

Smart City Digital Twin and Workshop Challenges: Towards Integration of Digital Twin and Smart City Thinking

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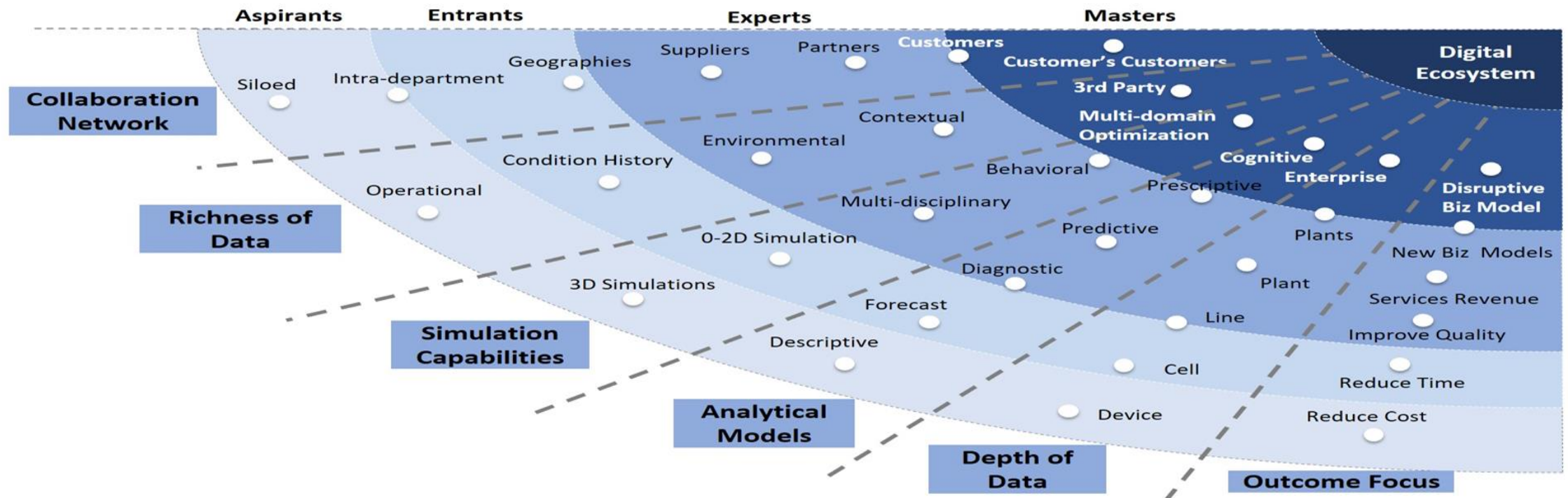
Vilnius, Lithuania, Thursday 5.10.2023



Theme 1: What is Digital Twin?

Challenges:

- DT meets customer needs broadly
- DTs connect 3rd parties and many motivated stakeholders
- DT includes multi-domain optimization
- DT development leads to cognitive enterprise 4.0/5.0 ecosystems
- DT includes disruptive business model thinking



The Term of Digital Twin (E Scholarly Encyclopedia 2023)



- *John Vickers of NASA* first coined the term “digital twin” in 2002 ^[11]. Around the same time, the research professor Dr Michael Grieves worked with Vickers to adapt the concept of digital twins as a way to improve product lifecycle management (PLM) in the manufacturing sector ^[12]. Initially, he called it the “Conceptual Ideal for PLM”. However, even during this early stage, he touched upon several key properties of digital twins ^[13]. In his paper, Grieves spoke about the difference between real and virtual spaces and highlighted the need for the exchange of data and information between the real and virtual entities to mirror each other.

Some Alternative Definitions of Digital Twin (Deren et al. 2021)

	Part of Understanding	Ideal Characteristics	Digital Twin Cities	Dimensions
1	a. Digital twins are 3D models b. Digital twins are copies of physical entities c. Digital twins are virtual prototypes	Multi-dimensional/multi-space-time/multiscale Dynamic/evolutive/interactive High fidelity/ Highly reliable/high-precision	Accurate Mapping	Model
2	a. Digital twins are data/big data b. Digital twins are PLM (Product Lifecycle Management) c. Digital twins are digital thread d. Digital twins are digital shadow	Total factor/all-service/ complete flow scheme/full life circle Virtual-real fusion/ multi-source fusion/heterogeneous integration Real-time update/real-time interact/real-time respond		Data
3	a. Digital twins are Physical union platform b. Digital twins are industrial Internet platforms	Bi-directional connection/interaction/driving Cross-agreement/interface/platform	Virtual-real Interaction	Connection
4	a. Digital twins are simulation b. Digital twins are virtual verification c. Digital twins are visualization	Model driven + Data driven Simulation verification/visualization/control/predict/optimize	Software Definition	Services/Functions
5	a. Digital twins are pure digital representation or virtual bodies b. Digital twins are irrelevant to entities	models vary from object to object/data vary by feature/services and functions vary according to needs	Intelligent Feedback	Physical

Basic Idea of Digital Twin (E Scholarly Encyclopedia 2023)

