
# SYSTEMS APPROACHES TO DEVELOP SUSTAINABLE MOBILITY HUBS: A METHOD

## Ph.D research project

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# Disclaimer

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# CONTENT

# 1. INTRODUCTION

1

Leveraging solutions for sustainable transport choices.

**Mobility hubs** enable multimodal and green transport connectivity; therefore, they play a key role in encouraging sustainable transport choices. While mobility hub solutions vary, all them **support transport interchange** between two (or more) transport modes, such as collective, shared, or individual options.

Airport hub

Shared  mobility hub

Metro station & TOD

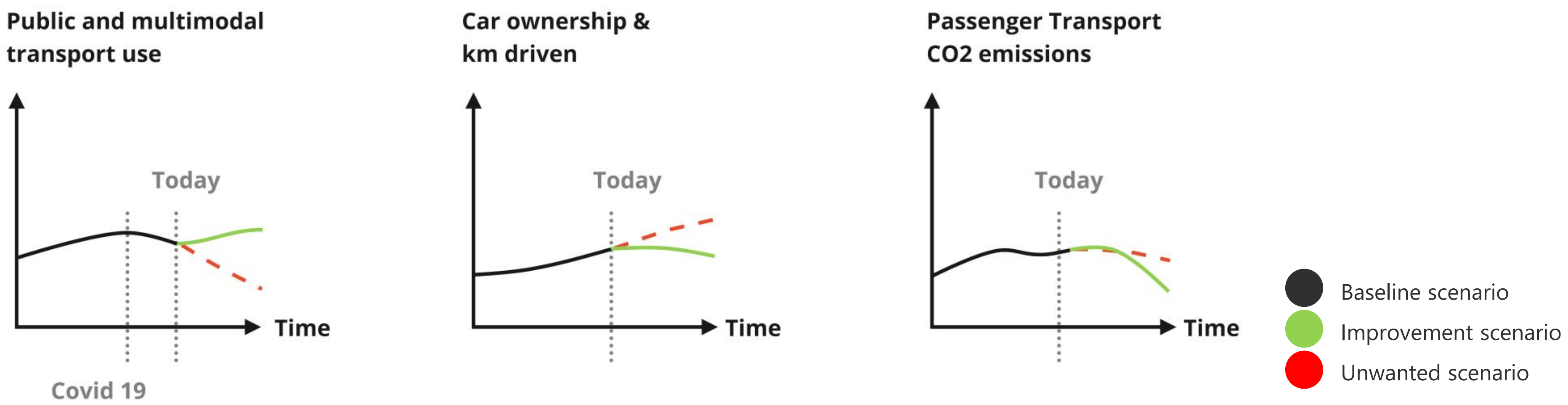
Intermodal hub

Park and ride

1. *DK. Kastrup Airport Hub By kallerna - Own work, CC BY-SA 4.0,*
2. *GE. Switchh mobility hub in Hamburg – Sophia von Berg https://twitter.com/multi_mobility/status/651984012777492480*
3. *DK. Ørestad Metro & train Station in Copenhagen. Own Photo*
4. *CHI Intermodal Mobility Hubs in China https://smmr.asia/topics/intermodal-mobility-hubs/*
5. *DK. Køge Nord Station. Foto: Rasmus Hjortshøj*

