Smart City Digital Twins Project
Workshop Assessment Report: TURKU

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SUMMARY

The convergence of Smart Cities (SC) and Digital Twins (DTs) concepts emerges as a desirable alliance in the dynamic interplay of urbanisation and innovation enabled by Internet and Communication Technologies (ICTs), inspiring cities to an outstanding wisdom in the future. At city level operations DTs transforms standard public services into efficient real-time actions, and strategic precision uses cutting-edge ICTs. Amidst latest technological advances – Artificial Intelligence (AI), Machine Learning (ML), Data Analytics, Extended Reality (XR), Internet of Things (IoT), and sensor technologies, for example, the synergy between SC and DTs allows cities confidently navigate the complex landscape of urban transformation by using DTs as their visionary compass. Likewise, strategic use of DTs optimises public sector open data, promoting data-based economic growth, social well-being, and environmental sustainability.

While cities intensively pursue to explore the possible futures of SC with DTs and realizing the what-if scenarios could come to life, reveals a plausible future for their cities in which smart grids might flourish and traffic might move autonomously and seamlessly. While the ideal alliance of DTs and SC could open the door to a revitalised future urban landscape, this mission necessitates a systemic integration of ICTs, public awareness, talent & tech-skills, public-private-people partnership, and continuous strategic transitions in the city systems.
Thus, the project's main goals, which are in line with the Finland Digital Compass, Ecosystem Agreements and Smart Specialisation Strategy – 3S, were to advance sustainable public procurement, implement innovative strategies for regional development, and promote competency in DTs. Accordingly, the project emphasises the value of collaboration between the public, private, and people domains by highlighting the necessity of resolving the matching problem regarding SCDT development models.

With this motivation, the project designed as a one-year foresight research project spanning from February 1, 2023, to April 30, 2024, stands as a promising endeavour in the realm of urban innovation. In collaboration with esteemed partners, University of Turku, Turku University of Applied Sciences and Turku Science Park Ltd., this visionary project is co-funded by the European Regional Development Fund and fuelled by a total budget of EUR 241.399. This initiative completed wide-ranging up-to-date integrative literature review, mapping survey and engaged on-site workshops held within partner cities.

Mapping survey was publicly available via Webropol weblink and aimed to get insights of subject matter expert respondents on Smart City Digital Twins. In this regard, while the survey link has been provided to partner cities to distribute experts in their networks, it was also

accessible in project website. Eventually, the survey reached 982 potential respondents, and 22 of which 45 started responding, submitted their responds.

Aligning with project objectives, the foresight workshops were held in;

- September 19th 2023 Gdańsk Science and Technology Park,
- September 21st 2023 Wrocław Science Park,
- October 5th 2023 Vilnius Municipality Building,
- November 2nd EDUCity, Turku - Part 1 (Current Solutions)
- November 22nd 2023 EDUCity, Turku - Part 2 (Visions & Near Future Needs)

Participants registered to workshops via project website. Total foresight workshop participant number was 99 and according to registration records, city-based participants numbers are 17, Gdansk; 22, Wroclaw; 41, Vilnius and 19, Turku respectively (See, Error! Reference source not found.).

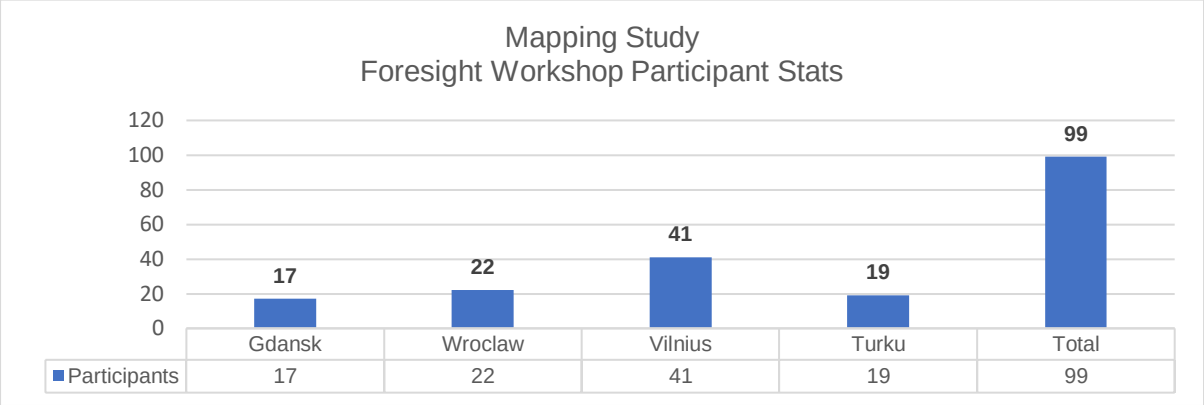


Figure 1 Foresight Workshop Participants in Number.

Project research team recorded 433 insights after completing workshops in four partner cities. According to the data, participants added 216 current solutions, 125 visions and 60 near future needs during workshop sessions (See, **Error! Reference source not found.**).

