

A-IARG CONFERENCE 2023

# Digital and Physical: The Role of Digital Twins in Praxis

*Presented by*

*Mani Dhingra, Ph.D. (She/Her)*

Senior Postdoctoral Researcher, Maynooth University Social Sciences Institute

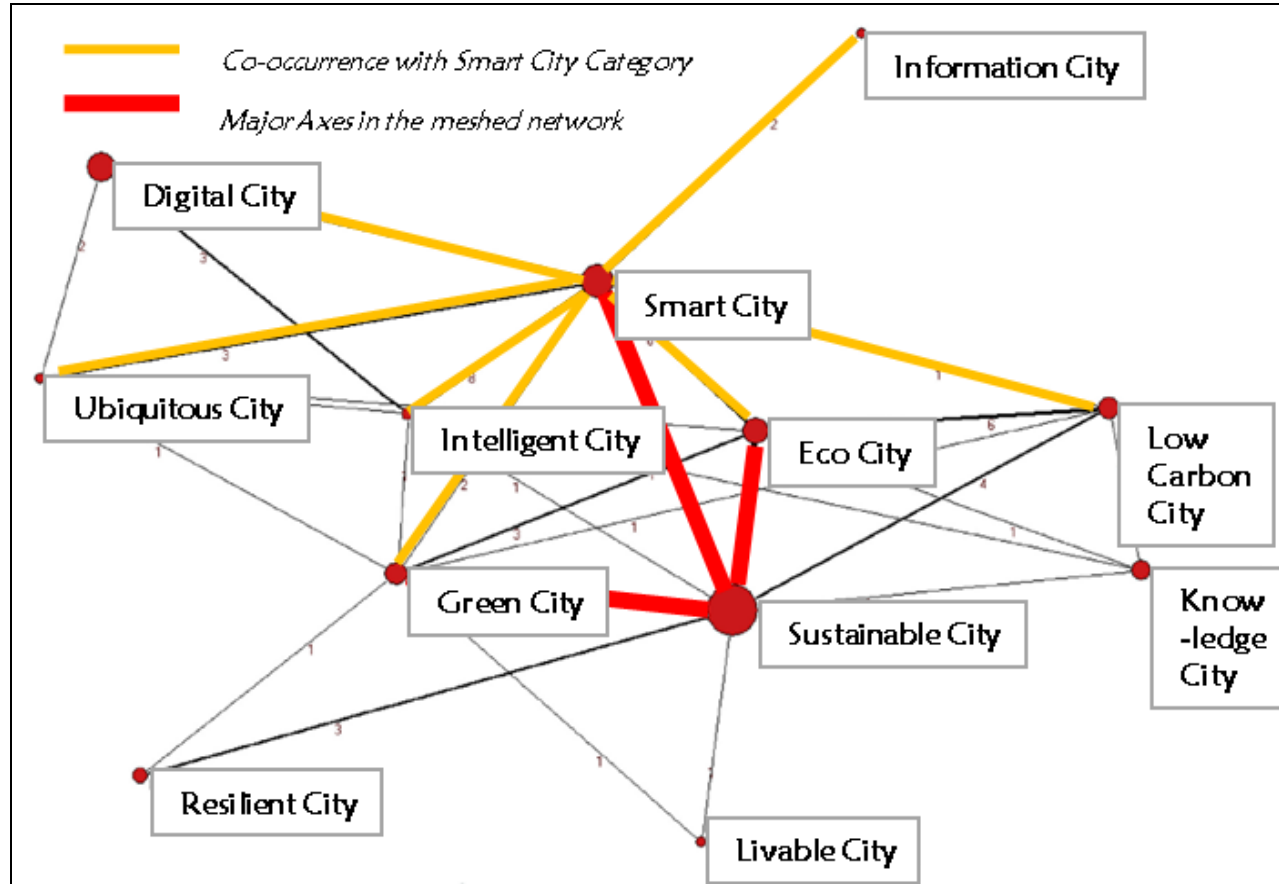
Digital Twin Ecosystem Manager, Smart Dublin, Dublin City Council

E: [mani.dhingra@mu.ie](mailto:mani.dhingra@mu.ie); [mani.dhingra@adaptcentre.ie](mailto:mani.dhingra@adaptcentre.ie); [mani@smartd8.ie](mailto:mani@smartd8.ie)



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# THE CONCEPT of 'Smart Cities'



**Inter-relationship between popular city categories**

Source: Dhingra, & Chattopadhyay (2017)



*UN initiative coordinated by ITU, UNECE, UN-Habitat and supported by other 14 UN bodies, that help support the development of institutional policies and strategies which encourage the use of digital technologies to facilitate digital transformation and ease the transition to smart sustainable cities.*

*“However, in reality, there is no fully fledged smart city till now”* Yigitcanlar (2015)

# *Overall Narrative of Smart Cities*

## **Space and Smart City**

First so-called smart cities were designed in a generic space with no sense of history and terrain. Ex- New Songdo in Korea, Masdar in UAE, and PlanIT Valley in Portugal

## **Technology and Smart City**

There is a misconception that there is only one pareto-optimal solution for dealing with complex urban problems by installing technology into an existing urban system.

## **Citizens and Smart City**

It is yet not clear if the units of analysis for smart city projects are people or firms. Inclusive innovation projects involve smart citizenship and not simply civic participation.

## **Time and Smart City**

Smart city rhetoric is always promising a Proximate Future which is just around the corner and beyond our reach. For smart city enthusiasts, this concept is deemed necessary and forever remains beyond our reach.

## **Economy and Smart City**

Smart city market majorly focuses on a neo-liberal economy to ensure a smooth flow of capital, talent, and material building idea of branding and urban entrepreneurship comes into being.

## **Governance and Smart City**

The city is a client as well as a site of innovation, production, distribution, and consumption. The functional difference between vendors seeing a solution and the city providing services is rarely specified.



Global Interventions

Trend and Evolution

Scholarly Critique

Experts' Survey

Text Analytics

## 'Not Smart'

## 'Real Smart'

1. **Fragmented infrastructure-oriented strategies**
2. Stressing the idea that **'technology is enough'** (Angelidou, 2014) (Hollands, 2008) (Neirotti et al., 2014) (Allwinkle & Cruickshank, 2011) (Gaffney & Robertson, 2016)
3. **Singular focus on efficiency** (Angelidou., 2014) (Angelidou, 2015)
4. **Short term spatial Fixes** (Hollands, 2008)
5. **Singularity of one size fits all** informational layers (Claire. & Catherine., 2014)
6. **Generic concepts** of smart cities without social innovation (Tanzela., 2015)
7. **~ 50% world population with access to internet** and an acute gender gap in connectivity as around 327 million fewer women than men owns a smartphone. Inappropriate digital intervention can **widen these social gaps** instead of bridging them (UN-Habitat, 2021)

