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Department of Engineering
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Comfort, health and energy-use behavior for homeostasis in informal settlements

Investigating sustainability of the slum rehabilitation process in Mumbai using backcasting approach

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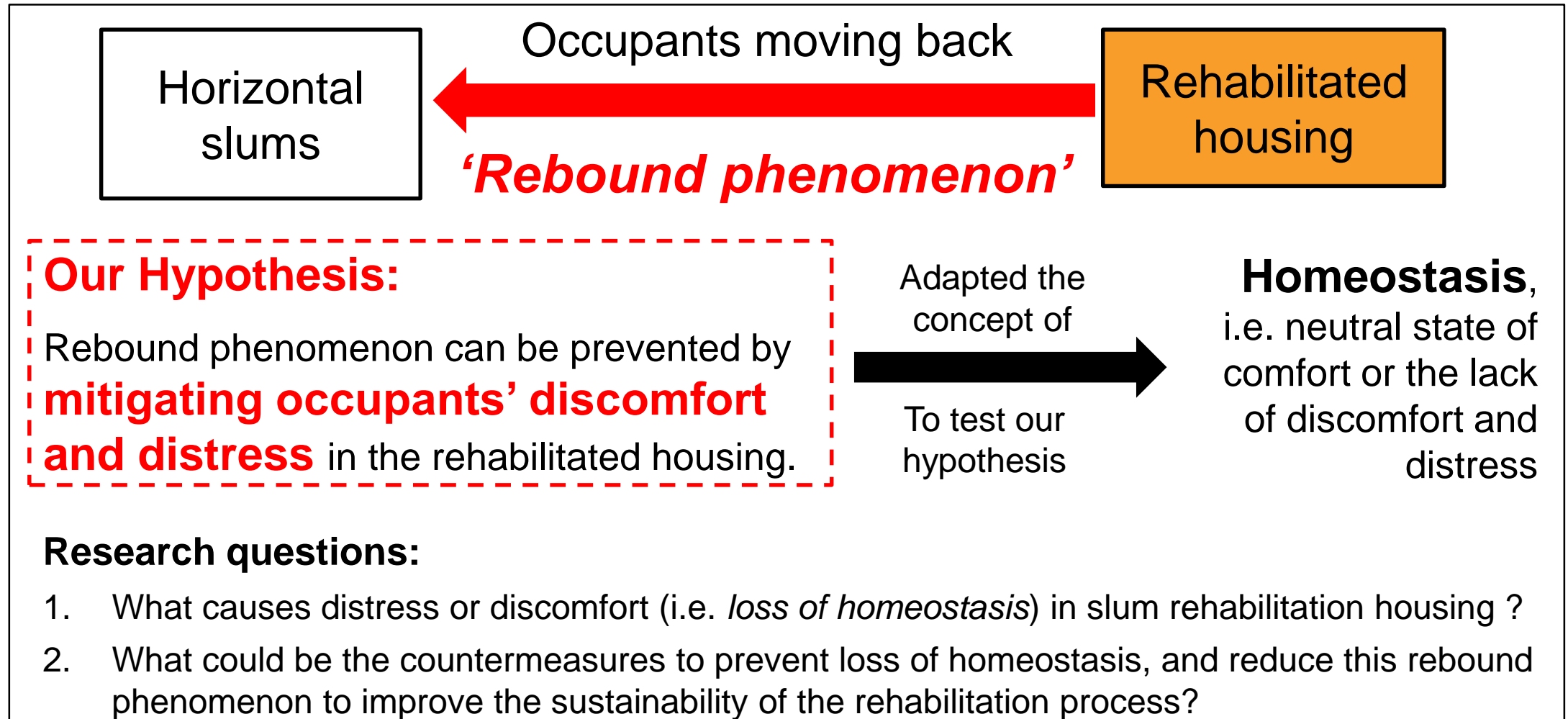
Overview

Broad scope of this study:

SUSTAINABLE DEVELOPMENT GOALS

11 SUSTAINABLE CITIES AND COMMUNITIES

SDG 11: TARGET 11.1
By 2030, ensure access for all to adequate, safe and affordable housing and basic services.
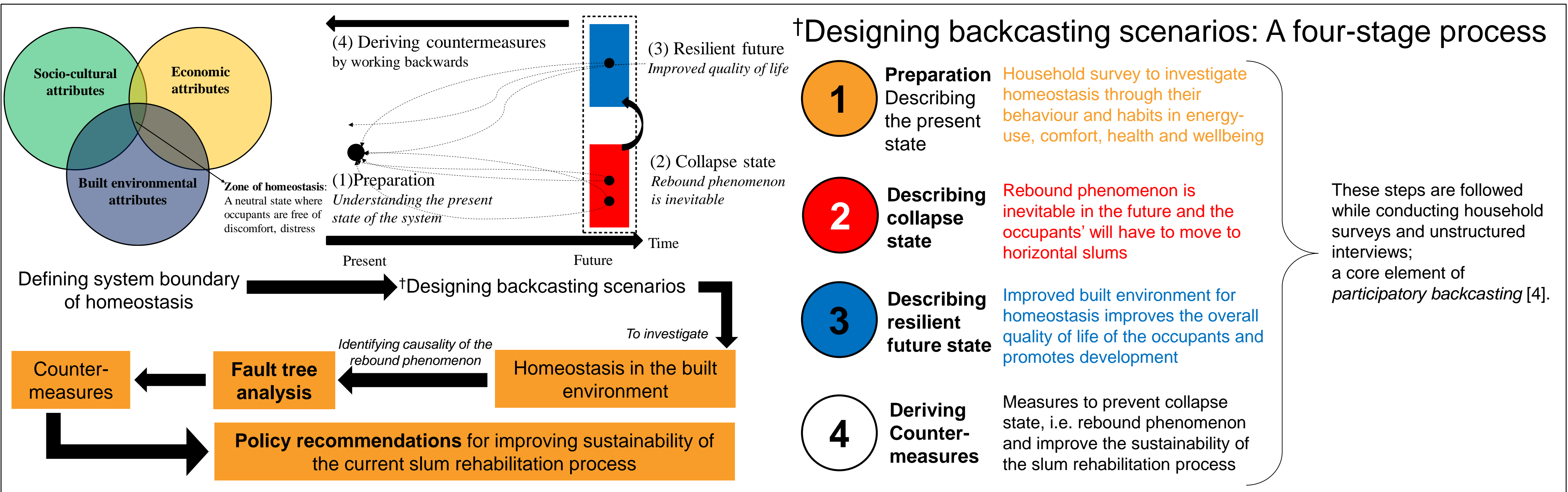
- India's **commitment** towards SDG 11 → **Housing for All 2022** scheme