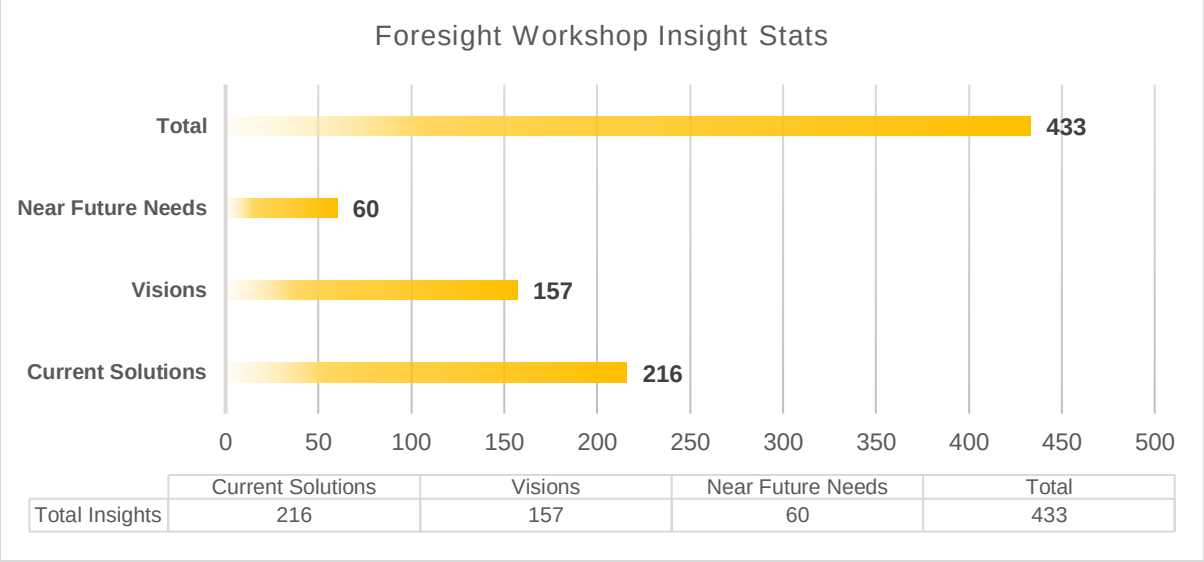


Figure 2 Total gathered insight numbers by workshop theme.

Notably, the project has initiated the creation of a marketplace for Smart City Digital Twin solutions, marking a pivotal step in its journey towards advancing the concepts of Smart Cities. In this sense, companies and start-ups running their business in partner cities had opportunity to pitch their business solutions before each foresight workshops held in four cities. Then there were able to publish their SCDT solutions in project marketplace.

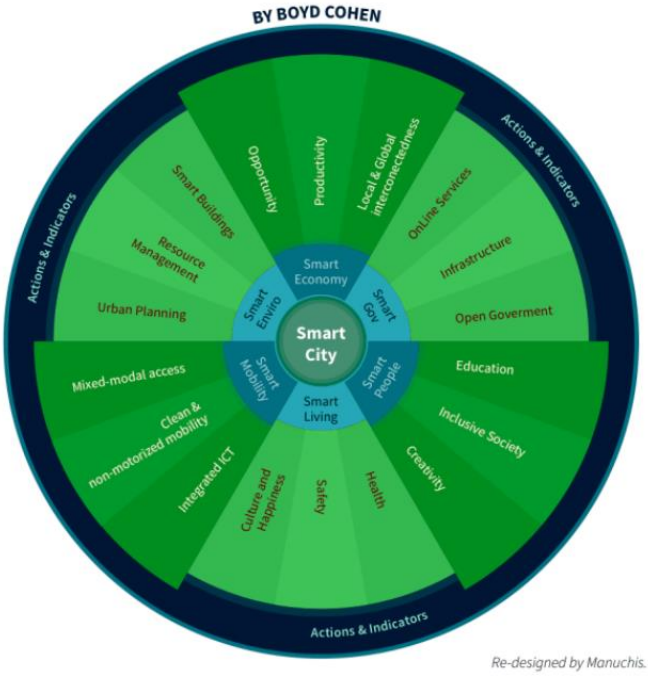
1. Introduction

Smart City Digital Twins are currently in an exciting phase of development. They offer vast potential for the advancement of Smart City initiatives, promising benefits to society, the economy, businesses, and the environment. The Smart City Digital Twins project is specifically dedicated to harnessing the power of public sector open data to foster sustainable economic growth within urban areas in Finland. This initiative explores the capacity of digital twins to facilitate the transition to environmentally friendly practices, support equitable working conditions, enhance citizen well-being, and promote the adoption of advanced technologies in larger subsequent projects.

The project actively contributes to the enhancement of research and innovation capabilities. The incorporation of advanced technologies into research and development, the project aspires through the following avenues as such strengthening expertise, foresight, and innovation activities by driving the development of digital twins, piloting their capabilities, and introducing potential commercial applications in line with the Public-Private collaboration model. This project serves as an implementation and development platform for the Research, Development, and Innovation (RDI) cooperation model, as it collaborates with the University of Turku, Turku University of Applied Sciences, and Turku Science Park. There are four cities Turku, Vilnius, Wroclaw, and Gdansk that operate in three countries, Finland, Lithuania, and Poland.