**TOD – Transit-oriented development*

# Denmark: The challenge with today's passenger transport preferences and emissions.



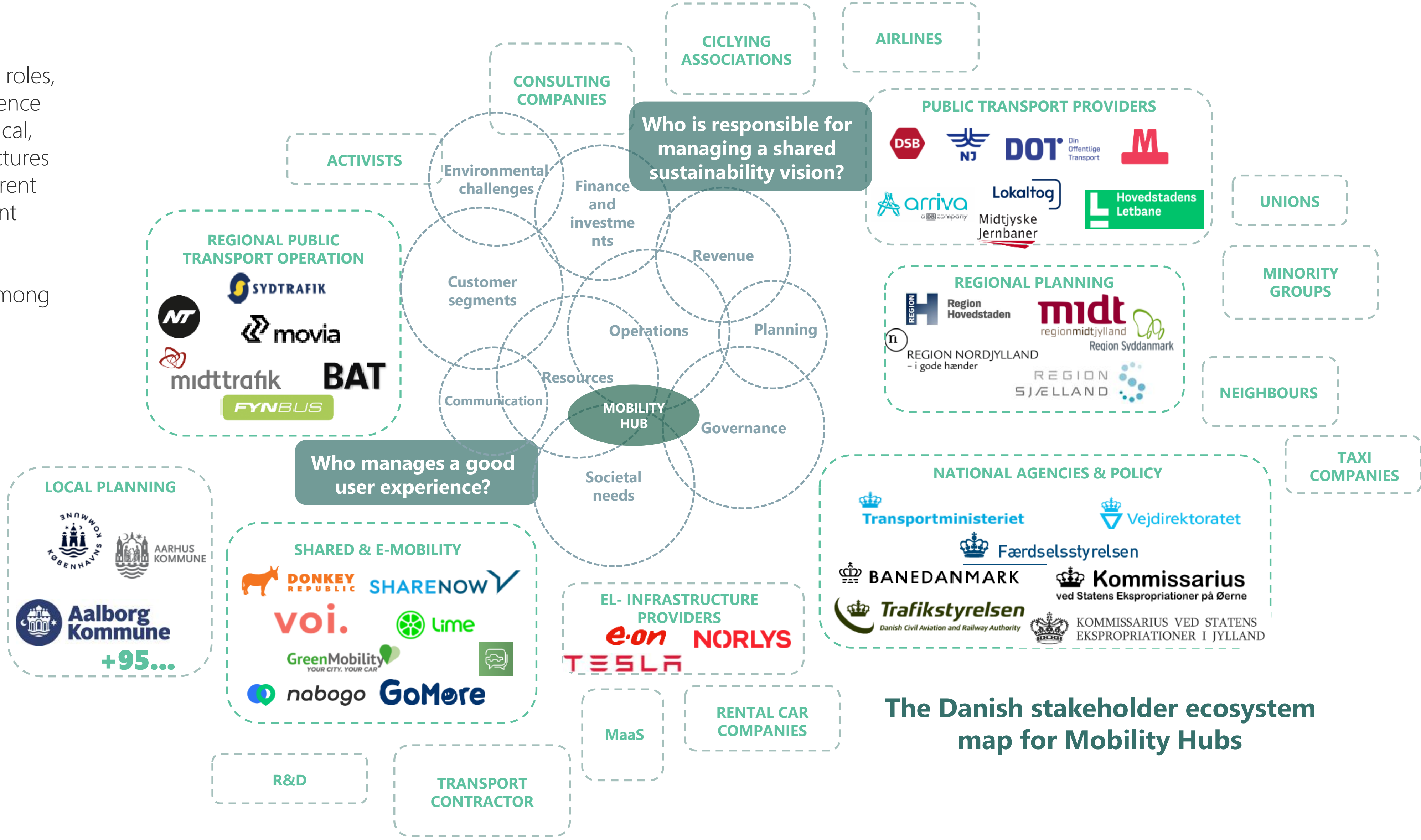

There is the need to develop sustainable mobility hubs to nurture sustainable transport choices and reduce car use and CO2 emissions.

*A reference mode, based on data. See Reference list 1,2,3 and 4*

1

# The Challenge of Alignment in Sustainable Mobility Hub Development

Organizational aspects, stakeholder roles, and their impact on the user experience are fragmented. MH integrate physical, digital, and organizational infrastructures where various entities perform different actions and have sometimes different and conflicting goals. Achieving sustainable solutions requires collaboration and a shared vision among all actors.




