Working on better cities with fewer cars

Report: Outcome Report on the XCARCITY–DMI Ecosystem Synergy Workshop

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1. Motivation for the Workshop

The XCARCITY and DMI synergy workshop, held on Thursday, 10 April 2025, at Het Vakwerkhuis Delft, was organised to explore and identify potential synergies between the XCARCITY research programme and the DMI Ecosystem.

The DMI ecosystem is a national public-private ecosystem aimed at building sustainable and liveable cities together with governments, companies, and knowledge institutions. One of its accelerators the adoption of digital twins in different domains in the Netherlands, such as urban mobility systems. In parallel, XCARCITY focuses on integrating diverse models and methods into a digital twin federation that supports strategic and operational decision-making for cities with reduced private vehicle dependencies.

As both initiatives share a strong focus on sustainable urban environments through digital twin technology, our workshop served as a platform to explore synergies between ongoing research and other national and international digital twin efforts. We also sought to understand how stakeholders at different layers—policy, research, implementation—can collaborate more efficiently, and identify future opportunities for innovation. Amsterdam Zuidas was selected as a specific use case, serving as a practical reference point to review ongoing digital twin developments and identify opportunities for joint actions.

2. Participation

The workshop hosted over 30 participants across the various sectors, including academic institutions, government agencies, research organisations, and industry partners.

The following organisations were present on the day:

- AMS Institute
- CROW
- Gemeente Amsterdam
- Gemeente Almere
- Geonovum
- Goudappel
- Ministry of Infrastructure and Water Management
- Map TM
- Technolution
- TNO
- TU Deft

3. Insights from Separate Presentations

3.1. Opening Statement

The workshop opened with an introduction by Bart van Arem emphasising the need for innovative, digitally driven solutions to address growing urban challenges such as accessibility and sustainability. The joint effort between the XCARCITY programme and the DMI ecosystem was presented as an opportunity to leverage complementary expertise and resources.

3.2. XCARCITY Introduction

Bart van Arem introduced the XCARCITY programme, highlighting its aim to understand the transformation of urban mobility through digital twin federations. Emphasis was placed on the shift from traditional mobility paradigms towards flexible, service-oriented, and data-driven solutions, aiming for sustainable, inclusive accessibility in increasingly dense urban areas.

3.3. DMI Introduction

Roy Boertien outlined the DMI Ecosystem's purpose, focusing on creating favourable conditions for digital twin scalability and adoption (in public-private cooperation). Key activities include setting unified standards for data exchange and practical demonstrators designed to validate and encourage widespread digital twin use in urban mobility management.

3.4. XCARCITY Digital Twin Federation

Jingjun Li presented XCARCITY's Digital Twin Federation concept, detailing its functionalities for real-time management and strategic urban planning. Core components include data integration, advanced modelling capabilities, interactive visualisation tools and human-in-the-loop control, aimed at effectively supporting sustainable urban mobility decisions.

3.5. DMI Digital Twin Overview

Gineke van Putten introduced Geonovum's National Digital Twin reference architecture, framing it as an interoperable "Digital Twin as a Service". She stressed the importance of open standards that connect data, models and visualisations. Testbeds and field labs already demonstrate how these modular building blocks can be reused nationally and shared across Europe.

3.6. Car-low Development and Regulation

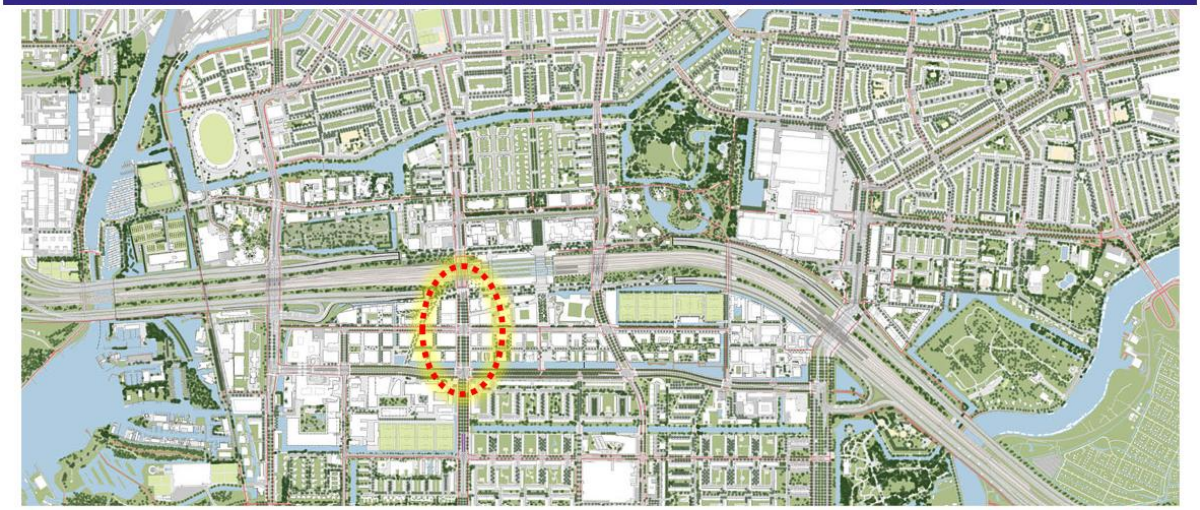
The session was hosted by Michiel van Dongen, Jyotsna Singh and Sean van der Lee. They addressed regulatory frameworks, strategies, and success factors for car-low city development, showcasing international examples like Copenhagen's cycling superhighways and Barcelona's superblocks. Emphasis was on balancing push (restrictions) and pull (alternatives) strategies, integrated transport planning, and developing measurable KPIs for assessing policy effectiveness.

3.7. Interactive Session

In the afternoon interactive session, Barry Ubbels first introduced the Amsterdam Zuidas redevelopment project, highlighting challenges related to transitioning from a traditionally car-centric area to a more pedestrian-friendly, multimodal urban space. The presentation stressed the importance of digital twins for informed spatial planning and behavioural changes among stakeholders. Currently, Zuidas relies on tools such as 2D mapping and a traditional transport model (VMA). There is a stressing need for new visualisation tools (3D) that support in spatial planning choices (how to divide space between staying and moving). Special attention should be paid for walking as large pedestrian flows in Zuidas are expected after construction.

Then, Bart van Arem summarised insights from surveys during participant registration, noting widespread familiarity with digital twin technologies among participants. He introduced the interactive workshop goals: identifying how digital twins can concretely inform intervention decisions, with special attention to integrating data, models, and visualisation tools effectively.

Case Parnassusweg (intersection)



Proposed (Zuidas finished)

Finally, in the interactive session, participants were divided into four groups, each tasked with exploring how digital twins could concretely support policy goals at different spatial and decision-making scales. Specifically, participants were asked to look at (1) How can a digital twin help to understand the contribution of the interventions on policy goals; and (2) What are the components of the digital twin in terms of data, models and visualisation?.

Three groups focused on specific intersections within the Amsterdam Zuidas case:

- At the **Micro Level**, Zuidas is eager to explore the interaction between modalities such as public transport, bicycles, pedestrians and cars. How do we evaluate the flows of pedestrians to support the design decisions in the area?
- At the **intermediate level**, Zuidas is aiming to reduce the impact of cars (including traffic flows and better spatial quality). How do we support Zuidas with insight for strategic decisions based in space and time?
- At the **Macro level**, Zuidas is interested in the behaviour change of citizen. How do we shift behaviour to more sustainable modes of transport and what policy interventions could we include to support this.
- The fourth group took an **integrative perspective**, examining how digital twins could effectively aggregate insights from all three intersections into a cohesive planning strategy.

4. Main findings

The XCARCITY–DMI Ecosystem Synergy Workshop successfully identified several areas of common interest and synergy potential between both initiatives. The key outcomes are summarised as follows:

1. **Shared Vision on Digital Twins for Urban Mobility:** Participants reached a consensus on the development and use of digital twins for urban mobility, highlighting four essential components:
    - **Data and Data Acquisition:** Establishing robust methods for gathering accurate and relevant urban mobility data.
    - **Modelling and Analytics:** Enhancing analytical capabilities to better model urban scenarios and mobility behaviours.
    - **Visualisation and Imagination:** Using advanced visualisation tools to better understand and communicate complex urban dynamics.
    - **Interactive Human-in-the-loop:** Ensuring user-centric design and facilitating stakeholder involvement throughout the decision-making process.
2. **Complementary Approaches:** A clear delineation of complementary roles emerged:
    - The **DMI Ecosystem** primarily aims to create favourable conditions for the efficient scaling and broader adoption of digital twins. This includes the development of unified data standards, facilitating seamless data exchange, and setting up demonstrators to showcase practical applicability.
    - The **XCARCITY Project** contributes foundational knowledge on digital twin components and develops tailored demonstrators that translate research insights into real-world applications. It focuses on fundamental research into the building blocks of digital twins, providing the scientific basis needed to design and evaluate innovative mobility solutions in urban environments.
3. **Common Demonstration Areas:** There was notable alignment regarding demonstration locations, with Almere, Amsterdam, and Rotterdam identified as mutually beneficial cities for piloting and validating digital twin solutions.
4. **Commonality of Partners:** The workshop highlighted significant overlaps among key stakeholders and partner organisations involved in both ecosystems, including:
    - Ministry of Infrastructure and Water Management (IenW)

- TU Delft
- TNO
- City of Amsterdam
- AMS Institute
- City of Almere
- MapTM
- Fietsersbond
- BAM Infra
- Technolution

This shared network provides a strong foundation for collaborative initiatives and joint projects.

5. **Digital Twins for Sustainable Accessibility:** Participants proposed specific use-case suggestions illustrating how digital twins could support decision-making for sustainable accessibility in the Amsterdam Zuidas area. Digital twin could effectively demonstrate the impacts of various infrastructure and policy options, enabling stakeholders to visualise and evaluate their implications comprehensively.

5. Future steps

The workshop identified substantial opportunities for deeper collaboration between the DMI Ecosystem and the XCARCITY Programme. Specifically:

- **Structured Collaboration Framework:** To build on the synergies identified during the workshop, the development of a concrete collaboration framework or joint action plan is recommended. This would enable more systematic knowledge exchange, coordination of ongoing efforts, and alignment of goals across both initiatives.
- **Joint Demonstration Projects:** Immediate opportunities were identified to jointly pursue demonstrator projects in Amsterdam Zuidas and Almere, where ongoing activities can readily benefit from collaboration. Furthermore, substantial long-term collaboration potential exists for the Merwe4haven area in Rotterdam, which is currently in its planning phase.