2. Mapping Study

2.1. Workshop Method



The Smart City Wheel (SCW) is an analytical tool for smart city ranking and benchmarking developed originally by Boyd Cohen. While it is applied by various scholars for case studies, city officials may find it a useful tool for self-analysis since indicators are easy to assess. Essentially, SCW is a framework for understanding six key components of a smart city: Smart Economy, Smart Government, Smart People, Smart Living, Smart Mobility and Smart Mobility. The rankings are done with mostly publicly available

data (i.e., secondary data) with data collected directly from eligible cities (primary data). Since 2014, SCW assess smart cities with 62 indicators in which 16 of them are also directly mapped to the ISO standards for Sustainable Cities and Communities (ISO 37120:2018). (To achieve indicators, please check **Bibliography**)

Within the SCW, each 6 dimension contains 3 sub-components.
Therefore, there are 18 total sub-components in the model, and with 62 indicators. Each of the 6 components are then assigned a maximum of 15 points and the results are transformed in a way that the highest performing city in each category is assigned 15 points. Thus, if one city is to lead in each of the six components, the city would obtain a maximum score of 90 points.

Moreover, it is clear from our foresight workshop on smart city digital twins that ISO standards are essential for directing the creation and evaluation of sustainable, resilient, and smart cities. For example, aligning with Boyd Cohen's Smart City Wheel including some vital ISO 37120:2018 indicators, our analysis will broaden the examination of existing SCDT solutions via ISO 37120:2018, which focuses on indicators for city services and quality of life. We emphasise the significance of evaluating and enhancing current urban SC services as well as the general well-being of inhabitants. Looking ahead, ISO 37122:2019, which focuses on indicators for smart cities, is extremely relevant to our data analysis about needs for the near future because it highlights the vital role that cutting-edge technology plays in fostering innovation via DTs, improving data-driven decision-making, and streamlining city operations. Finally, the indicators for resilient cities covered by ISO 37123:2019 are directly in line with project goals of developing urban settings that are resilient to a range of unpredicted landscape issues. By incorporating these ISO standards into our analysis, the project aims to ensure that cities are using smart technologies to their fullest potential while moving towards a sustainable and resilient direction. They also provide a foundational framework for measuring the success of smart city initiatives in partner cities Gdansk, Vilnius, Wroclaw, and Turku.

2.2. Workshop Objectives

Foresight workshops in partner cities aimed to find out type of SCDT current solutions cities have now. Also, by gathering insights about their visions and near future needs the project aimed to map different cities' current systems, current system providers, and their future visions. By conducting workshop in cities, project aims to assess:

Current Solutions: The workshops will find out how cities work now. By sharing the current situation of different cities, we find out current systems, current suppliers, and their abilities, what kind of data repositories currently exist, and environmental impact assessments.

The Needs of The Near Future: The analysis of near-future needs helps to understand what kind of fast-coming needs exist in different cities. This helps to target the development and possibly find common needs that can be met quickly: systems to be developed, challenges, interfaces, modularity and data, and assessments of environmental effects.

Visions: What kind of SCDT services can we expect in the future. Future opportunities and challenges are envisioned: different SCDT visions are described, what kind of research and education is needed to implement the visions, how standards, open-source codes, modularity, and data repositories can have an impact, and assessments of environmental effects.

2.3. Key Insights Gathered from Turku Workshop

2.3.1. Current Solutions

Economy

- **Smart Specialisation Strategy (S3):** Turku explored the implementation of a Smart Specialization Strategy (S3) to enhance competitiveness and innovation, utilizing technologies like data analytics and AI for economic modelling.
- **Cost Efficiency in Future Poor Public Economy:** The workshop delved into the potential of digital twin cities to create cost efficiency amidst economic challenges, employing digital twin technology and predictive analytics.
- **Value Delivery of Smartness (Easy to Use and Value Creating):** The importance of user-friendly, value-driven smart solutions was emphasized, requiring technologies such as user-centric design, IoT, and data analytics.
- **Virtual Markets E.G. Carbon Emissions:** Discussions included the exploration of virtual markets for trading carbon emissions, involving technologies like blockchain for transparent transactions and IoT for emissions monitoring.
- **Innovation Hubs – Incubators Of E-Business:** Emphasis was placed on the role of innovation hubs as incubators for e-business and digital innovation, incorporating collaboration tools and platforms.
- **Only Public Service Are Interested:** Concerns were raised about limited interest and the need to establish wider networks among private companies and organizations, requiring collaboration platforms and data-sharing frameworks.
- **Public Budgeting:** The workshop discussed challenges and potential solutions in public budgeting for smart city initiatives, involving technologies like financial analytics and budgeting tools.
- **Low Exploration of Different Business Models:** Participants recognized the necessity of exploring diverse business models to improve the overall economy, utilizing technologies such as business intelligence and economic modelling.
- **Lounaistieto Data for Usage:** The utilization of Lounaistieto data for economic purposes was discussed, incorporating technologies like data analytics and business intelligence.
- **Economy/Company Statistics and Services Business Turku:** The role of economic and company statistics in Business Turku's services was discussed, involving technologies such as data analytics and business intelligence.
- **University Test Beds (Autonomous):** Discussions included the role of university test beds in testing and developing autonomous technologies, utilizing technologies like autonomous vehicle testing and simulation platforms.

- **Huge Amount Free Open Data:** The recognition of the value of open data and associated challenges was discussed, involving technologies like open data platforms and data governance tools.