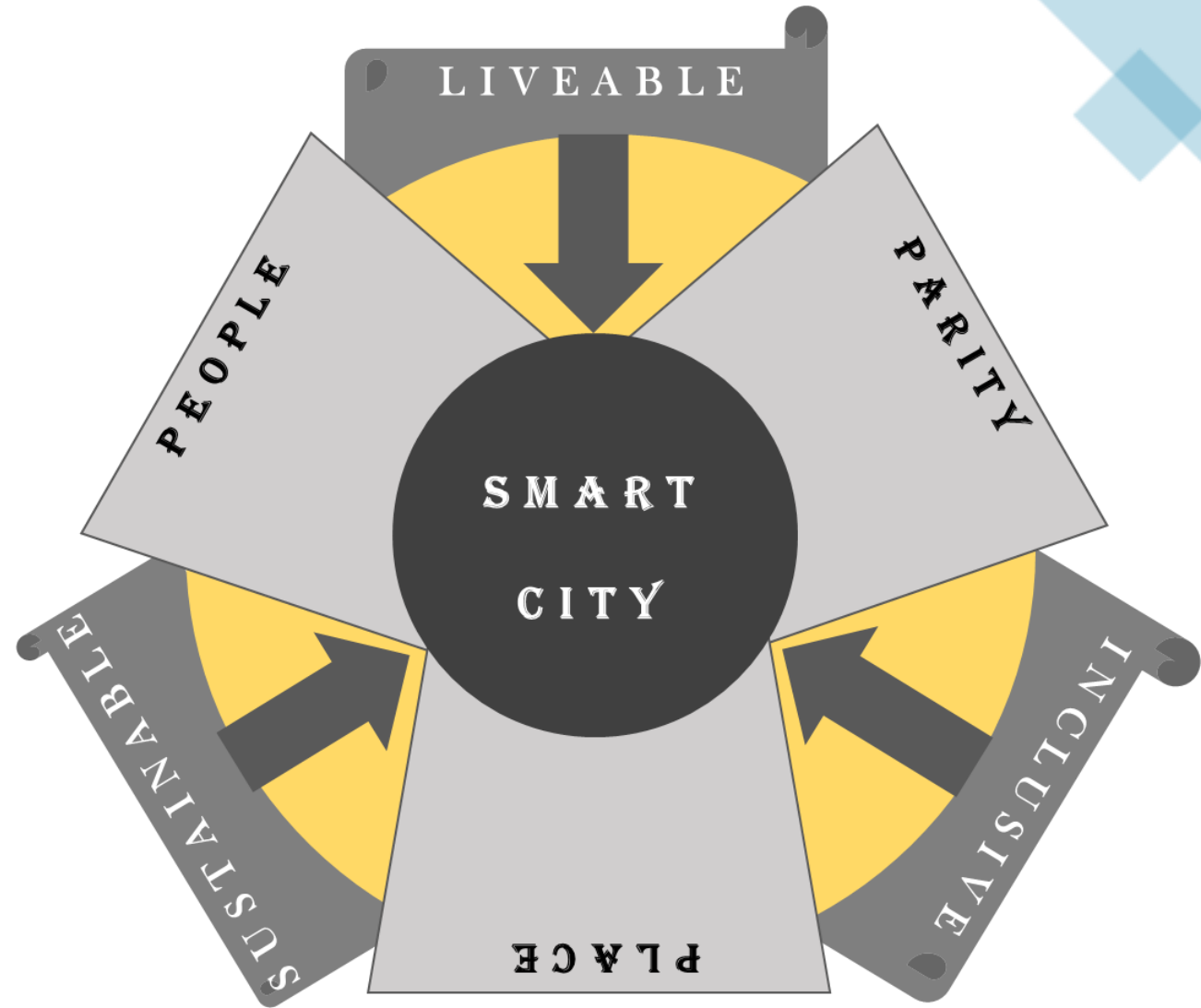
1. **Human capital and people first** (Claire. & Catherine., 2014) (Shapiro, 2006) (Hollands, 2008) (Angelidou., 2014) (Angelidou, 2015)
2. Go significantly **beyond information technologies** and wired cities
3. Effectively **contextualised in wider social and physical systems** (Jong et al., 2015).
4. **Human centred approaches** for urban environmental problems (Angelidou, 2015)
5. **Technology at the service** of their inhabitants and not vice versa (Angelidou., 2014)
6. **Focus on Urban Place-making** instead of Urban Place-marketing (Hollands, 2008)
7. Responds **socially, culturally and spatially** (Hollands, 2008)



### *Objectives of Smart Urban Development*

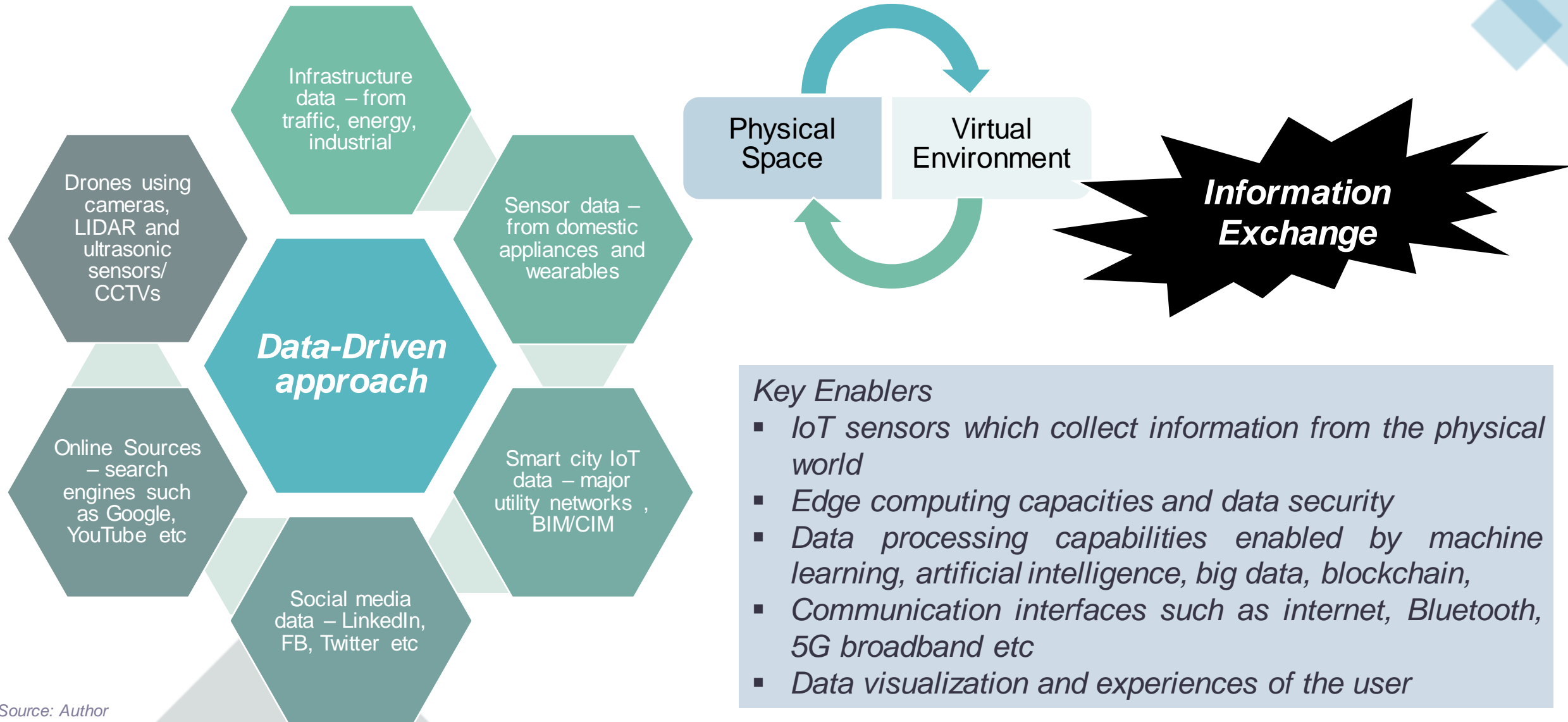
*A **Smart City** is an urban system that strategically leverages the hidden potential of its existing communities in terms of their social, cultural, economic, environmental and physical attributes to improve the quality of life and well-being of its citizens, promote urban sustainability, and ensure inclusive socio-economic growth.*