6. Pictures During the Workshop

Figure 1 Group Picture

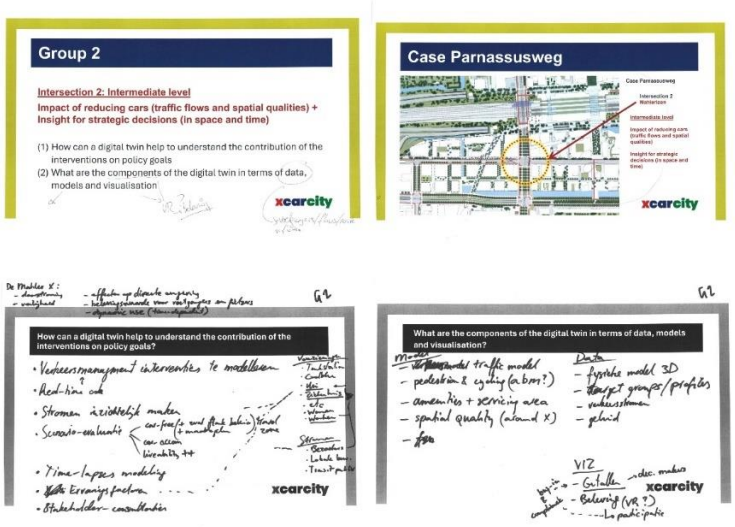
Figure 2 Opening Session by Bart van Arem & Roy Boertien

Figure 3 Result Demonstration of the Pre-Workshop Survey

Figure 4 Discussion during the Interactive Session

7. Appendix 1: Results for the Zuidas Interactive Session

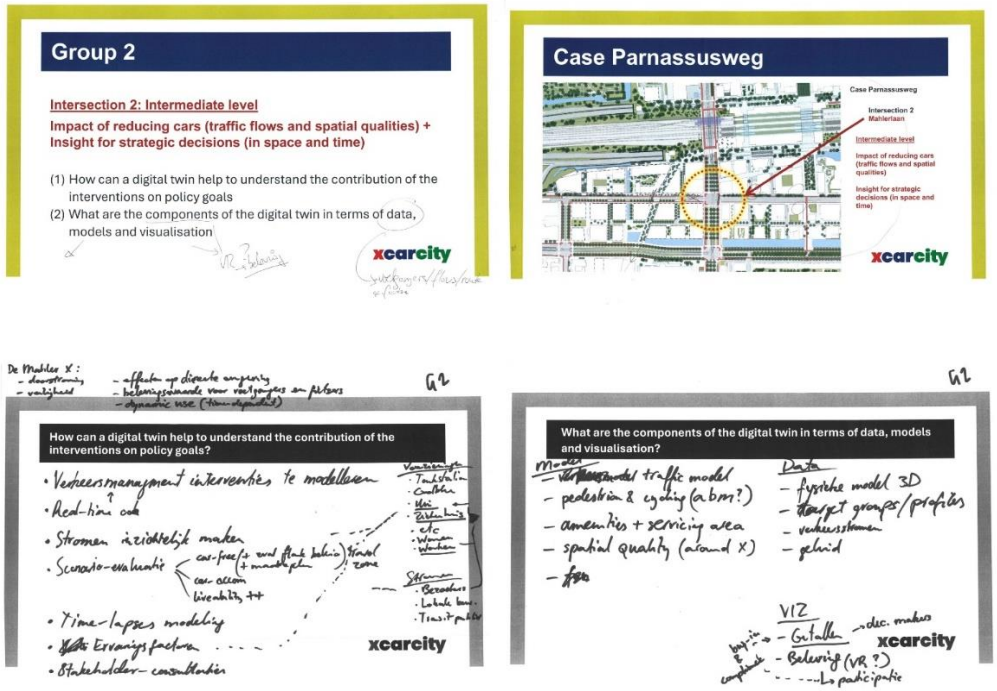
7.1. Group 1



Components of the digital twin: The digital twin ingests infrastructure and mobility-device sensor data (e.g. check-in/PT data), origin–destination and received data, and synthetic scenario datasets, plus traffic-flow measurements, which feed into a predictive modelling framework that links data and model layers.

Policy-goal contributions: An interactive visualisation model lets stakeholders compare the social, financial and environmental impacts of different interventions, select and analyse specific KPI subsets, and integrate multi-sector data for a holistic evaluation of policy measures.

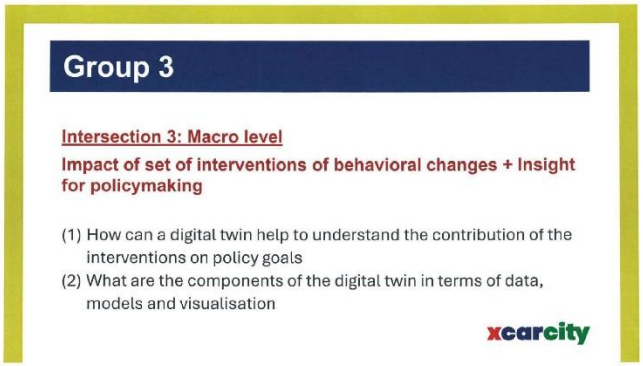
7.2. Group 2



Components of the digital twin: By modelling traffic-management interventions in real time, visualising multimodal flows (pedestrians, cyclists, vehicles), running scenario-evaluations (e.g. car-free vs. car-access, liveability trade-offs), animating time-lapse impacts and integrating stakeholder feedback to quantify each measure's effect on policy objectives.

Policy-goal contributions: It combines a vehicular traffic model, pedestrian & cycling agent-based modules, amenity/service-area and spatial-quality layers with 3D physical infrastructure, target-group profiles, traffic-flow and noise datasets, and delivers both numerical dashboards for decision-makers and immersive (e.g. VR) experiences for broader stakeholder participation.

7.3. Group 3


Group 3
Intersection 3: Macro level
Impact of set of interventions of behavioral changes + Insight for policymaking
(1) How can a digital twin help to understand the contribution of the interventions on policy goals
(2) What are the components of the digital twin in terms of data, models and visualisation
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Case Parnassusweg
Case Parnassusweg
Intersection Boelelaan
Macro level
Impact of set of interventions of behavioral changes
Insight for policymaking
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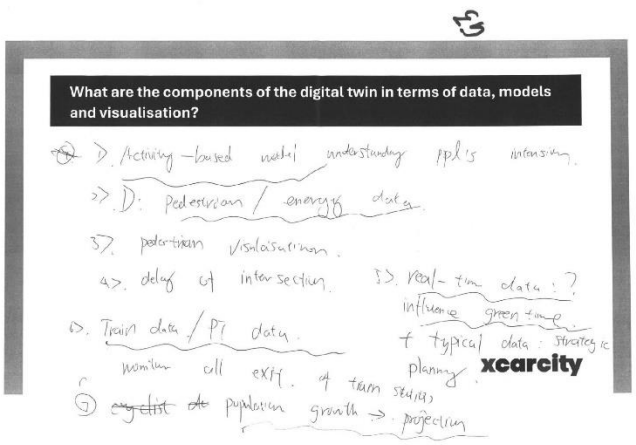
What are the components of the digital twin in terms of data, models and visualisation?
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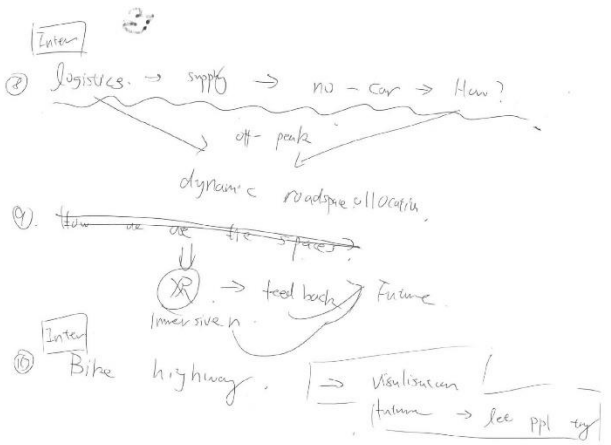
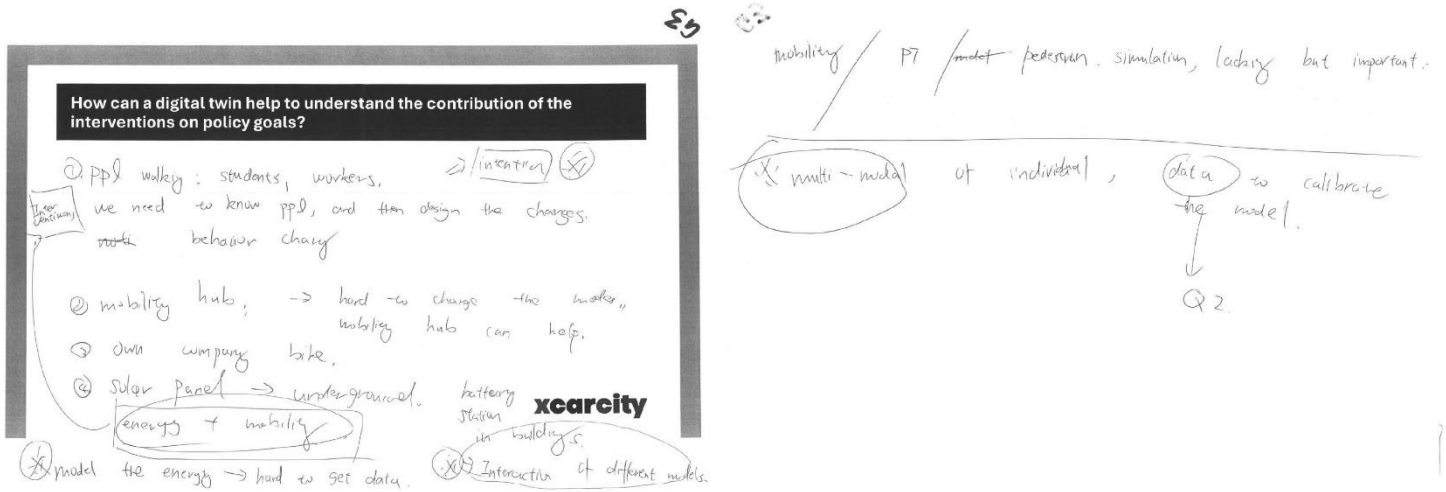
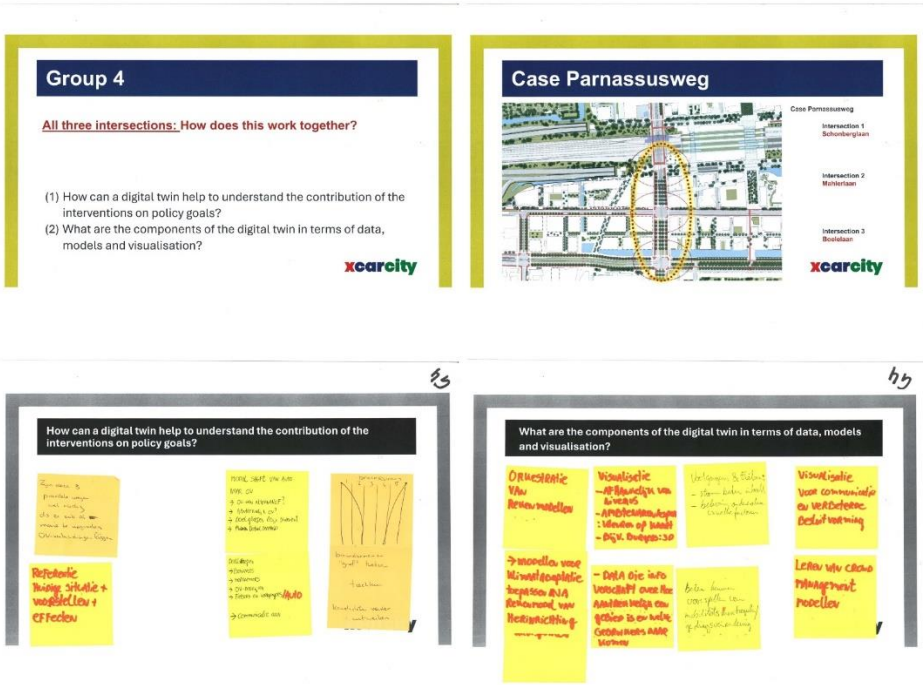




Components of the digital twin: It combines an activity-based, multi-modal individual behaviour model (walking, cycling, PT) calibrated with pedestrian counts, PT exit flows, energy and population-growth projections, plus intersection-delay and signal-control engines, all delivered through interactive 3D or dashboard visualisations for strategic planning and stakeholder engagement.

Policy-goal contributions: The digital twin simulates traffic-management interventions and dynamic roadspace reallocations in real time—making pedestrian, cycle and vehicle flows visible—supports “what-if” and time-lapse scenario evaluations (e.g. car-free vs. car-access, off-peak logistics), captures experiential factors and stakeholder feedback, and enables immersive trials (e.g. bike highways) to quantify each measure’s impact on safety, liveability and network performance.

7.4. Group 4



Components of the digital twin: It integrates an organised suite of computational models (traffic assignment, climate-adaptation and crowd-management), multi-level 3D and dashboard visualisations tailored to decision-makers, pedestrian/cyclist flow and experiential modules, ambition-level data layers on outcomes and adaptation needs, plus predictive engines for forecasting mobility and behavioural change.

Policy-goal contributions: It provides a clear reference of the current road network and public-transport links, lets you compare scenarios (e.g. upgrading three parallel roads vs. enhancing PT connections), quantifies modal-shift potential for target groups (students, commuters), and supports co-creative “brainstorm and test” workshops to refine and validate intervention proposals.