Environment

- **Big Data Initiative for Forest Industry:** Mention was made of a big data initiative for the forest industry to enhance sustainability, involving technologies like big data analytics and IoT in forestry.
- **Performance Assessment – How Much Carbon Do We Save?** The need for assessing the performance of sustainability initiatives in terms of carbon reduction was emphasized, requiring technologies like carbon tracking and sustainability analytics.
- **Balance: Sustainability & Business Performance:** Discussions emphasized the importance of balancing sustainability goals with overall business performance, utilizing integrated sustainability platforms and performance analytics.
- **Understanding Of Sources of Pollutants:** Challenges related to understanding pollutant sources, such as fertilizers affecting the Baltic Sea, were discussed, involving technologies like environmental sensors and water quality monitoring.
- **Green Roof Digital Twins (Stormwater Management):** The workshop discussed digital twins for green roofs to manage stormwater effectively, involving technologies like digital twin technology and IoT for stormwater monitoring.
- **Electricity Distribution, District Heating:** Mention was made of technology's role in managing electricity distribution and district heating for sustainability, involving technologies like smart grids and district heating management systems.
- **Safety: Not Fully Developed:** Concerns were raised about the safety not being fully developed, necessitating further initiatives and safety monitoring systems.
- **Air Conditioning Waste of Energy:** The issue of wasteful energy use in air conditioning was addressed, involving technologies like smart HVAC systems and energy management.
- **Air Pollution Monitoring:** The use of technology for monitoring air pollution, including initiatives in Vilnius, was discussed, involving technologies like air quality sensors and drone monitoring.
- **Technology Used for Biodiversity:** Reference was made to technology's role in preserving biodiversity in the Linnanniemi area, involving technologies like biodiversity monitoring and conservation technology.

Mobility

- **Mobility As a Service (MaaS) Apps:** Discussions cantered around the concept of Mobility as a Service (MaaS) and the role of related applications, involving technologies like MaaS platforms and mobile applications.
- **Parking Apps:** Mention was made of the use of apps for parking solutions, involving technologies like smart parking apps and geolocation.
- **During Corona Time City Developed Routing Software for Food Delivery:** The development of routing software during the pandemic for efficient food delivery was highlighted, involving technologies like routing algorithms and delivery optimization.
- **Improving Inter-Modality:** Discussions emphasized the need to enhance inter-modality and integrate mobility with other services, involving technologies like integration platforms and intermodal transportation systems.
- **Data Visibility:** Challenges related to technical and security issues in ensuring data visibility were discussed, involving technologies like secure data sharing platforms and encryption.
- **Public Car Sharing:** Mention was made of the existence of public car-sharing services, like the library car, involving technologies like car-sharing platforms and booking systems.
- **Overall Visibility of Mobility:** Emphasis was placed on the importance of overall visibility in mobility solutions, involving technologies like integrated mobility platforms and data analytics.
- **Smart Mobility – School Taxi Scheduling:** An issue related to smart mobility in school taxi scheduling was identified, involving technologies like scheduling algorithms and school transportation systems.
- **FÖLI-Timetable:** Questions were raised about whether data is collected and how it is used in the FÖLI public transportation timetable, involving technologies like public transportation systems and data analytics.
- **Public Bikes Very Convenient:** Acknowledgment was made of the convenience of public bikes in the city, involving technologies like bike-sharing platforms and IoT for bike tracking.
- **Charging Stations for EVs:** Mention was made of the importance of charging stations for electric vehicles, involving technologies like EV charging infrastructure and smart grid.
- **FÖLI, Incl. Bicycles, Electric Bus, etc.:** The workshop discussed various modes of transportation included in FÖLI services, involving technologies like integrated public transportation systems and IoT.

- **FÖLI Bus Ticketing:** Mention was made of the advanced e-ticketing system for FÖLI buses, involving technologies like e-ticketing systems and contactless payment.
- **Smart Traffic Lights:** The use of smart traffic lights for efficient traffic management was highlighted, involving technologies like intelligent traffic control systems and IoT.

Governance

- **Quality Of Data:** The workshop emphasized the importance of maintaining high-quality data for effective decision-making, involving technologies like data quality tools and governance frameworks.
- **Quality Of Decisions Based on Data (AI):** Discussions highlighted the need for ensuring high-quality decisions based on AI-driven insights, involving technologies like AI algorithms and decision support systems.
- **Efficient Data/Stuff Rostering:** Challenges in efficiently managing data under changing conditions, such as in healthcare, were discussed, involving technologies like dynamic data management systems and AI-driven rostering.
- **Alignment Of City Development Strategies:** The importance of aligning city development strategies was emphasized, involving technologies like strategic planning tools and collaboration platforms.
- **Knowledge Management Tools:** Discussions included the use of knowledge management tools for effective governance, involving technologies like knowledge management systems and collaborative tools.
- **Fragmented Governance of Digitalization Responsibilities:** Challenges in the fragmented governance of digitalization responsibilities were discussed, involving technologies like integrated governance platforms and collaboration tools.
- **Challenges To Navigate Decision Making:** The workshop acknowledged challenges in navigating decision-making processes, involving technologies like decision support systems and collaborative platforms.
- **Participatory Methods in Urban Planning:** The existence of participatory methods in urban planning was recognized, involving technologies like citizen engagement platforms and collaborative planning tools.
- **Open Project Planning in Smarter Ways:** The need for smarter ways of open project planning was discussed, involving technologies like project management tools and collaboration platforms.
- **IME: City "Divisions" Are Not Coordinating Their Digital Actions/Projects:** Coordination challenges among different city divisions in digital projects were identified, involving technologies like integrated project management systems and collaboration tools.