## **A TRIPARTITE SMART CITY MODEL**



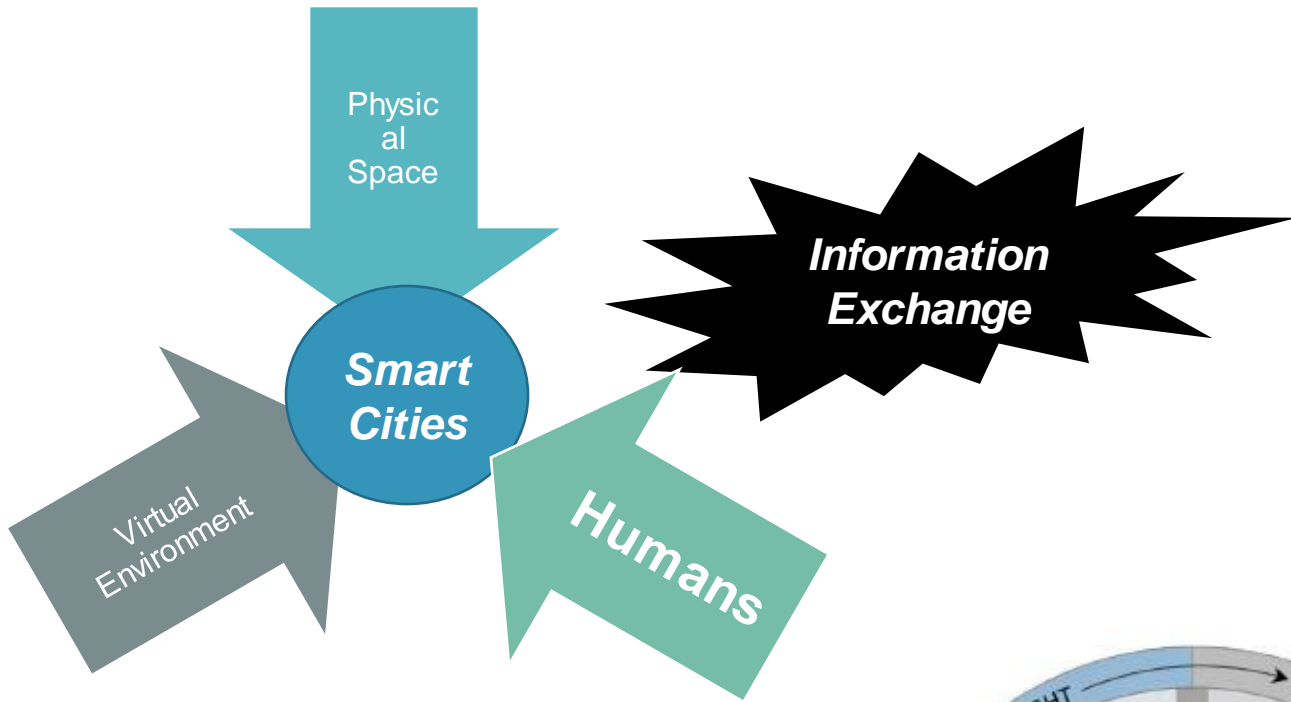
Source: Dhingra & Chattopadhyay (2022)

# Design Shift from *Physical* to *Digital*

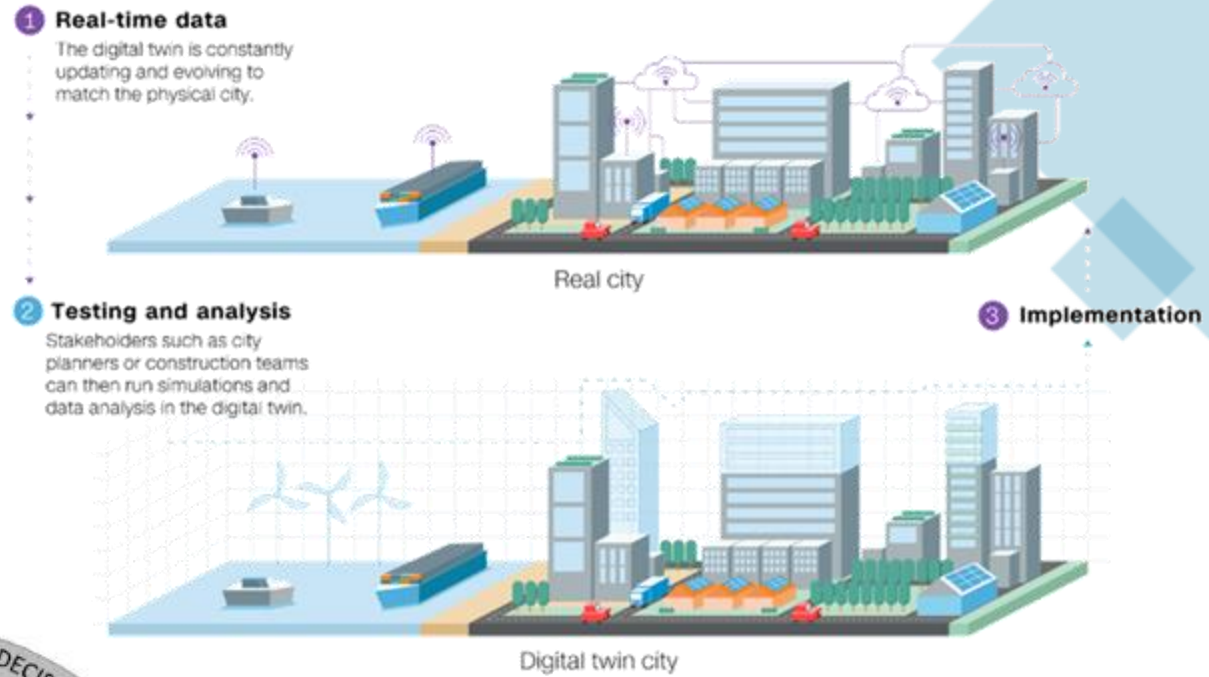


## Key Enablers

- IoT sensors which collect information from the physical world
- Edge computing capacities and data security
- Data processing capabilities enabled by machine learning, artificial intelligence, big data, blockchain,
- Communication interfaces such as internet, Bluetooth, 5G broadband etc
- Data visualization and experiences of the user