8. Appendix 2: Slides for the Presentation

XCARCITY-DMI Digital Twin Workshop 10th April 2025

DMI·ECOSYSTEEM

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Agenda

10:00 - 10:10	**Opening Statement**	Bart van Arem (TU Delft) and Roy Boertien (I&W)
10:10 - 10:20	**XCARCITY Introduction**	Bart (TU Delft)
10:20 - 10:30	**DMI Introduction (why DMI)**	Roy Boertien (I&W)
10:30 – 10:50	*Tea Break (20min)*	
10:50 – 11:10	**XCARCTY Digital twin federation**	Jingjun Li (TU Delft)
11:10-11:30	**DMI Digital twin overview**	Gineke van Putten (Geonovum)
11:30 – 12:00	**Car-low development and regulation**	Michiel Van Dongen (I&W); Sean van der Lee; Jyotsna Singh
12:00-13:00	*Lunch break (60min)*	
13:00-13:15	**Introduction of the Amsterdam Zuidas use case**	Barry Ubbels (Amsterdam)
13:15 – 13:30	**Introduction to Interactive Workshop + Results from the survey**	Bart van Arem (Tu Delft)
13:30-14:00	**Interactive workshop**	All - 4 groups
14:00-14:15	*BREAK*	
14:15 – 14:45	**Feedback and Discussion**	All
14:45 – 15:00	**Way Forward and Next steps**	Roy Boertien (IenW), Bart van Arem (TU Delft)

Opening

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XCARCITY Introduction By Bart van Arem

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Toward sustainable urban mobility using digital twins

Bart van Arem

NWO TU Delft xcarcity

The Netherlands

Population large cities growing
(Amsterdam, Rotterdam, The Hague, Utrecht)

1 Million new houses planned by 2030

Mostly densification within existing cities

17,5 Million population
41.850 km²

Randstad area
(Amsterdam, Rotterdam, The Hague, Utrecht)
8,5 Million population
11.370 km²

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1 Million new houses? What about accessibility and liveability ?

- The road transport system has reached the limits of what is:
  - usage of space
  - externalities
- Public transport system has also reached capacity limits.

Can we imagine a city without private cars?

Scarcity of space
eX Car City
---------- +
XCARCITY?

XCARCITY facts and figures

- Duration: 1st June 2023 -1st June 2029
- Budget: 4 M€ by NWO, 2 M€ by partners
- 9 PhD candidates, 2 postdocs, 1 programmer, TNO researchers (60 person years)
- 33 partners from academia, public and private sector
- Lead by TU Delft: Bart van Arem (PI), Maaike Snelder (co-PI)

NWO

Perspectief programme of NWO (Dutch Research Council)

New, challenging research projects within the application-oriented and technical sciences that generate economic and social impact in thematic areas relevant to the Netherlands.

https://www.nwo.nl/en/researchprogrammes/perspectief/previous-awards

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Smart mobility – promising solutions

Flexible combinations of:
- walking and cycling
- shared electric vehicles
- transport hubs
- traffic management

Building on service orientation and electrification of mobility.

Will this work?

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Traditional theories and methods are out dated

Traditional mobility	Smart mobility
Roads and traffic	People and services
Physical infrastructure	Digital infrastructure
Long-term planning and ex-ante models	Learning by doing and systematic feedback models

We need new theories and methods to start collecting evidence what works (and what doesn't).

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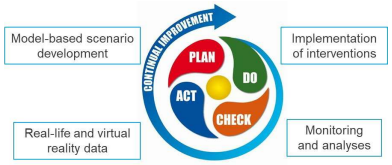
Proposition XCARCITY

Digital twin federation
Real-time management & Strategic planning



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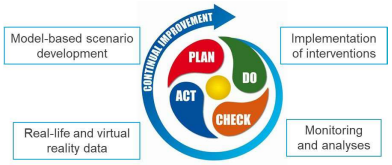
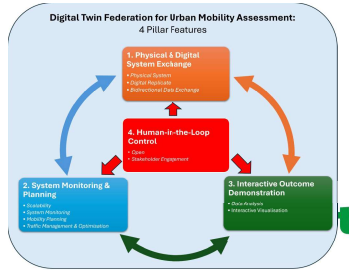
Proposition XCARCITY

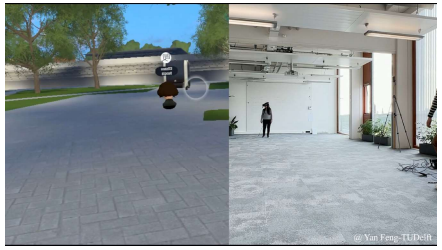
Digital twin federation
Real-time management & Strategic planning





Interactive urban planning digital twin

Real-time mobility digital twin



Immersive, multi-user VR digital twin

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Scientific challenges

Measuring the behaviour of individuals and flows while respecting privacy and security

Developing smart mobility services that meet travel demands

Assessing the contribution of smart mobility to sustainable and inclusive accessibility.

In a context characterized by:

Multiple stakeholders

Highly dynamic interaction and feedback

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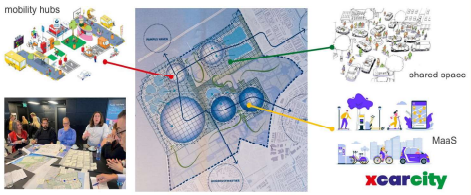
Almere Pampus



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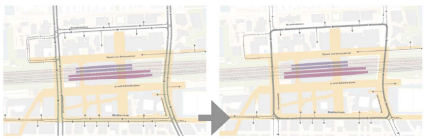
Amsterdam Zuidasdok



Redesign Parnassusweg around Zuidas train station

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Rotterdam Merwe4Haven

Immersive VR research by design Urban Community Vehicle (with BMW)

Integration of Rotterdam Open Urban Platform, Digital Twin Federation, Vehicle data (with BMW)

Modeling and optimisation of sustainable mobility

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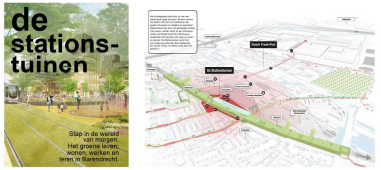
Barendrecht Stationstuinen



Uit: Koersdocument Barendrecht – de Stationstuinen (2019)

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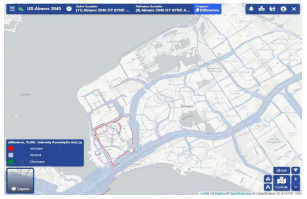
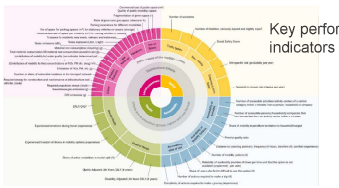
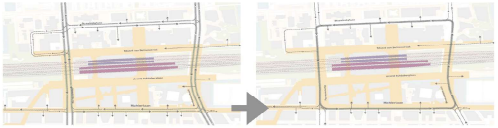
DESIGN SESSION November 2024



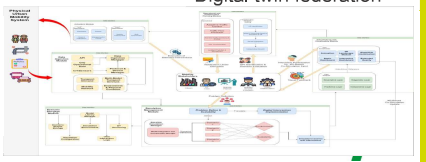
Digital twin assessment Almere Pampus



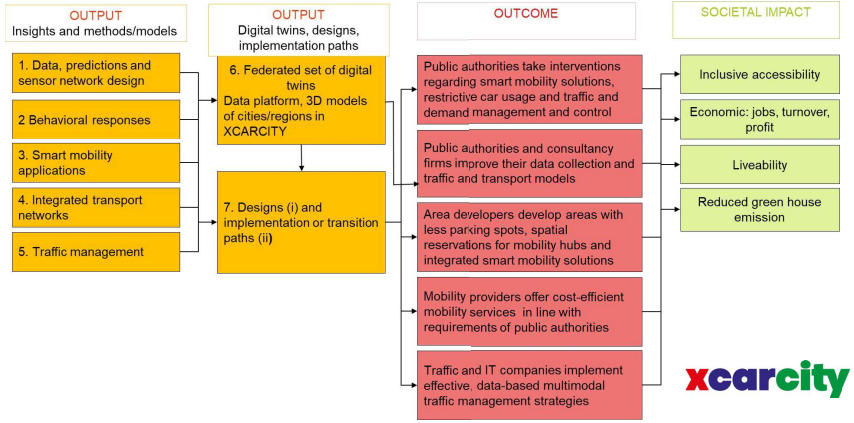
Digital twin federation



Redesign Parnassusweg



Impact plan



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Partner contributions

Define user needs
Provide data
Co-design areas
Pilots
Organise annual design sessions
Implementation paths
Organise consortium meetings
Co-program coordination

Public authorities
- Gemeente Almere
- Gemeente Amsterdam
- Gemeente Rotterdam
- Ministerie van Infrastructuur & Waterstaat
- MRDH-regio
- Rijkswaterstaat
- Vervoerregio Amsterdam

Contribute to digital twin development
User needs future residents
Implementation paths

Area and project developers
- ABB
- BAM
- FSD

Contribute case studies
Pilots
Provide training
Implementation paths

Mobility providers
- PON
- RET

Contribute expertise
Provide data
Support VR realisation
Contribute to digital twin architecture
Pilots
Implementation paths traffic sector

Traffic sector and IT industry
- MapTM
- OpenRemote
- Technolution
- VRBase

Consultancy firms
- Buck consultants International
- DTV consultants
- Future mobility Network
- Goudappel
- Mobycon
- RHDHV
- Witteveen en Bos

Execute case studies
Provide data
Provide tools
Provide test facilities
Contribute to digital twin development
Support pilots
Support implementation paths
Report annual design sessions
Develop training material
Design and manage website

Research and knowledge institutes
- AMS Institute
- CROW
- PBL
- SWOV
- TNO
- TU Delft
- TU Eindhoven
- Universiteit Twente

Support VR environment
Support intern studio
Knowledge dissemination
Yearly scan spatial and safety impacts
Research activities

Other
- Connekt
- Fietsersbond
- Toertje

Data cycling
Organise annual design sessions
Connekt network
Co-program coordination

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Toward sustainable urban mobility using digital twins

From transportation infrastructure to smart mobility service orientation.

Digital twin federation integrating data-driven and model-based approaches.

Collaborative what-if analyses of new smart mobility approaches to ensure sustainable and inclusive accessibility.

THANK YOU!

Future work:

Automated Vehicles in Shared Space
XCARCITY and climate change

SUM Lab
Sustainable Urban Multimodal Mobility

xcarcity.n
l

https://www.linkedin.com/groups/12822203/

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DMI Introduction By Roy Boertien

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NOG **1.728**

DAGEN TE GAAN VOOR **2030**

-55% CO_2

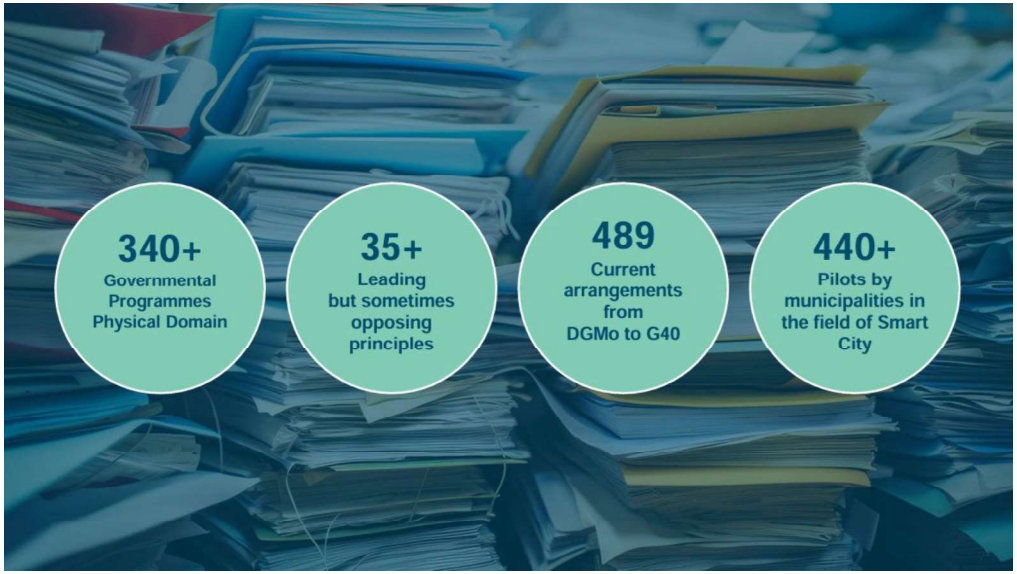
-50% NO_x

+900K

Minimaal 50%:
- binnenstedelijk
- in nabijheid van ov-knooppunten

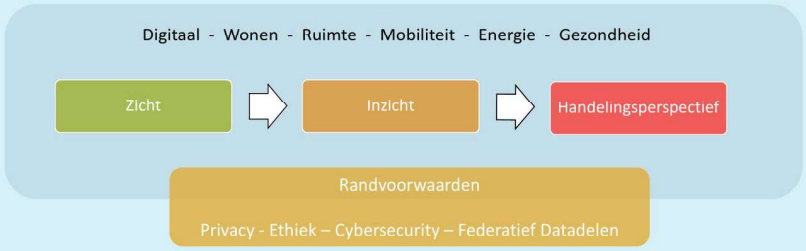
We are reaching system boundaries

DMI ECOSYSTEM



DMI·ECOSYSTEEM

Kennis structureren in het fysieke en / + het digitale domein



DMI·ECOSYSTEM

Current participants in the DMI ecosystem

2 Dutch ministries
21 Cities
80 Private organizations
7 Knowledge Institutions

And counting.

