03. Annual Income distribution of Mumbai

By author. Data retrieved from Census of India, 2011

Fig. 2.04. Median house price to monthly income ratio graph of different cities in India over four years

By author. Data retrieved from Reserve Bank of India housing affordability survey

Fig. 2.05. Percentage of Migrant population in Mumbai

By author. Data retrieved from Census of India, 2011

Fig. 2.06. Percentage of house ownership status in Mumbai

By author. Data retrieved from Census of India, 2011

Fig. 3.01. Important home priorities graph according to caring responsibilities and age (as per a survey conducted in UK)

By author. Data retrieved from "A Public Vision for the Home of 2030," *Design Council* (London: Design Council, n.d.), accessed December 3, 2020.

Fig. 3.02. Quotes of what residents prefer in a home according to a survey conducted in UK

By author. Data retrieved from Stephan Finlay et al., "The Way We Live Now: What People Need and Expect from Their Homes" (RIBA and Ipsos MORI, 2012), https://www.ipsos.com/sites/default/files/publication/1970-01/sri-riba-the-way-we-live-now-may-2012.pdf.

Fig. 3.03. Typically found adaptable elements in an apartment

By author.

Fig. 3.04. Lifestages of an Indian family affecting space usage of the apartment

By author.

Fig. 4.01. Steps of getting a building permit in Mumbai

By author. Data retrieved from MCGM's online building plan approval system (https://autodcr.mcgm.gov.in/BPAMSClient2/Login.aspx)

Fig. 4.02. History of Mumbai's housing typology development

By author. Data retrieved from Priyanka N. Karandikar, "Chawls: Analysis of a Middle Class Housing Type in Mumbai, India" (Master of Science, Iowa State University, 2010), https://doi.org/10.31274/etd-180810-1039. and Prasad Shetty et al., "Housing Typologies in Mumbai," CRIT (Mumbai, 2007), https://critmumbai.files.wordpress.com/2011/10/house-types-in-mumbai-final.pdf.

Fig. 4.03. Household composition in Mumbai according to number of habitable rooms and number of residents

By author. Data retrieved from Census of India, 2011

Fig. 4.04. Typical site elements found in Mumbai

By author.

Fig. 4.05. Typical tower elements found in Mumbai

By author.

Fig. 4.06. Case study of Wadhwa Apartments Mumbai for typical tower elements

By author.

Fig. 4.07. Encroached balcony to add storage

Illustration by author. Image retrieved from What Apartments Look Like Around The World • Mumbai, vol. Video (Youtube, 2020), https://www.youtube.com/watch?v=at5wFFGN1c8&ab_channel=BuzzFeedBringMe.

Fig. 4.08. Apartment entrance door with additional security door

Illustration by author. Image retrieved from What Apartments Look Like Around The World • Mumbai, vol. Video (Youtube, 2020), https://www.youtube.com/watch?v=at5wFFGN1c8&ab_channel=BuzzFeedBringMe.

Fig. 4.09. Metal bars on the window for security

Illustration by author. Image retrieved from What Apartments Look Like Around The World • Mumbai, vol. Video (Youtube, 2020), https://www.youtube.com/watch?v=at5wFFGN1c8&ab_channel=BuzzFeedBringMe.

Fig. 4.10. Traditional Indian Door and latches

Illustration by author. Image retrieved from What Apartments Look Like Around The World • Mumbai, vol. Video (Youtube, 2020), https://www.youtube.com/watch?v=at5wFFGN1c8&ab_channel=BuzzFeedBringMe.

Fig. 4.11. Window in the bathroom

Illustration by author. Image retrieved from What Apartments Look Like Around The World • Mumbai, vol. Video (Youtube, 2020), https://www.youtube.com/watch?v=at5wFFGN1c8&ab_channel=BuzzFeedBringMe.

Fig. 4.12. Traditional Indian wooden blinds

Illustration by author. Image retrieved from What Apartments Look Like Around The World • Mumbai, vol. Video (Youtube, 2020), https://www.youtube.com/watch?v=at5wFFGN1c8&ab_channel=BuzzFeedBringMe.

Fig. 4.13. Prayer corner

Illustration by author. Image retrieved from What Apartments Look Like Around The World • Mumbai, vol. Video (Youtube, 2020), https://www.youtube.com/watch?v=at5wFFGN1c8&ab_channel=BuzzFeedBringMe.

Fig. 4.14. Utility area behind the kitchen

Illustration by author. Image retrieved from What Apartments Look Like Around The World • Mumbai, vol. Video (Youtube, 2020), https://www.youtube.com/watch?v=at5wFFGN1c8&ab_channel=BuzzFeedBringMe.

Fig. 4.15. Standalone wardrobe with storage above

Illustration by author. Image retrieved from What Apartments Look Like Around The World • Mumbai, vol. Video (Youtube, 2020), https://www.youtube.com/watch?v=at5wFFGN1c8&ab_channel=BuzzFeedBringMe.

Fig. 4.16. Window with operable shutters

Illustration by author. Image retrieved from What Apartments Look Like Around The World • Mumbai, vol. Video (Youtube, 2020), https://www.youtube.com/watch?v=at5wFFGN1c8&ab_channel=BuzzFeedBringMe.

Fig. 4.17. Utility area in the corridor

Illustration by author. Image retrieved from What Apartments Look Like Around The World • Mumbai, vol. Video (Youtube, 2020), https://www.youtube.com/watch?v=at5wFFGN1c8&ab_channel=BuzzFeedBringMe.

Fig. 4.18. L-shaped kitchen with window for ventilation

Illustration by author. Image retrieved from What Apartments Look Like Around The World • Mumbai, vol. Video (Youtube, 2020), https://www.youtube.com/watch?v=at5wFFGN1c8&ab_channel=BuzzFeedBringMe.

Fig. 4.19. Typical housing aggregation diagrams.

By author.

Fig. 4.20. Different housing facade aesthetics

Images retrieved from

https://snappygoat.com/s/?q=bestof%3Aoberoi+hotel+mumbai+building+india+architecture+bombay#dc77085bf92d1aefe94afb58de46e3e72a0f42d6,6,0.

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https://snappygoat.com/s/?q=bestof%3Aoberoi+hotel+mumbai+building+india+architecture+bombay#5c4492d9480e98285e588262397862d0c6752aa4,6,82.

Ravi Karandeekar, Paranjape Schemes' Gloria, 2 BHK & 3 BHK Flats, at Bavdhan, on Paud Road, Kothrud Annexe, Pune, July 29, 2011, photo, July 29, 2011, https://www.flickr.com/photos/ravikaran/5988267938/.

Ravi Karandeekar, Visit DSK Sadaphuli at Varale, Talegaon Dabhade, Pune, January 16, 2017, photo, January 16, 2017, https://www.flickr.com/photos/ravikaran/32019856580/.

Fig. 4.21. Typical construction axonometric diagram

By author.

Fig. 4.22. Template for Interview data collected

By author.

Fig. 4.23. House 02 speculative representation

By author.

Fig. 4.24. House 04 speculative representation

By author.

Fig. 4.25. House 07 speculative representation

By author.

Fig. 4.26. House 10 speculative representation

By author.

Fig. 5.01. Approach towards adaptable design

Image retrieved from Robert III Schmidt et al., What Is the Meaning of Adaptbility in the Building Industry?, O&SB2010 "Open and Sustainable Building" (Bilbao: LABEIN Tecnalia, 2010), https://www.irbnet.de/daten/iconda/CIB17993.pdf.

Fig. 5.02. Decision making levels in Open building Movement

Image retrieved from Stephen Kendall and Jonathan Teicher, Residential Open Building (New York: E&FNSpon, 2000).

Fig. 5.03. Permitted expansion possibilities in UK

Image retrieved from “Permitted Development Rights for Householders” (Ministry of housing, communities and local government, September 2019), www.gov.uk/mhclg.

Fig. 5.04. Static incremental balcony expansion in Social housing, France

Image retrieved from Harvard GSD, Anne Lacaton and Jean-Philippe Vassal, “Freedom of Use,” accessed July 10, 2021, https://www.youtube.com/watch?v=zdgYGkQM9zc.

Fig. 5.05. Demountable wall and plan configuration of Nuewil

Image retrieved from Stephen Kendall and Jonathan Teicher, Residential Open Building (New York: E&FNSpon, 2000).

Fig. 5.06. Site and apartment plan of Molenvliet Project

Image retrieved from Ir. Frans van der Werf, “OPEN BUILDING EXPERIENCE: 1. ‘MOLENVLIET’ PAPENDRECHT 1978,” ThematicDesign, 2017, 1–15, https://thematicdesign.org/open-building-experience-1-molenvliet-papendrecht-1978-2/.

Fig. 5.07. Movable wall of Schroder house and before and after plans

Image retrieved from

https://commons.wikimedia.org/wiki/File:RietveldSchroderInterieur.png

https://commons.wikimedia.org/wiki/File:RietveldSchroderPlans.png

Fig. 5.08. Movable studio unit of ORI

Image retrieved from https://www.youtube.com/watch?v=5lqwN60rzqY

Fig. 5.09. The urban village kit of parts for an apartment

Image retrieved from Build In Brief- The B1M, IKEA Has Imagined a Shared-Living Community | The B1M, accessed July 10, 2021, https://www.youtube.com/watch?v=7ge3y-mSlU0.

Fig. 5.10. Newways services kit of parts

Image retrieved from Abdul Samad Kazi, Matti Hannus, and Samir Boudjabeur, Open Building Manufacturing, Book, Whole (ManuBuild, 2009), http://adaptablefutures.com/wp-content/uploads/2011/10/Fuster-et-al.-20091.pdf.

Fig. 5.11. System Analysis Table

By author

Fig. 6.01. Typical traditional and cultural elements in a housing in Mumbai

By author

Fig. 6.02. Typical adaptable elements to be incorporated in a housing in Mumbai

By author

Fig. 6.03. Typical adaptable elements to be incorporated in a housing in Mumbai

By author

Fig. 6.04. Plans of one bed, two bed, and three bed adaptable apartment

By author

Fig. 6.05. Adaptable and traditional elements marked in a one bed apartment plan

By author

Fig. 6.06. Demountable wall kit of parts

By author

Fig. 6.07. Wall panel detail with composition, weight, and acoustic calculations

By author. Data derived from "Sound Control for Commercial and Residential Building" (Naima), accessed July 4, 2021, https://www.eaglerocksupply.com/application/files/4514/4890/6046/Sound_Control.pdf.

Fig. 6.08. Wall panel assembly and joinery detail

By author

Fig. 6.09. Aerial View of Dharavi

Image derived from Danny Mcgee. FLYING OVER MUMBAI (DHARAVI) 4K Aerial Film. Video. Mumbai, 2019. https://www.youtube.com/watch?v=uFEq-CB0Ev8.

Fig. 6.10. Wall kit of parts movement from site to storage

By author

Images retrieved from https://www.flickr.com/photos/baronreznik/30740441564,

https://www.pxfuel.com/en/free-photo-eisoc,

https://www.flickr.com/photos/meanestindian/4153908897/in/photostream/

Fig. 6.11. Persona development of house no. 03

By author

Fig. 6.12. Summary of different configuration options in an adaptable three bed apartment

By author

Fig. 6.13. Two bed apartment axonometric with a key section

By author

Fig. 6.14. Three bed apartment axonometric with a key section

By author

Fig. 6.15. Temporary two bed apartment axonometric with a key section
By author

Fig. 6.16. Three bed apartment + study axonometric with a key section
By author

Fig. 6.17. Three bed apartment + storage axonometric with a key section
By author

Fig. 6.18. Three bed apartment + a new bathroom axonometric with a key section
By author

Fig. 6.19. Two bed apartment + a new bathroom axonometric with a key section
By author

Fig. 6.20. Two bed apartment + a nursery axonometric with a key section
By author

Fig. 6.21. Three bed apartment axonometric with a key section
By author

Fig. 6.22. Four bed apartment axonometric with a key section
By author

Fig. 6.23. Two bed apartment axonometric with a key section
By author

Fig. 6.24. Updated family persona of house no. 03
By author

Fig. 6.25. Speculative family persona's of potential tenants in a one bedroom apartment
By author

Fig. 6.26. One bedroom apartment turned into a studio
By author

Fig. 6.27. One bedroom apartment
By author

Fig. 6.28. One bedroom apartment with a nursery
By author

Fig. 6.29. Speculative housing tower aggregation using design adaptable apartments
By author

Fig. 6.30. Different layout possibilities in Wadhwa Apartments
By author

Fig. 7.01. Current time resistant architecture
By author.

Fig. 7.02. Potential time resilient architecture
By author.

CHAPTER 1 – INTRODUCTION

In the summer of 2020, when COVID-19 lockdown suddenly hit, I was trying to complete my second term of Masters when suddenly everything moved online. I had to now do all my work video calls, school classes, and friends meet-up – over Zoom, MS Teams, Whatsapp video, or CISCO Webx – while living in a small student apartment which I rented before the pandemic, thinking I wouldn't need the extra interior space anyways. Sharing the apartment with three other roommates in a similar situation became difficult. Calls had to be coordinated and timed perfectly.

At the same time, my family back home in India was having similar issues. My dad had to set up a new office space to allow him to be on video call all the time without anyone disturbing him. After setting up a makeshift office for a few weeks, not knowing how long it would last, a dedicated space was needed. Renovating the home to add an office space was not an option due to the financial constraints and, at the same time, allowing multiple people inside the home to renovate was an issue being in a global pandemic. The layout could not be changed, and therefore, his bedroom had to become an office space with no one allowed inside during office hours – a major problem for the rest of the family. My sister, living in Mumbai, could not work from home due to space constraints and had to eventually move back home, to Delhi, with her in-laws adding a different problem of coordinating calls between more people.

All this took me back to my ancestral home, in a small town, with open layouts allowing them to change and define it however they wanted whenever they wanted. It made me realize how our houses and architecture are not able to adapt to the changes taking place in the society and world at large. The years of planning, designing, and construction eventually led the building to cater to the society for only a few decades provided the society

Fig. 1.01. Traditional vs Proposed design process diagram (Right)

Traditional Design Process

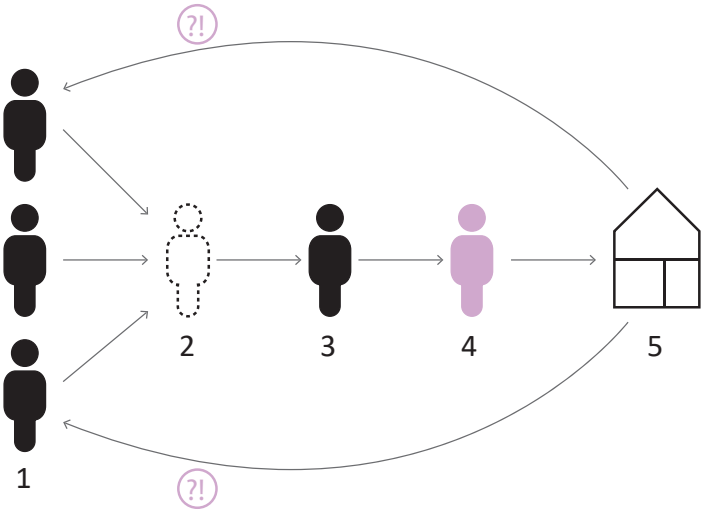
1. Users
2. Fictitious User
3. Developer
4. Architect
5. Finished Product

Proposed Design Process

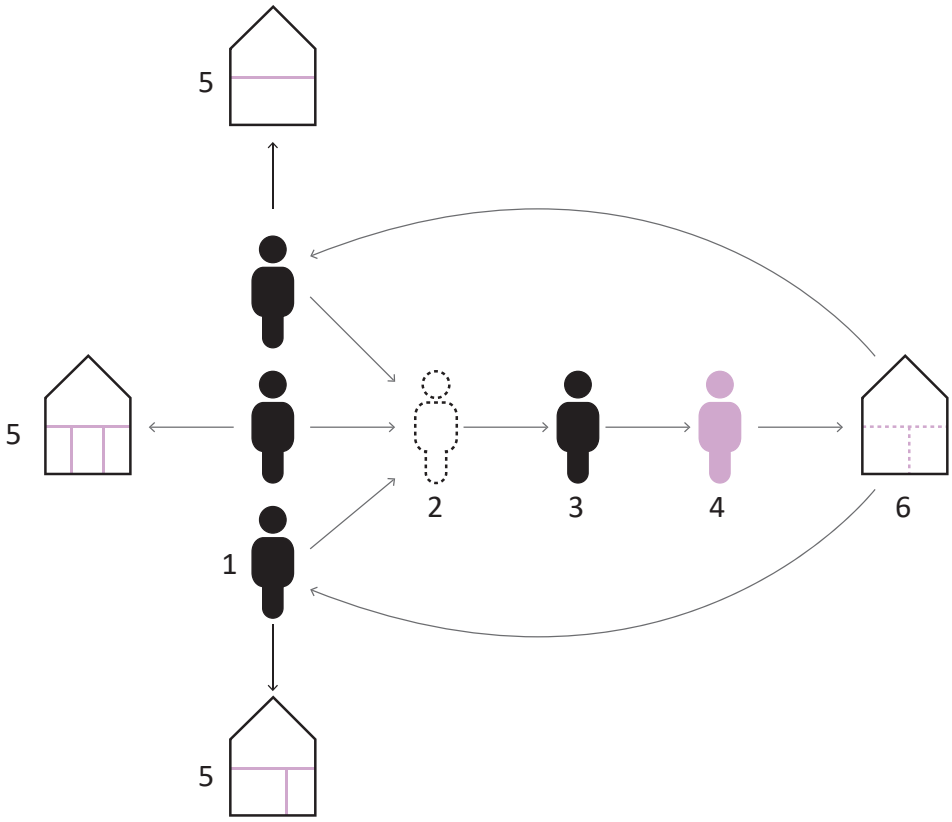
1. Users
2. Fictitious User
3. Developer
4. Architect
5. Finished Product
6. Unfinished Product

does not undergo a major shift. The change – which is the only constant – is incorporated neither in the months of planning nor in the finished product. The change, which is still being incorporated in the pop-up traditional Indian architecture for cultural events, is now being lost in the static and rigid cities. Cities, like Mumbai, which are becoming more and more unaffordable for the residents are not able to provide a place for the residents without them compromising. People are adjusting to the architecture, rather than the architecture helping them live comfortably. This makes us question, how can our existing housing typologies undergo adjustment as people's lives change? Can we design mass housing apartments in dense urban cities, like Mumbai, India, that provides the residents' autonomy over their spatial layouts?

The first chapter of the thesis highlights the problem of affordability and migration in Mumbai leading to residents living in tight spaces, compromising on their needs, and the city slowly becoming out of reach for the middle-class resident. Chapter two then looks at the aspect of rigidity and standardization in the housing industry as a whole and the problems due to it. Chapter three talks about the housing typologies in Mumbai and interviews the residents living in such apartments. Chapter four leads us to adaptability as a solution to incorporate time in an otherwise rigid housing. The final chapter designs an adaptable prototype to be employed in any housing typology to allow residents to stay in place comfortably and allow the apartment to change with the changing time and lifestyles of the people.



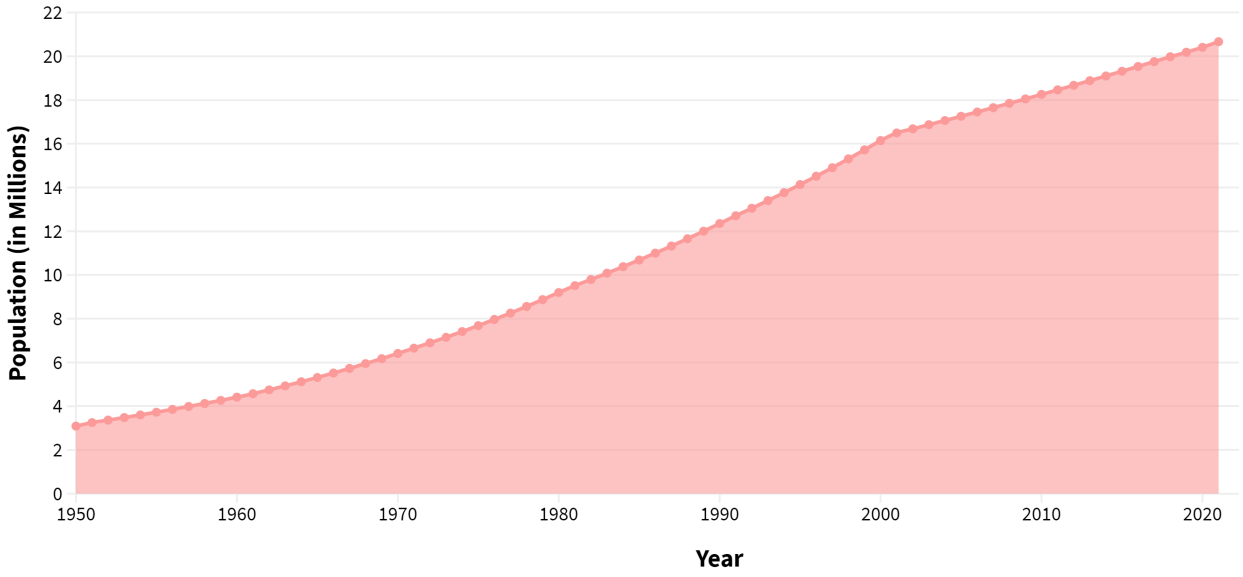
Traditional Design Process

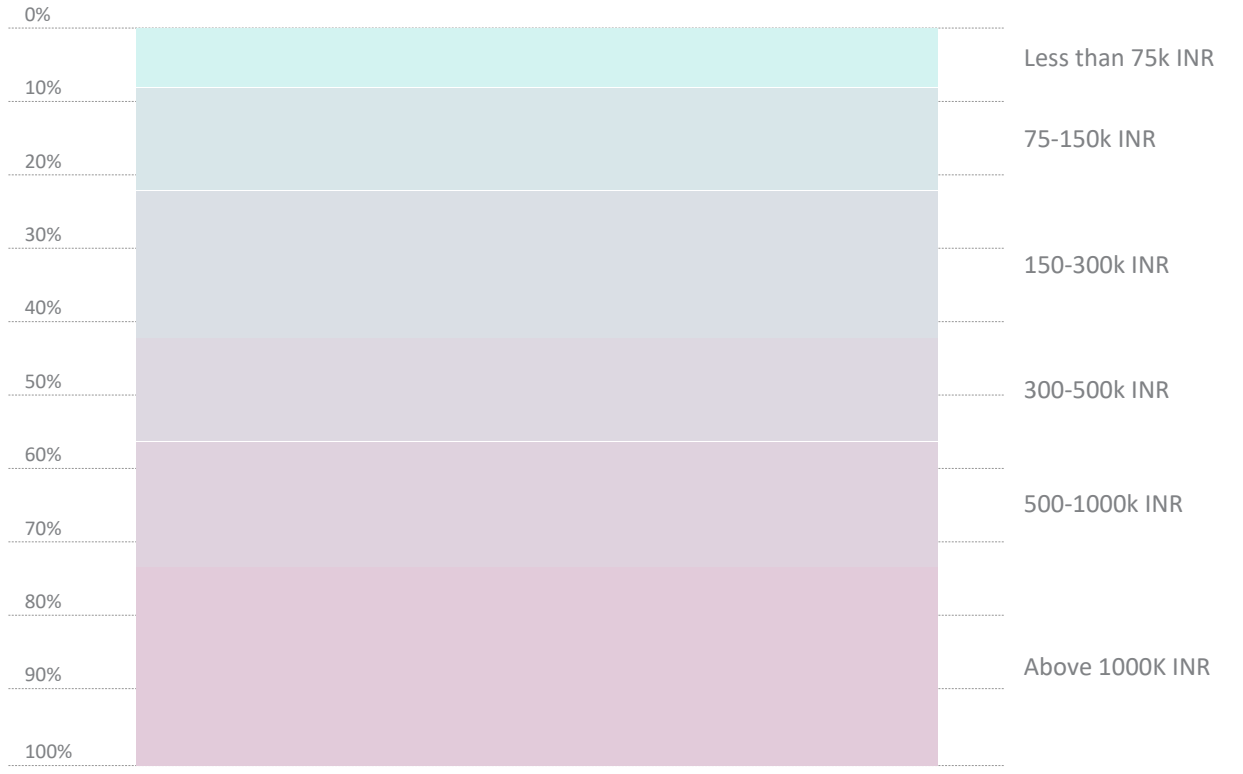


Proposed Design Process


Thane
Mumbai


Maharashtra





Annual Income Distribution

CHAPTER 2 – PROBLEM OF AFFORDABILITY AND MIGRATION IN MUMBAI

India is one of the world's fastest-growing economies with rapid urbanization driving the country's economic engine. A large number of people seeking upward mobility have often been drawn to these urban centers because of the available jobs and business opportunities. This economic development, as well as the resulting increase in income, has resulted in a growing demand for consumer goods. For an ordinary Indian citizen, owning a house is a sign of accomplishment and social status, as well as a solid base for the future. This has mainly ensured that residential real estate is the most desirable commodity, as a result, demand and consequently its value increasing in recent years.[1]

Fig. 2.01. Location map of Mumbai (Page Before)

Fig. 2.02. Population graph of Mumbai (Top Left)

Fig. 2.03. Annual Income distribution of Mumbai (Bottom Left)

MUMBAI – ABOUT THE CITY

Mumbai, where everyone believes dreams come true and the capital of Maharashtra, is India's financial capital and one of the country's biggest urban centers. It is densely populated with limited land availability, has a high concentration of industry and financial activities, and a booming service sector. It is one of the most populous cities in the world with the 2011 census putting Mumbai's urban agglomeration at around 20 million while the city itself has a 12.5 million population.[2] (fig 2.02)

Through the income distribution data, collected by Statista in 2015, we see that 44% of the population forms the middle and upper-class population sector who can afford to buy or rent an apartment in Mumbai (with an average annual income of more than 500,000 INR) with the majority of the remaining population living in settlements. (fig 2.03)

Mumbai forms a major economic force in Maharashtra, accounting for roughly 21% of the state's gross domestic product. With a budget greater than some Indian states, its municipal corporation

1 Arvind Nandan and Yashwin Bangera, "Rediscovering Affordability" (Knight Frank), accessed April 9, 2021, https://content.knightfrank.com.

2 "Mumbai Population 2021 (Demographics, Maps, Graphs)," World Population Review, accessed May 20, 2021, https://worldpopulationreview.com/en/world-cities/mumbai-population.

(a local government body) is one of the wealthiest in the country.[3]

MIGRATION AND HOUSING

By the mid-nineteenth century, Mumbai had established itself as a major trade center and port in India. By the time India gained independence in 1947, Mumbai became the country's financial hub, with migrants accounting for more than half of the population.[4] Migration has always played a significant role in Mumbai's growth and development.[5] Although the city has faced numerous challenges over the last century, it remains India's primary migration hub. While Delhi attracts a large number of migrants from the north's populated states, Mumbai attracts migrants from everywhere[6] because the city provides opportunities for employment in the field of production, sales, administration, and business.[7]

With the continuously rising employment, businesses, investments, and consequently migration, the housing prices of the city have skyrocketed over the past few decades. The city as a result has become unaffordable for the residents.[8] It is not migration that has created a challenge for an expanding metropolis like Mumbai; rather, the lack of an effective integrated growth strategy, as well as affordable and change-resistant housing, is a matter of concern.[9]

When comparing the MEDIAN HOUSE PRICES TO THE AVERAGE MONTHLY INCOME OF PEOPLE (HPTI) of Mumbai with the rest of the urban cities of India, over the past 10 years, we see that Mumbai is the least affordable city (fig 2.04). From the figure, it is clear that the national capital Delhi and the technology hub Bangalore fall in the median range of the country with the house price of 58.5 times the monthly income and 56.1 times the monthly income respectively, as of March 2019. At the same time, the house price of Mumbai is 74.4 times the monthly income - the highest in the country.

Adding to the rising house prices, rental policies prevalent in the city do not help the tenants or the landlords.

3 Veidehi Tandel et al., "Decline of Rental Housing in India: The Case of Mumbai," *International Institute for Environment and Development (IIED)* 28, no. 1 (2015): 259–74, www.sagepublications.com.

4 Kunal Kulkarni, "How Mumbai Became a Magnet for Migrants," in *Migration and IDPs in South Asia* (Consortium of South Asian Think-Tanks (COSATT), Kathmandu, Nepal: Consortium of South Asian Think-Tanks (COSATT), Konrad Adenauer Stiftung (KAS), 2016), 191–201, https://www.gatewayhouse.in/how-mumbai-became-a-magnet-for-migrants/.

5 D P Singh, "Migration and Occupation in Mumbai - Issues and Implications," in *International Union for the Scientific Study of Population* (XXV International Population Conference, France, 2005), 3, http://www.shram.org/uploadFiles/20131106035214.pdf.

6 Kulkarni, "How Mumbai Became a Magnet for Migrants."

7 Singh, "Migration and Occupation in Mumbai - Issues and Implications."

8 Tandel et al., "Decline of Rental Housing in India: The Case of Mumbai."

9 Singh, "Migration and Occupation in Mumbai - Issues and Implications."

RENTAL POLICIES

The Bombay Rents, Hotel, and Lodging House Rates Control Act of 1947 controlled rents in Mumbai for several decades after WWII. It was set to expire in 1973, but it was constantly extended until it was replaced in 1999. Rents in rent-controlled properties were required by the 1947 Act to stay at or below regular rents, which were set by the court or controller, or the rents at which the properties were let on September 1, 1940. The Rent Act restricted the growth of rental and allowed for only minor increment in the rent in the case of landlord-performed maintenance and upgrades, which were also decided by the courts.[10]

Unintended repercussions resulted from the Bombay Rent Act. Due to landlords' reluctance for their premises to be covered under rent control, they preferred short-term arrangements (11 months) under the Indian Easement Act of 1882, under which the tenant must pay a license fee for the easement privilege of occupancy, thereby bypassing all tenancy issues. These "leave and license" rental agreements grew in popularity and became profitable at market rates. In 1973 the Tenancy Act was amended to put all leave and license properties under rent control recognizing that short-term leave and licenses were gaining traction.[11]

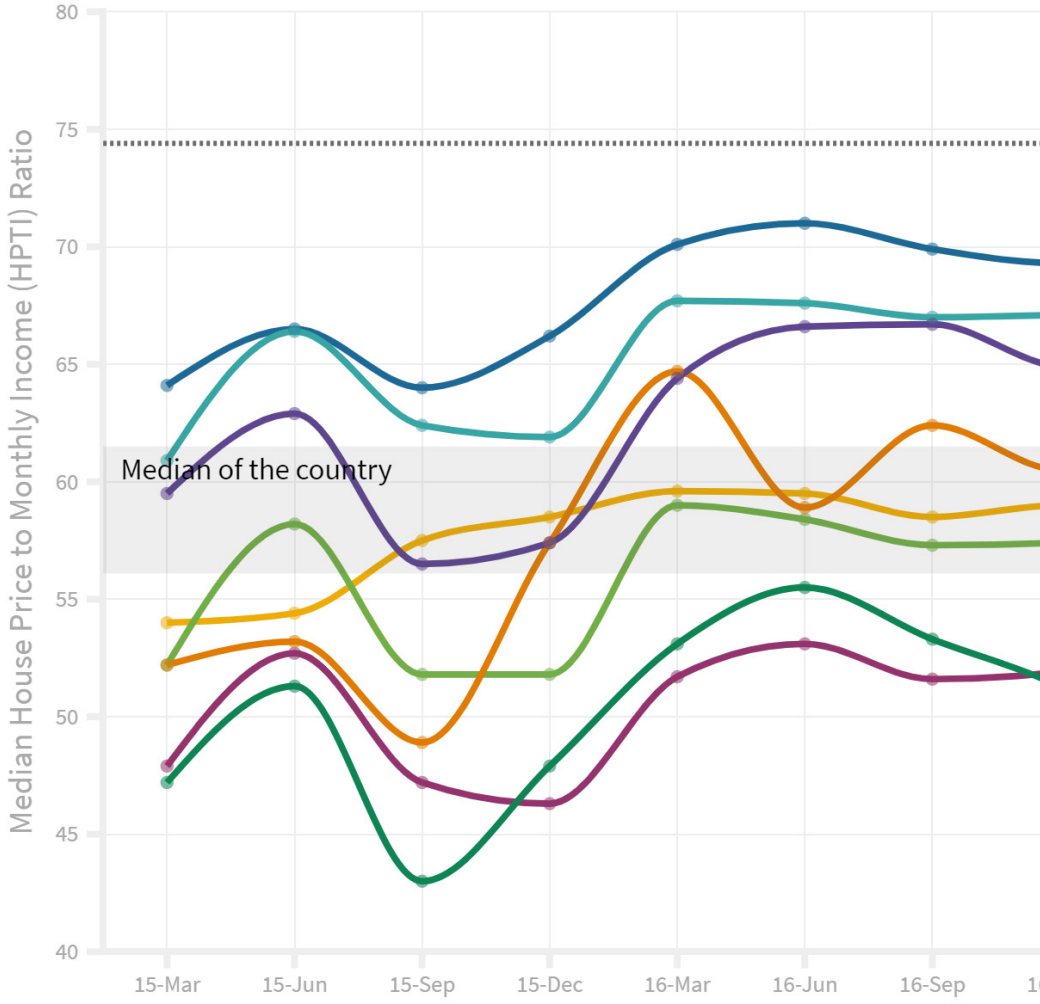
Previously, the Rent Act may vary from one city to the next. The Maharashtra Rent Control Act was passed in 1999. The act covers the whole state under a common rent control rule. The court sets the uniform rent under this act.[12]

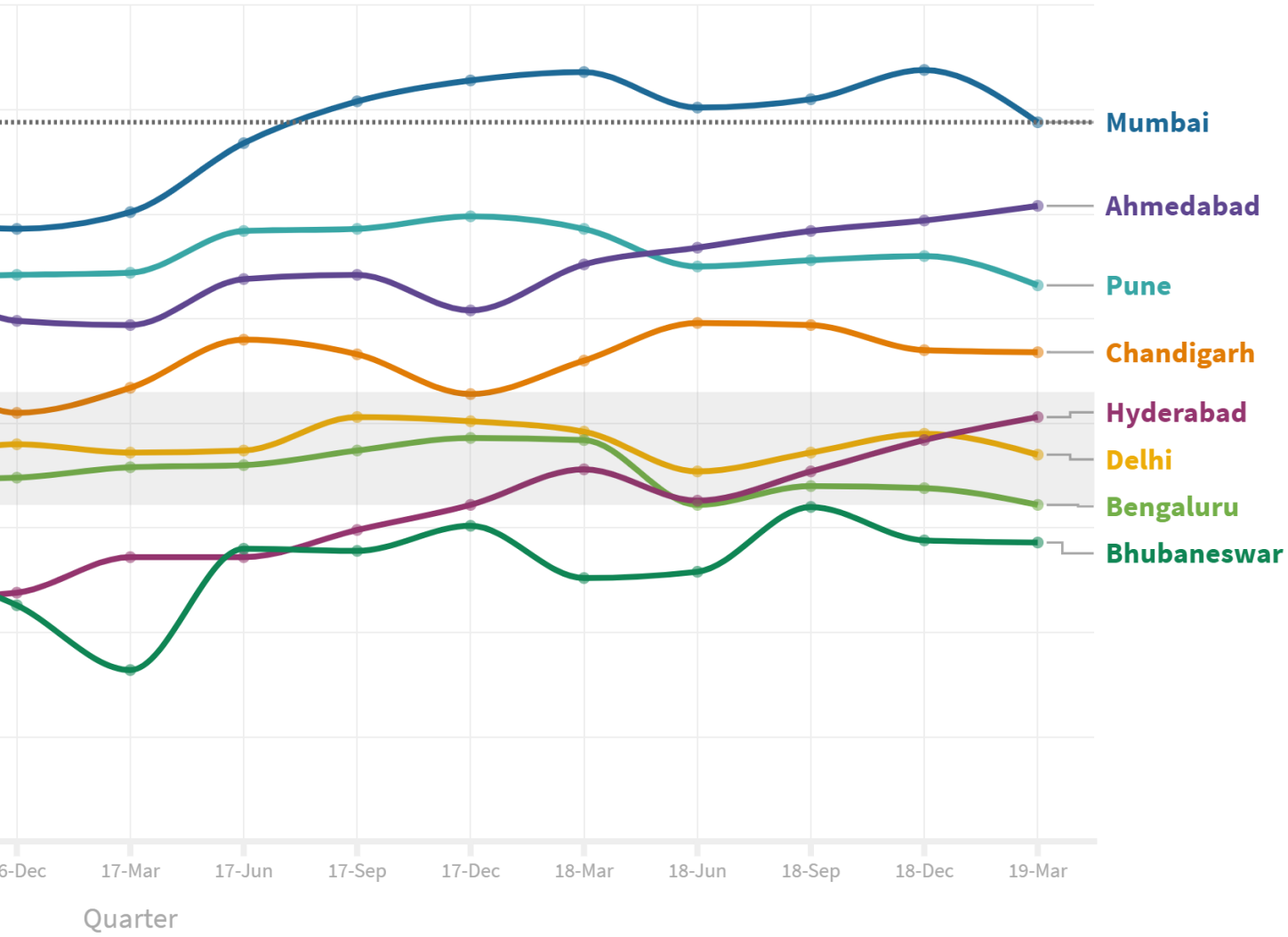
10 Tandel et al., "Decline of Rental Housing in India: The Case of Mumbai."

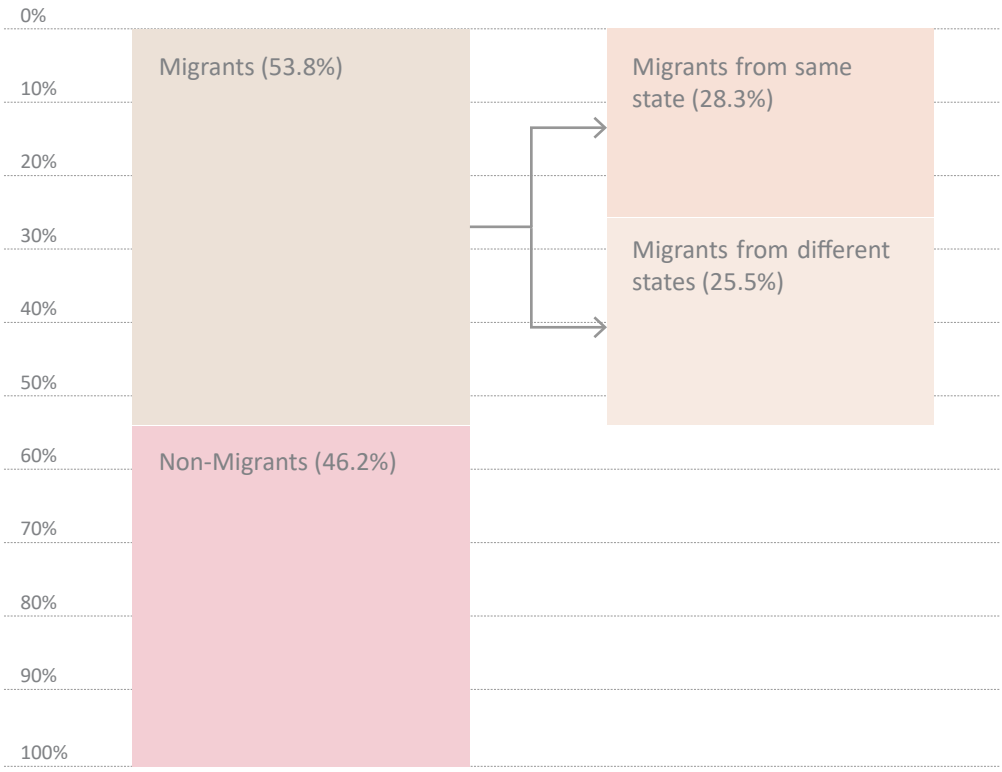
11 Tandel et al., "Decline of Rental Housing in India: The Case of Mumbai."

12 Tandel et al., "Decline of Rental Housing in India: The Case of Mumbai."

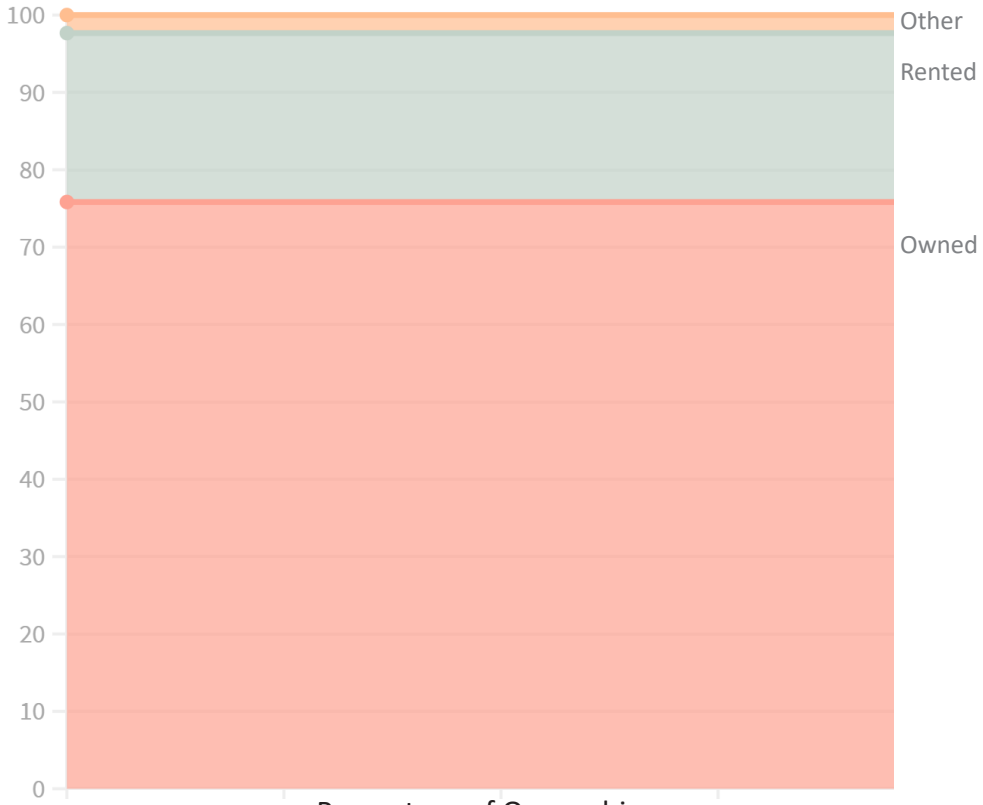
Fig. 2.04. Median house price to monthly income ratio graph of different cities in India over four years




Mumbai
Ahmedabad
Pune
Chandigarh
Hyderabad
Delhi
Bengaluru
Bhubaneswar
6-Dec
17-Mar
17-Jun
17-Sep
17-Dec
18-Mar
18-Jun
18-Sep
18-Dec
19-Mar
Quarter



Percentage of Migrants



Percentage of Ownership

The current Rent Control Act does not provide relief to landlords and tends to control rent caps with very low average growth rates. The city's strict rent restrictions have resulted in continued dilapidation of the current affordable housing stock, "muddled land rights," and no investments in new rental housing due to the difficulty of eviction and subsequent generations of tenants residing on the same rent-controlled premises. This has kept these units from being sold on the market, and landlords' incentives to retain their properties have been affected as a result of the exceptionally poor rental returns.[13]

Due to the non-existent rental housing, 75.83% of the residents own their homes by taking a housing mortgage. The rest of the residents are either living in rented homes which are in poor conditions (21.84%) or are rented for free by their employers (2.33%) (fig 2.06).

