



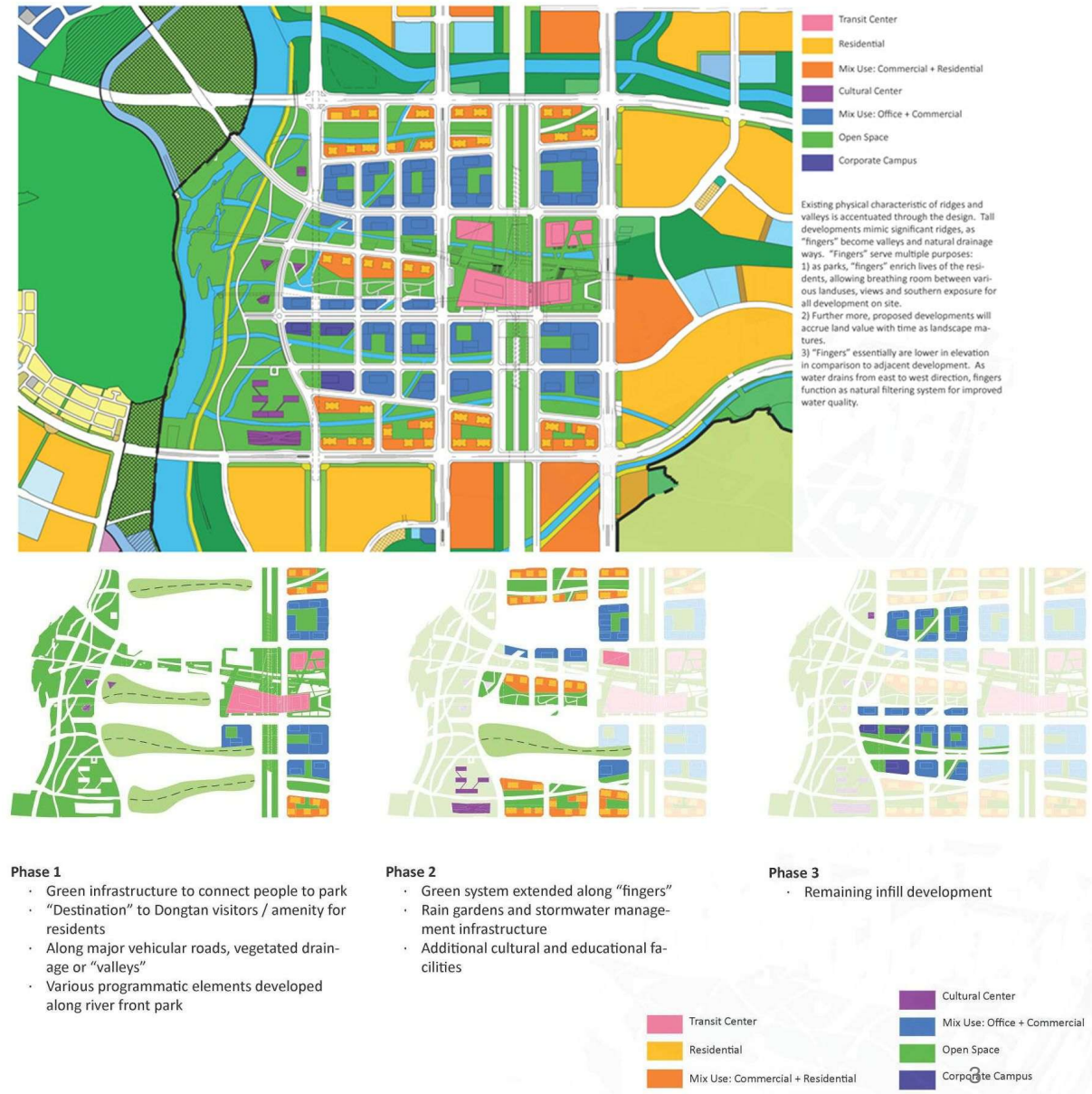
Articulating Multidisciplinary Knowledge Bundles for Urban Planning

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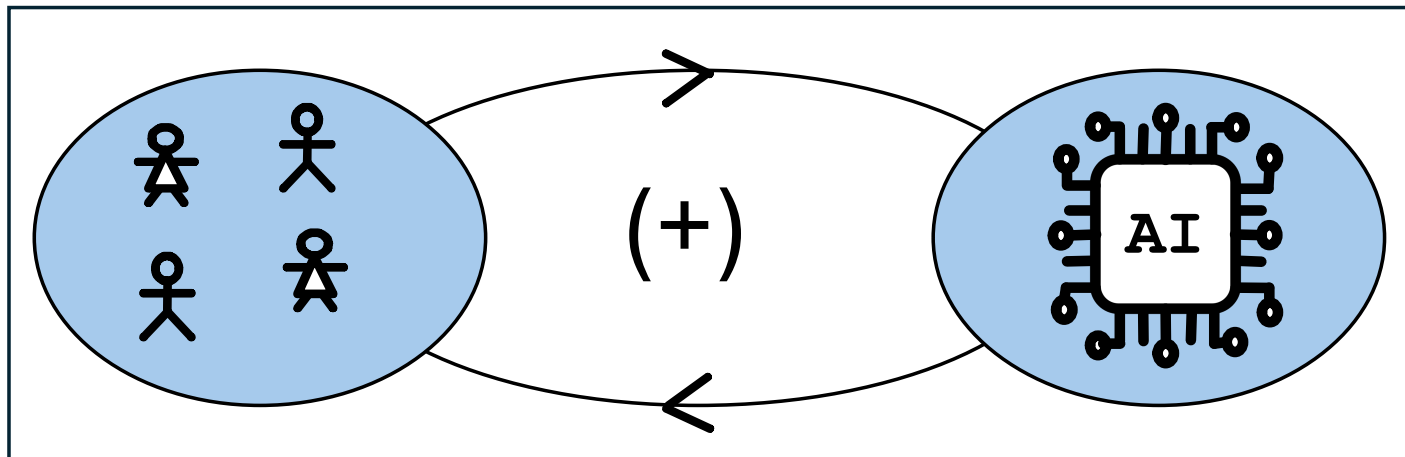
Objectives

- A bundle of knowledge is a set of consistent knowledge chunks concerning a specialized issue
- Objectives of the talk
 - Identifying all knowledge bundles used in urban planning
 - Modeling their articulation
 - Proposing a visual model: a bundle-oriented knowledge model
- Long-term objective:
 - Passing from data-oriented planning system to knowledge-oriented

Example of a Master Plan for a city



Synergies: territorial intelligence



Contents

- 1 – State of the art for modeling knowledge in urban planning
- 2 – Bundle-oriented model for UP
 - Background knowledge
 - Multidisciplinary model
 - Tips from digital twin cities
 - Recommendation from public participation
 - Ending the planning process
- 3 – Conclusions

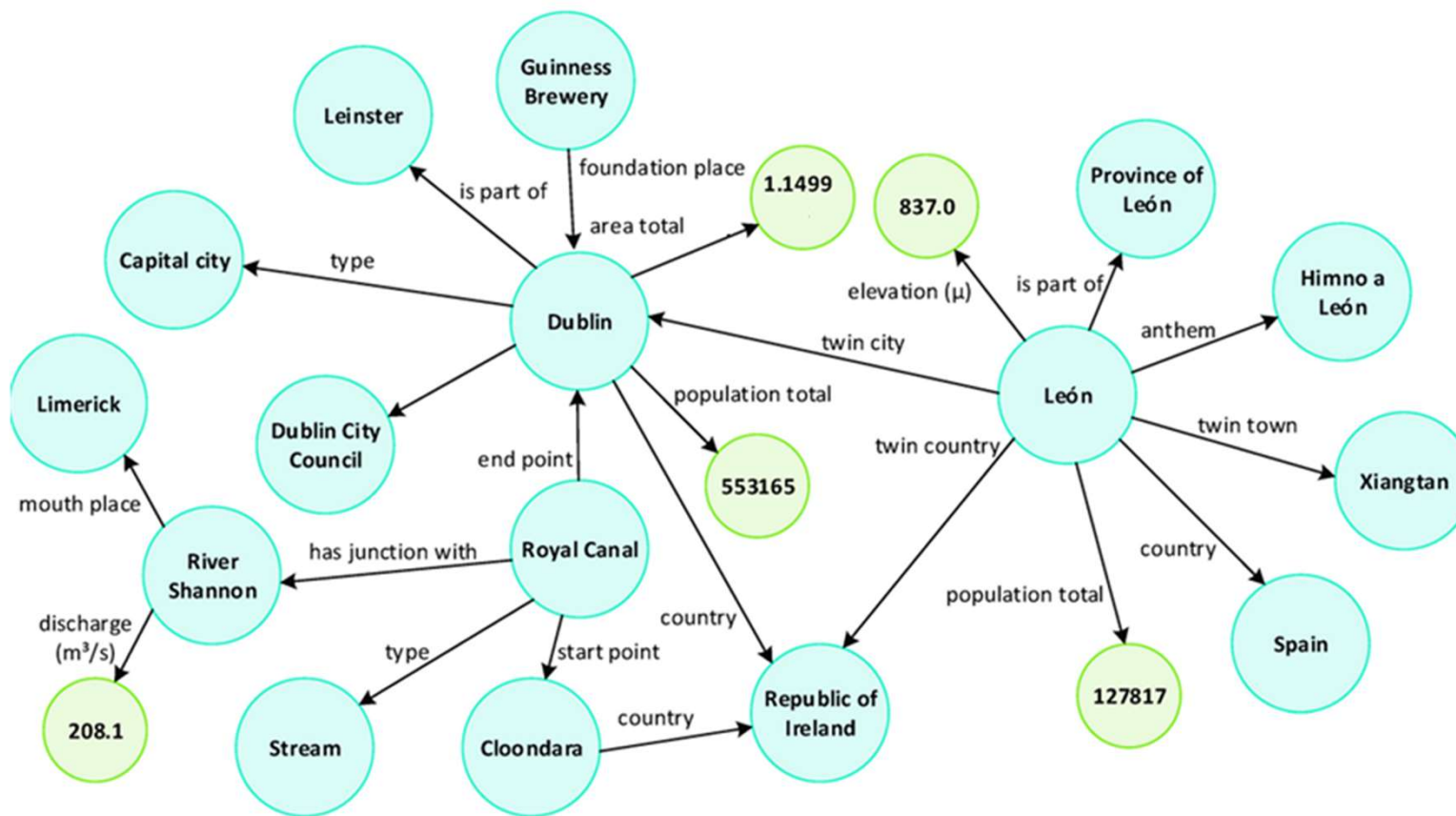
1 – State of the art for modeling knowledge in urban planning

- Geographic networks
- Geographic ontologies
- Rule-based models
- Bundle-oriented model