- In Mumbai, more than 50% of the 18.41 million people lives in informal settlements like slums.
- Government is addressing this problem through **Slum Rehabilitation Authority** by providing **free housing** to the slum dwellers, called **Slum Rehabilitation Housing**.
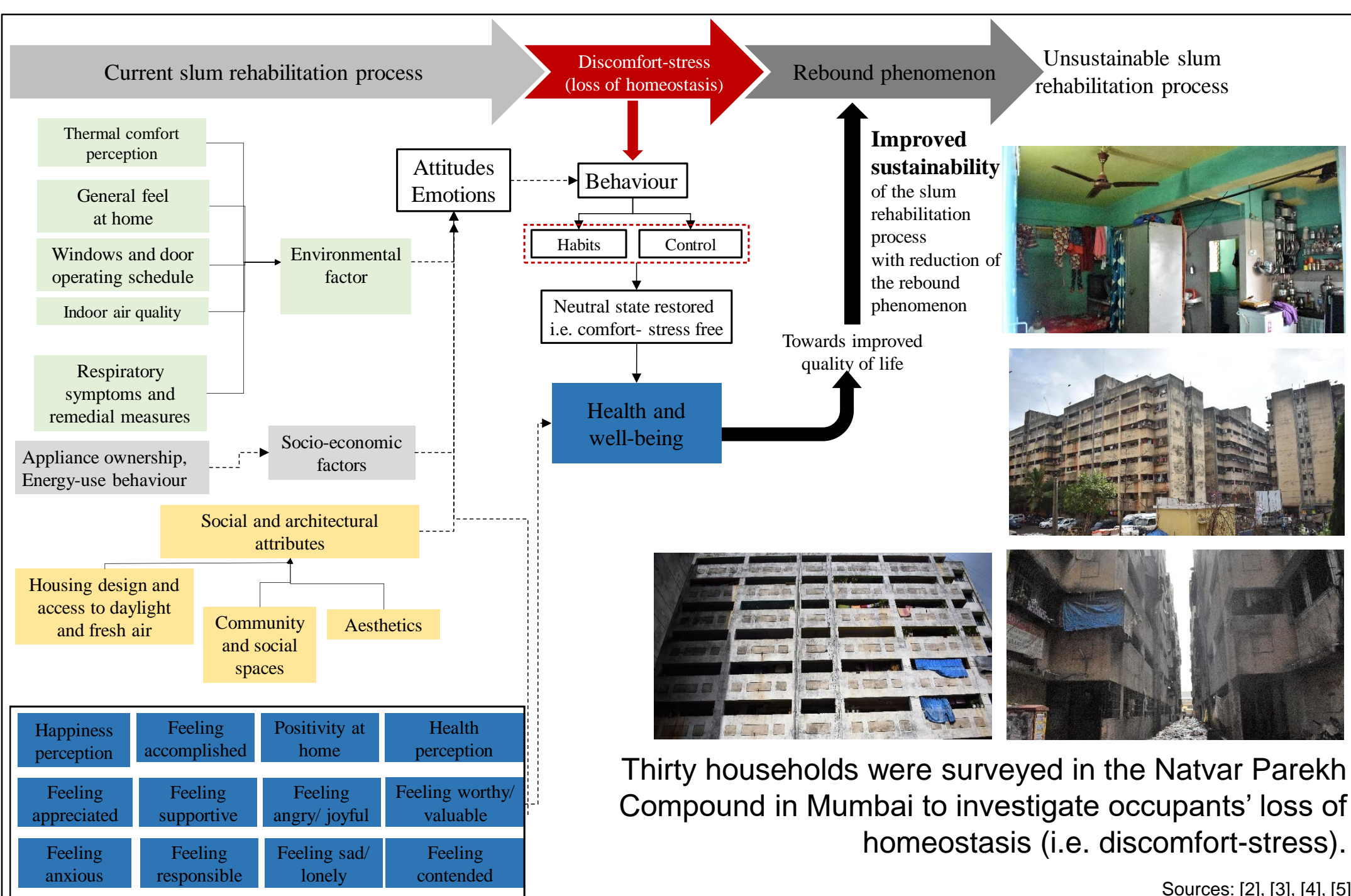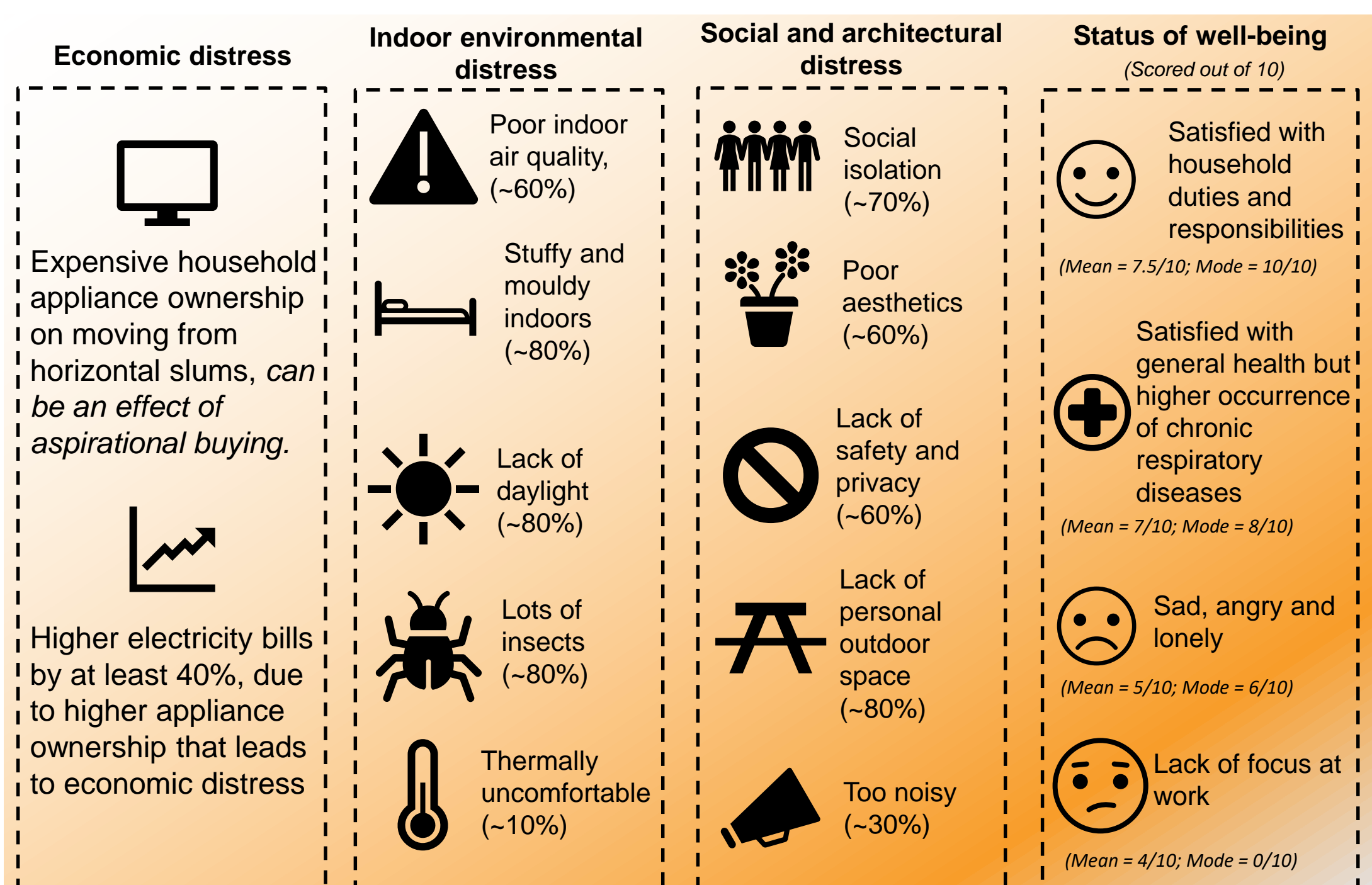
Horizontal slums → Slum Rehabilitation Authority → Rehabilitated housing
Government's strategy to meet Housing for All 2022 targets