DMI·ECOSYSTEM

TEA BREAK

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XCARCITY Digital Twin Federation By Jingjun Li

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DTs in Transport Planning

(a) Current Street View

(b) Current Digital Twin

3D Modelling of Infrastructure in Dublin
(White et.al 2021)

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DTs in Transport Planning

(a) Current Street View

(b) Current Digital Twin

Regional Public Transport Supervision DT in Paris
(Amrani, et.al 2020)

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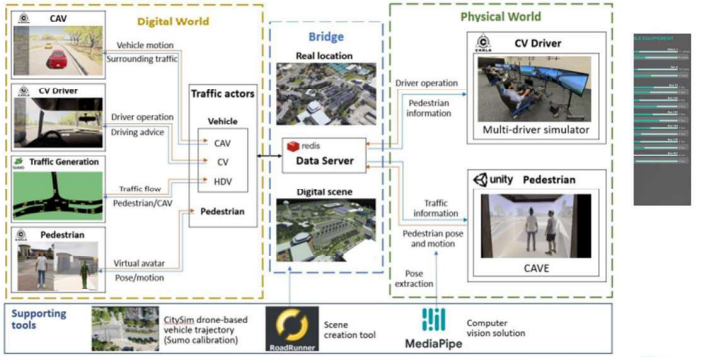
DTs in Transport Planning

(a) Current Street

(b) Current Digital



DT for the management of intelligent vehicular systems
(Wang, et.al 2022)

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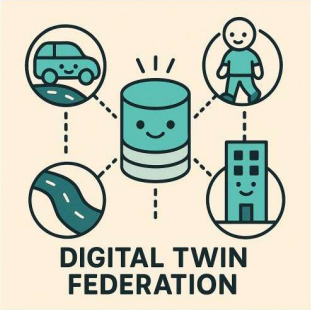
Towards a Digital Twin Federation



Single (technical) DT is not sufficient for a comprehensive evaluation of mobility systems with fewer private vehicles!

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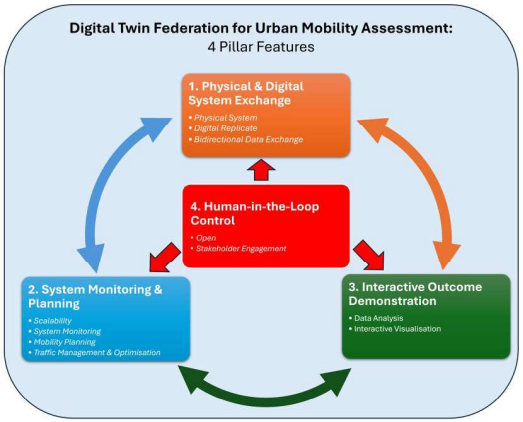
Features of Digital Twin Federations



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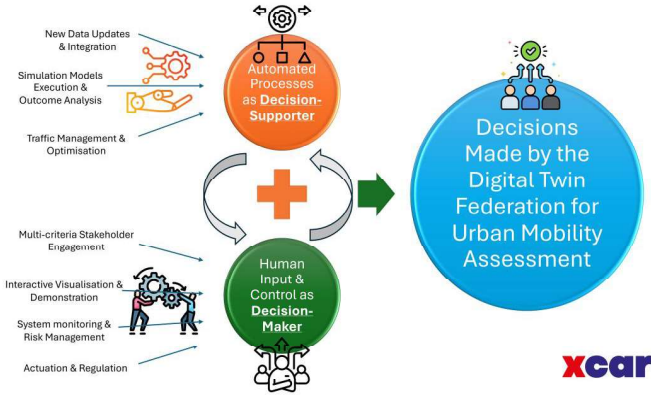
Joint Decision-Making Between Automation & Human



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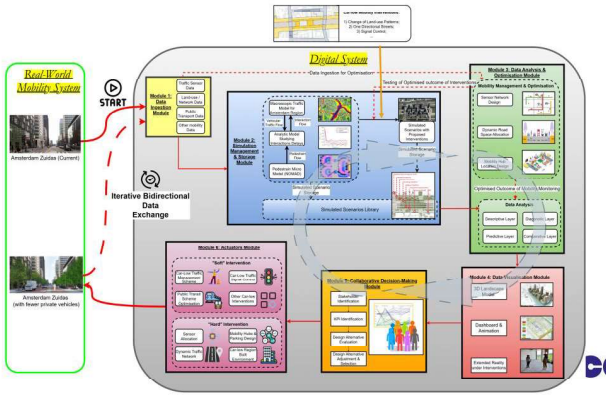
FedDT Use Case Zuidas



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References

White, G., Zink, A., Codec´a, L., Clarke, S., 2021. A digital twin smart city for citizen feedback. Cities 110, 103064. doi:10.1016/j.cities.2020.103064;

Amrani, A., Arezki, H., Lellouche, D., Gazeau, V., Fillol, C., Allali, O., Lacroix, T., 2020. Architecture of a Public Transport Supervision System Using Hybridization Models Based on Real and Predictive Data. Proceedings - Euromicro Conference on Digital System Design, DSD 2020 , 440–446doi:10.1109/DSD51259.2020.00076;

Wang, Z., Zheng, O., Li, L., Abdel-Aty, M., Cruz-Neira, C., Islam, Z., 2022. Towards Next Generation of Pedestrian and Connected Vehicle In-the-loop Research: A Digital Twin Co-Simulation Framework. IEEE Transactions on Intelligent Vehicles 8, 2674–2683. URL: http://arxiv.org/abs/2212.05090http://dx.doi.org/10.1109/TIV.2023.3250353, doi:10.1109/TIV.2023.3250353;

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DMI Digital Twin By Gineke van Putten

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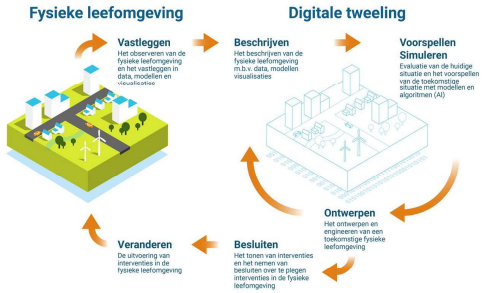
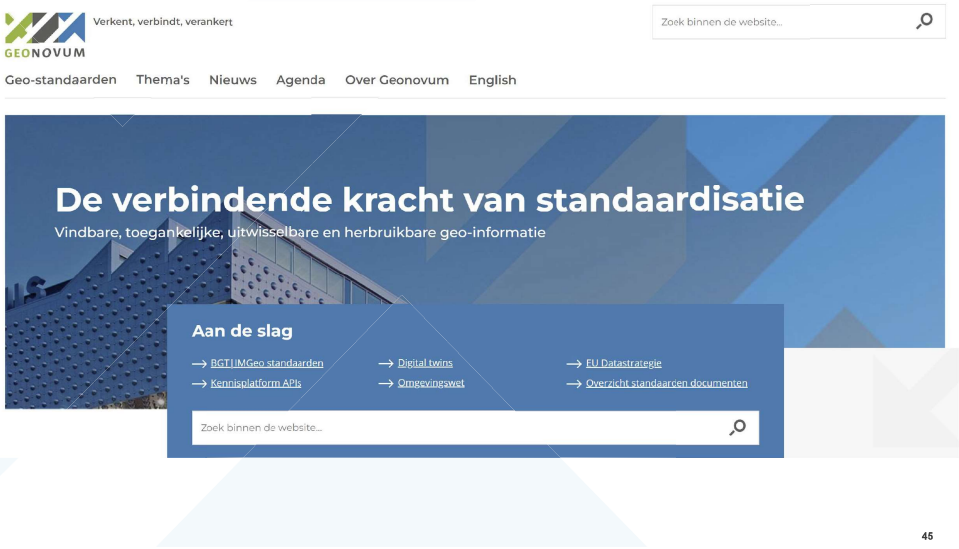
Geonovum

GEONOVUM

- Government foundation
- Knowledge and network partner
- Develop standards for the national spatial data infrastructure



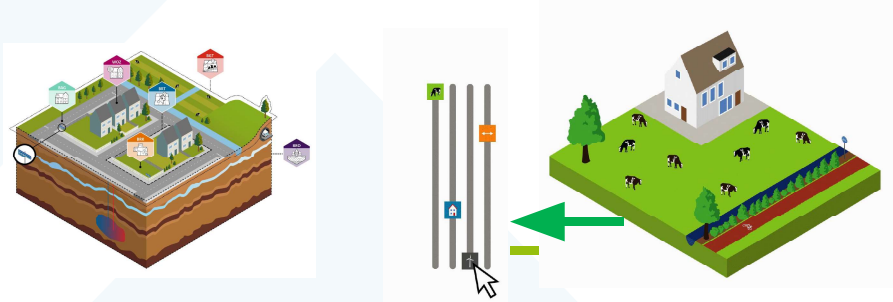


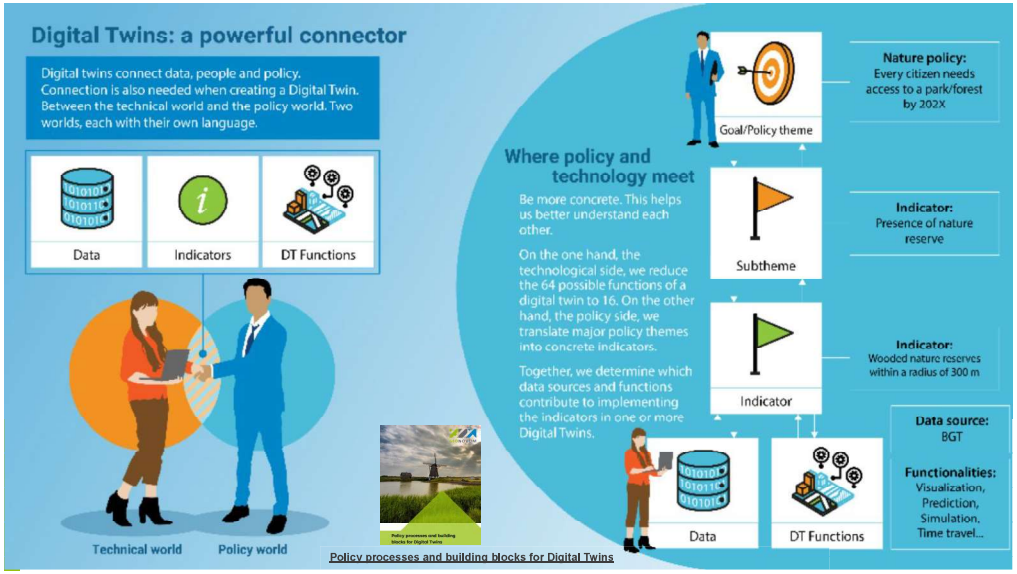
45

Why

GEONOVUM

'A digital twin enables information from different domains to be brought together in an integrated, dynamic and interactive way. This provides a holistic insight into complex issues and supports the development of sustainable solutions.'