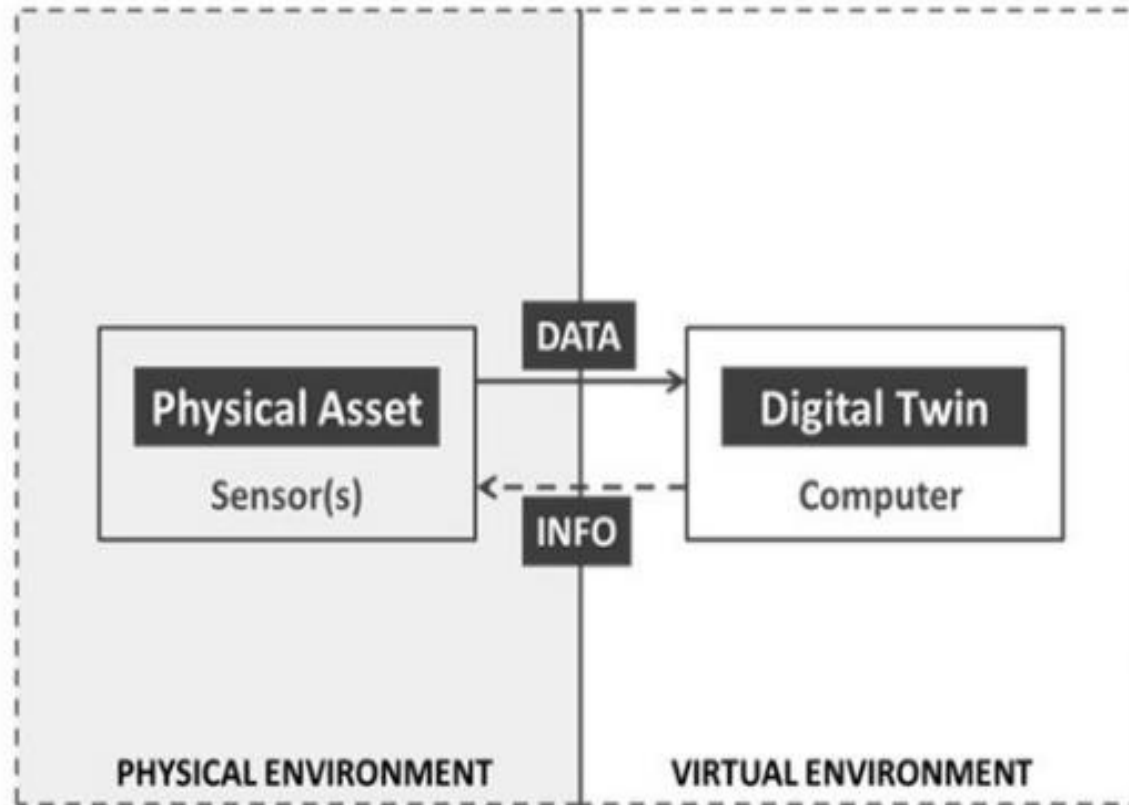


Figure 2. A conceptual representation of digital twin technology and its relation with a physical asset.

Digital Twin BIM Development in Building and Construction Industry (Deng et al. 2020)

Level 5: Ideal Digital Twin
Ideal Matrix Digital Twin

Level 4: BIM – simulation model linked to Artificial Intelligence (AI)
Digital Twin for Sensor-based and AI-based simulation

Level 3: BIM-model linked closely to simulation model
Digital Twin for Sensor-based simulation

Level 2: BIM-model supporting simulation
Digital Twin for Gaming, "Mirror" Game

Level 1: BIM –Basic level
BIM = Building Information Modeling
"Shadow Level (Shadow BIM)"

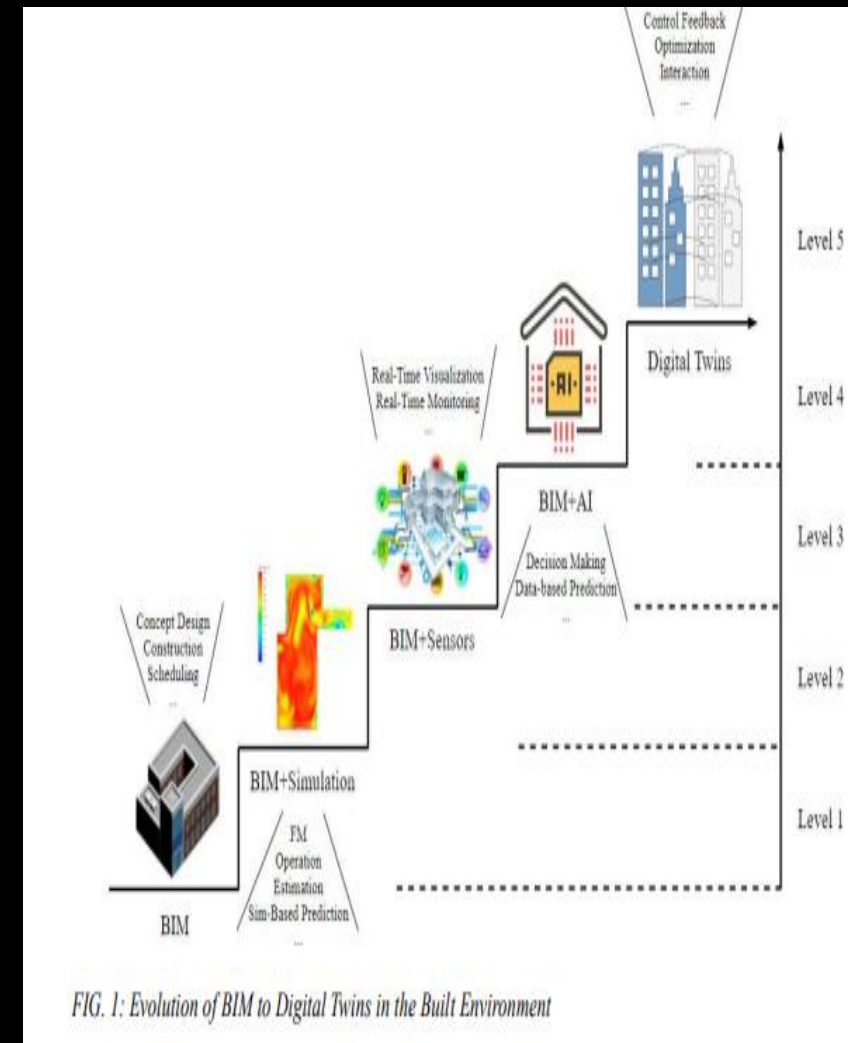
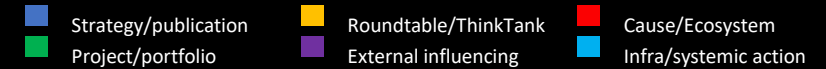


















FIG. 1: Evolution of BIM to Digital Twins in the Built Environment

Industry 4.0 and Techno Futures in Cities and Business: Next Steps and Challenges (Allied ICT Finland, AIF 2022). Towards Metaverse Roadmap

AIF 2022 THEME forms a focused topic & agenda that aims to **0) initiate** the theme via strategy work, **1) network** top-knowledge, **2) create** strategy, priority and narrative, **3) build** high-impact, and **4) self sustaining**.