Fig. 2.05. Percentage of Migrant population in Mumbai (Top Left)

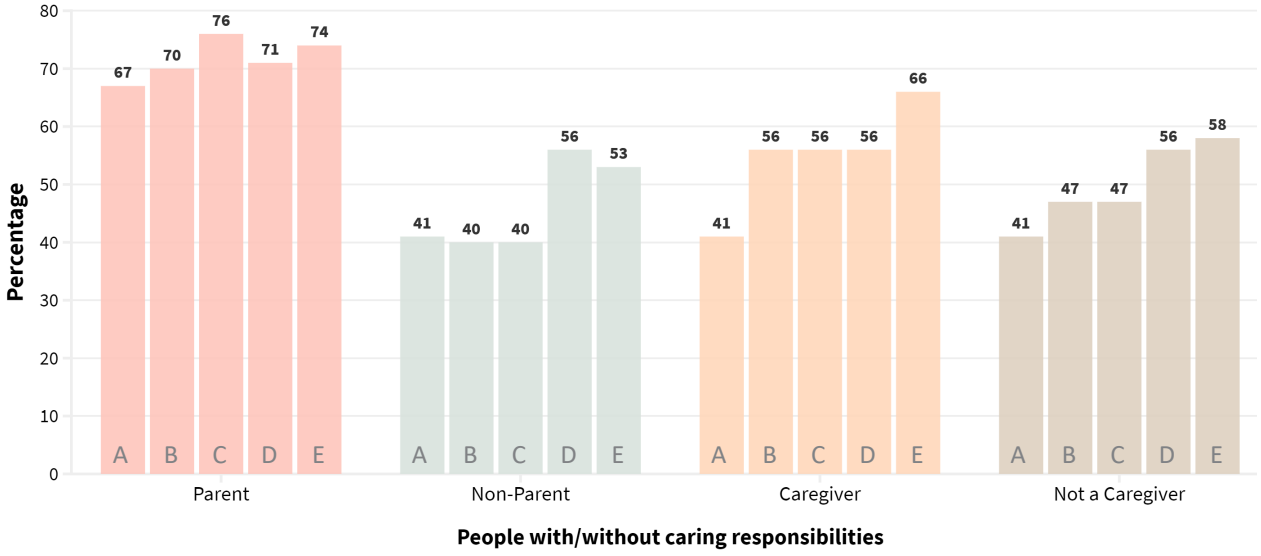
Fig. 2.06. Percentage of house ownership status in Mumbai (Bottom Left)

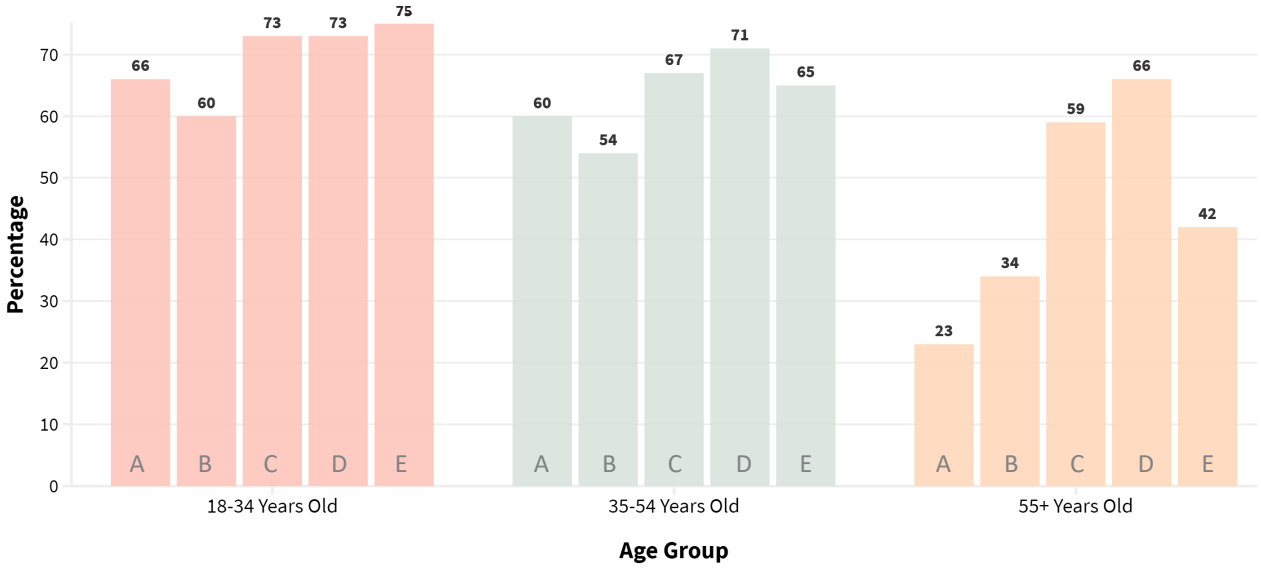
CONCLUSION

The migration into the city and the lack of government policies to support it has led to an increase in the unaffordable housing market. The middle and upper-class population (forming 44% of the total population) can afford a starter home which is then passed down from generation to generation due to the constantly rising costs and the lack of a rental market. The house bought on a mortgage, or rented at cheap rates back in the day, is passed down for generations to grow into due to the inability to afford/shift in a new home. This leads to people compromising on their needs, in a rigid home, throughout their life.

The thesis aims to provide a better home for the residents by reimagining a new typology that changes with time and supports the residents' ability to stay in place without making the building redundant in the future years or having the residents compromise on their needs.

13 Tandel et al., "Decline of Rental Housing in India: The Case of Mumbai."


Percentage
80
70
60
50
40
30
20
10
0
67 70 76 71 74
41 40 40 56 53
41 56 56 56 66
41 47 47 56 58
A B C D E
Parent
Non-Parent
Caregiver
Not a Caregiver
People with/without caring responsibilities


Percentage
70
60
50
40
30
20
10
0
66 60 73 73 75
60 54 67 71 65
23 34 59 66 42
A B C D E
18-34 Years Old
35-54 Years Old
55+ Years Old
Age Group

CHAPTER 3 – STANDARDIZATION AND RIGIDITY IN THE INDUSTRY

To introduce time as a factor in design, we first look at the current housing industry to understand and analyze the requirement and need for time as a design variable.

DIFFERENT NEEDS

Different people have different requirements and ways of life. They follow different religions, are in different stages of life, or have different relationship statuses which lead to different priorities and everyone requiring different things from their home. It is difficult to club everyone under one generic set of requirements and provide a single solution. But this is what currently happens – the standard rigid apartments being constructed and sold in the market are all designed in the same way for a fictitious resident, disregarding the individuality of the users.

This is highlighted by the 'Home of 2030' research report which indicates the lack of consensus on an ideal layout that would cater to all households. Life stage was a big factor, with couples, older residents, and first-time buyers without children all prioritizing different layouts and qualities that matched their different lifestyles.[1] This can be seen in fig 3.01 of how the residents in different stages of life prefer different elements of the house. A parent prefers having a home that can adapt as compared to someone who doesn't have a child or is not a caregiver. Thus marking the importance for a family to grow and stay in the same place and have the home change with them to be able to form a connection with the home, neighborhood, and the community. We see a similar trend in the people of the age group 18-34, who would prefer having choices in the type of housing provided to be able to make decisions based on their future priorities as compared to people over the age of 55, who have already made the decisions

Fig. 3.01. Important home priorities graph according to caring responsibilities and age (as per a survey conducted in UK) (Left)

LEGEND

A - A home where it is possible to work from home

B - A home which is suitable for multiple generations to live in

C - A home that's easy to adapt

D - Having control over what digital technology can do in my home

E - Having more choice and freedom over my housing options

1 "A Public Vision for the Home of 2030," *Design Council* (London: Design Council, n.d.), accessed December 3, 2020.

"For me it's the sociability as well. I'd design a house so that I can fold the bad away and stuff so that I can have a party and have people over to eat, although it's a box."

"If you're buying a new home as a young family you'd want to be able to evolve with that space and not think, oh my youngest is now going to high school, they're going to need more room... I don't quite know how it would work... If I could get a house that could adapt... that would be ideal because then I could.. then allow the house to grow with me."

"I think I've accepted, where I buy, it's going to be quite small, but I want to dictate those rooms myself and how I use them and how big they should be... instead of having open plan, perhaps have the doors that fold back, so you have the choice between open plan and closing off an area."

"[I'd] probably [prefer] the living room and the dining room separate, so that when my daughter brings her friends round I can be in one room and she can be in the other."

"[I want] a room that you could just shut off, it is just a living room."

"I prefer an open space between the kitchen and the living room for entertaining purposes, but at the same time, if it's just me there and I'm cooking, I'd rather partition that space off and keep the smells and everything within the kitchen."

"I do have a prayer mat out but the children just walk right through it... So that's why they don't wear their shoes in the house. So if they want to pray in whatever room is free, they can do... But there isn't enough room to have just one room dedicated to your prayers."

and settled in a place.

Apart from life stages, people have different preferences. Some people want an open living space to accommodate entertaining friends or family, whilst others find the idea less appealing. They believe it is more important for the living space in the home to be private than for the space to be sociable so that members of their family can entertain friends separately, as shown in the report 'The way we live now' by RIBA.[2] Nonetheless, some degree of flexibility is important to most residents, reflecting the fact that many activities take place simultaneously, such as eating and relaxing by watching television; entertaining and cooking; preparing meals, and supervising children's homework.[3] More progressive home layouts with flexibility may accommodate the needs of the user in a better manner than the current designs, which lack in providing the people the ability to decide for themselves. John Habraken discusses this in his book, entitled 'Supports: An alternative to mass housing' published in 1962, where he proposes the separation of 'support', designed by the architect, and 'infill', determined by the occupant, to provide more agency to the user.[4]

Fig. 3.02. Quotes of what residents prefer in a home according to a survey conducted in UK
(Left)

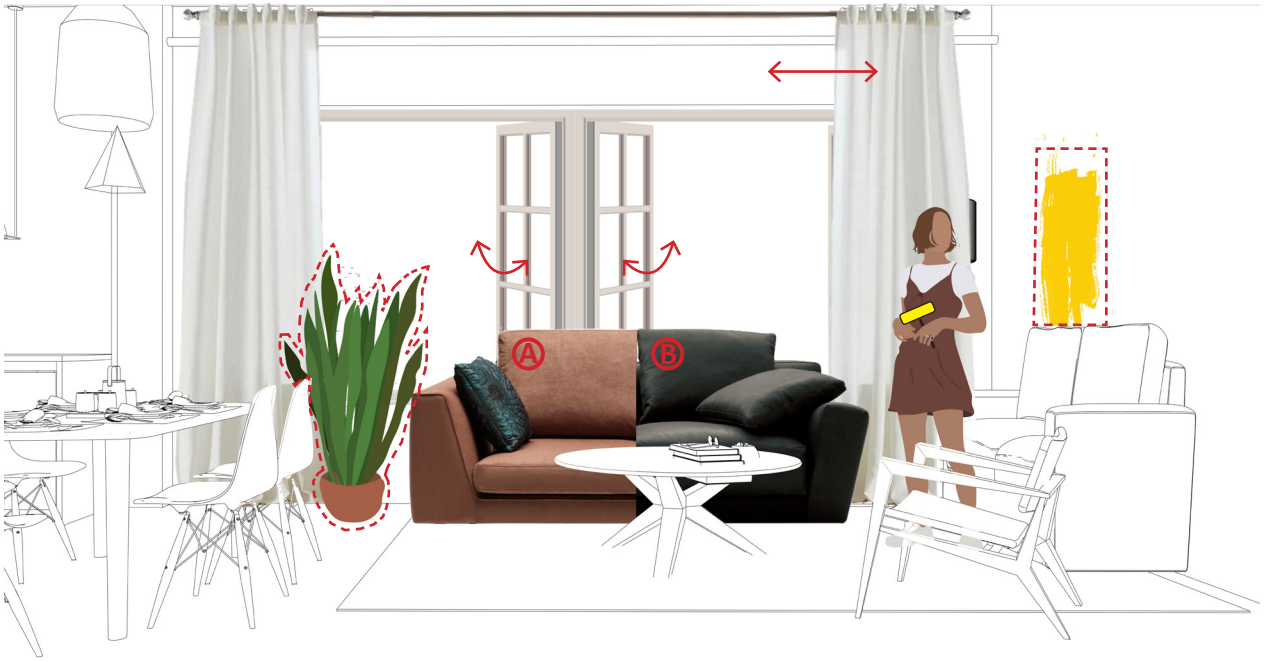
But currently, apartments designed are standard, fixed, and rigid in their layout options. The elements are decided beforehand, usually without the input of the user, with the furniture left as the only infill element which the user can decide upon. They can choose which furniture to have, or maybe the color of their walls, and have a few decorating items. They can open or close their windows, doors, and curtains but only in a fixed direction where they have been permanently installed. (fig 3.03) The residents have little to no agency or decision in deciding how to use the space.

Moreover, the layouts designed do not incorporate the ability to change with time. This lack of incorporating time as a variable in design leads to families compromising on their needs over their lifetime. Even though the debate began in the 1960s, we still have typologically rigid, generic, and repetitive houses that are viewed

2 Stephan Finlay et al., "The Way We Live Now: What People Need and Expect from Their Homes" (RIBA and Ipsos MORI, 2012), https://www.ipsos.com/sites/default/files/publication/1970-01/sri-riba-the-way-we-live-now-may-2012.pdf.

3 Finlay et al., "The Way We Live Now."

4 Denise M. Nascimento, "N.J. Habraken Explains the Potential of the Open Building Approach in Architectural Practice," *Open House International*, Adapting Buildings to Climate Change, 37, no. 4 (December 2012): 5–13.



Adaptable Elements in the Apartment

1. Movable curtains
2. Operable windows
3. Furniture and Decor
4. Color of Walls

as a commodity to be bought rather than a process to be designed and transformed over time.[5]

Fig. 3.03. Typically found adaptable elements in an apartment (Left)

STANDARDIZATION AND RIGIDITY

Take any object at random. It is likely to be standardized. Fountain pen, paper, and ink, the furniture, the television set, the radio, the electric bulbs - the whole house for that matter. Due to standardization in apartment layouts all over the city, a family moving in a two-bedroom apartment does not have the decision-making power to choose if they would prefer a larger living room, an open layout, or a study as a secondary bedroom. The whole civilized world is filled with standardized objects. But the world itself is not standard, and this is something we must learn to appreciate.[6]

Standardization does help in controlling efficiency, quality, and quantity. Industrialized systems can simplify production and thereby achieve cost reduction and higher quality at the same time.[7] But with the trend of mass production on the rise, standardization has taken control of the housing sector and reduced individuality. Standardization can instead be used as a guide with the small elements of the complete house as standard – windows, doors, panels, balconies, tiles, and other building elements - and their different combinations and incorporation of end users can produce new architectural variants highlighting the individuality of the resident.[8]

Dividing the elements into standards, instead of standardizing the whole home, building, and market, we can apply them throughout the country easily - unlike the current scenario. India is a vast country with wide variation in its topography, living patterns, and socio-economic conditions. The concept of industrialization of complete housing in India should be decentralized and not follow the Western model of organized centralization. With its diversity, India should adopt prefabrication by the masses rather than massive prefabrication.[9] By prefabricating according to different

5 M. Nascimento, "N.J. Habraken Explains Open Building Approach."

6 Georgi Borisovsky, "Science and Technology: Architecture and Technical Progress," *Soviet Review* 3, no. 2 (February 1962): 3–20, https://doi.org/10.2753/RSS1061-142803023.

7 Uttam Kumar Roy and Madhumita Roy, "Space Standardisation of Low-Income Housing Units in India," *International Journal of Housing Markets and Analysis* 9, no. 1 (2016): 88–107, https://doi.org/10.1108/IJHMA-12-2014-0057.

8 Borisovsky, "Science and Technology."

9 Roy and Roy, "Space Standardisation of Low-Income Housing Units in India."

needs, topography, and requirements, we can create better living conditions for the residents at the same economic cost – with also promoting the uniqueness of every resident and every city.

Adding to this, with the apartment being rigid, users are not able to grow in the same place and have the apartment grow with them. Time as a design contingency depends on contextualizing architecture, rendering it vulnerable to its temporal truth and greatest fear - change. Designers often overlook these temporal considerations in favor of visual obsession and functionality, effectively locking time in the creation of a static idealized object of perfection.[10] By doing so, they do not support the changing requirements of the residents or the flexible use of the rooms thereby making the apartment not fulfill the needs and rather have the residents adapt their behavior and compromise so that rooms can be used in multiple ways.[11] The built environment is in constant transformation and that change must be recognized and studied.[12]

This effect can be seen in fig 3.04 of how the space usage changes over a period of time, as the family grows and multiplies. The figure depicts how an apartment goes from a two bed one bath, with parents occupying one bedroom and the two children sharing the other till they become teenagers, to a two bed two bath, with parents occupying one bedroom and a married couple in the other. This cycle goes on for the next generation and the house is passed down from one generation to the other.

CONCLUSION

This makes us question, how can our existing housing typologies undergo adjustment as people's lives change? Do we design new typologies to provide new living spaces?[13] How does one design for time?

The research therefore questions can we design mass housing apartments in dense urban cities, like Mumbai, India, that provides

10 Robert III Schmidt et al., *What Is the Meaning of Adaptbility in the Building Industry?*, O&SB2010 "Open and Sustainable Building" (Bilbao: LABEIN Tecnalia, 2010), https://www.irbnet.de/daten/iconda/CIB17993.pdf.

11 Finlay et al., "The Way We Live Now."

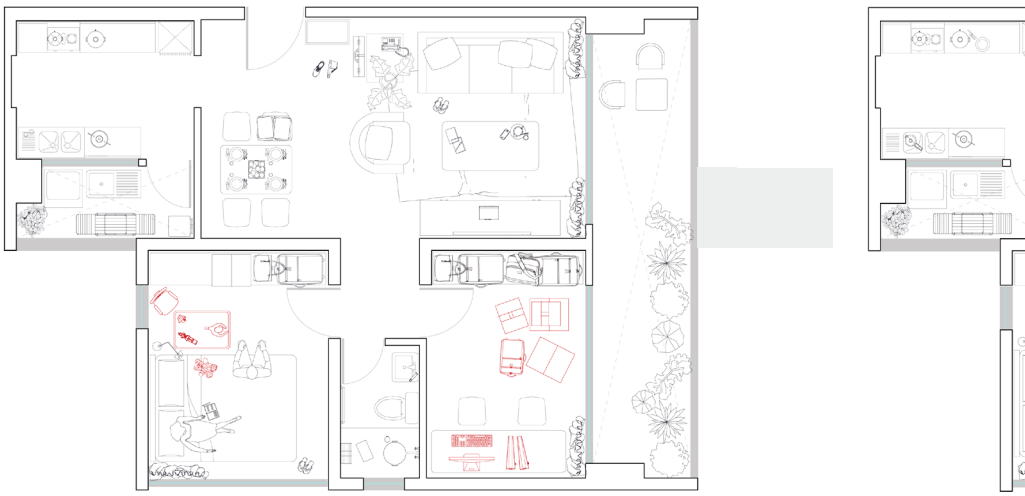
12 M. Nascimento, "N.J. Habraken Explains Open Building Approach."

the residents' autonomy over their spatial layouts? What are the ways people can change the spatial layout of their apartments to better suit their changing requirements and expectations?

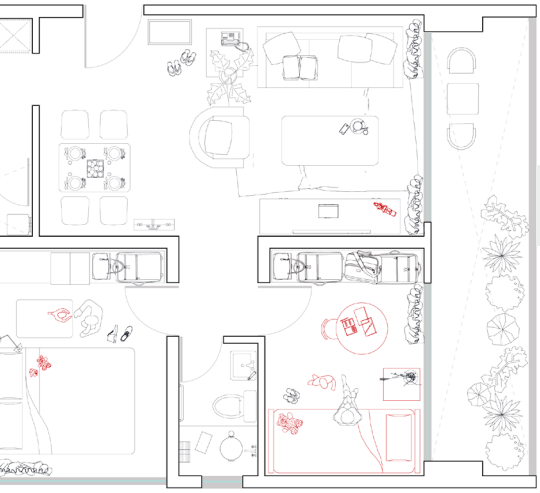
The next chapter looks at the housing industry of Mumbai in detail to then apply the concept of time and change. It analyzes the typical housing typology and investigates the homes of the residents to understand which elements can undergo change, to improve the housing industry without losing the cultural importance and requirements of the residents or make the whole industry unaffordable. It will help understand which system would work in the context without completely changing the housing industry.

13 Lorraine Farrelly, "Housing from 8 to 80: An AD Ideas Project," *Architectural Design* 84, no. 2 (2014): 126–35, https://doi.org/10.1002/ad.1739.

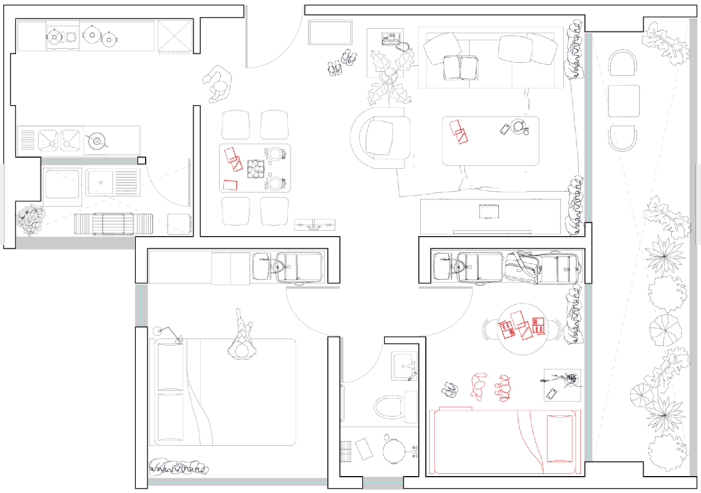
Fig. 3.04. Lifestages of an Indian family affecting space usage of the apartment



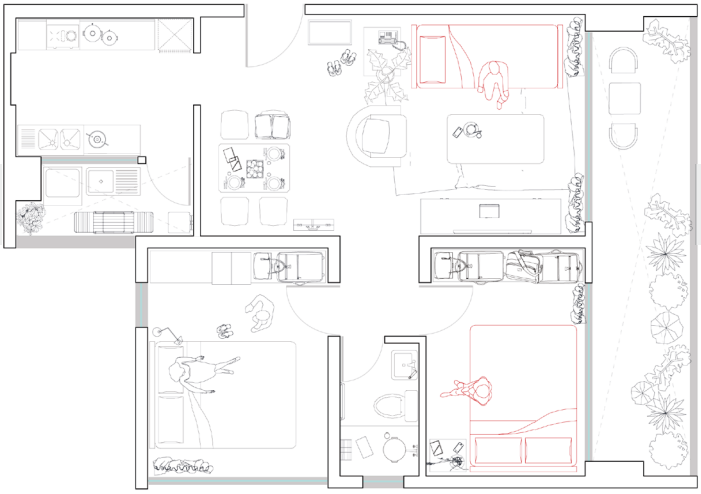
1. Two bed one bath apartment for new parents



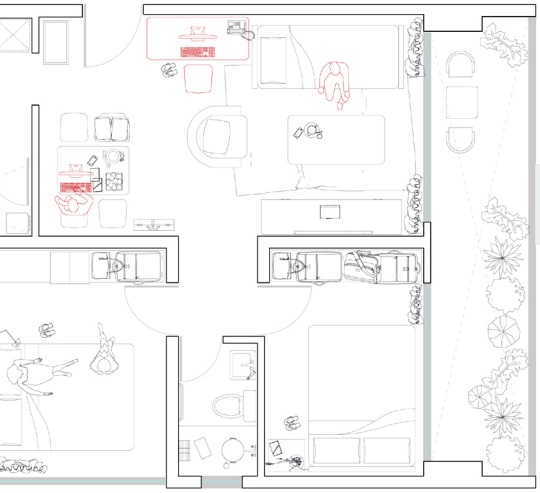
2. The child is moved into a separate bedroom with the new baby sleeping in a cot with the parents



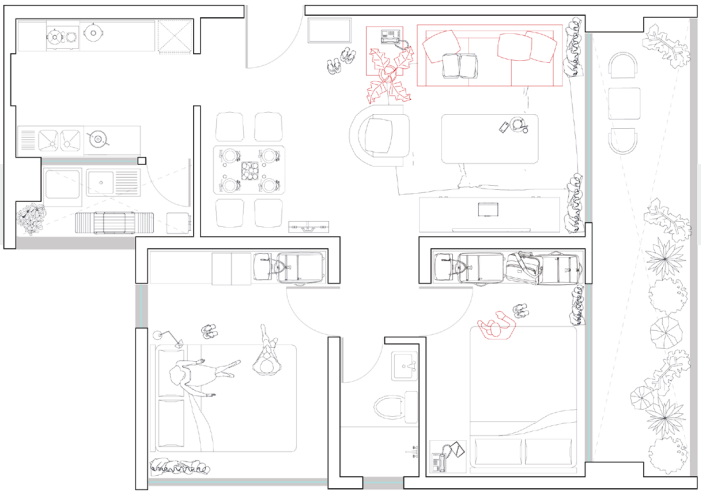
3. Both children share the other bedroom



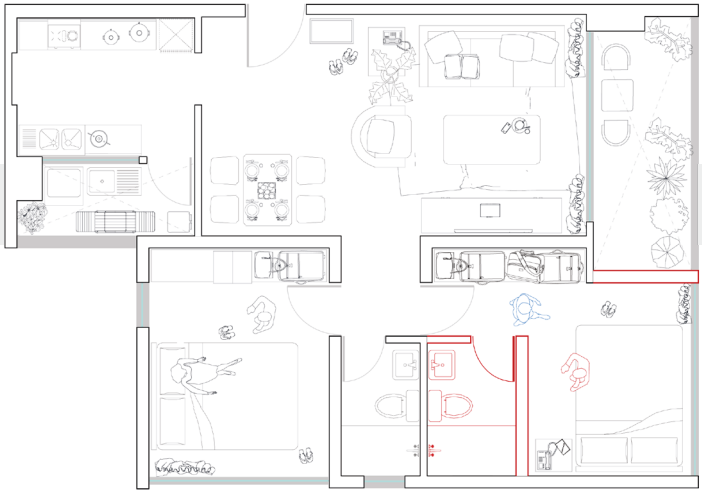
4. The daughter takes one bedroom with the son moving out in the living room turned bedroom



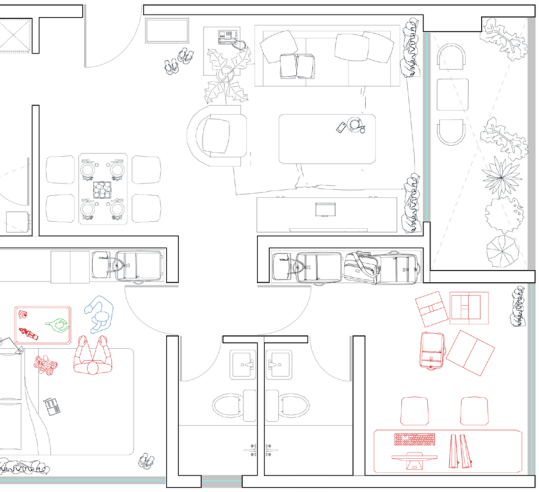
5. Dining table and living room being used as a workspace due to Covid-19 Lockdown



6. Daughter marries and moves out. Son takes the bedroom



7. Son gets married and his wife moves in with him. Another bathroom is added



8. The new couple have a baby with the spare bedroom being used as an office

01.

The Architect **submits all the relevant documents** and CAD file to the MCGM website for approval

02.

They **attach site photos** and videos to the application

03.

BMCs BPO department gets the application package and **reviews it** with survey office

04.

Sub-engineer from the BPO **conducts a site inspection** to check the provision of civil infrastructure

05.

The file goes to different departments for **NOCs**. Each conducts a site visit if necessary

06.

If satisfactory, BMC issues a **Intimation of disapproval (IOD)**

07.

A **CC upto plinth level** is provided after completing reviews, NOCs, and passing inspections

08.

Another **CC for beyond plinth level** (FCC) is provided after 7 days after passing inspection

09.

A **completion NOC** is requested from all the different departments

10.

The Architect requests for **Occupancy Certification and Completion Certificate**

11.

Both Certificates are provided after **inspection** within 7 days

12.

Permanent power, water and sewerage connections are obtained from the BMC

CHAPTER 4 – MUMBAI HOUSING INDUSTRY

This chapter goes through the history, typology, and design of the current housing typology in Mumbai and also analyzes the problems people face in them.

Fig. 4.01. Steps of getting a building permit in Mumbai (Left)

MCGM - Municipal Corporation of Greater Mumbai

BMC - Brihanmumbai Municipal Corporation

BPO -Building Permit Office

NOC -No Objection Certificate

CC - Completion Certificate

ABOUT THE GOVERNMENT STRUCTURE

The National Building Code (NBC) guides the bylaws of building for the whole country. NBC states the minimum construction standards. Figure 4.01 describes the steps that need to be taken to get a building permit for housing development in Mumbai. The authority providing the building permit and keeping a check on the development standards is Bombay Municipal Corporation (BMC) whose Building Permit Office (BPO) conducts site inspections and checks whether the bylaws are met.

HISTORY OF HOUSING DEVELOPMENT

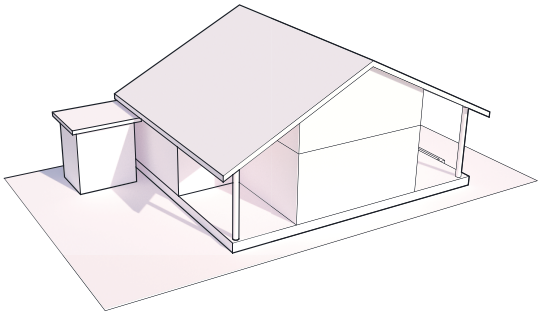
The next subsection covers the development of housing typology in Mumbai since the time Mumbai was assembled into a city from seven marshy islands.

Fig. 4.02. History of Mumbai's housing typology development

Migration Period

Trade-Mills Period

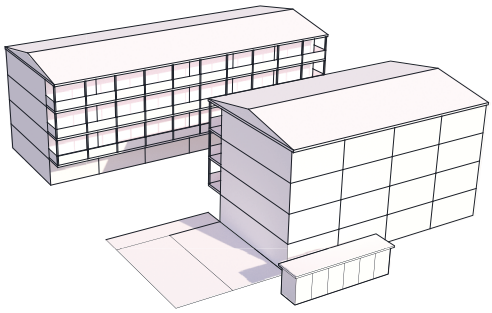
Colonial Rule



Englishmen came and **divided Mumbai into plots**. These plots were alloted to people who wish to build and live in Mumbai leading to sudden influx of people.

1700s 1750

People living in Mumbai were **primarily fishermen and farmers**. The housing type was small **single storey family homes** on agriculture lands.

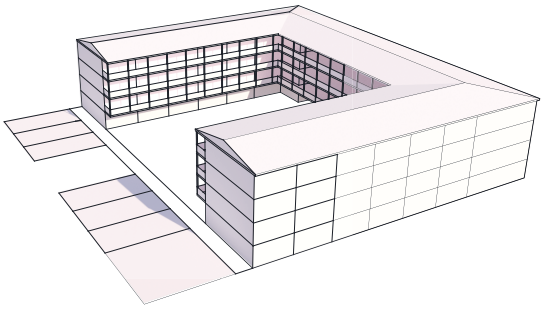


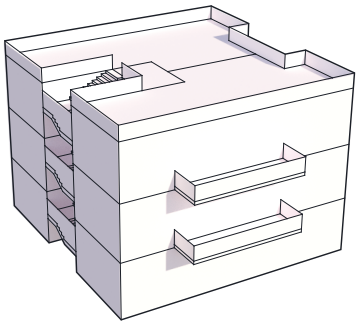
American civil war led to an end of textile supply from America. British thus encouraged textile production in India and **set up textile mills in Mumbai.** With the opening of Suez Canal as a trade route, Mumbai became one of the world's largest textile producing center. This led to mass **migration for working class laborers and 'chawls' were developed** as housing by the mill owners for the workers. Chawls were similar in architecture to wadis, but initially made for single worker living in one room. With the working class moving inside the city, the rich started moving to the suburbs.

1780

East India Company (EIC) established trade routes in Mumbai. This led to **'wadis'** as a housing type to flourish. The land owners developed small two-four storey buildings with shops on the ground floor and residences above. The rooms above were occupied by several tradesmen households with shared toilets and a single owner, who collected rents. Landowners became landlords. **These settlements worked as large wholesale markets** for the city trading certain agrarian products.

1860s



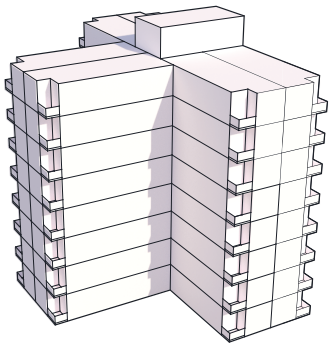


After Independence, Mumbai became regional capital of Maharashtra. While apartment became the predominant type, **slums started to grow due to migration.** Rent control Act of 1947 was introduced. This discouraged landlords to invest. **The developer group was born.**

1890s

National Freedom Movement was gaining strength. British therefore started getting involved in the governance issues and **set up Municipal Corporations, Courts, Universities, Improvement trusts etc to plan and manage the city. The apartment type was introduced** and started gaining prominence as a mass housing type. These were first rented apartments developed by private owners for educated Indian families - with generous spaces and private washrooms, as opposed to the prevalent chawls. This typology gained popularity with notions of upward mobility.

1947

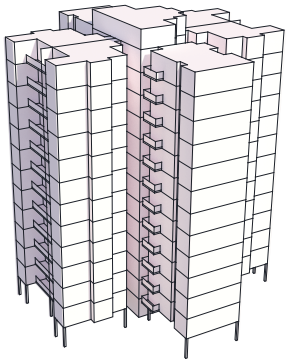


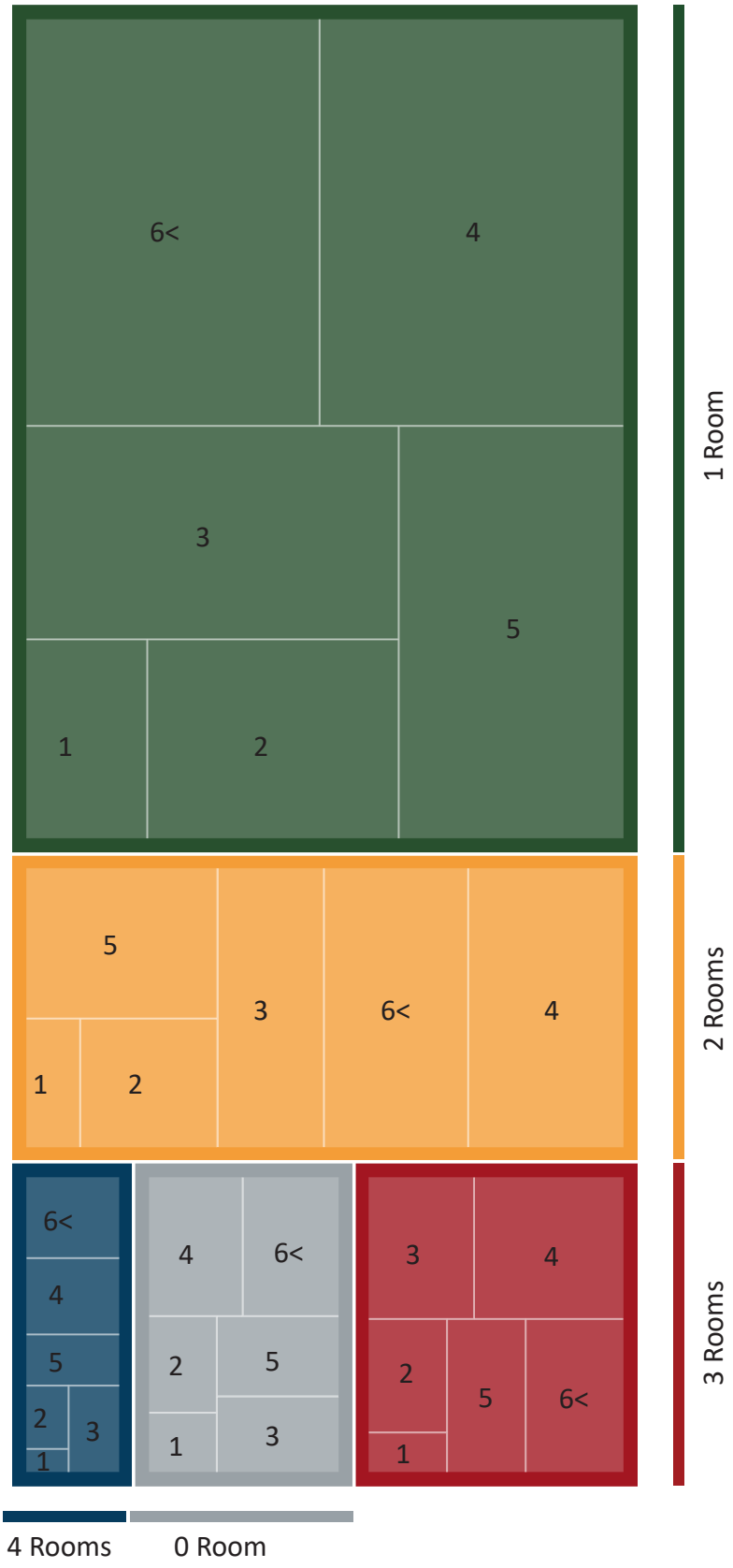
State adopted economic liberalization policies and increased the salaries of formal labors. **Real estates were bought as investments.** They needed to be functional but also provide luxury. **This gave rise to luxury apartments and townships which were guarded and enclosed.** These township provided gardens, pool, parking, and shopping centers. They are maintained by cooperative housing societies formed by the residents and are generally **14-25 stories with 2-4 apartments per floor.** Medium size housings were also built by smaller developers for the middle class for their own use or as investment.

1970s

Slums became very intense due to high migration and lack of housing infrastructure. **Site and service schemes, apartment and slum housing became the predominant type.** Rent control Act strangled the rented housing and the state was unable to supply enough housing to the city. This led to the developers becoming the prominent agents in housing delivery. Developers raised funds from a chain of financers - and got plans passed illegally. **End users got move in ready flats which were unaffordable**, which led them to raise money from informal savings.

1990s




6<
4
3
5
1
2
1 Room
5
3
6<
4
1
2
2 Rooms
6<
4
5
2
3
1
4
6<
2
5
1
3
3
4
2
5
6<
1
3 Rooms
4 Rooms
0 Room

HOUSEHOLD COMPOSITION

Figure 4.03 divides the household composition into percentages. From the tree graph, we see that 1 room (1 habitable room) households are in majority shared by either 4 or 5 people. Such households live mostly in settlements and chawls where only a single room is provided to a family with common washrooms. Apartments in housings are 2 rooms (2 habitable rooms) or above with an average of 4 people sharing it, to whom the thesis applies to. Therefore, for the adaptable proposal, the average family size is taken as 4 people living in 2 rooms or more. Also, the statistical data does not include residents living on the pavements without permanent structures. The 0 room (0 habitable room) includes families sharing 1 habitable room with another family, therefore, the room is not considered to be anyone due to lack of privacy.

Fig. 4.03. Household composition in Mumbai according to number of habitable rooms and number of residents
(Left)

The inside division shows the number of people living in the household

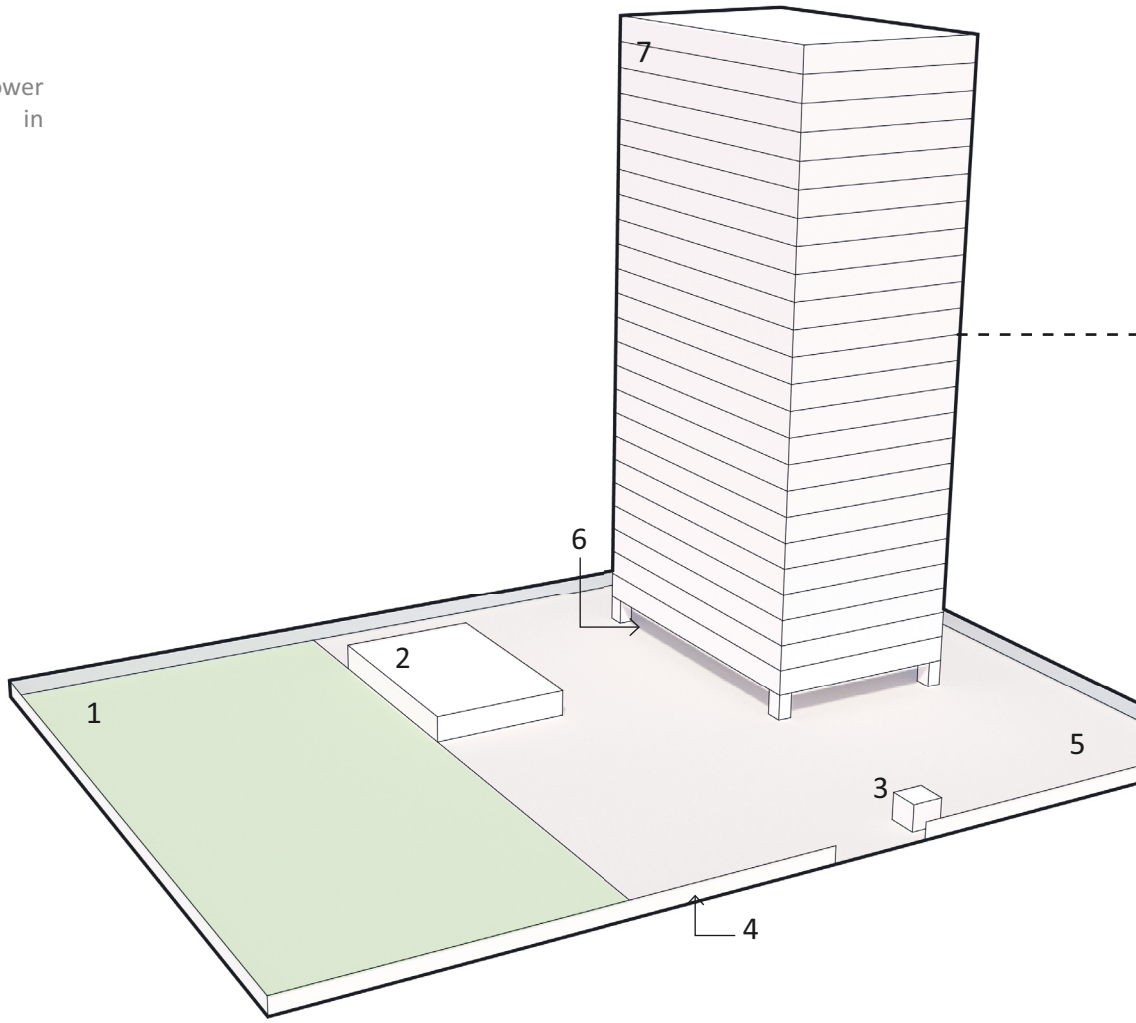
TYPICAL HOUSING ELEMENTS

The housings in Mumbai have some typical elements found in all the multi-residential buildings. The following figures (fig 4.04 and fig 4.05) describe the typical elements found at the site level and the tower level. Wadhwa apartments are taken as a precedent study (fig 4.06) for the typical tower and apartment design. It details out the different cultural elements found in an apartment with typical layouts. Following that, the precedent study of different apartments of four residents (fig 4.07 – fig 4.18) detail the design elements found in apartments with images to better understand how an apartment looks and works.

