Digital Twins for Stakeholder and Community Engagement (DT4E): an ADAPT-DCC Collaboration

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The ADAPT centre at Maynooth University and smart cities unit of Dublin City Council (DCC) are collaborating on a 2-year targeted project to enable the development of a Digital Twin ecosystem and facilitate its application for stakeholder and community engagement. DCC has been experimenting with state-of-the-art technologies such as drones and LIDAR across various thematic challenges such as energy consumption, urban planning, public engagement, environment, tourism, and infrastructure management. Advancing towards a more sophisticated system, the DT4E project intends to apply a people-centric approach for effective stakeholder collaboration and explore novel forms of community engagement.

1. Motivation

While the concept of digital twins has existed for decades, it primarily refers to mirroring physical system(s) to their digital counterparts via linking information throughout their lifecycle [1]. This new emerging technology offers possibilities of advancement from traditional 3D city models towards AI driven living city models to simulate urban infrastructure system(s), improve city management process(es) and exploring new user-interfaces between communities, public authorities, service providers and researchers [2]. Theoretically, it seems to be a sustainable digital solution [3], however this project intends to investigate and inform its role, benefits and challenges for efficient decision-making, and diminished participatory inequalities. DT4E is expected to generate new data, methods, and citizen science around the interaction between digital twins, and multiple stakeholders.

1.1. Research questions

DT4E will address following three research questions -

- What are the challenges and opportunities in using digital twin technology for developing people centric, inclusive, sustainable, and smart urban solutions?
- How can we use digital twin technology to achieve international sustainable development goals aligning with DCC's priorities and goals?
- What are the governance and ethical challenges raised during implementation of urban digital twins and how to mitigate them?

1.2. Objective and goals

The core research objective is to develop a toolkit for stakeholder and community engagement using digital twin technology and trial proof of concept engagements for further optimization. The goals of the project are listed below -

- To identify, evaluate and advance existing 3D modelling technology towards digital twin ecosystems for effective stakeholder and community engagement.
- To engage with and encourage collaboration of all stakeholders in the development and deployment of digital twin technologies across a wide range sectors and applications.
- To evaluate and mitigate ethical challenges in deploying digital twin technologies for stakeholder and community engagement.

2. Urban digital twins

The global demand for digital twin technology is expected to increase from USD 3.8 billion to USD 36 billion by 2025 [4]. Although both smart city and digital twin terms are ambiguous and contested, there is a co-creative link between the two [5], [6]. While in a regular city, city elements are digitally disconnected and overall fabric is static and non-responsive to changes, in a smart city, city elements are digitally connected, and interactions between them and users take place [7]. Some success stories around city digital twins include the ones developed by Singapore, Zürich, Utrecht, Wellington, and Helsinki [6]. A few potential benefits of city digital twin identified from the literature review are represented in Figure 1.

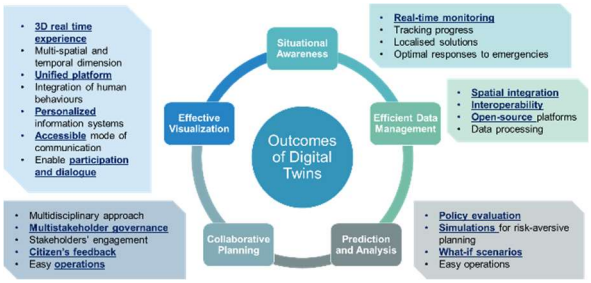

Figure 1 : *Potential benefits of urban digital twin.*

Over 500 urban digital twins are expected to be deployed by 2025 and could save cities USD 280 billion by 2030 through more efficient urban planning[8]. A digital twin is different from traditional city models in terms of the level of data integration. They are more than digital representations of physical spaces, systems and processes ensuring bidirectional exchange of information between physical and virtual

environment [4], [9]. Ideally, they are supposed to be dynamic and living models representing a system throughout its life cycle. However, the trend shows that till date, 3D models with real-time component and simulation capabilities are the preferred approach [9]. Some interesting ways to engage with the general audience are shown in Figure 2.

Figure 2: *Examples of visual tools for engagement.*

3. Digital twin ecosystem at DCC

The first phase of this project analyses and compiles the ongoing digital twin works at DCC. A digital twin of three residential blocks located on Lower Dominick Street in Dublin was also developed and assessed for the whole-life cycle carbon impact of retrofit strategies aligned with national targets for 2030, 2050 and beyond. DCC's Surveying and Mapping department actively uses drones and LIDAR technology for generating 3D models of selected sites as well as a comprehensive BIM strategy is in the formulation stages. Besides using 3D models for planning and management purposes, Smart Tourism programme, supported by DCC and Failte Ireland are exploring augmented reality for immersive engagement solutions with public and visitors- example being the Dublin Discovery Trails app launched in January 2023. Figure 3 illustrates digital twin models of Smart DCU's Glasnevin campus for real-time monitoring, St. Patrick's cathedral model used by Dublin Fire Brigade for pre-incident planning and open model of Docklands Strategic Development Zone released for 3D Hackathon in 2019 using Bentley's software.

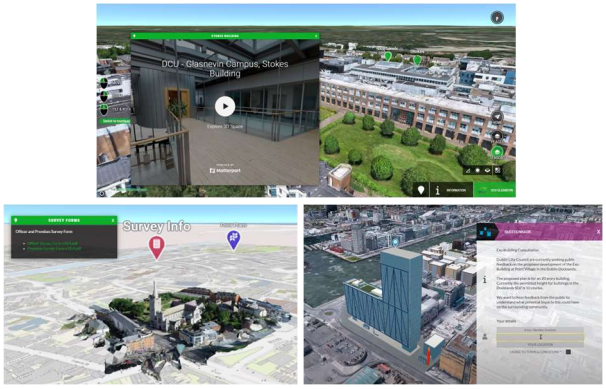

Figure 3: *Digital twin models on OpenCities planner.*

Figure 4 highlights some of the common challenges faced during implementation of digital twins such as data management, data acquisition, advanced processing capabilities, trained staff, data storage, data sharing among departments, lack of open data, accessibility for public and other stakeholders, interoperability between platforms, digital privacy and scaling to city level solutions considering vast amount of heterogenous city data. In the next phase of DT4E, use-cases are expected to be developed, deployed, and evaluated to complement the ongoing public consultation of Active Travel project, Smart DCU showcase and climate awareness using Dockland's model.

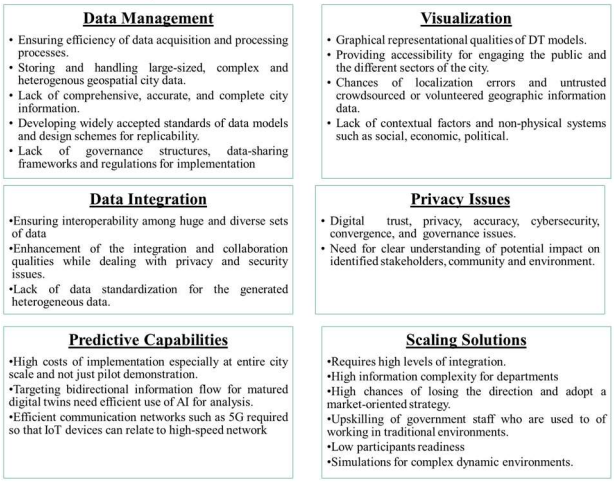

Figure 4: *Digital twin implementation challenges.*

4. Funding acknowledgement

This research is conducted with the financial support of Science Foundation Ireland under Grant Agreement No. 13/RC/2106_P2 at the ADAPT SFI Research Centre at Maynooth University and Dublin City Council.

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