- Each THEME has a AIF sponsor, operative lead(s), agreed work methods, and target setting based on agreed agenda
- THEMEs will report to AIF board periodically, AIF network will support each theme, based on needs
- THEMEs will be promoted to key external stakeholders based on THEME strategy and targets

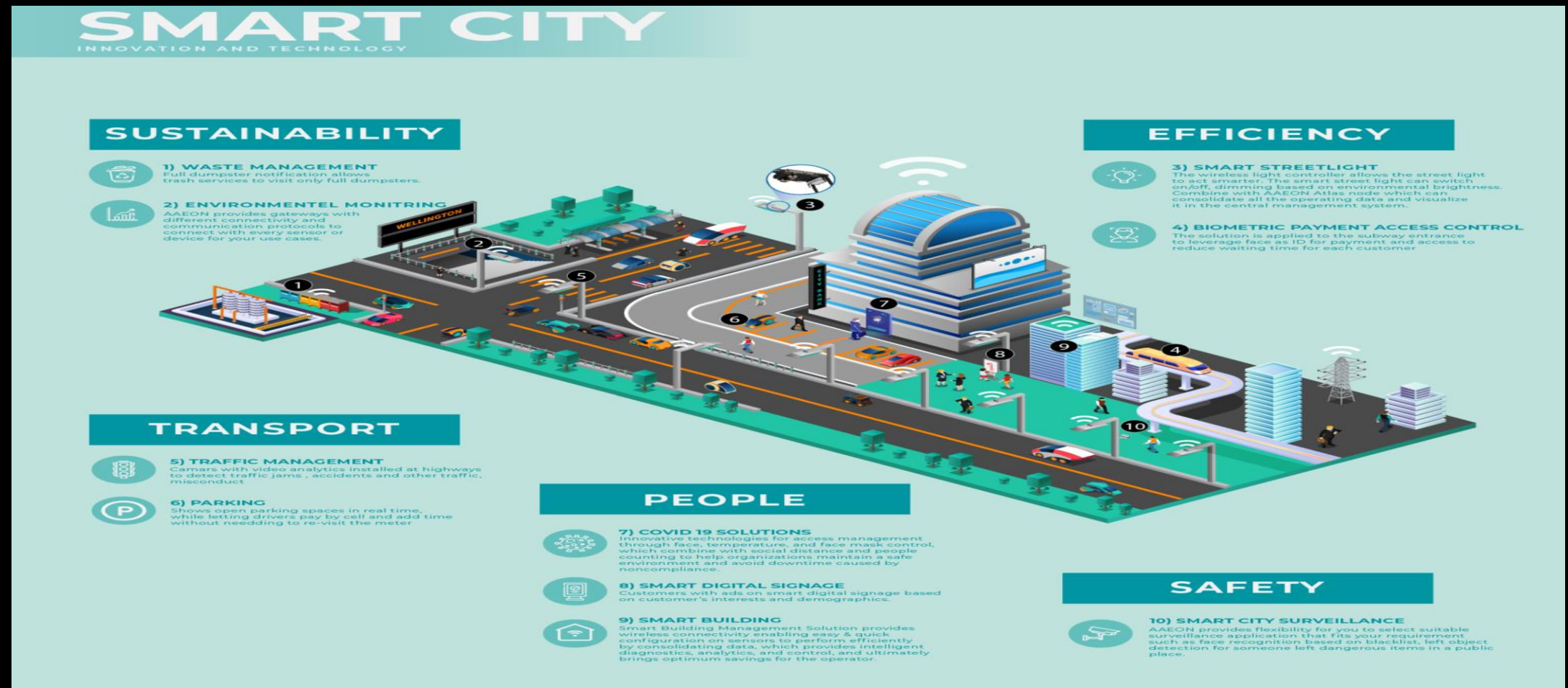


Metaverse	Human driven ICT	Industry X	Future Data Economy	Strategy notes
Lead: Jari Kaivo-oja Focus: Metaverse tech roadmap, 6G Scenarios, Moonshot Opportunities, Game Changing Open Windows, Global Follow Ups.  Status: 2	Lead: Dominik Siemon Focus: Design and development of human-centred ICT, driven by human values and needs.  Status: 1-2	Lead: Jari Kaivo-oja Focus: IX dynamics analytics by big data, cross-border innovation management (EU S3 analytics), EDIH network analytics, global digital, waves analytics, game changing opportunities, open window, global research follow ups.  Status: 2-3	Lead: Marika Iivari Focus: Advancing "born digital" business opportunities based on new technologies holistically by combining business, societal, technology & environmental perspectives.  Status: 1-2	<p>AIF aims to identify emerging and key priority topics per annum through strategy dialogue between core partners, vast expert network and advisors.</p> <p>Criteria for elevating topics to theme:</p> <ul style="list-style-type: none"> Major opportunity Core of Finnish R&D Stakeholder interest Scientific & R&D upside Expectation of impact Availability of funding Partnership creation <p>Each selected themes will target to create a strategy, key people network, outbound narrative, KPIs and impact portfolio.</p> <p>Current strategy topics are described, engaged, executed and advertised throughout AIF internal and external network.</p> <p>Themes are supported by AIF board and steering group, with reporting responsibility.</p> <p>Emerging topics for next strat round:</p> <ul style="list-style-type: none"> Addressing the changing worldview, NATO membership, security concerns, resilience and subsequent new research topics. Cross-co-creation between themes.
IoT next	Future connectivity	Smart Campus	Microelectronics - Hardware	
