

# PBL South Asia

**Mumbai Workshop for faculty and advanced students**

**IIT Bombay/ Mumbai, India**

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## Modular Housing Scheme for Bhiwandi Locality



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## Prof. Venkata Santosh Kumar Delhi – Team Mentor

	Expertise in terms of Modular Housing	Background
<b>Fabio</b>	Flexibility for long-term usage, Recycling materials	Architecture
<b>Kishor</b>	Affordability, repeatability, scalability	Civil Engineering
<b>Laura</b>	Ventilation	Building Services Engineering
<b>Paridhi</b>	Product Design & Liveability	Mechanical Engineering
<b>Pravakar</b>	Climate change, Adaptation and Mitigation	Environment and Climate Change
<b>Rosa</b>	Urban scale: Social aspect & Culture	Urban Design
<b>Sudeep</b>	Locality and its impact in modular design	Civil Engineering
<b>Thrinley</b>	Energy Efficiency, Materials	Electrical Engineering

How to provide **affordable** and **modular**  
**housing** in Bhiwandi?





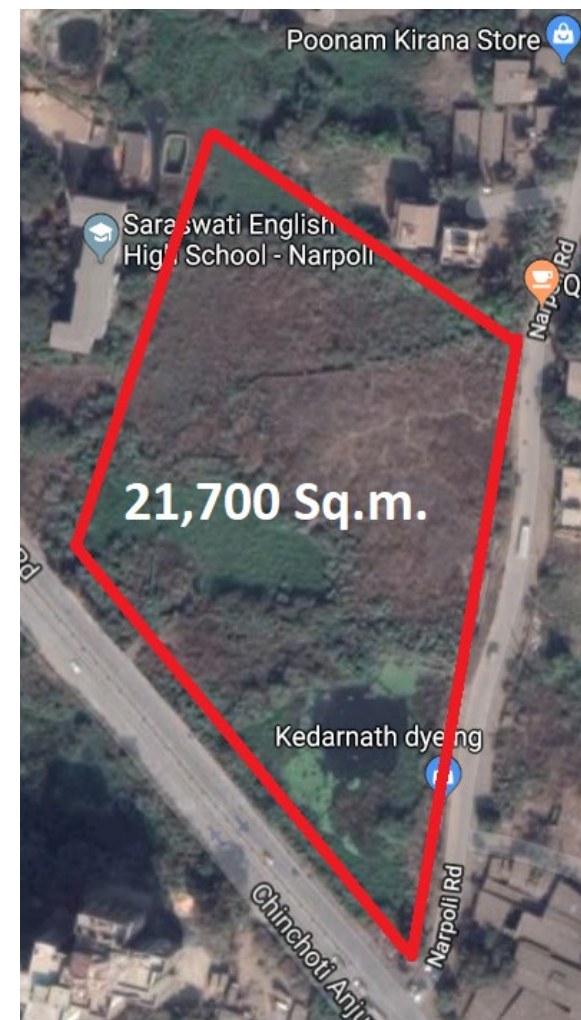
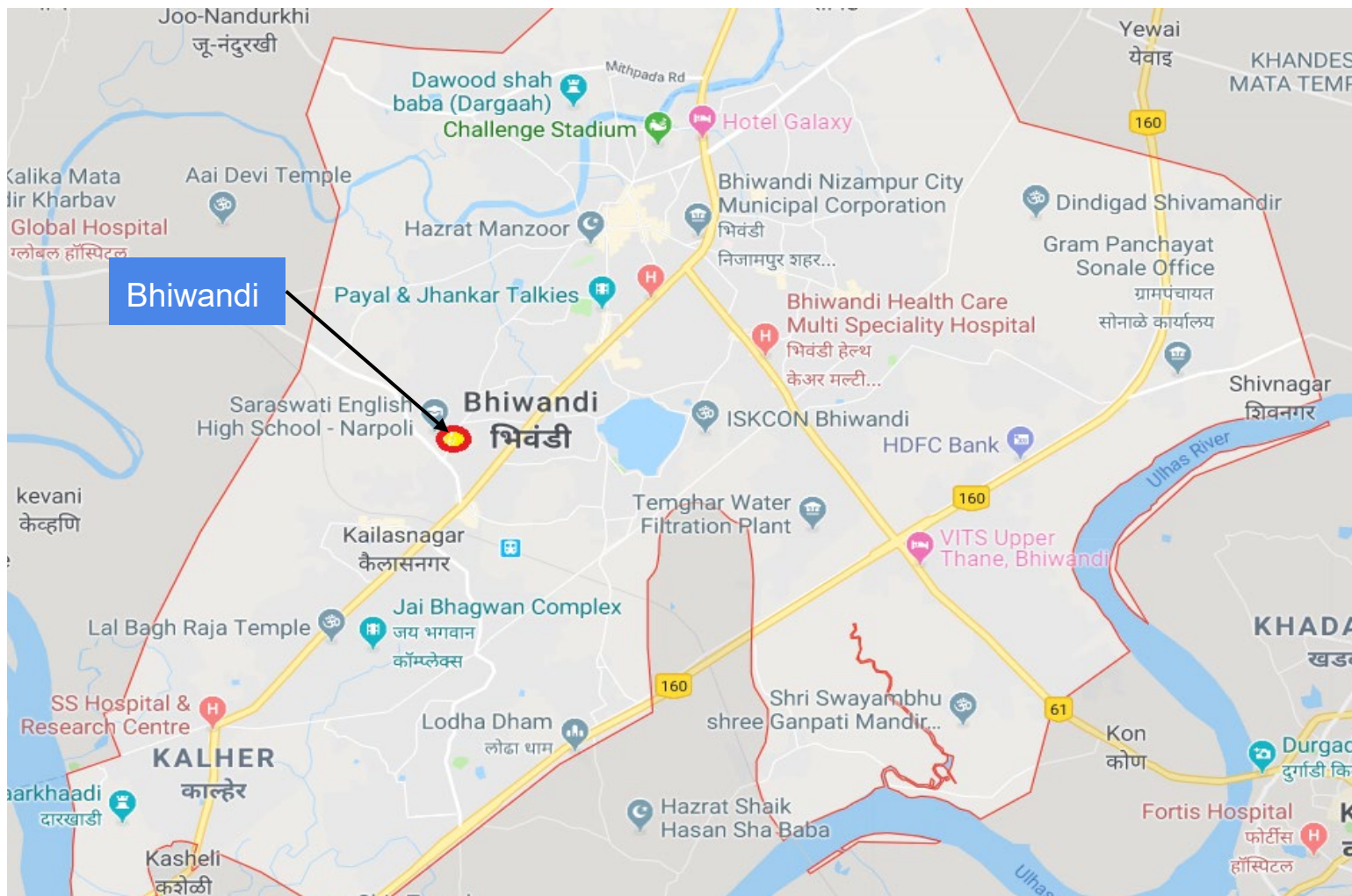
South Asia