Geographic networks

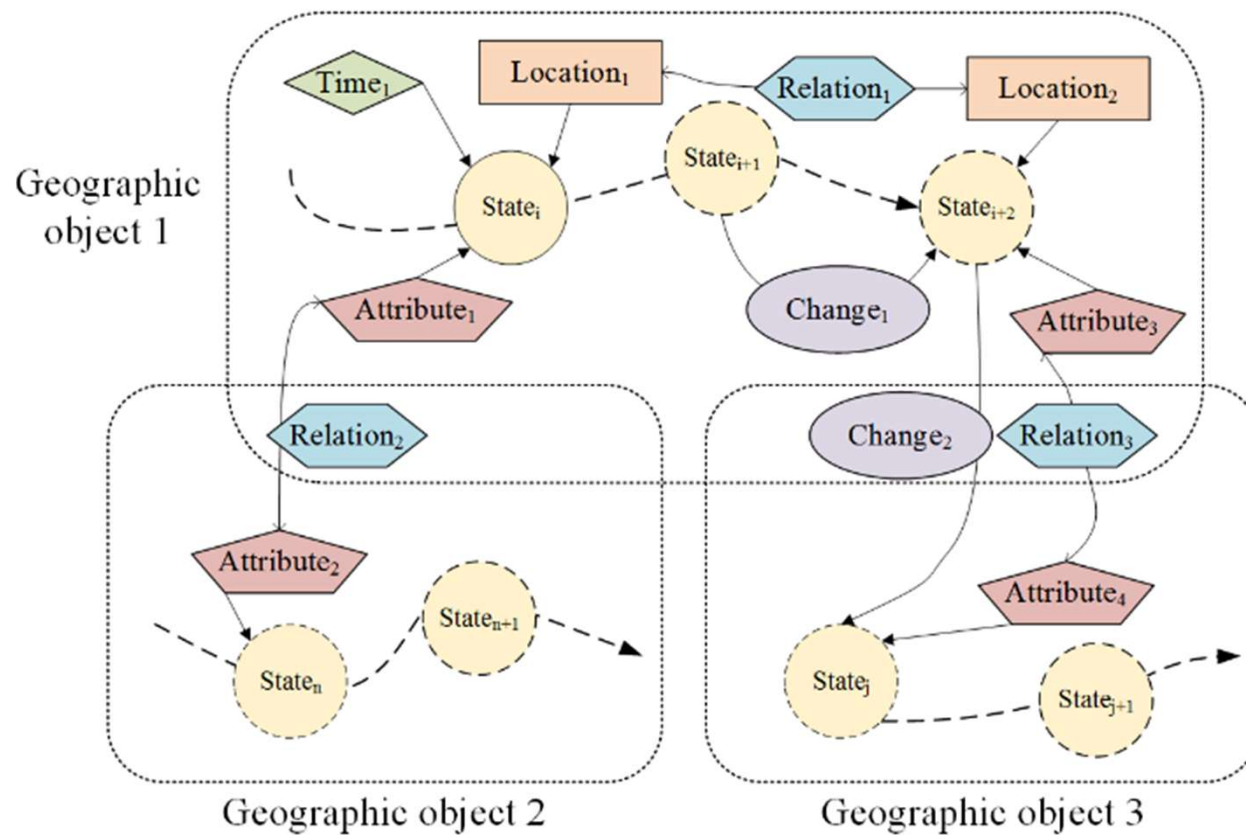
- Basic idea:
 - Modeling the relations between several objects
 - Reasoning is navigating the graph or finding a path
- Existing formalisms
 - Seminal paper: Semantic networks (Sowa, 1991)
 - Geographic knowledge graphs
 - Geographic networks Geo-KG

Geographic Knowledge Graph (ex Dublin)



Qiu, P.; Gao, J.; Yu, L.; Lu, F. Knowledge Embedding with Geospatial Distance Restriction for Geographic Knowledge Graph Completion. *ISPRS Int. J. Geo-Inf.* **2019**, *8*, 254.
<https://doi.org/10.3390/ijgi8060254>

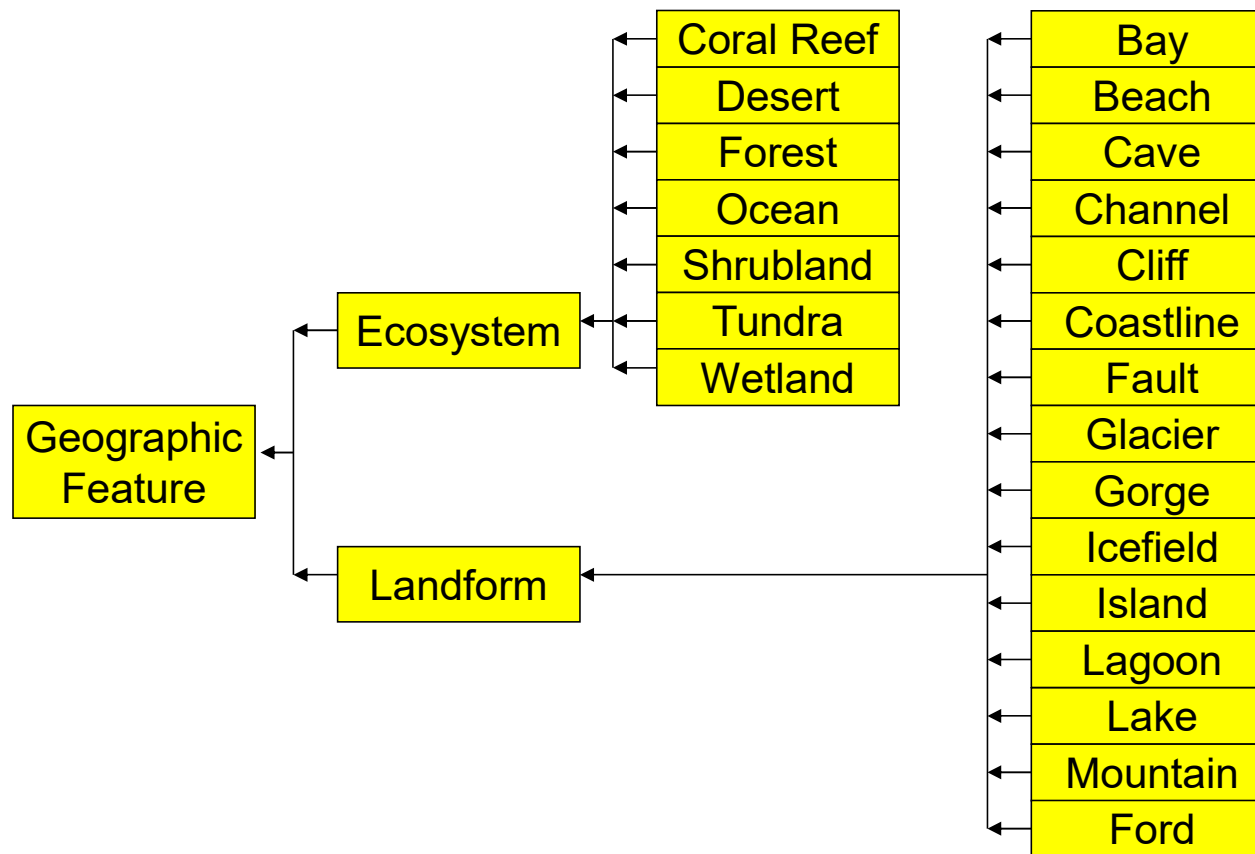
Geographic networks Geo-KG (Shu Wang 2019)



Geographic ontologies

- Basic idea:
 - Modeling classes of objects
- Characteristics
 - Acyclic graph
 - Organization of a vocabulary
 - Main relations « is_a », has_a », « part_whole »
 - Sometimes with additional constraints

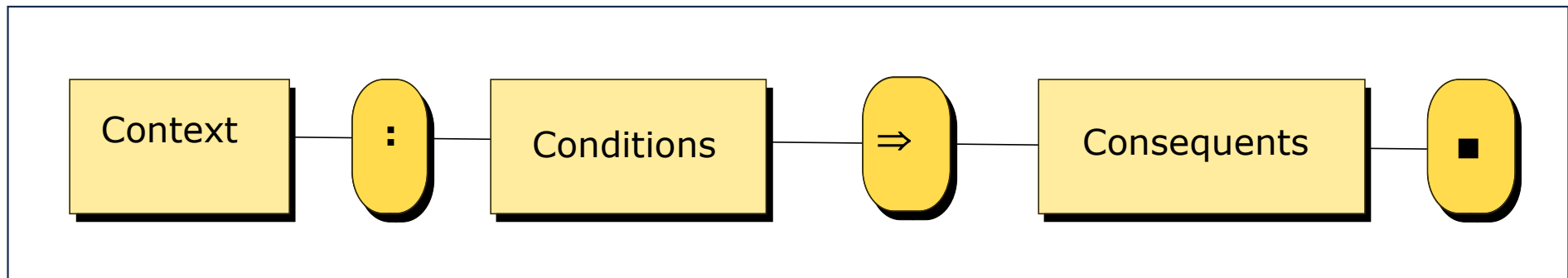
Example of a Geographic Ontology



Rule-based systems

- Basic idea:
 - Modeling rules governing the evolution of a geographic system
 - Extension of expert systems
- Characteristics
 - Logic-based model (IF-THEN)
 - Integration of topology, computational geometry, operation research, etc.

Grammar

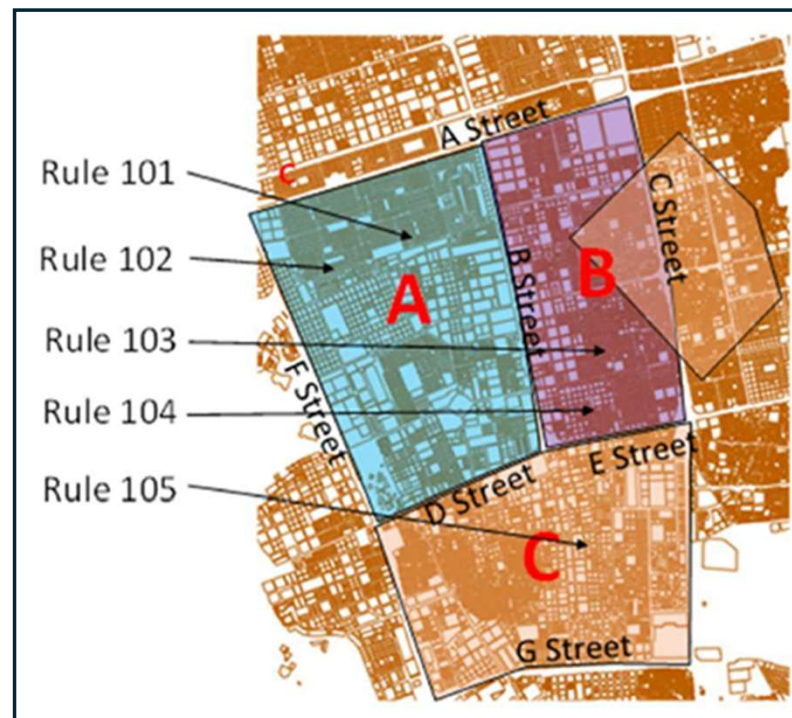


Example of rule

- In an airport, interdiction to construct a building


$$\begin{aligned} & \exists C \in \text{City}, \exists \text{Airstrip} \in \text{Terr}, \forall B \in \\ & \quad \text{Project.Building}, \\ & \quad \text{Name}(C) \equiv \text{"Smart Town"}, \\ & \quad \text{Geom}(\text{Airstrip}) = \text{Polyg}(670, 311; 724, 365; 707, \\ & \quad \quad 386; 650, 330), \\ & \quad \models \text{Contains}(\text{Geom}(C), \text{Geom}(\text{Airstrip})), \\ & \quad \quad \vdots \\ & \quad \text{Contains}(\text{Geom}(\text{Airstrip}), \text{Geom}(B)) \\ & \quad \Rightarrow \\ & \quad \models \text{Status}(B) = \text{Denied} \blacksquare \end{aligned}$$

Located rules



Criticisms of those formalisms

- Interesting to model knowledge elements/chunks and their relations
- But limitation to model bundles of knowledge and their connections