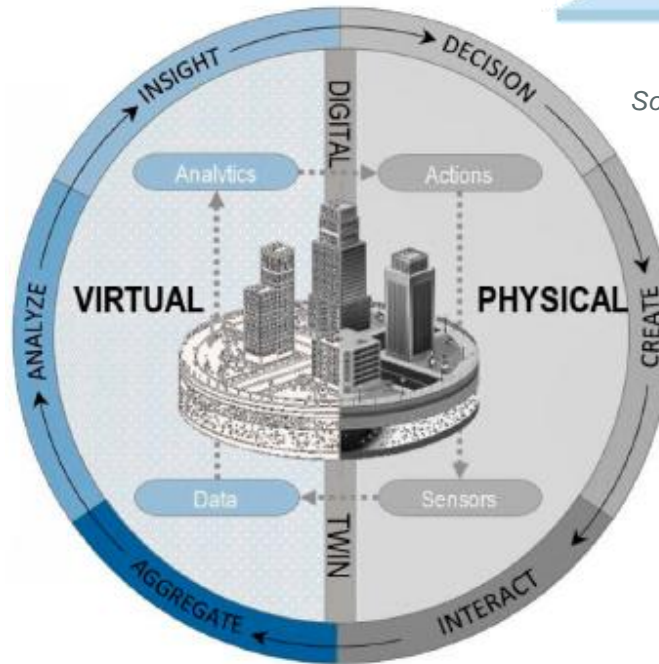
According to analyst predictions, over 500 urban digital twins are expected to be deployed by 2025 and the technology could save cities US\$280 billion by 2030 through more efficient urban planning.



Source: Digital twins: Why virtual city clones are the future of urban planning | CNN

## City Digital Twin (CDT)

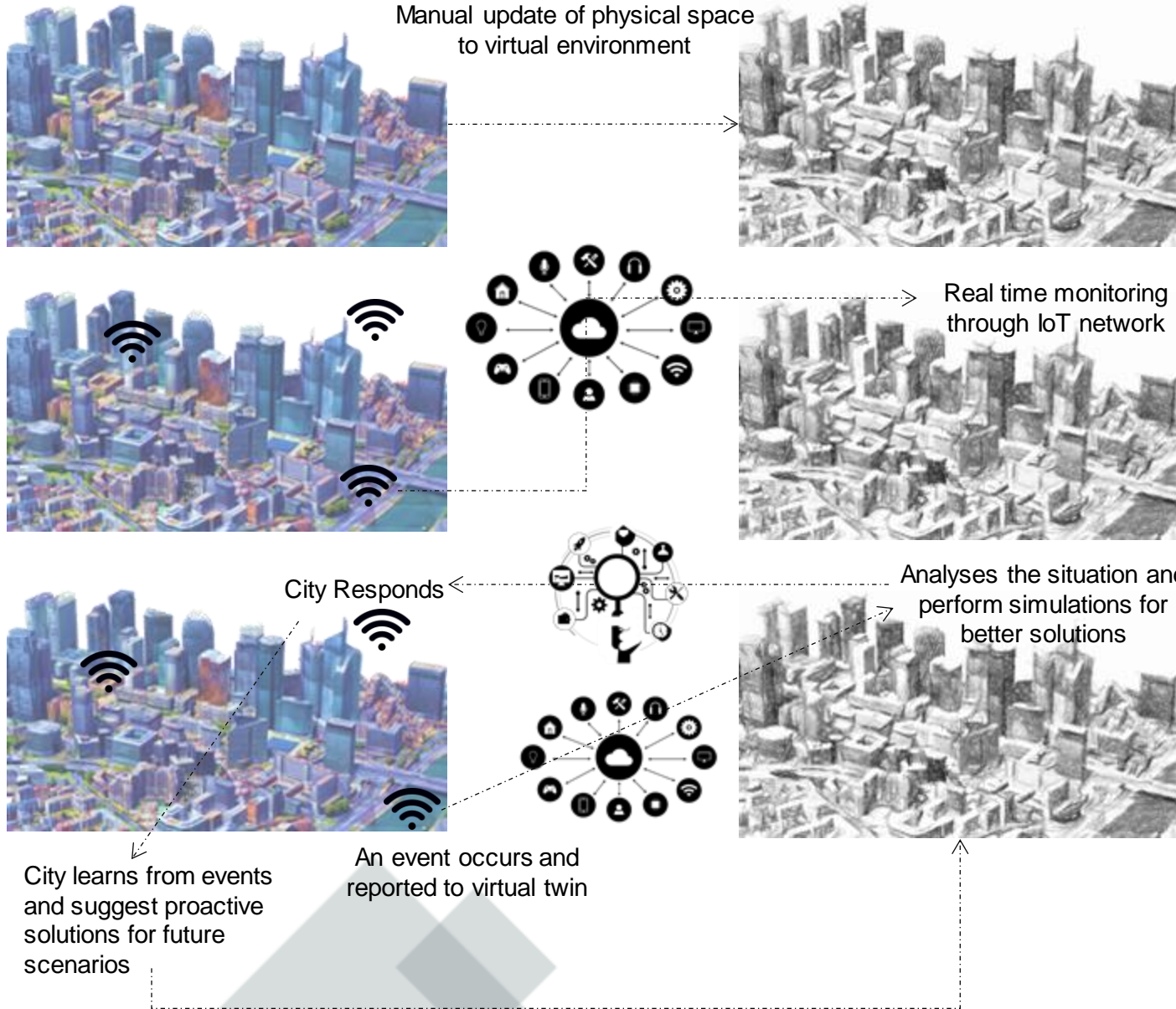
Digital Twin Technology enable advancement from traditional 3D city models to AI driven living city models, allowing possibility to simulate all urban infrastructure systems, terrain and buildings into one integrated system.