# System Boundary





# Site Location in Bhiwandi

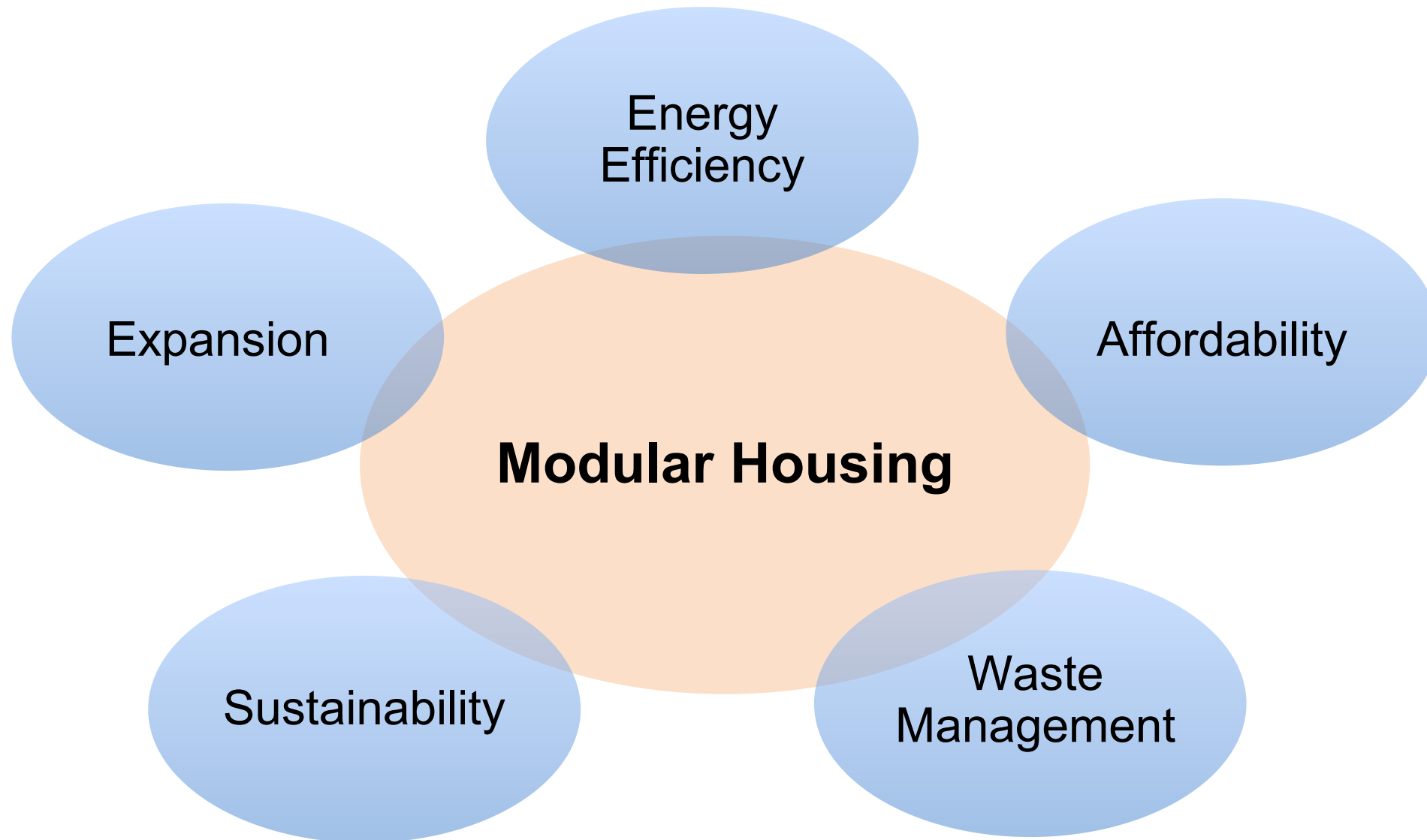




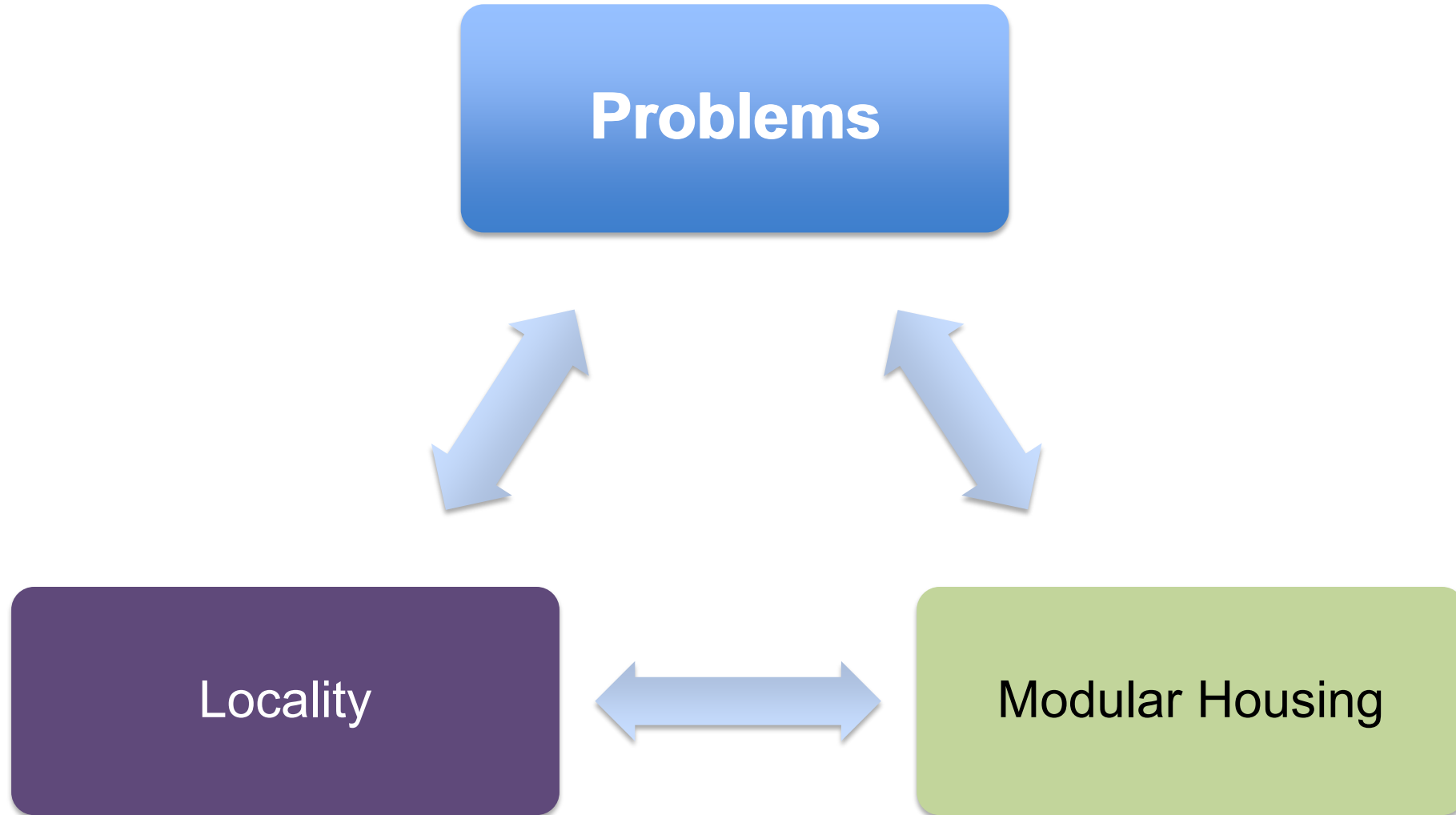
# Initial Discussions



# Our Pointers for Modular Housing







# List of probable problems for **locality**

from our perspective

1. **Accommodating** low income group
2. Risk of **flooding** in monsoon
3. **Adaptation** capacity
4. Risk of **high temperature and humidity**
5. Scarcity of pure **drinking water**
6. Improper **waste management** system
7. Ground/land **stratas**
8. Availability of **space** for construction
9. Risk of **earthquakes**

# List of probable problems for **modular housing**

from our perspective

## Aspects we considered for problem identification

1. Environmental sustainability



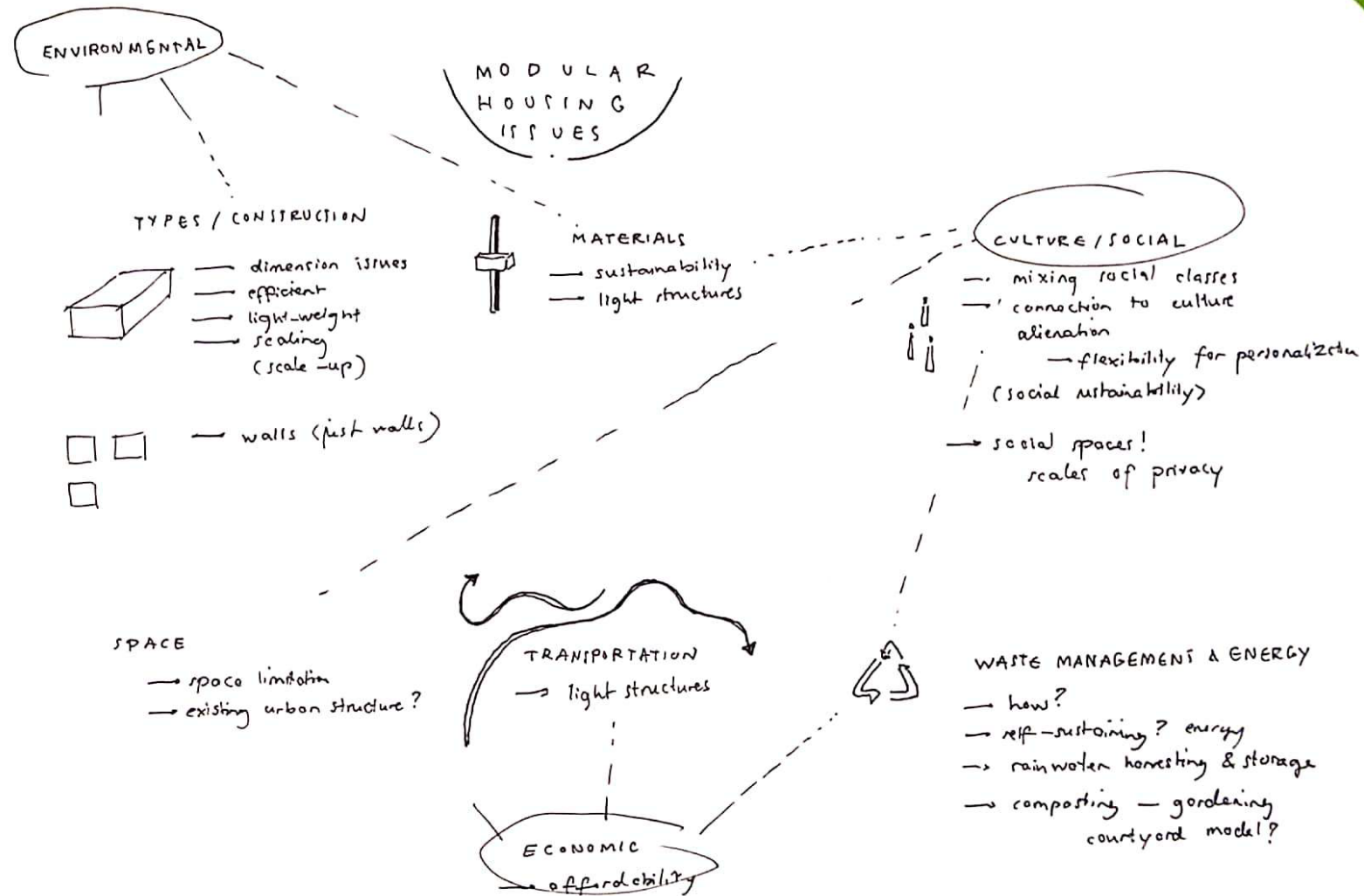
1. Socio-cultural adaptation



1. Economic feasibility



# List of probable problems for modular housing





# Preliminary list of **Requirements**

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1. **Need low cost** rental/own housing
2. Modular system should withstand flooding
3. Modular system **should withstand high temperature and humidity**
4. Need provision for pure **drinking water**
5. It should inhibit **waste management** system
6. It should facilitate construction **in different ground stratas**
7. It should withstand **mild to severe earthquakes**
8. Modules should be **scalable**
9. Modules should be **lightweight to facilitate transportation**

# Preliminary list of **Requirements**

- 10. Should **facilitate expansion** in future
- 11. **Materials and construction** process should be **sustainable**
- 12. Modular system should **encourage socio-cultural interaction**
- 13. Should **provide flexibility** for personalisation