⇒ Design of a bundle-oriented model of knowledge
based on a visual language

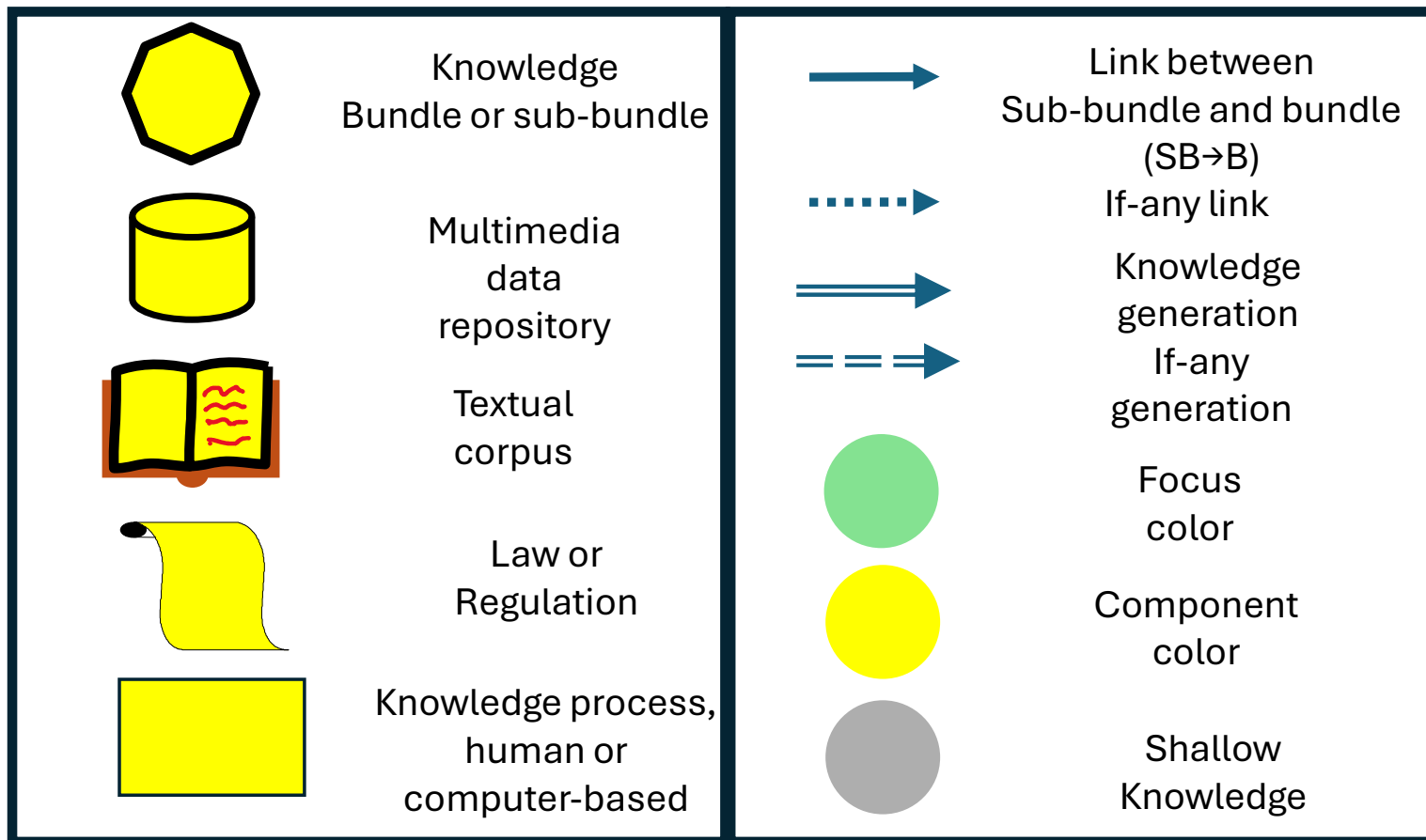
Categories of knowledge

- Bennett and Bennett (2008)
 - Superficial knowledge
 - What a kid knows about a car
 - Shallow knowledge
 - What a car vendor knows about a car
 - Expert knowledge
 - What a car designer knows about a car

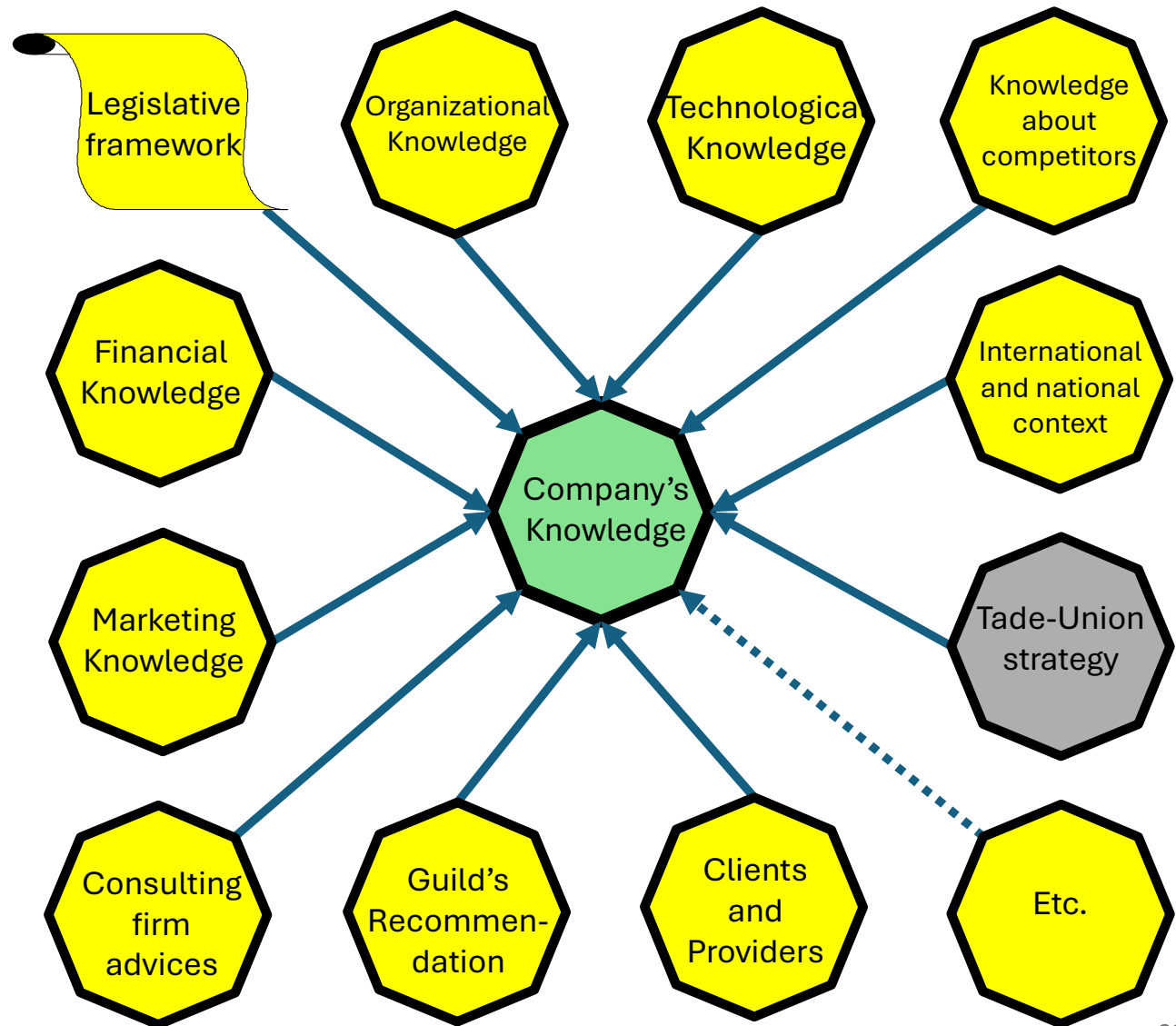
Specifications of the bundle-oriented model

- Not relations between knowledge chunks, but bundles
- Modeling connections between knowledge bundles and sub-bundles
- Distinction between shallow and expert knowledge
- Links with
 - Existing multimedia databases
 - Existing document repositories (textual corpora)
 - Laws
 - Processes generating knowledge

Visual vocabulary

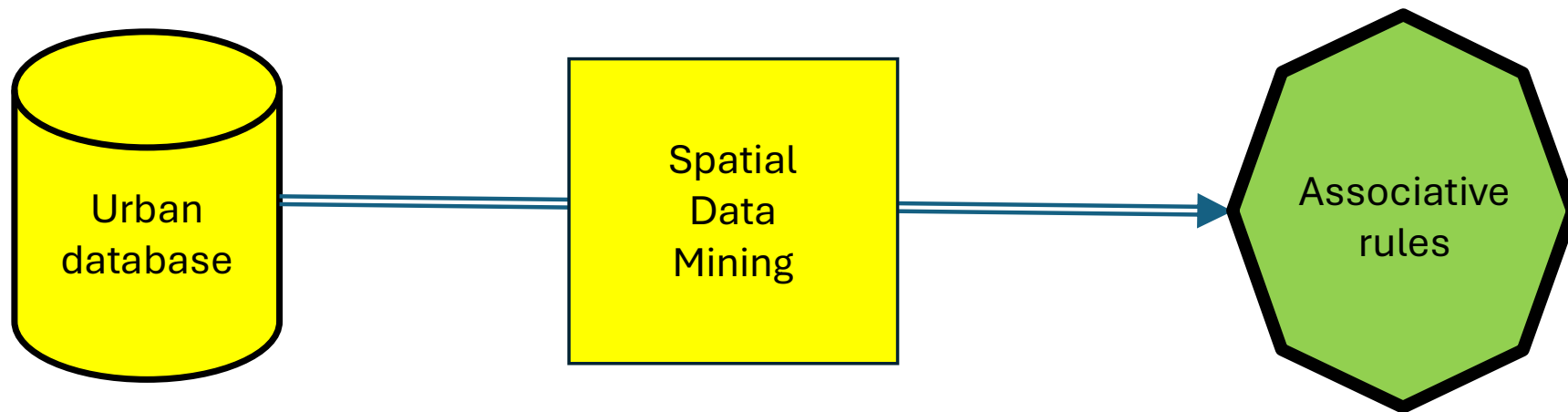


Application on a company



Associated Rules

- Knowledge extracted from data mining



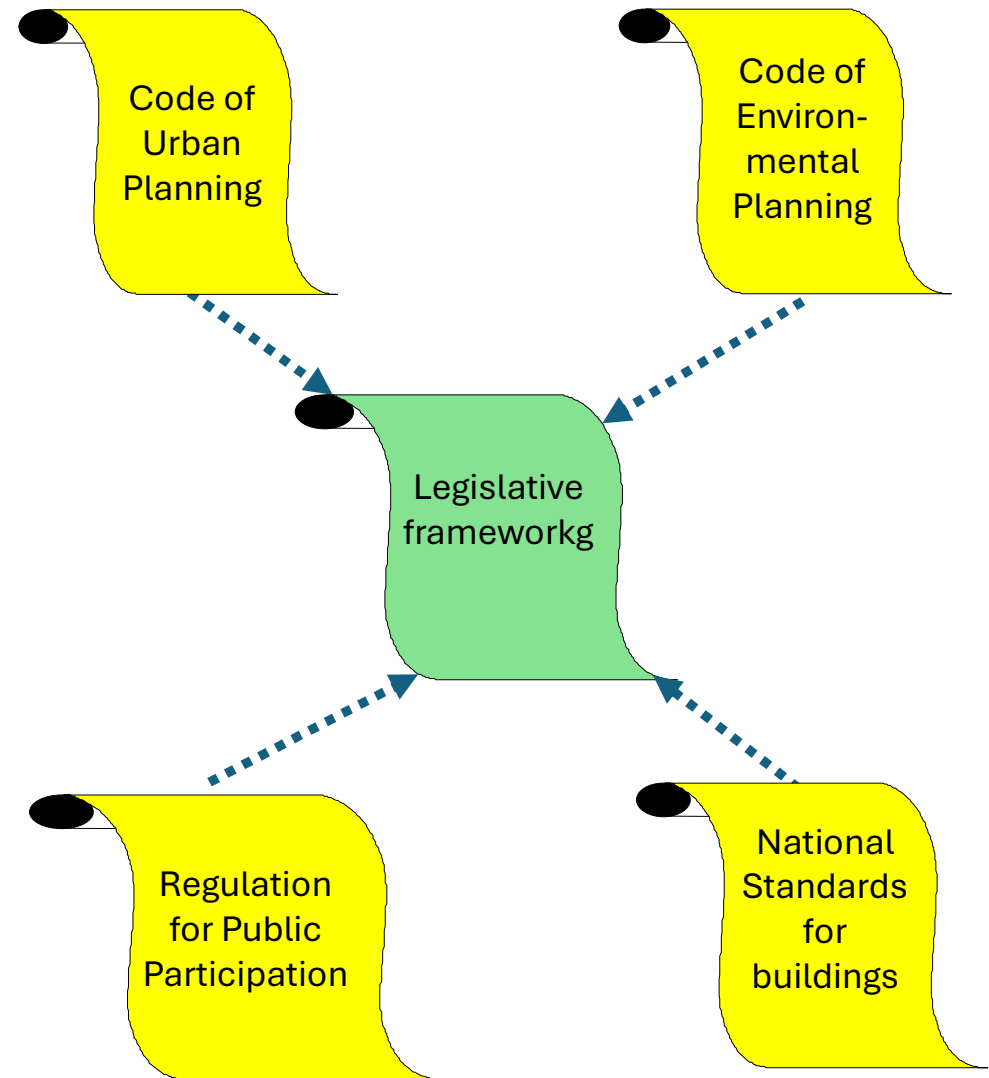
2 – Bundle-oriented model for UP

- Background knowledge
- Multidisciplinary models
- Tips from digital twin cities
- Recommendation from public participation
- Concluding the planning process