Fig. 4.04. Typical site elements found in Mumbai (Left)

Fig. 4.05. Typical tower elements found in Mumbai (Right)

1. Green Space
2. Community Building
3. Guard Room
4. Boundary Wall
5. Surface Parking
6. Stilt Parking
7. Housing Tower
8. Two Fire exit Staircases
9. Stretcher Lift
10. Smaller Lift
11. 3m wide Corridor
12. Apartment



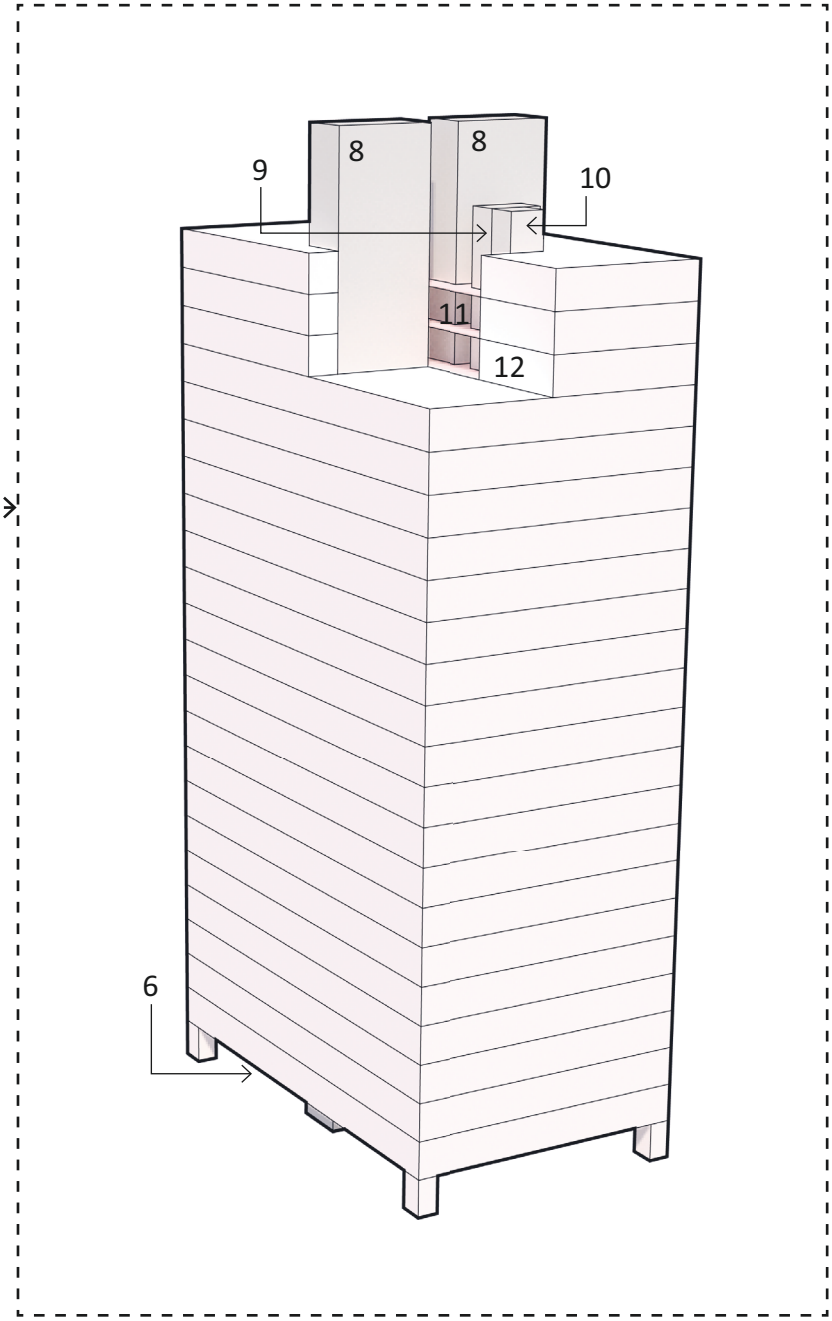

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Fig. 4.06. Case study of Wadhwa Apartments Mumbai for typical tower elements

1. The core typically has 4-6 apartments with 2 staircases and at least 1 lift able to fit a stretcher

2. Sunlight and ventilation form an integral part of the culture, and therefore design, with every room, washroom, and common spaces having a window. Sunlight is believed to kill germs in the room.

3. The kitchen is typically a closed kitchen, to keep the smell of the food inside, with a utility area attached to it to wash and dry clothes.

4. There is a prayer corner present in most homes where there are no shoes allowed. Adding to this, generally, shoes worn outside the home are not bought inside. Most homes, thus, have a shoe rack and storage right at the entrance.

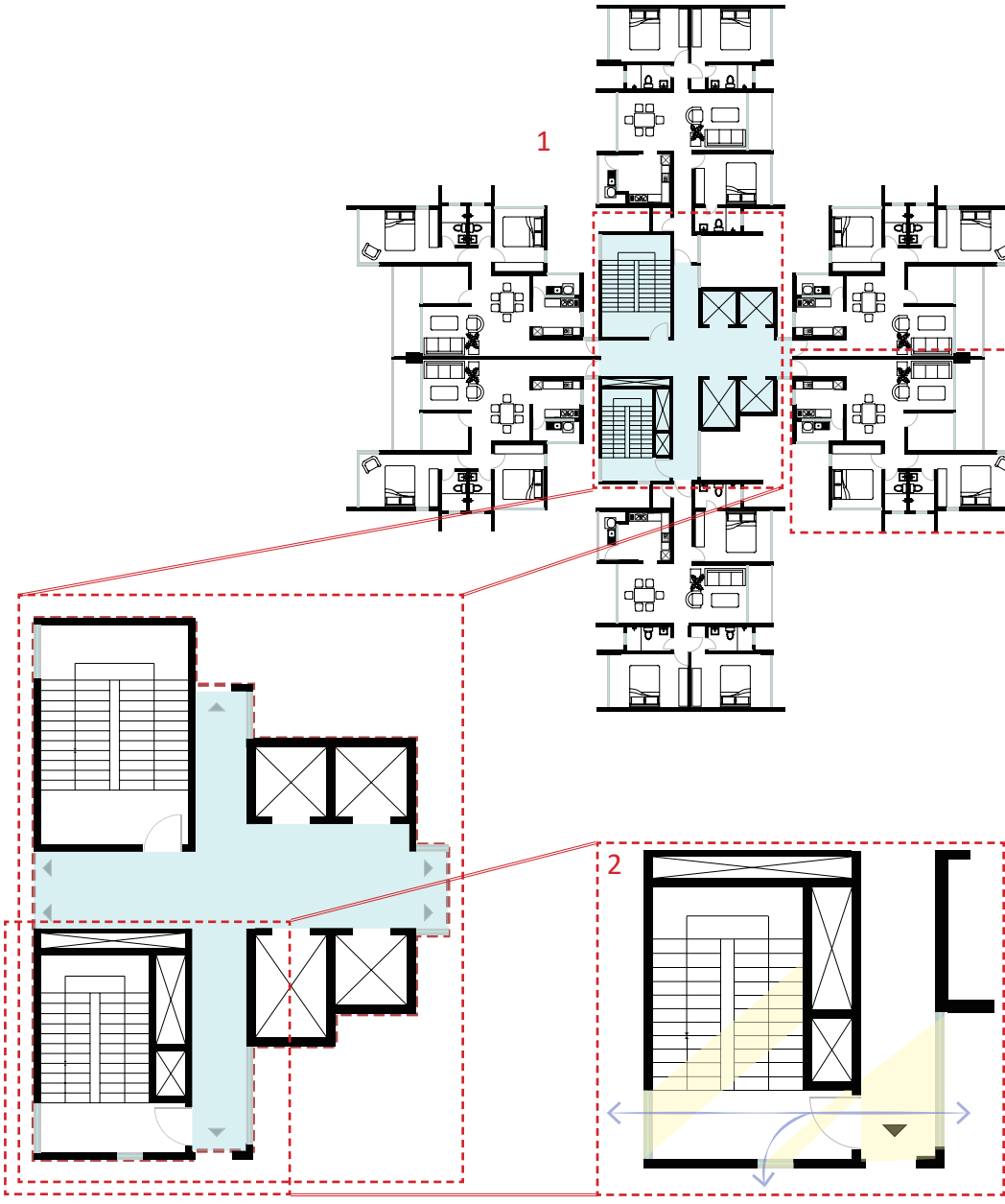
5. Balconies are used by the residents to interact with their neighbors, have greenery, and have evening tea.

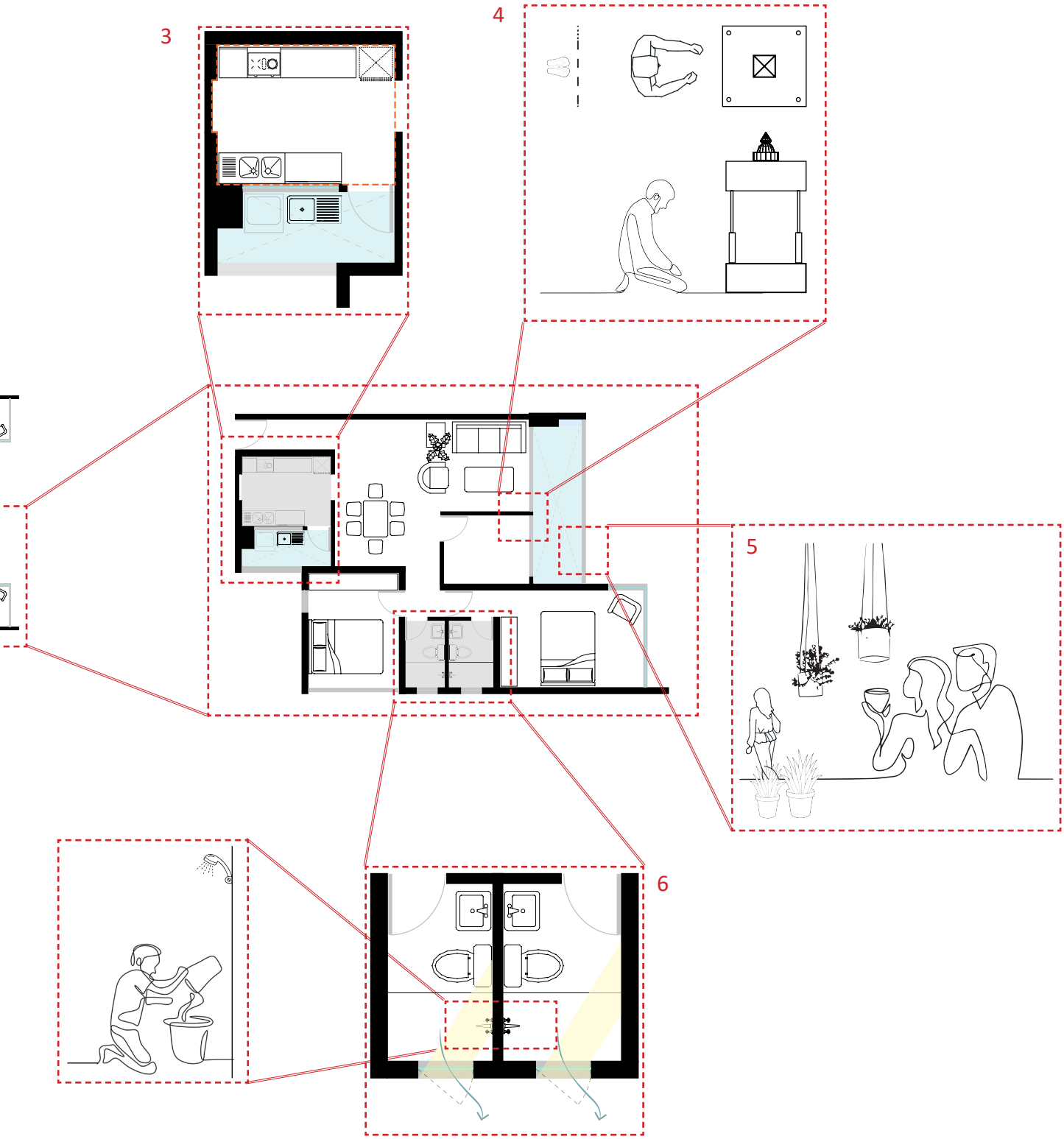
6. The washroom also has a small window for sunlight and ventilation. The shower area usually has a bucket to take a bath, as bathtubs are not common neither are a requirement in India.

Naturally Ventilated Zone

Mechanically Ventilated Zone

Air-Conditioned Zone

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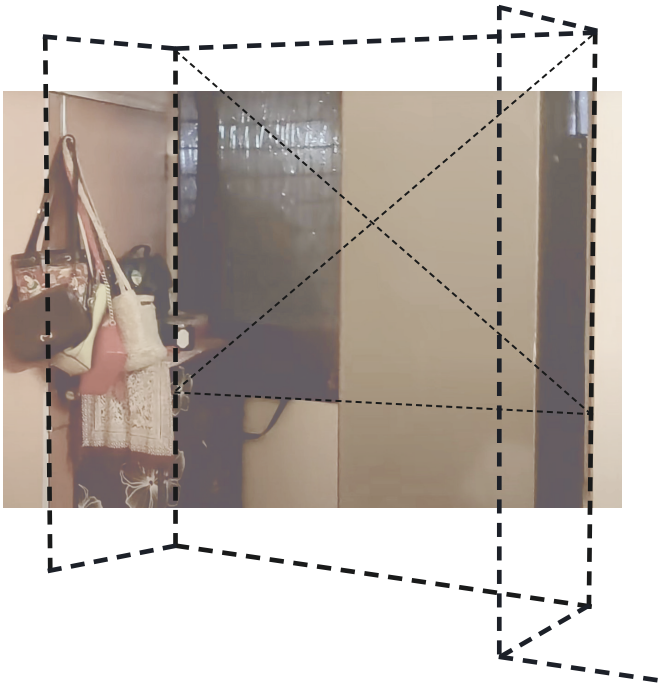
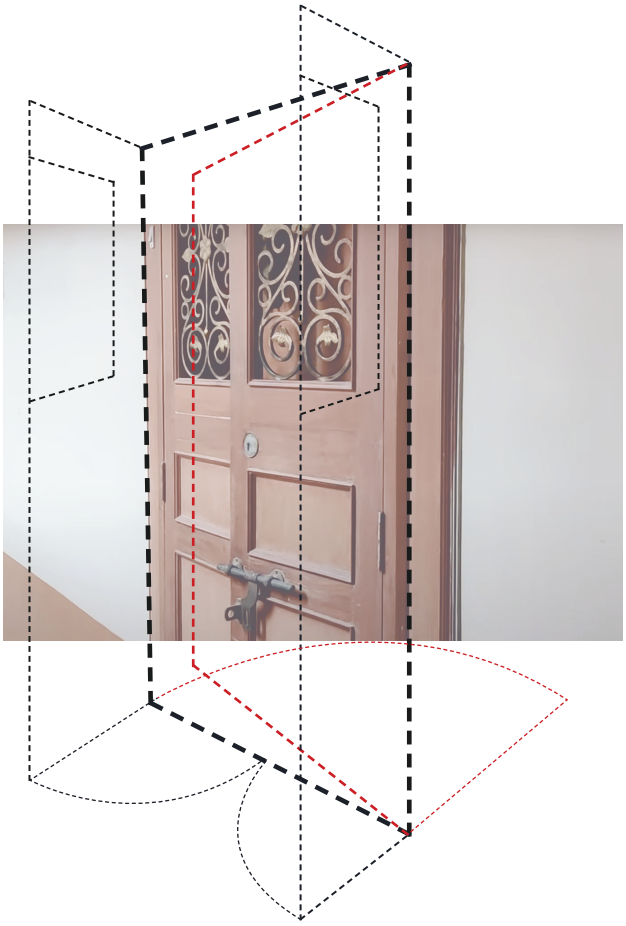
Resident living in a 1 Bed 2 Bath with a cat. She pays Rs 35,000/month (USD 466/month) for 550 sqft.





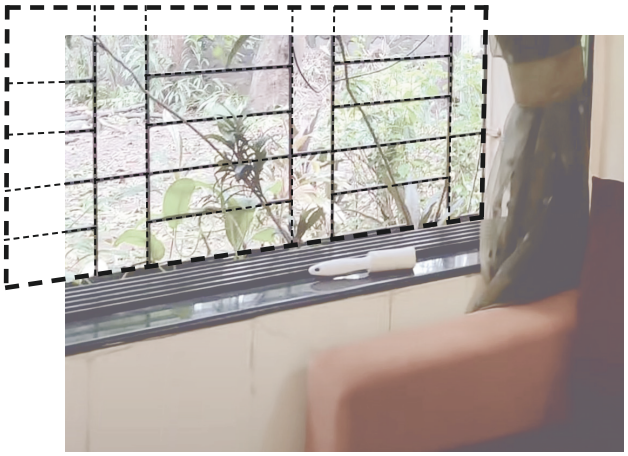


Fig. 4.07. Encroached balcony to add storage (Top Right)

Fig. 4.08. Apartment entrance door with additional security door (Bottom Left)

Fig. 4.09. Metal bars on the window for security (Bottom Right)

Resident living in a 2 Bed 2 Bath with parents. The apartment is Rs 90,000/month (USD 1200/month) for 1000 sqft.

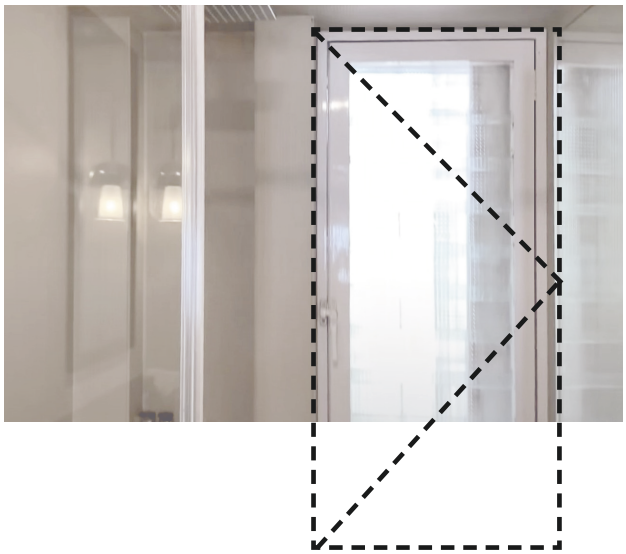


Fig. 4.10. Traditional Indian Door and latches (Top Right)

Fig. 4.11. Window in the bathroom (Bottom Left)

Fig. 4.12. Traditional Indian wooden blinds (Bottom Right)

Resident living in a 2 Bed 2 Bath with parents. The apartment is Rs 30,000/month (USD 400/month) for 970 sqft.

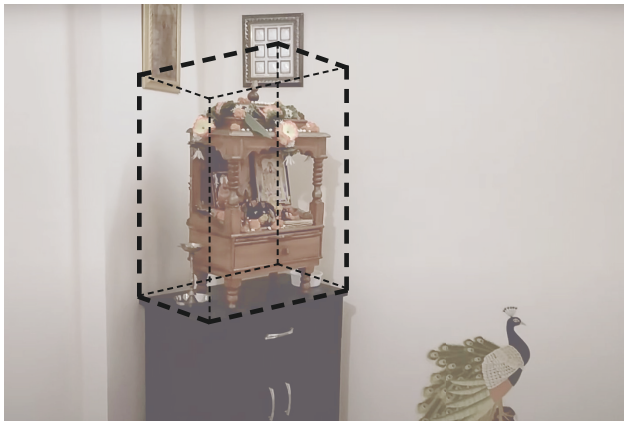


Fig. 4.13. Prayer corner (Top Right)

Fig. 4.14. Utility area behind the kitchen (Bottom Left)

Fig. 4.15. Standalone wardrobe with storage above (Bottom Right)

Resident living in a 1 Bed 1 Bath with a roommate. She pays half of the rent - Rs 17,500/month (USD 233/month) for 477 sqft.

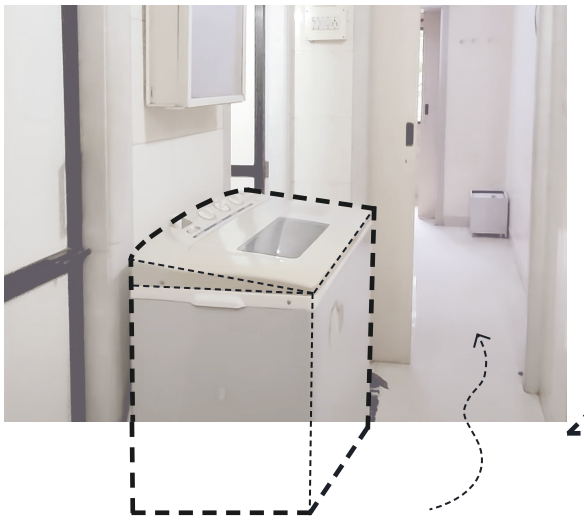


Fig. 4.16. Window with operable shutters (Top Right)

Fig. 4.17. Utility area in the corridor (Bottom Left)

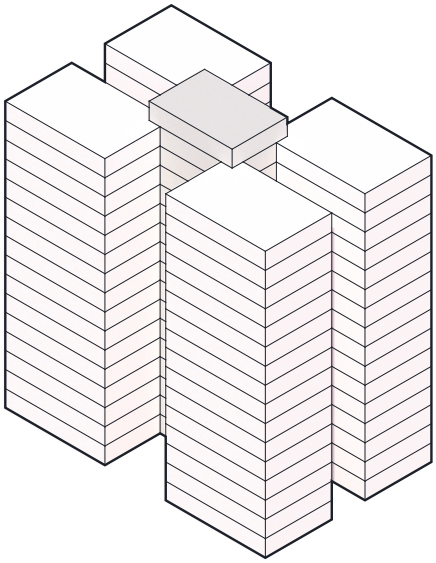
Fig. 4.18. L-shaped kitchen with window for ventilation (Bottom Right)

Fig. 4.19. Typical housing aggregation diagrams. (Right)

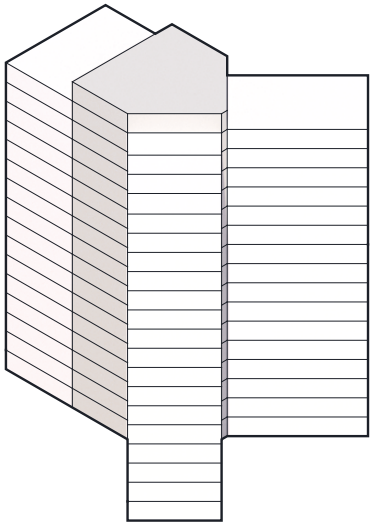
TYPICAL HOUSING AGGREGATIONS

From doing the research through multiple rental websites and collecting the plans of the housings, we see that the housings are typically aggregated in four types of configurations. All four types have a core (marked in grey) with two staircases as fire escapes, minimum of two lifts with one being a stretcher left, garbage chute, and servicing shafts. The difference comes with the number of apartments they serve and the placement of apartments around the core. In type one, the apartments are placed on the corners of the core which leads to the core typically serving four apartments per floor. This allows two towers to be connected via a bridge or a corridor if needed. In type two, the triangular core serves three apartments per floor. This is done in comparatively high-end housing, as the apartments have the opportunity to have light from three sides and the ratio of the number of apartments to the core is less. But having this typology allows the architect to join the two towers from one of the blank spaces of the apartment and create interesting site massing with courtyards, and therefore is very common as a typology. Type three is not the most common but does exist in some scenarios. In this typology, the core with the lifts and services runs in the center with two staircases on each side, connected via a corridor with apartments. The distance between the staircases does not exceed 45 meters, allowing only two or three apartments per side. In the last type, the core runs in the center with apartments on all four sides. This was the most common typology found during the analysis as the number of apartments per floor is the highest with the maximum possible apartments as eight and minimum as four. The average number of apartments in such a typology is six per floor.

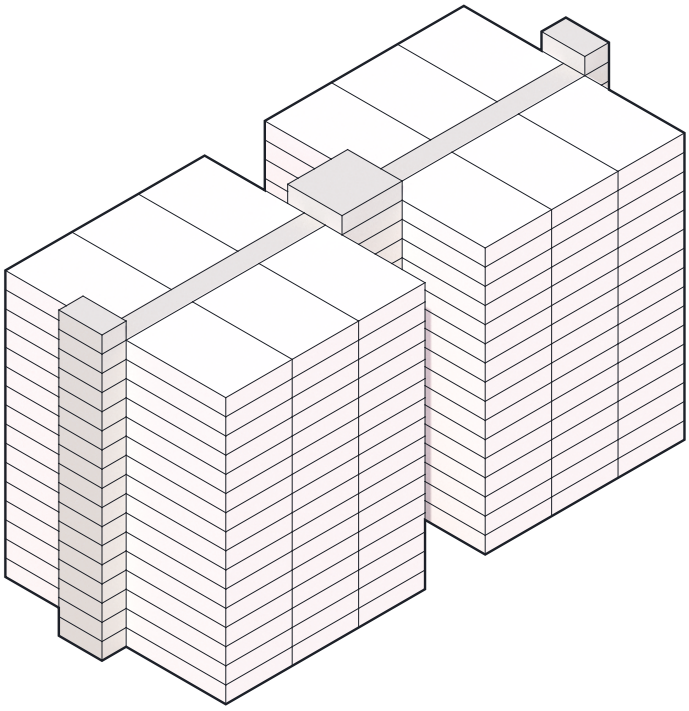
Through the analysis, we find that the housing aggregation is mostly a point tower with the core in the center serving a minimum of three and a maximum of eight apartments. The towers may or may not be connected physically by the means of a bridge or a corridor, or visually by forming a chain as part of the site design.



TYPE 1



TYPE 2



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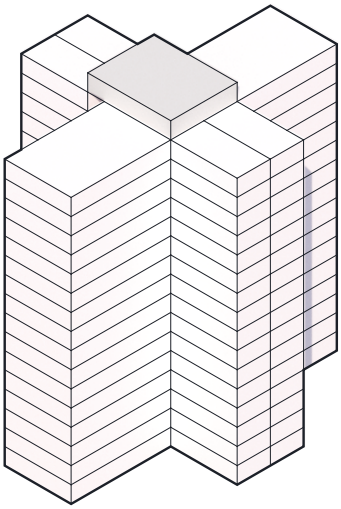


TYPE 4

Fig. 4.20. Different housing facade aesthetics (Image 1 - 8)

Fig. 4.21. Typical construction axonometric diagram (Right)

CONSTRUCTION AND MATERIALITY

The housings are constructed with in-situ casted concrete columns, beams, and slabs with either brick or concrete masonry units as wall infills. The services are installed inside the false ceiling with a vertical shaft running throughout. Figure 4.21 shows an exploded view of housing. In terms of the façade, the housings are all similar with glass windows of varying sizes and plaster of Paris, stucco, and paint on the remaining infill wall. (fig 4.20)

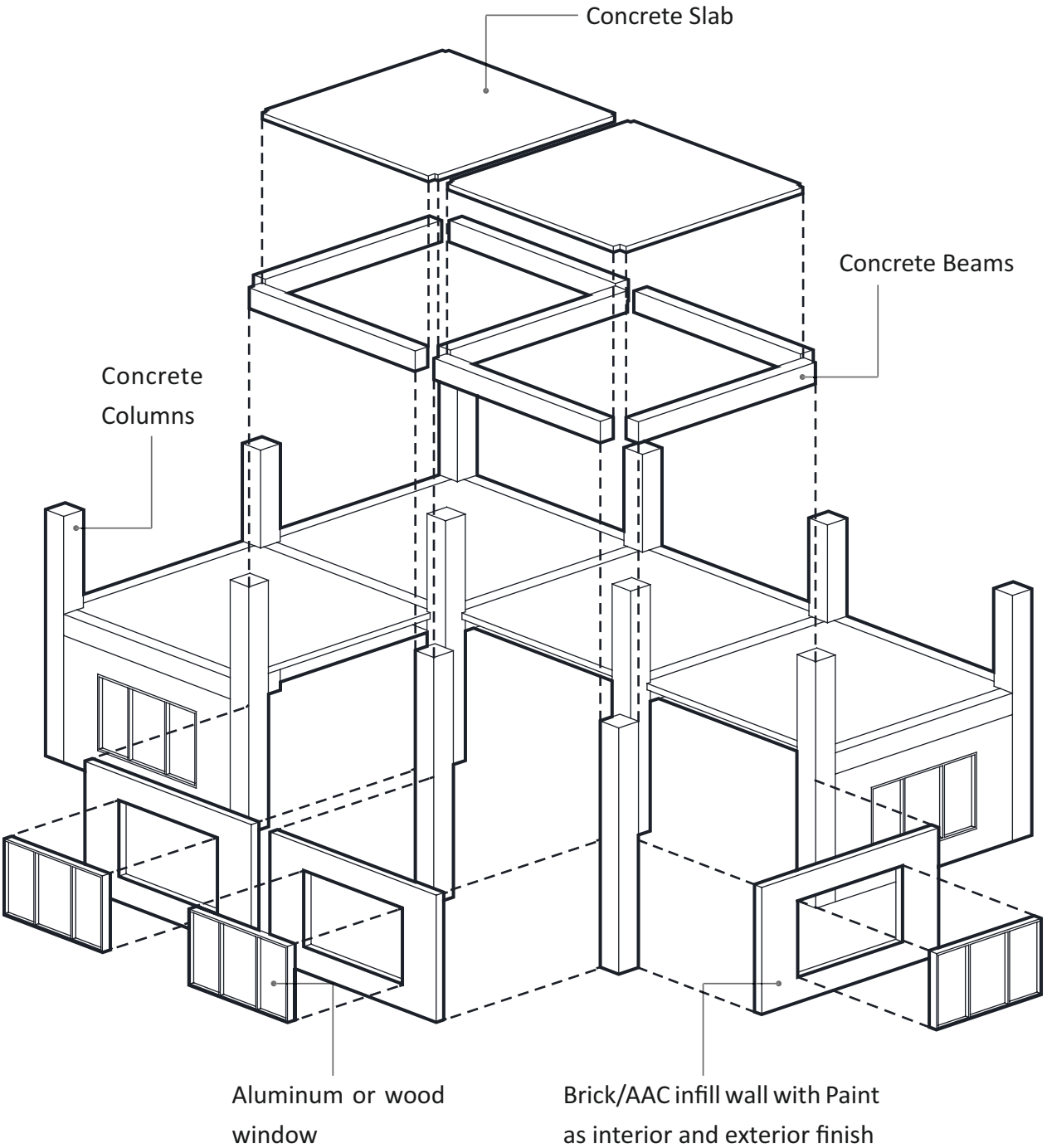

Concrete Slab
Concrete Beams
Concrete
Columns
Aluminum or wood
window
Brick/AAC infill wall with Paint
as interior and exterior finish

Fig. 4.22. Template for Interview data collected (Right)

INTERVIEWS CONDUCTED

In order to understand the problems faced by residents living in apartment buildings and forming the middle class of Mumbai, interviews were connected. The participants could not afford to rent or shift to a new place due to the limited source of income and the high cost of the current housing industry. They formed a subsection of the society but still form a large group in India – as the majority of the country is either middle class or lower income.

The questionnaire provided to the participants during the interview was based on understanding their family size, apartment size, apartment use, and priorities. The two main questions asked were “Have you changed anything in your apartment?” and “What do you wish to change in your apartment?”. These questions help us understand the changes people did since they moved in and what is lacking in their apartments. The following section goes through the interviews and what each participant described in their homes.

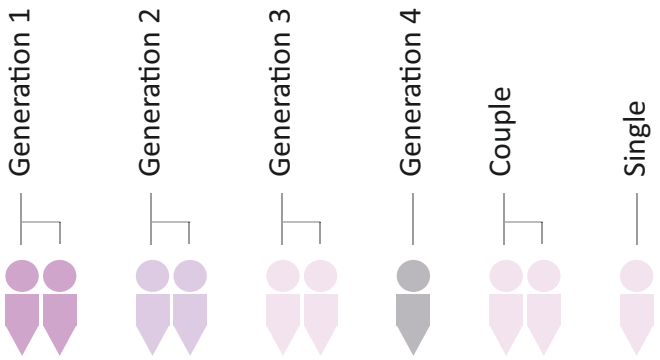
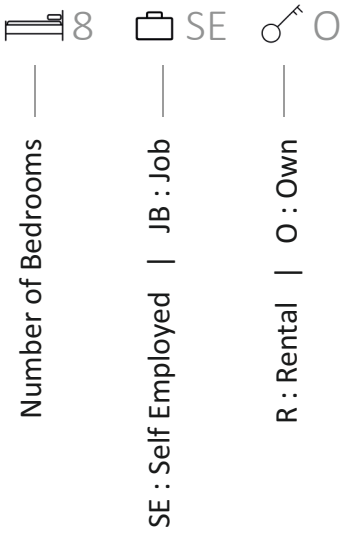


Illustration depicting the problem of the house

HOUSE NO. XX



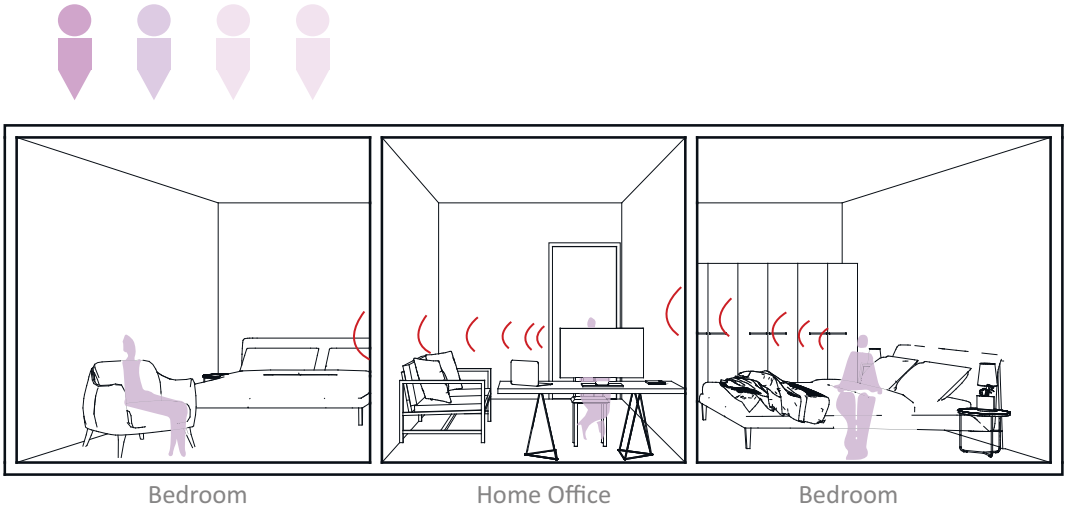


Fig. 4.23. House 02 speculative representation

HOUSE NO. 02

3 JB O

Living in the apartment since the past 2 years and prefers to stay in place. One member temporarily moved out to go to university.

Have you changed anything in your apartment?

“I moved back in with my mother and we did basic maintenance changes.”

What do you wish to change in your apartment?

“Create dedicated workstation and have sound barriers. Voice travels easily in the apartment.”

HOUSE NO. 01

2 JB O

Living in the apartment since the past 15 years and prefers to stay in place, rather than shifting.

Have you changed anything in your apartment?

“Changed the piping since we have been living here for the past 15 years. Added a working station for everyone during the lockdown.”

What do you wish to change in your apartment?

“Possibility to change the pipes and services easily at a later stage so that minimum walls are broken and better ventilation”

HOUSE NO. 03

3 JB O

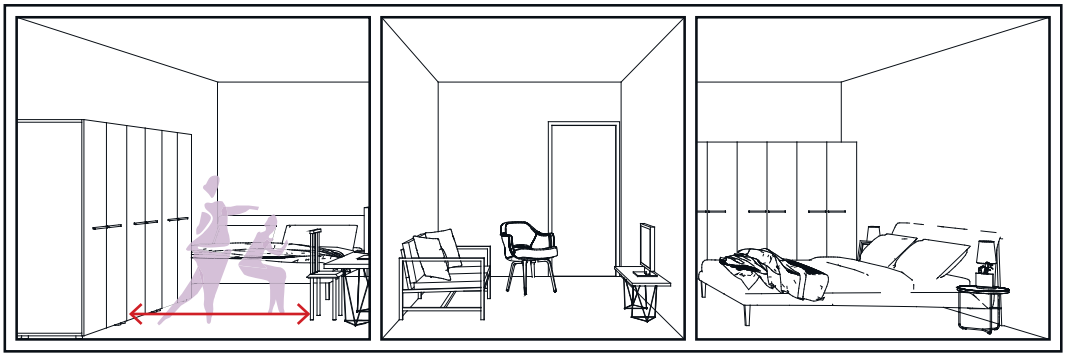
Living in the apartment since the past 15 years and prefers to stay in place. There are more number of room but all are too small to be useful.

Have you changed anything in your apartment?

“We tried to make some rooms multi-functional by changing the furniture as my sister comes back home rarely and we need more space to work”

What do you wish to change in your apartment?

“Have bigger rooms to make it functional. Right now we have 2 different spaces in 450 sqft and it feels cramped. But we like partitions to maintain privacy”



Guest Room / Office | Living | Bedroom

Fig. 4.24. House 04 speculative representation

HOUSE NO. 04

2 JB R

Living in the apartment since the past 1 year and prefers to stay in place, rather than shifting but wants the apartment to work for them.

Have you changed anything in your apartment?

"We created zones for work and workout during lockdown. Though the workout space remains the same, we keep changing the work place."

What do you wish to change in your apartment?

"Have a proper workout section to keep bench etc. Something multifunctional which can be rolled up based on requirements."

HOUSE NO. 05

3 SE R

Living in the apartment since the past 15 years and prefers to stay in place. The family is very mobile (except the parents) so prefers multi functionality in rooms.

Have you changed anything in your apartment?

“Renovated the interiors.”

What do you wish to change in your apartment?

“We travel a lot for work, so would like the opportunity to make use of the rooms in different ways.”

HOUSE NO. 06

3 SE O

Living in the apartment since the past 25 years and wants to stay there forever. The number of residents increased because of marriage.

Have you changed anything in your apartment?

“We added another room and renovated the apartment because my brother got married”

What do you wish to change in your apartment?

“Add more light in the living room”

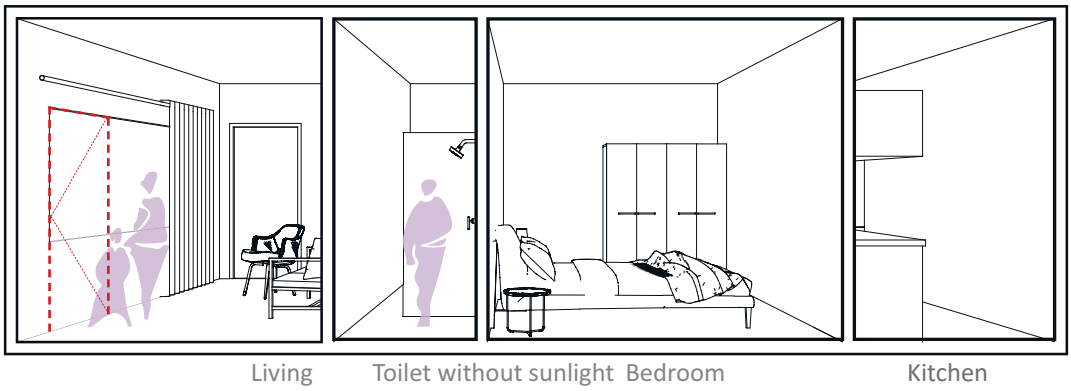


Fig. 4.25. House 07 speculative representation

HOUSE NO. 07

3 SE O

Living in the apartment since the past 13 years and prefers to stay in place. Wants to shift in a new apartment which has more sunlight.

Have you changed anything in your apartment?

"We renovated the apartment gradually and temporally converted the guest room into a study space"

What do you wish to change in your apartment?

"We don't have a washing area and both our toilets don't get sunlight. Most importantly, we don't have balcony space to have tea or plants"

HOUSE NO. 08

3 JB O

Living in the apartment since the past 26 years and prefers to stay in place.

Have you changed anything in your apartment?

“We changed the layout to increase space in a room”

What do you wish to change in your apartment?

“The rooms are very small and the living area is quite large for our requirement. We don’t use the living often and would have preferred bigger rooms”

HOUSE NO. 09

1 JB R

Living in the apartment since the past 4 years and prefers to stay in place.

Have you changed anything in your apartment?

“We didn’t change much as it is a rental. We just bought some furniture”

What do you wish to change in your apartment?

“We would love to add another small room for our child, and want a separate small play area where he can spend some time”

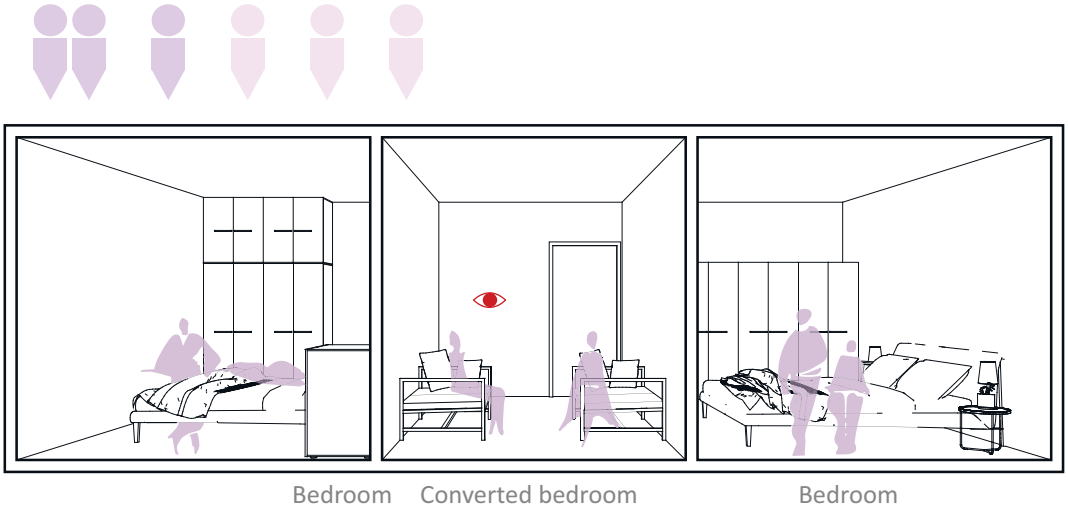


Fig. 4.26. House 10 speculative representation

HOUSE NO. 10

2 SE O

Living in the apartment since the past 23 years. Extended family moved in the apartment permanently.

Have you changed anything in your apartment?

"We renovated the apartment decor. We couldn't change the layout much"

What do you wish to change in your apartment?

"Our living room is being used as a bedroom but there is no privacy. We would have preferred if it was enclosed"

HOUSE NO. 11

2 JB O

Living in the apartment since the past 23 years and prefers to stay in place.

Have you changed anything in your apartment?

“Initially we were ten people living in a 1BHK, but then the other family moved out and we converted a 1BHK into a 2BHK”

What do you wish to change in your apartment?

“The location of apartment is very crowded and commercialized due to which we have noise issues, otherwise I am satisfied with my home”

HOUSE NO. 12

2 JB O

Living in the apartment since the past 30 years and prefers to stay in place. They have two children, both married.

Have you changed anything in your apartment?

“Our daughter got married and moved in with her husband and our son got married and his wife moved in with us. So we did small renovations and added a washroom”

What do you wish to change in your apartment?

“It feels a bit cramped with no privacy”

CONCLUSION

From the current housing typology present, we see only some of the priorities of the residents being fulfilled. Most of the apartments provided do have some possibility to include green space and have natural light in as many rooms as possible. But none of the apartments include multifunctionality and the ability of the residents to change their homes without doing major renovations. The housing industry hasn't changed since the 1990s, with the same point towers provided to the residents without incorporating newer trends and facilities. Some high-end condominiums do provide newer amenity spaces but at a higher price and without changing much in the apartments.

