The potential and challenges of Digital Twins for 15-minute cities

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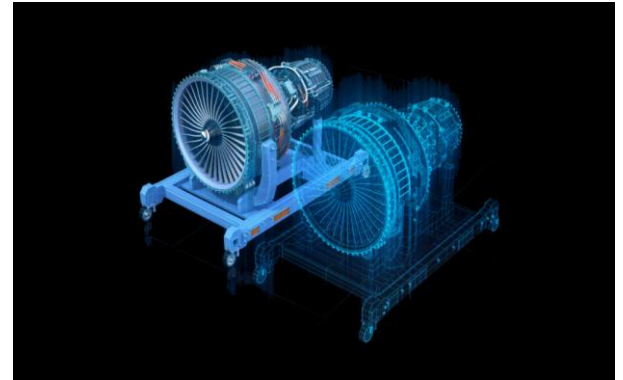MobilTUM Conference - 10.04.2024

Part I
What are Urban Digital Twins and what are they not?

Digital Twins

- A realistic digital representation of a physical object or system (the "physical twin") and its processes.
- Constant interaction through feedback loops: the physical twin informs the digital twin and vice versa.
- Originated from mechanical engineering.

Urban Digital Twins

- A digital twin of a city.
- Originated from the smart city vision.
- Boosted by the constantly increasing volumes of data (the "big data era"), and advancements of data analysis/processing techniques (in particular artificial intelligence).
- Usually consists of a highly-realistic 3D model of the physical environment of the city (buildings, streets, trees).
- Through sensory data collection and simulations we can approximate dynamic processes within that environment in near-real time, and predict or explore possible future scenarios.
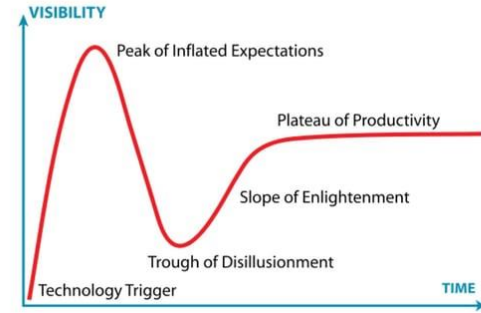
PHYSICAL CITY

VIRTUAL CITY

INFORMATION FLOWS

SIMULATIONS & PREDICTIONS
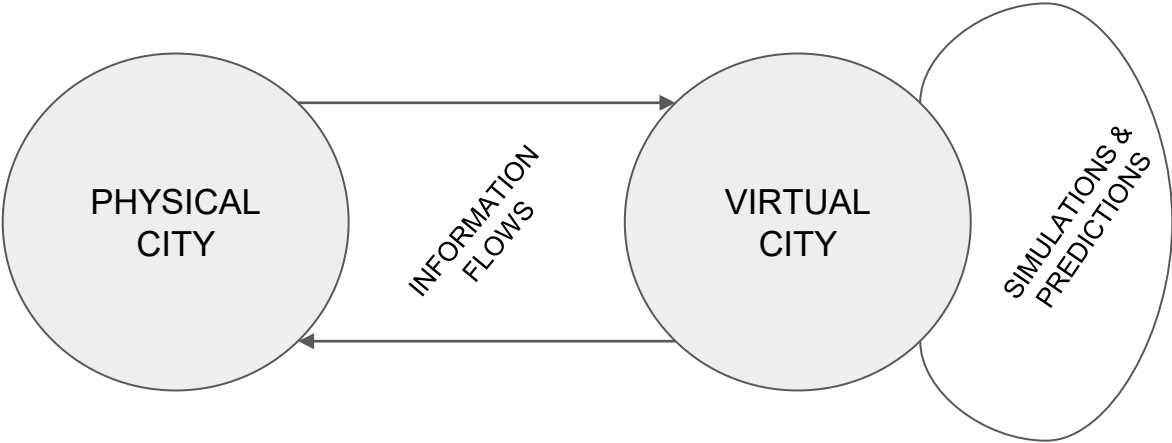
Are Urban Digital Twins a hype?

- Certainly yes!
- There are a lot of promises being made but it remains unclear what "this thing" really is and how it can really be of value.
- But also hypes can develop into something useful →

Gartner Hype Cycle

Part II
Digital Twins of 15-minute cities?

The broader vision of the 15-minute city

- More than just the 15-minute walk or bike ride to important services.
- Cities in which people are at the core of planning practices, not technology.
- Stimulating community building, social interactions, citizen participation, equality, green and liveable streets.