- **E-Services Big City:** Mention was made of the scale of e-services in a big city context, involving technologies like large-scale e-service platforms and cloud infrastructure.

Living

- **Security Systems of Private Houses:** Participants acknowledged the availability of security systems for private houses, involving technologies like home security systems and IoT-based surveillance.
- **Urban Planning with Twin City:** The workshop discussed how urban planning could leverage the concept of twin cities, involving technologies like digital twin technology and urban planning simulations.
- **Digital Twins for Predicting Hazardous Conditions:** Discussions highlighted the use of digital twins for predicting hazardous conditions, such as an ammonia gas leak at the main railway station, involving technologies like digital twin technology and IoT sensors.
- **Availability Of Social Services Digitally:** The availability of social services digitally, especially in the medical system, was acknowledged, involving technologies like e-health platforms and telemedicine systems.
- **Safety: Winter Difficulties:** Concerns were raised about the difficulties of moving around icy pedestrian areas in winter, involving technologies like weather monitoring and smart city infrastructure.
- **Turku Sport Services:** Mention was made of the availability of digital services for Turku Sport, including reservations, involving technologies like sports facility management systems and reservation platforms.
- **Feedback Services:** The existence of feedback services, potentially related to mapping, was acknowledged, involving technologies like feedback platforms and mapping apps.
- **Healthcare Booking Systems:** The use of digital healthcare booking systems was recognized, involving technologies like health information systems and appointment scheduling.

People

- **Language Of the Systems:** Discussions included the use of international languages for urban services, involving technologies like multilingual support in software and localization.
- **University – Society Engagement:** The engagement between the university and society was discussed, involving technologies like collaborative platforms and research collaboration tools.

- **Few Experts in City Organization:** Participants recognized the need for experts in city organizations to ensure efficient networks, involving technologies like expertise mapping tools and collaborative platforms.
- **Ecosystem Of Proactive Services:** Discussions included how to create an ecosystem of proactive services, involving technologies like proactive service platforms and AI-driven automation.
- **Health Data (Kunta)***:* Reference was made to the future use of health data from the Kunta system for diagnostics, involving technologies like health data analytics and diagnostic AI.
- **Scheduling Of Home Visit Elderly Care:** The workshop mentioned scheduling challenges in home visit elderly care, involving technologies like scheduling algorithms and home healthcare management systems.
- **3D Participatory Methods:** Discussions highlighted the use of 3D participatory methods to engage citizens in urban planning, involving technologies like 3D modelling tools and participatory mapping.
- **Health Appointments Not Fully Digitalized:** The issue of health appointments not being fully digitalized was identified, involving technologies like e-health platforms and appointment scheduling systems.

2.3.2. Visions

Economy

- **City/Building Energy Systems: HVAC – Heating, Ventilation and Air Conditioning Optimized for Price/Availability Of Energy/Electricity:** The vision includes optimizing HVAC systems based on the price and availability of energy/electricity, which could involve the use of smart building technologies and IoT sensors to dynamically adjust heating, ventilation, and air conditioning based on energy costs and availability.
- **Economy Is Dynamical According to Personal Need And Resource Usage:** This suggests a flexible economic model that adapts based on individual needs and resource consumption. Advanced analytics and AI systems could be employed to dynamically adjust economic policies and services based on real-time data on personal needs and resource usage.
- **Platform Where Stakeholders Can Meet: Customer Search, Local Supplier:** The idea of a platform for stakeholders to meet involves a digital marketplace or platform where customers can search for services and connect with local suppliers. This could leverage blockchain for secure and transparent transactions, as well as AI algorithms for personalized recommendations.
- **Turku City to Operate as Guidance & Owner Of A Digital Twin "Consortium" With Investors, Companies, University:** The concept of a digital twin consortium involves collaborative efforts between the city, investors, companies, and universities. This might require a robust digital twin infrastructure, blockchain for secure collaboration, and AI for data analysis and decision-making within the consortium.

Environment

- **Digital Twins for Greener Area and Healthier Area: "City Planning App"** The vision emphasizes the use of digital twins and a city planning app for creating greener and healthier areas. This involves the use of GIS (Geographic Information System) technology for city planning and digital twin platforms for simulating and optimizing environmental scenarios.
- **Minimal Environmental Pressures and Ecological Footprint:** Achieving minimal environmental pressures and ecological footprints suggests the use of sustainability metrics and digital twin models. Technologies involved might include IoT for real-time environmental monitoring, big data analytics, and AI for optimizing resource usage.
- **More Knowledge on To Planners On Real-Time (Knowledge Regarding The Green Environment):** Providing real-time knowledge to planners about the green

environment could involve the use of IoT sensors, satellite imagery, and GIS technologies for monitoring and analysing environmental data in real-time.

- **Circular Use of Resources:** The concept of circular resource use implies the implementation of circular economy principles. Blockchain technology can be utilized for transparent and traceable resource circulation, while AI algorithms can optimize resource usage.