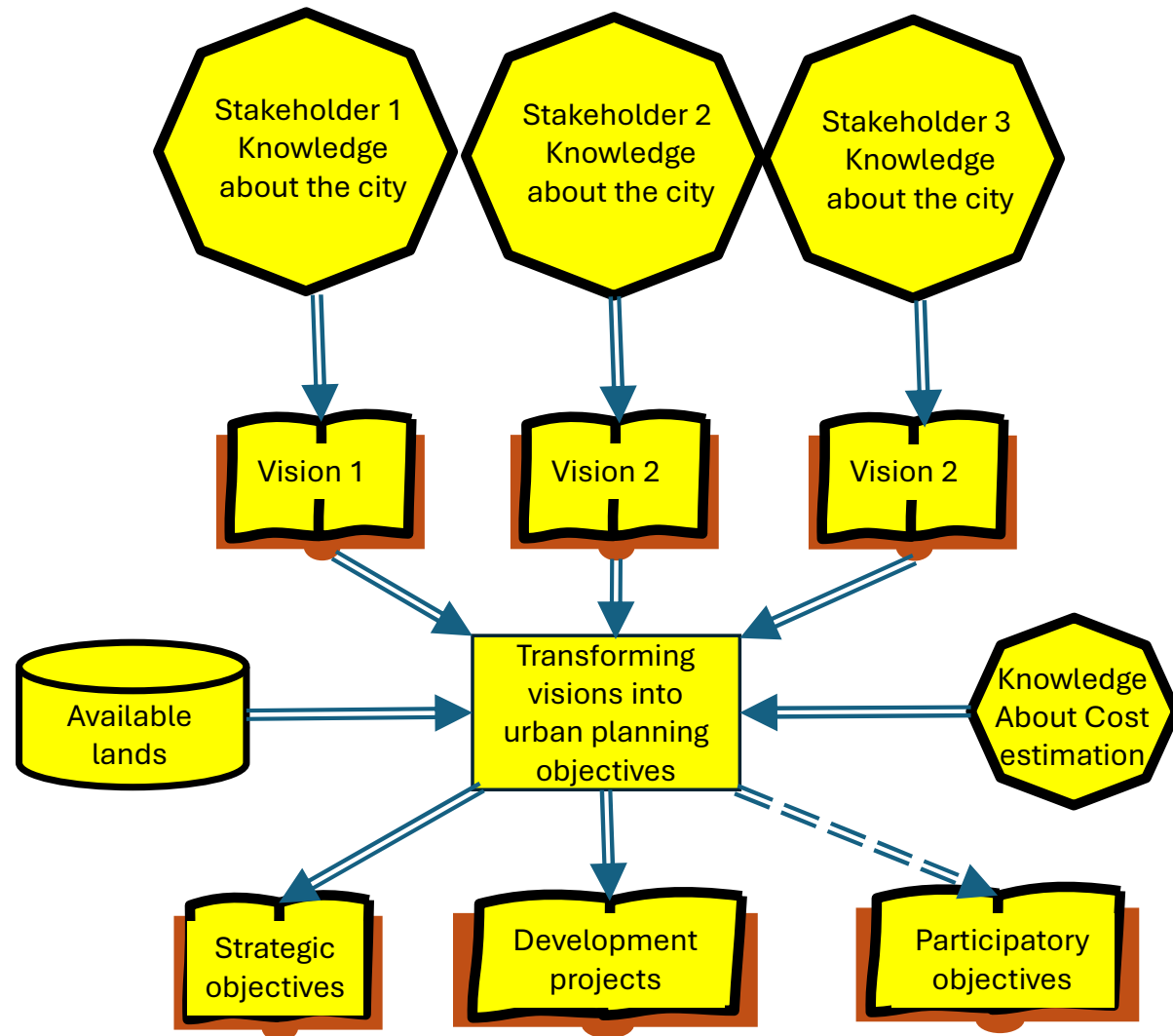
Background Knowledge

- What a planner does know before beginning to plan
- Contents
 - Juridical framework
 - From vision to objectives
 - Methodology
 - Peculiarities of the city