Digital Twins of 15-minute cities: Terms of Use*

- I will remember that a digital twin is not the real world, but just a simplification of it. The real world does not satisfy my equations.
- I will remember that a digital twin is one tool in the urban planners toolkit, which I will use to gain insights I may not have had before, but not to replace all essential phases of the planning process.
- I will not give people false comfort about the accuracy of the digital twin. Instead, I will make explicit its assumptions and oversights.
- I understand that the digital twin can influence the functioning of the city that it represents, in ways that may be beyond my comprehension.

CITIES ARE COMPLEX SYSTEMS

...AND THEY'RE MADE OUT OF PEOPLE

* Adapted from "The Financial Modelers' Manifesto":
https://en.wikipedia.org/wiki/Financial_Modelers%27_Manifesto

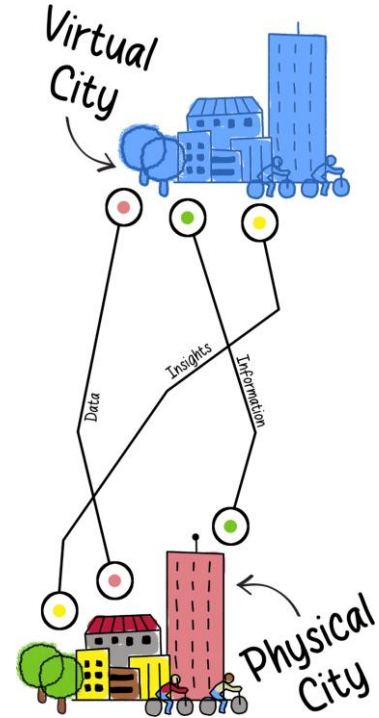# Digital Twins of 15-minute cities: Benefits

A central platform to …

- … simulate and assess urban planning scenarios in all four dimensions (3D space and time), from the human perspective.
- … make planning scenarios imaginable and interactively adjustable in participatory planning processes.
- … collect, store, organize, visualize all different kinds of data about the city.
- … integrate data analysis workflows using interdisciplinary, holistic approaches that build bridges between different sectors.
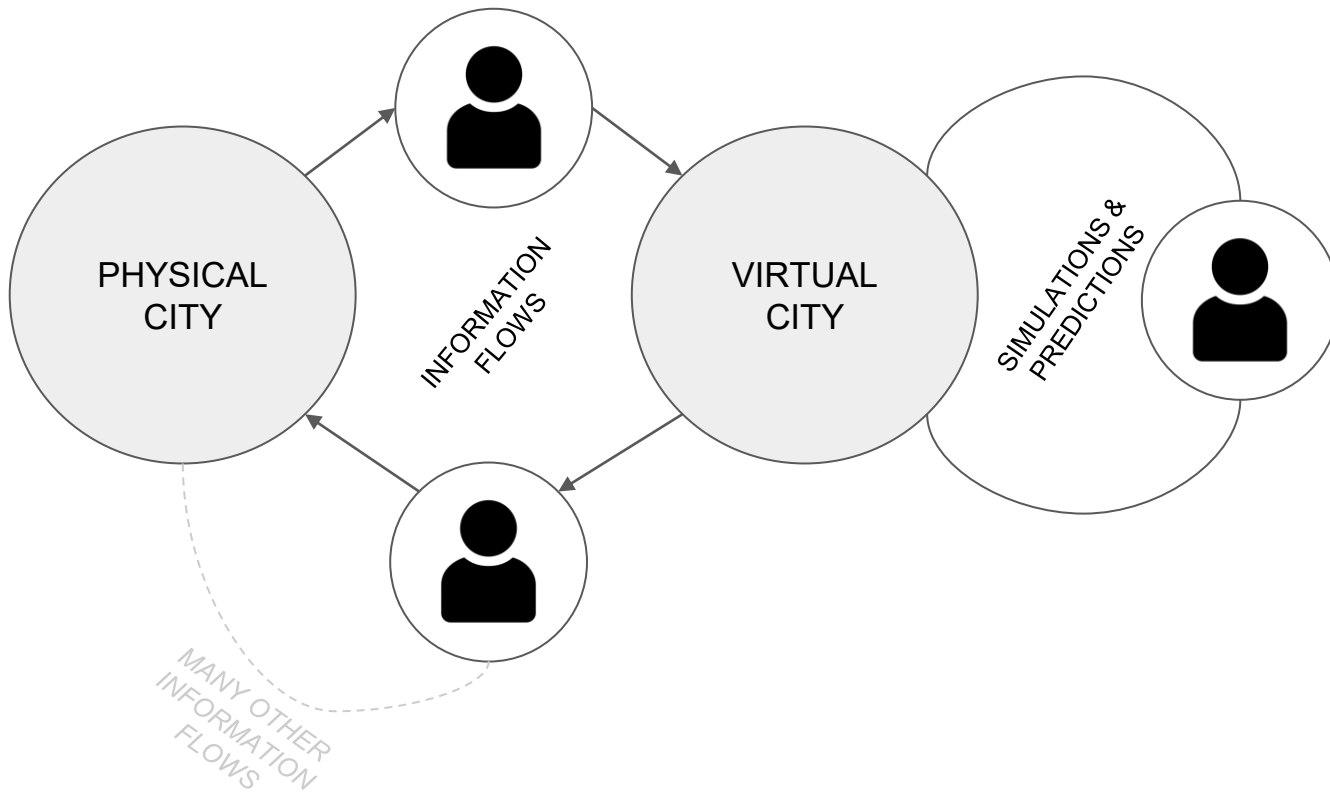
Digital Twins of 15-minute cities: Requirements