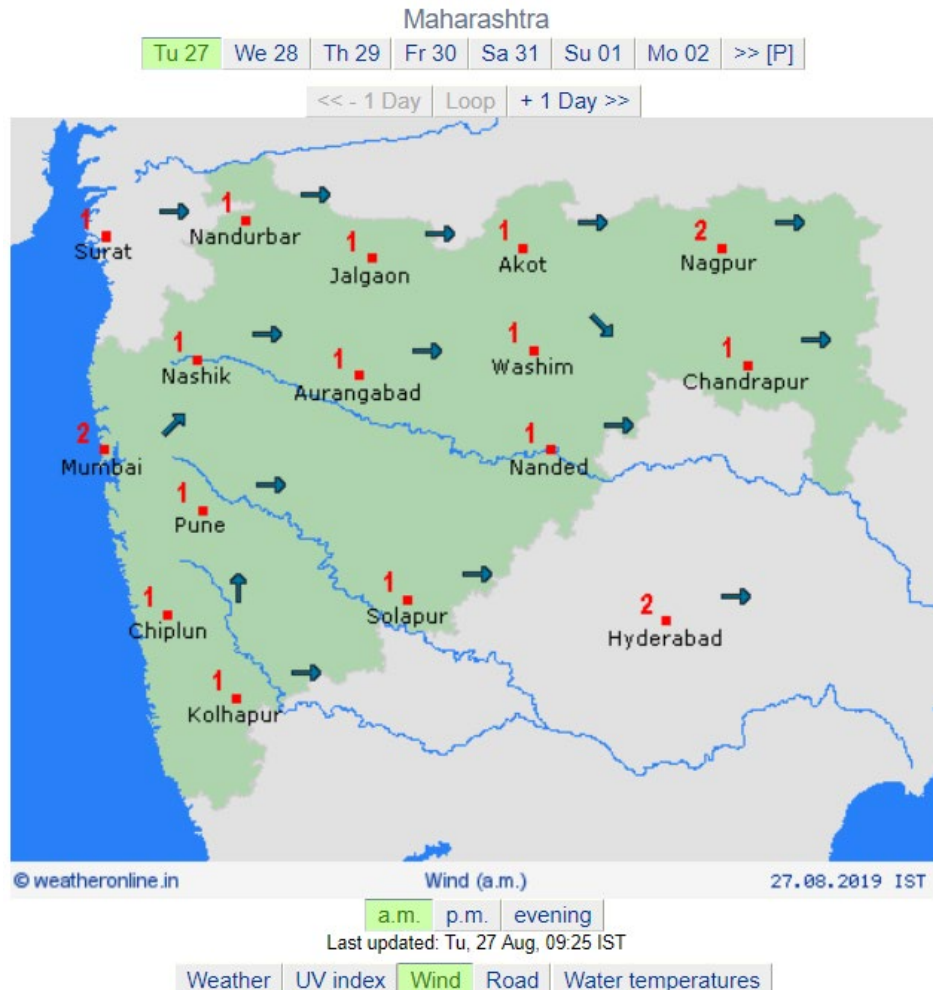
# Climate Data for Bhiwandi

Climate data for Bhiwandi							
Month	Jan	Feb	Mar	Apr	May	Jun	Jul
Record high °C (°F)	34.4 (93.9)	35.3 (95.5)	37.6 (99.7)	39.5 (103.1)	42.8 (109.0)	39.6 (103.3)	33.5 (92.3)
Average high °C (°F)	29.2 (84.6)	30.5 (86.9)	32.4 (90.3)	34.2 (93.6)	34.4 (93.9)	31.2 (88.2)	29.1 (84.4)
Average low °C (°F)	15.1 (59.2)	16.5 (61.7)	19.5 (67.1)	22.7 (72.9)	25.2 (77.4)	25.1 (77.2)	24.2 (75.6)
Record low °C (°F)	6.7 (44.1)	8.3 (46.9)	16.5 (61.7)	18.6 (65.5)	20.2 (68.4)	21.1 (70.0)	19.6 (67.3)
Average rainfall mm (inches)	3.6 (0.14)	1.0 (0.04)	1.3 (0.05)	2.0 (0.08)	21.3 (0.84)	502.4 (19.78)	1,015.7 (39.99)
Average rainy days	0	0	0	0	1	14	31
Mean monthly sunshine hours	269.4	259.3	272.9	286.4	295.6	143.3	73.2

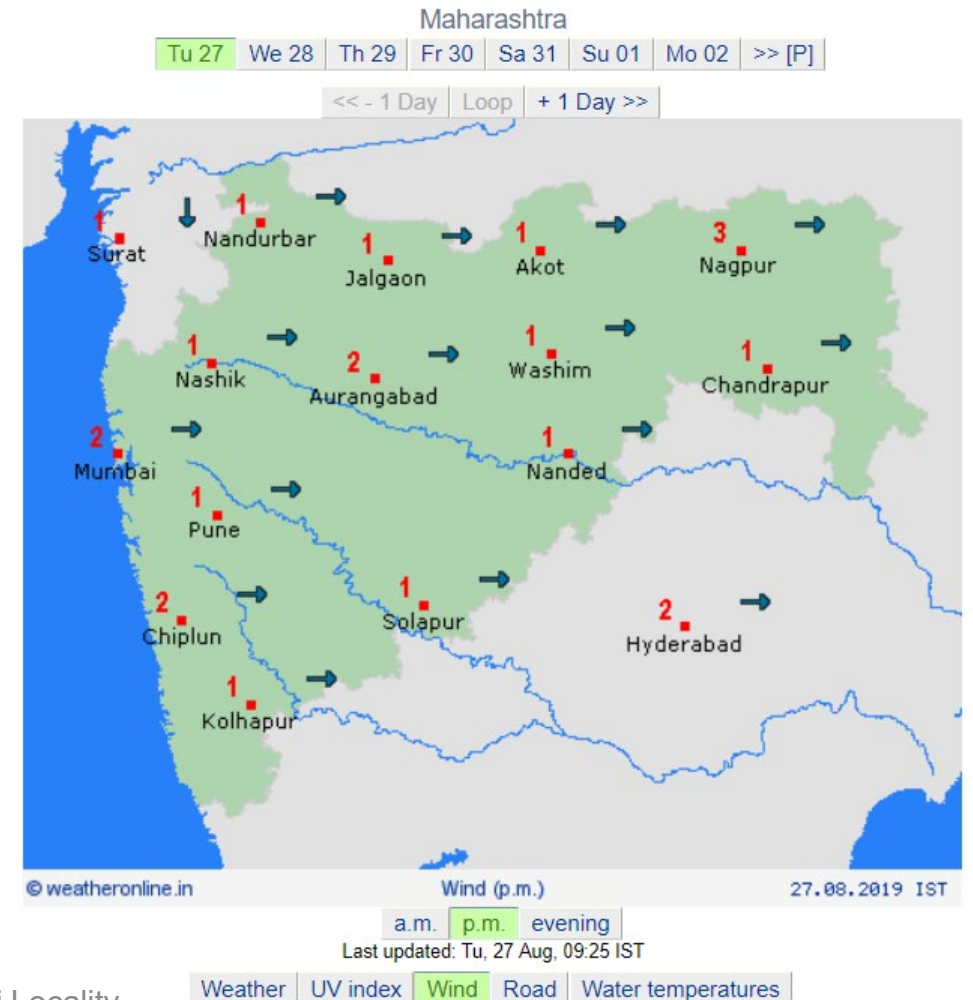
Month	Aug	Sep	Oct	Nov	Dec	Year
Record high °C (°F)	33.2 (91.8)	34.5 (94.1)	37.6 (99.7)	36.7 (98.1)	34.5 (94.1)	42.8 (109.0)
Average high °C (°F)	28.6 (83.5)	29.4 (84.9)	33.3 (91.9)	32.4 (90.3)	31.2 (88.2)	31.3 (88.3)
Average low °C (°F)	23.7 (74.7)	22.8 (73.0)	22.3 (72.1)	19.4 (66.9)	16.3 (61.3)	-1.1 (30.0)
Record low °C (°F)	18.9 (66.0)	19.2 (66.6)	18.6 (65.5)	16.5 (61.7)	12.4 (54.3)	6.7 (44.1)
Average rainfall mm (inches)	584.2 (23.00)	336.3 (13.24)	95.3 (3.75)	12.9 (0.51)	2.0 (0.08)	2,578 (101.5)
Average rainy days	24	15	6	1	0	92
Mean monthly sunshine hours	71.2	157.5	234.5	245.6	254.2	2,563.1