**The Danish stakeholder ecosystem map for Mobility Hubs**

*©Visual representation made by the author of this work, 2022*

# 2. METHOD

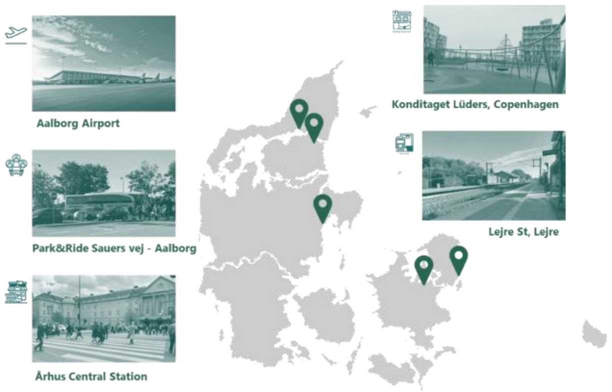
# Overall research approach

**How can different governance models, organisational frameworks, and operational models support the creation and operations of Sustainable Mobility Hubs, and how can they be adapted to the Danish context?**

1 Key factors for a sustainable mobility hub strategy: a definition

**understanding**

2 Systems thinking: The local mobility hub development & the Danish stakeholder ecosystem map




3 100 cases of international mobility hub development

**framing**

4 15 international cases: solutions, organizational structures, business models and mobility hub qualities.

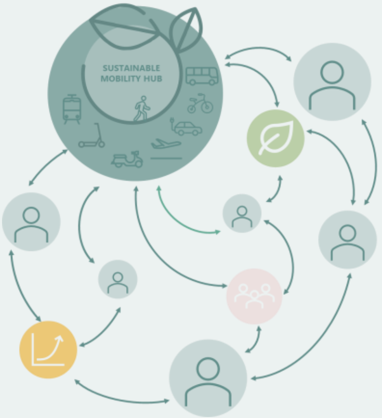

5 System Dynamics: Systemic methods to develop sustainable mobility hub strategies: a tool

**application**

LOCAL PILOT

LOCAL PILOT

6 A case study

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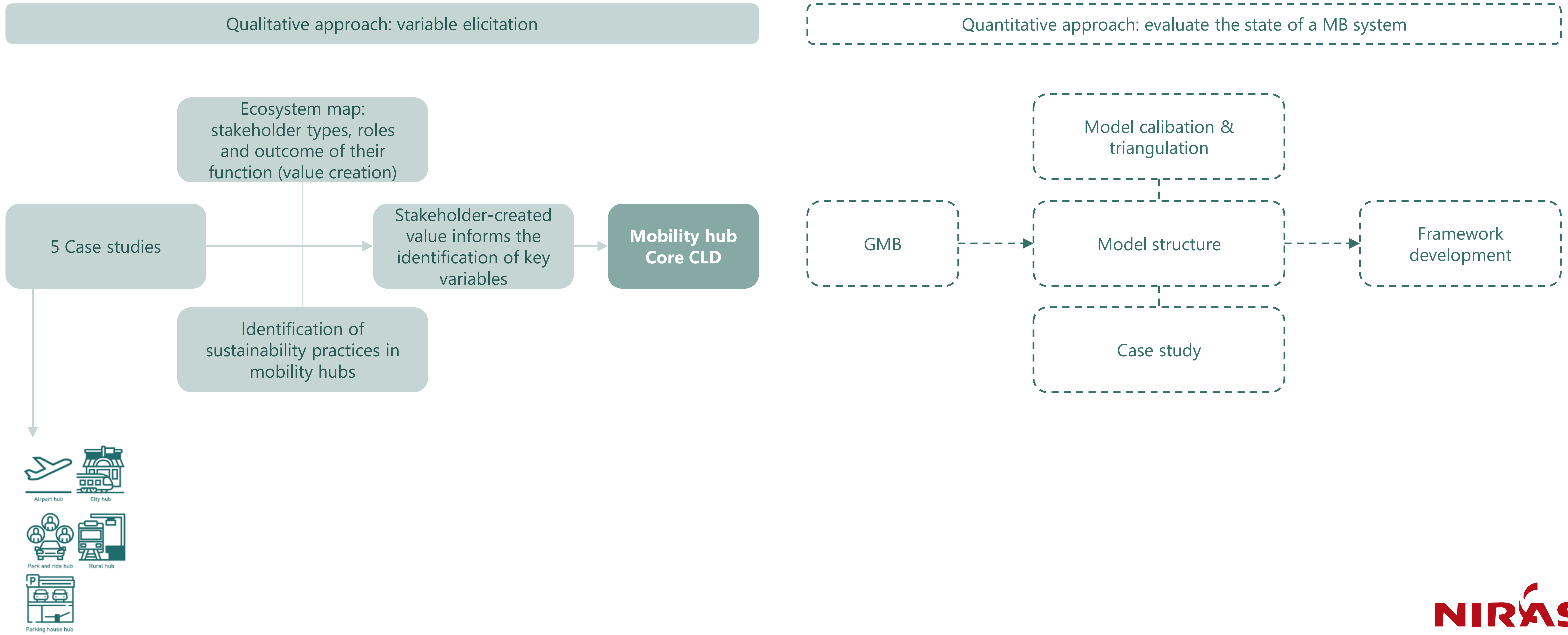
# Systems Thinking and Dynamics methodological approach