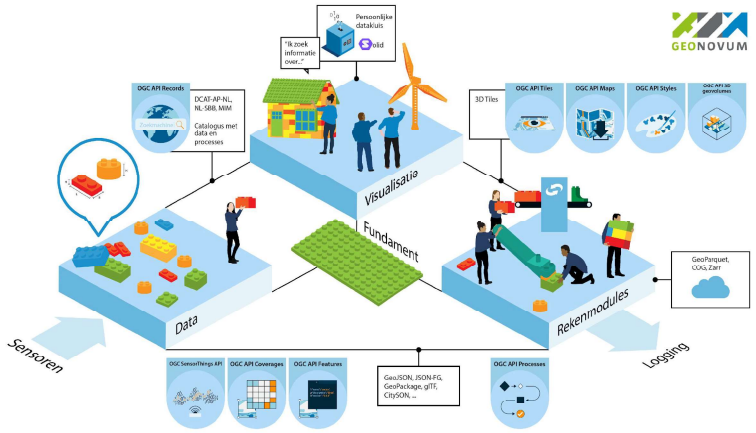
Policy processes and building blocks for Digital Twins

Digital Twin Building Blocks (NLDT)

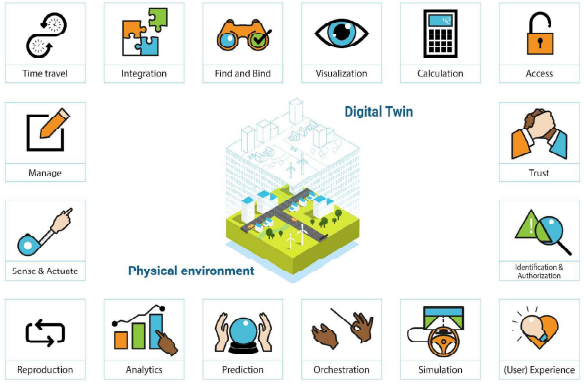
Interoperable, modular, scalable

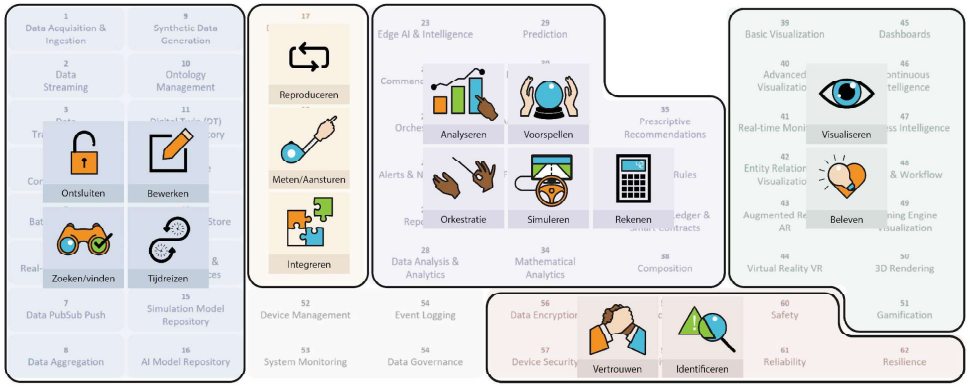
GEONOVUM

Standards in play between building blocks



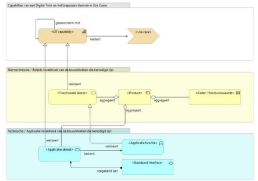
Basic Capabilities for NLDT





NLDT reference architecture

https://geonovum.github.io/NLDT-Architectuur/

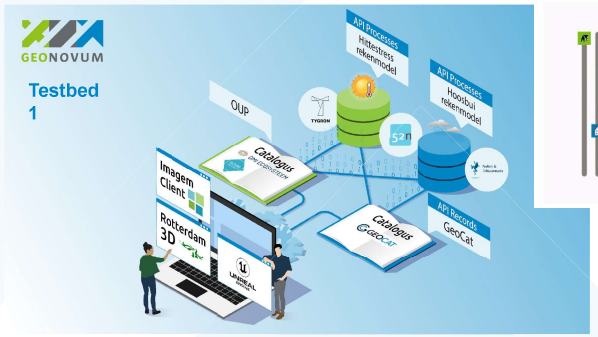


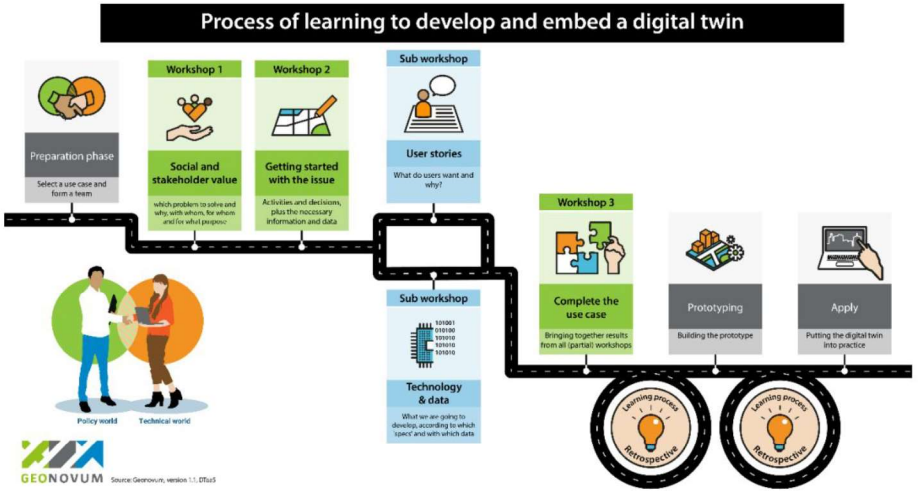
https://geonovum.github.io/T4R/

Testbeds

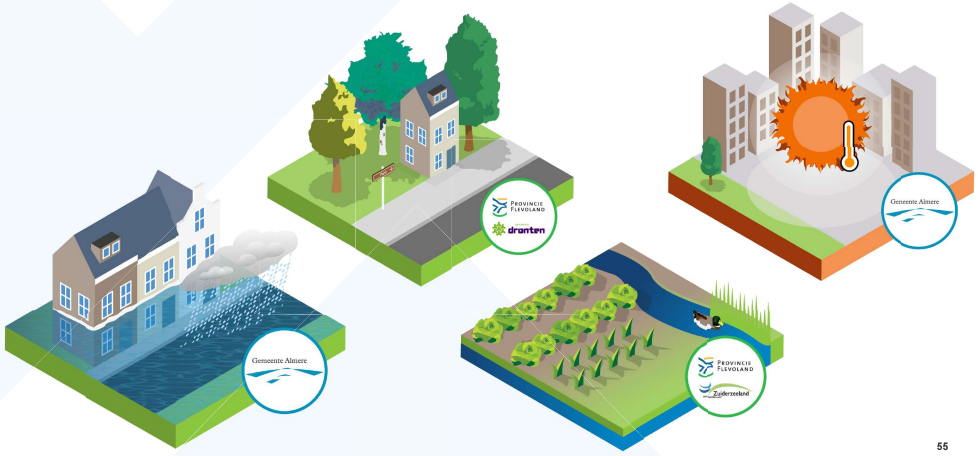
Invitation to tender | call for Testbed nr. 2 Digital Twin as a service is published

11 MAART 2025

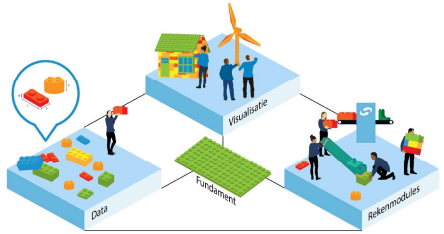




Fieldlabs



From pioneers and frontrunners to a system of Digital Twins



NLD T

- Reusable recipes for data, computational models & visualizations
- Avoiding silo formation: platform and vendor independence
- Collaborating and sharing data/ computational models.
- Being able to share applications at the national & European level

NLDT reference architecture

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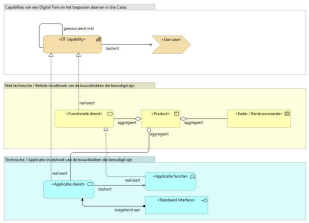

https://geonovum.github.io/T4R/

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Car-low development and regulations By Michiel van Dongen

xcarcity

Developing car-low cities within a regulatory and policy framework for Dutch sustainable urban mobility planning and the role of DTs

Xcarcity Digital Twin workshop

Cities with effective car-low measures

	City	Mobility Focus	Tech Used	Policy Type	Impact Metrics
1	Amsterdam, Netherlands	Bike infrastructure, reduced parking, car-free zones	Mobility data, modeling (no full digital twin)	Car-lite agenda, street redesign	Reduced car use, increased cycling
2	Ljubljana, Slovenia	Pedestrian-only city center	Data-backed policy, no digital twin	Pedestrianization	Improved air quality, increased public transport use
3	Pontevedra, Spain	Extensive car-free zones	Minimal tech, people-first approach	Car ban in city center	90% reduction in traffic injuries
4	Paris, France	15-minute city, pedestrianization	Modeling, participatory tools	Car-free zones, urban redesign	Increased walking/cycling, cleaner air
5	Berlin, Germany	Neighborhood traffic reduction	GIS, traffic data	Kiezblocks (superblocks)	Reduced traffic, increased livability
6	Vienna, Austria	Car-free development (Aspern)	Simulation and planning models	Transit-oriented development	High transit use, low car ownership
7	Oslo, Norway	Car ban in city center	Smart city strategy, data analysis	Car ban, public space reclaiming	Fewer accidents, more pedestrians/cyclists
8	Copenhagen, Denmark	Cycling, pedestrian infrastructure	Live cycling data, dashboards	Cycling priority, parking limits	62% bike commuting, carbon neutrality goal
9	Ghent, Belgium	Car-free zones via circulation plan	Data-informed planning	Circulation plan	20% drop in car traffic, rise in active travel
10	Barcelona, Spain	Superblocks (car-free neighborhoods)	Simulations, environmental sensors	Urban superblocks	More public space, reduced traffic
11	Montreal, Canada	Pedestrian-priority downtown	GIS, urban models	Pedestrianization, transit integration	Improved public realm, reduced car dependence
12	Zurich, Switzerland	Transit and walking priority	Traffic light prioritization, data use	Parking limits, transit-first	Reduced car use, high transit ridership

Quick polling some experts within I&W

What are the most effective measures to achieve car-low cities?

- Parking policies (rates, norms for spaces)
  - Levers exist within the housing and energy challenges
- Densification with alternatives to car
- Prioritise accessibility (through safe and fast physical infrastructure) for non-car modes
- Applying traffic rules and regulations differently
- Fiscal policy

- None are “easy”, due to path dependencies and human behaviour, and there are variations based on region, size and character of cities involved.
- System view with broad set of economic and wellbeing indicators is preferred. See e.g. KAW-Ecorys study

Over to the researchers ☺️

- Sean and Shyotsa max max 15min in total (prefer 10min)
- Add comment or 1pager on KPIs (“Delphi”?)

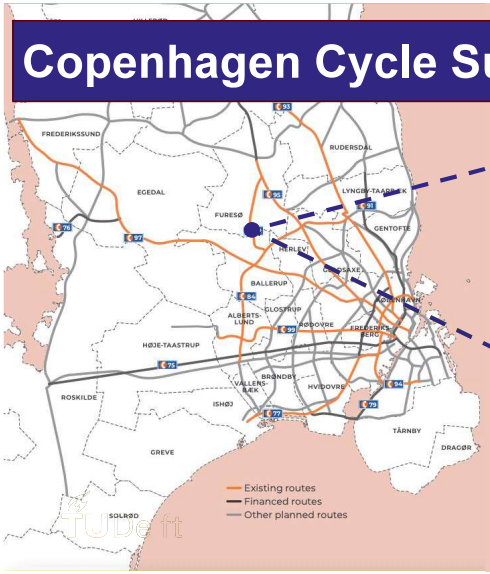
Reducing the number of cars in European cities

What are the keys to success?