Source: Caprari et al. (2022) , Sepasgozar (2021)

## Physical Urban Environment

## Virtual/ Digital Environment



## Digital Model

*Digital representation of physical spaces*

## Digital Shadow

*Real-time monitoring and lifecycle management*

## Digital Twin

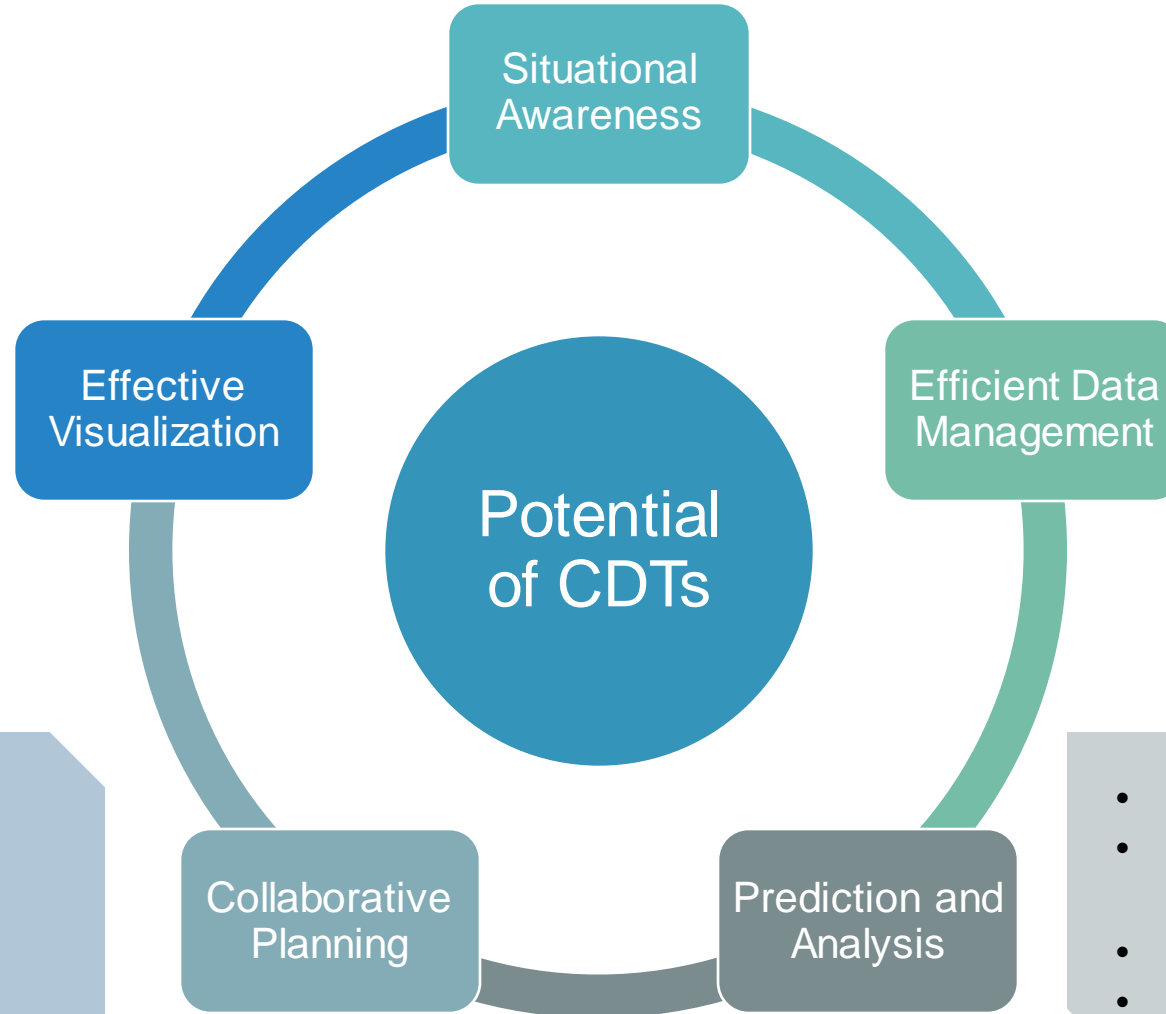
*Bi-directional exchange of information: Living model*

Level of Data Integration



- 3D real time experience
- Multi-spatial and temporal dimension
- Unified platform
- Integration of human behaviours
- Personalized information systems
- Accessible mode of communication
- Citizen participation and dialogue

- Real-time monitoring
- Tracking progress
- Localised solutions
- Optimal responses to emergencies

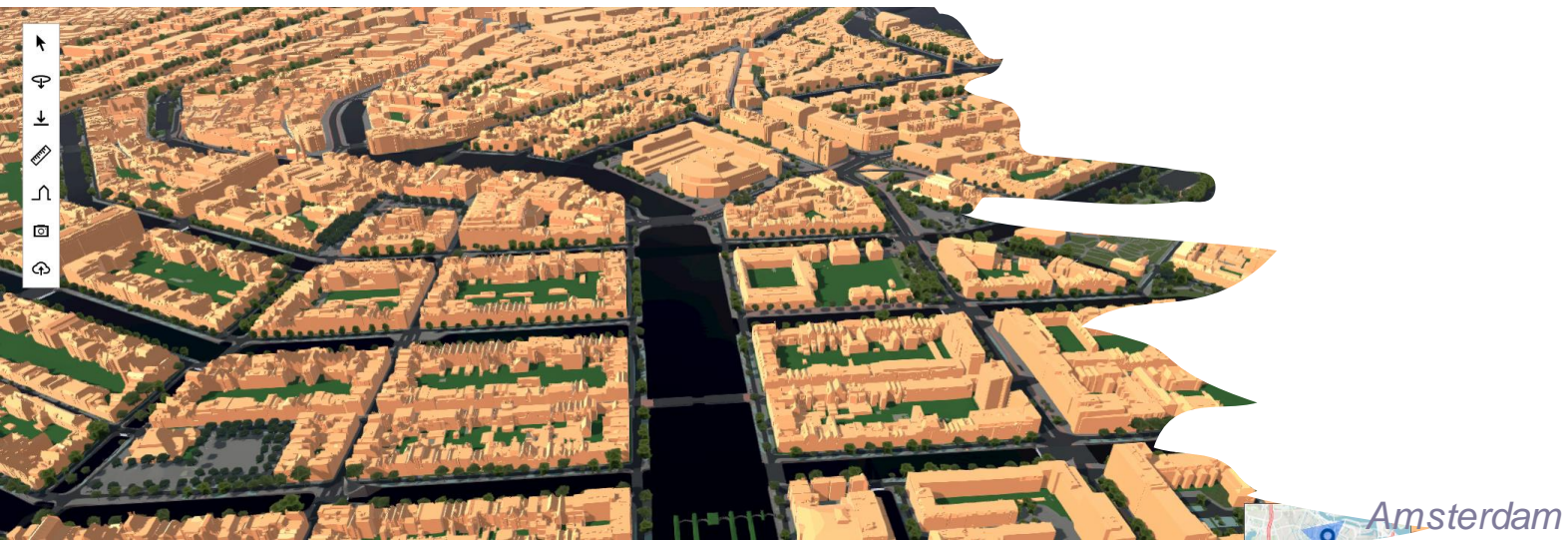


- Spatial integration
- Interoperability
- Open-source platforms
- Data processing

- Multidisciplinary approach
- Multistakeholder governance
- Stakeholders' engagement
- Citizen's feedback
- Easy operations

- Policy evaluation
- Simulations for risk-averse planning
- What-if scenarios
- Easy operations

Source: Author



# Some Case Studies of City (Urban) Digital Twins...

# Visualization & Data Representation

*(P)DT: A Participatory Digital Twin for Consensus-Building in Herrenberg, Germany*



Source: Dembski, et al. (2020)