**Research question: How can the evidence-based insights from the case studies be used to create methods to develop the added value of Sustainable Mobility Hubs?**



2

# Variable elicitation

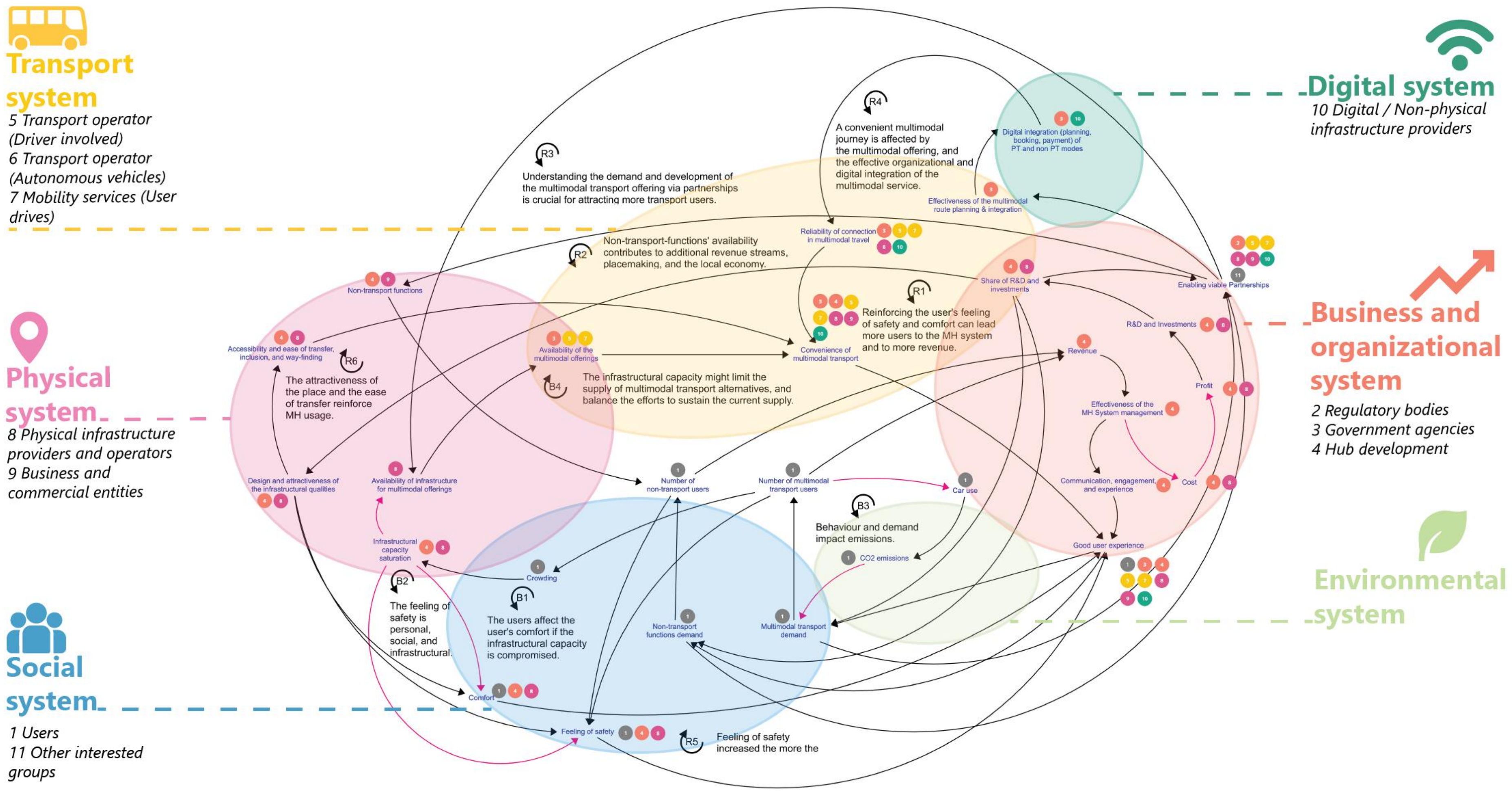
METHODOLOGICAL APPROACH FOR VARIABLE ELICITATION

| | | | | | |
|---|---|---|---|---|---|
| STAKEHOLDER CATEGORIES | 3. GOVERNMENT AGENCIES<br>4. HUB DEVELOPMENT INSTITUTIONS | 5. TRANSPORT OPERATORS(DRIVER INVOLVED)<br>6. TRANSPORT OPERATORS (AUTONOMOUS VEHICLES)<br>7. MOBILITY SERVICESSUPPLIERS (USER DRIVES) | 8. PHYSICAL INFRASTRUCTURE PROVIDERS & OPERATORS<br>9. BUSINESS AND COMMERCIAL ENTITIES | 10. DIGITAL INFRASTRUCTURE PROVIDERS | 1. USERS<br>2. REGULATORY BODIES<br>11.OTHER INTERESTED GROUPS |
| INFRASTRUCTURAL SUBSYSTEM | ORGANIZATIONAL INFRASTRUCTURE | TRANSPORT INFRASTRUCTURE | PHYSICAL INFRASTRUCTURE | DIGITAL INFRASTRUCTURE | USERS AND OTHER INTERSTED GROUPS |
| STAKEHOLDER FORM & FUNCTION<br>*Process and operand* | **Municipal transport planning**<br>**Pays and manages local PT** | **Train company**<br>**Drives trains** | **Hub owner**<br>**manages hub** | **PT booking, ticketing & timetable co.**<br>**Integrates regional PT booking, timetables and payment & Distribute earnings** | **Multimodal transport User**<br>**Travels multimodal** |
| VALUE CREATED<br>*Outocme of the function* | Ensured funding and established integrated municipal network of public transport bus routes that meet the local demand. | Enabled access to fast and collective transport offering that facilitates a long-distance commute and reliable travel | An effective management of the infrastructure and partnerships, resulting in an ensured multimodal transport connectivity and accessibility, its additional attractive basic services delivering a good user experience, and value for the investors. | A regionally integrated digital infrastructure system for booking, planning, and ticketing among public transport offerings resulted in effective and seamless linkage of a multimodal journey based on public transport. | The usage of the multimodal transport offering and the services at the MH, the direct impact on demand for transport alternatives, basic services, and facilities, and the impact on other user's experience, feeling of safety and comfort. |
| VARIABLES<br>*Key words* | bus, public transport, funding, integration, | train, transport offering: multimodal offering, reliable | infrastructure, basic services, user experience, attractiveness, partnerships | public transport, seamless integration, digital infrastructure | demand, use, users, comfort, feeling of safety, user experience, |

# 3. RESULTS

A system dynamics approach using a Causal Loop Diagram (CLD) to define strategic factors that holistically link user experience, sustainability, and partnerships to understanding what drives increased mobility hub usage.