Through the study, the elements that work and should be incorporated in the design are:

(1) Closed Kitchen to contain food smells

(2) Fixed wet areas

(3) Concrete and Brick construction to not deviate from traditional elements and make the housing unaffordable by incorporating new techniques

(4) Possibility of sunlight and ventilation in all rooms

(5) Serviceability through the false ceiling to make it easier to update services

(6) Possibility of having green

(7) Possibility of incorporating a small utility area for the house-help to wash and dry clothes

From the interviews, most of the residents preferred to stay in place if the apartment could fulfill all their needs and everyone had different living situations and priorities, with some overlaps. Also, most people owned their homes rather than renting it. The participants renting were the ones living away from family due to

jobs. Most of the houses were multigenerational, and therefore, they owned their place. The four main sections of problems identified were:

(1) Having multifunctionality and adaptability of rooms and furniture to support changing needs

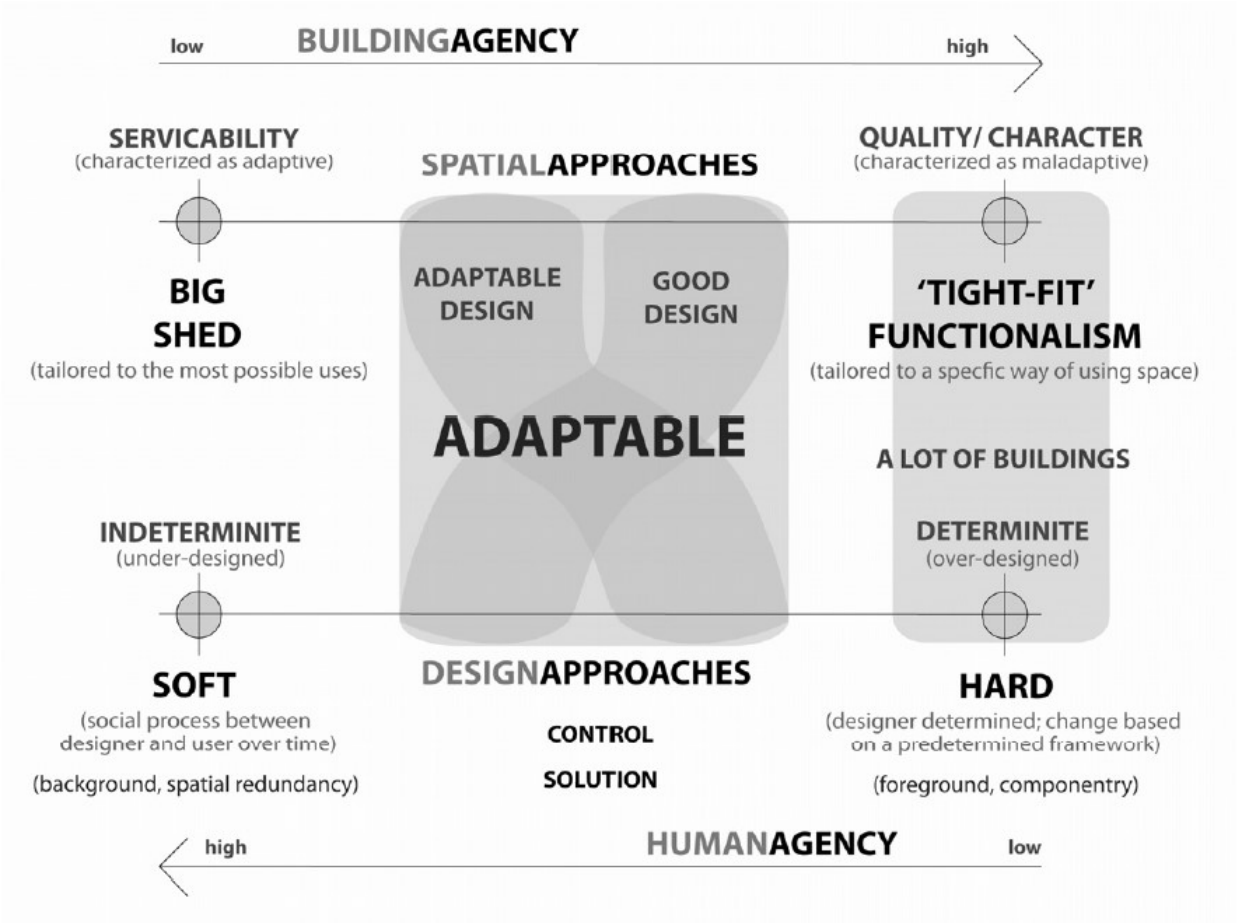
(2) Possibility of adding noise barriers to increase privacy

(3) Easy serviceability of the apartments during renovations

(4) Natural light in every room and having some amount of green in the apartment

To incorporate the multifunctionality we look into adaptability theories present in the housing industry to help incorporate time as a design variable and help people stay in place. Can we use adaptability as a potential solution, if adaptability brings an understanding of time, as it brings an emphasis on process and enabling the building to 'learn' and the users to 'teach' or shape the space themselves?[1]

1 Robert III Schmidt et al., *What Is the Meaning of Adaptbility in the Building Industry?*, O&SB2010 "Open and Sustainable Building" (Bilbao: LABEIN Tecnalia, 2010), https://www.irbnet.de/daten/iconda/CIB17993.pdf.


low
BUILDINGAGENCY
high
SERVICABILITY
(characterized as adaptive)
SPATIALAPPROACHES
QUALITY/ CHARACTER
(characterized as maladaptive)
BIG
SHED
(tailored to the most possible uses)
ADAPTABLE
DESIGN
GOOD
DESIGN
'TIGHT-FIT'
FUNCTIONALISM
(tailored to a specfic way of using space)
ADAPTABLE
A LOT OF BUILDINGS
INDETERMINITE
(under-designed)
DETERMINITE
(over-designed)
SOFT
(social process between
designer and user over time)
(background, spatial redundancy)
DESIGNAPPROACHES
CONTROL
SOLUTION
HARD
(designer determined; change based
on a predetermined framework)
(foreground, componentry)
high
HUMANAGENCY
low

CHAPTER 5 – ADAPTABILITY AS A POTENTIAL SOLUTION

Orthodox Western architecture has long been framed as solid and static objects, and thus as a means to stabilize society and represent permanence. It treats the completed building as a finished project for a particular user and location. This type of architecture is what is used as a benchmark in India. However, this limits buildings to a series of explicit requirements and overly subjects space to use.[1]

Fig. 5.01. Approach towards adaptable design (Left)

Traditionally, this was absent in vernacular Indian homes, where rooms were used in multiple ways with no fixed furniture. The home was divided into multiple equal-sized rooms, with fixed partition walls and a kitchen, and a large courtyard connecting everything. The usage of each room was defined by the user, with no room having an ensuite washroom to keep the planning open. The subsequent move towards western architecture as a precedent reduced the flexibility of usage and increased rigidity. Temporal and time-dependent structures still exist in some aspects of Indian architecture in the form of temporary structures for festivals or weddings on playgrounds which are erected in the evening and disassembled by the next morning, temporary city for 7 million people, which pop up for a few weeks, as the 'Kumbh Mela' (Hindu religious festival) and disappear without leaving a trace, temporary community center in the middle of roads in Mumbai to show movies, theatre, and exhibitions celebrating the festival of 'Ganesh Chaturti" (Festival celebrating the god Ganesh), and the small carnivals that pop up now and then in different parts of the cities for a long weekend. The concept of time, change, and disassembly has always been in the traditional and cultural Indian architecture, which has been lost in the newer building construction. The rigid architecture reduces the use of the space and building while also leaving a permanent mark on the land and the extensive amount of resources wasted. This lack of incorporation of time can be resolved by adopting adaptability and flexibility in the design. The

1 Pingping Dou, "Lost and Found: Reinventing Multi-Screen Adaptable Architecture," *Architectural Design* 88, no. 6 (2018): 32–39, https://doi.org/10.1002/ad.2362.

notion of adaptability introduces time and the unknown causes of change to the architecture.[2]

ADAPTABILITY

”The obsessively purist vision of architecture, as opposed to the unknown, must be abandoned in order to accept architecture as an active and flexible organism” said Li Hua.[3] This strategic shift reflects buildings, not as finished work removed from time, but as imperfect objects whose forms are in constant flux continuously evolving to fit functional, technological, and aesthetic metamorphosizes in society. Here, architecture is no longer a noun, but a verb, constantly in motion and adapting to a changing environment.[4]

The current definition of adaptability is a synthesis of four underlying characteristics, namely capacity to change, fit for purpose, value for money, and incorporating change due to time in both near and distant requirements. Therefore, it is defined by Robert Schmidt in his article ‘What is the meaning of Adaptability in the building industry’ as ‘the capacity of a building to accommodate effectively the evolving demands of its context, thus maximizing value through life’.[5] Adaptability in this conceptual space emphasizes an architecture of transience, a disjunction between use and space, and ultimately buildings as unfinished products in a perpetual making, which as demographics change can respond to society’s changing needs. Such buildings have the greatest potential to cater to society’s needs.[6] The most prevalent view of adaptable structures is that they are costly and have a negative connotation. It’s been dubbed as “expensive, barely used gadgetry that only works half the time and is prone to breaking” as discussed by Robert Schmidt in his article ‘What is the meaning of Adaptability’.[7] But the systems used are not fragile and have been in the housing industry since the 1960s. The cost of initial investment is generally a little higher which is paid out throughout the life of the building and makes it affordable by reducing the probability for the building

2 Dou, “Lost and Found.”

3 Dou, “Lost and Found.”

4 Robert III Schmidt et al., *What Is the Meaning of Adaptbility in the Building Industry?*, O&SB2010 “Open and Sustainable Building” (Bilbao: LABEIN Tecnalia, 2010), https://www.irbnet.de/daten/iconda/CIB17993.pdf.

5 Schmidt et al., *What Is the Meaning of Adaptbility in the Building Industry?*

6 Robert Schmidt III and Toru Eguchi, “Mediating Change: A Japanese Perspective on Adaptable Architecture,” *Architectural Design* 84, no. 2 (2014): 74–79, https://doi.org/10.1002/ad.1731.

7 Schmidt et al., *What Is the Meaning of Adaptbility in the Building Industry?*

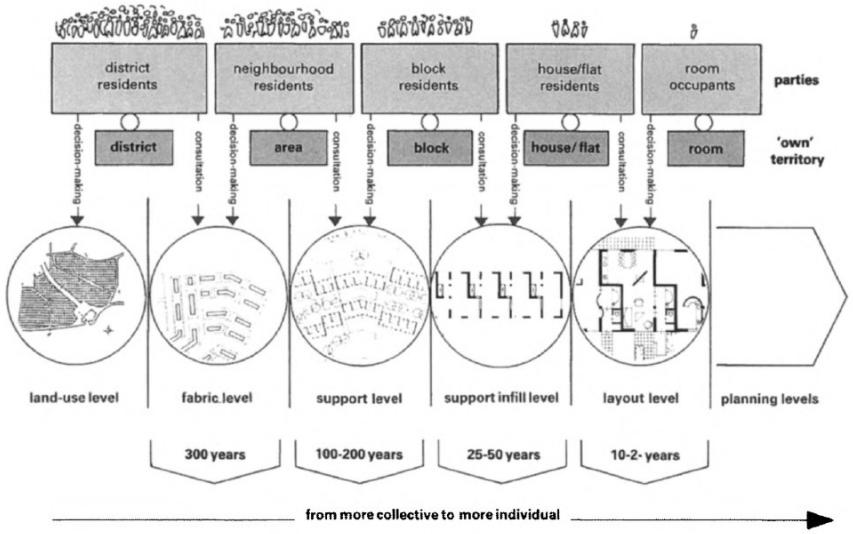


Fig. 5.02. Decision making levels in Open building Movement (Above)

to be demolished. The effects of the issues resolved by adaptable buildings are much greater as compared to the higher initial investment. Residential architecture should be adaptable, natural, and able to be changed, not expensive, pretentious, or irrelevant, but with a sense of purpose that is socially and economically relevant enough to enhance and reinforce the quality of life in the community.[8] Hertzberger (1991) stresses, "Architecture should offer an incentive to its users to influence it wherever possible, not merely to reinforce its identity but more especially to enhance and affirm the identity of its users."[9]

Adaptability can be introduced in several ways – namely, open building movement, movable partitions, static incremental, expandable footprint, and easier building permits.

OPEN BUILDING MOVEMENT (OBM)

The concept of the open building movement has been in the housing industry since the 1960s with John Habraken as the most prominent preacher of the idea. Open Building (OB) began as a

8 Paul Archibald, "Houses for All Ages: Adaptable Design," *Australasian Journal on Ageing* 18, no. 3 (1999): 106–7, https://doi.org/10.1111/j.1741-6612.1999.tb00107.x.

9 Schmidt et al., *What Is the Meaning of Adaptbility in the Building Industry?*

response to the post-World War II housing boom in the 1960s, and a need to enable the user. Its objectives include fostering a diverse, fine-grained, and sustainable ecosystem, as well as increasing individual preference and accountability within it. Responsibility for decision-making is divided into different levels in Open Building. New design interfaces, as well as new licensing and inspection procedures, untangle subsystems to simplify design, reduce tension, provide individual flexibility, and promote overall environmental coherence.[10] It follows similar protocols to the current typical construction of an office building, of having the infill walls being constructed separately at a later stage by the prospective tenants without affecting the structure or the base building. The infill then can independently be updated and renovated according to its lifespan without changing or demolishing the base building. By minimizing interference and conflict between subsystems and the parties controlling them; and enabling the substitution or replacement of each part during design, construction, and long-term management,[11] the life of the building and individual elements can be increased. Open Building practice, households work with an infill architect to custom design their dwelling units according to their functional, aesthetic, budget, and other preferences. This allows individuality in otherwise standard apartments and increases the love for their home. This is seen from the report “Post occupancy investigation of two open building projects” by Ll Shanshan which describes the life of a family (described as Family 13) living in the Molenvliet Project in the Netherlands, one of the open building projects. He described Family 13’s life as “Family 13 lived in the duplex apartment for 28 years. In 1986, as soon as they moved in, they shut off the interior staircase with transparent material to improve the heating of the lower floor. The door to the staircase was later substituted by a wooden one to prevent the young children from knocking into it. Around 2000, the grown children found that the entrance space to their rooms on the upper floor was unreasonably arranged. consequently, they launched a renovation, in which part of the

10 Stephen Kendall and Jonathan Teicher, *Residential Open Building* (New York: E&FNSpon, 2000).

11 Kendall and Teicher, *Residential Open Building*.

corridor was included in the sons' room. The plan to divide their daughters' shared room into two was conceived, however, it was abandoned due to the cost of separating the window. When the investigation was conducted, an internal elevator and a mini kitchen were being added to accommodate the man's 90-year-old mother who would move into the upper floor. The self-built experience inspired this family's deep love for their house. When being asked if he liked living in this old community, the householder's answer was affirmative for various reasons, among which was the love caused by his involvement."[12] This shows the ease of conducting renovations and the ability of the apartment to transform according to the users changing needs.

The open building movement has a large presence in Japan. Traditional Japanese culture saw buildings as ephemeral, empowering a mindset that encouraged the use of lightweight materials and non-permanent physical ties to create buildings that could be quickly modified (a reflection of the Japanese belief in all things transient and imperfect – wabi-sabi). With the sudden influx of standard mass housing in the market after WWII, not following traditional Japanese culture, the residents revolted against the low quality of the housing and the lack of traditional Japanese elements. Thus, the traditional Japanese home provided an opportune framework to accommodate changing conditions – mixing physical, spatial, and operational tactics.[13] Japanese Metabolists advocated for large-scale infrastructures as stable environments for prefabricated homes or other functional capsules to plug in and out of. They wanted to get rid of functionalism's stagnant philosophy and promote social change by allowing organic development in response to changing demands while also re-establishing conventional Japanese building principles like prefabrication, modularity, circular growth, and regeneration.[14] The capsule tower in Japan, with the same ideology, was not a successful project due to its shoebox-like apartments and lack of communal and private space overall. The project was designed to

12 Li Shanshan, "POST-OCCUPANCY INVESTIGATION OF TWO OPEN BUILDING PROJECTS," *Open House International* 40, no. 4 (2015): 94–100, http://search.proquest.com.proxy.lib.uwaterloo.ca/scholarly-journals/post-occupancy-investigation-two-open-building/docview/1792477221/se-2?accountid=14906.

13 Schmidt III and Eguchi, "Mediating Change: A Japanese Perspective on Adaptable Architecture."

14 Schmidt III and Eguchi, "Mediating Change: A Japanese Perspective on Adaptable Architecture."

Fig. 5.03. Permitted expansion possibilities in UK (Right)

be plug and play but was never maintained throughout its lifetime which led to water damage due to leaking pipes. The ideology of having a dynamic city with transitional and temporal elements is a relevant one, especially because of the problems stated earlier, but these ideologies need to be applied by thinking of the possible futures and optimal space requirements.

GOVERNMENT POLICIES

Due to the presence of such construction and housing typology in Japan, the Japanese government has introduced the '200 year' policy – which states that the buildings need to last 200 years before they need to be demolished. This is to reduce the amount of unnecessary construction and demolition and make the buildings more resilient to withstand time and change. Similar policies have started to come up in the UK, but the motive is slightly different - to let people age in place. The UK government allows extensions of property by up to 6 meters (20 feet), enabling construction without the need for a full planning application. Using a traditional mid-terrace house as an example, the building of an extension not only supports a growing family but also allows for aging residents to live entirely on the ground floor while their caregivers live upstairs.[15] This makes sure that the residents can age in the neighborhood and home they are comfortable in while also have the option to have rental income, if they want to, by renting out the floor above and become financially independent. By introducing the policies, the government helps support adaptable building movement which results in a more sustainable industry, also leading to more autonomy and control for the residents.

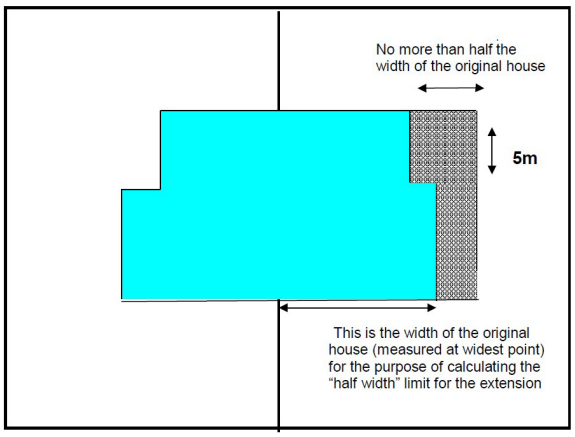
The purpose of design for flexibility is to enable individual control in an otherwise collective setting. As a result, the principle of distribution of control is at the heart of flexible architecture.[16]

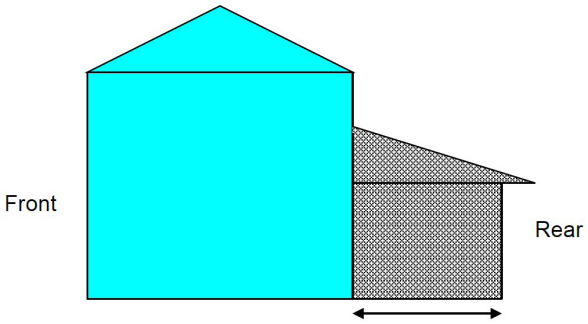
END USERS

The design of multi-unit residential buildings is usually affected

15 Lorraine Farrelly, "Housing from 8 to 80: An AD Ideas Project," *Architectural Design* 84, no. 2 (2014): 126–35, https://doi.org/10.1002/ad.1739.

16 John Habraken, "Design for Flexibility," *Building Research and Information : The International Journal of Research, Development and Demonstration* 36, no. 3 (June 1, 2008): 290–96, https://doi..1080/09613210801995882.





UK Government 'Lifetime Home Policy', United Kingdom

Architect: -

Year: 2019

Key Features: permitted development rights for the enlargement, improvement or other alteration of a house, allows 6m extension (8m for detached homes) for easier renovations and aging in place

Japanese 2006 Policy, Japan

Architect: -

Year: 2006

Key Features: The "200-year Housing" initiative aims to extend the life of housing, It involves the construction of houses that are durable and are easy to maintain, Wooden components are used on the façade and interior made by a standard size in the timber market so that they're easy to replace

by the housing trends prevalent in the city. The variety of spatial, political, and locational considerations obstruct the central issue of what people want and need from their homes, with the design considerations usually geared toward people who live near new construction rather than potential inhabitants.[17] This leads to new homes being designed and constructed based on how the building looks instead of what the future residents would require from the spaces within. There is a clear disconnect between what is provided and what is needed. Understanding and knowledge about what do people want and need from their homes are limited, and the research paper 'Home of 2030' shows exactly that. In general, what people want from their future homes is not being met in their current homes. It emphasizes the differences between what people have now and what they desire in the future and describes specific life periods where those things are more significant.[18]

Due to the initial lack of user participation and not introducing time as a variable, renovation accounts for more than half of the construction market in many developed nations.[19] Buildings' ability to respond to improvements in infill systems, usage, or residents' needs has significantly decreased. The estimated life expectancy of new buildings has drastically reduced.[20] Costs, technological challenges, and the idea that dwellers are incompetent and in need of guidance are all common arguments against adaptability and flexibility.[21] People have been constructing for themselves since the early times, and the user knows best of what they require. As architects, we should not bring our judgments and preconceived notions of priorities to the design table and allow the residents to have more control over the decision of their homes. The initial cost of such a typology might be higher as compared to the traditional construction, but the increase in the lifetime of the building due to it still being relevant to the changing time subsets the initial cost eventually making it affordable. And for the technical difficulties, the theses aim to provide a flexible solution that is user-friendly and resilient to not

17 "A Public Vision for the Home of 2030," *Design Council* (London: Design Council, n.d.), accessed December 3, 2020.

18 "Home of 2030."

19 Kendall and Teicher, *Residential Open Building*.

20 Kendall and Teicher, *Residential Open Building*.

21 Habraken, "Design for Flexibility."

eventually decrease the lifespan of the product. Where should the flexible building stop and inhabitation's domain begin?[22] This is discussed in further sections and analyzed to understand the best possible balance between the rigid and the flexible elements.

SYSTEM STUDIES

There are multiple systems available in the market which incorporate adaptability in the buildings. The various systems are analyzed to understand the working of each and a potential application in Mumbai. There can not be just one solution as the answer may vary from one place to another depending on the circumstances, cost, and culture.[23] The effect of government policies is already investigated at the beginning of the chapter. Apart from the policies, as architects, we can employ systems and make design decisions to help residents grow old in place.

22 Habraken, "Design for Flexibility."

23 Habraken, "Design for Flexibility."

Fig. 5.04. Static incremental balcony expansion in Social housing, France (Right)

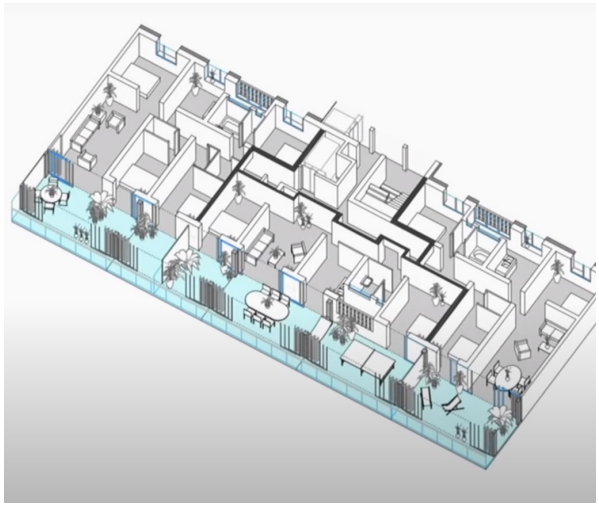
STATIC INCREMENTAL

This system allows the residents the potential to expand in the future if they require more area as a result of growing family or changing priorities. This can be seen in the Social housing project by Lacaton and Vassal in France. The project involves the renovation of three fully occupied modernist social housing. The transformation process begins with the interior of the houses, intending to give the residents new attributes by investing with accuracy and consideration in existing qualities that should be retained, as well as what is lacking and must be replaced. The addition of winter gardens and balconies to the original building gives each apartment the ability to enjoy more rooms, natural light, mobility of use, and views. The balcony added can be used as a sitting space and allows the functions of the home to spill over. These additions increase the amount of usable space and versatility inside the home, as well as provide a private outdoor space, similar to that of a detached house. The apartments have extensive winter gardens and balconies that have nice outdoor spaces that can be completely used.[24] By allowing this, the residents are provided with a multipurpose space that they can adapt according to their requirements. Using a similar method in Mumbai allows the potential of increasing the floor area of the apartment, and provides for future extension, which already happens in most cases illegally. By already incorporating this in design, the interior spaces can be designed efficiently thinking about the possible configurations of the extension.

OPEN BUILDING PLAN AND SUPPORT / INFILL

In this system, the building is designed with all the subsystems as separate elements to allow an easier change in future renovation projects. This also makes sure that the systems with different lifespans can be replaced at different times without disturbing or demolishing the complete building. One example is Neuwil in Switzerland. The building has been studied by Stephan Kendall and

24 "Transformation of 530 Dwellings / Lacaton & Vassal + Frédéric Druot + Christophe Hutin Architecture," ArchDaily, April 18, 2019, https://www.archdaily.com/915431/transformation-of-530-dwellings-lacaton-and-vassal-plus-frederic-druot-plus-christophe-hutin-architecture.



Social Housing, France

Architect: Lacaton and Vassal

Year: 2016

Key Features: Renovation to improve quality of life, Adding outdoor winter garden for each apartment, allows residents to have more space to move around and have more light, increased environmental performance of the building

Captions from Left to Right

Fig. 5.05. Demountable wall and plan configuration of Nuewil (Left)

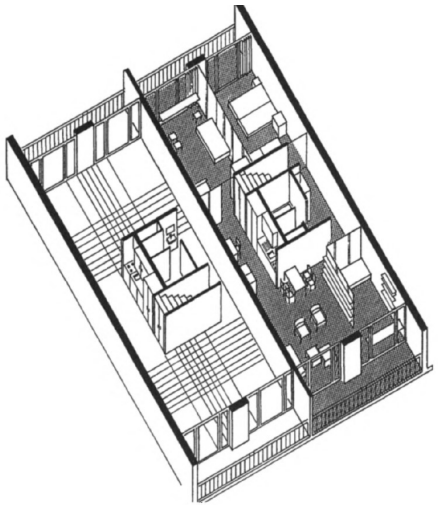
Fig. 5.06. Site and apartment plan of Molenvliet Project (Right)

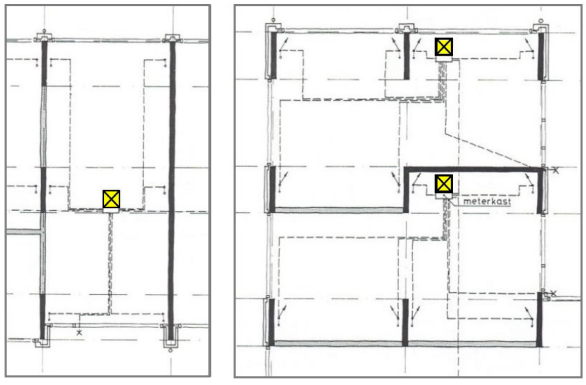
Jonathan Teicher for their book 'Residential Open Building'. They say "This eight-story apartment building contains 49 rental units with 'flexible' interior space divisions. Dwelling dimensions are standardized to one fixed size. Sizes, locations, and products for stairs, kitchens, and bathrooms are also fixed. All units are oriented east-west. Dwellings are accessed via a common central corridor. Because the quality, size, and solar orientation of these spaces are essentially identical, the living room can face either direction. The Interior layout of the dwellings may be determined by the tenants and changed according to their preferences. Space is designed to be partitioned according to a 30cm grid, using any of five varieties of ready-made wall panels. All five kinds of gypsum board panels are stored in a common room in the building, available for tenant use. They are made in 60cm or 90cm widths and are light and easily moved. To assist in this process, the architects prepared My Flat is My Castle, a three-part users' manual with easy-to-read design drawings and illustrations."[25] The manual covers the history of a fictitious family and their changing needs over ten years using sketches, descriptions, illustrations, and photographs of the apartment. It also introduces the potential residents to the different wall elements, how to assemble them, sample floor plans, and the movable and fixed elements in each. By offering a manual to assist the residents with renovations, the architects ensure cohesion between the inhabitants and the common infrastructure. This allows adaptations to take place fluidly without the further input of a specialist and provides the residents with an opportunity to self-build their home.[26] The manual can include the structure and unchangeable elements, possible configurations and the advantages of each, availability of building materials, and maybe an outline of construction techniques to help start the process.[27] One of the other examples is the Molenvliet Project in the Netherlands. The famous project is social housing and has a movie, with the same name, based on it. The typology consists of an infill-able base building structure with piers, floors, and roof around a courtyard. The infill is designed by the resident without

25 Kendall and Teicher, *Residential Open Building*.

26 Schmidt III and Eguchi, "Mediating Change: A Japanese Perspective on Adaptable Architecture."

27 Shanshan, "POST-OCCUPANCY INVESTIGATION OF TWO OPEN BUILDING PROJECTS."





A transversal unit

Longitudinal units

Neuwil, Switzerland

Architect: Metron Architect Group

Year: 1966

Key Features: Dwelling dimensions, stairs and kitchens are fixed, Interior layout of the dwellings is determined by the tenants, Space is designed to be partitioned according to a 30cm grid, using any of five varieties of ready-made gypsum wall panels stored in a common room in the building, available for tenant use.

Molenvliet Project, Netherlands

Architect: Frans van der Werf

Year: 1978

Key Features: The support structure of this typology, made up by standard piers, floor slabs and pitched roofs could be mass produced for low costs and is extendable, Free standing central shafts for pipes and wires are spread all over the support structure.

Captions from Left to Right

Fig. 5.07. Movable wall of Schroder house and before and after plans (Left)

Fig. 5.08. Movable studio unit of ORI (Right)

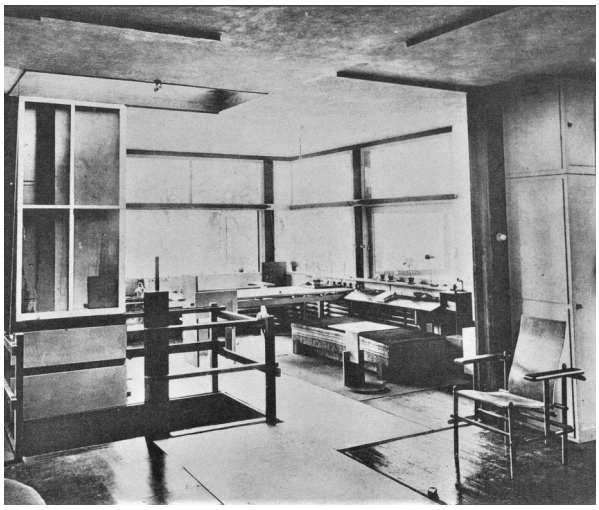
the preconceived judgment of an architect. All the units are serviced by a free-standing central vertical shaft with pipes and wires spread over the support structure. This allows for infill connections from all four sides.[28] Molenvliet project is based on user participation at the design stage to incorporate them in the final project, as opposed to Neuwil, which is more about letting people change the apartment throughout the life of the building without being involved in the earlier stages. Both the projects still incorporate the ideologies of separate support and infill. Such a technique can be used on a large scale of the whole building to make the building and its function adapt to future changes, replacements, or adaptations. On a small scale as a single apartment, the support infill separates the different elements of the system thus allowing easier renovations but does not incorporate time as efficiently as other system examples due to less availability of flexible area.

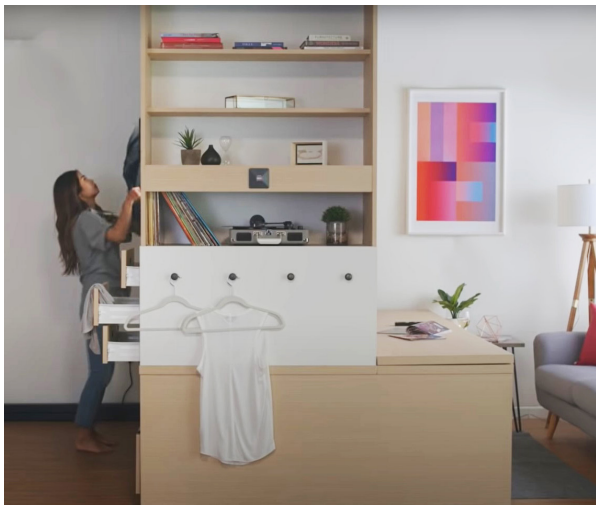
MOVABLE SYSTEMS

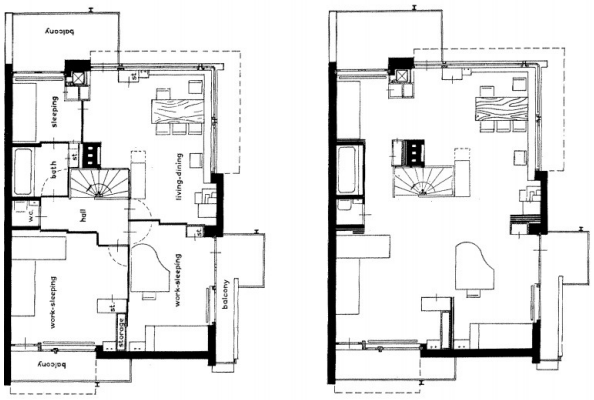
Having movable systems allows change to happen in synchronic time. It accommodates change during the same day or over multiple days. Such a change could be opening up the plan in the morning to allow the children to have a larger space to play and closing it at night to give the privacy of individual bedrooms. This can be seen in the Schroder house which contains a transformable living area, studio, and reading space on the lower floor, and bedrooms on the upper. This allows for no hierarchical arrangement of the rooms. The collapsible partitions are all positioned around a central staircase. This divides the rooms from the central axis when closed and provides a large open space when opened.[29] Similar collapsible and movable partitions can be seen in multiple examples. Some movable walls can also be used as storage or furniture, like in the case of Baitasi House by dot Architects in China. The movable walls can be a complete unit with furniture, storage, and work station. Studio Suite developed by ORI incorporates a bed, wardrobe, and a TV unit in a single movable unit placed on a rail. This unit can be

28 Ir. Frans van der Werf, "OPEN BUILDING EXPERIENCE: 1. 'MOLENVLIET' PAPENDRECHT 1978," *ThematicDesign*, 2017, 1–15, https://thematicdesign.org/open-building-experience-1-molenvliet-papendrecht-1978-2/.

29 "AD Classics: Rietveld Schroder House / Gerrit Rietveld," ArchDaily, December 29, 2010, https://www.archdaily.com/99698/ad-classics-rietveld-schroder-house-gerrit-rietveld.







Schroder House, Netherlands

Architect: Gerrit Reitveld

Year: 1925

Key Features: No hierarchal arrangement due to flexibility of space, Possibility to open up space in the morning to play and divide it into multiple bedrooms at night, all rooms have access to outdoors, concrete slabs and steel profiles with brick walls

Studio Suites

Architect: ORI

Year: -

Key Features: A flexible solution to fixed floor plans, the Studio Suite moves with the users needs to create multiple rooms within one space. From bedroom to private office to living room to walk-in closet, the right space is revealed when you need it.

Captions from Left to Right

Fig. 5.09. The urban village kit of parts for an apartment (Left)

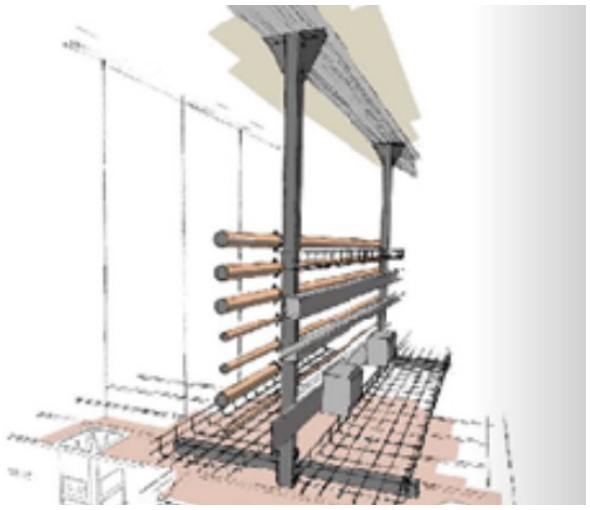
Fig. 5.10. Newways services kit of parts (Right)

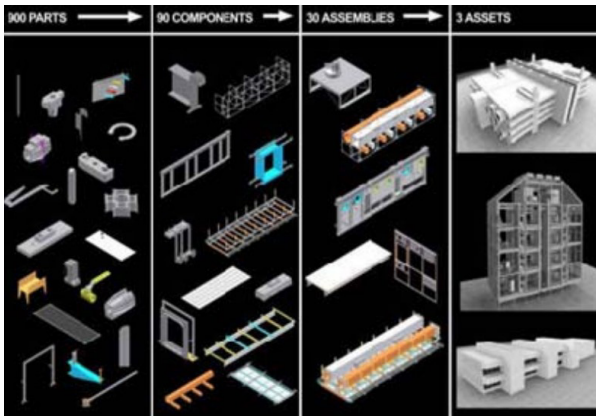
installed in a home, essentially a studio apartment, and controlled via an app. It divides the studio space into different rooms, with each room being revealed only when required. This saves the unused space and also creates a division in a typically open plan. Multiple such units are designed by the company such as a bed and sofa combination, bed and work station combination, office and TV unit combination, wardrobe and TV unit combination, and a bed and TV unit combination.[30] This shows the flexibility and scalability of the design ideology. In a home, not all spaces are used at the same time. Moreover, sometimes due to the time of the day, a particular space might be required which becomes redundant at other times. Having movable walls allows the residents to change the layout during a single day and make use of the spaces in multipurpose ways. It not only solves the issue of having unused spaces but also allows for greater flexibility for the user to decide the space usage. The drawback of movable elements, especially in Mumbai, is the possibility of the rails bending or breaking, making the whole system unusable. It also overtly specifies the placement of the rails reducing the ability of the user to decide on the layout configuration, making the wall move in only one direction. It allows for synchronic change but causes a problem to future adaptations.

KIT OF PARTS

The building can be sold as separate parts to be assembled and completed. By using a standardized modular building system, like in the Urban Village project by Space10 and EFFEKT Architects, the building parts can be prefabricated, mass-produced, and flat-packed saving construction costs. This standardization does reduce customization and makes the homes look similar. But by doing the standardization in parts, rather than the whole building, allows the residents to choose the elements according to their needs and preferences without paying the cost of customization and assemble it into a home showing individuality. By disassembling the components, the materials can be replaced, reused, and

30 "Studio Suite," Ori, accessed April 19, 2021, https://www.oriliving.com/products/studio-suite.





The Urban Village

Architect: Space10

Year: 2018

Key Features: Community building facilities, Cross laminated timber construction, almost all building components and materials can be disassembled and replaced, reused and recycled over the lifespan of the building, Residents would be able to edit their home as they see fit, Mass produced and prefabricated

Newways, Netherlands

Architect: GSK

Year: -

Key Features: A completely flexible system of equipment on wheels, with all services fed from above, Newways kit-of-parts includes the structure, M&E services and the fabric, A ‘10 - 80 - 10’ rule has been set up - Building context - Standard Elements - Customization

recycled benefitting the planet by minimizing waste and also giving freedom to the people to edit and change their homes. The Urban Village project proposes multiple apartment types which can be built by purchasing different components. The residents then can stay in their community by swapping apartment types with others and essentially take their home with them.[31] The kit of parts can be done for the services also. This can be seen in the Newways technology built by GSK in the Netherlands. The Open Building Manufacturing manual by ManuBuild describes the systems as "Central to the Newways value proposition is the concept of constructing new facilities quickly using standard components that fit together and work together the first time. This would be achieved at no extra cost, rather, the cost would be significantly reduced through the industrialization of the process, reduction in variation of parts, and so forth. Newways principles are linked to the Open Building Manufacturing philosophy. The strategy and product have been developed from a similar basis. A set of assemblies have been identified for the delivery of an open floor plan plate building, able to fit any of the three main types of built environment assets, that GSK builds all over the world. A '10- 80-10' rule -context-product-enhancement- has been set up, which refers to different aspects of the idealized platform. The '80' represents the percentage of standard components and assemblies. The first '10' relates to the context where buildings will be placed (site-related elements, regulations, etc) and the last '10' to the enhancement or customization (finishes & specific features). Newways manufactured buildings are planned to facilitate a high degree of design flexibility and the team is adapting an 'Ikea' approach to design deliverables."[32] By using a kit of parts as a system, we can use the benefits of standardization and deliver affordable housing options while maintaining decision-making power to the user and incorporating individuality by not providing a complete finished product. It allows change in both synchronic and diachronic time and is durable as each part is a separate element that can be easily replaced without making the

31 "The Urban Village Project," accessed April 19, 2021, https://www.urbanvillageproject.com/.

32 Abdul Samad Kazi, Matti Hannus, and Samir Boudjabeur, *Open Building Manufacturing*, Book, Whole (ManuBuild, 2009), http://adaptablefutures.com/wp-content/uploads/2011/10/Fuster-et-al.-20091.pdf.

whole system unusable. It does require supporting businesses with the design and instructions to help the users make the system on their own.

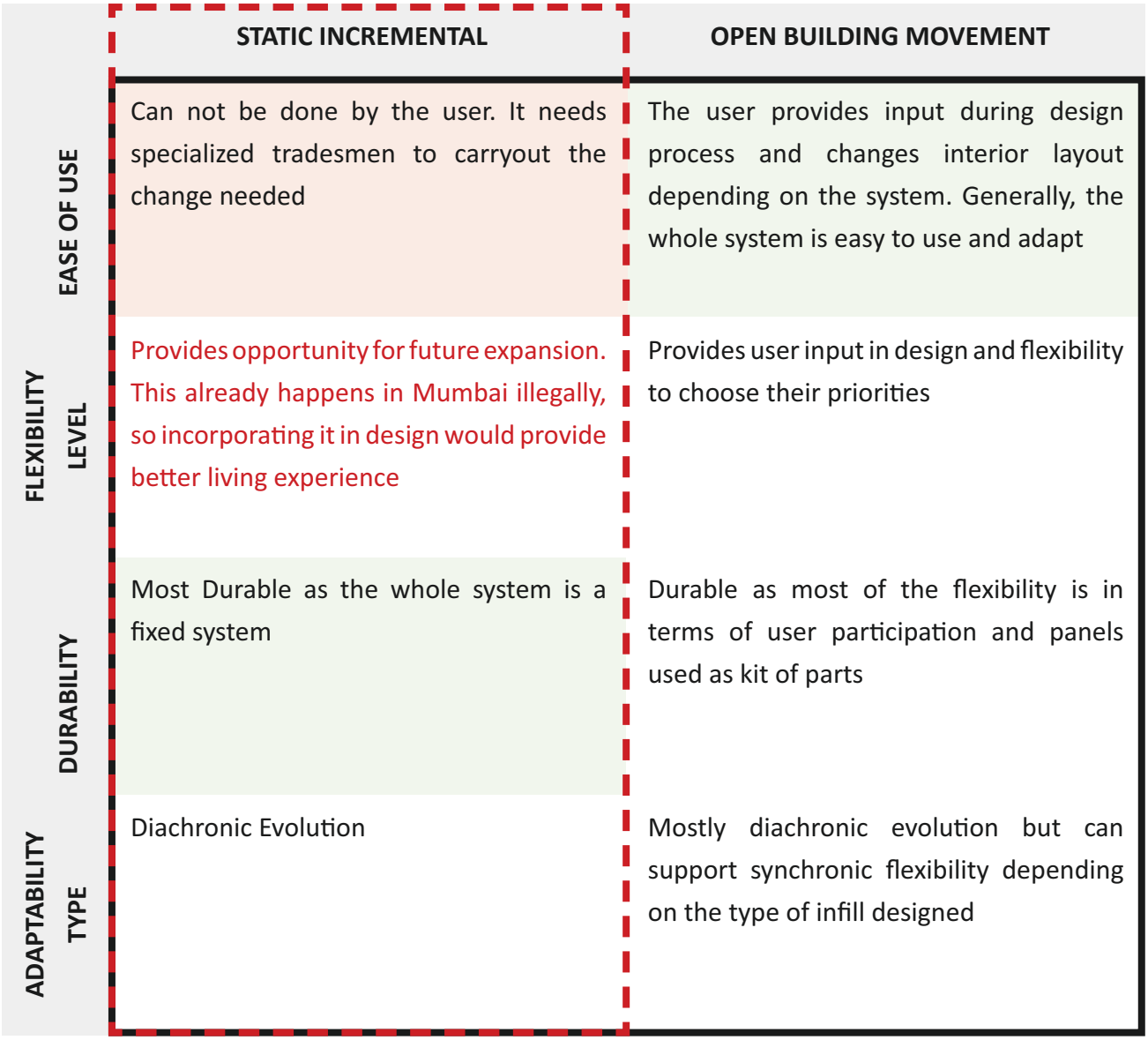


Fig. 5.11. System Analysis Table

	MOVABLE ELEMENTS ON RAILS	KIT OF PARTS
FLEXIBILITY LEVEL — EASE OF USE	Easiest system to use for the user as the movement happens on rails using wheels or technology in generally one direction	The system is easy to understand and use but is generally time consuming and needs some kind of instructions to put together
	Provides flexibility to move the elements in one direction only on specified rails. It needs to be provided as a specialized system during construction	Provides maximum flexibility to choose the part most applicable to the use and build the system yourself. It needs a supporting business which produces the kit of parts
DURABILITY	Least durable as the rails can bend or collect dirt making the system unmovable, especially in Mumbai where there is a lot of dust and things are comparatively less maintained	Durable as all the elements are separate individual parts connected together to form a whole. Therefore, each can be replaced according to their lifespan without compromising the whole system
ADAPTABILITY TYPE	Synchronic Flexibility	Mostly diachronic evolution but can support synchronic flexibility easily by spending a small amount of time on the system everyday to make it change in time

CONCLUSION

Through an analysis of the systems studied, figure 5.11 compares each against the other based on four factors: ease of using the system, amount of flexibility provided, the durability of the system, and the type of adaptability provided (synchronic change is in time during a single day and diachronic adaptation is with time due to changing requirements). For Mumbai, static incremental and kit of parts is chosen as the system to be implemented in the housing industry to incorporate time. Static incremental allows future expansion, if needed, which already happens illegally but incorporating it in design ideology allows for a better and efficient apartment. Kit of parts is chosen due to its durability as a system and maximum flexibility and decision-making power for the user. Also, both systems allow the industry to flourish by providing more jobs, business opportunities, and economic advantages, thus helping everyone in the process.