Mobility

- **Autonomous Vehicles: Available On Demand (Vs. Current Garage Storage):** The vision suggests a shift from car ownership to autonomous vehicles available on demand. This involves the use of autonomous vehicle technology, IoT for connectivity, and AI for route optimization.
- **Mass Transportation with Electricity:** This involves the use of electric mass transportation, likely including electric buses and trains. Technologies include electric vehicle infrastructure, smart grids, and AI for optimizing transportation routes.
- **No Congestion: Autonomous Cars and Traffic Flow Control:** Achieving no congestion involves the use of autonomous cars and advanced traffic flow control systems. Technologies include AI for traffic management, V2X – (Vehicle-to-Everything) communication, and autonomous vehicle technology.
- **Most Of the Mobility Is Shared:** Emphasizing shared mobility involves platforms for ride-sharing, potentially blockchain for secure transactions, and AI algorithms for optimizing shared transportation routes.
- **I Do Not Want to Park My Car:** This vision implies a reduction in the need for parking space through shared mobility and autonomous vehicles, leveraging smart city infrastructure.
- **Car-Free City Centre:** A car-free city centre suggests prioritizing pedestrian-friendly spaces. This could involve smart city planning using GIS technology and digital twin simulations.
- **Faster & Slower Lanes for Different Pace:** This involves creating lanes for different paces of travel, likely utilizing smart traffic management systems and dynamic lane allocation based on real-time data.
- **More Autonomous Traffic Lights Etc.:** Increased autonomy in traffic management, including traffic lights, may involve AI-driven traffic control systems and V2X communication.
- **Low-Carbon Föli:** This indicates a commitment to low-carbon public transportation. Achieving this involves transitioning to electric or hydrogen-powered buses and implementing sustainable practices.

- **Traffic Join Data in Public Spaces. Staggered Larger Projects To Avoid Data Broker (API User Development Blocks.):** Providing traffic data in public spaces suggests real-time information dissemination using IoT and smart city communication infrastructure. Staggering projects aims to avoid development bottlenecks, requiring effective project management and collaboration platforms.
- **Seamless Transportation Experience. No Need to Pay When Boarding:** Achieving a seamless experience involves integrated payment systems, potentially using blockchain for secure transactions, and technologies like contactless payments for public transportation.
- **Autonomous Vehicles:** Reiterating the use of autonomous vehicles, this emphasizes their widespread adoption and integration into the transportation network.
- **The River Underutilized:** Utilizing the river for transportation involves electric autonomous boats, requiring infrastructure for docking, charging, and autonomous navigation.

Governance

- **On-Line Voting on City Problems and Challenges:** Implementing online voting requires secure and transparent platforms, potentially utilizing blockchain for ensuring the integrity of the voting process.
- **Data Vs. Security: What Is the Future?** Balancing data utilization with security involves implementing robust data governance frameworks, encryption technologies, and AI-driven security systems.
- **Citizens Are Active Decision-Makers Through Digital City Tools (E.g. Apps):** Empowering citizens involves providing user-friendly digital tools and apps for participation, potentially utilizing blockchain for secure and transparent citizen engagement.
- **City Uses Citizens for Crowd Sourcing & Fast and Efficient Task Performance:** Utilizing citizens for crowdsourcing tasks implies the use of platforms that connect citizens with municipal needs, possibly leveraging blockchain for incentivizing and verifying contributions.
- **Initiate Active Bi-Directional Communication Between City and Citizens:** Establishing active communication involves smart city platforms with real-time communication channels and feedback mechanisms.

Living

- **New Living Area Planning (Digital Twins for Future Residents – Safety, Services, Houses, Museums, Tourism):** Digital twins for new living areas involve GIS for planning, digital twin simulations for safety and services, and potentially augmented reality for visualizing future spaces.
- **Living In Dynamical According to The Family Needs:** Dynamically adjusting living spaces based on family needs involves smart home technologies, IoT sensors, and AI algorithms for predictive analytics.
- **Analysis & Planning of Modernization Of Building, Utilizing People Flow Behaviour:** Utilizing people flow behaviour for building modernization involves sensors for occupancy tracking, AI for behaviour analysis, and digital twin simulations for planning.
- **More Knowledge from Living Space:** Enhancing knowledge from living spaces involves IoT sensors for environmental monitoring, smart home technologies, and AI-driven analytics for insights into daily living.

People

- **Social Digitalization:** This suggests the integration of social aspects into digital platforms, potentially using AI-driven social analytics and communication technologies.
- **No Lonely Elderly Person:** Addressing loneliness among the elderly involves digital platforms for social connection, potentially using virtual reality and AI-driven matchmaking.
- **Wise People:** Continuation of Smart and Wise Turku vision. Encouraging wisdom in the population involves educational platforms, possibly using AI-driven personalized learning systems.
- **Technology Enables More Freedom for People: To Choose Work And Hobbies Etc.:** Enabling freedom through technology involves flexible work platforms, potentially using AI-driven scheduling and task management tools.
- **Every Citizen Knows Their Environmental Footprint:** This involves platforms that provide citizens with information about their environmental impact, potentially using IoT for data collection and AI for personalized recommendations.
- **Children Thought Out Planning:** Planning for children involves considerations for safety, education, and play spaces, utilizing GIS for planning and digital twins for simulations.
- **Access To Green Areas for Disabilities (Physically Challenged People):** Ensuring green space accessibility for people with disabilities involves inclusive urban planning, IoT for accessibility features, and AI for optimizing inclusive spaces.

- **Health & Access to Public Services Done With Seamless Services Evaluation Of Case Booking & Execution:** Seamless health access involves digital health platforms, potentially using blockchain for health records and AI for efficient service evaluations.