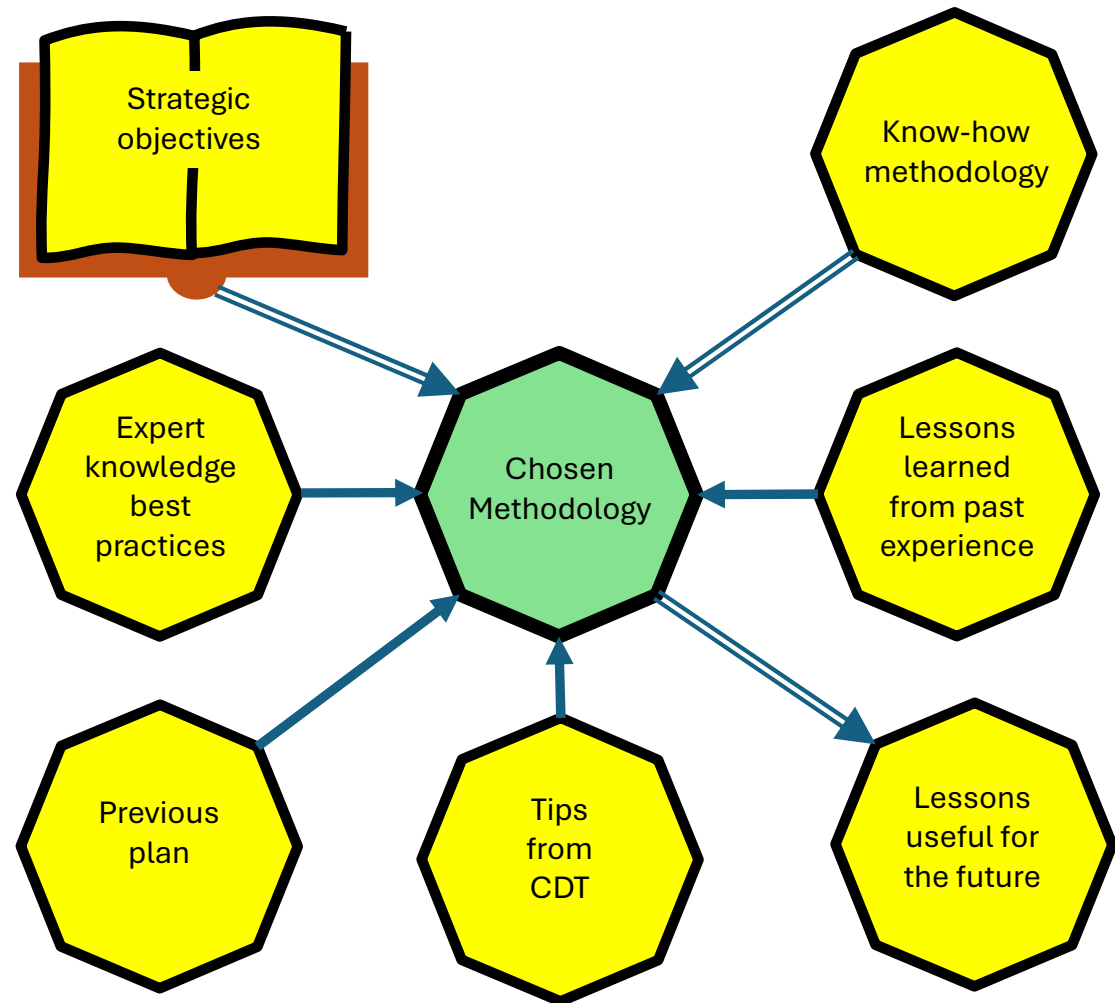
Juridical Framework



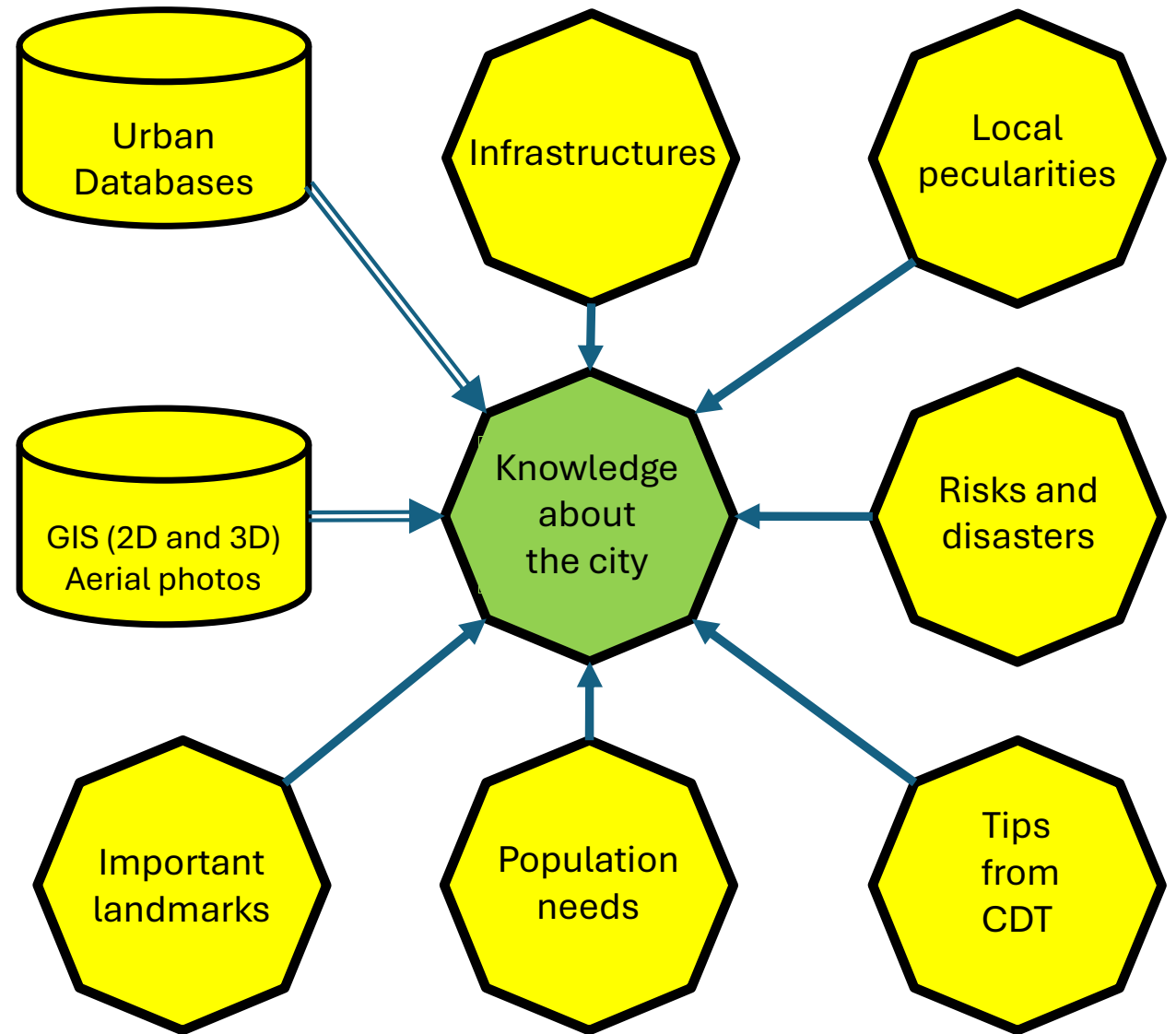
From Visions to Objectives



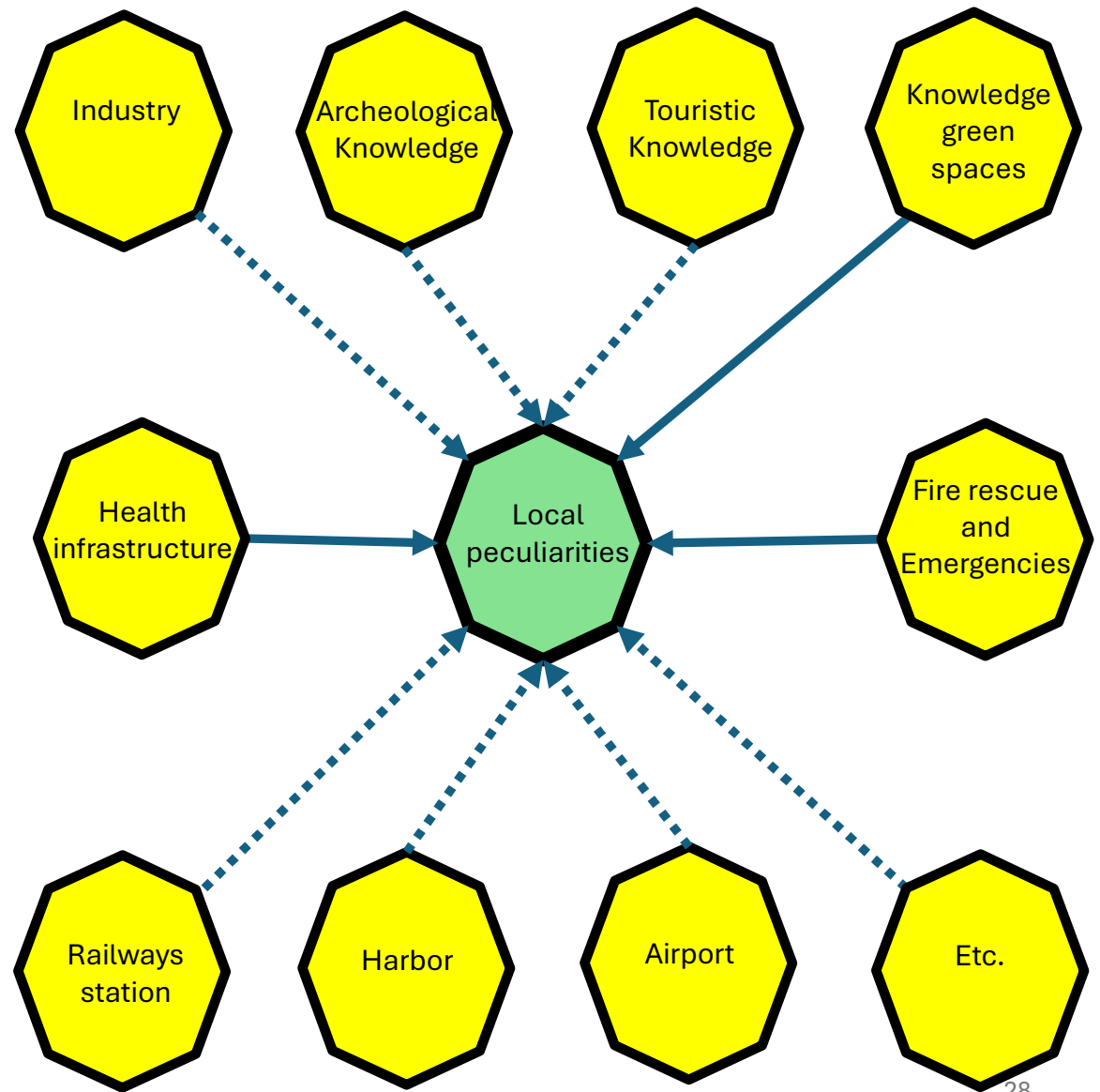
Methodology



Knowledge about the City



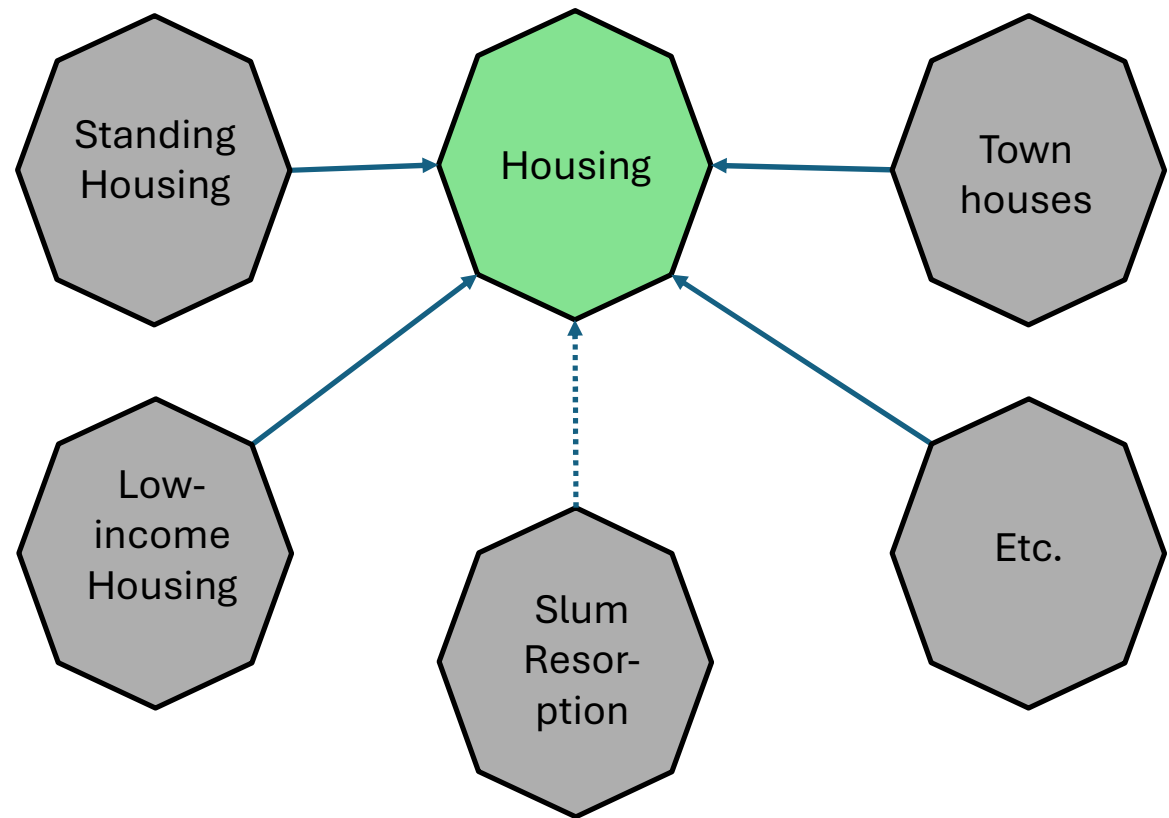
Local peculiarities



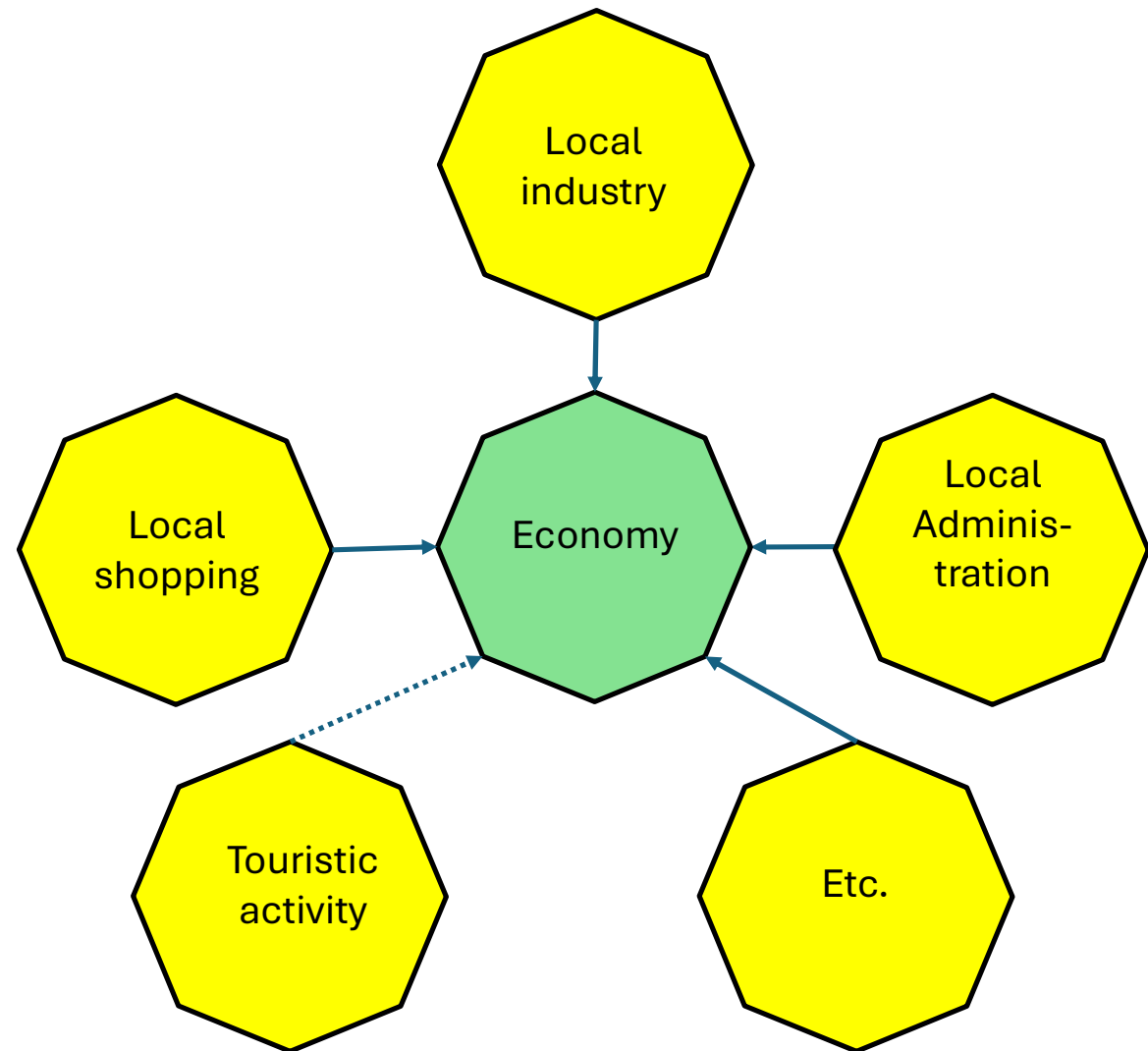