Lead: Marjo Heikkilä Focus: User-centric, trustworthy, low-cost, sustainable, scalable, and responsible IoT.  Status: 2	Lead: Jaakko Sauvola Focus: Bridging 5G to 6G, support national 6G Finland hub, and through Flagship - creating priority projects of applied research and verticals around Finnish 'G'-core.  Status: 2-3	Lead: Risto Jurva Focus: From campuses to business life and smart cities. Piloting of multi-discipline research innovations and scaling up to businesses and smart cities.  Status: 3	Lead: TBD (from industry or research) Focus: Strategy creation with key Finnish actors to clarify focus, define targets, roles, identify collaboration and national standing.  Status: 0	
Space ICT	CyberSecurity	Green ICT	Smart Logistics	
Lead: Heidi Kuusniemi Focus: ICT solutions for space industry and sectors applying space-based data.  Status: 3	Lead: Martti Lehto Focus: continuing to work with all OEMs on the HX project. Strengthening the ecosystem.  Status: 2-3	Lead: Jari Porras Focus: Realization of the LVM Climate and Environmental Strategy for the ICT sector.  Status: x	Lead: Sami Kantanen Focus: Carbonneutral supply chain is main priority. Looking for possibility to Apply application.  Status: 0	
Health, wellbeing and Sports	Automotive ICT	Software	External affairs (EU, US, Asia)	
Lead: Laura Rajala Focus: Boosting R&D to promote Health.  Status: 3	Lead: TBD Focus: Sharpen Finnish strategy and create enablers-platforms-solutions roundtable & RDI portfolio for ICT automotive needs.  Status: 1	Lead: Kari Systa Focus: Update to the 2018 study started. Community meeting in the Fall.  Status: 2-3	Lead: P. Sivonen, I. Peltonen, M. Klemettinen Focus: Systematic collaboration - a forum addressing strategy, content and actions for key partners.  Status: 2-3	

Theme 2: What is Smart City?

Challenges:

- SC supports sustainability, efficiency, safety and smart living of people meets customer needs
- SC includes top standards of Digital Twins, resilience and sustainable development
- SC supports smart enterprise 4.0/5.0 development
- SC is having various domains of smartness



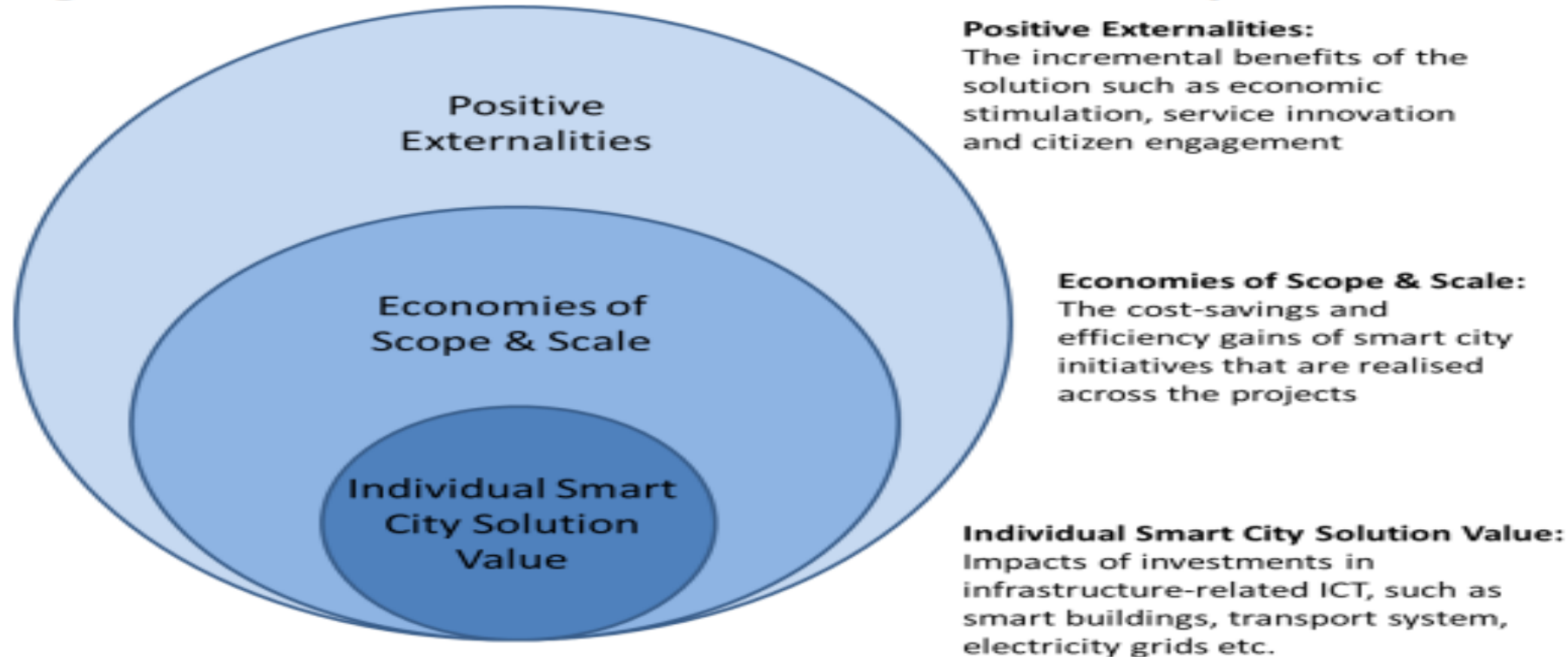
Smart City Wheel Classification (Boyd Cohen)