Sean van der Lee
10/04/2025

xcarcity

Copenhagen Cycle Superhighways



Success factors

- Strategic communication
- Organising responsibility
- Showing openness and flexibility

Barriers

- Resources
- Policy & institutional

Barcelona Superblocks

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Success factors

- Trials to create legitimacy
- Organising responsibility
- Timing and windows of opportunity

Barriers

- Social
- Policy & institutional

Success factors

- Trials to create legitimacy
- Organising responsibility
- Strategic communication
- Showing openness and flexibility
- Timing and windows of opportunity
- Combining sticks and carrots

Barriers

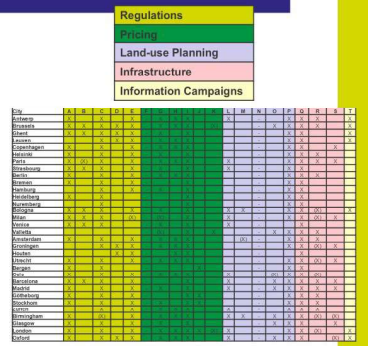
- Social
- Path dependence
- Policy & institutional
- Resources
- Legal

Additional success factors

- The undeniability of hard evidence
- The inarguability of schools

General Lessons

1. **Continuously explore new possibilities**
2. Be aware of the context and stakeholders' needs
3. Create and identify windows of opportunity
4. Test new measures



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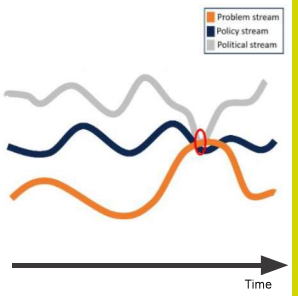

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General Lessons

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Reducing the number of cars in European cities

What are the keys to success?

Sean van der Lee
10/04/2025

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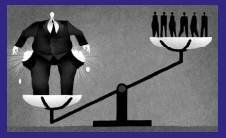
Why Low Car/No Car?

Environmental Impacts

Traffic Congestion

Reduced Social Equity



Space Requirements

Deteriorated Health

Accidents/ Safety Problems

Pressure on authorities

Liveability for People

Popular Interventions

- Land-Use Density & Diversity
- Constraining Traffic
- Pricing
- Limiting Traffic
- Alternatives
- Fare/Subscription Schemes

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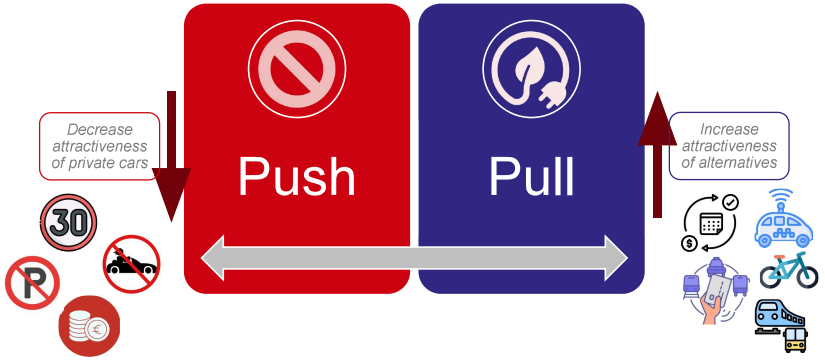
Push & Pull Interventions



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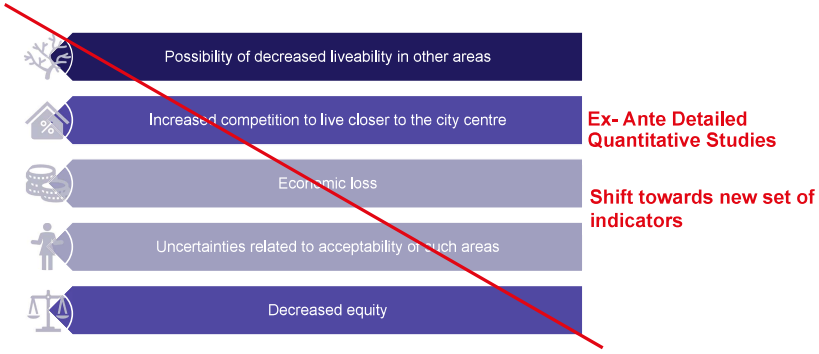
But if not planned properly..



Ex- Ante Detailed Quantitative Studies

Shift towards new set of indicators

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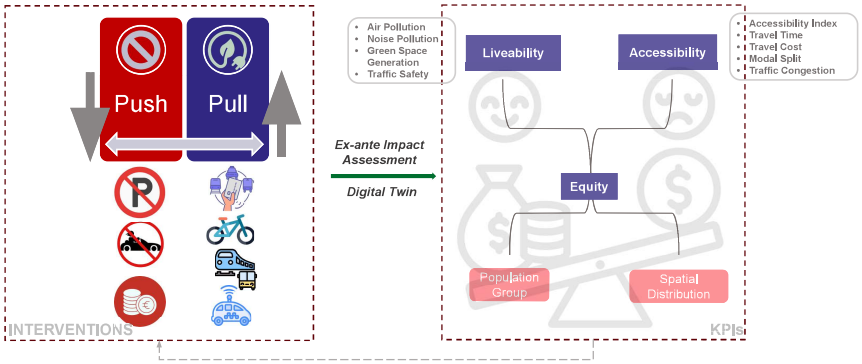
Framework



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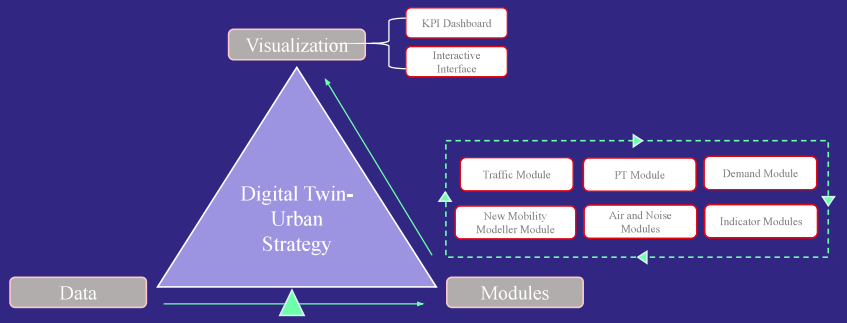
Digital Twin-Urban Strategy



Working on better cities with less cars

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Almere Delphi Study Approach

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Defining KPI – approach in detail

- Interviewee organisations:

BAM, Fietsersbond, FSD, Gemeente Amsterdam, Ministerie I&W, MRA, MRDH, RET, Rijkswaterstaat, SWOV

Interviewees invited, questions developed, and interviews conducted by Azarakhsh Salem

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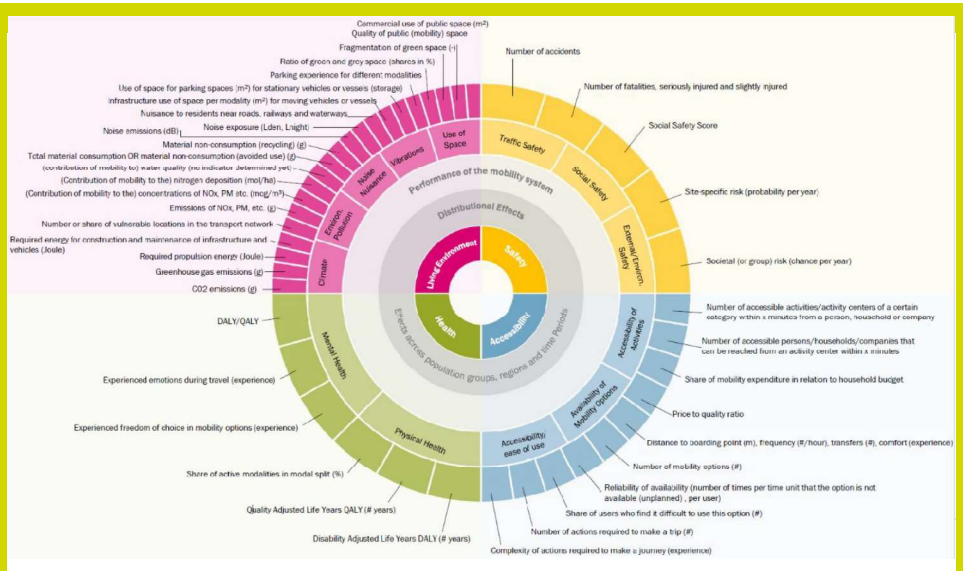

Defining KPI – longlist ‘families’

- Accessibility and Mobility
- Quality & Price of mobility
- Environment & Livability, Emissions & Concentrations
- Spatial Quality
- Social and Traffic Safety

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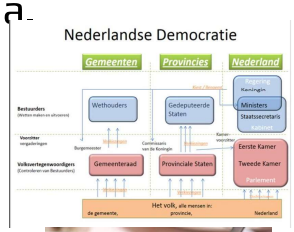
With measures and KPIs defined, from which framework are we implementing? Welcome to the Dutch governance lasagna.

Five Key Components:

1. National-Level Framework
2. Regional-Level Framework
3. Municipal-Level Implementation
4. Funding & Incentives
5. Guiding Principles for Mobility Planning



1. National Framework – Overview

SETS STRATEGIC DIRECTION AND LEGAL BASIS

ANCHORED IN SUSTAINABILITY, ACCESSIBILITY, EQUITY AND INNOVATION

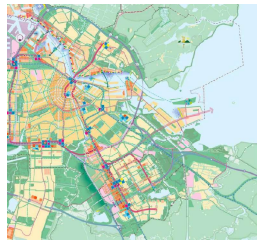
INTERLINKED WITH SPATIAL PLANNING AND CLIMATE GOALS

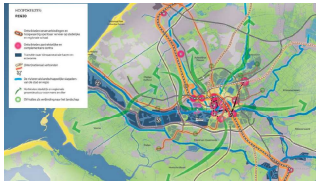
National Mobility Vision (Mobiliteitsvisie)

- Strategic vision to 2050 by Ministry of Infrastructure (IenW)
- Goals: Multi-modal networks, inclusive and climate-neutral transport, innovation
- Supports economic growth and quality of life
- Calls for multi-governance operationalisation in regions
- Feeds into NOVi -> NOVEX areas

Environment and Planning Act (Omgevingswet)

- In force since 2024 – merges 26 laws into one
- Integrated land use, mobility, environment, health
- Municipalities must create environmental visions/plans (Omgevingsvisies)
- Emphasizes citizen participation and faster processes





Accessibility Monitoring – Bereikbaarheidspeil (brand new!)

- National tool for measuring access to jobs, services, etc.
- Multi-modal: cycling, transit, car
- Supports data-driven evaluation and prioritization


Interprovinciaal Overleg
van, voor en door provincies

THEMA'S OVER HET IPO NIEUW

Kabinetsstandpunt 'Bereikbaarheid op Peil' omarmd

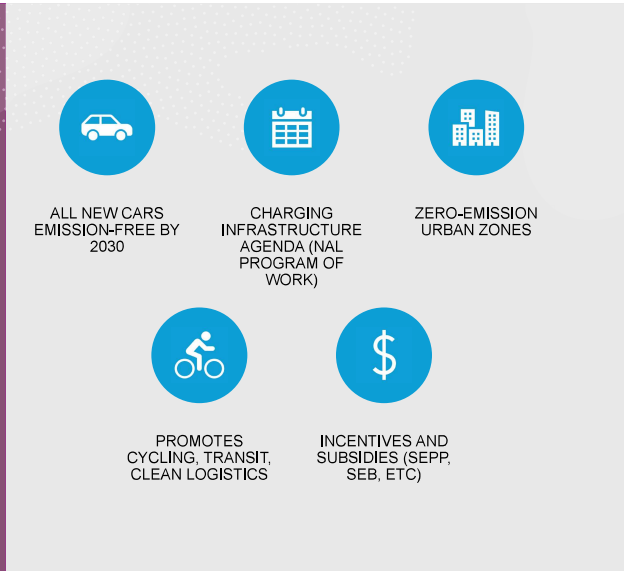
27 MAART 2025

Het IPO en de VNG omarmen het kabinetsstandpunt 'Bereikbaarheid op Peil'. Ter voorbereiding op het commissiedebat 'Strategische keuzes bereikbaarheid' van 2 april 2025 roepen we op strategische keuzes die nodig zijn in het bereikbaarheidsbeleid onderdeel te maken van de Nota Ruimte. Daarnaast roepen we het Rijk op de medeoverheden de juiste instrumenten toe te kennen en juichen we verdere ontwikkeling van het Bereikbaarheidspeil toe.