Multidisciplinary models

- Housing
- Economy
- Mobility
- Infrastructure
- Disaster management

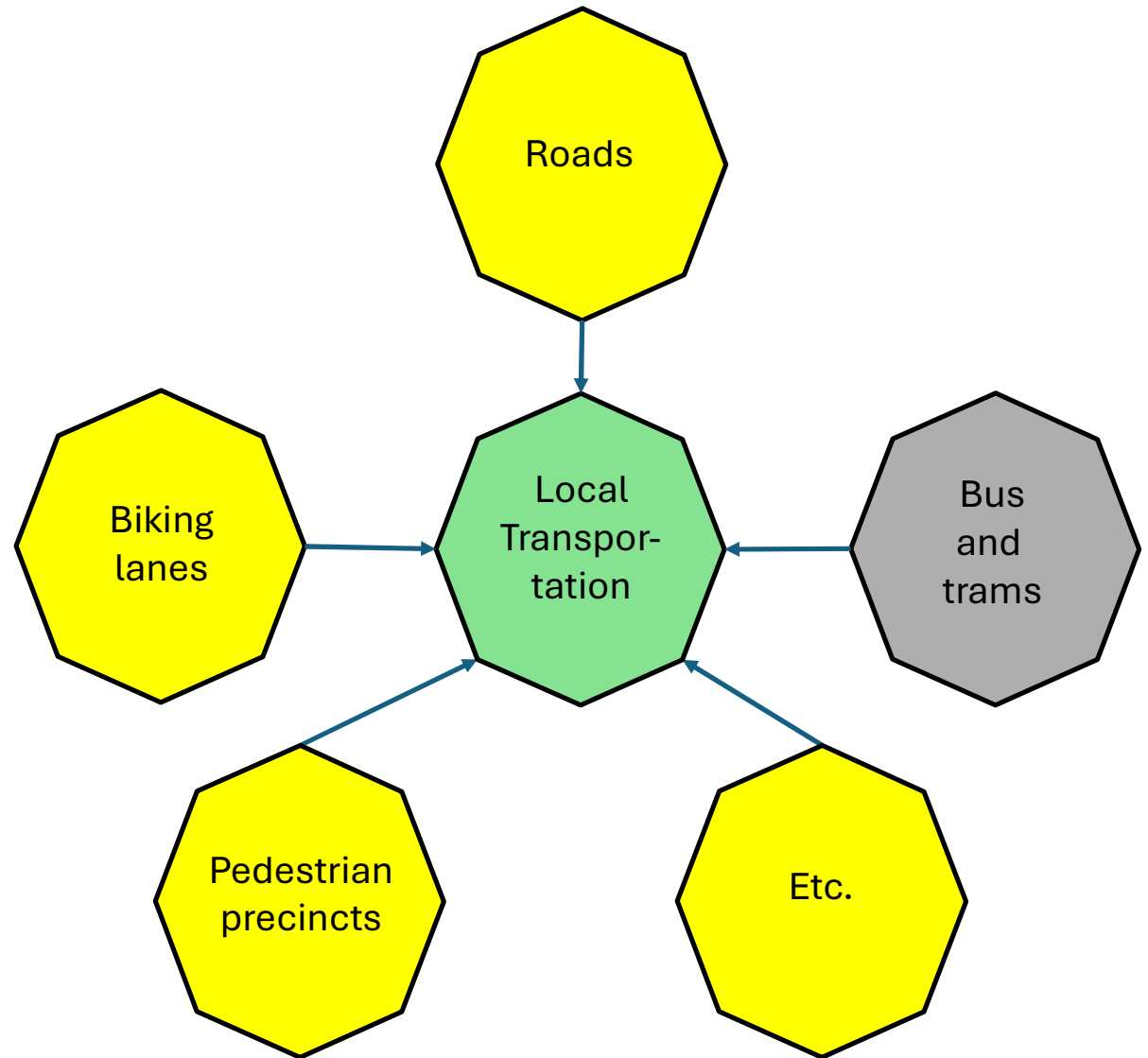
Housing



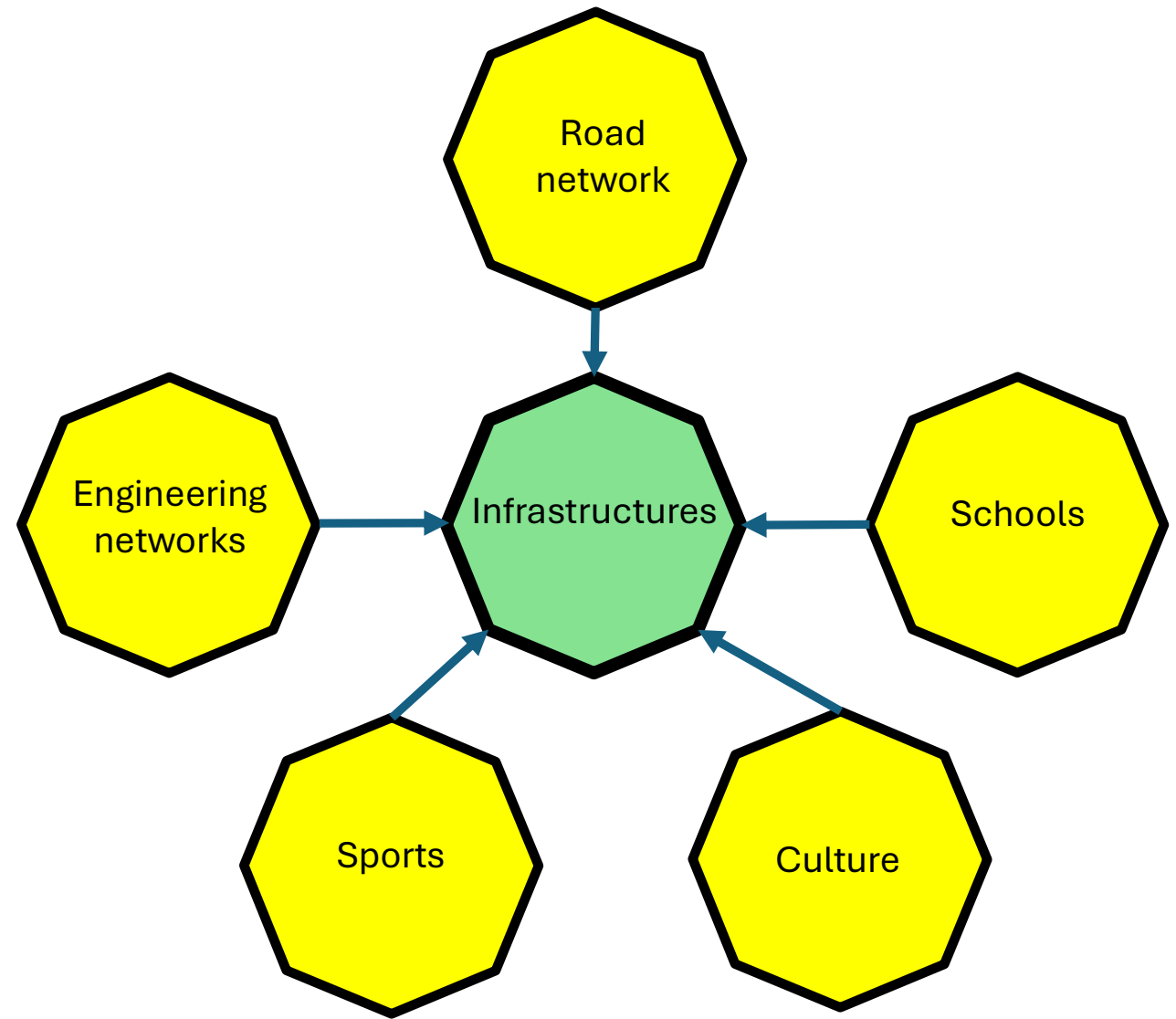
Economy



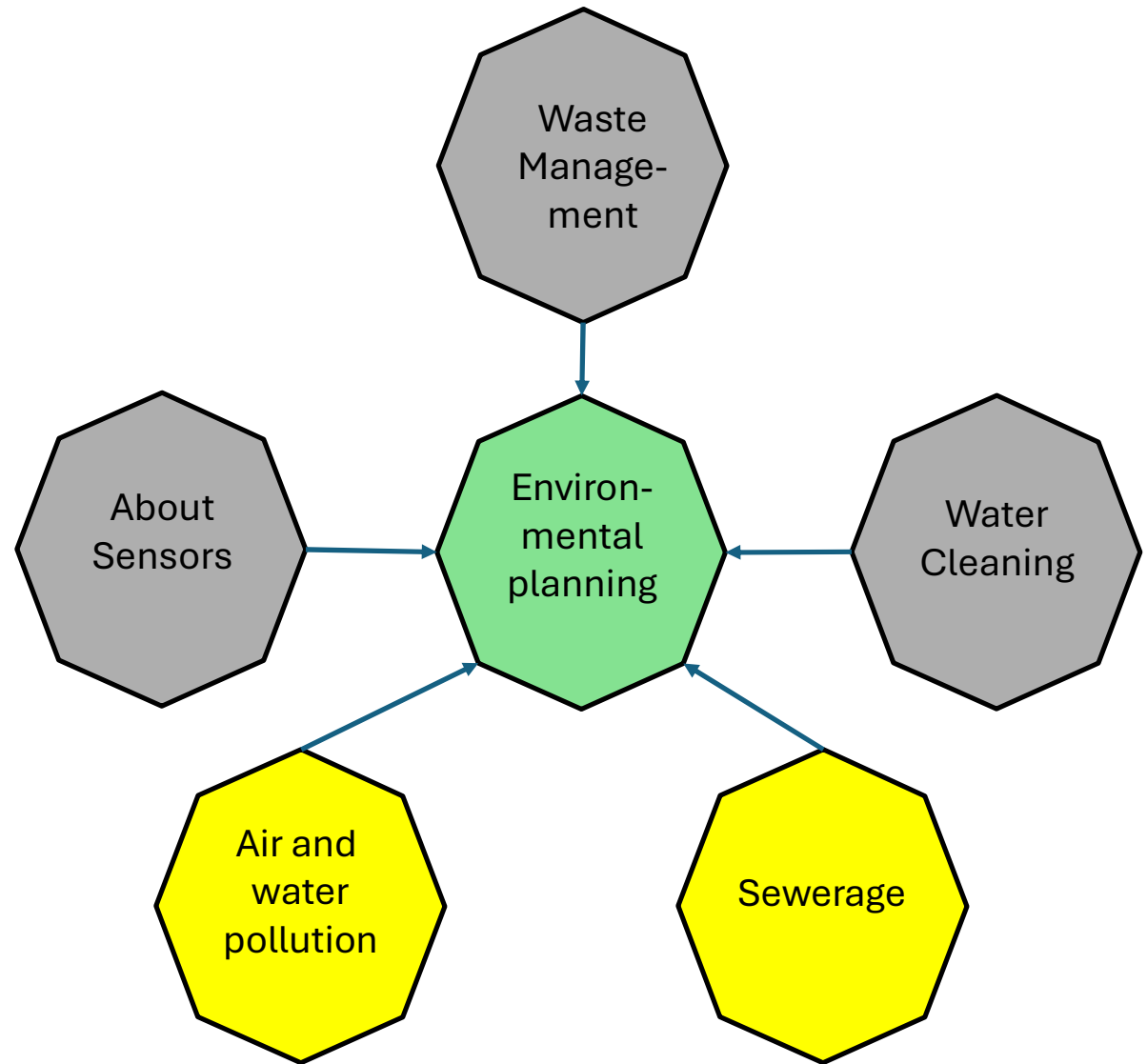
Mobility



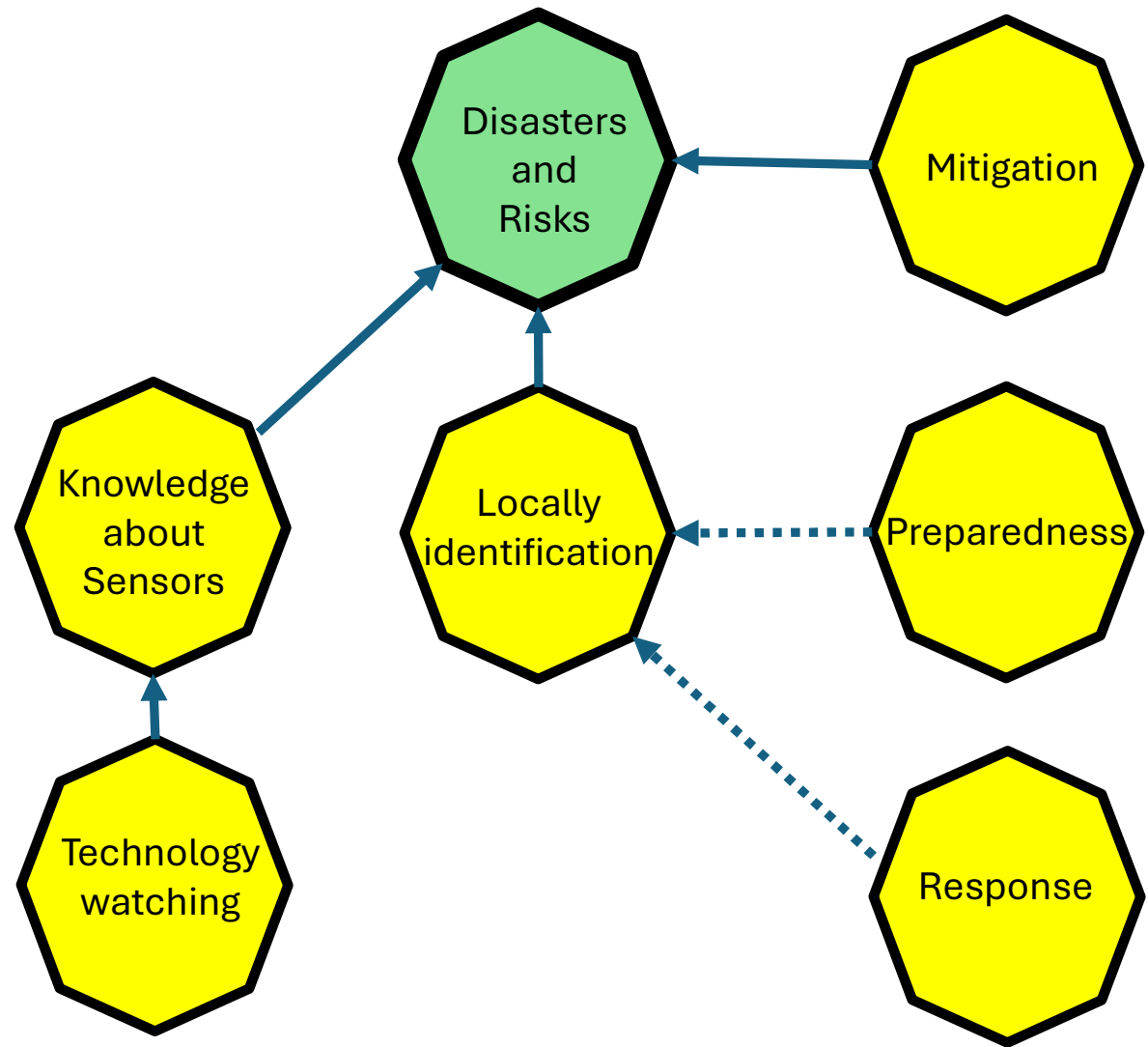
Infrastructures



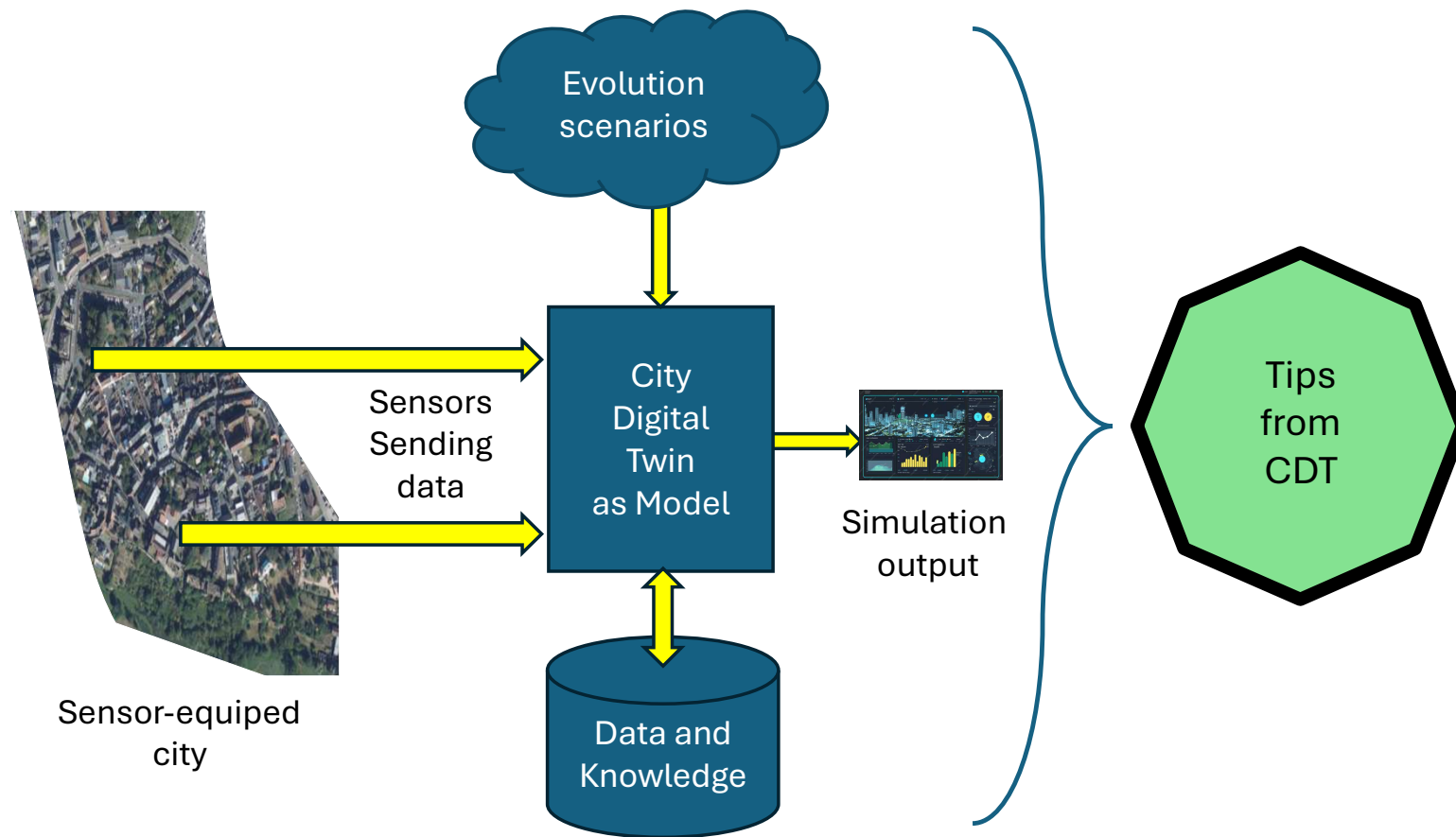