Using the systems and concepts of adaptability, architects allow people independence in their homes. It empowers people to make their own decisions and for their homes to respond to their needs rather than constraining people to certain ways of living and creating barriers.[33] All the different systems bring with them certain advantages and disadvantages, but all promote people to remain in place without compromising. As discussed in the previous chapters, with the current unaffordability in Mumbai and the subsequent inability to shift to a new home, people compromise on their needs by staying in the same apartment. By incorporating adaptable building solutions, the problem of affordability can not be resolved, but it will help people staying in place to live a better life in a home that fulfills their needs with time. Adaptability does have its challenges. The initial cost to make the building would be higher due to separating the infill products with embedded technology which can cost more than the conventional infill construction.[34] But this initial cost is subsetted

33 "Home of 2030."

34 Kendall and Teicher, *Residential Open Building*.

against the long-term cost by making the building stay relevant and having the ability to change individual elements according to their lifespans instead of demolishing the complete building. Adding to this, maintenance of the adaptable elements is an important aspect to justify the high initial cost and investment. The elements should be easy to use and maintain to not change the system again and again because of the unreliability of breakage. Applying the ideology of adaptability should benefit the consumer and the industry, and not become one of the marketing tactics to promote an unreliable product. The drawbacks and challenges of adaptability are overcome by the value of social impacts created. The residents can live comparatively comfortably in the home they grew up in and stay in place rather than shifting to a place they are unfamiliar with. Adding to that, they are able to make decisions for their home based on their requirements, thus forming an integral part of the decision-making process.

To allow adaptability, the next chapter designs a prototype of an apartment to be used in housings in Mumbai using the concept of static incremental expansion, kit of parts to allow movable and demountable walls, and fixed wet areas to keep with traditional construction and cultural context.

CHAPTER 6 – DESIGNING A PROTOTYPE

Fig. 6.01. Typical traditional and cultural elements in a housing in Mumbai (Right)

DESIGN ELEMENTS

Through the research the typical cultural and traditional elements of the housings are extracted to be incorporated in the design. The elements, listed in fig 6.01 are:

1. Concrete and Brick construction – This is the most common construction typology present in India. This element would not guide the design as the prototype construction can be adapted to the present construction techniques keeping with the design ideology of introducing time and changing the spatial layout.

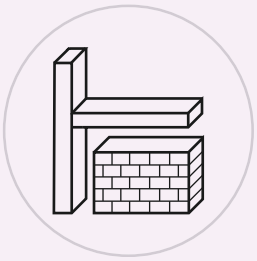
2. Servicing through the false ceiling – The services are run through the false ceiling and are thus easy to adapt and change.

3. Sunlight in rooms – Sunlight is an important part of the culture with sunlight and ventilation required in every closed space. Sunlight is associated with the concept of having natural light and killing unwanted germs in the room and having a window allows for ventilation in the humid weather of Mumbai.

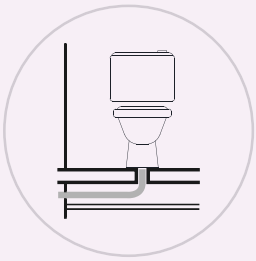
4. Introducing Nature – Having the possibility of a small balcony to grow plants or have a cup of tea in the morning is an important part of the culture. But with the rising costs and new bylaw by the BMC of including the balcony in FSI (as of 2018), developers are becoming reluctant to provide balconies in the buildings, thus taking away an important part of the culture.

5. Utility area – Having a small utility area behind the kitchen allows for a space to dry and wash clothes and for the househelp to come and help out with washing utensils and clothes in a separate space without being disturbed by the day to day activities of the home. This element is completely optional and depends on the cost of the project. Although it is required by the residents, but it can be accommodated in other ways to reduce the cost of the unit.

TYPICAL TRADITIONAL AND CULTURAL ELEMENTS



Concrete and Brick Construction

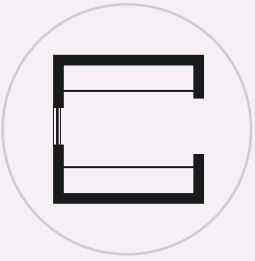


Servicing through false ceiling

Sunlight in rooms

Introducing Nature

Utility Area



Closed kitchen

Fig. 6.02. Typical adaptable elements to be incorporated in a housing in Mumbai (Right)

6. Closed kitchen – The kitchen is kept closed in the Indian household to control the smell of food from spreading into the entire home.

Apart from the traditional and cultural elements, the design also incorporates adaptable elements to make the housing adapt to the time and changing requirements of the residents. The elements, listed in fig 6.02, are:

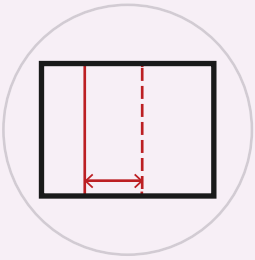
1. Movable and demountable wall – the partition wall of the apartment should be kept as movable, demountable, or removable to allow the residents to guide their layout and space requirements according to their needs

2. Static incremental – Mumbai till 2018 allowed balconies to be enclosed with prior permit permission and did not include them in the FSI. This allowed the owners of the apartment unit to expand their homes keeping with the regulations and gain more area in an already tight apartment. Starting 2018, BMC started including the balconies in the FSI and disallowing them to be enclosed. This led the developers to stop providing balconies altogether in an already small apartment. The design argues the new policy to be changed back to its original one to allow the residents to have some more breathing room and agency over their living situations. This allows static incremental adaptability where the resident can build a small portion of their bacony to expand their bedroom, create storage, or add another washroom.

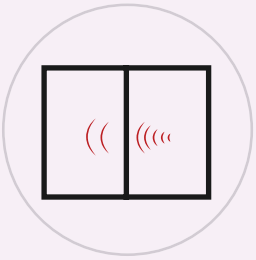
3. Acoustic Separation – Acoustic separation between two spaces was an important priority among the residents interviewed. Currently, the partition walls are constructed using 115mm thick bricks which provide an acoustic value of STC 45. The design aims to achieve higher acoustic value to provide better separation and privacy.

4. Fixed wet areas – Wet areas are kept fixed to keep with the traditional and cultural way of construction and living as making

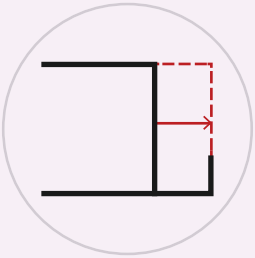
ADAPTABILITY ELEMENTS



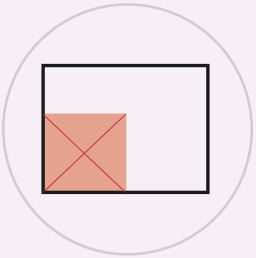
Movable and demountable Walls



Acoustic separation



Static Incremental



Fixed wet areas

Fig. 6.03. Typical adaptable elements to be incorporated in a housing in Mumbai (Right)

them movable will probably create problems pertaining to drainage and water. Therefore, adaptability is incorporated only in the space divisions and layout configurations of the rooms.

DESIGN GOALS

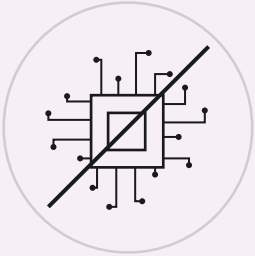
The three main design goals, as listed in fig 6.03, are:

1. Low-tech Design – Keeping the design of the adaptable apartment low tech to allow ease of manufacture and use, providing unskilled laborers the opportunity to work with it.

2. Local Materials – The materials used are local materials to keep the construction easy without hiring skilled labor or acquiring costly materials.

3. Local Craftsmen – Provide business and employment opportunities to local craftsmen and uplift the community

DESIGN GOALS



Low tech Design

Local Materials

Local Craftsmen

Fig. 6.04. Plans of one bed, two bed, and three bed adaptable apartment (Right)

UNIT DESIGN

From the research of various rental websites, units are designed keeping the areas as what is typically found in Mumbai and incorporating the design elements discussed. The plans of the one bed, two bed, and three bed are detailed out in the fig 6.04.

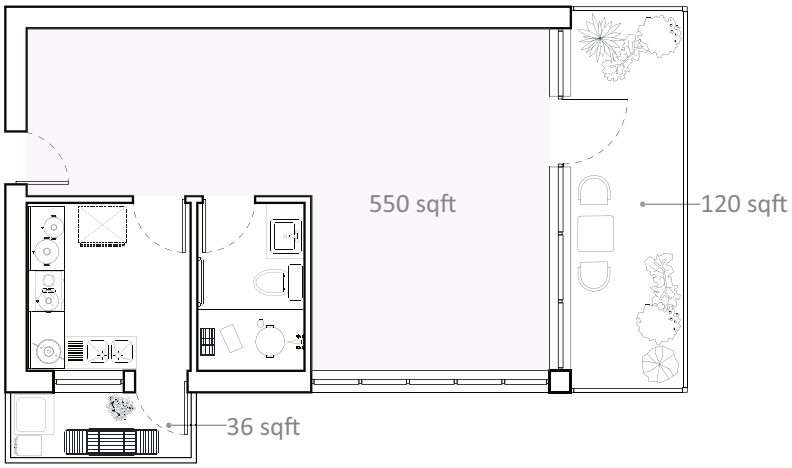
APARTMENT AREAS

500 sqft	650 sqft	800 sqft
1 bed apartment	2 bed apartment	3 bed apartment

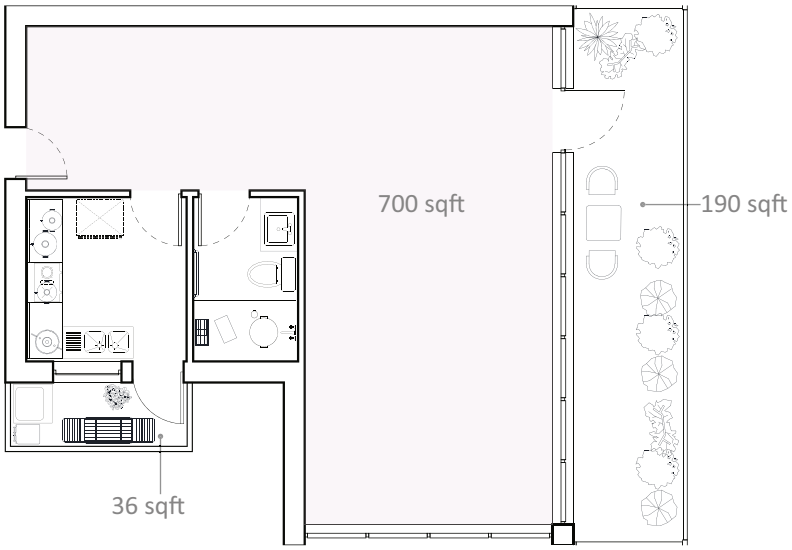
ROOM AREA BYLAWS

9.5 sq.m minimum area with 2.4m width	1.8 sq.m minimum area with 1.2m width	5 sq.m minimum area with 1.8m width
1. Habitable Space	2. Washroom	3. Kitchen

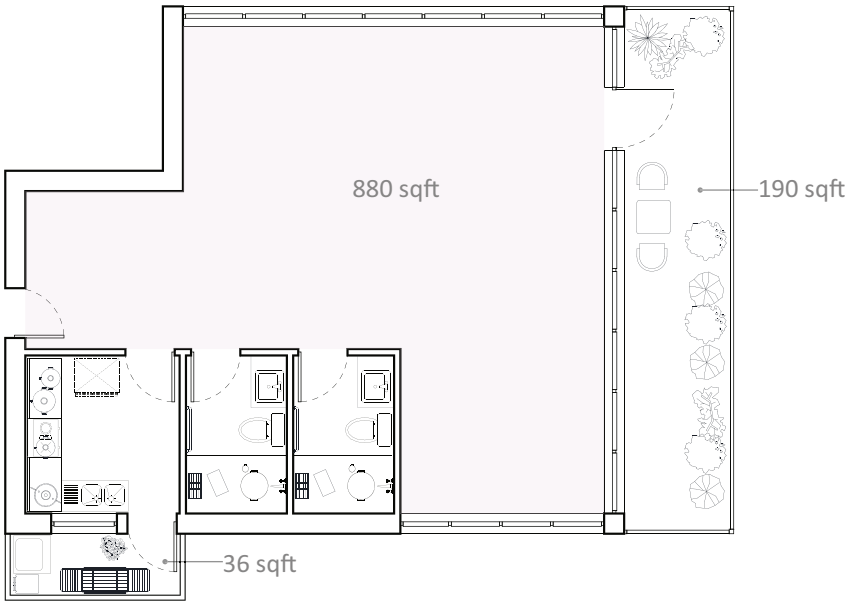
One bed apartment



Two bed apartment



Three bed apartment



ELEMENTS IN THE UNIT

Fig 6.05 marks the design elements on the unit plans. The plan details the traditional elements of a closed kitchen, utility area, sunlight, and balcony for nature with the adaptable elements of fixed wet areas, open space for adaptable interior layout, and the possibility of static incremental on the balcony.

DESIGN INTERVENTION

The design proposal is to create a unit that can adapt to the changing lifestyles of the residents. The motive is to understand how can the user and time be incorporated in the design process to allow the building to stay relevant and change according to the needs. To understand this, the designed plan is taken and a concept of a demountable wall is integrated as an interior partition that can allow the space to adapt and be informed by the user itself. The wall design is a conceptual framework of how a demountable or movable wall can make the unit adaptable and incorporate time.

SCHEMATIC DEMOUNTABLE WALL DESIGN

The wall would be provided as a kit of parts that can be easily assembled by the user to construct a partition wall for his apartment. (fig 6.06) The kit would come in three different height sizes starting from 2400mm which can go up to 2500mm due to the panels' ability to adapt in height up to 100mm, 2500mm which goes up to 2600mm, and 2600mm which goes up to 2700mm. 2700mm is the maximum apartment height typically present below the false ceiling as the floor to floor height of the building is around 3000mm. The kit has 450mm wide panels which overlap with each other and are joined in place by a small wooden piece being inserted in the provided holes. Apart from the typical 450mm panel, the kit also has a 900mm wide door panel, two types of end pieces, a top rail for each panel to be screwed to the ceiling, and a key to be inserted in the wooden piece to demount the panels. The end pieces of the wall can be custom-made by the supplier to

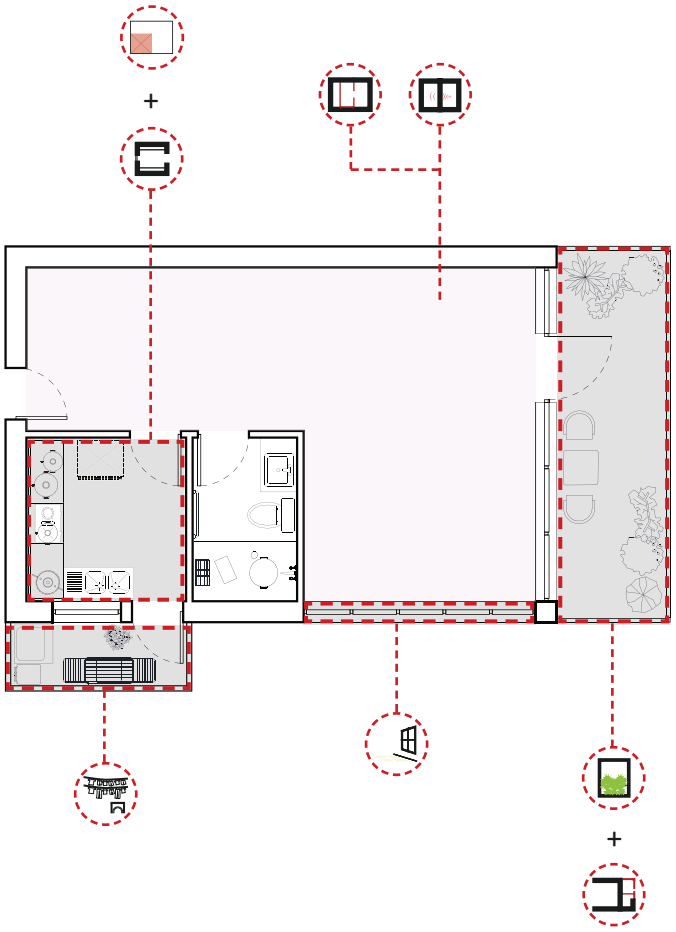


Fig. 6.05. Adaptable and traditional elements marked in a one bed apartment plan (Above)

make the dimension of the wall fit perfectly in each apartment. Each panel is made with two 5mm thick plywood boards on each side with 50mm thick mineral wool acoustic insulation in between providing an STC value of 50 and weighs about 19.6 kg. With that, there are two 24mm thick steel stiffeners on each side to provide vertical stability. The whole panel can be slid onto the T-rail from the ceiling with the rubber gasket forming a seal at the bottom. The exterior finish of the panel can be chosen by the user with the option to either keep its natural wood, polish it, add a layer of laminate or veneer in the shop, paint the wall, or finish it with wallpaper in 450mm wide sections. The wall is detailed out and assembled in fig 6.07 and fig 6.08.

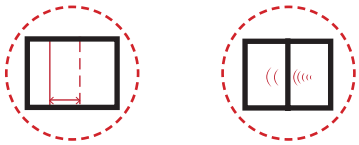


Fig. 6.06. Demountable wall kit of parts
(Left)

Kit comes in three height sizes - 2400mm, 2500mm, 2600mm - each with additional 100mm height adjustability

1. Key for wooden piece

2. Wooden pieces to join panels

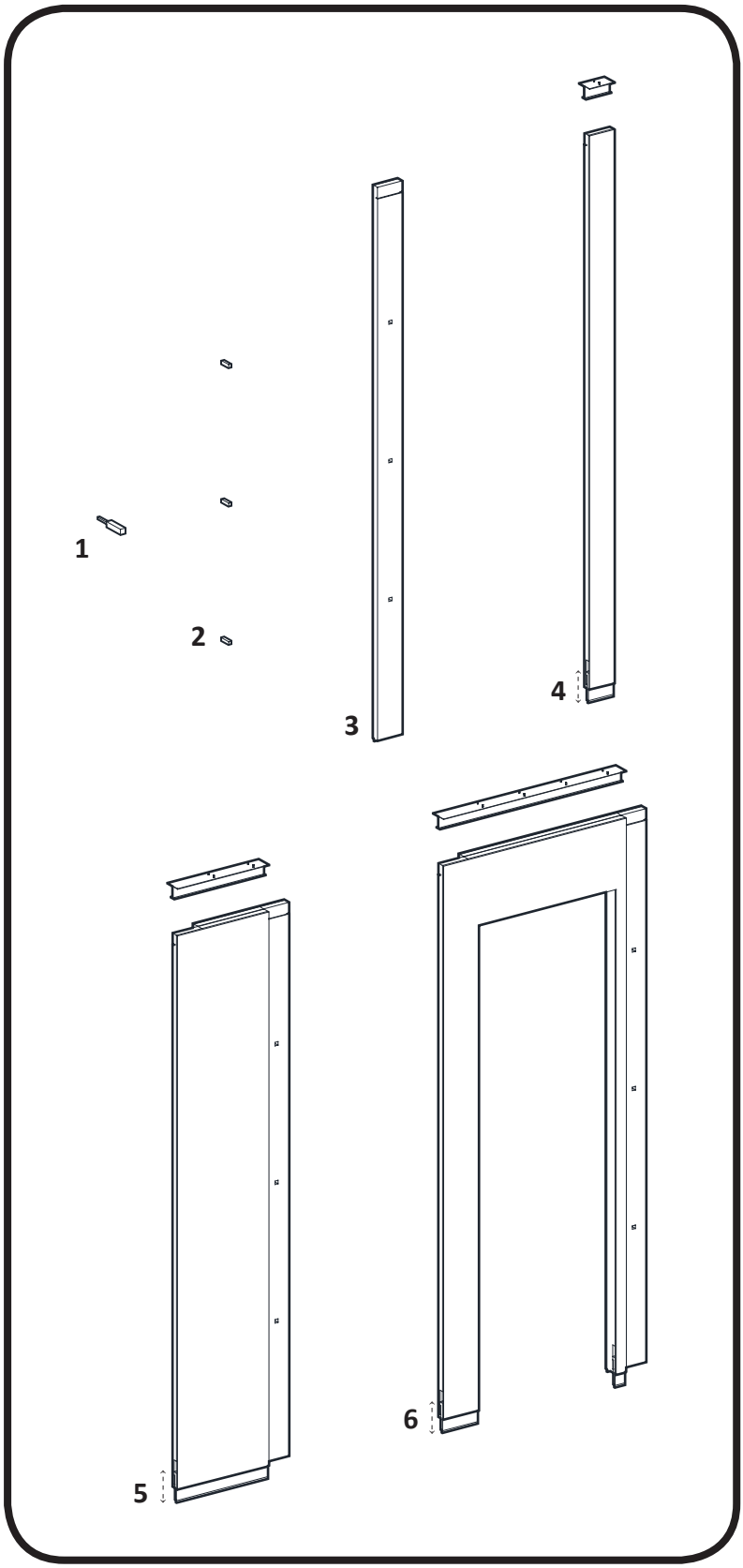
3. End piece type 1 (size customizable)

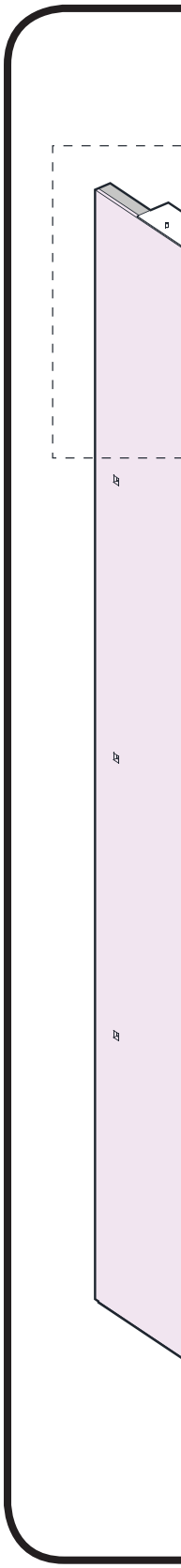
4. End piece type 2 (size customizable)

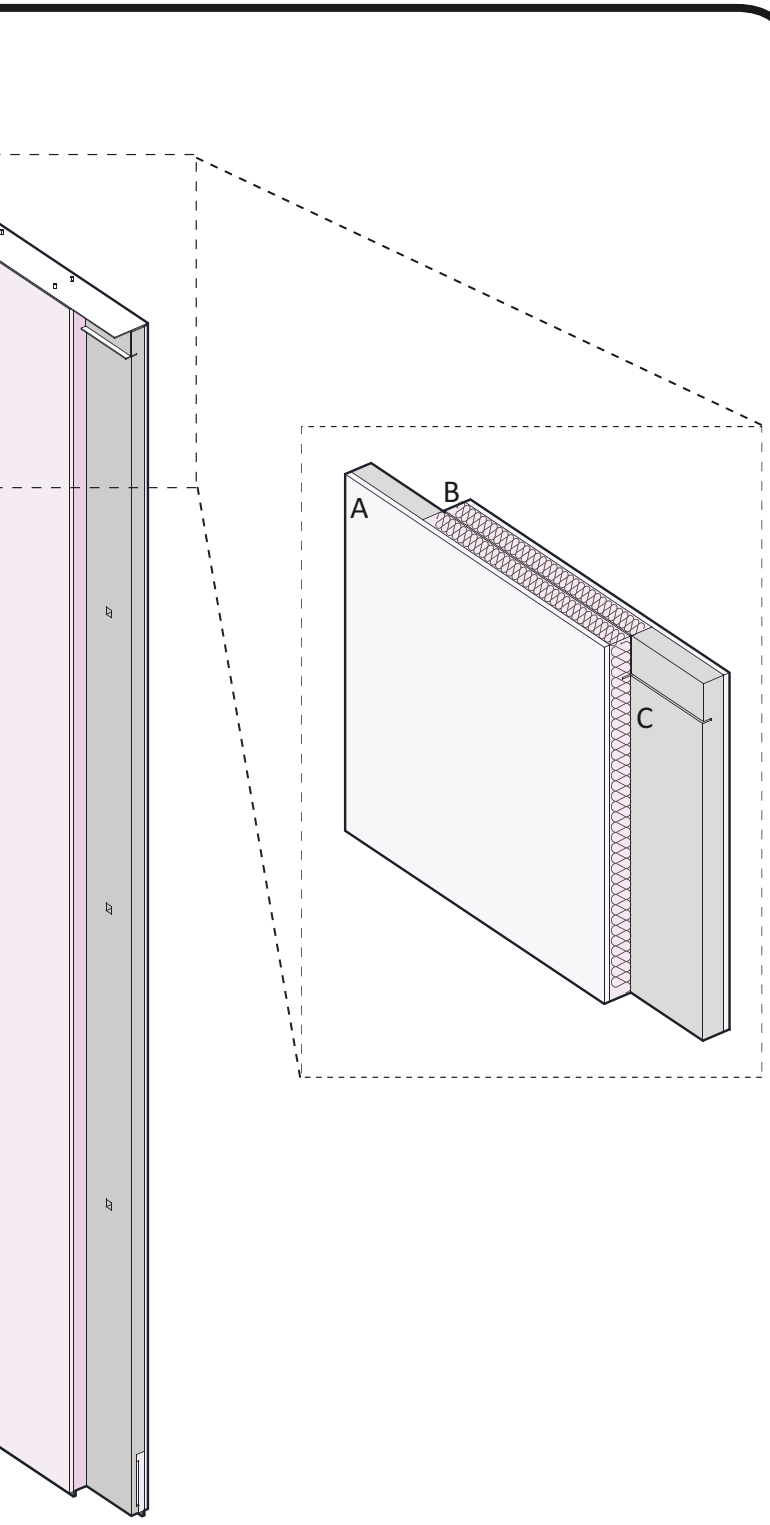
5. 450mm wide panel with ceiling rail (number according to space)

6. 900mm wide door panel with ceiling rail

Fig. 6.07. Wall panel detail with composition, weight, and acoustic calculations
(Right)







COMPOSITION AND WEIGHT CALCULATIONS

A. 5mm thick **PLYWOOD BOARD** on both sides

Density of plywood = 500 kg/cub.m

Size of 1 plywood = 450X2400X5

Weight of 1 plywood = (0.45X2.4X0.005) X 500 = 2.7kg

Weight of 2 plywood = 2.7 X 2 = 5.4kg

B. 50mm thick **MINERAL WOOL ACOUSTIC INSULATION** (with STC - 50)

Density of mineral wool = 70.4 kg/cub.m

Size of mineral wool insulation = 325X2400X50

Weight of mineral wool insulation = (0.325X2.4X0.05) X 70.4 = 2.75kg

C. 24mm thick **STEEL STIFFENERS** on both sides

Density of steel = 8050 kg/cub.m

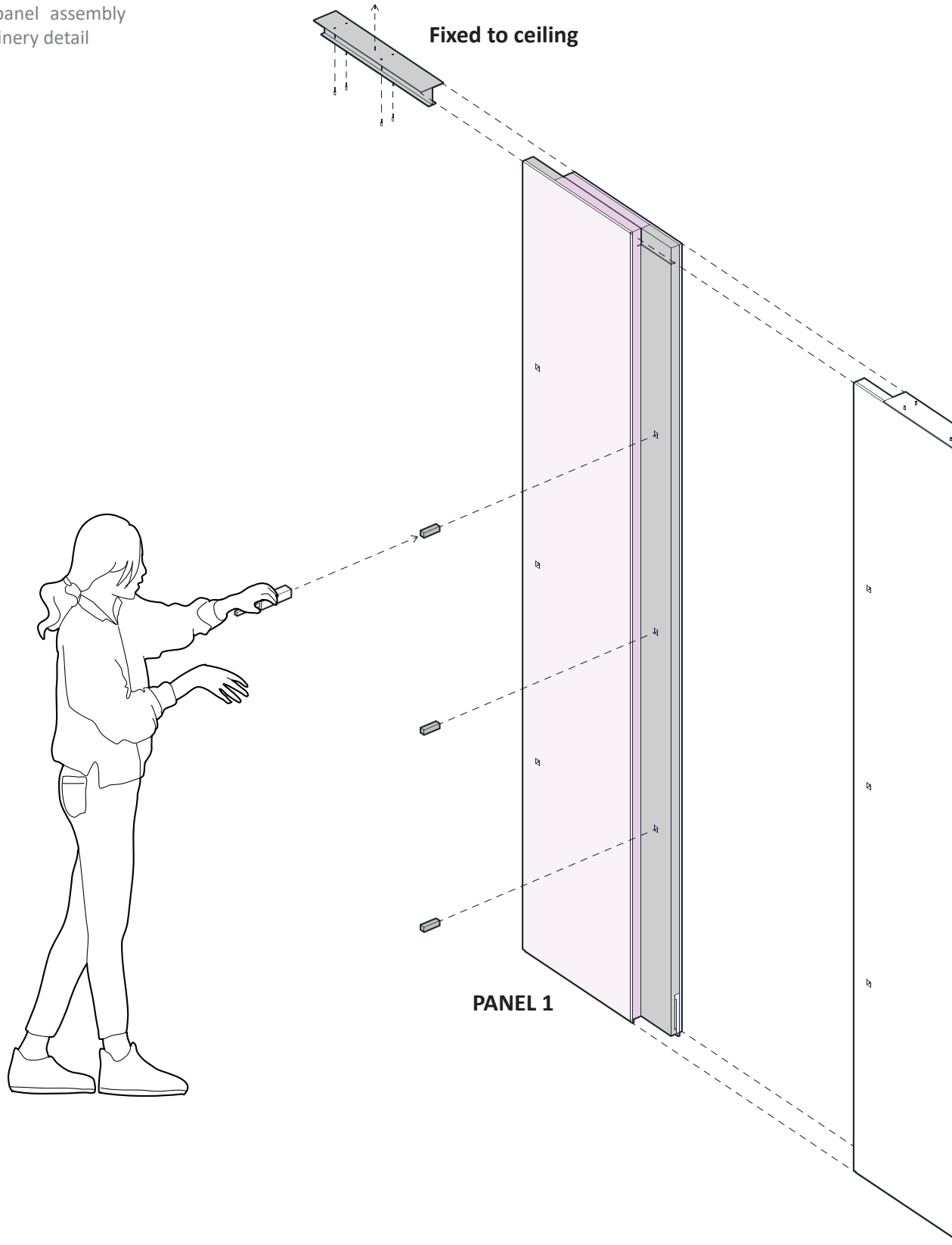
Size of 1 steel stiffener = 2 X (125X2400X1 + 24X2400X1)

Weight of 1 steel stiffener = (2 X (0.125X2.4X0.001 + 0.024X2.4X0.001)) X 8050 = 5.75kg

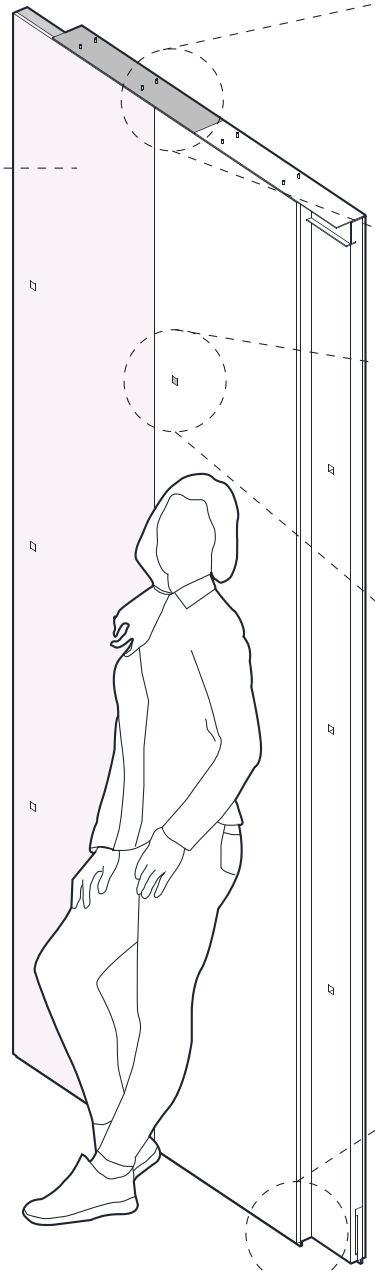
Weight of 2 steel stiffener = 5.75 X 2 = 11.5kg

TOTAL WEIGHT OF THE PANEL = 5.4 + 2.75 + 11.5 = 19.6kg

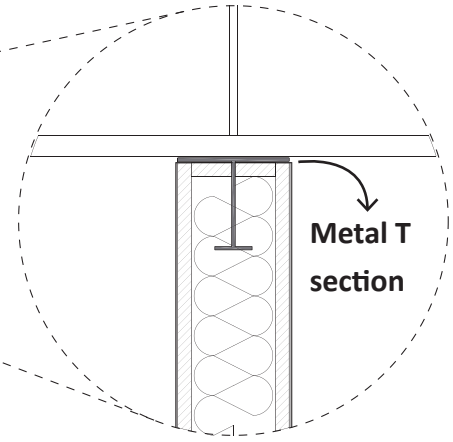
Fig. 6.08. Wall panel assembly and joinery detail



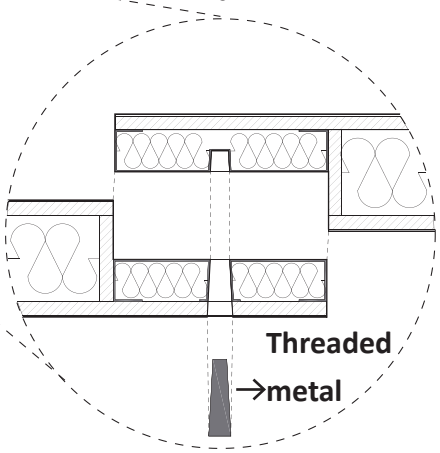
Material Palette



Section



Plan



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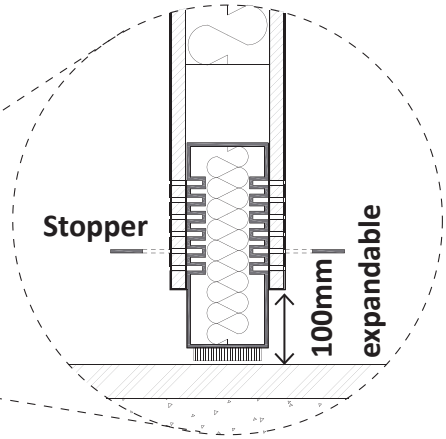


PANEL 2

WALL MOVEMENT

The wall panel will be manufactured in Dharavi. Dharavi is a triangular-shaped informal settlement spread over only 2.1 sq. km. of land, and housing 700,000 to a million people making it one of the world's largest informal settlements. Dharavi is situated at the edge of Downtown Mumbai, making it close to the center of Greater Mumbai. It is a self-contained city within a city - schools, hospitals, pharmacies, restaurants, bars, clothing shops, electronics, or groceries - Dharavi has it all. A distinguishing feature of Dharavi has always been its production and commercial activity. It consists of over 20,000 industries with 80% of its population working within the settlement. The estimated annual turnover for the thriving businesses within Dharavi stands at somewhere in the region of $500-650 million.[1]

When a resident rents or buys an adaptable apartment, they could choose between two options. In case one, the condominium would provide them with a list of vendors from whom the wall panel can be purchased. The wall panel is designed to be low tech so that the small businesses in Dharavi can manufacture them, thus providing business opportunities to the local craftsmen living in the settlement. The panel can then be transported via a rental small truck to the apartment and installed. In case two, the resident can get the wall panel made by the carpenter of their choosing using the drawings provided by the condominium. Traditionally, a carpenter would come to the new homeowner's apartment to custom make large furniture. The same carpenter could then make the wall panel for the resident according to their aesthetics, and install it.

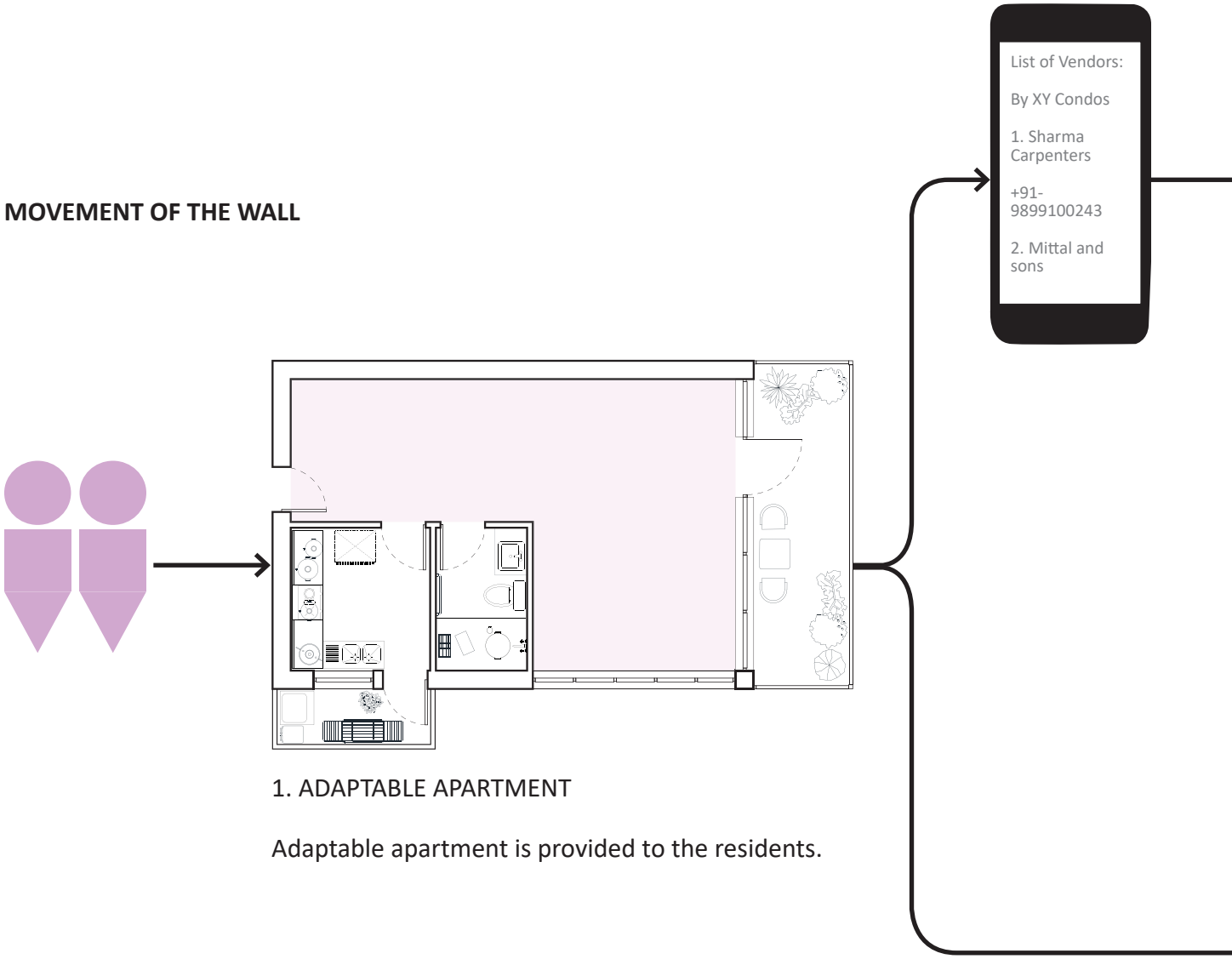
Towards the end of the life of the panel, it can be sold back to recycling businesses in Dharavi, India's biggest recycling unit, thus closing the loop and providing employment opportunities. The recycled materials can then be reused or sold to other businesses.

1 Tanvi Kundliwal, "Dharavi: Merging Boundaries" (Waterloo, University of Waterloo, 2019), https://uwspace.uwaterloo.ca/handle/10012/15080.

The idea is to keep a bottom-up approach allowing everyone to benefit from the design, from the residents in Dharavi to the residents in the apartments. Multiple cottage industries can benefit from the low-tech panel design such as: small shops in Dharavi, carpenters based out of Dharavi, small transport companies, handyman, scrap seller who buys the recycling from homes and further sells it to recycling plants in Dharavi, and the recycling plants themselves who recycle the materials and sell them. This movement of the wall and involvement of the cottage industries is described in fig 6.10.

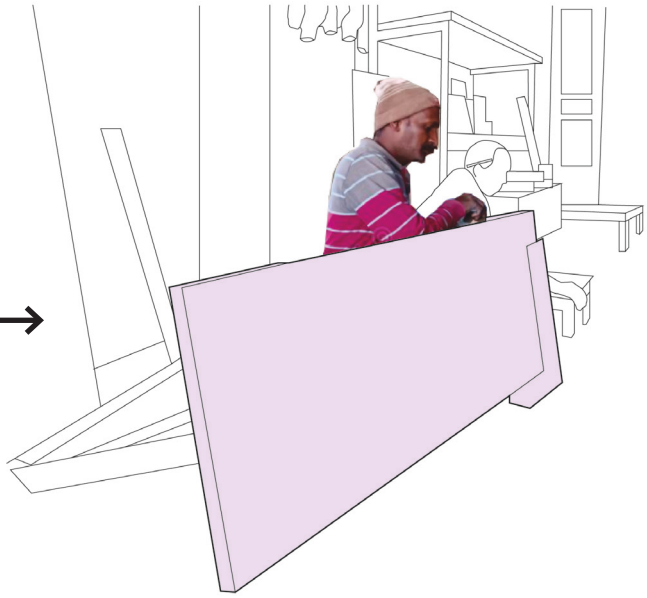
Fig. 6.09. Aerial View of Dharavi (Right)

Fig. 6.10. Wall kit of parts movement from site to storage



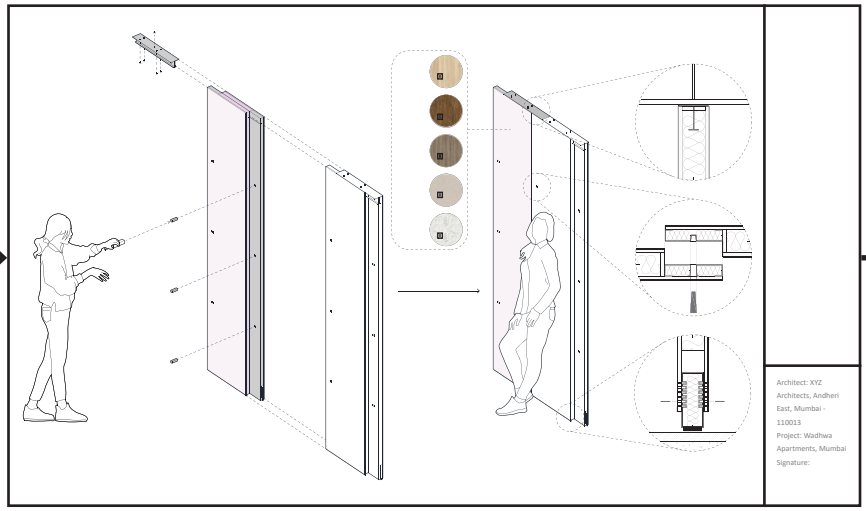
2. Dharavi, Mumbai

Dharavi houses a large number of small businesses.



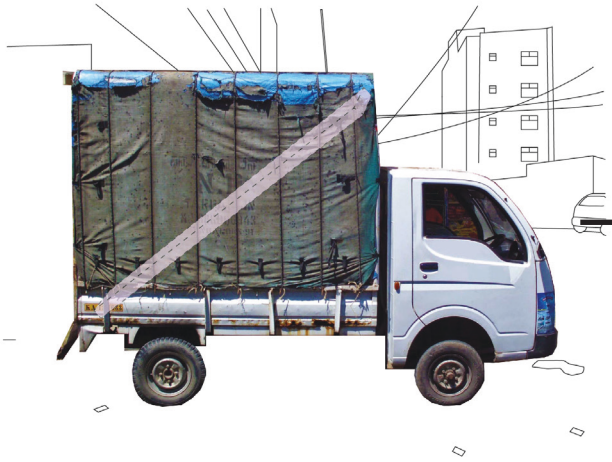
3. CONSTRUCTION

The panels are constructed in Dharavi providing employment opportunities to local craftsmen.



2. Drawings as manual

Drawing of the wall panel is provided by the condominium to the residents.