# Wind Flow Pattern in Bhiwandi

## Forenoon



## Afternoon



- **Local population:** 0.7 million (2011 Census)
- **Nature of Industry:** Textile
- **Labour**
  - Low income: (80% migrated)
- **Average labour income:** Rs. 400 to 500 per day

*(Source: India Today, June 29, 2018)*

## Design/structures

1. Fixed frameworks - but can also be assembled in different ways
2. Modularity created through walls and the division of different spaces
3. Room for personalization through modularity etc.
4. Modular connectivity - designed connections
5. Built on open spaces/demolition sites

## Environment & energy

1. Space for green - both for public/open/cultural spaces & water retention
2. Flood resilience through leveling from street level
3. Includes some net-zero energy concepts (self-sustaining?)
4. Waste management is taken care of

## Affordability

1. Affordability through efficiency, pre-fabrication, mass production and light-weight, sustainable materials



## Respondent's Background Information

- Collecting general information related to respondent and family background.

## Social aspect

- How long have they/their family stayed there?
- Why do they live here/where from did they come, if from outside Bhiwandi?
- Does Bhiwandi meet their expectations?
- What works - what do they like?
- What doesn't - what should be improved?
- Does it feel safe? Comfortable? Enjoyable? If so, what qualities make it so?
- What would they want if they moved to a new home? Ask both about home and surroundings (indoor and outdoor qualities)
- How do they understand modular housing? (Perhaps not a necessary question)

## Environmental aspect

- What kind of annual environmental changes take place?  
How do they adapt to them?
- How does water management work?
- What about waste management?

## Economic aspect

- Is it affordable to live here?



# Bhiwandi Field Visit





# Bhiwandi Field Visit





# Interview Summary

- Flooding Issue – Low
- Wind Direction – West to East
- Electricity – Rs. 12,000 / Month
- Solar for electricity generation – No
- Rain water harvesting – No
- Modular housing will not work
- Solar water heater

- Modular housing will work, if it would offer spacious and affordable rental housing
- **Currently, living in 1 room only, where labors cook and sleep, 3 labor/ room – Rs. 1800/month. (Rs. 1500 (Room Rent) + Rs. 300 (Electricity Charge))= Rs. 1800/3 labor.... Rs. 600/Person/Month**
- No proper ventilation in room.
- 1RK and 1BHK would be the best option.

- Modular housing will work, if it would offer **spacious and affordable** rental housing
- 80% people from outside
- 1Rk would be a good option
- Drainage and solid waste management is poor

- Instead of salable component **focus on rental homes.**
- **1RK and 1 BHK are in demand**
- 1RK – 300 to 350 sq. ft. – Rs. 3000/month
- 1BHK – 500 to 550 Sq. ft. – Rs. 4500/month
- New flat rate – Rs. 3000 to 3500 sq. ft.
- Solid waste management – No
- Modular housing will not work



**Woman, 25**  
**Textile industry worker**

From a nearby rural area

Low-income, illiterate

Wants to live in Bhiwandi for max. 3 years to earn money and spend as little as possible

Needs a very cheap place to stay for rent - can share a room, but only with other women

Wants to receive guests and friends while in Bhiwandi



**Man, 55**  
**Local school teacher**

Wants to live close to work because of the traffic

Married with no kids

Middle-income, literate

Wife works in the same school

Would like a spacious apartment with opportunities to modify his home

Likes to play music



**Woman, 58**  
**Housewife, husband died 5 years ago**

1 child who is not married and lives with her, works in a nearby factory and dropped out of studies