Environment



Disaster and Risks Management



Tips from City Digital Twins

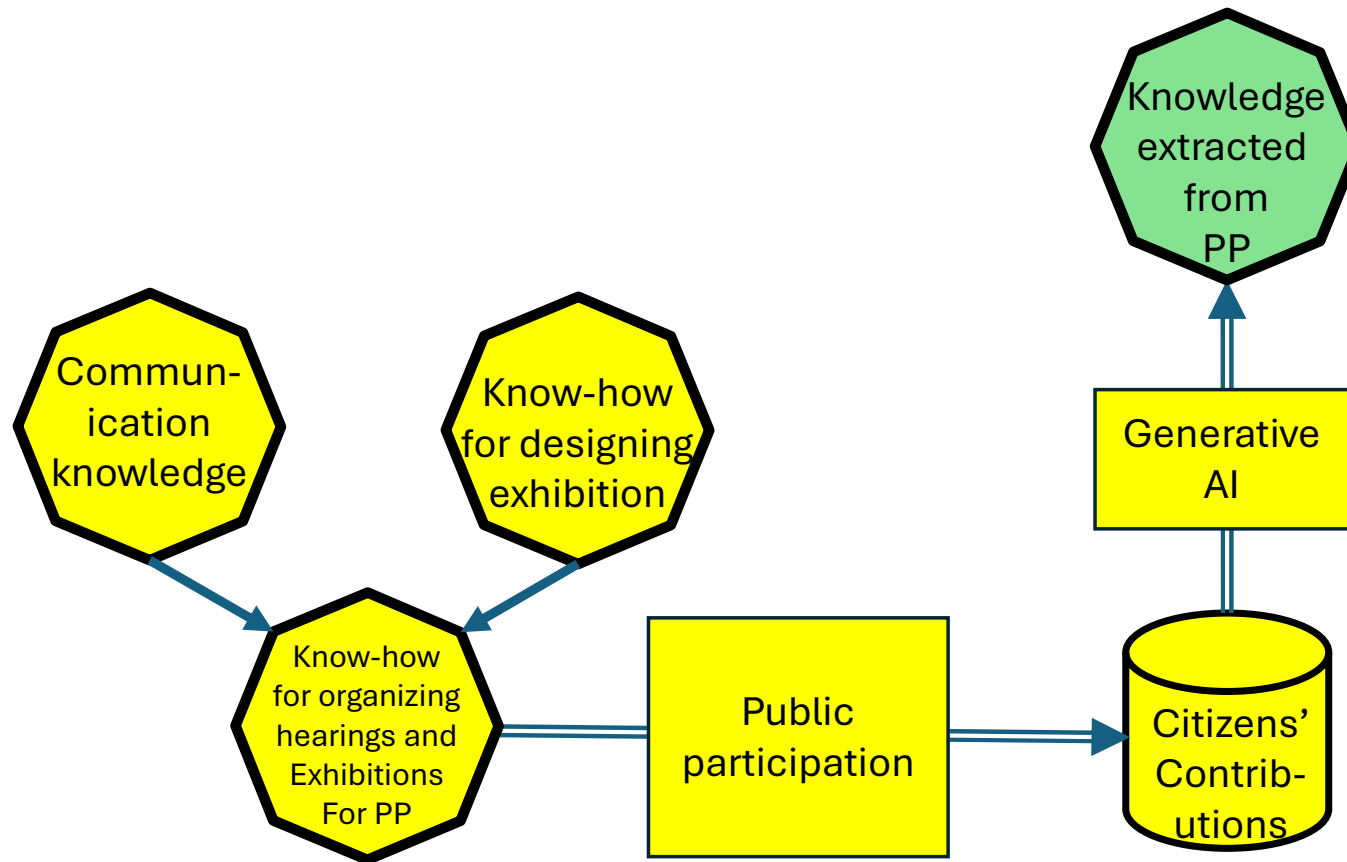


Recommendations from public participation

- According to countries, during the planning process, there are one or several meetings with the citizens in which they give their opinions
- Exhibition, hearings