Problem statement and research questions

Occupants moving back
Horizontal slums ← Rehabilitated housing
'Rebound phenomenon'

Our Hypothesis:
Rebound phenomenon can be prevented by **mitigating occupants' discomfort and distress** in the rehabilitated housing.

Adapted the concept of → To test our hypothesis → **Homeostasis**, i.e. neutral state of comfort or the lack of discomfort and distress

Research questions:
1. What causes distress or discomfort (i.e. *loss of homeostasis*) in slum rehabilitation housing ?
2. What could be the countermeasures to prevent loss of homeostasis, and reduce this rebound phenomenon to improve the sustainability of the rehabilitation process?

Methodology: Backcasting to investigate the cause of rebound phenomenon

(4) Deriving countermeasures by working backwards
(3) Resilient future *Improved quality of life*
(1) Preparation *Understanding the present state of the system*
(2) Collapse state *Rebound phenomenon is inevitable*
Zone of homeostasis: A neutral state where occupants are free of discomfort, distress
Present — Future — Time

Defining system boundary of homeostasis → †Designing backcasting scenarios

Identifying causality of the rebound phenomenon
Counter-measures ← **Fault tree analysis** ← Homeostasis in the built environment
To investigate

Policy recommendations for improving sustainability of the current slum rehabilitation process

†Designing backcasting scenarios: A four-stage process

1 **Preparation** Describing the present state — Household survey to investigate homeostasis through their behaviour and habits in energy-use, comfort, health and wellbeing

2 **Describing collapse state** — Rebound phenomenon is inevitable in the future and the occupants' will have to move to horizontal slums

3 **Describing resilient future state** — Improved built environment for homeostasis improves the overall quality of life of the occupants and promotes development

4 **Deriving Counter-measures** — Measures to prevent collapse state, i.e. rebound phenomenon and improve the sustainability of the slum rehabilitation process

These steps are followed while conducting household surveys and unstructured interviews; a core element of *participatory backcasting* [4].

Survey design

Current slum rehabilitation process — Discomfort-stress (loss of homeostasis) — Rebound phenomenon — Unsustainable slum rehabilitation process

Thermal comfort perception, General feel at home, Windows and door operating schedule, Indoor air quality → Environmental factor

Respiratory symptoms and remedial measures, Appliance ownership, Energy-use behaviour → Socio-economic factors

Housing design and access to daylight and fresh air, Community and social spaces, Aesthetics → Social and architectural attributes

Attitudes Emotions → Behaviour → Habits, Control → Neutral state restored i.e. comfort- stress free → Health and well-being

Improved sustainability of the slum rehabilitation process with reduction of the rebound phenomenon
Towards improved quality of life

Happiness perception, Feeling accomplished, Positivity at home, Health perception, Feeling appreciated, Feeling supportive, Feeling angry/ joyful, Feeling worthy/valuable, Feeling anxious, Feeling responsible, Feeling sad/ lonely, Feeling contended

Thirty households were surveyed in the Natvar Parekh Compound in Mumbai to investigate occupants' loss of homeostasis (i.e. discomfort-stress).
Sources: [2], [3], [4], [5]

Results: Cause of distress

Economic distress
Expensive household appliance ownership on moving from horizontal slums, *can be an effect of aspirational buying.*
Higher electricity bills by at least 40%, due to higher appliance ownership that leads to economic distress

Indoor environmental distress
- Poor indoor air quality, (~60%)
- Stuffy and mouldy indoors (~80%)
- Lack of daylight (~80%)
- Lots of insects (~80%)
- Thermally uncomfortable (~10%)

Social and architectural distress
- Social isolation (~70%)
- Poor aesthetics (~60%)
- Lack of safety and privacy (~60%)
- Lack of personal outdoor space (~80%)
- Too noisy (~30%)

Status of well-being
(Scored out of 10)
- Satisfied with household duties and responsibilities *(Mean = 7.5/10; Mode = 10/10)*
- Satisfied with general health but higher occurrence of chronic respiratory diseases *(Mean = 7/10; Mode = 8/10)*
- Sad, angry and lonely *(Mean = 5/10; Mode = 6/10)*
- Lack of focus at work *(Mean = 4/10; Mode = 0/10)*

Initial conclusion

- Lack of social and community spaces in the current rehabilitation housing design leads to social isolation and loneliness. It affect the well-being of the occupants.
- Distress due to the poor built environment contributes significantly to the rebound phenomenon.

Work in progress

- Performing fault tree analysis on the survey results.
- Deriving counter measures based on the fault tree analysis and converting it to policy recommendations for the Slum Rehabilitation Authority.

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