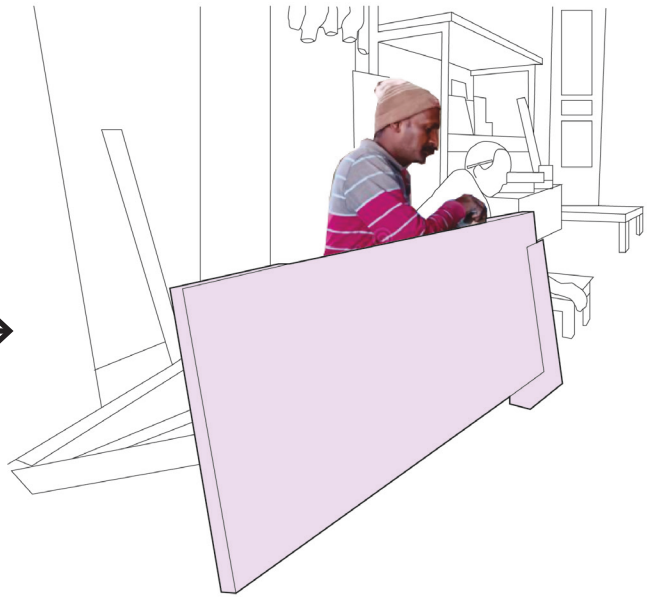


4. DELIVERY

The panels are transported via a local truck to the apartment.

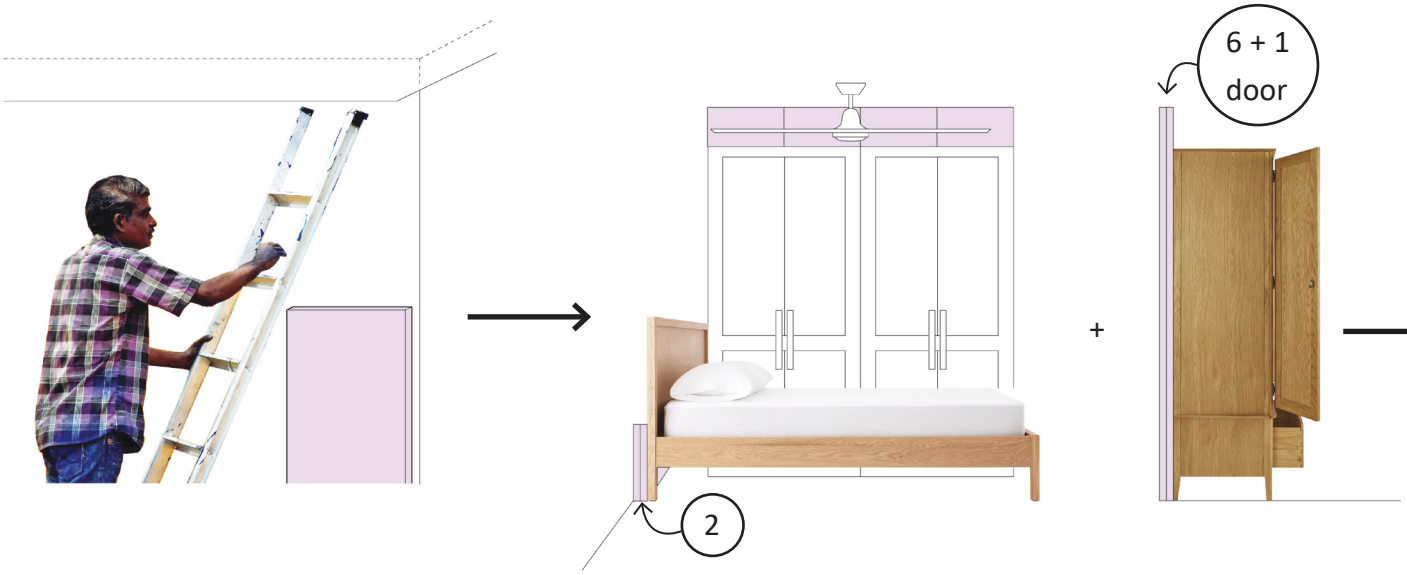
5. Transported to the apartment

3. A carpenter is hired to make furniture for the home.



4. CONSTRUCTION

The panels are also constructed by the same carpenter according to the user's aesthetics.



6. ASSEMBLY

Wall panels are then fixed to the ceiling and the wall is assembled which can be done by the user or hired help.

7. STORAGE

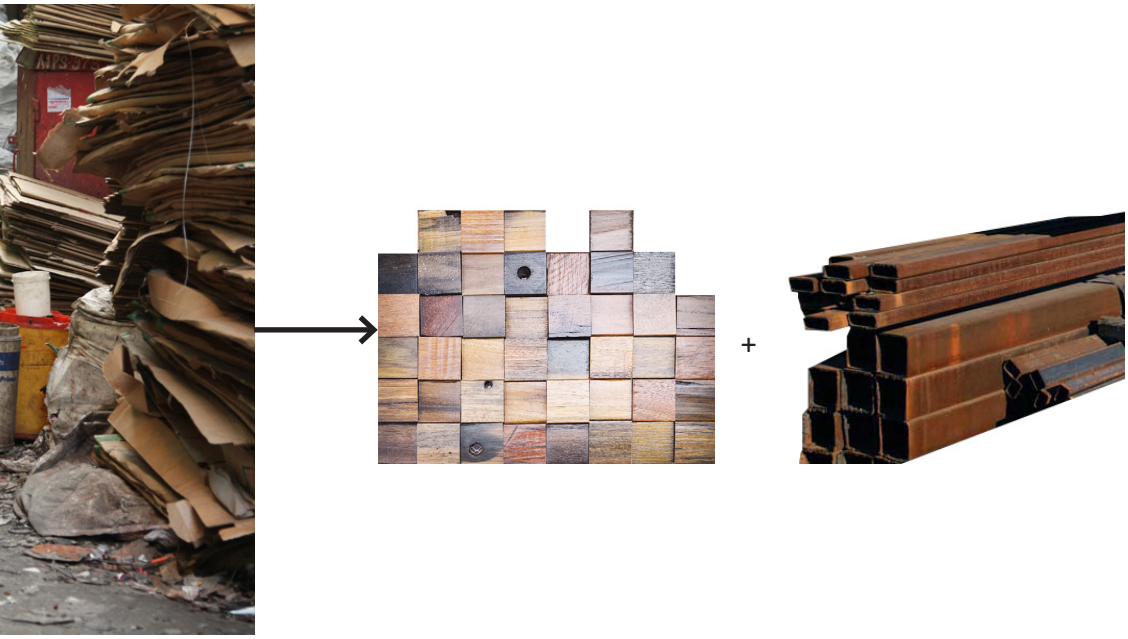
Panels can be stored behind the bed horizontally and behind the cupboard vertically. For a 4000m long wall 2 panels can be stored horizontally and 7 vertically.

8. RECYCLING COLLECTION

Scrap seller comes to the home to buy recycling waste and further sell it to recycling plants.

9. RECYCLING PLANT

The panels are then sold bacl
businesses run in Dharavi - where
sorted, ground and re-produced i
- providing more employment opp



k to the recycling
they are separated,
nto its original form
portunities.

10. RECYCLED MATERIALS

The recycled materials are sold to various businesses.

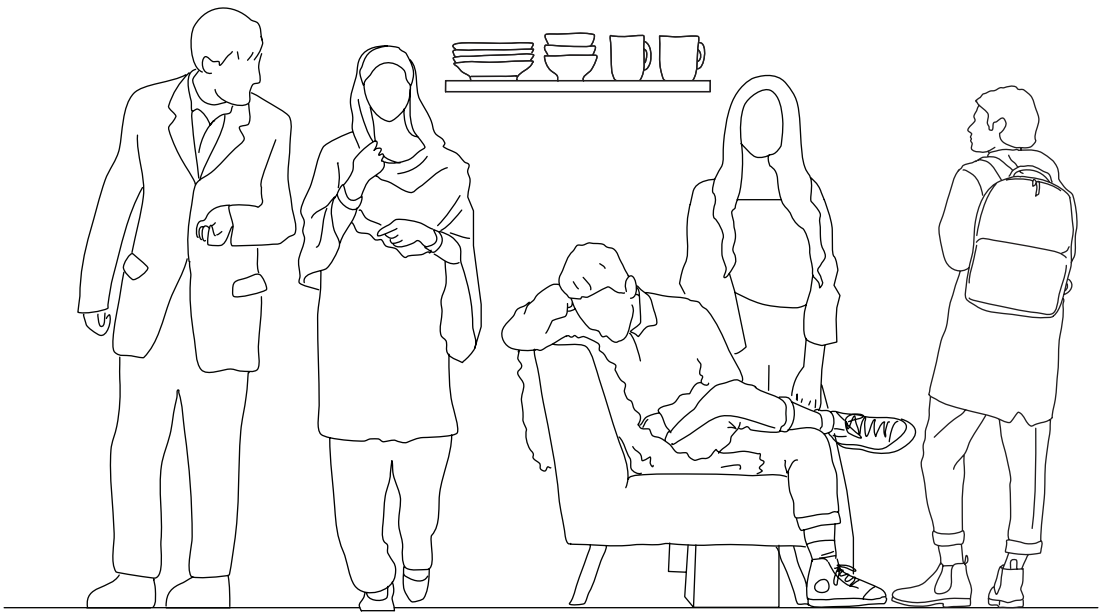
Fig. 6.11. Persona development of house no. 03 (Right)

DESIGN IMPLEMENTATION – APARTMENT OVER THE YEARS

The schematic wall design and unit design are incorporated into the lives of the interviewed family living in house no. 3.

House No. 3 had five people living in a three-bedroom apartment which they owned. They wanted their spaces to be multifunctional as one of the children was living outside the city. This would allow them to have more space when needed as they felt the apartment was very tight and cramped due to a lot of space divisions.

The apartment design with the demountable wall is used to imagine the life of the family starting from 2019 and is described in the storyline that follows (fig 6.13 – fig 6.23). The life imagined is what a typical Indian family goes through with the son with his wife living with the son's parents and the daughter moving out of her parent's home to live with her in-laws. Although the trend is starting to change, this is still the norm currently in the Indian culture. The apartment, therefore, goes through different transitions and changes which are summarized in fig 6.12. This storyline intends to demonstrate the fact that if the apartment was adaptable with an open layout and movable or demountable partition walls, the residents could change the layouts according to their needs, and the apartment, or the building, would not become redundant over the years. This not only makes the residents stay in place comfortably but also reduces unnecessary demolition of buildings.



HOUSE NO. 03

The house has parents with three growing children and live in a 3 bedroom apartment. The parents go to work. Two of the children are also working while one is currently studying.

REQUIREMENTS:

1. Need some rooms to be multi-functional as one of the child lives in a different city and visits home on holidays and festivals.

2. The rooms are cramped due to small area and a lot of divisions but they also need the privacy of having separate spaces.

Fig. 6.12. Summary of different configuration options in an adaptable three bed apartment

The graphic depicts the different lifestages a family goes through, from a young couple to being grandparents living in a multigenerational home, and the different configurations they can do with the apartment layout if the design incorporates time as a variable.

01 - 2 bed 2 bath apartment

02 - 3 bed 2 bath apartment

03 - 3 bed 2 bath apartment with study

04 - 3 bed 2 bath apartment with storage

05 - 3 bed 3 bath apartment

06 - 2 bed 3 bath apartment

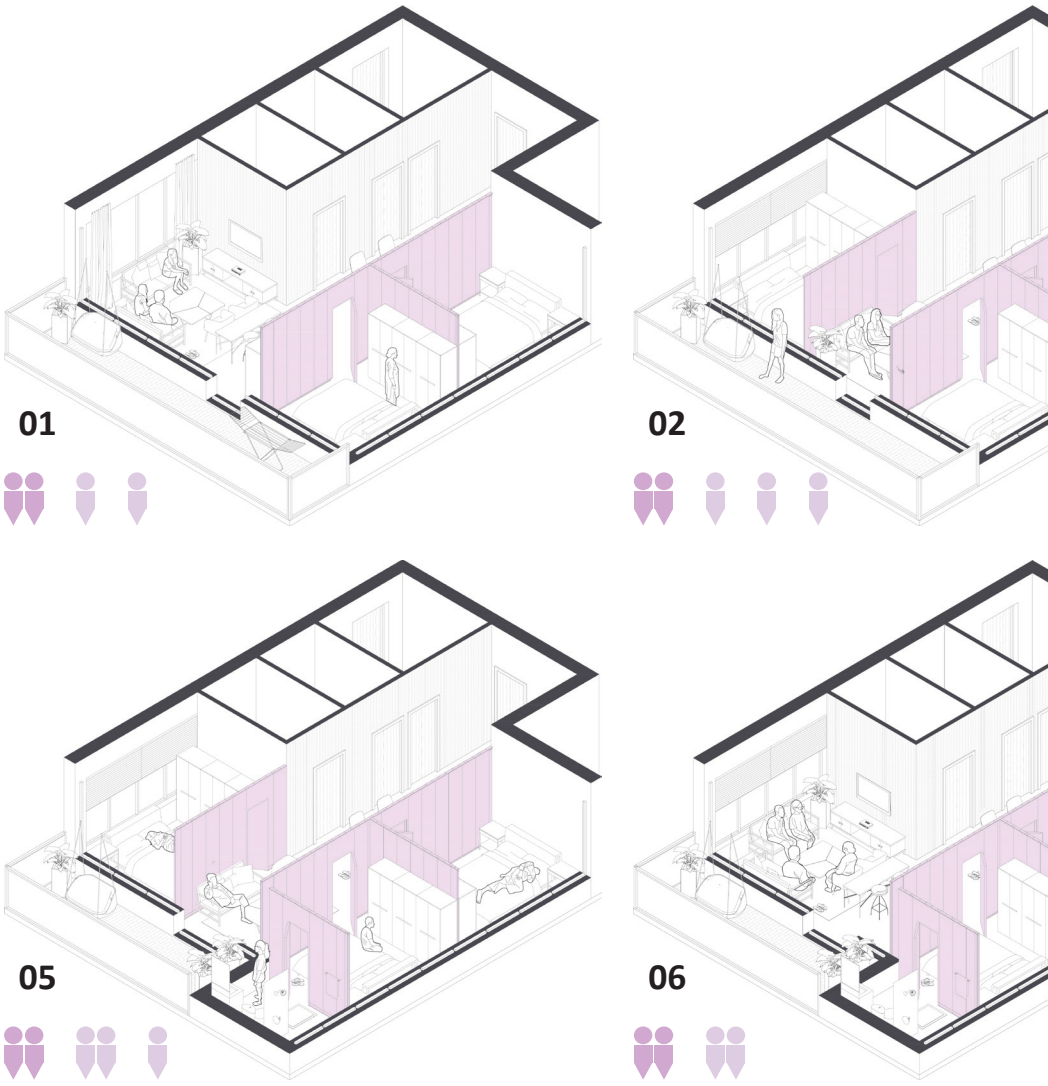
07 - 2 bed 3 bath apartment with nursery

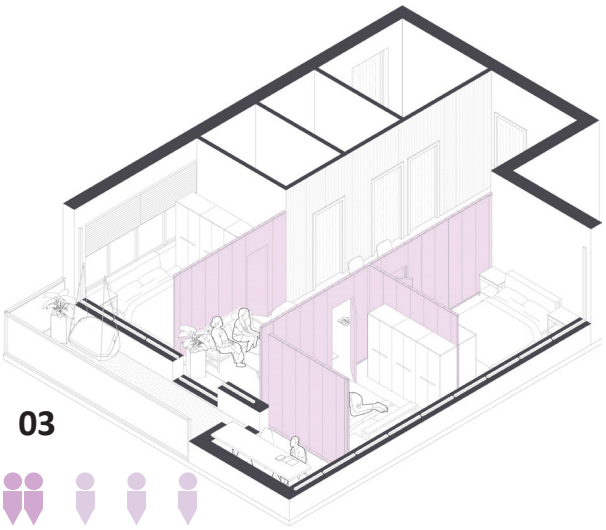
08 - 4 bed 3 bath apartment

Generation 1

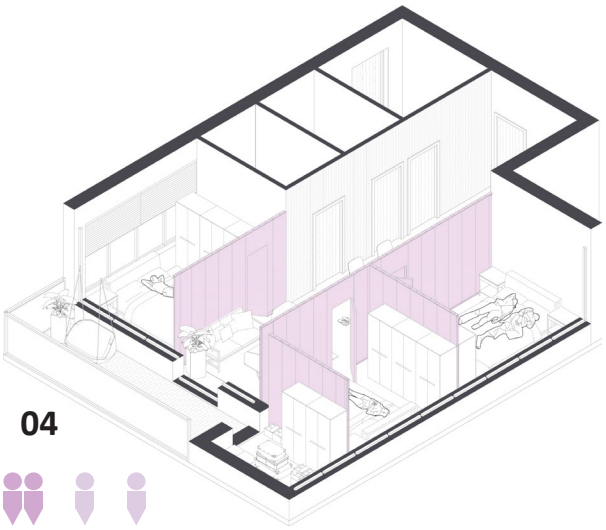
Generation 2

Generation 3

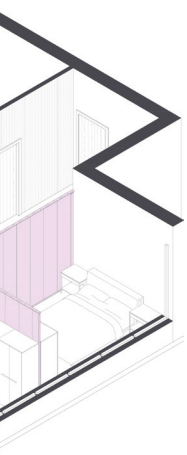


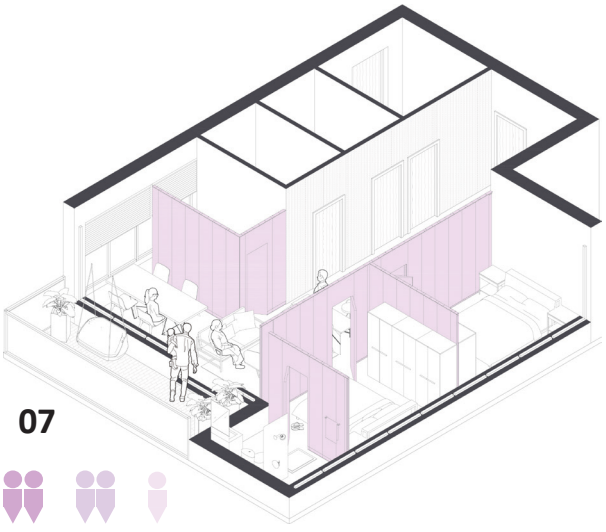


03



04





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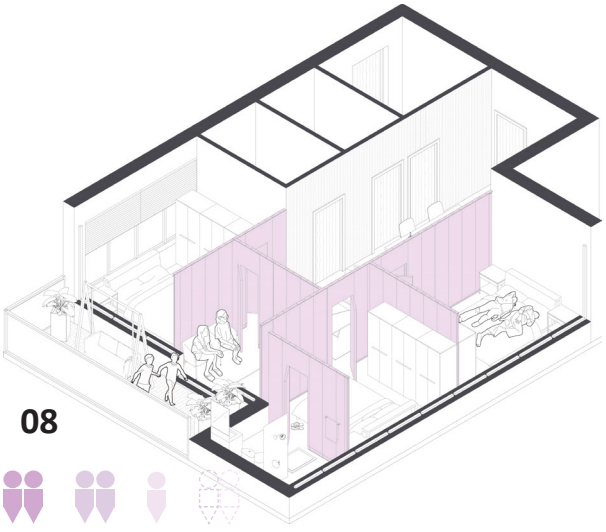

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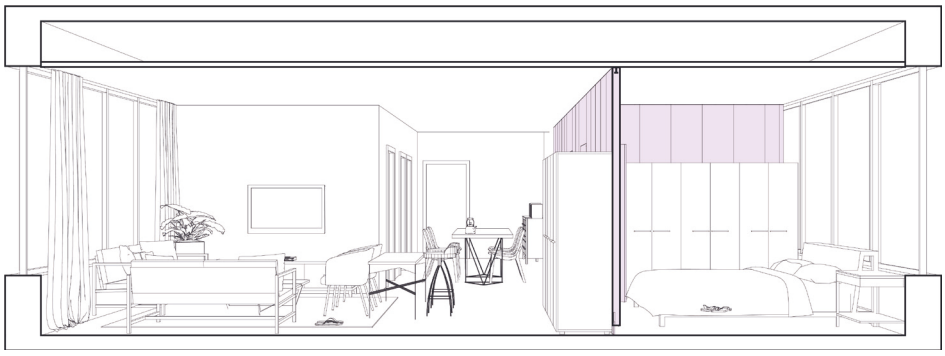
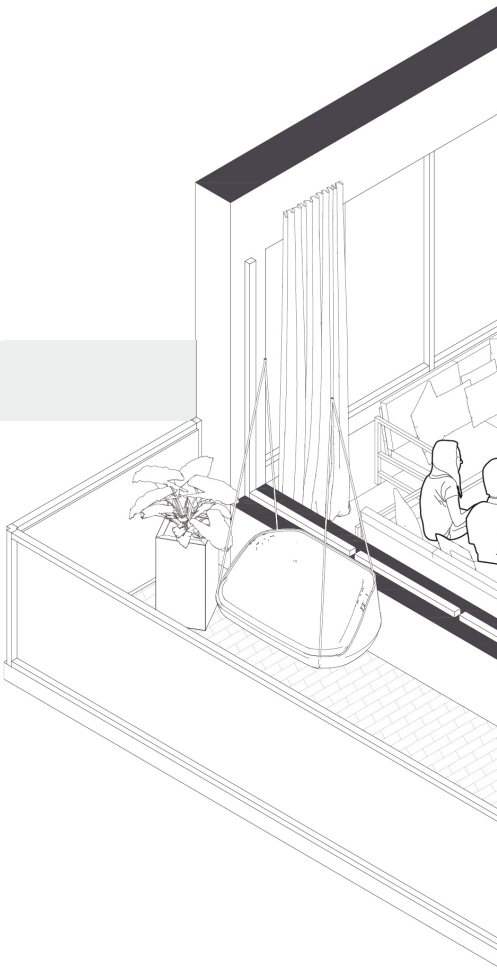


June 2019



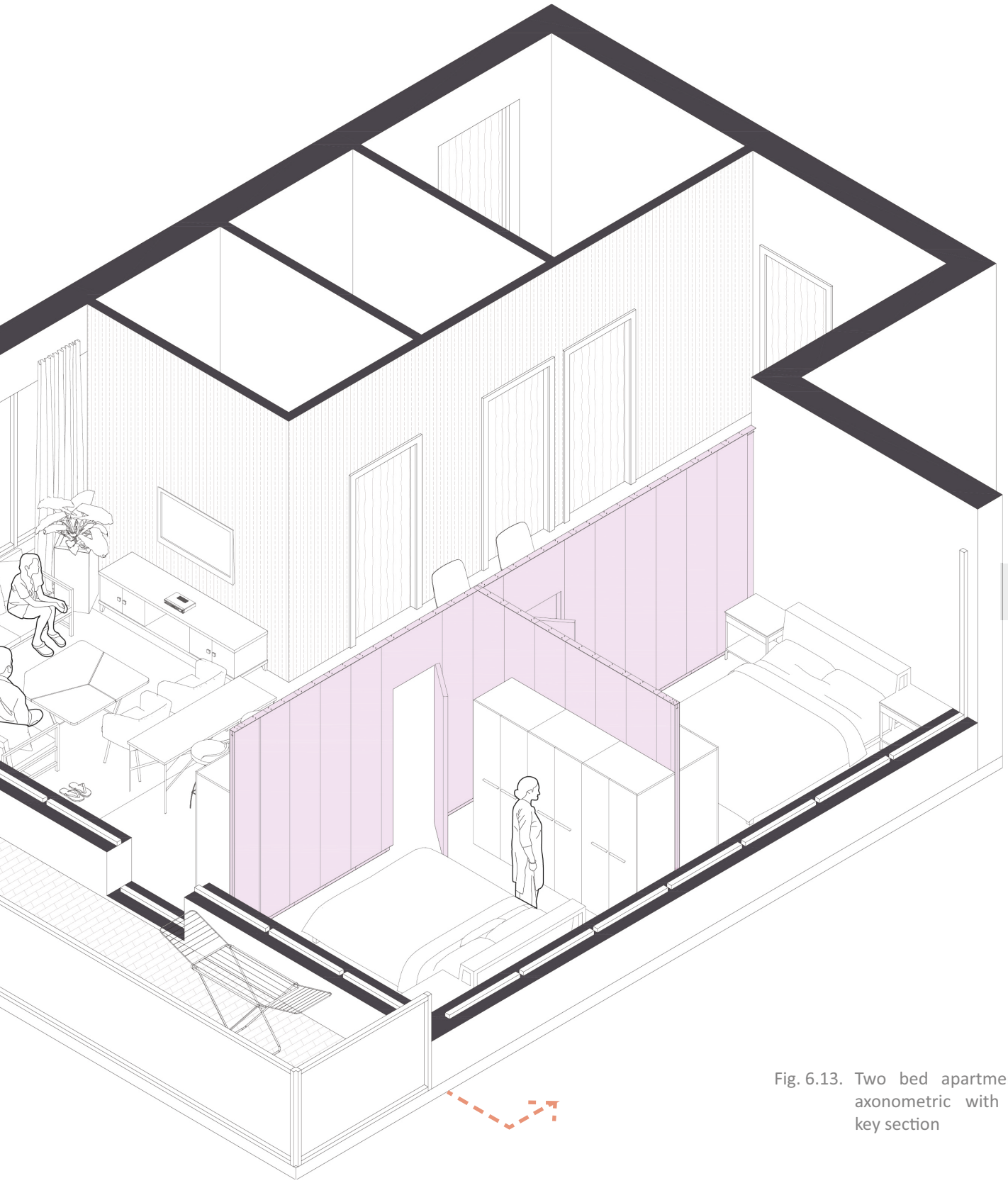


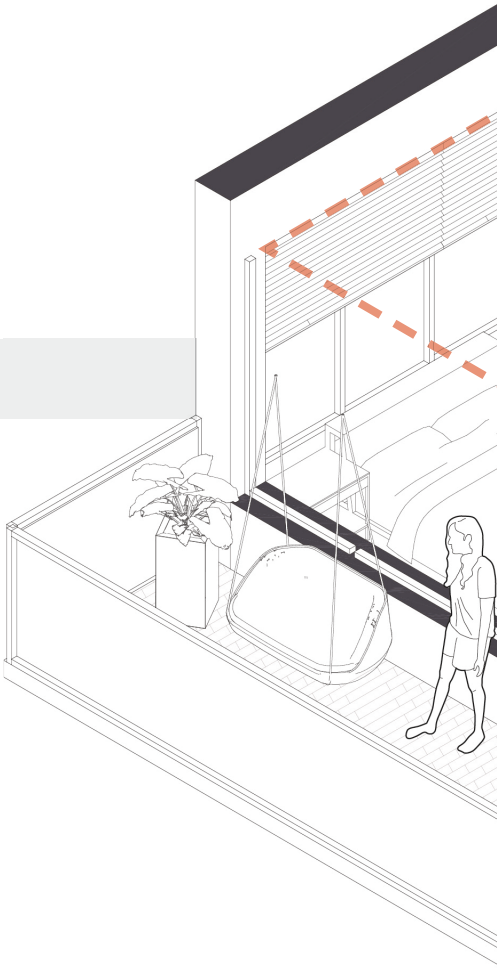
Fig. 6.13. Two bed apartment axonometric with a key section

Oct 2019

Hi Mom! How are you? How has everyone been at the home?

Hello! We are all good. We are missing you 😔 When are you coming back home?

My college is FINALLY going on a break!!! 🥳 So, I'll come home on the 20th. Can you tell dad to come pick me up from the railway station? I have too much laundry and bags. 🙈



Again? Why don't you do your laundry in the hostel?! Anyways, we are very excited to meet you! I'll make your favorite dish. 😘

Also, you will have to help us make your bedroom. See you soon!

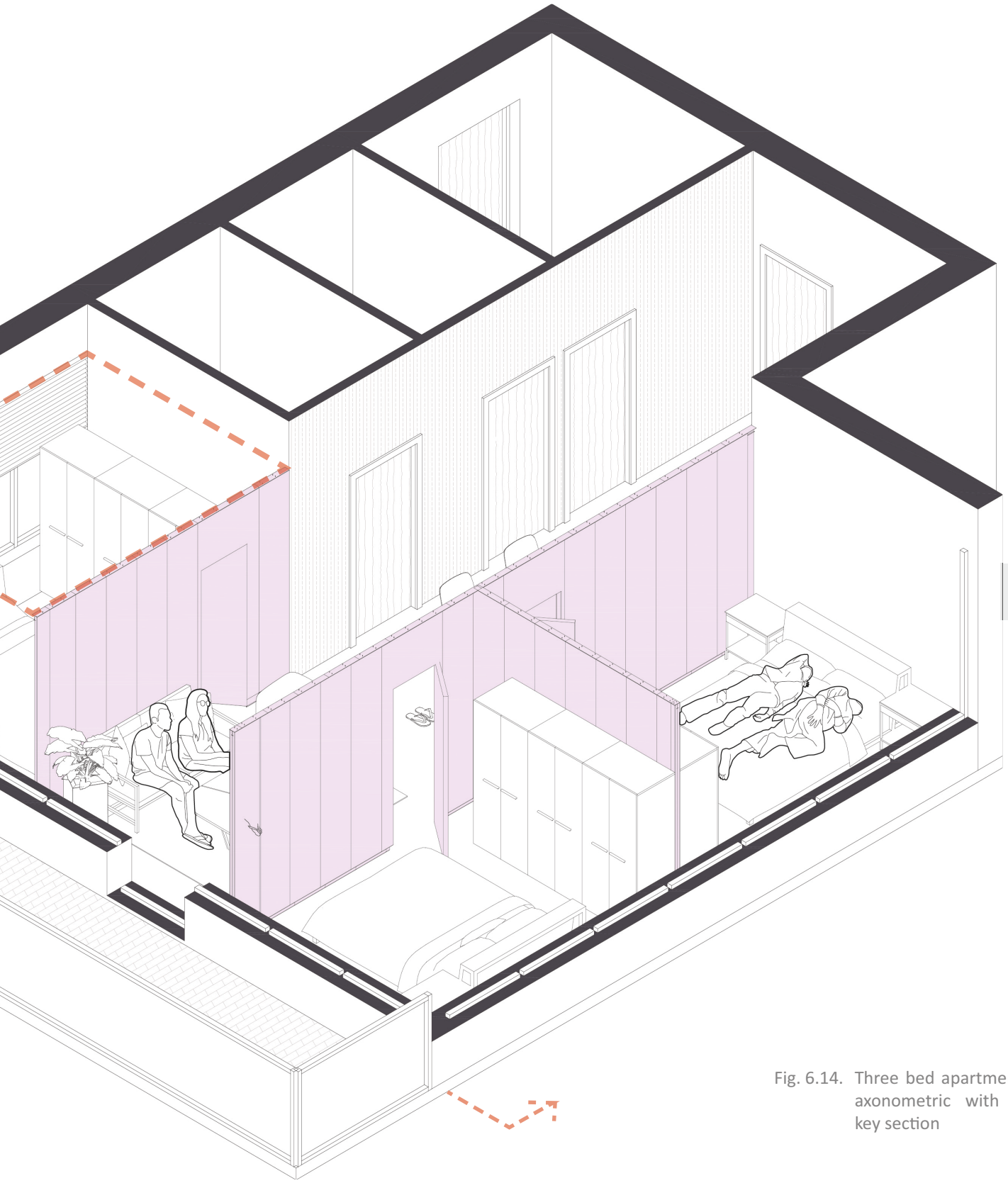
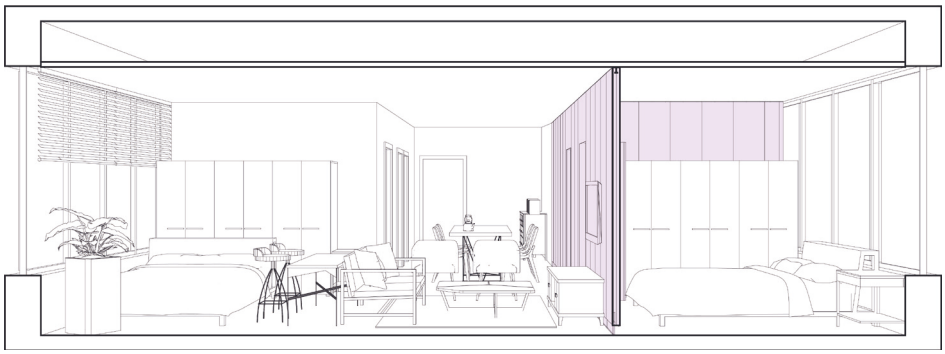


Fig. 6.14. Three bed apartment axonometric with a key section



Diwali 2019

Hello Mr. Verma! How are you? How is your family?

Hello Mr. Sharma! Everyone is great! Are we on for the Diwali party at your home this year?

I called you for that only! I have removed the partition wall for the party. We will have a large space to ourselves. My wife will also be cooking some Indian food and snacks.

Great! I love how your home opens up! You have to give me the number of the place where you got this from. I'll get my home renovated and then next time we can meet at my place!

Oh for sure! I'll keep the card ready. See you at 8pm on the 26th!

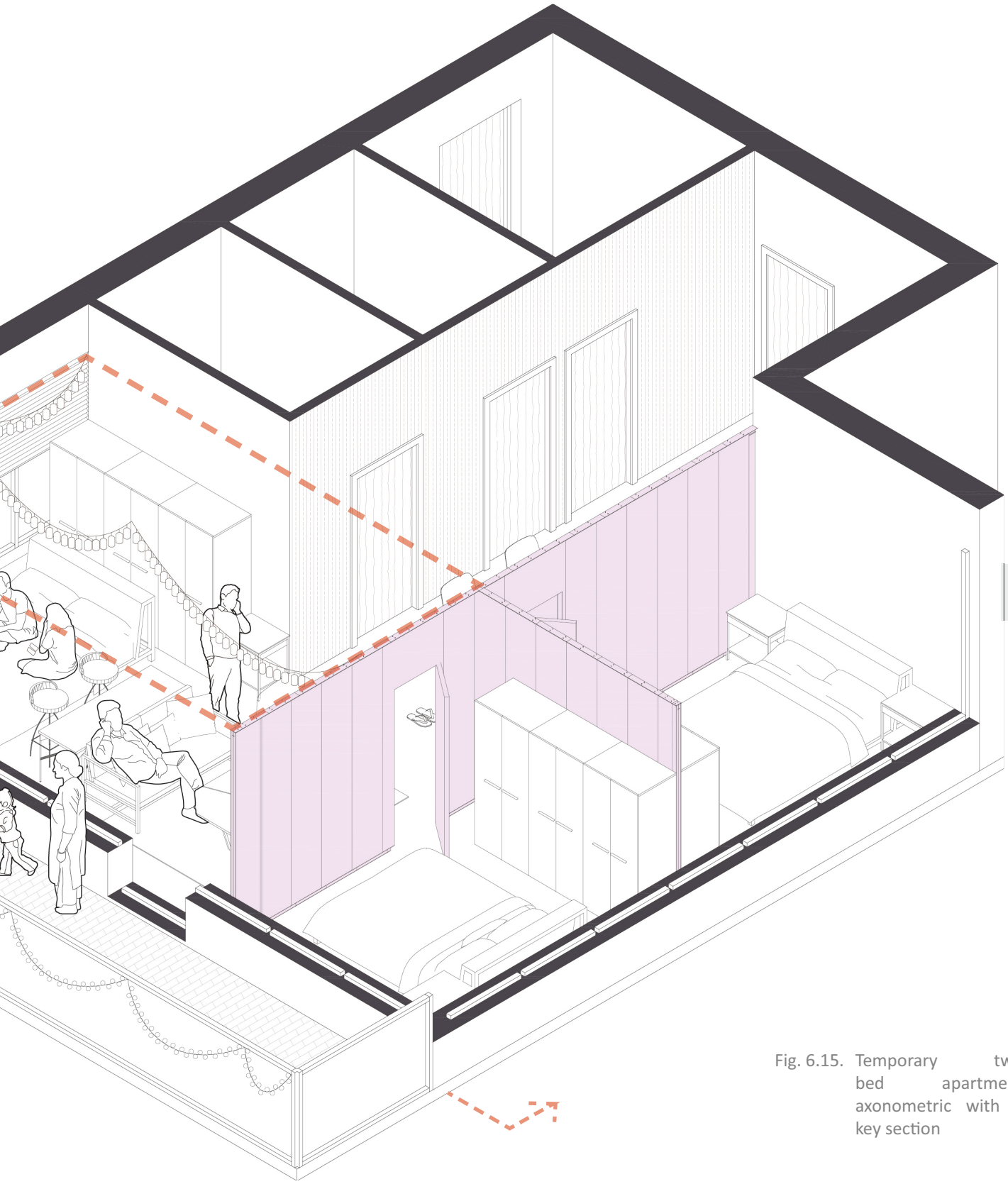
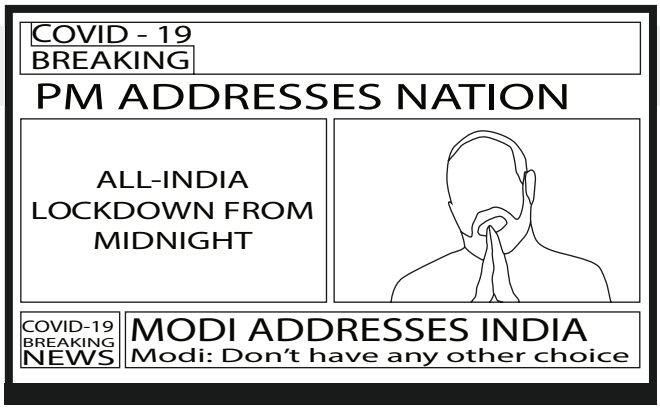


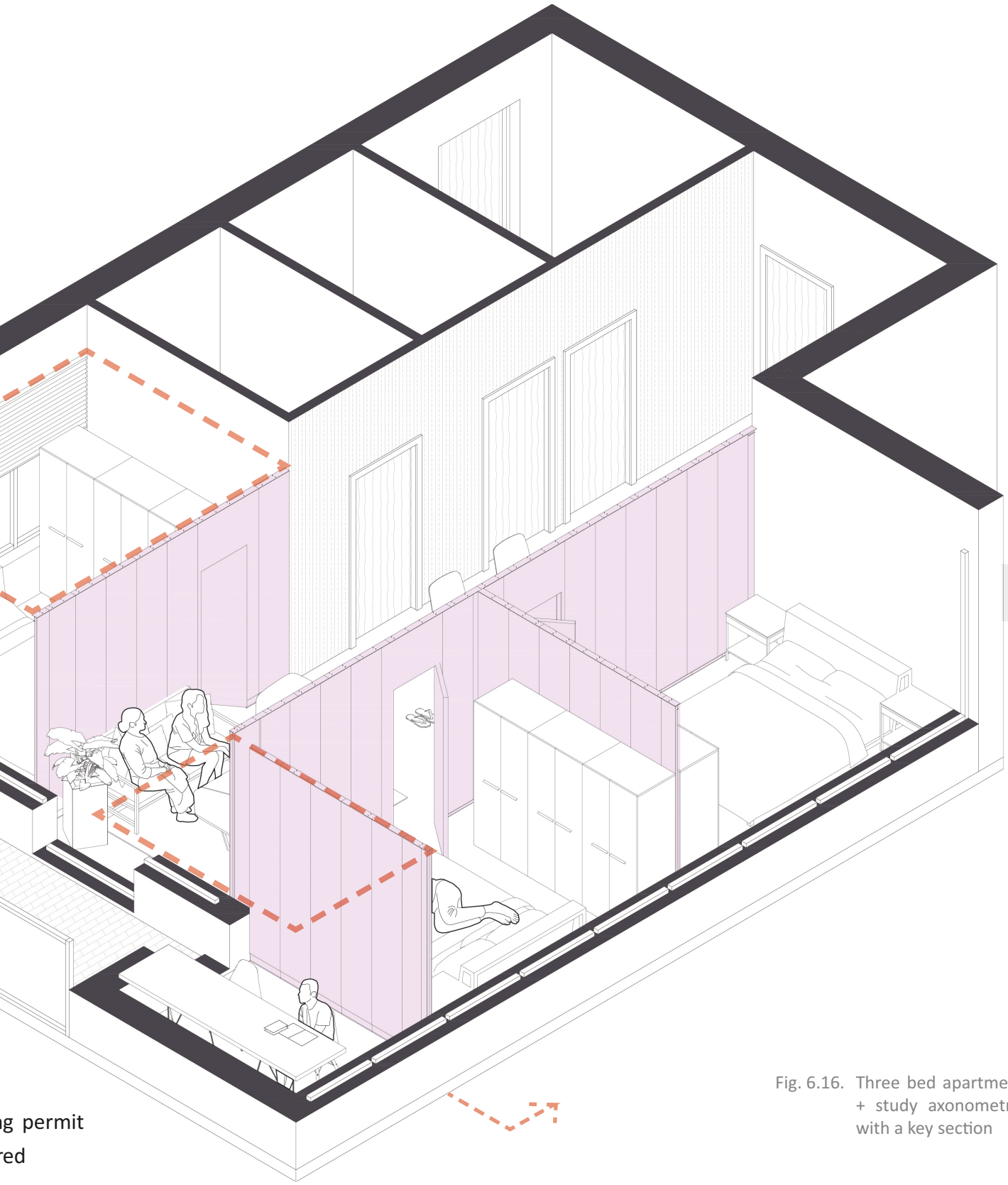
Fig. 6.15. Temporary two bed apartment axonometric with a key section

2020

Dad! India is going into a lockdown! Where will we study and work now?



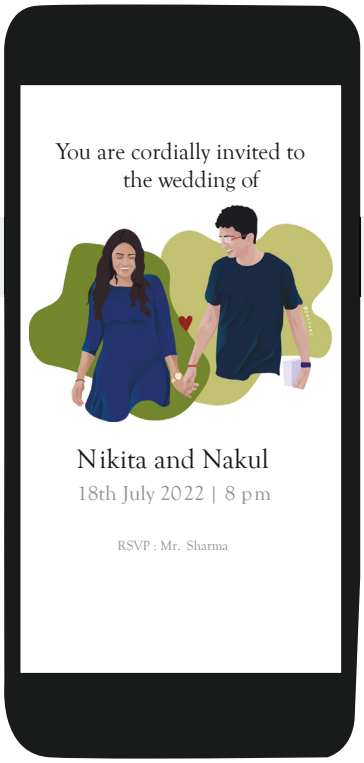
*Buildin
is requir



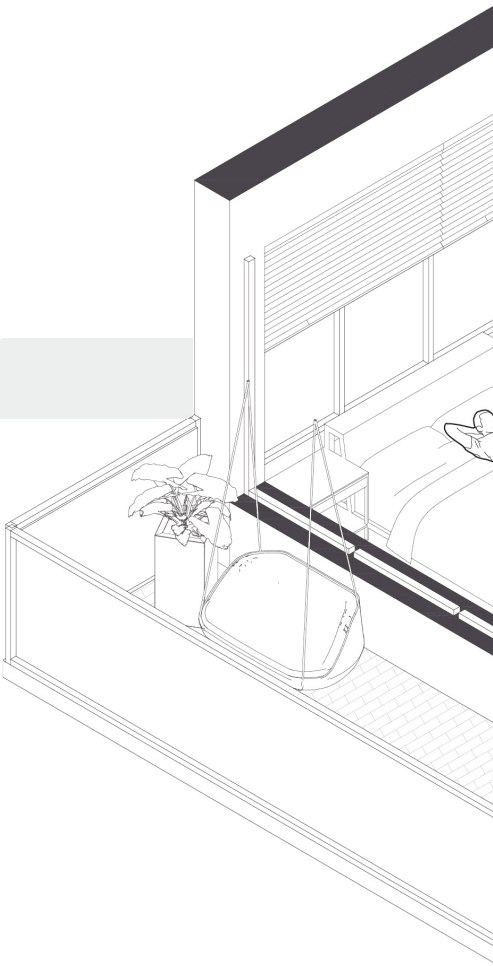
ng permit
red

Fig. 6.16. Three bed apartment + study axonometric with a key section

2022



We have to do a lot of work for our daughter's wedding celebration! Should we make a list?