# Causal loop diagram




DYNAMIC HYPOTHESIS A user-centric and sustainability-oriented MH develops strategies that understand feedback systems over time of the value delivered among stakeholders to provide solutions oriented to increasing the attractiveness of multimodal travel, inviting more users to the hub, and consequently reducing greenhouse emissions.

# 3 Relevance

**How do the current organizational structures and decisions impact the attractiveness of multimodal travel and drive mobility hub usage?**

R1: Reinforcing the user's feeling of safety and comfort can lead more users to the MH system and to more revenue

R2. Non-transport-functions' availability contributes to additional revenue streams, placemaking, and the local economy.

R3. Understanding the demand and development of the multimodal transport offering via partnerships is crucial for attracting more transport users.

R4. A convenient multimodal journey is affected by the multimodal offering, and the effective organizational and digital integration of the multimodal service.

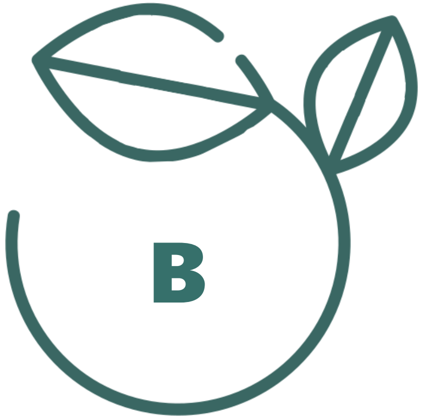
R5. The feeling of safety increases the more the MH is used.

R6. The attractiveness of the place and the ease of transfer reinforce MH usage.


B1. The users affect the user's comfort if the infrastructural capacity is compromised.

B2. The feeling of safety is personal, social, and infrastructural.

B3. Behaviour and demand impact emissions.