- Smart Economy Apps
- Smart Environment Apps
- Smart Government Apps
- Smart Living Apps
- Smart Mobility Apps
- Smart People –Apps



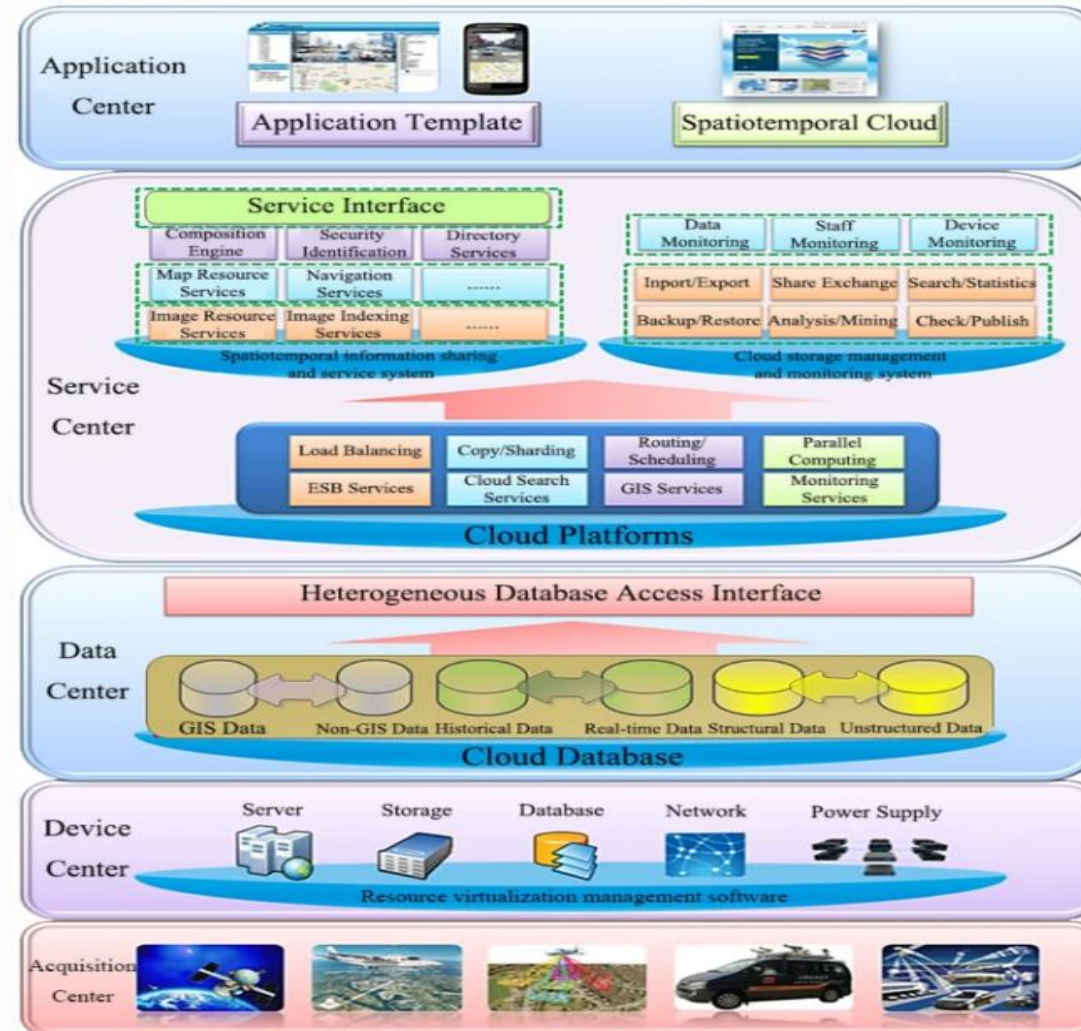
Why Smart Cities Need Our Attention? Benefits of Smart City Development – (European Commission 2014)

Figure 24: The different levels of benefit of a Smart City solution¹⁵⁰



Digital Twin Smart City System Description (Deren et al. 2021)

Fig. 2



Schematic diagram of the structure of a smart city public information cloud service platform based on digital twins

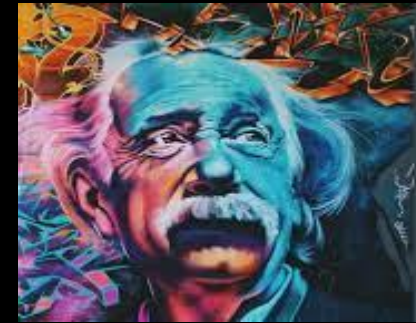
Smart City –ranking in year 2023 (IMD World Competitiveness Center 2023)

City	Rank 2023	Rank 2021	Rank 2020	Rank 2019
Zurich	1	1	1	1
Oslo	2	2	2	2
Canberra	3	—	—	—
Copenhagen	4	5	3	4
Lausanne	5	4	—	—
London	6	3	10	3
Singapore	7	7	7	10
Helsinki	8	9	5	6
Geneva	9	6	8	7
Stockholm	10	11	9	9
Hamburg	11	8	6	—
Beijing	12	17	22	30
Abu Dhabi	13	12	14	16
Prague	14	10	4	8
Amsterdam	15	13	11	11
Seoul	16	18	20	23
Dubai	17	14	19	13
Sydney	18	29	32	22
Hong Kong	19	33	34	38

Theme 3: Workshop Challenges

Challenges:

- Culture of Curiosity
- Culture of Openness
- Many What If -questions
- To have much fun and big time together!