Has respiratory issues



**Man, 19**  
**Just came to Bhiwandi from Uttarpradesh**

Is looking for opportunities to earn

An acquaintance from his village lured him to come to Mumbai region



**Man, 40**  
**Textile industry worker, for the last 20 years**

Low-income and illiterate

Married, two kids

Family lives further away, but he would like to bring the family to Bhiwandi

Wants to rent a bigger place to stay in case family joins

# Redefining Problem Statement

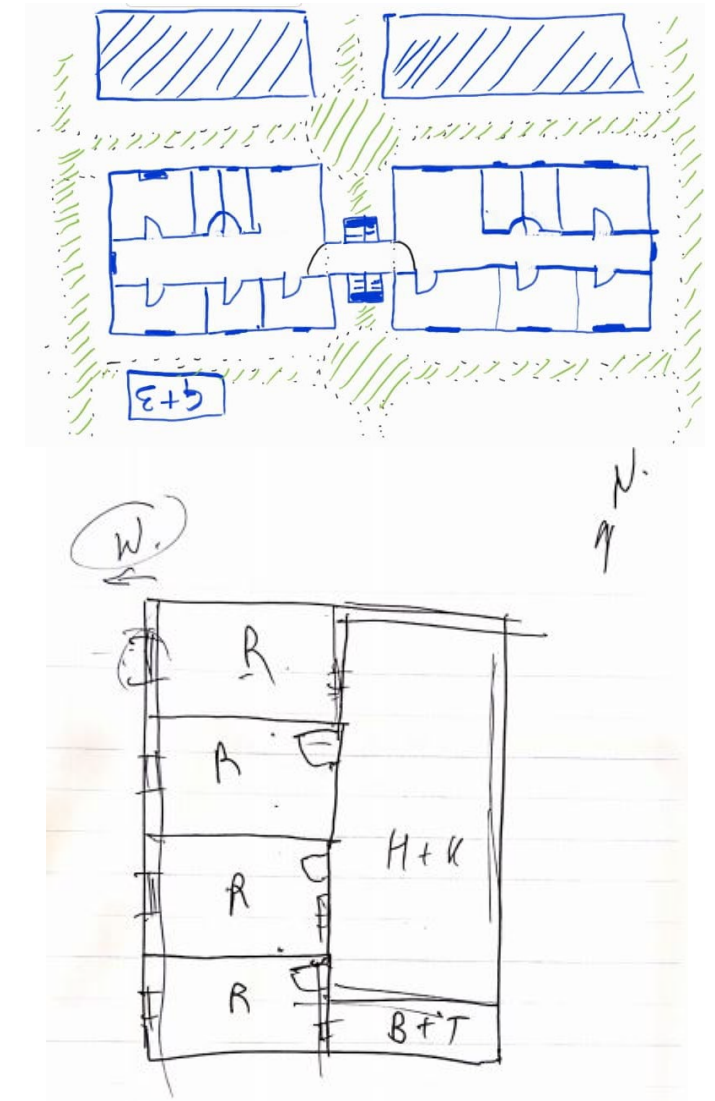
How to provide **affordable and modular housing** in Bhiwandi ?



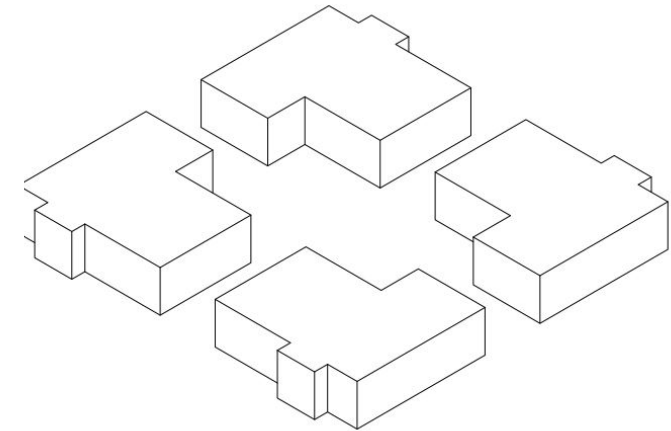
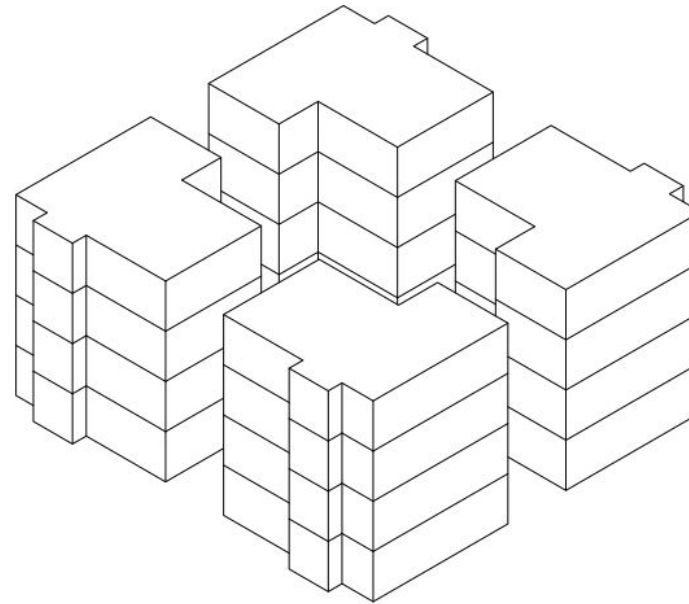
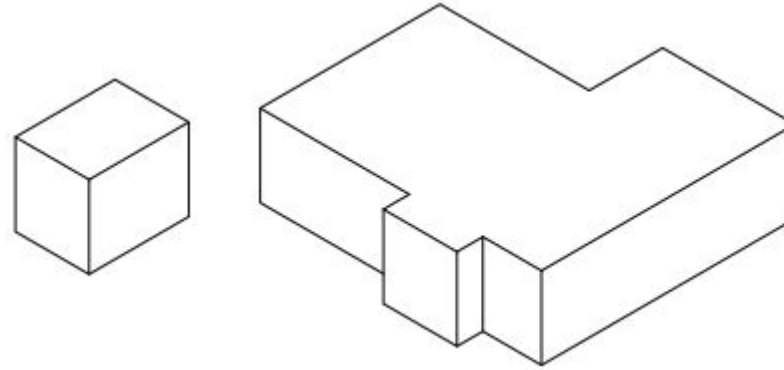
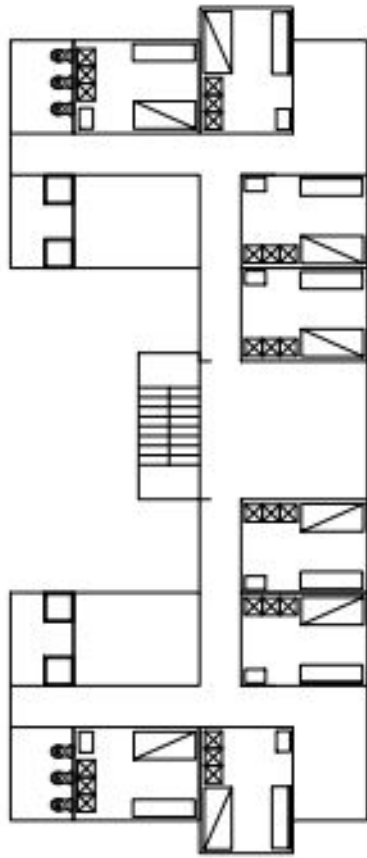
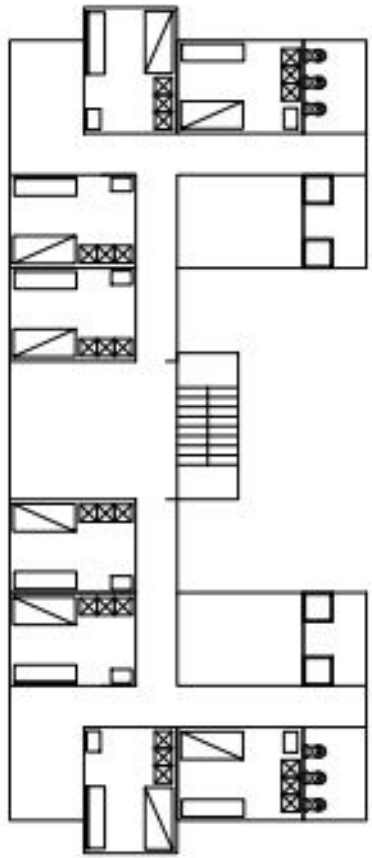
How to provide **affordable, safe and spacious housing** for Bhiwandi's **low-income labour/workers** through modular solutions?