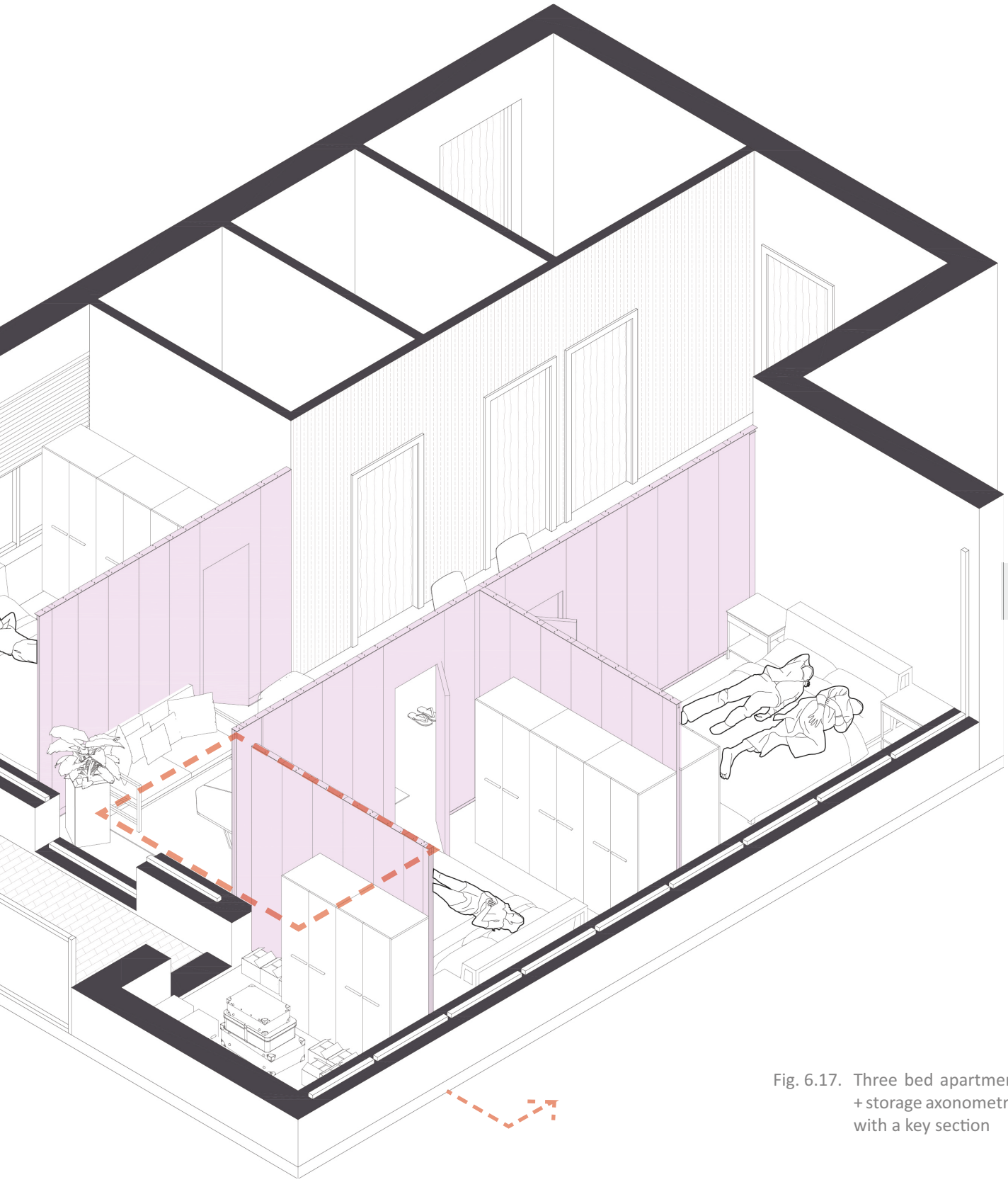


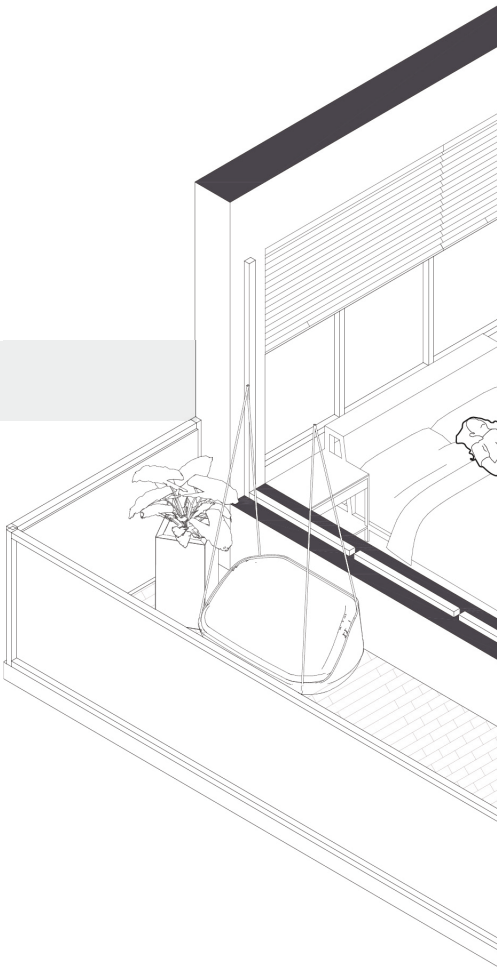
Fig. 6.17. Three bed apartment + storage axonometric with a key section

I am getting married in two months! I can't believe it!

Yes, we need to go over the menu once again whenever you have the time.

2026

Yes, for sure! I am free today evening. Let us do it before dinner? Also, did you talk to the building contractor about renovating the storage into a washroom?



Before dinner sounds great! I'll finish my work early and grab the list from the caterer on the way home. And the contractor will come on Monday to get the work started.

Amazing! I'll clean up the storage by then. See you soon!

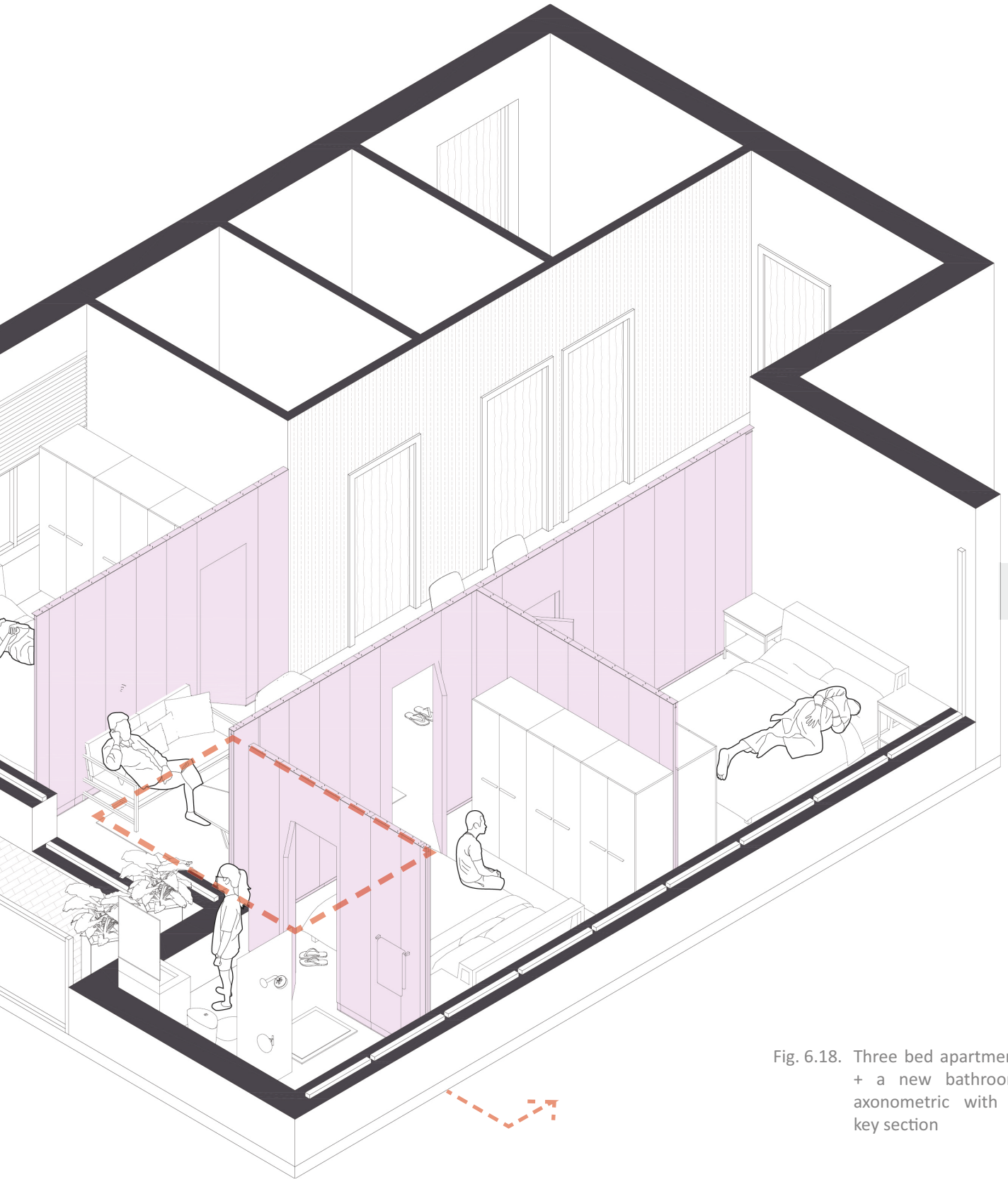
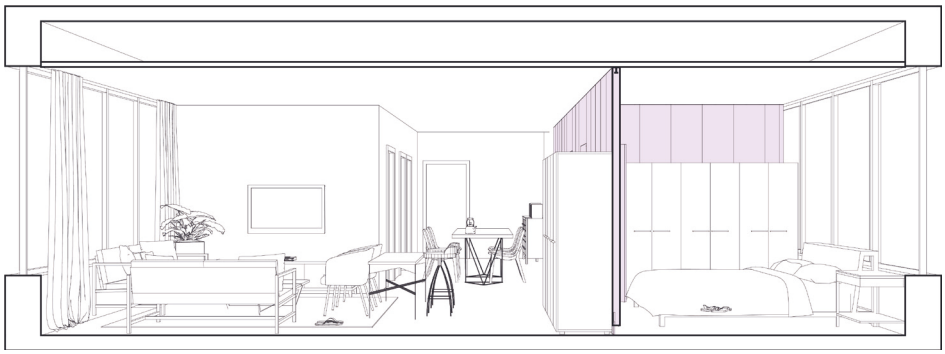
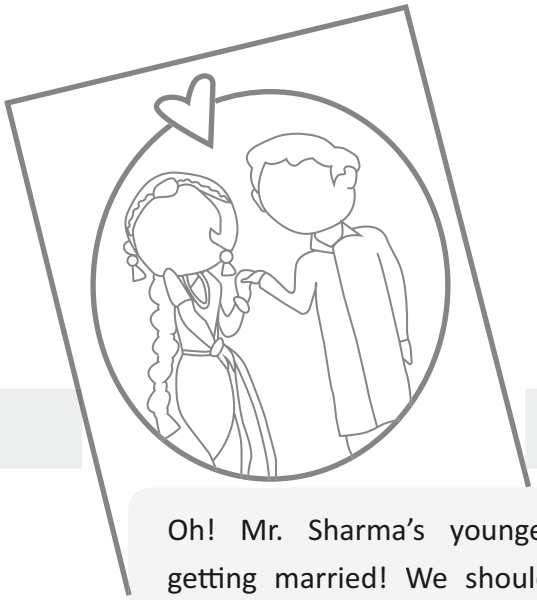


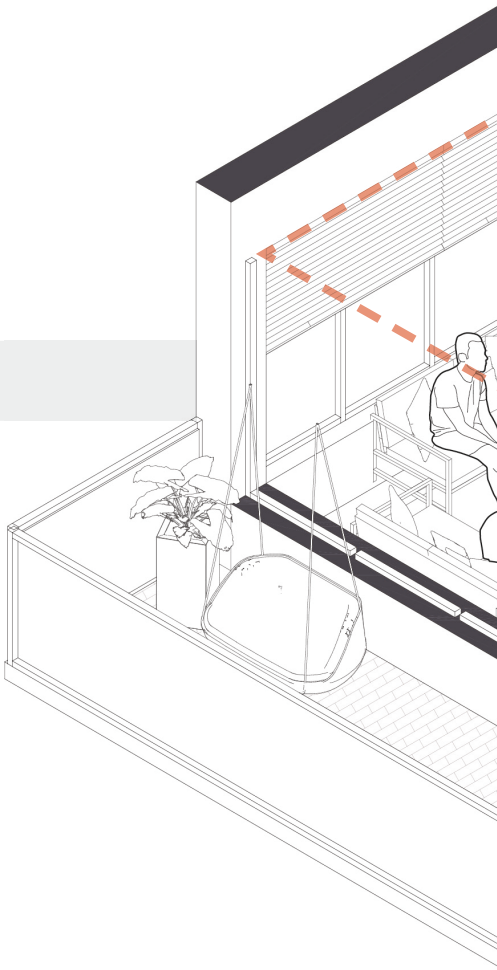
Fig. 6.18. Three bed apartment + a new bathroom axonometric with a key section



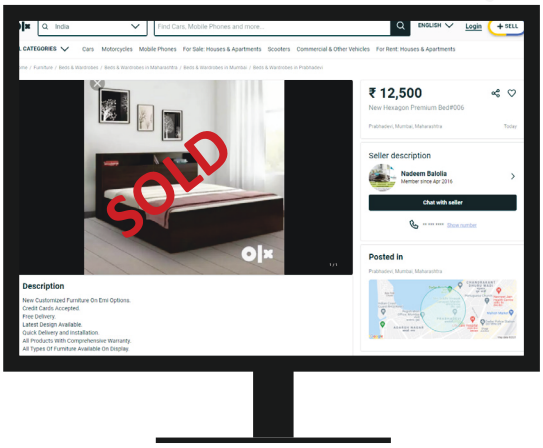
2027



Oh! Mr. Sharma's younger daughter is getting married! We should call them to congratulate. I also need to buy some new clothes now!



*The daughter's bed is sold



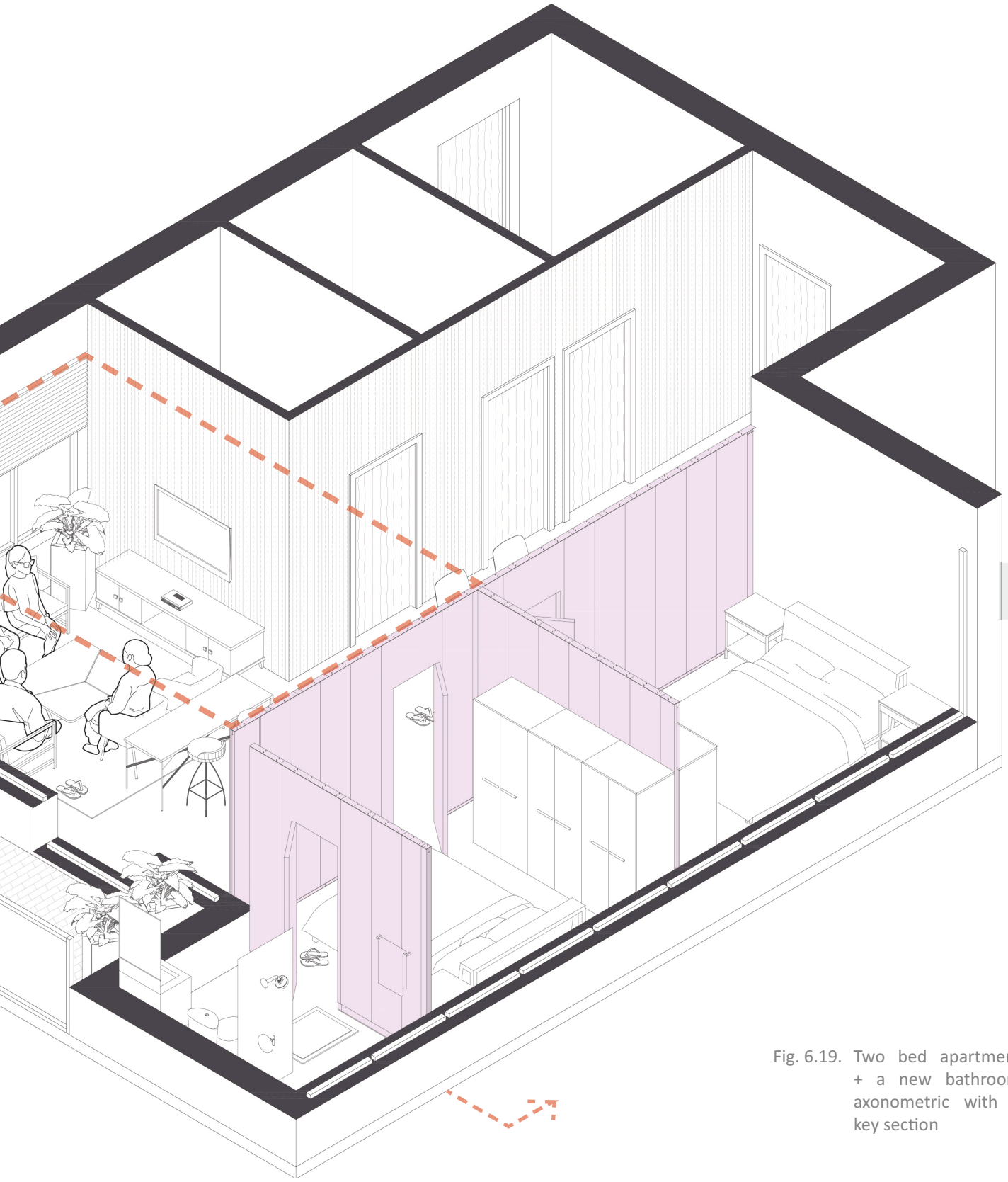
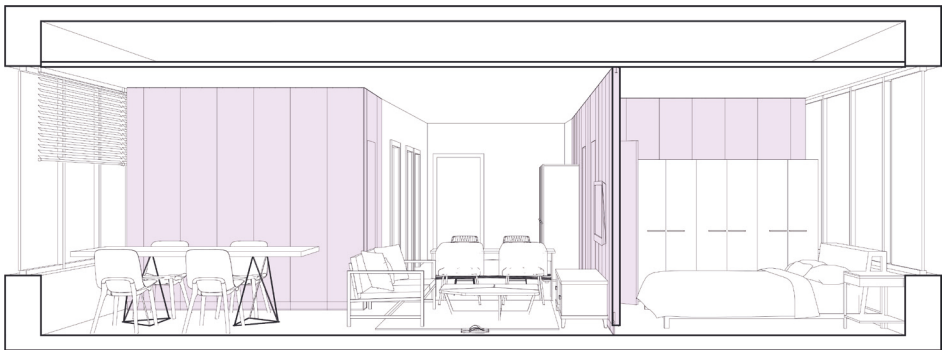
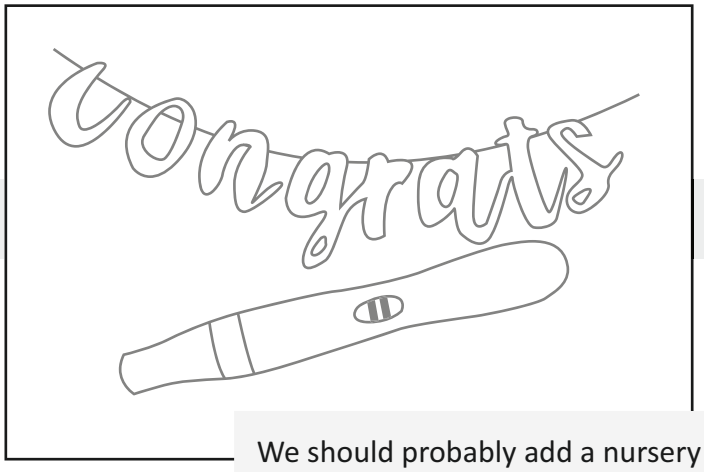


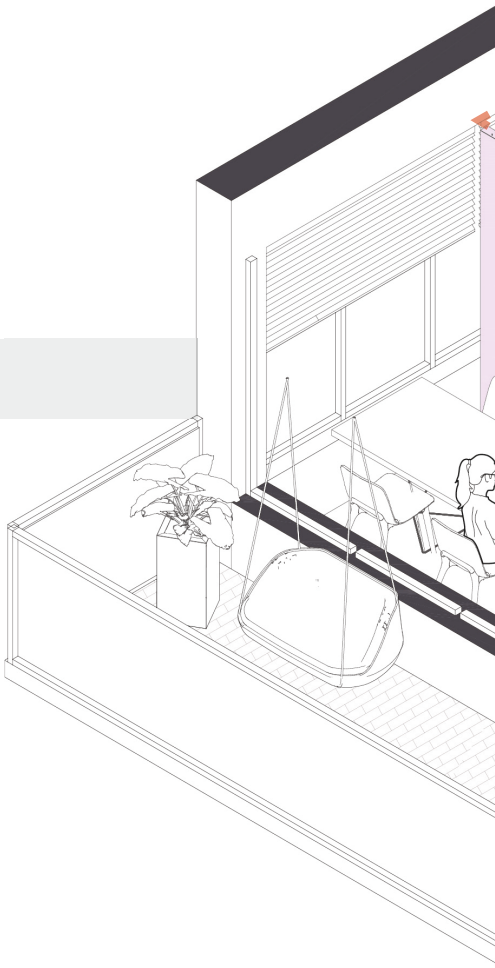
Fig. 6.19. Two bed apartment + a new bathroom axonometric with a key section



2029



We should probably add a nursery!



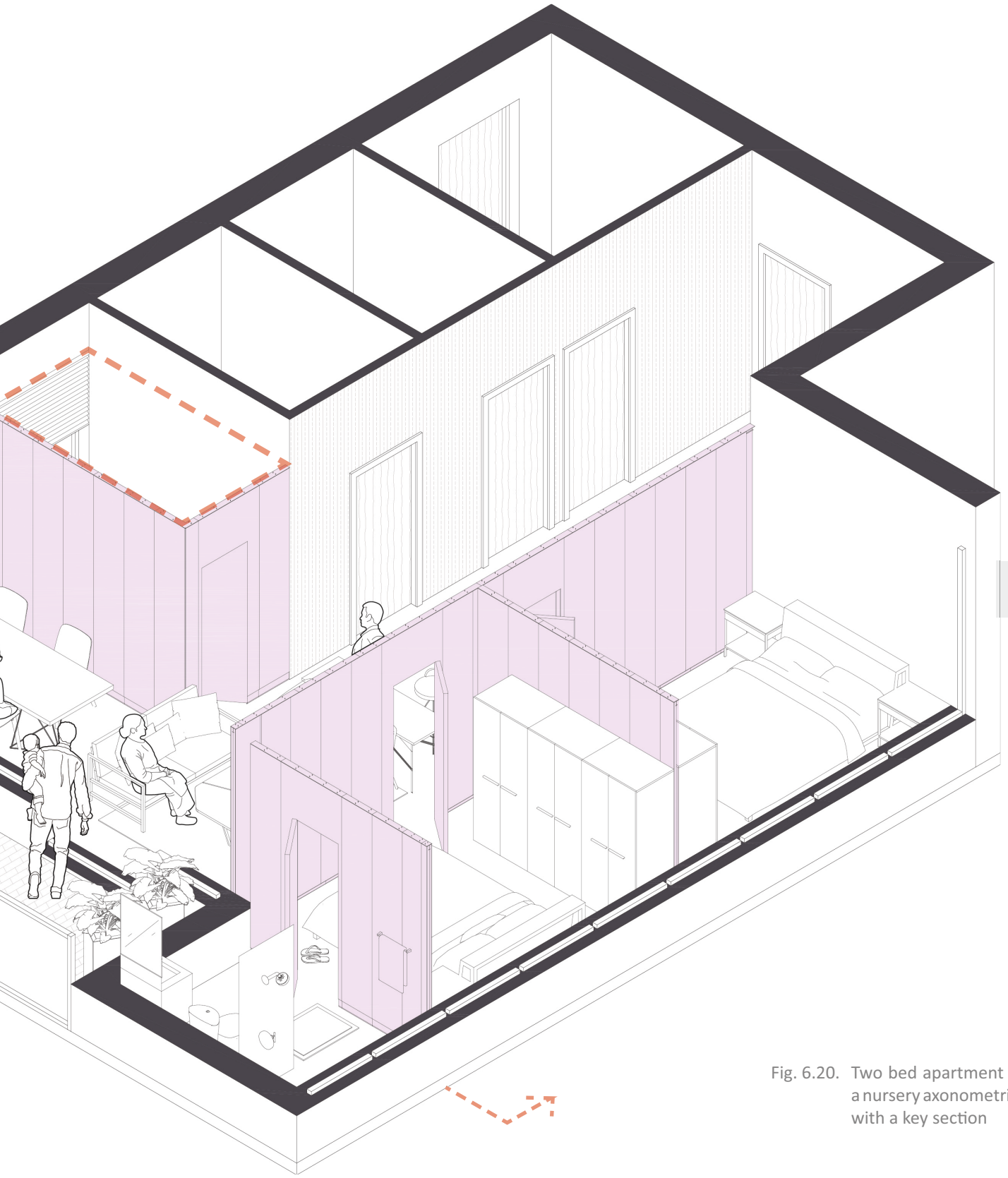
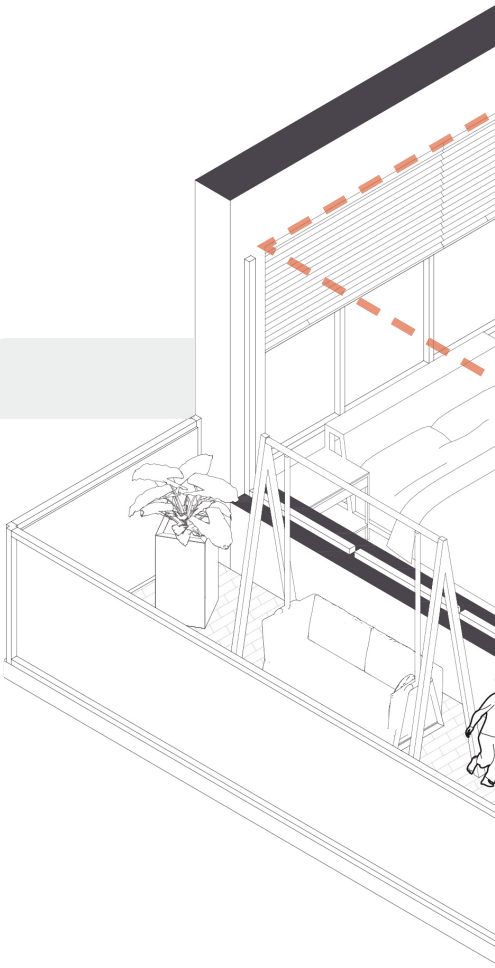


Fig. 6.20. Two bed apartment + a nursery axonometric with a key section

Hey, what time will you be home today?

2035

I am running a little late but I'll be home before dinner. Do you want me to bring something on my way back?



No.. I'll grab some groceries on my way back. You just reach home and convert the nursery into a bedroom. It is becoming very difficult for our son to sleep in a small room.

Oh yes, I completely forgot about it. Don't worry! I'll do it today as soon as I reach home. I have just been so busy with work. 😔 See you at dinner! 😘

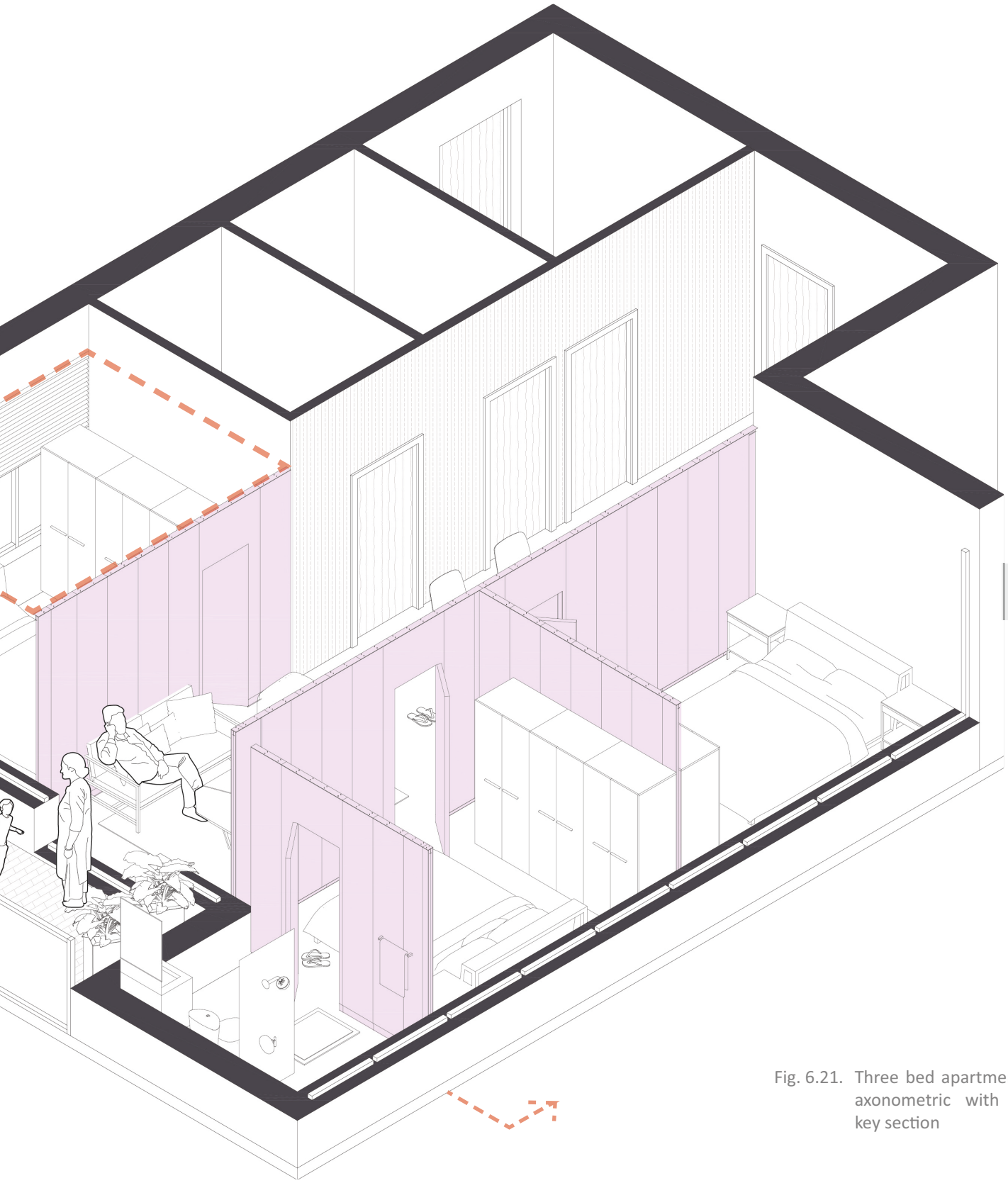
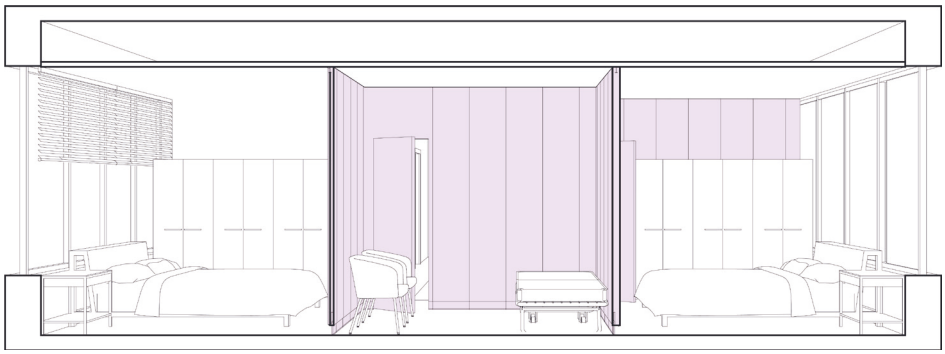


Fig. 6.21. Three bed apartment axonometric with a key section



2036

Summer vacations have started. Your sister will be coming with her son. We should add a small guest room for her.

Great! When is she coming? It will be so much fun being together again after so long. My son was also missing them. I'll move the furniture tomorrow and add a wall.

Perfect! Don't forget though. They'll be here the morning of day after tomorrow. I am also going to cook her favorite dish and ask your dad to get some sweets from the market.

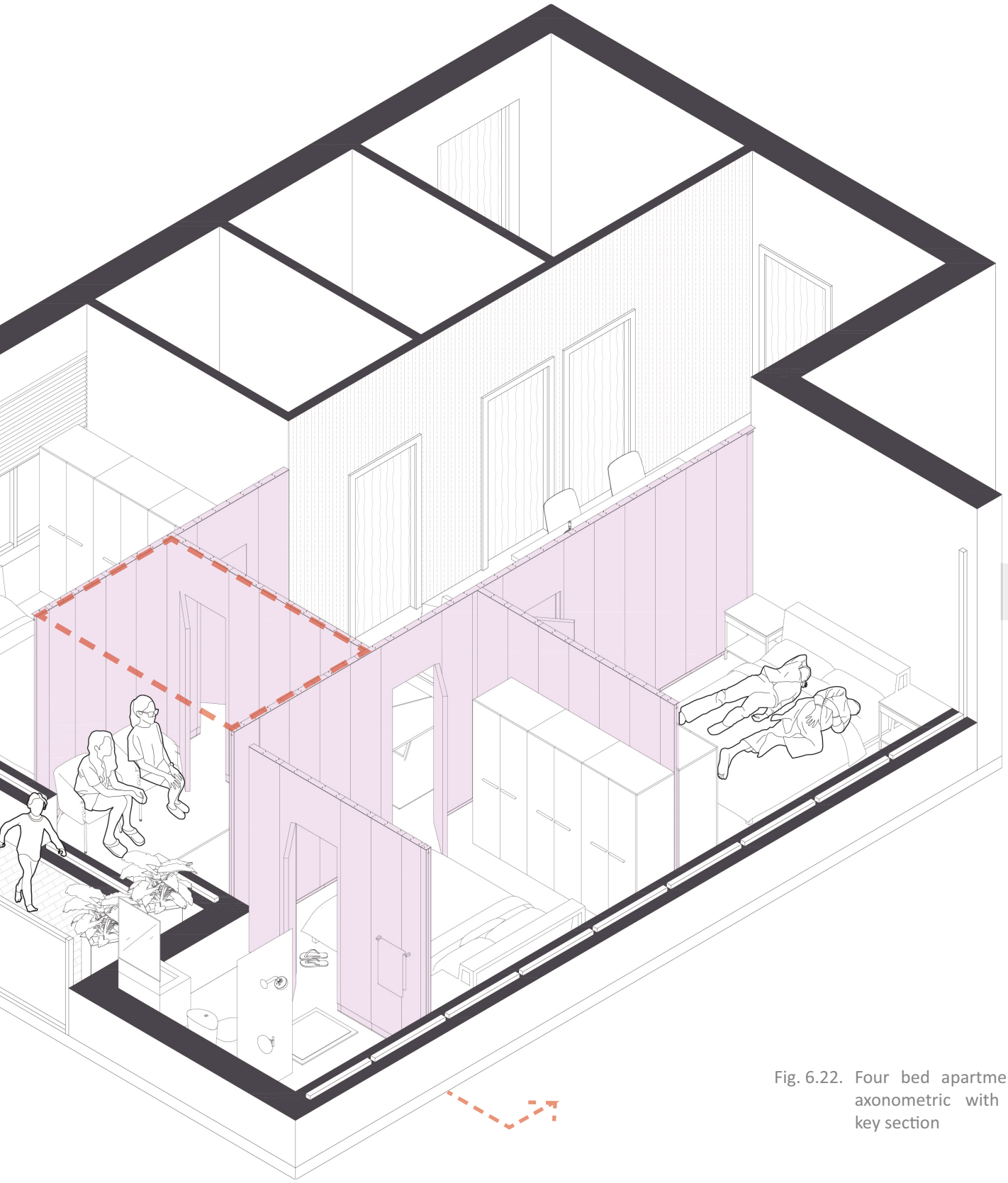
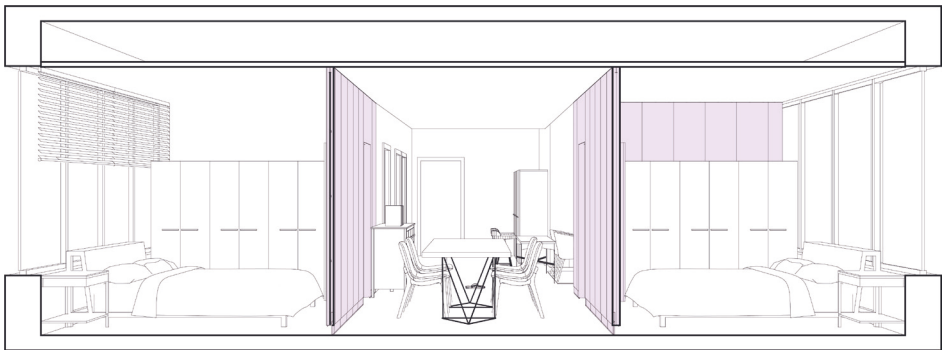
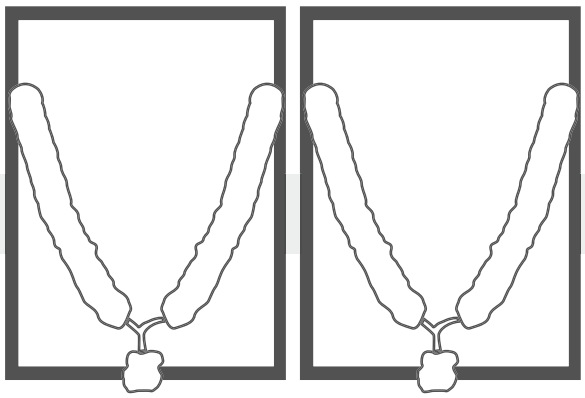


Fig. 6.22. Four bed apartment axonometric with a key section



2042



Can’t believe it has been over 2 years since they died. I miss them so much. I wish I could see them once again.

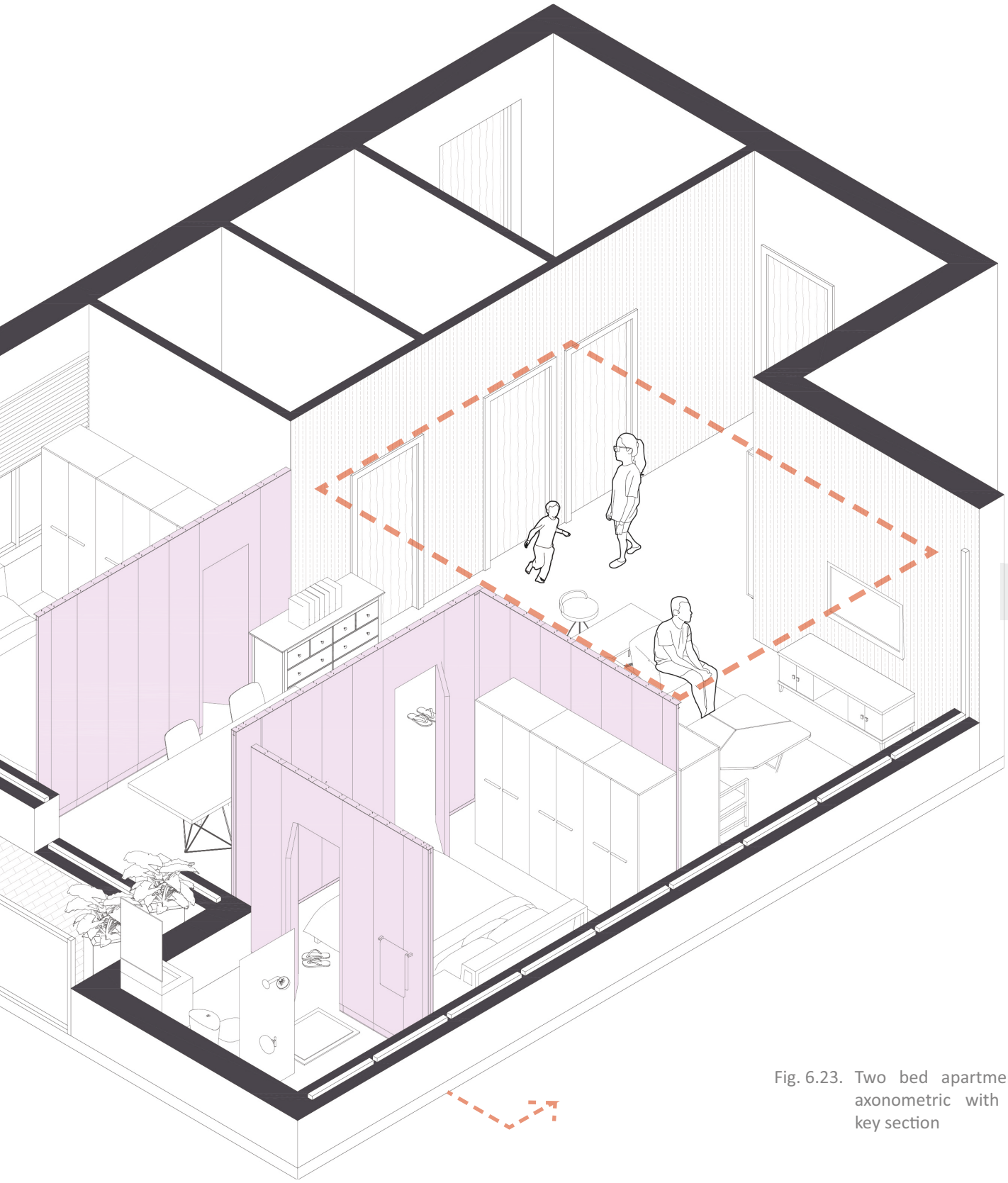
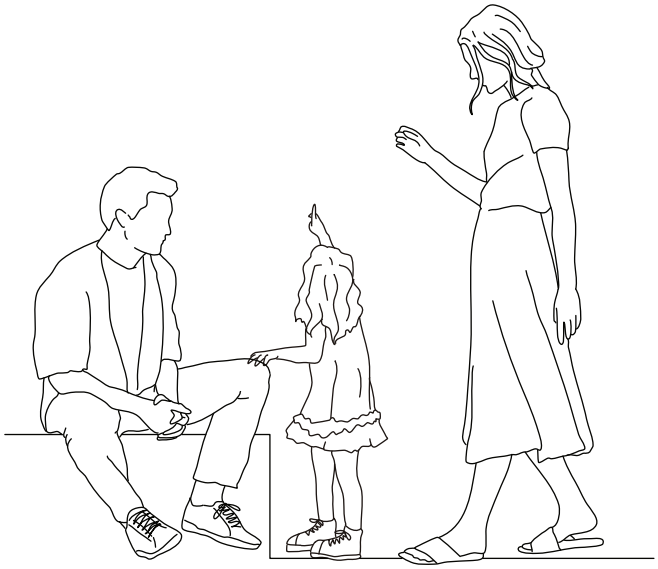


Fig. 6.23. Two bed apartment axonometric with a key section



COUPLE + A CHILD

A couple with a child live in their generational three bed apartment which their parents left for them.

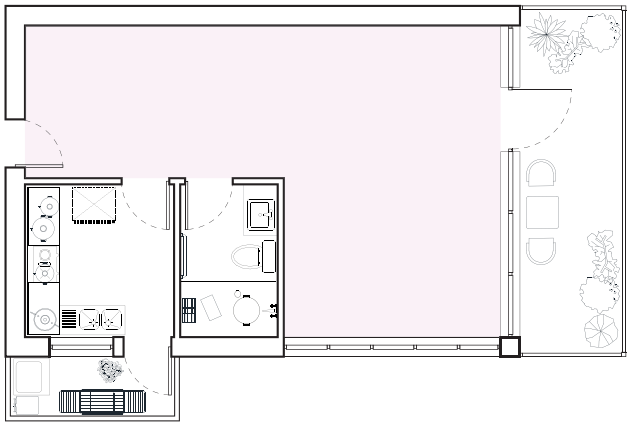
The apartment goes through eight different configurations over eleven different situations with a new family eventually taking over the generational apartment. By having an adaptable apartment, the family was able to live comfortably and change the apartments according to their needs which would not have been easily possible in the current rigid apartment system.