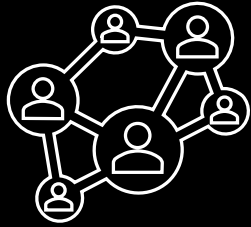
"I have no special talents, I am only passionately curious."

ALBERT EINSTEIN



Key Challenges to Futures & Foresight Workshops: Creating the Culture of Curiosity

The Ability to Listen to Other People

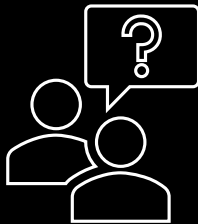


The Ability to Find New Perspectives to Topical Issues

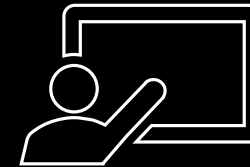


A Culture of Curiosity

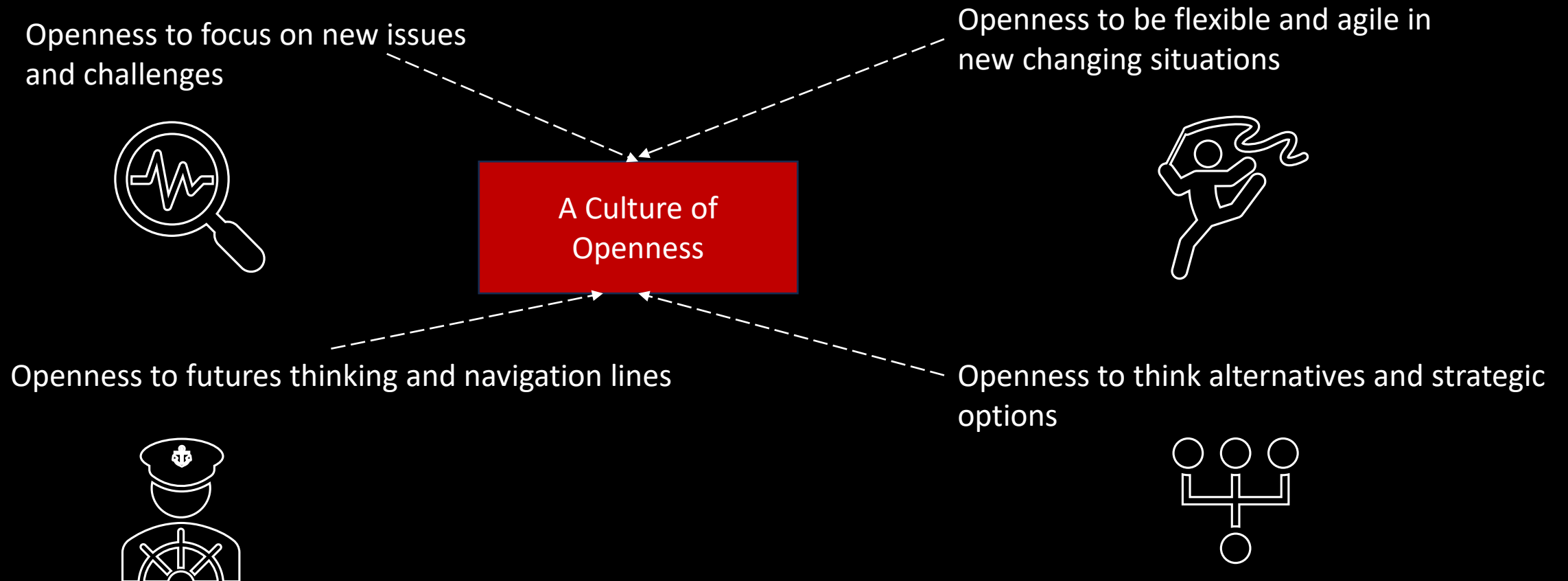
The Ability to Make Questionmarks and See Complexity Issues



The Ability to Interact with Other People

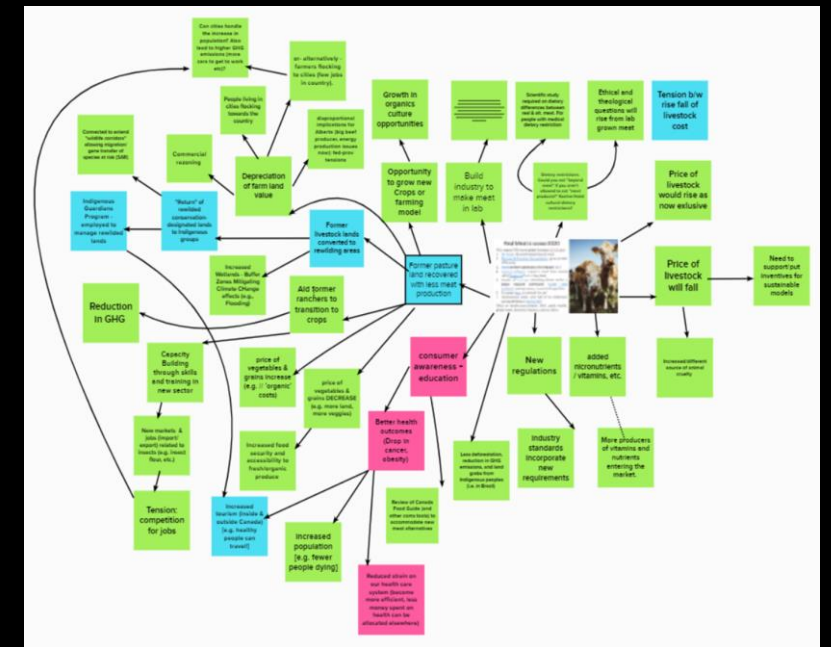


Key Challenges to Futures & Foresight Workshops: Creating the Culture of Openness



Summary: Key Behavioral Issues in Futures/Foresight Workshops

- Listening
- Create New Ideas and Perspectives
- Make Questions
- Interact
- Think about futures and alternatives openly
- Focus on new issues and challenges
- Pay attention to flexibility/agility
- Think new and old alternatives



Visionary Thinking and *a Visionary Leader*: Typical personal aspects

- Have some emotional intelligence.
- Visionary Leader is a creative person.
- Visionary Leader has communication skills.
- Visionary Leader is resilient and sustainable.
- Visionary Leader has courage.
- Visionary Leader does strategic risk-taking in strategic operations.
- Visionary leader has good collaboration skills.
- Visionary leader has a growth mindset



Thank your attention! Have a nice day!