2.3.3. Near Future Needs

In The Middle

- **A Clear Strategy for Digital Twins:** The participants discuss the necessity for a well-defined strategy for implementing digital twins in the urban context. This involves understanding the purpose, scope, and objectives of digital twin applications.
- **Research Funding: (Fundamentals and Applied):** Funding for research in fundamental and applied aspects of digital twin technology is highlighted as crucial. The participants emphasize the need for financial support to explore and develop digital twin solutions.

Economy

- **Stronger Budget for Pilots:** There is a call for allocating and lasting a stronger budget for pilot projects. This emphasizes the importance of practical implementations and testing to validate digital twin concepts.
- **Profitable Growth Strategies & Business Models:** Participants stress the significance of developing profitable growth strategies and business models in the context of digital twins. This involves exploring new avenues for economic growth through smart city initiatives.
- **More Dialogue: There Could Be Catalogue of Local Companies & Collaboration Partners. Chamber Of Commerce One Idea of Platform Facilitator:** The need for enhanced communication and collaboration is emphasized, suggesting the creation of a catalogue or platform to facilitate dialogue among local companies. The Chamber of Commerce is mentioned as a potential facilitator.
- **We Need Also Deeper Understanding of These Concepts: What Do They Mean for People? What Do They Mean for Companies? Risks For Business Continuity? (E.G. The Question of How a Company Operates on Various Digital Platforms/Systems/APIs > Continuous Updating > A Lot of Work):** There is a recognized need for a deeper understanding of digital twin concepts, considering their implications for individuals and businesses. The challenges related to continuous updates and potential risks to business continuity are highlighted.

Environment

- **Better And Faster Planning Process (Now It Takes Too Long):** The participants express a desire for an improved and expedited planning process, particularly in the context of smart city and digital twin initiatives.

- **Ecological & Doughnut Economy Roadmap + Biodiversity Highways[1]:** The importance of incorporating ecological and doughnut economy principles, along with creating biodiversity highways, is stressed. This indicates a focus on sustainable and environmentally conscious urban development.

Mobility

- **Flexible Legislation:** The need for flexible legislation is discussed, particularly in the context of autonomous mobility. Participants emphasize the importance of adapting regulations to accommodate emerging technologies.
- **Innovation Hubs Need Mobility Planning:** Innovation hubs are identified as requiring dedicated mobility planning. This suggests that the integration of smart mobility solutions is seen as essential for areas fostering innovation.
- **Battery Development More Sustainable:** Sustainable battery development is highlighted, with a focus on reducing waste and improving environmental impact.
- **Mind Shift: Now Owning A Car And Sharing, Planning Accordingly:** There is a call for a mindset shift, moving from individual car ownership to shared mobility solutions, and planning urban spaces accordingly.

Governance

- **Bold Pilot Projects:** Participants stress the importance of bold pilot projects to test and implement digital twin solutions. This involves engaging various stakeholders and initiating projects that drive innovation.
- **A Lot Of Education On "What Digital Twins Are":** The need for education on digital twins is emphasized. This involves raising awareness and understanding among the public and key stakeholders.
- **Closer Cooperation: Triple Helix Model On Focus And Shared Projects:** Closer cooperation among the public sector, universities, and businesses (Triple Helix Model) is suggested, emphasizing shared projects and collaborative initiatives.
- **Smart Governance Roadmap: Towards Strong Democracy And Trust:** There is a call for developing a roadmap for smart governance to strengthen democracy and trust in digital twin implementations.
- **GDPR Questions Will Become More Sensitive In The Upcoming Years:** The sensitivity of GDPR (General Data Protection Regulation) questions is acknowledged, particularly as digital twin initiatives evolve. This highlights the importance of privacy and data protection considerations.

[1] 'Doughnut Economics: Seven Ways To Think Like A 21st-Century Economist' by Kate Raworth 2017.

- **Different Layers Of Security Questions Related To Open Data: National Defense, Health Care System, Personal Data, Etc.:** Participants discuss security concerns related to open data, including considerations for national defense, healthcare systems, and personal data. This underlines the importance of addressing security at various levels.
- **Question Of Data Management The Most Important In The Near Future. Data Is The Raw Material (In The Core Of SCDT Development.):** The central importance of data management is stressed, considering data as the raw material at the core of Smart City Digital Twin (SCDT) development.

Living

- **Citizen Initiatives Asked In Turku About Smart Living:** There is a mention of seeking citizen initiatives in Turku related to smart living, indicating a participatory approach in urban development.
- **Does A Digital Twin Make A City More Vulnerable Or More Resilient?** The question of whether a digital twin makes a city more vulnerable or resilient is raised, prompting consideration of the potential risks and benefits associated with digital twin implementations.

People

- **Integrated Smart Apps And Information Packages:** Participants express the need for integrated smart apps and information packages, indicating a desire for cohesive and user-friendly digital services.
- **My Data:** Reference is made to the "My Data" concept, which involves individuals having control over their personal data. This aligns with the emphasis on data privacy and user control.
  https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/78439/MyData-nordic-model.pdf?sequence=1&isAllowed=y
- **Competence Question: We Need More People With Skills To Work SCDT Development:** The need for a skilled workforce in Smart City Digital Twin (SCDT) development is highlighted, indicating a demand for individuals with the necessary expertise in this field.