Future Outlook – Car, rail and PT (Toekomstbeeld Automobiliteit & OV en spoor)

- Strategy for sustainable car use
- Smart infrastructure, EV transition, shared mobility
- Urban restraint, rural access, dynamic pricing
- Vision through 2040 for public transport
- Investments in rail upgrades, TOD, electrification
- High-frequency trains and integrated mobility
- Agenda for developing stations (Stations agenda)

Climate Agreement & Energy Policy



Strategic Tools & Funding

- MIRT – long-term investment program
- National Growth Fund – innovation, infrastructure
- Smart Mobility Agenda – digital and automated mobility
- EU co-financing – Green Deal, Horizon, SCF, CEF, EIB

2. Regional-Level Framework & Programs

- Managed by Vervoerregio's (regional transport authorities)
- Align national goals with local needs
- Public transport, cycling highways, logistics
- Coordinate across municipalities
- Integrate housing, employment, mobility
- Projects: bike corridors, P+R, clean logistics

3. Municipal-Level Implementation

- Local Mobility Plans (Mobiliteitsplannen)
- Address walking, cycling, parking, logistics
- Align with Environment and Planning Act
- Active mobility prioritized: woonerven, bike lanes, fietsstraten, safety
- Smart tools: MaaS, traffic flow data, mobility hubs, smart traffic lights and digital access management

4. Funding & Incentives

- National Growth Fund – major projects
- MIRT – spatial/mobility co-investment
- Local tools: parking fees, congestion pricing
- EU funds: CEF, Horizon, Green Deal

5. Guiding Principles

- Avoid–Shift–Improve framework
- 15-Minute City model and compact planning
- Inclusive mobility: accessibility for all
- Aligned with health, climate, land use

Reality can bite back

Enter: SUMPs

- Mandatory tool from the TEN-T directive (2024), delivery dec 2027
- Focus on multi-governance, comprehensive and system based based approach to sustainable urban mobility planning
- Key elements:
  - **Urban Nodes** with a **Functional Urban Area (FUA**)
  - **Analysis of current mobility system**
  - **Long term vision** AND **short term action plan** with financial underpinnings
  - **Participation** + **monitoring and evaluation** (M&E)
  - **A long list of guidelines** towards seamless mobility, accessibility, sustainability, health and safety, and **use of ICT and ITS** (begging for operationalisation)
- Basic requirement: **a common operational view** of past, present and future to guide KPI-based, comprehensive, and internally consistent mix of policy measures.

Question:

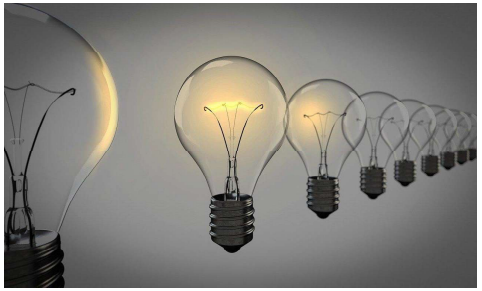
- Why would 26 Dutch or 431 European urban nodes go through this ordeal?!

A word on data collection…

- ITS Richtlijn https://eur-lex.europa.eu/eli/dir/2010/40/oj en de herziening https://eur-lex.europa.eu/eli/dir/2023/2661 (zie m.n. annex III)
- MMTIS verordening https://eur-lex.europa.eu/eli/reg_del/2024/490/oj
- RTTI verordening https://eur-lex.europa.eu/eli/reg_del/2022/670/oj
- SRTI verordening https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013R0886
- SSTP verordening https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013R0885
- eCall verordening https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024R1084
- TEN-T urban mobility indicators

Not starting from scratch:

- Helsinki 3D+
- DUET (Rotterdam)
- Smart Cambridge
- Smarter Together (Lyon)
- Virtual Singapore
- Etc



Conclusions

Call to action

- Join a SUMP pilot or the SUMP practice of your organisation
- Likewise, connect with the ClimateNeutral team in the G5, Helmond or Groningen
- Share knowledge and best practices with expert groups from within the SUMP (and UMI) and NZC space
- Start thinking about how to apply XCARCITY findings to make the Dutch lasagna more digestible

LUNCH BREAK

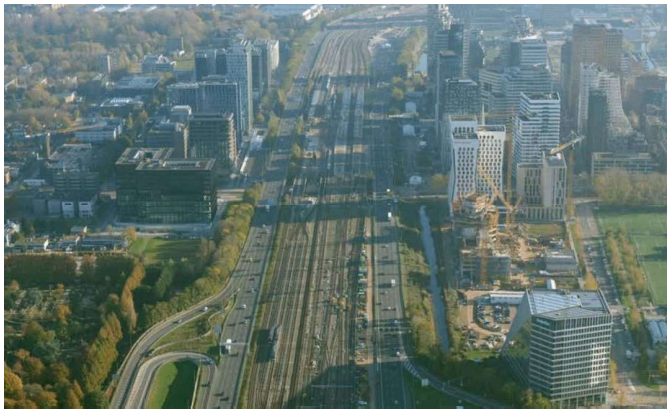
Amsterdam
Zuidas
Barry Ubbels

Amsterdam is growing (2020-2030)

Zuidas is developing

- Zuidasdok
- Redevelopment of Zuidas (city area with businesses, housing and public spaces)
- 50% more users: citizens, students, commuters and visitors
- Jobs + 47%-73% in 2040, population from 6000 to 20000 (+233%)

Use case Zuidas (now)



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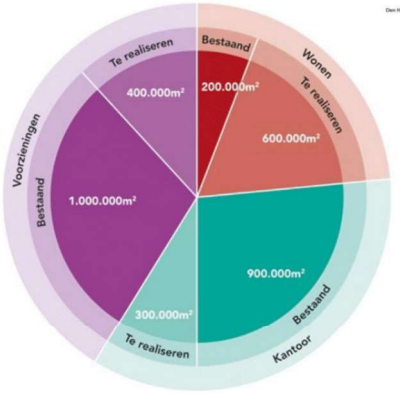
Use case Zuidas (planned)



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Policy making (Amsterdam city)

Policy programmes

- ***Autoluw***
- ***Walking***
- ***Traffic safety***
- ***Cycling***
- ***Logistics***
- ***Shared mobility***

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Amsterdam Zuidas Mobility policy (2023)

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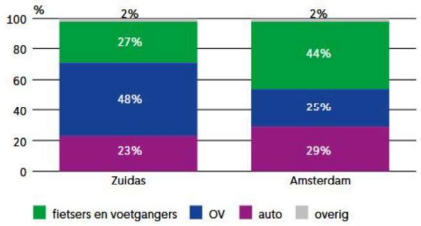
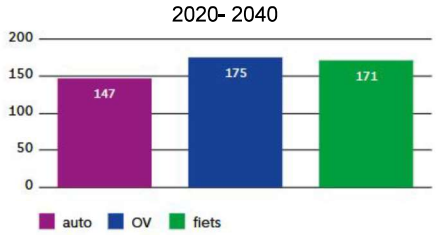
Zuidas area

- Objective: keep Zuidas accessible and liveable
- Now: well accessible by car and public





Zuidas policy interventions (4 pillars)

- Redevelop public space (space to meet, enjoy, play etc.) to support walking and cycling
- Change mobility behaviour (off peak travelling, less car traffic)
- Less car parking
- Development programme and impact on mobility

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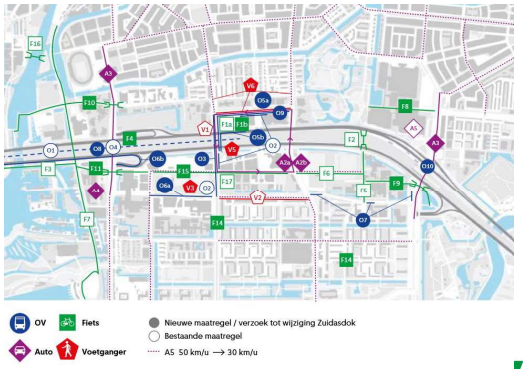
Different policy measures

- One way traffic Mahlerlaan – Beethovenlaan – Parnassusweg
- Car sharing support
- Support cycling and walking
- Redesign intersections



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New tooling to support decision making

- Zuidas relies on tools such as 2D mapping and traditional transport model (VMA)
- Need for new visualization tools (3D) that support in spatial planning choices (how to divide space between staying and moving)
- Special attention for walking (large pedestrian flows expected)
- Use case design Parnassusweg

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Case Parnassusweg (intersection)

Proposed (Zuidasdok finished)

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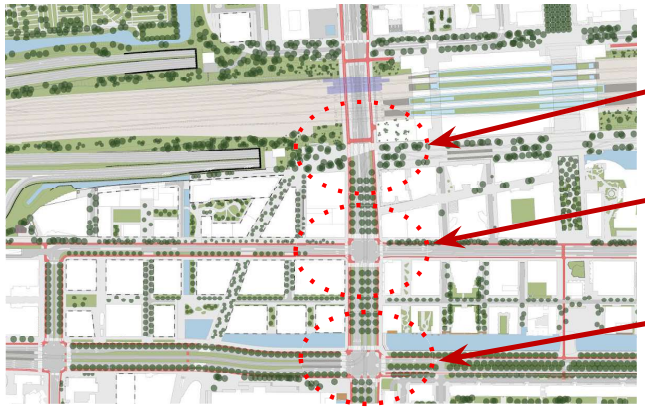
Case Parnassusweg - Interventions



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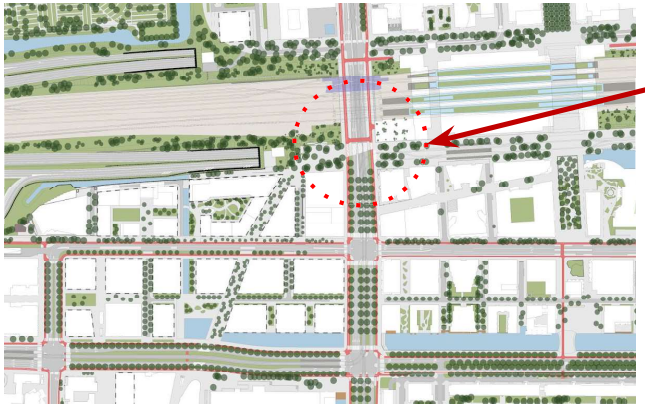
Case Parnassusweg



Microlevel

Interaction between modalities PT/Bike /Pedestrians/cars

Interfering flows of pedestrians

Insight for design decisions in public realm

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Case Parnassusweg

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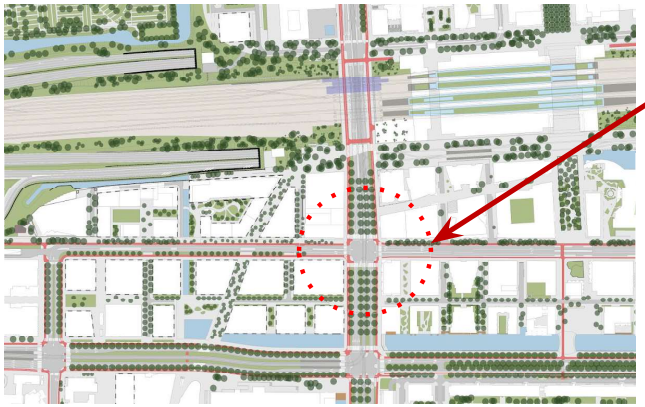
Case Parnassusweg



Case Parnassusweg

Intersection 2
Mahlerlaan

Intermediate level

Impact of reducing cars (traffic flows and spatial qualities)

Insight for strategic decisions (in space and time)

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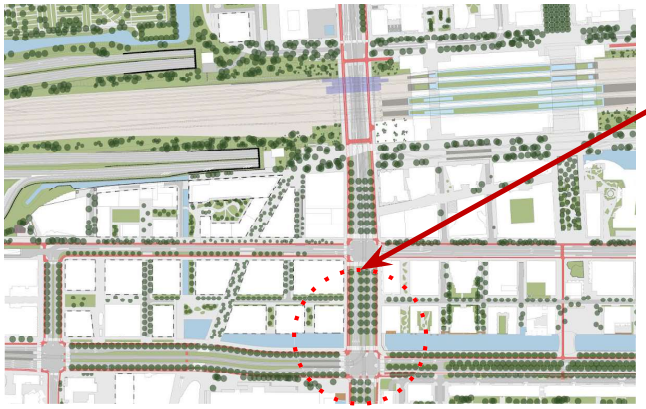
Case Parnassusweg