# Prioritisation of Requirements

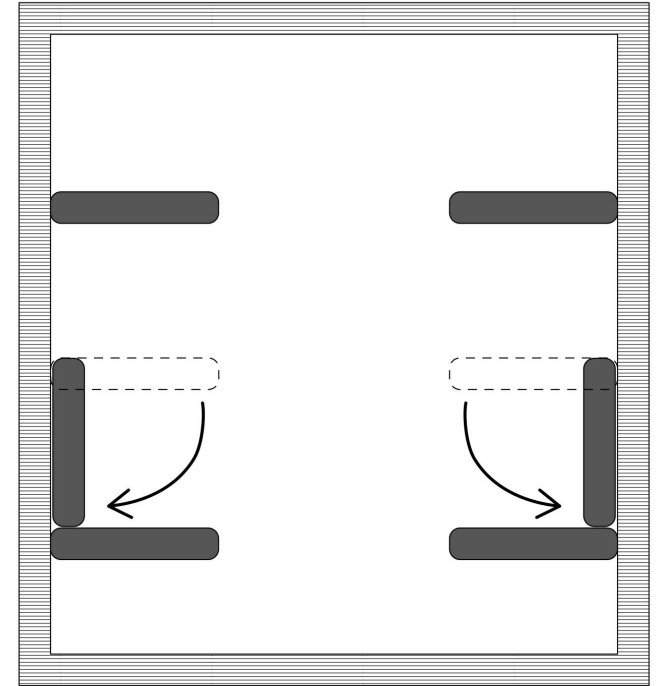
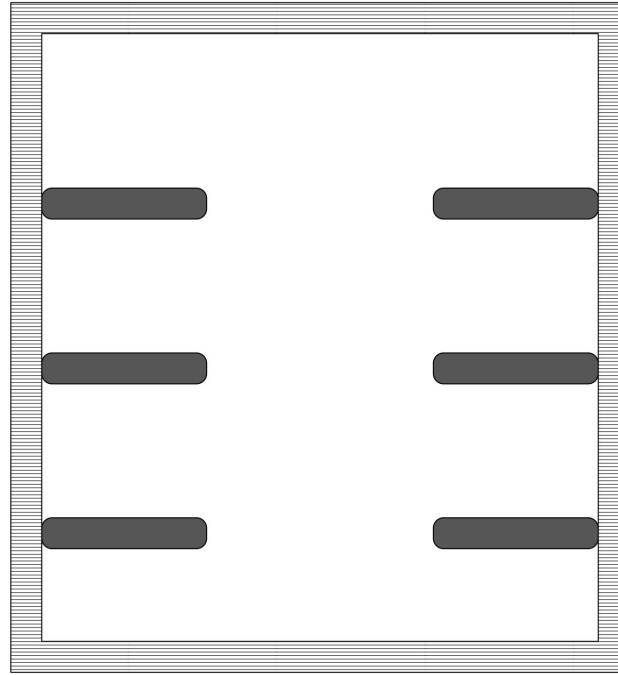
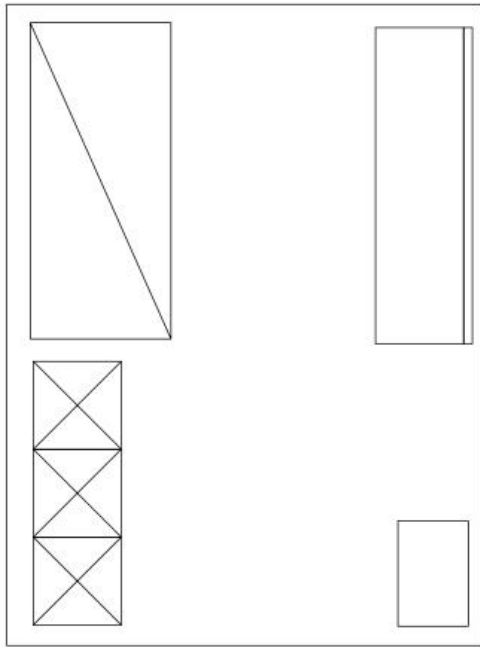
Requirements	Demand (D) / Wish (W)	Priority
Need <b>low cost</b> rental/own housing	D	1
Modules should be <b>scalable and flexible</b>	D	2
Should <b>facilitate expansion</b> in future	W	3
Materials and construction process should be sustainable	W	4
Need provision for <b>pure drinking water</b>	D	5
It should inhibit <b>waste management system</b>	D	6