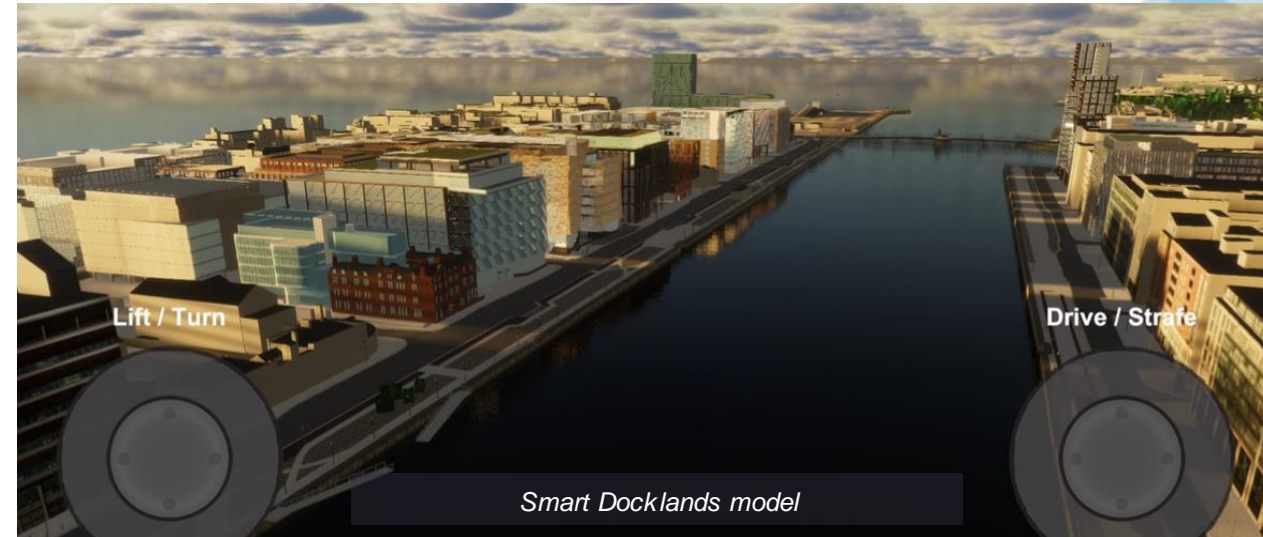
*“Although technological, focuses on the involvement of local actors and the potential role of the CDT in the dynamics of cooperative planning and co-design”*

# Smart Dublin

*Digital Twin Programme for Stakeholder and Community Engagement*

## Core Objective

*To identify and develop new frameworks for stakeholder and community engagement using digital twin technology and further optimize them using proof of concept.*

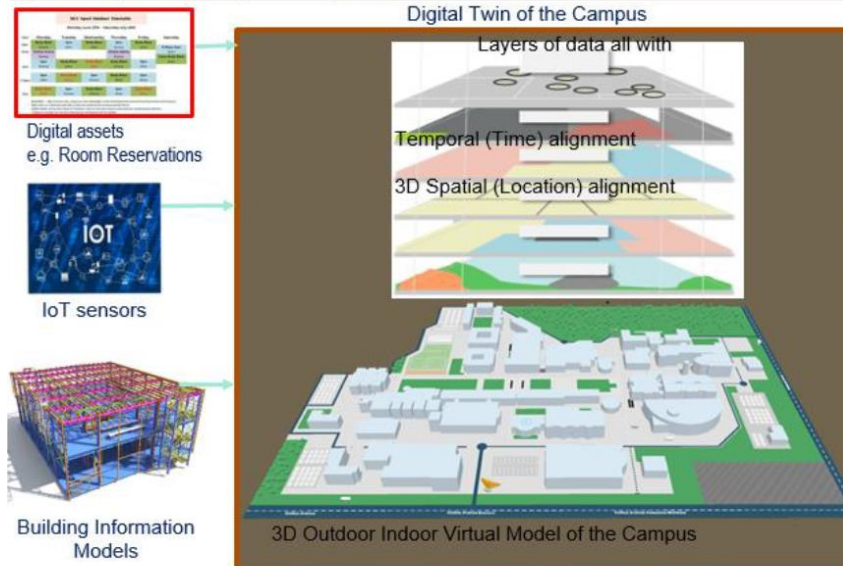




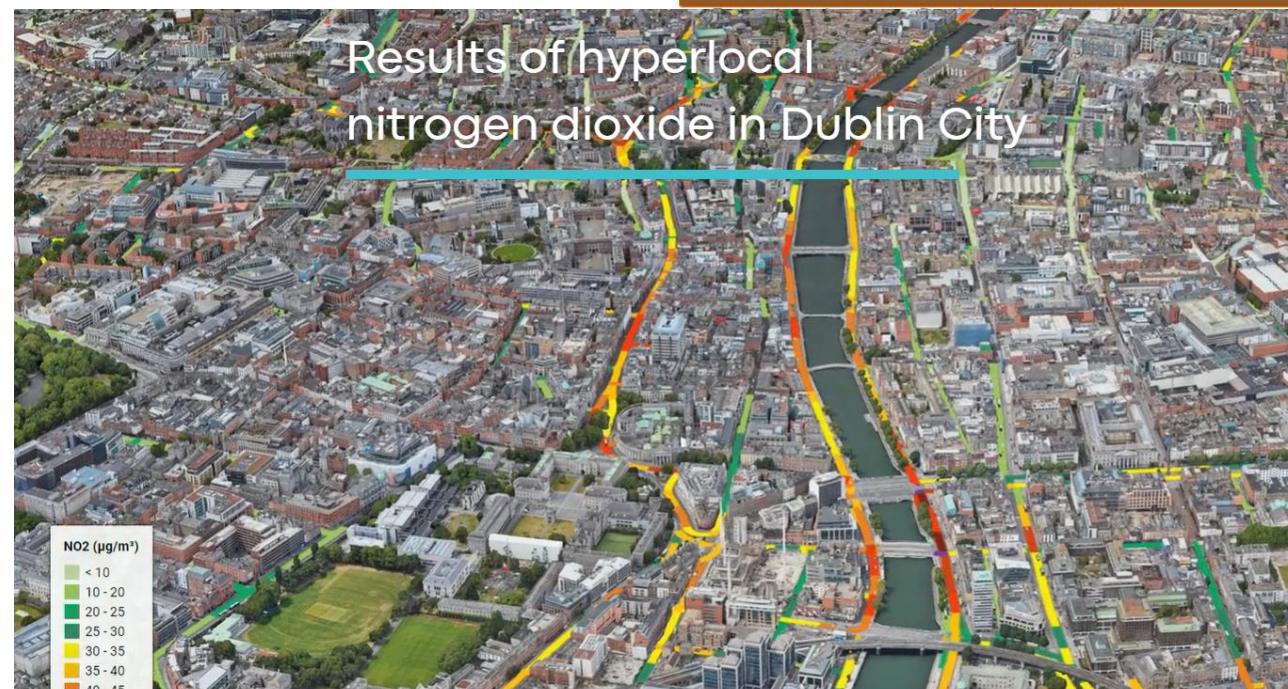
**D3D**  
(Data Hackathon – explore use cases -> Planning case and DFB)