3. Conclusion and Discussions

At the Smart City Digital Twin (SCDT) workshop in Turku, Finland, current solutions, visions, and near future needs from a wide range of subject areas were uncovered. A strategic focus on economic growth, environmental sustainability, effective government, efficient mobility, and raising citizen quality of life characterises the participants' approach to SCDT. Important takeaways from the session clarified ongoing projects, visions, and needs that have been recognised for the near future.

1. **Digital Twin Strategy and Research Funding:** Workshop insights emphasized the necessity for significant financing for research into both the fundamental and applied elements of digital twin technology, as well as the significance of having a clear strategy in place for adopting digital twins in urban settings. This entails knowing the objectives, scope, and purpose of digital twin applications and making sure that ongoing project implementations have a strong basis for creative urban development in Turku.
2. **Economic Strategies:** The workshop data highlights the importance of creating viable growth plans and business models in the context of digital twins and recognizes the necessity for a larger budget allocation for pilot projects to evaluate digital twin concepts. There is a request for better knowledge of digital twin principles and their consequences for individuals and enterprises, as well as for increased communication and collaboration among local companies - possibly aided by the Chamber of Commerce and Business Turku.
3. **Communication and Collaboration:** Data insights acknowledges the need for increased communication amongst regional businesses and recommends the construction of a platform or catalogue to help with SCDT innovations and Turku collaboration. Furthermore, a deeper comprehension of digital twin concepts is acknowledged to be necessary, considering their consequences for enterprises, local government, and individuals.
4. **Environmental Sustainability:** In the context of smart city and digital twin initiatives, in particular, participants expressed a need for an enhanced and faster planning process. The emphasis on building biodiversity highways, incorporating ecological and doughnut economy concepts, and calculating every individual's carbon footprint in Turku all point to an emphasis on environmentally responsible and sustainable urban development.
5. **Mobility Challenges:** The Turku workshop data recognizes the necessity for flexible legislation, particularly in the context of autonomous mobility, and highlights innovation clusters as requiring specific mobility planning. The importance of sustainable battery development was emphasized, with the focus on decreasing waste and enhancing

environmental effect. There is a need for a paradigm change, from owning your own car to shared mobility alternatives, and for urban areas to be planned properly.

6. **Governance and Security:** Insights highlighted the necessity of risk-taking pilot initiatives to test and deploy digital twin solutions, as well as involving multiple stakeholders and launching projects that foster innovation. There is a need for digital twin education in Turku, to raise awareness and knowledge among the general public and key stakeholders. It was proposed that the public sector, universities, and corporations work together more closely, focusing on common projects and collaborative activities on threats and uncertainties for resilient future of Turku in all six SC dimensions. Recognizing the sensitivity of GDPR questions and security concerns connected to open data, the development of a roadmap for smart governance to improve democracy and confidence in digital twin deployments was called for.
7. **Living and Citizen Involvement:** Overall, participants expressed a desire for citizen initiatives connected to smart living, showing a participatory approach to urban development. The topic of whether a city is more vulnerable or resilient as a result of a digital twin was addressed, prompting analysis of potential hazards and advantages. Special input was made on on-line real-time voting mechanism in Turku.
8. **People and Skills:** The demand for unified and user-friendly digital services was stated, as was the necessity for integrated smart apps and information packages. The Helsinki's "My Data" concept was mentioned, which involves individuals having ownership over their personal data. The necessity for a trained workforce in the creation of Smart City Digital Twins (SCDT) was emphasised, suggesting a demand for personnel with the appropriate experience in this sector.

In addition to all these, some distinctive topics were brought up during the workshop discussions in Turku. Although some of them overlap with the workshop insights carried out in the partner cities, it is vital to evaluate them under separate headings as provided below.

- **Smart National API Strategy:** Because there is no standardized Smart National API approach, interoperability and smooth integration across diverse smart city efforts are difficult. Creating a consistent framework for APIs across Finland is critical for encouraging collaboration and innovation among all other Finnish cities, including the City of Turku.
- **National Security and Data Repository Management against Smart City Cyber Attacks:** The closure of some data repositories owing to national security concerns may cause disruptions in the operations of firms that rely on these repositories. This

was also expressed in Vilnius, a project partner. As a result, Turku workshop findings indicated that one firm in Turku crashed because of shutting open data. Striking a balance between protecting national interests and reducing the economic consequences for impacted business is a difficult task.

- **Smart Port City Concept in Turku:** The ***Smart Port City*** idea offers integration issues in Turku, notably in integrating multiple technologies for effective port operations. However, the workshop's feedback was highly stimulating. Despite Turku Airport's more than 70-year existence, current global trends on ***Airport City*** (also known as ***Aerotropolis***) concept development appear to have lost their importance in Turku. In this sense, balancing the optimization of port operations with airport operations may be significant to the growth of SCDT in Turku. However, environmental sustainability is still an issue, and there is a need for strong cybersecurity measures, community participation, and addressing any environmental effect and logistical issues related with these notions.

Overall, Turku's SCDT workshop were highlighted by a dedication to innovation, sustainability, and citizen-centric SCDT development. A distinct digital twin approach, economic initiatives, and improved communication demonstrate the city's commitment to revolutionary urban planning. Prioritizing environmental sustainability, transportation problems, and governance considerations highlight Turku's complete approach even more. As the city navigates issues of citizen involvement, skill development, and national-level strategies, it has the potential to position itself at the forefront of smart city development, combining both bottom-up and top-down approaches promising positive effects on the economy, environment, and overall urban quality of life in Turku, the South-West Region, and Finland.

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