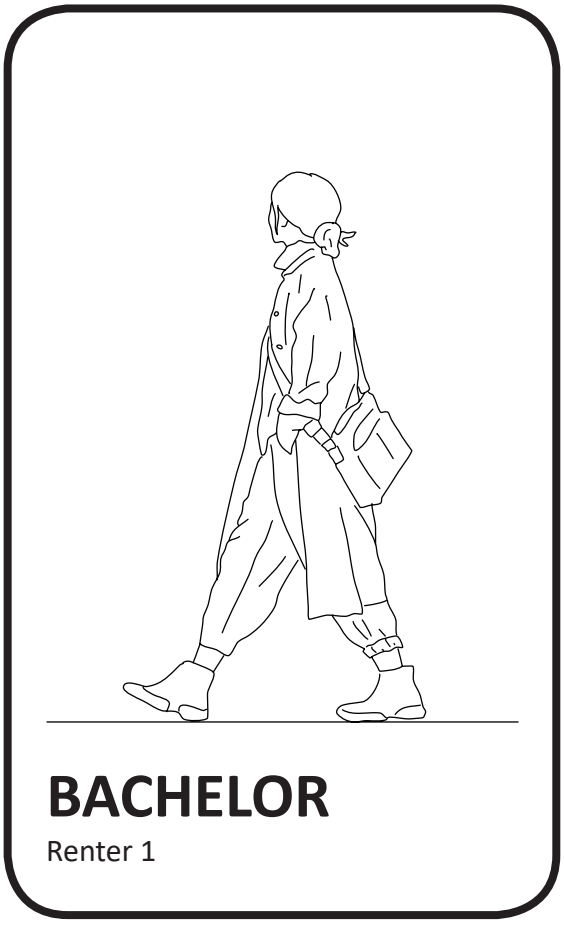
Fig. 6.24. Updated family persona of house no. 03
(Right)

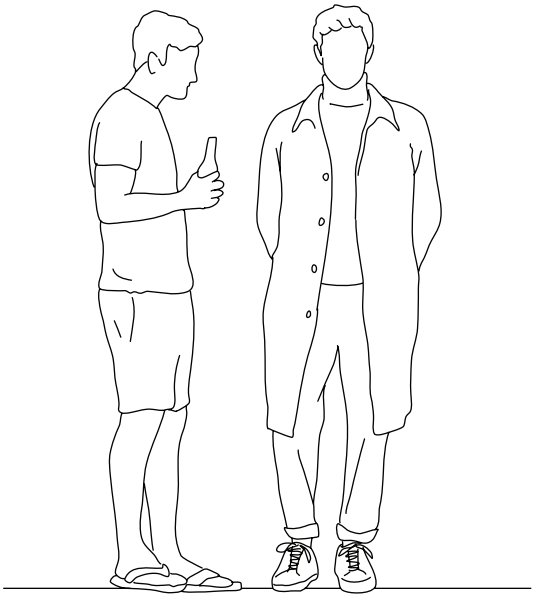
RENTAL POSSIBILITIES

The apartment can also be used to adapt to rental situations. By having an open plan, the owner of the apartment can easily change the configuration of the layout to suit the tenant and provide an apartment that works better according to the different people. This allows for the rental market to accommodate the different needs of the tenant while also providing an opportunity to the landlords to capture a larger market of tenants which otherwise would have been limited to the number of possibilities of the apartment layout. This is elaborated in the following section by creating three possible personas of tenants who might rent a one-bedroom apartment. In fig 6.25, we see the three types of people in their different life stages. The figures following it (fig 6.26 – fig 6.28) demonstrate how the same one-bedroom apartment can be changed for a bachelor, a couple, or new parents.

Fig. 6.25. Speculative family persona's of potential tenants in a one bedroom apartment

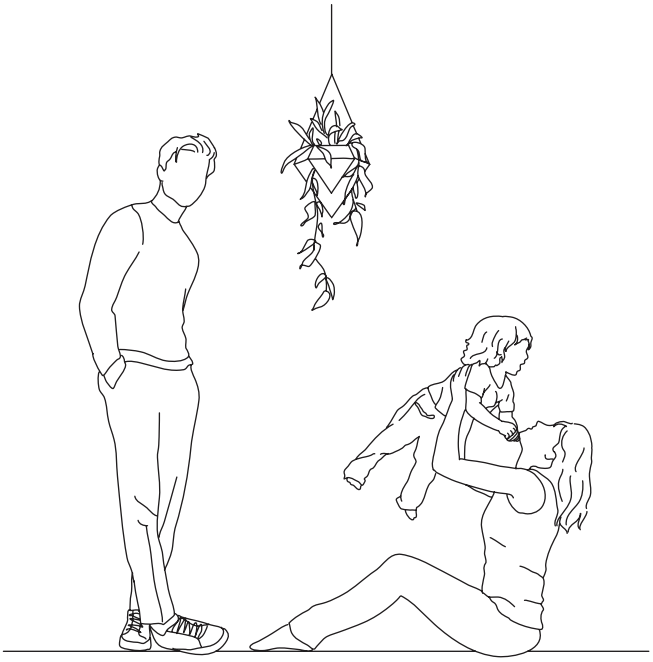






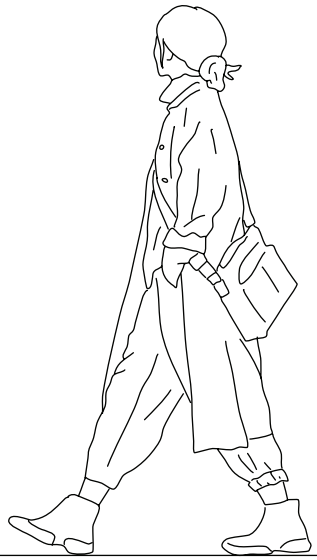
COUPLE

Renter 2



COUPLE + A NEWBORN

Renter 3

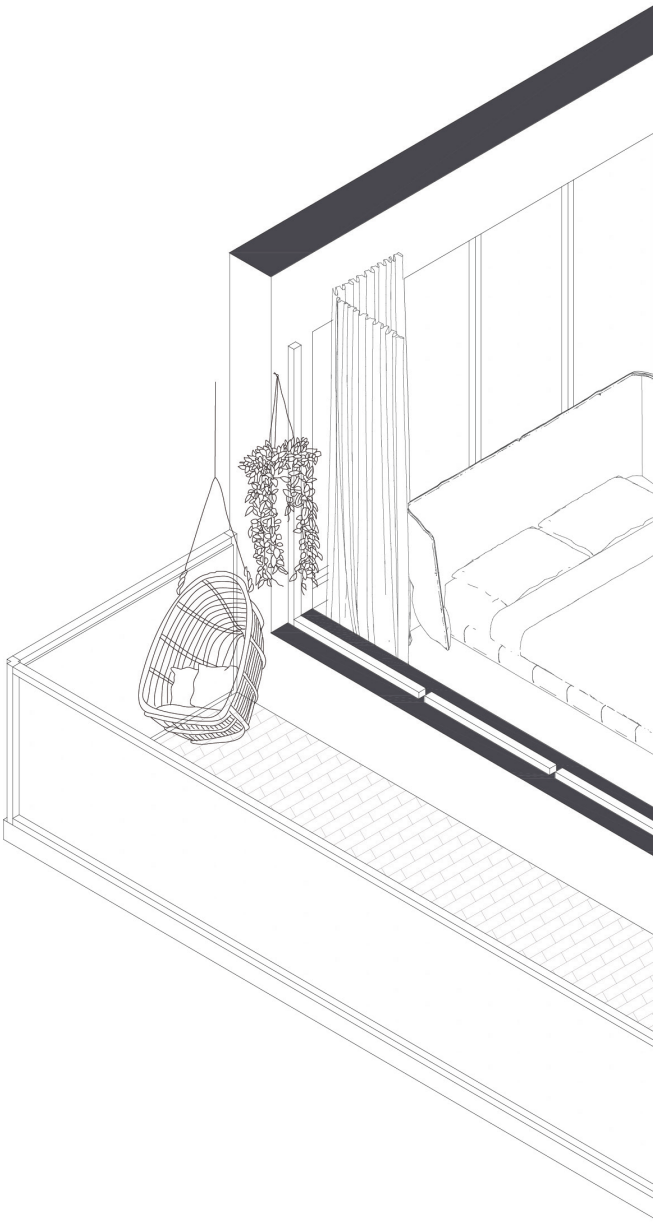


BACHELOR

A single student moves into a one bedroom apartment.

REQUIREMENTS:

1. Need an open space to have friends over and be able to do her daily workout.



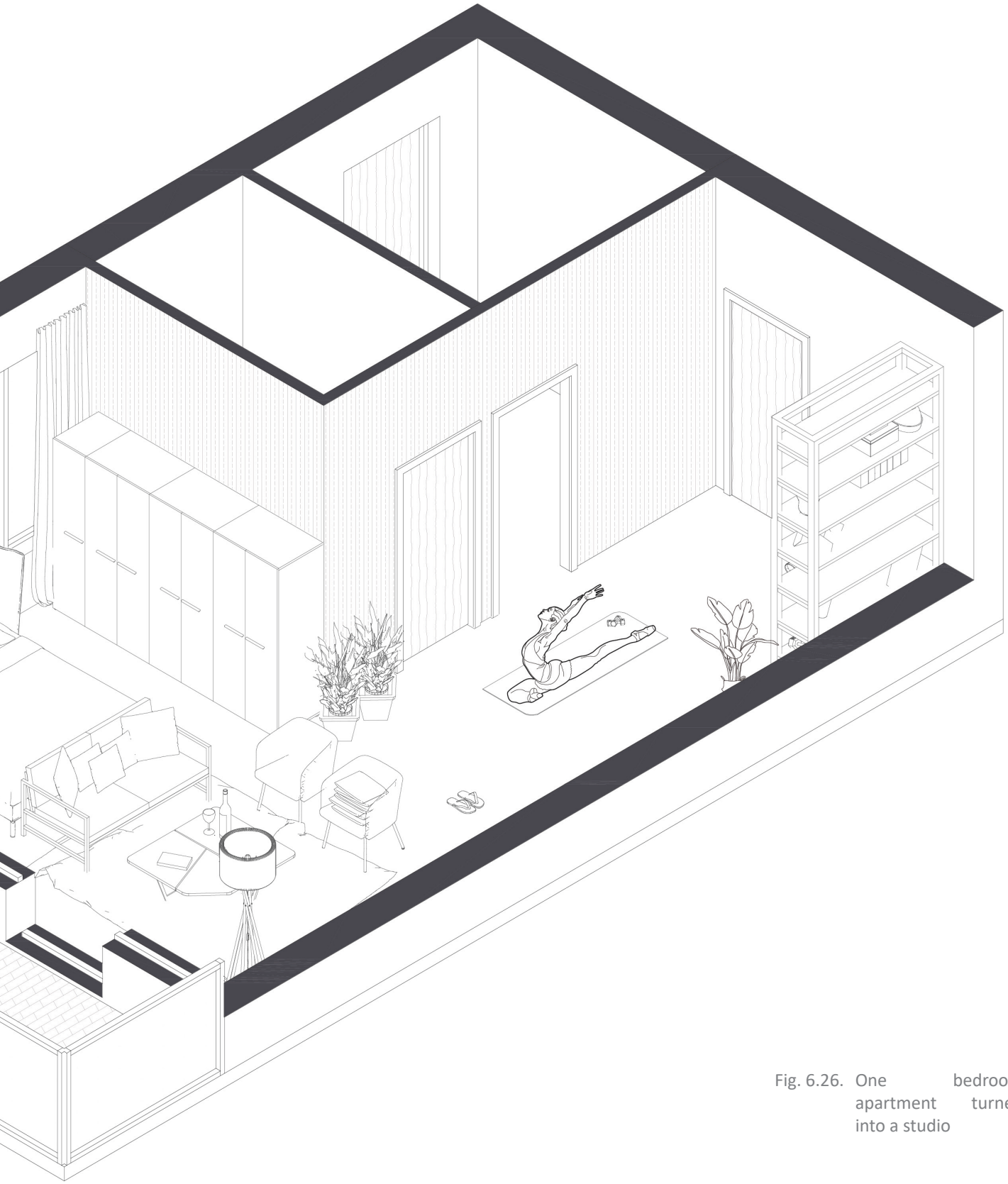
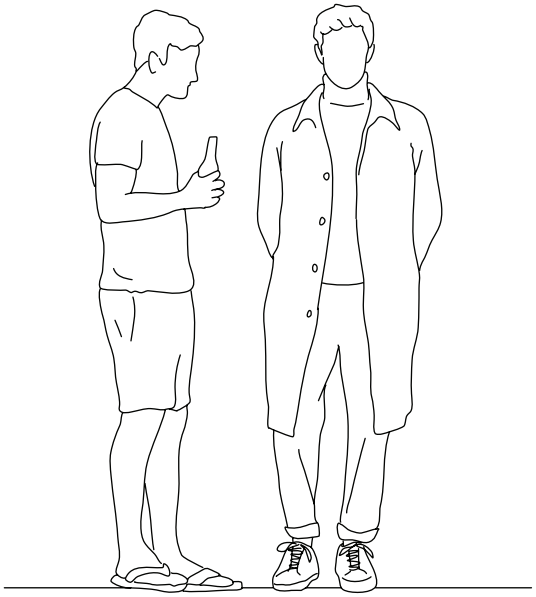


Fig. 6.26. One bedroom apartment turned into a studio



COUPLE

A couple move into a one bedroom apartment.

REQUIREMENTS:

1. Need space divisions to have some privacy.

2. Need a work-from-home setup.

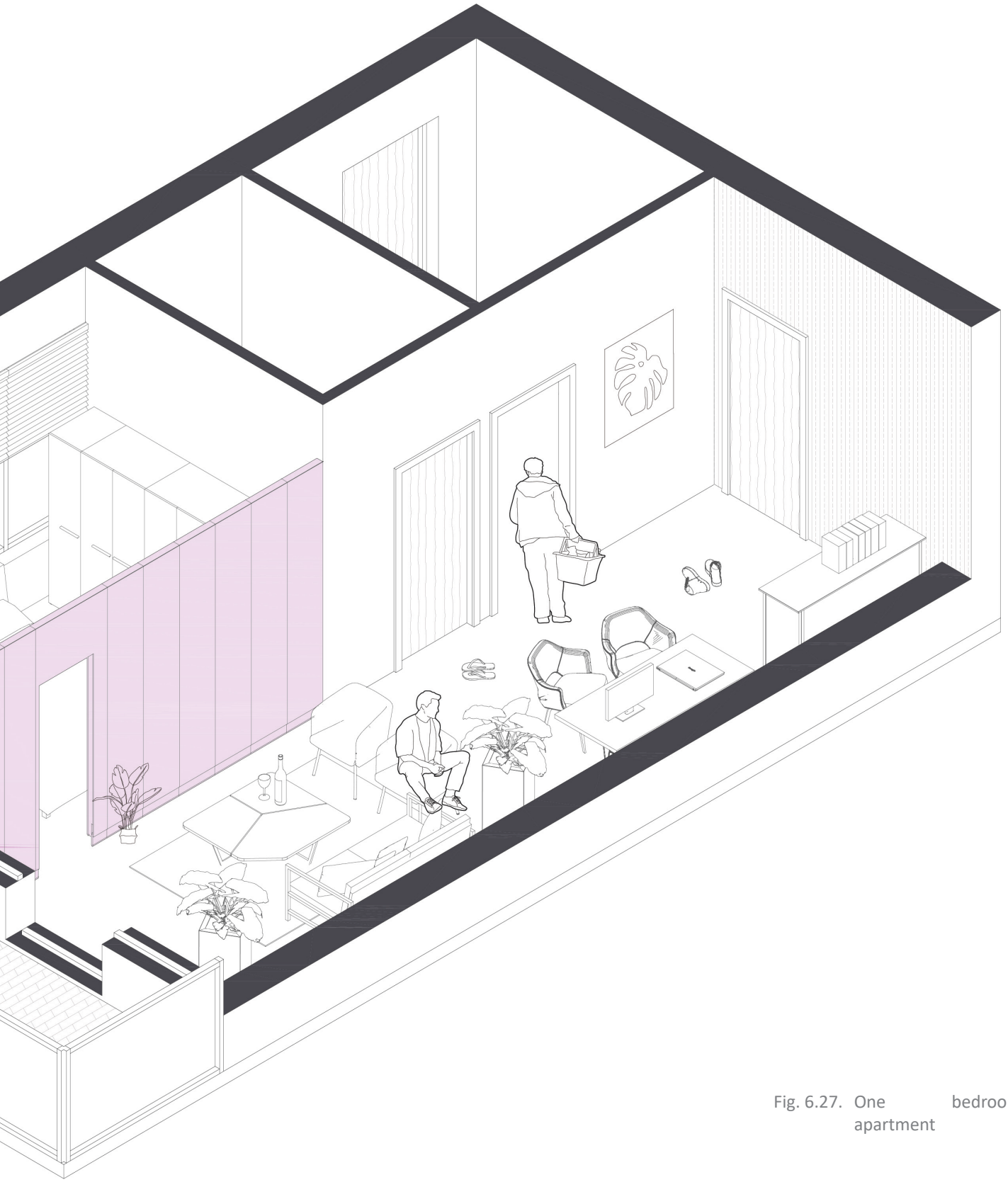
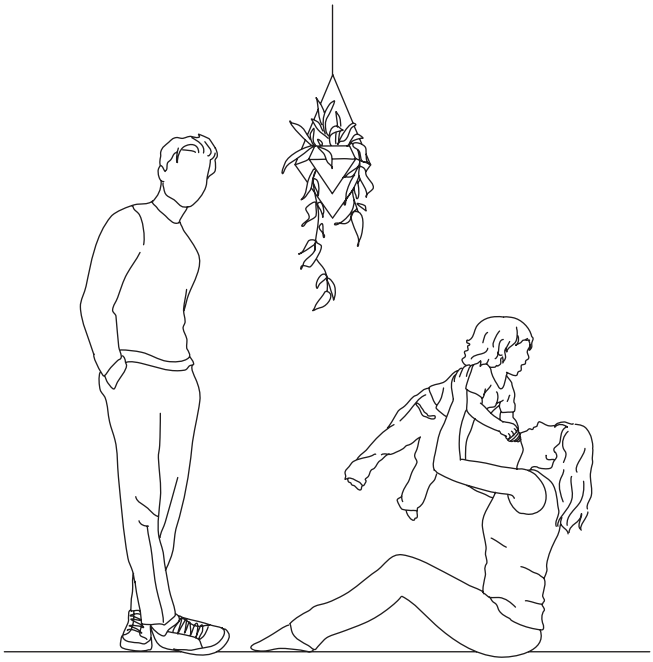


Fig. 6.27. One bedroom apartment

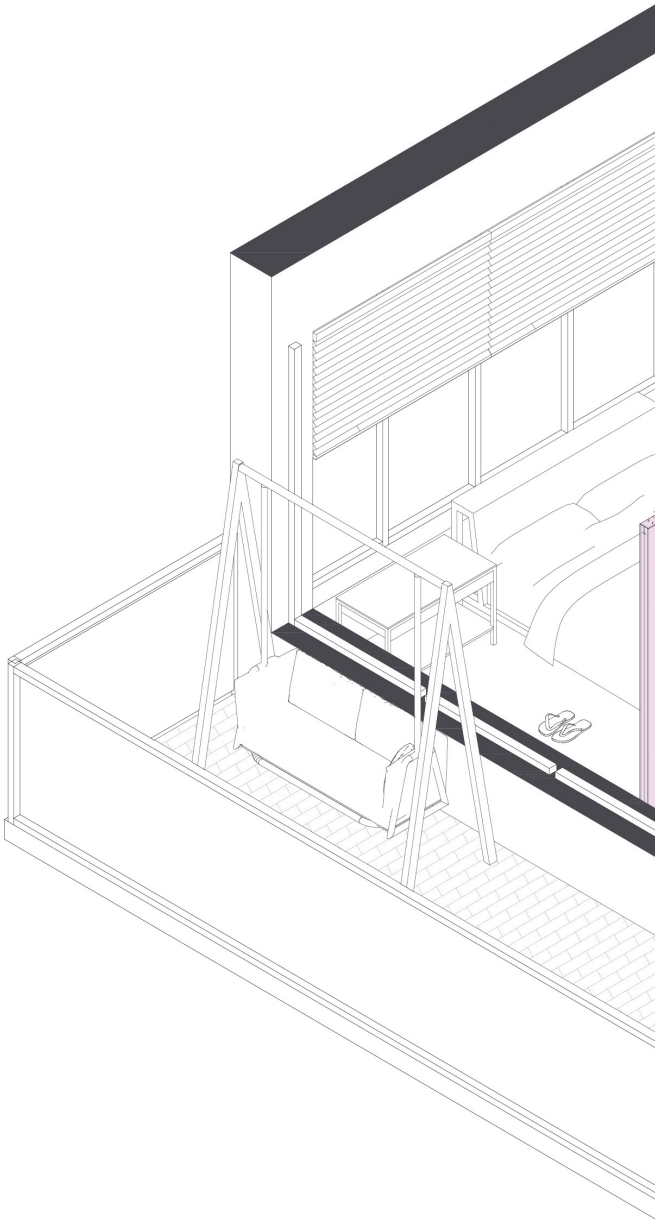


COUPLE + A NEWBORN

A couple with a newborn child move into a one bedroom apartment.

REQUIREMENTS:

1. Need a small space where the child can play without being continuously supervised and have his own space.



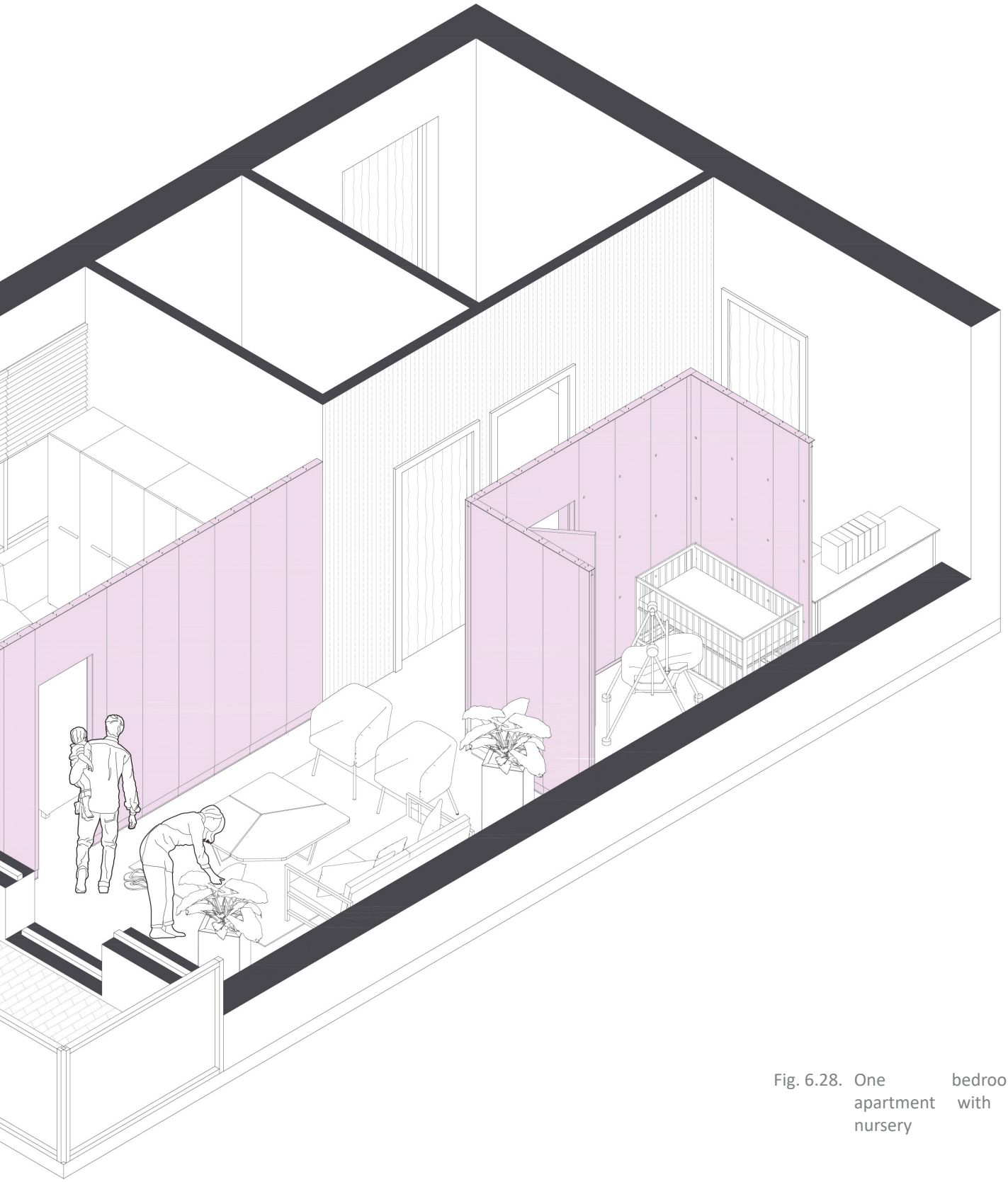


Fig. 6.28. One bedroom apartment with a nursery

Fig. 6.29. Speculative housing tower aggregation using design adaptable apartments (Right)

1. 3 Bed Apartment

2. Cluster of 2 Bed Apartments

3. Core

4. Cluster of 1 Bed Apartments

The adaptable apartment can benefit the whole housing market, be it for the residents who own or the residents who rent. The apartment design can be easily aggregated to form a tower, as shown in fig 6.29. The typology of tower selected to depict aggregation is the most common tower configuration present in Mumbai, as discussed in Chapter 04. The apartment can be combined in other tower typologies too. This gives an idea of how the tower would look and work with the adaptable apartment. The whole concept does not change the housing market drastically, only provides an opportunity to incorporate the users in the design and decision-making process.

CONCLUSION

The design intervention in the housing market of Mumbai benefits the residents in multiple ways. They are:

1. Possibility of Retrofitting – Any building currently constructed can be easily retrofitted to accommodate the adaptable system as the system itself is adjustable with minimal to no change to the building structure and working. This can be seen in fig. 6.30, where the studied precedent project Wadhwa Apartments is taken as an example and adaptable walls are incorporated to depict the possible layout options available. Moreover, the interior walls of the apartment are not load-bearing, so people generally renovate their apartments according to their needs. By incorporating the adaptable system, the need for renovation can be removed, and apartments can be easily retrofitted.

2. Easy space segregation – Indian families are typically large. By incorporating movable walls, it becomes easy to segregate spaces and create different layouts for different situations. Adding to this, in an Indian family, you typically have guests visiting and staying with you. Because of this, most homes tend to have a guest room dedicated for the occasional use. By having an adaptable layout, a space of the house does not need to be dedicated to the use and can be created when needed.

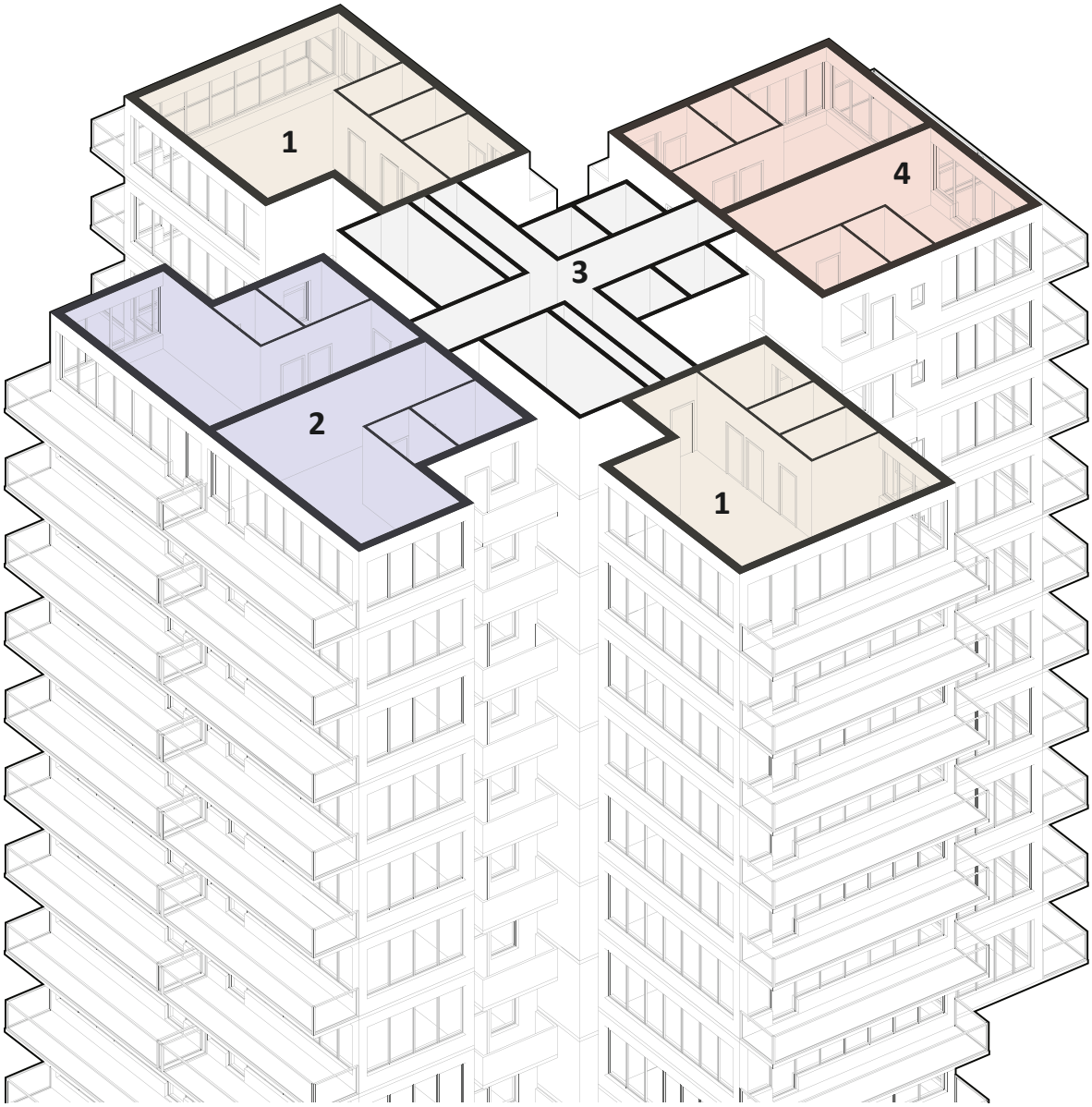

1
4
3
2
1

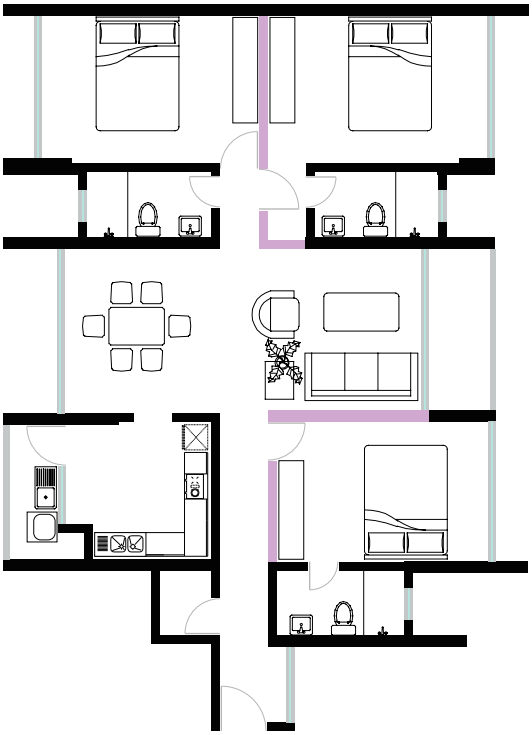
Fig. 6.30. Different layout possibilities in Wadhwa Apartments (Right)

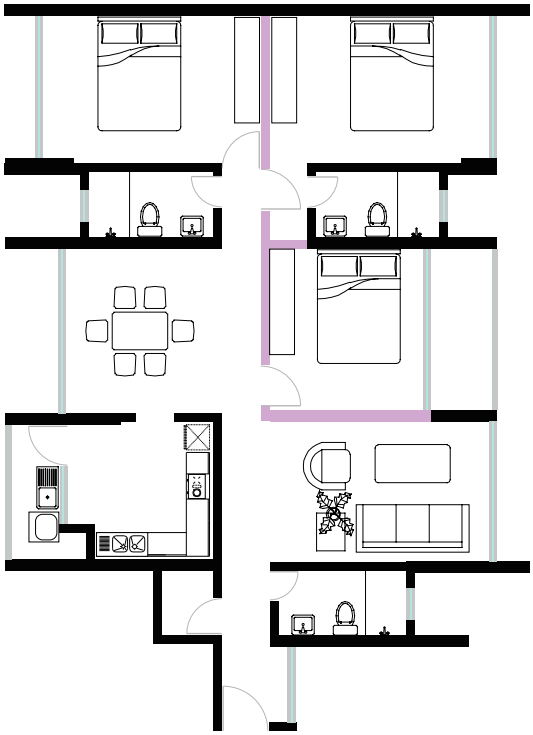
3. DIY process – The system designed is a DIY system that would not require any professional help and can be easily done by the user itself making the process cheaper and faster.

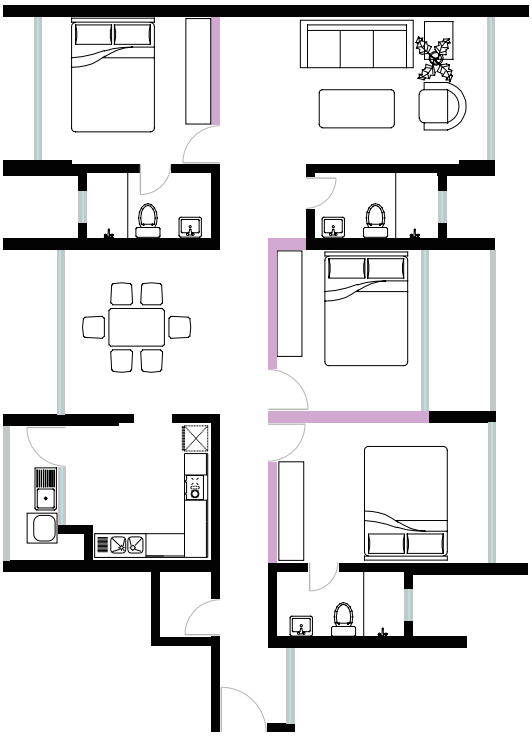
4. Increase in Users Agency – The users' agency and decision-making power are increased by controlling the spatial layout himself, without being dictated by someone else.

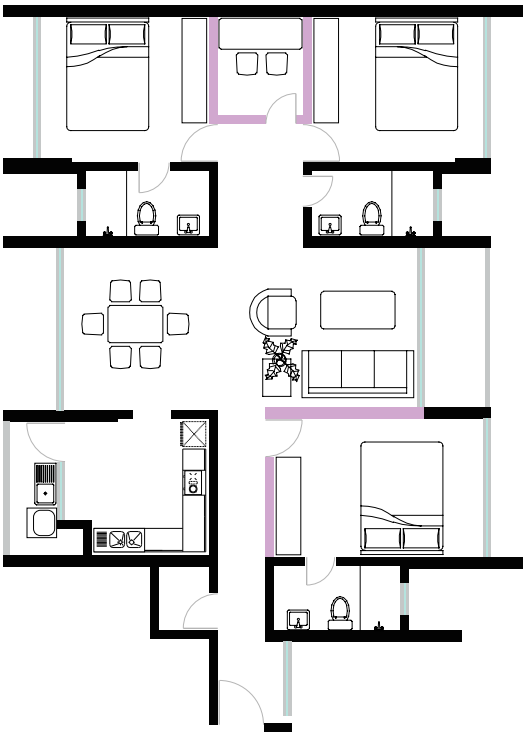
5. Job opportunities – The low-tech design provides job opportunities to multiple small industries, primarily based out of Dharavi, therefore enhancing the local economy, building resiliency, and uplifting the communities.

6. Adaptability in the supply chain – The existing manufacturing industry can adapt itself to accommodate the changes bought by introducing adaptability in design, as the whole industry is laid out to be adaptable to peoples changing needs. Due to the ease of the industry to adapt, the design is achievable without disrupting the supply chain. Thus, adaptability goes beyond the unit level.









CHAPTER 7 – IMPACTS OF ADAPTABILITY AND FUTURE POSSIBILITIES

IMPACTS

In the previous chapter, we see the impacts and advantages of applying the concept of time and allowing the residents to change their layout by following their life through different stages. By adopting time as a variable in the design of an apartment, we allow the residents to live comfortably, the city to adapt, and the environment to flourish. The impact of having an adaptable design in different aspects are as follows:

1. Social and Cultural Impacts

By introducing time and adaptability in an unaffordable city like Mumbai allows the residents to stay in place in the apartment they grew up in without compromising on their needs. By allowing people to grow old in the same neighborhood, the design fosters people to form connections with their neighbors and the place, which is a big part of the Indian culture. People are already reluctant to move away from home due to the familiarity and community they build. By having an adaptable apartment, they can stay in the same place comfortably and continue building relationships with the community. Apart from this, the residents also become part of the design process, which is not the case in a mass housing project. The design of the housing is predetermined by the people not residing in them. By giving the decision-making power to the residents, the residents can guide their living patterns and situations. This creates a relationship between the user and the architecture they inhabit by giving the user a chance to decide how they will occupy, move through, or dictate the space they are in.

2. Environmental Impacts

By allowing the building to change with time, the building stays

relevant over a longer period of time. It reduces the redundancy and makes the building last according to its material lifespan, instead of the currently present time-specific lifespan. This removes the unnecessary demolition of the buildings and conserves the resources spent, and mitigates the environmental impact of construction. Moreover, the materials spent on renovating the apartment by breaking and remaking a brick wall are conserved by having removable partitions which can be reused or recycled.

LIMITATIONS

Apart from the benefits of incorporating time and making the design adaptable, it does have a few limitations which need to be investigated to make the system more viable instead of creating problems. The limitations of the system are:

1. Cost – The cost of introducing time needs to be investigated. The whole system should not make an already unaffordable city, worse. Since the residents would potentially bear the cost of the system, the apartments should be affordable for people to adopt the idea of adaptability, instead of adaptability adding to the cost of the unaffordable apartment.

2. Size of the apartment – The size of the apartment plays an important role in adaptability. A smaller apartment would not be adaptable due to its limited area and thus limited opportunities for layouts. Research has to be done to design the apartment with optimal area to maximize the potential of adaptability without making the system and apartment costly.

3. Furniture – The furniture of the spaces also needs to be multifunctional to allow adaptability. If the furniture is static, the opportunities for changing the layouts are limited. Therefore, the furniture needs to accommodate time and multifunctionality as well to make the whole apartment work efficiently.

Fig. 7.01. Current time resistant architecture (Top Right)

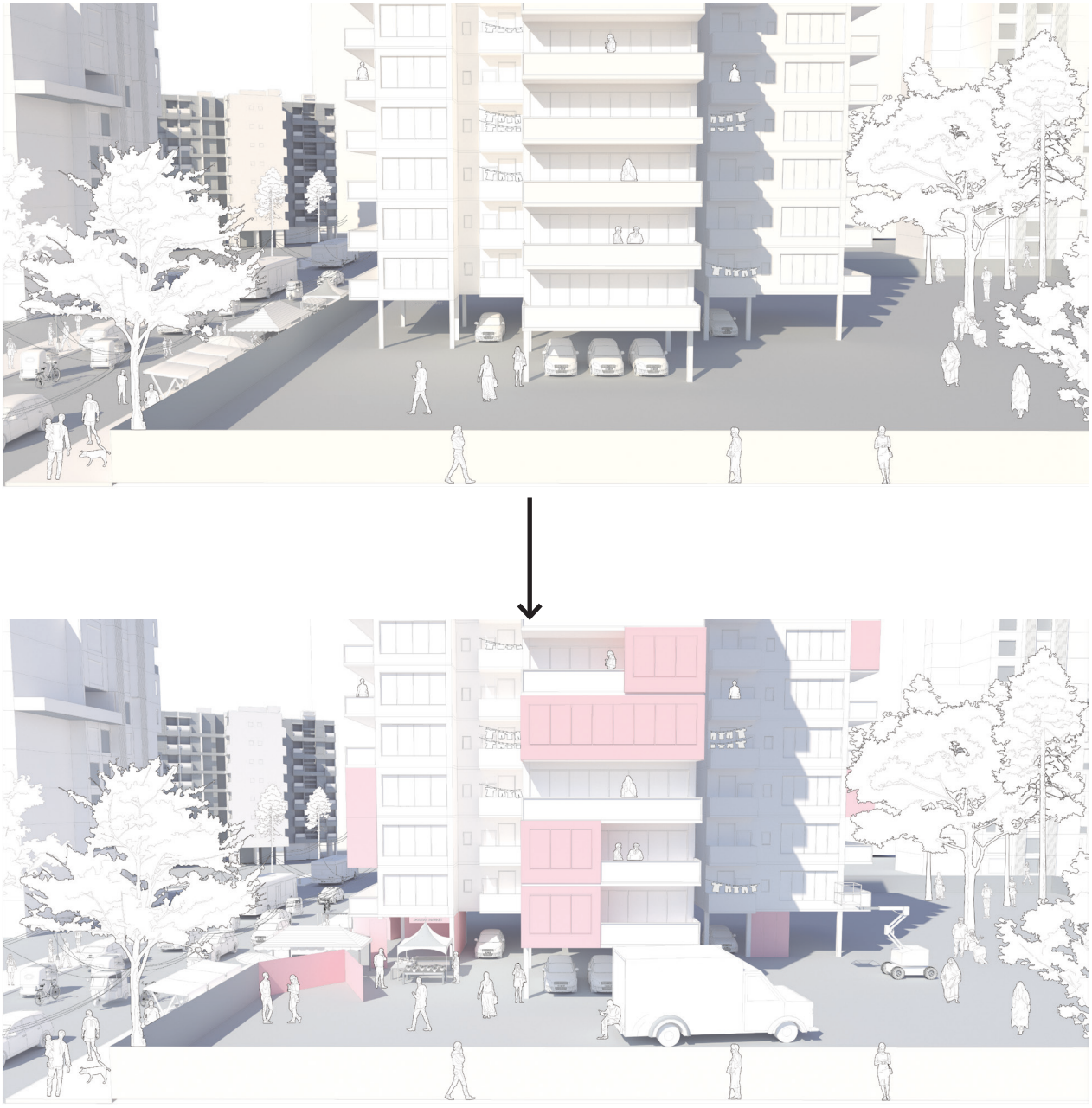
Fig. 7.02. Potential time resilient architecture (Bottom Right)

FUTURE POSSIBILITIES

The thesis discusses the possibility of introducing time and applies it in the context of an individual apartment. Moving forward, the next question can be investigating the possibility of introducing time at the tower level to adapt to change in function, site level to accommodate multifunctionality, or the city to allow kinetic movement. By expanding the concept, we can allow small businesses to pop up when needed, have temporary space for weekend markets and carnivals, and allow community interaction. By making the boundaries flexible rather than rigid and allow the design to be responsive to time and changing requirements, could we allow the residents to live comfortably in the city and provide a place for the kinetic city to flourish within the static framework?

Adding to this, at the unit level itself, adaptability can be investigated in terms of introducing multifunctional furniture in the design of the panel. Since most of the furniture is custom made in India, introducing multifunctionality in the panels itself to incorporate furniture within it could be possible. With that, designing a new set of furniture to adapt to changing space layout and allow the space to be used in different ways is also an opportunity to introduce a more holistic approach to adaptability.

By adapting to time, we can reduce unnecessary demolition and construction happening which is adding to the ongoing climate crises.



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APPENDIX

INTERVIEW QUESTIONNAIRE

Question 1: How many rooms do you have in your apartment?

Question 2: How many people live with you in the apartment?

Question 3: Can you tell me the age and occupation of all the members?

Question 4: How long have you been living here?

Question 5: Would you happen to know the square feet of your apartment?

Question 6: Is it a rental or do you own it?

Question 7: Have you changed anything in the apartment from the time you moved in?

Question 8: How has the space usage of your apartment changed over the years? Have children moved out? Has someone moved in?

Question 9: Does you apartment fulfill all your needs?

Question 10: What do you wish to change in your apartment?

Question 11: How long do you plan to stay here?

Question 12: If the apartment fulfilled your needs, would you still prefer shifting to new and different apartments and places or would you prefer staying in the same apartment for the long term?

Question 13: Is there anything you would like to tell me apart from all these questions about the issues you face from your apartment layout?