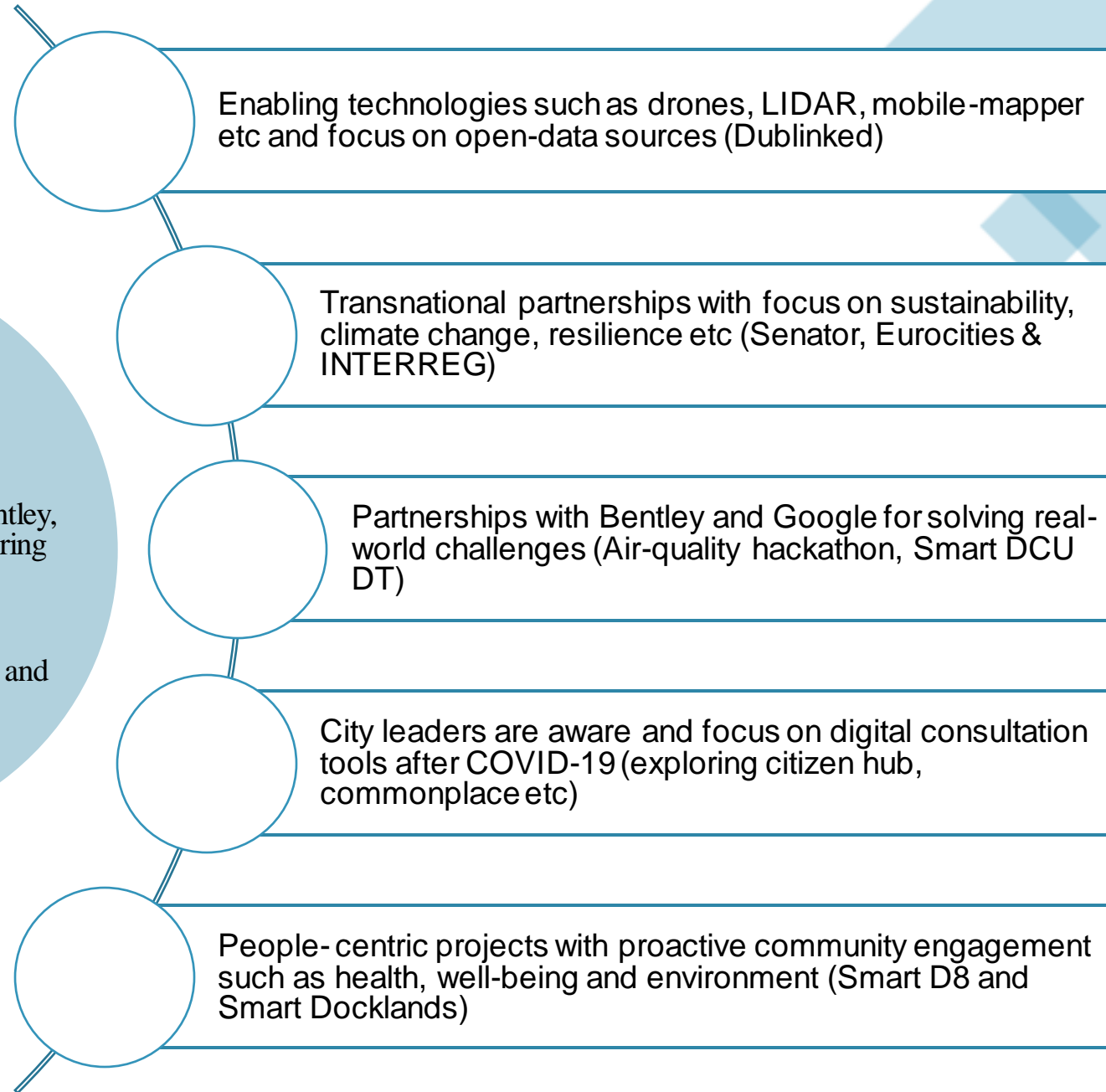
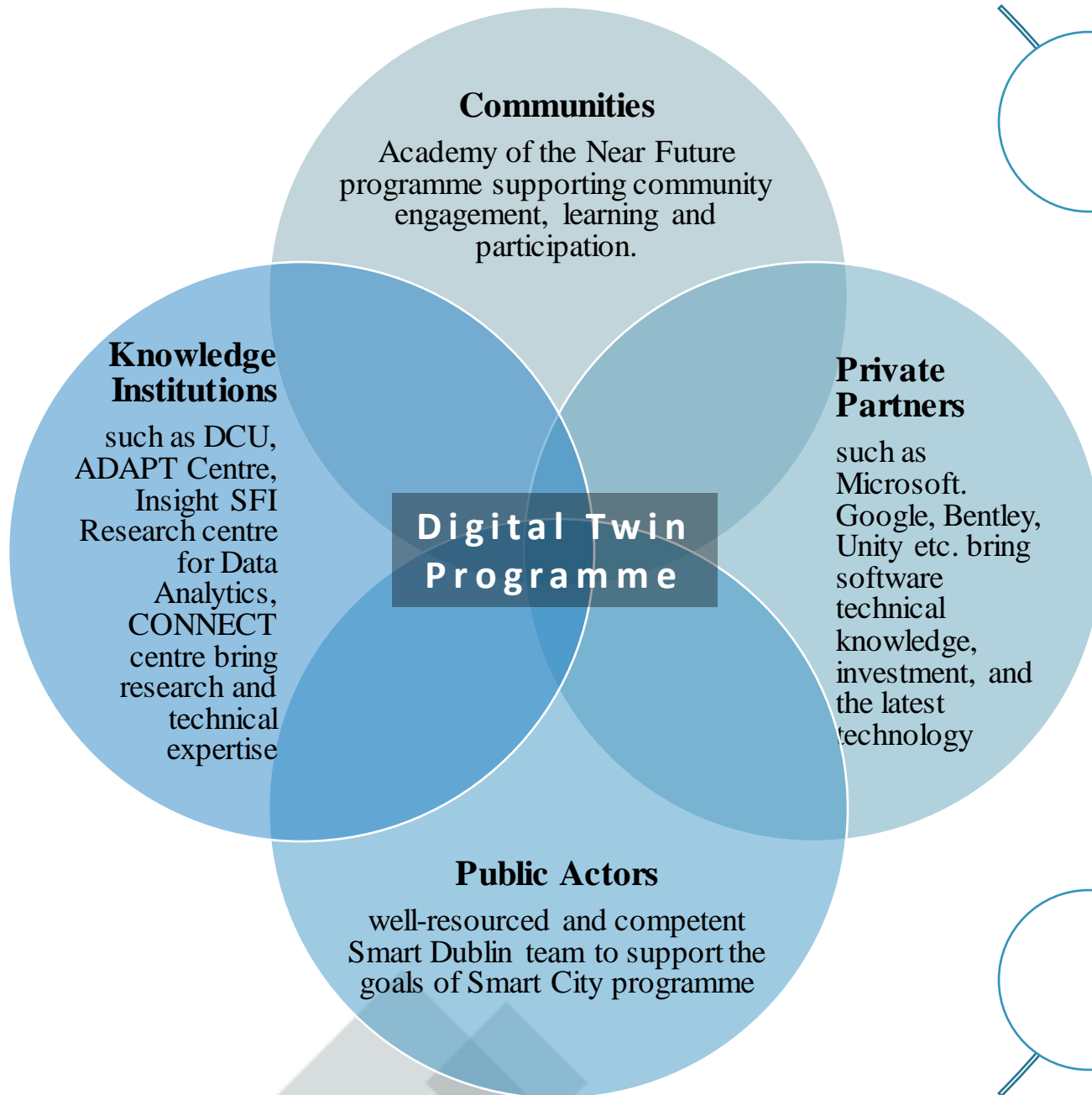
## Bentley and DCU Campus (Smart Dublin umbrella)

Exploring 3D data (outdoor/indoor) and integration of IoT data in real time with data analytics for insights and predictions.