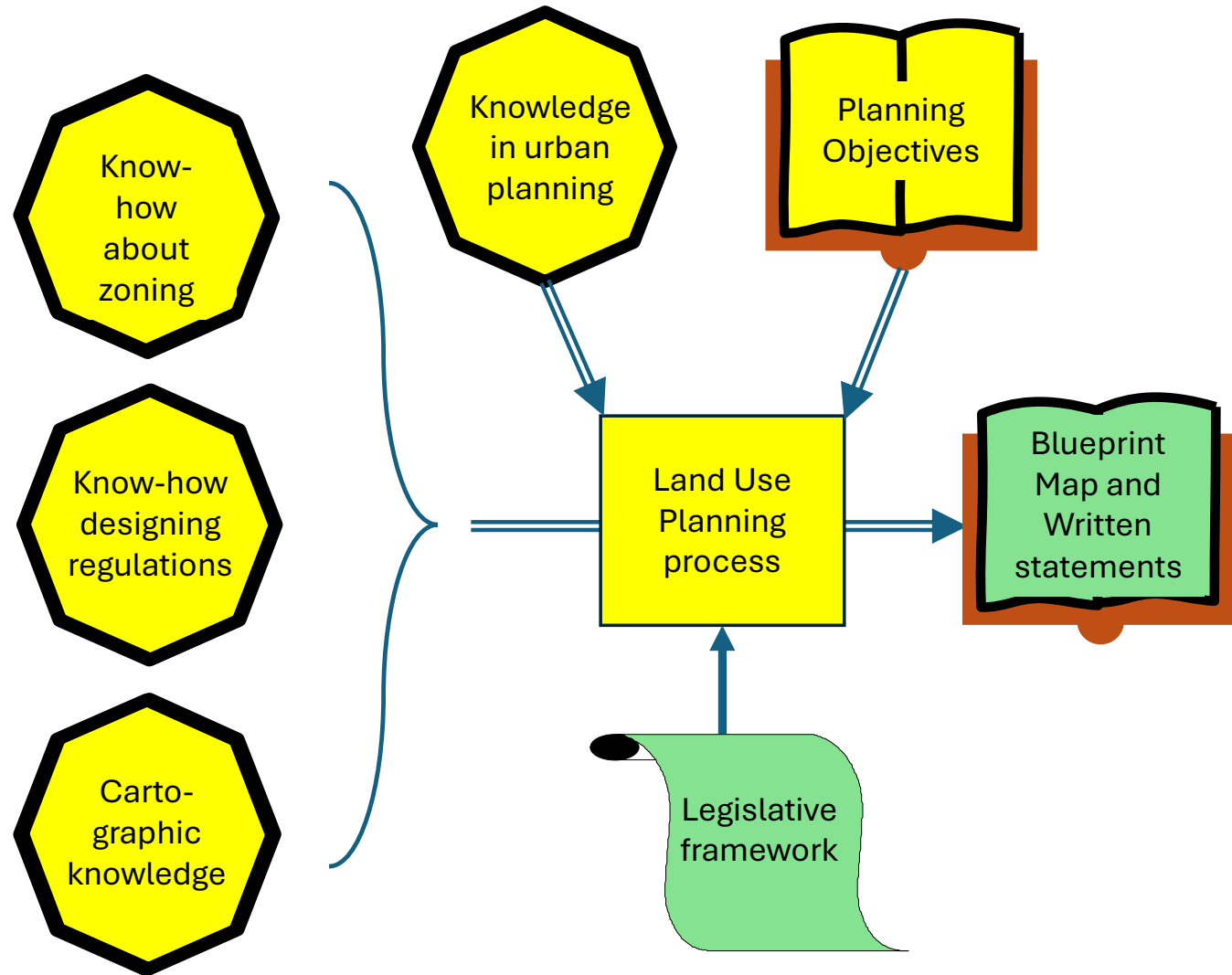
Recommendations from public participation



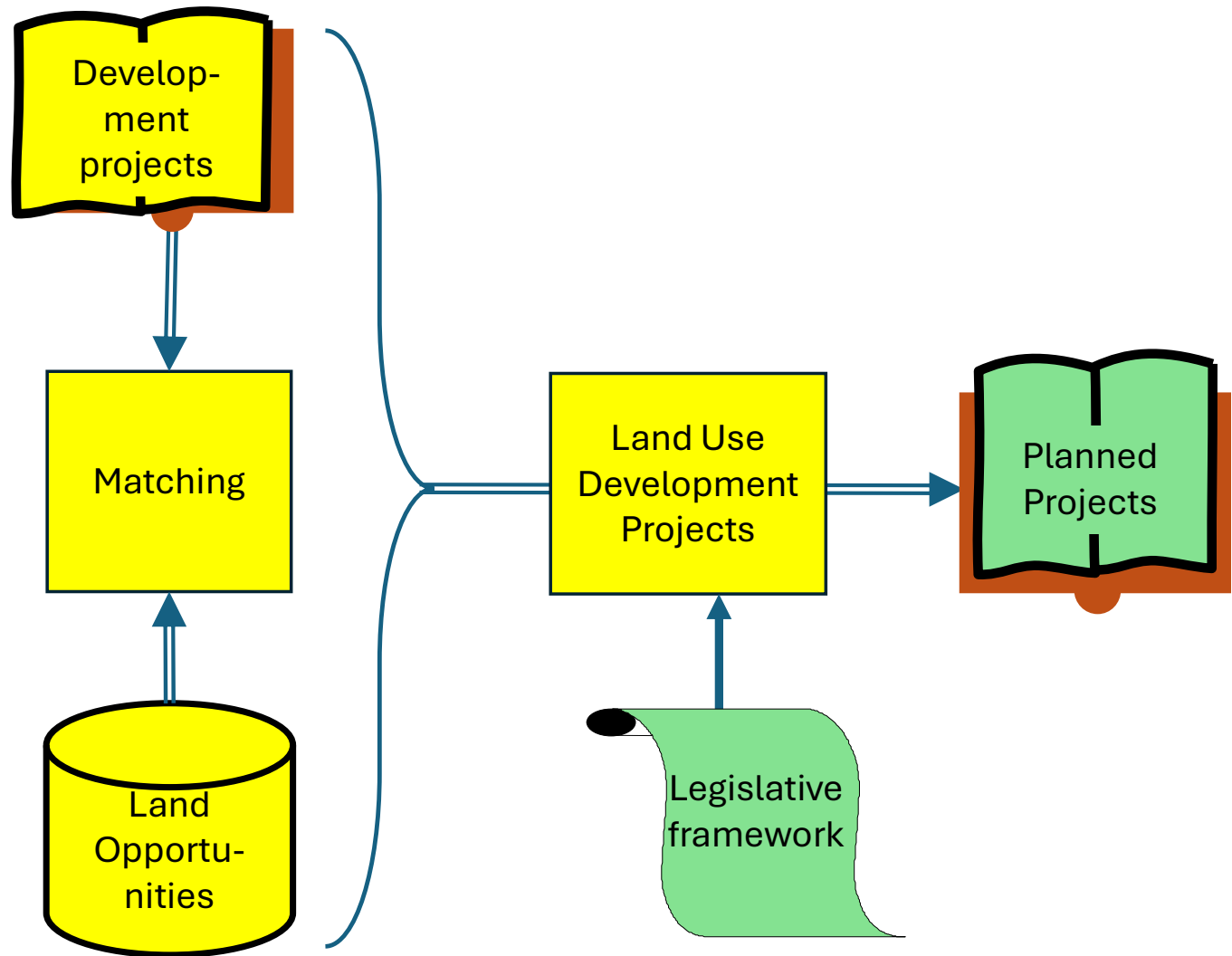
Concluding the planning process

- Design of blueprint of the map and written statements
 - Master plan
 - Various projects
- Approbation
- Lessons learned

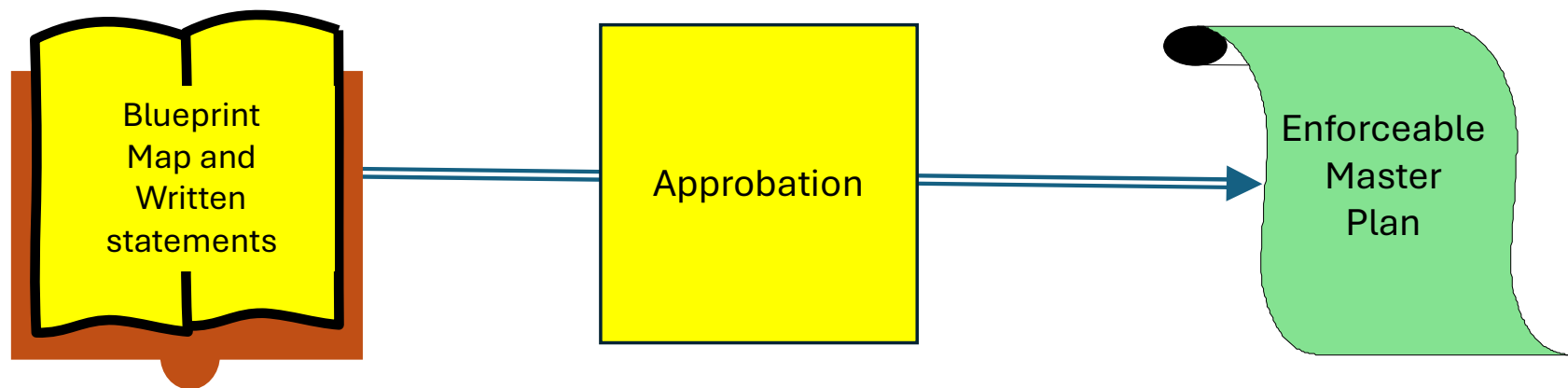
Design of the Blueprint



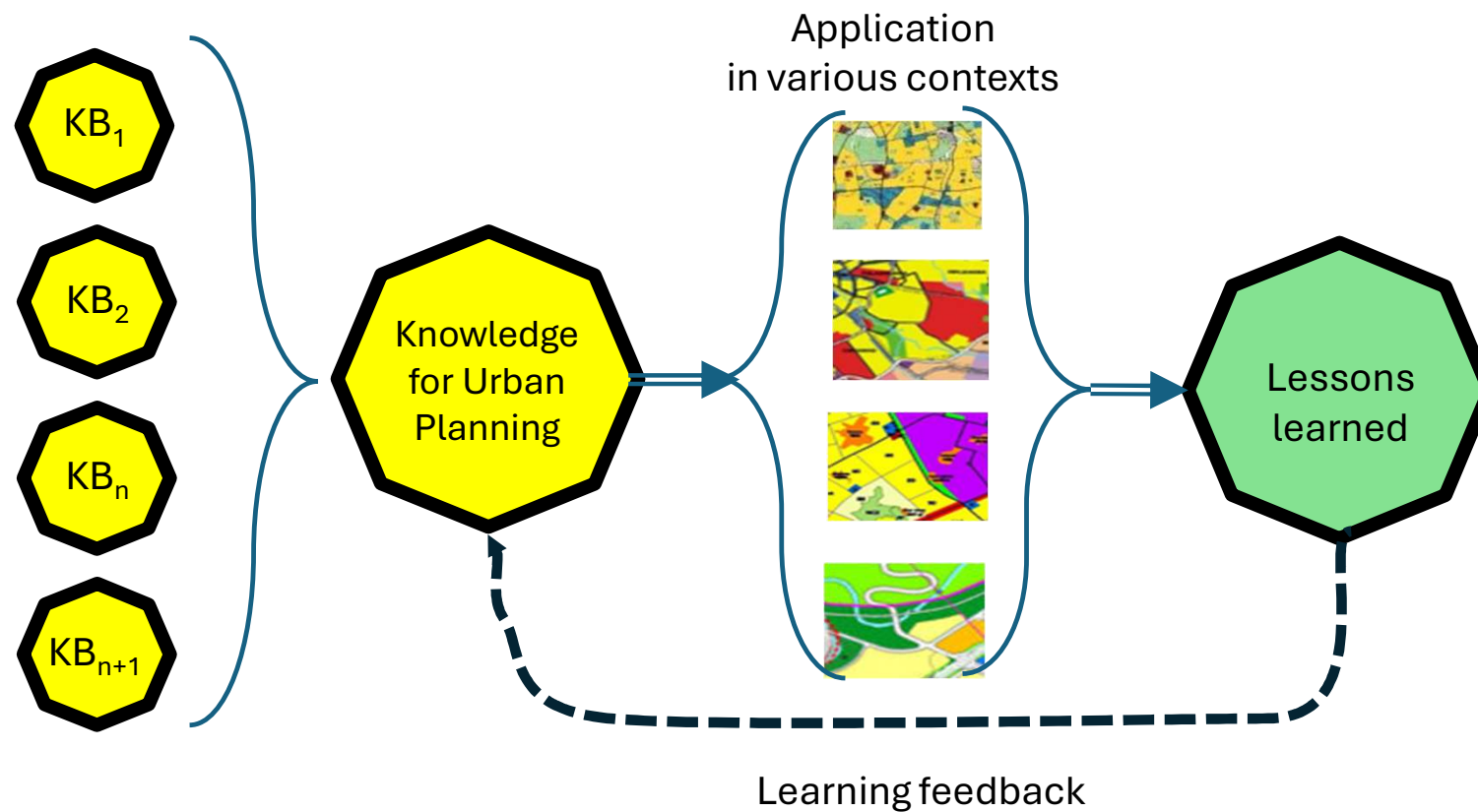
The Case of Development Projects



Final Approval



Learning Feedback from Other Experiences



3 – Conclusions

- Importance of modeling knowledge for any organization
- Example in urban planning
 - Necessity to complete it
- Not only knowledge chunks, but also knowledge bundles
- Proposing a visual formalism
 - Applied to urban planning
 - Can be applied to other domains



Thanks for your attention!



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