Case Parnassusweg

Intersection
Boelelaan

Macro level

Impact of set of interventions of behavioral changes

Insight for policymaking

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Interactive session

Bart van Arem

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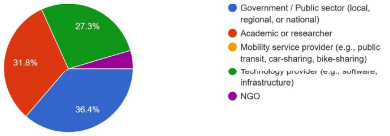
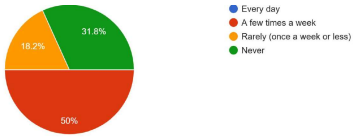
Our collective understanding…

1. Which stakeholder group in urban mobility best describes your role? (Please select one)
22 responses



8. How often do you use a car for your daily commute or travel?
22 responses



Awareness of National Digital Twin Initiative: yes(10), no (6), no response (6)

Worked with DT technology: Yes (19), no (3)

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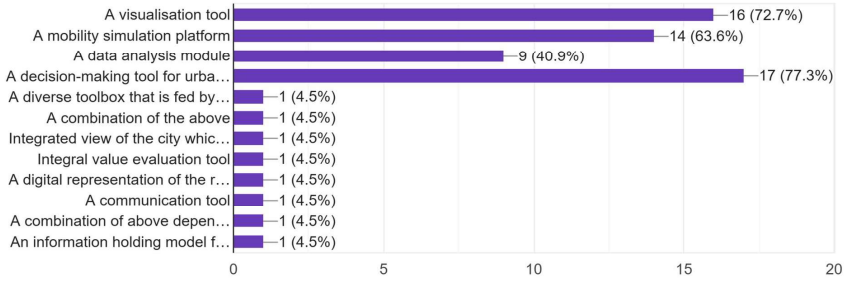
3. In your opinion, what is a Digital Twin? (Please select all that apply):

22 responses



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5. What do you believe is currently lacking in the digital twins that you are using in your organisation or today's digital twin solutions in general? (Please select all that apply)

16 responses

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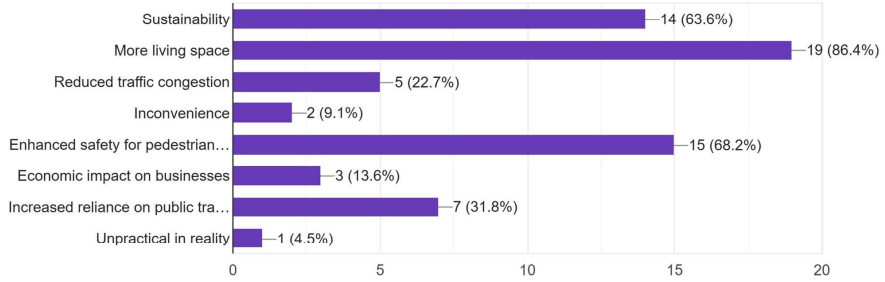
7. Which of the following are the top 3 features that describe your overall impression of car-low cities? (Please select top 3 that apply)

22 responses



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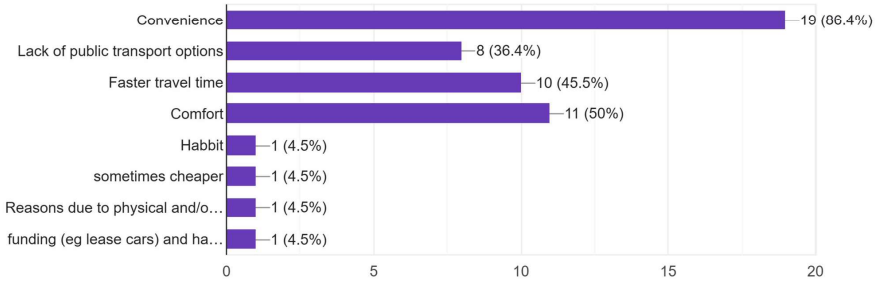
9. What do you think are the main reasons for choosing private cars other than other modes of transport? (Please select all that apply)

22 responses



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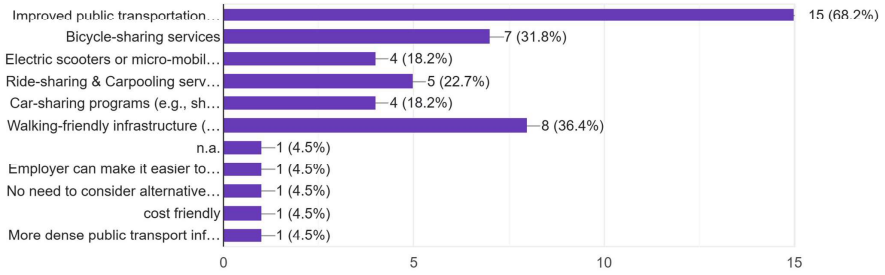
10. If offered the following alternatives in the Amsterdam Zuidas region, which one(s) would you consider using so that you no longer need to use your car? (Please select all that apply)

22 responses



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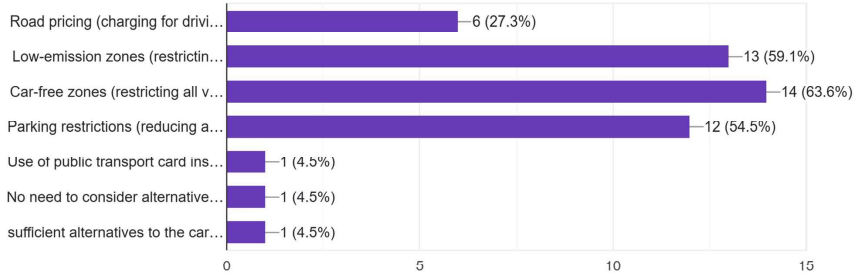
11. If offered the following interventions to reduce car usage and promote sustainable transport in the Amsterdam Zuidas region, which one(s) do you th...urrent experience? (Please select all that apply)

22 responses



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Interactive Workshop Details:

1. How can a digital twin help to understand the contribution of the interventions on policy goals
2. What are the components of the digital twin in terms of data, models and visualisation

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Group 1

Intersection 1: Microlevel

Interaction between modalities PT/Bike /Pedestrians/cars + Interfering flows of pedestrians - Insight for design decisions in public realm

(1) How can a digital twin help to understand the contribution of the interventions on policy goals

(2) What are the components of the digital twin in terms of data, models and visualisation

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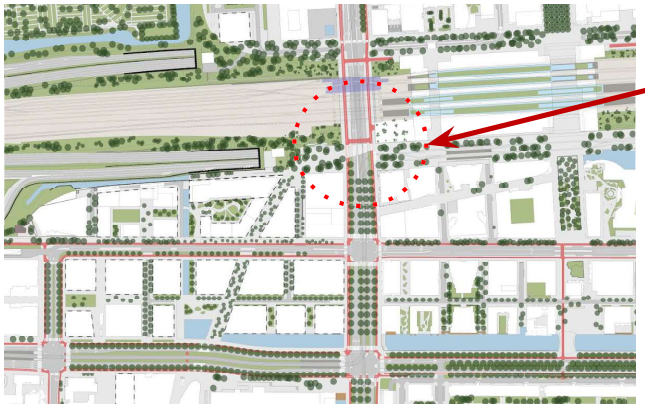
Case Parnassusweg



Case Parnassusweg

Intersection 1
Schonberglaan

Microlevel

Interaction between modalities PT/Bike /Pedestrians/cars

Interfering flows of pedestrians

Insight for design decisions in public realm

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Group 2

Intersection 2: Intermediate level

Impact of reducing cars (traffic flows and spatial qualities) + Insight for strategic decisions (in space and time)

(1) How can a digital twin help to understand the contribution of the interventions on policy goals
(2) What are the components of the digital twin in terms of data, models and visualisation

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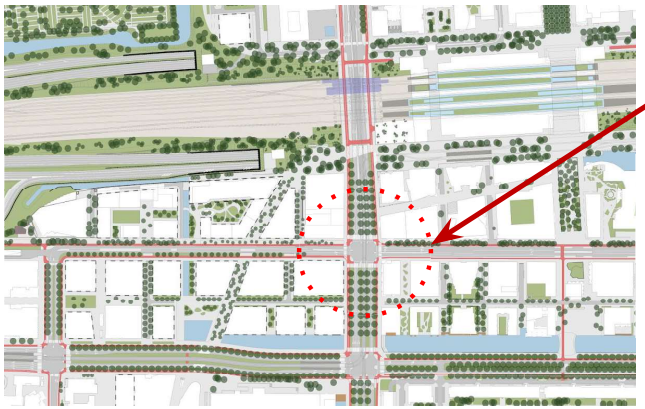
Case Parnassusweg



Case Parnassusweg

Intersection 2
Mahlerlaan

Intermediate level

Impact of reducing cars (traffic flows and spatial qualities)

Insight for strategic decisions (in space and time)

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Group 3

Intersection 3: Macro level

Impact of set of interventions of behavioral changes + Insight for policymaking

(1) How can a digital twin help to understand the contribution of the interventions on policy goals
(2) What are the components of the digital twin in terms of data, models and visualisation

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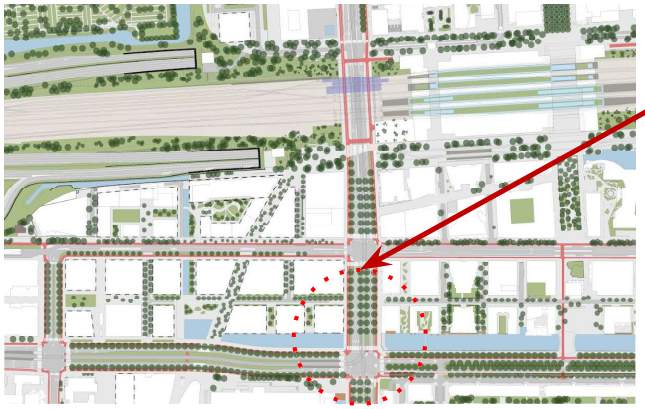
Case Parnassusweg



Case Parnassusweg

Intersection
Boelelaan

Macro level

Impact of set of interventions of behavioral changes

Insight for policymaking

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Group 4

All three intersections: How does this work together?

(1) How can a digital twin help to understand the contribution of the interventions on policy goals?
(2) What are the components of the digital twin in terms of data, models and visualisation?

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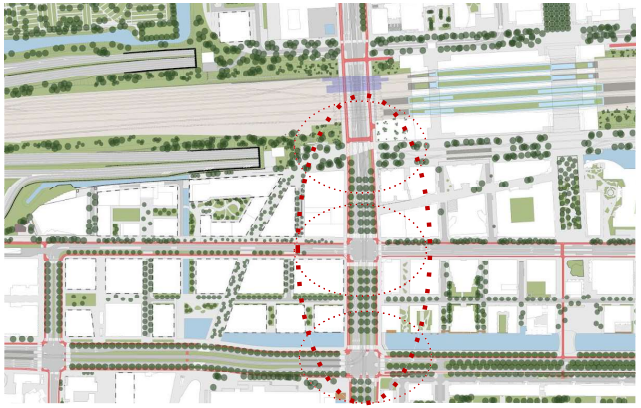
Case Parnassusweg



Case Parnassusweg

Intersection 1
Schonberglaan

Intersection 2
Mahlerlaan

Intersection 3
Boelelaan

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Break

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Feedback Session

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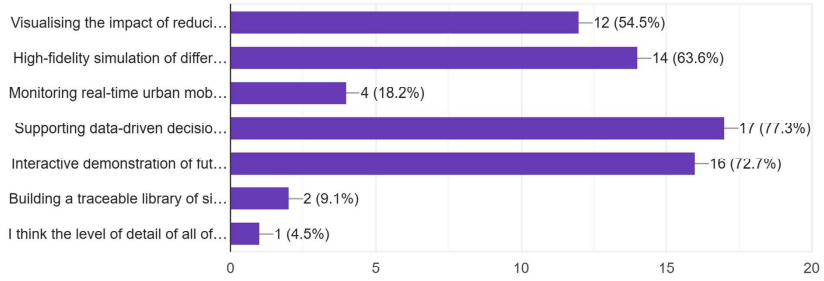
12. In your opinion, which of the following features are the top 3 most important for using Digital Twin technology to study the impact of car-low cities?

22 responses



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Close out and Next Steps By Bart van Arem

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Thank you!

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