Source: Smart Dublin





# Suggestive Implementation Journey

## Maturity Phase

## Key Questions to be asked in each phase



### Strategy Phase

- *What is a digital twin?*
- *How can a digital twin support better evidence-based decisions?*
- *Who else has implemented digital twins?*
- *What case studies are available?*
- *How to leverage existing 3D models, urban data sources and private partnerships?*

### Exploratory Phase

- *What outcomes/use case needs to be achieved?*
- *Is the data needed available?*
- *What existing methods, models and platforms can be leveraged?*
- *What ethical obligations and/or restrictions are to be considered?*
- *Does the data need processing/cleaning/formatting?*

### Insightful Twins

- *What kind of visuals and interface is needed for the use cases?*
- *What kind of prediction, IoT data and analytical models are needed?*
- *What security and access controls are needed?*
- *How will the digital twin outputs be integrated into existing DCC planning processes?*
- *How to develop a long-term digital twin strategy?*

Foster cross-departmental collaboration between various planning agencies

Allow scenario planning before implementation, reducing the risk and increasing the public trust

Provide accelerated feedback loops to make designs and construction more precise

Include people with diverse digital literacy levels in decision-making using visual learning, less complicated and more relatable data

Explore innovative solutions for urban planning activities in a controlled environment that mimics the real city

Viable tool for storytelling and communicating plans, policies, and outcomes to citizens

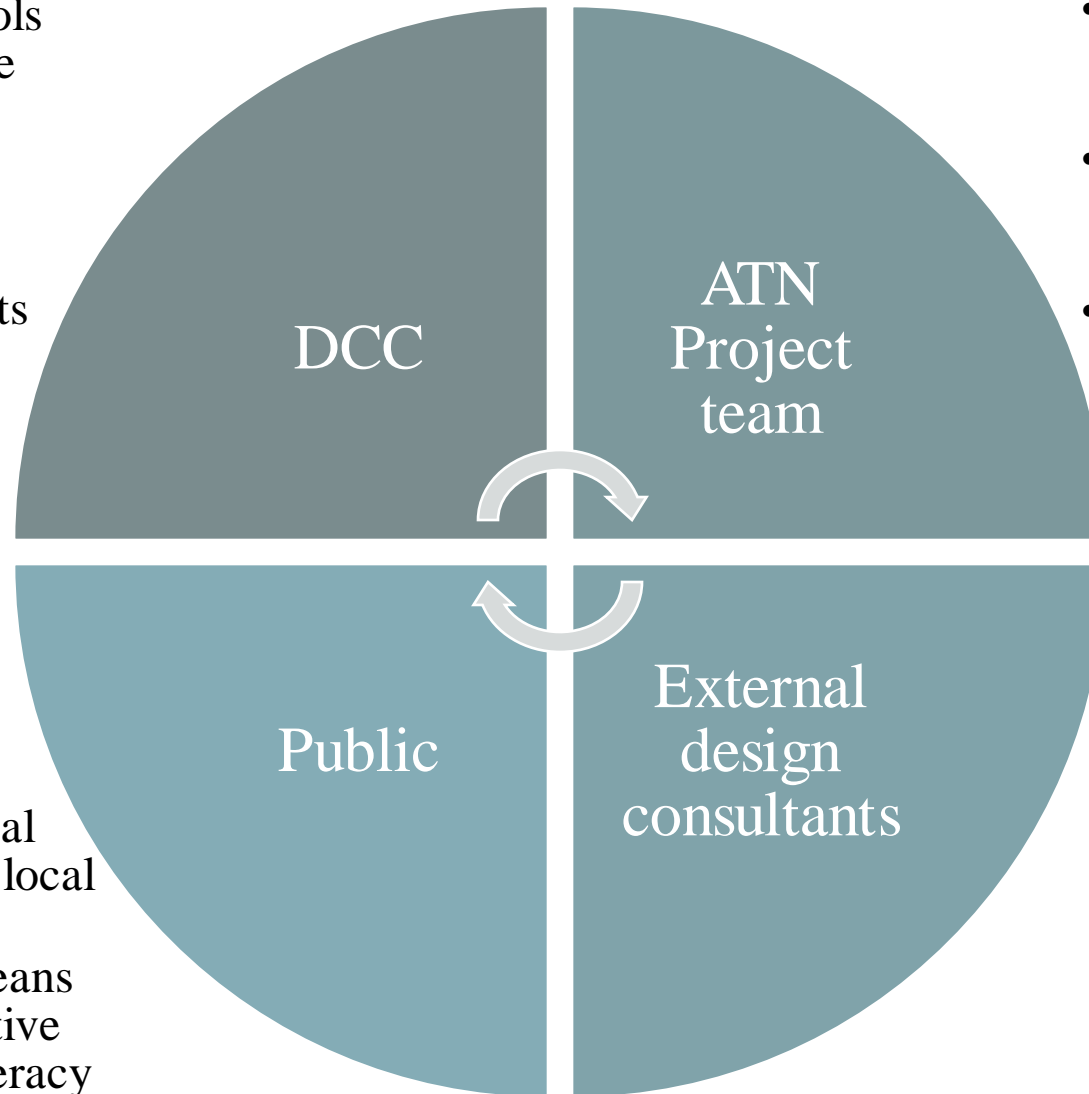
Equips consultation team with more tools to answer and demonstrate solutions to public through interactive and immersive simulations



Source: Author



- Using innovative digital tools for engagement and achieve goals of inclusive communities.
- Induce larger behavioural shifts towards sustainable mobility within public for its local climate action goals
- Build public trust and acceptance.



- Well-equipped to deal with difficult questions raised during public consultations.
- Efficient utilization of existing resources, data and capacities of hired consultants.
- Builds accountability of proposed design scheme.

- Possibility to create easy to relate, interactive, contextual and immersive realities for local communities
- Inclusive and accessible means of communication irrespective of their digital/technical literacy levels.

- Using the diverse datasets for the project to maximum potential.
- Improve collaboration and relationship with the council and stakeholders.
- Opportunity to innovate and brand itself in a collaborative framework.

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# Thank you!

*Questions??*



Comhairle Cathrach  
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