Research Director Jari Kaivo-oja
**Smart City Digital Twin Project in
Collaboration with Turku, Gdansk,
Wroclaw (Poland) and Vilnius (Lithuania)**
European Regional Development Fund (ERDF)/Turku ecosystem agreement
Finland Futures Research Centre
Turku School of Economics
University of Turku



Researcher, MSc. (Futures Studies) Tolga Karayel

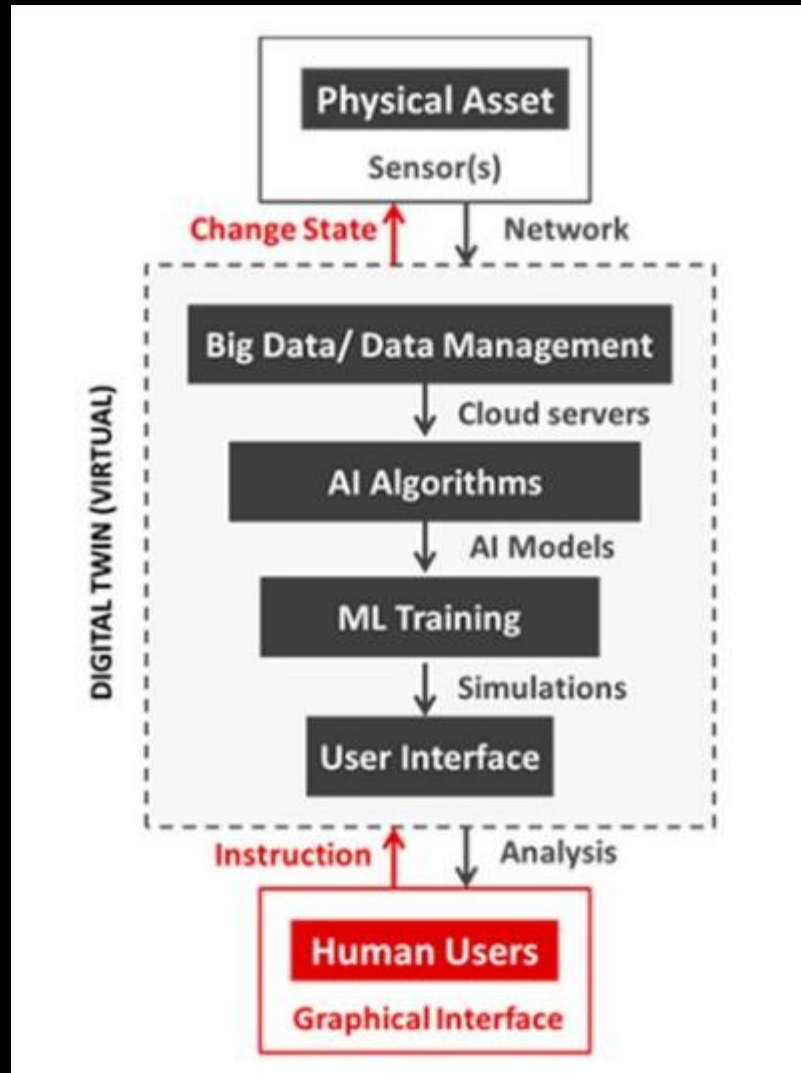


**Co-funded by
the European Union**

Extra Bonus Smart City Digital Twin Materials

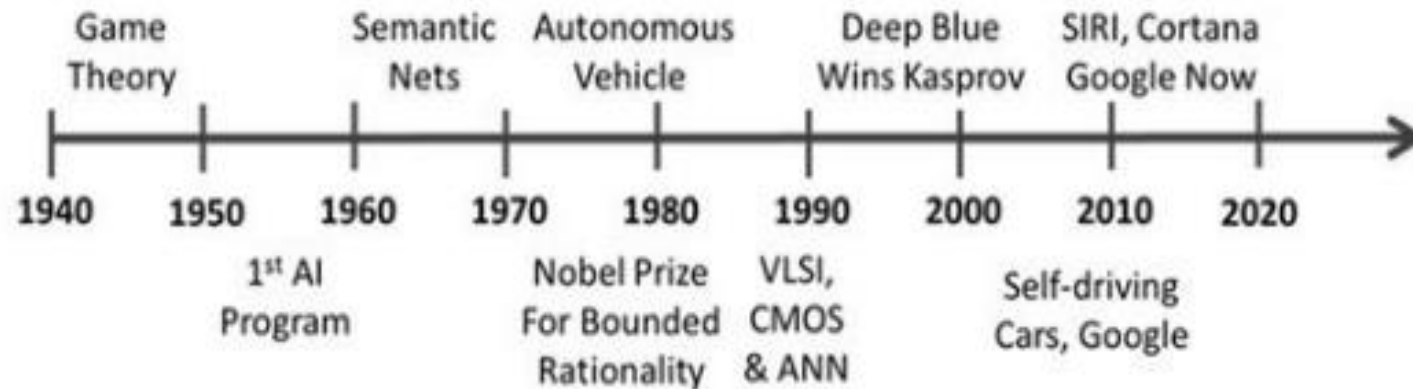


Digital Twin Thinking and Apps (E Scholarly Encyclopedia 2023)



s. Lisää [Evolution of Digital Twins | Encyclopedia MDPI](#)