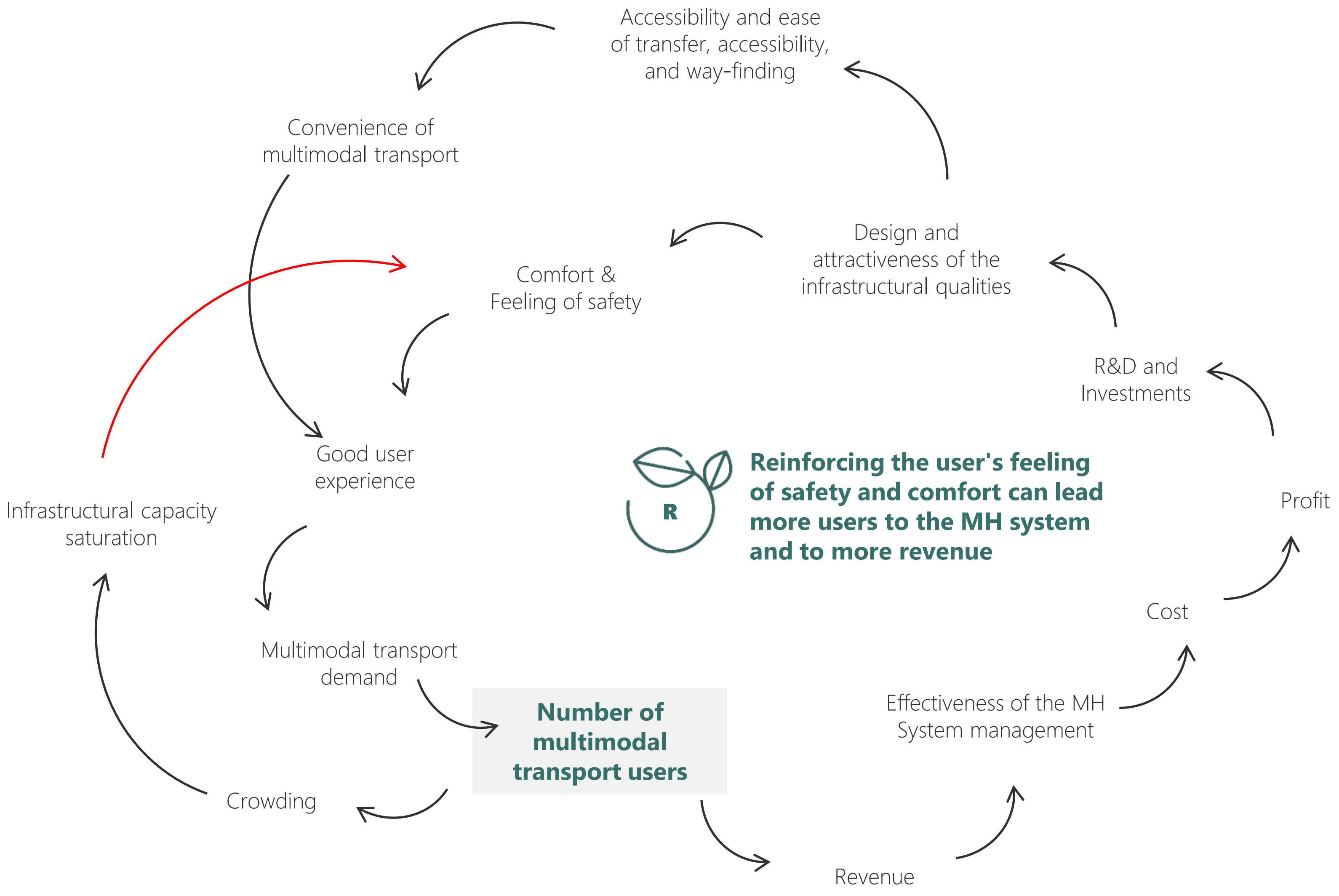

B4. The infrastructural capacity might limit the supply of multimodal transport alternatives, and balance the efforts to sustain the current supply.

# R1: Reinforcing the user's feeling of safety and comfort can lead more users to the MH system and to more revenue

**A loop of multiple pathways**

An increase in the **number of multimodal transport users** leads to higher **revenue**, which, if well managed by an **effective MH management** can result in **profit** being re-invested in improved **attractiveness measures** in the infrastructural qualities of the MH site. This can result in an increased **feeling of safety and comfort**, which can potentially increase the **usage and demand** for the MH.

The changes among the variables follow the same direction: positive changes that result in a growth cycle. The cycle of growth reaches its limits on the MH's infrastructural capacity, where this either cannot accommodate more infrastructural qualities or more users or when there are competing priorities for investment, such as different priority areas for re-investment of profit.



# 4. NEXT STEPS AND DISCUSSION

# Systems Thinking and Dynamics methodological approach

**Research question: How can the evidence-based insights from the case studies be used to create methods to develop the added value of Sustainable Mobility Hubs?**

Discussion points (among others you bring ☺ ):

1) Current structure and access to data

2) Mobility hub typology-specific structure: problem-specific analysis or generic structure applicable to multiple typologies. Likelihood to develop the latter one within a limited resource capacity.

3) Most beneficial approach and placement of GMB and how workshop design might (involuntarily) influence how participants theorize.

Quantitative approach: evaluate the state of a MB system

Objective: Structure triangulation
1. Hopes and Fears
2. Elaborating a Causal Loop Diagram

Model calibration & triangulation with key stakeholder

GMB → Model structure → Framework development

Case analysis:
present a real-life situation

Objective: To generate a core model that

1)Builds a generic structure of the key factors in the MH´s dynamics that reinforces multimodal transport choices and secures sustainability actions to reduce CO2 emissions.

2)Identifies and tests leverage points, and evaluate policy scenarios for improvement.

3) Supports strategy development when repurposing or developing new MHs.

# Thank you.

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