- A wide variety of input data, both quantitative and qualitative. Not just that which is "easily and objectively measurable".
- Explainable and transparent models, reducing black boxes.
- Shift of focus from the supply side (*how can we find use-cases for all the fancy data, technologies and algorithms we have?*) to the demand side (*what questions do we have that need an answer?*)
- Shift of focus from techno-centric model evaluation (*how does this optimize efficiency?*) to human-centric model evaluation (*how does this benefit people's well-being?*)
- No "one-fits-all" solution, but a flexible framework that can integrate local characteristics.
- Human involvement in all stages of the feedback loop: the "humans-in-the-loop".

PHYSICAL CITY

INFORMATION FLOWS

VIRTUAL CITY

SIMULATIONS & PREDICTIONS

MANY OTHER INFORMATION FLOWS

Digital Twins of 15-minute cities: Challenges

- Standard challenges of working with humans in data science:
  - Privacy, ethics and security
  - Accuracy assessment
  - Accountability
- Human-digital twin interaction:
  - Convert broader policy goals into specific questions for the digital twin
  - Convert model outputs into understandable and explainable narratives
  - Develop intuitive user interfaces that support participatory planning
- Develop interdisciplinary analytical workflows to link different types of data and gain insights from them in the 4D domain.
- What level of detail is needed to be fit-for-purpose? What monetary and computational resources does this use?
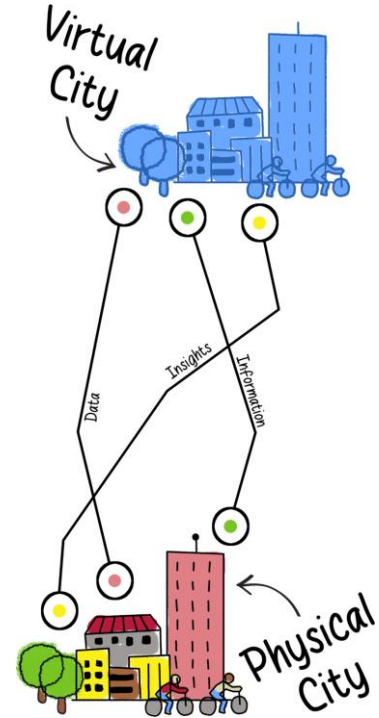
Part III
The CITWIN project

CITWIN

- A 3-year project aiming to explore the potential and challenges of digital twins for the 15-minute city in more detail, with a focus on sustainable mobility planning.
- Funded by the DUT partnership.
- Collaboration between universities, cities, companies and NGOs.
- A practical, innovation-oriented approach.
- All stakeholders are involved throughout all project phases.

CITWIN: Urban Living Labs

- Two medium-sized European cities that are adopting the 15-minute city paradigm.
- The planning authorities and the citizens will actively participate in:
  - Designing policy scenarios and converting them into questions the digital twin may answer.
  - Collecting and providing input data from different sources.
  - Evaluating benefits and shortcomings of the developed digital twin framework.

Aarhus, Denmark

Eskilstuna, Sweden

Thank you!

Questions, comments, …?

More info about CITWIN on the project website (under construction): http://citwin.eu/
Or follow the project on LinkedIn: https://www.linkedin.com/company/citwin/