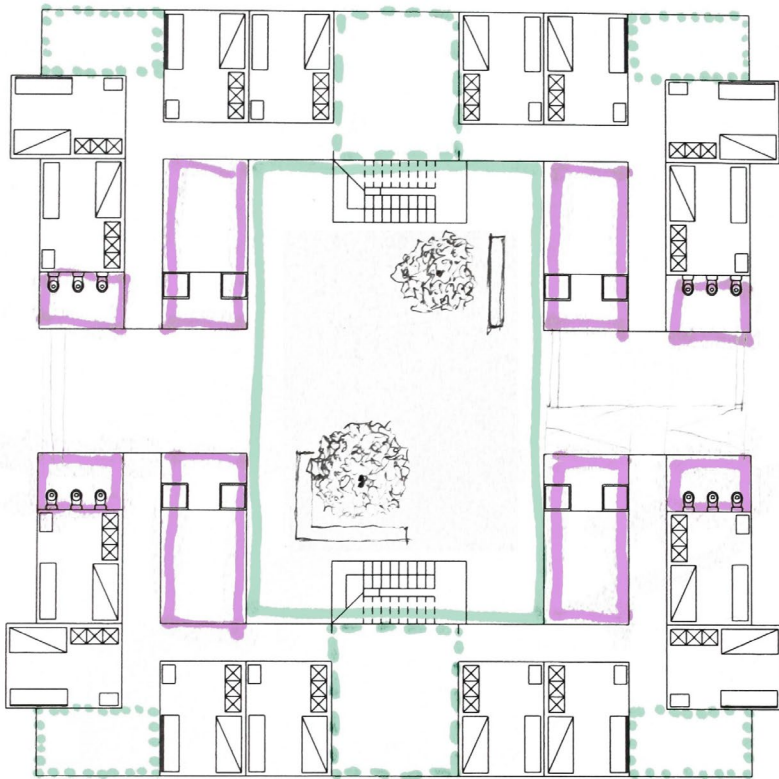




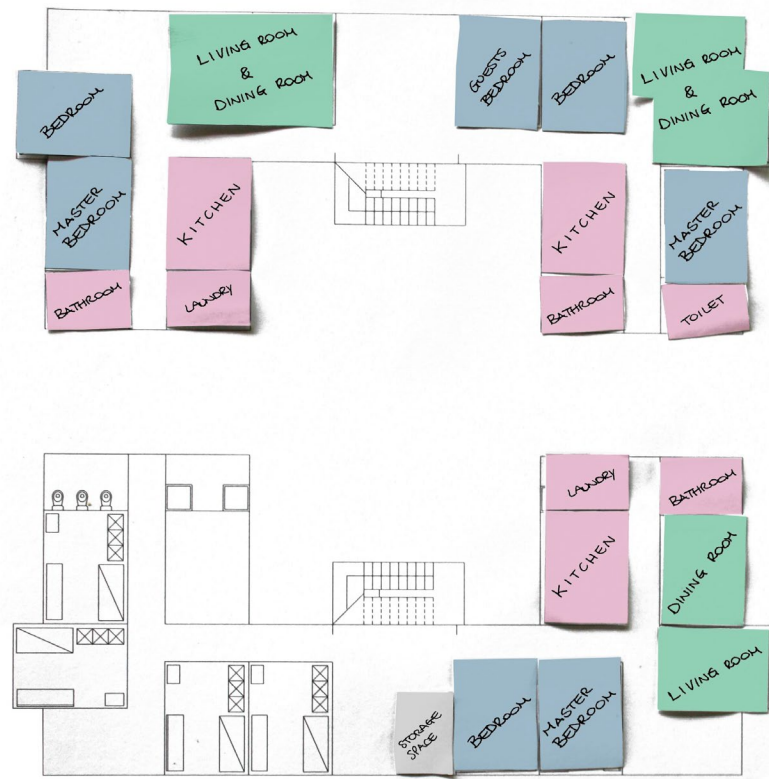




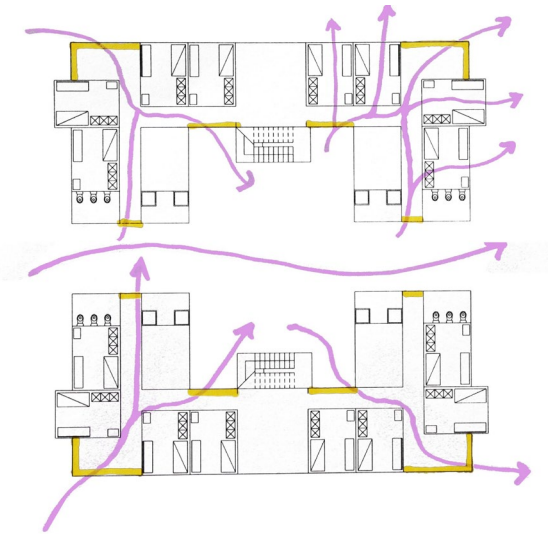
# Concept studies: shared spaces and flexibility



Shared spaces and facilities of different scales



Modular flexibility over time:  
different configuration possibilities



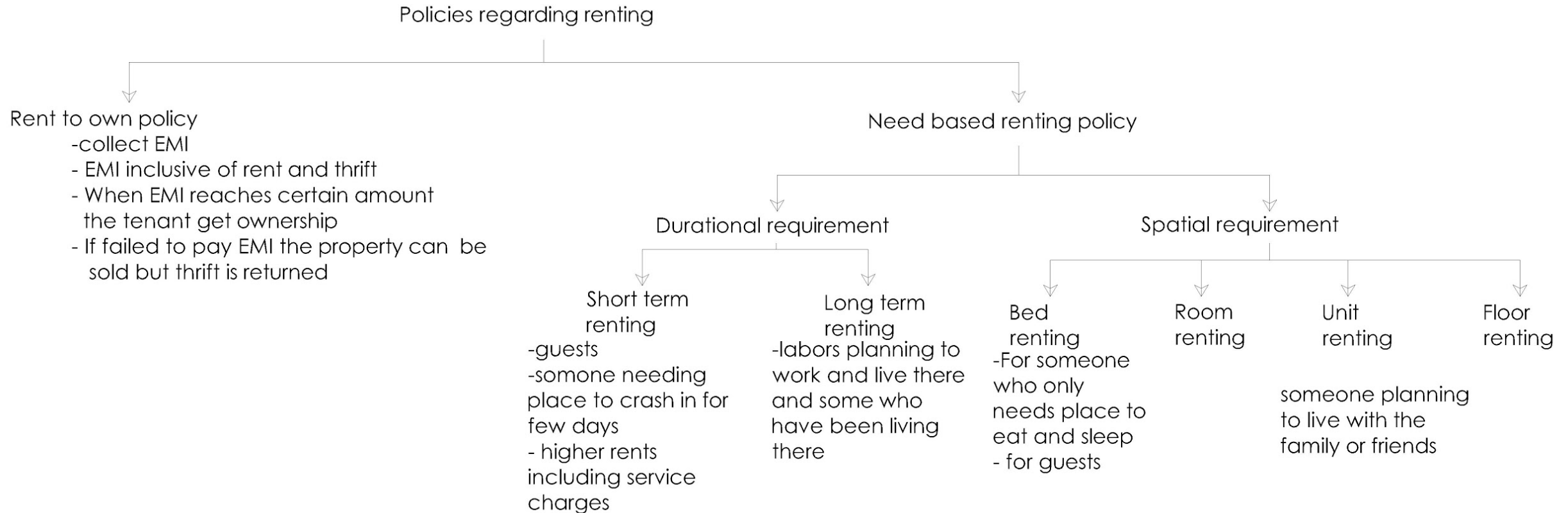
Prevailing wind flows  
and breathing walls

## Smart energy and waste management systems

- **Facilities for recycling**
- **Earning opportunities from energy production**
  - Small-scale biogas production
  - Solar PV system integrated to the grid
- **Energy saving**
  - Smart switch-off systems
  - Solar water heating
  - Efficient lights and maximising daylight usage



# Concept studies: policies and regulations





## METHODS USED

- Challenge framing
- Secondary research
  - learning the broader context*
- Team building
- Brainstorming
- Observation
- Interviews
- Creating personas
  - creating fictional characters who represent the target group*
- Prototyping
- Sketching, drawing and modelling
- Collage



## LIMITATIONS FACED

### Project work

- Establishing and setting priorities
- Late field visit in relation to project schedule
- Limited time for team building
- Time constraint for understanding the problem context and defining a solution neutral problem statement

### Interviews

- Trust issues, limited time for building trust
- Limited perspective from interviews



## LEARNING OUTCOMES

- how to contribute in a multidisciplinary and diverse team environment
- unlearning solution-oriented approaches and converging our minds to problem complexity and systems thinking
- learning new and different perspectives



# Thank you! Questions?