Historical Development of Artificial Intelligence: Before AI Hype (E Scholarly Encyclopedia 2023)



Timeline of Key Milestones in Artificial Intelligence (AI)

Smart City- development and key modules (European Commission 2014)

Figure 3 : The relationship between components and characteristics of Smart Cities

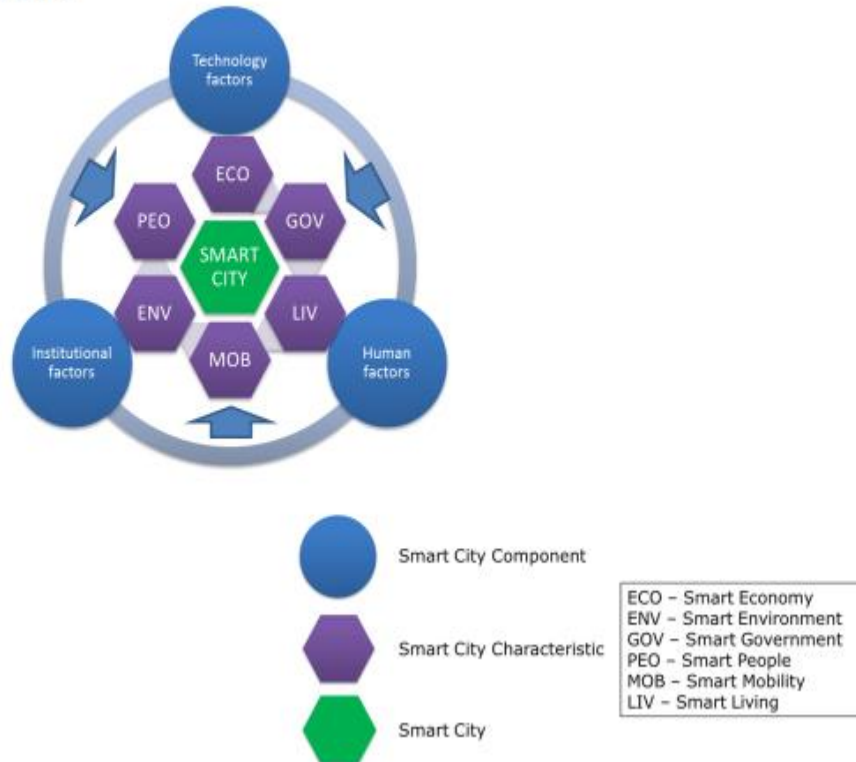
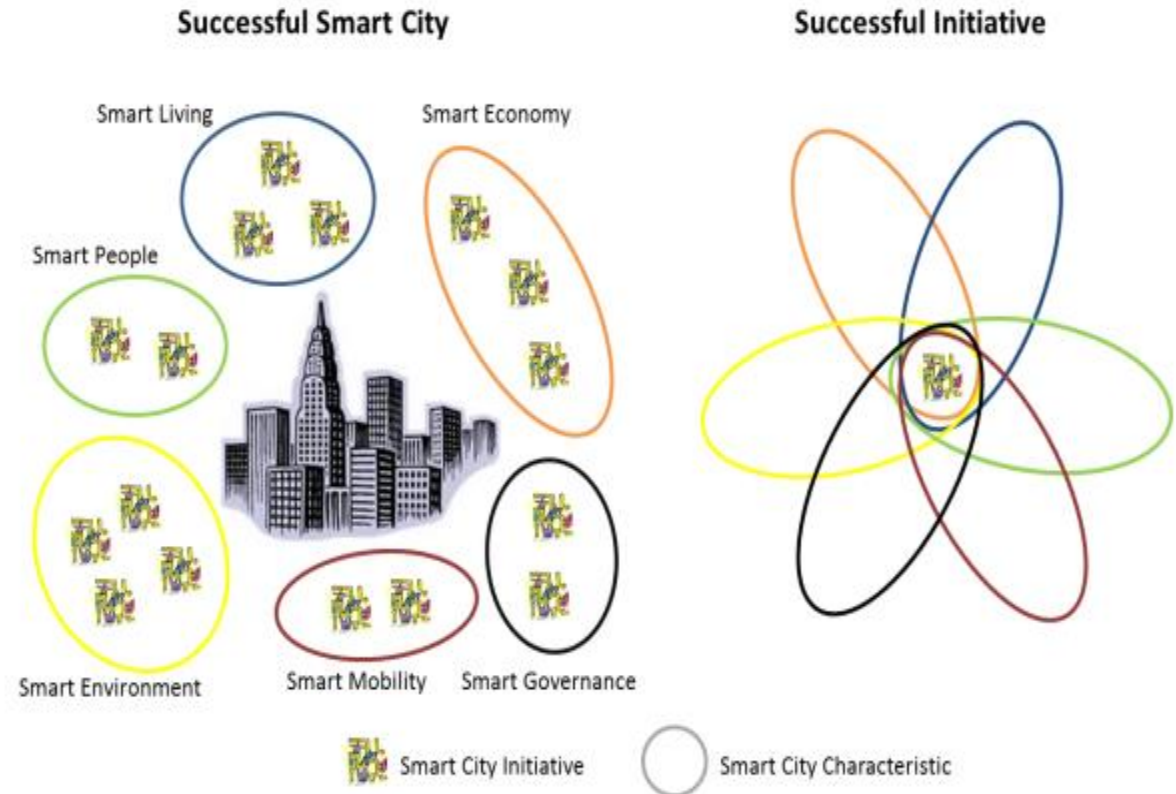
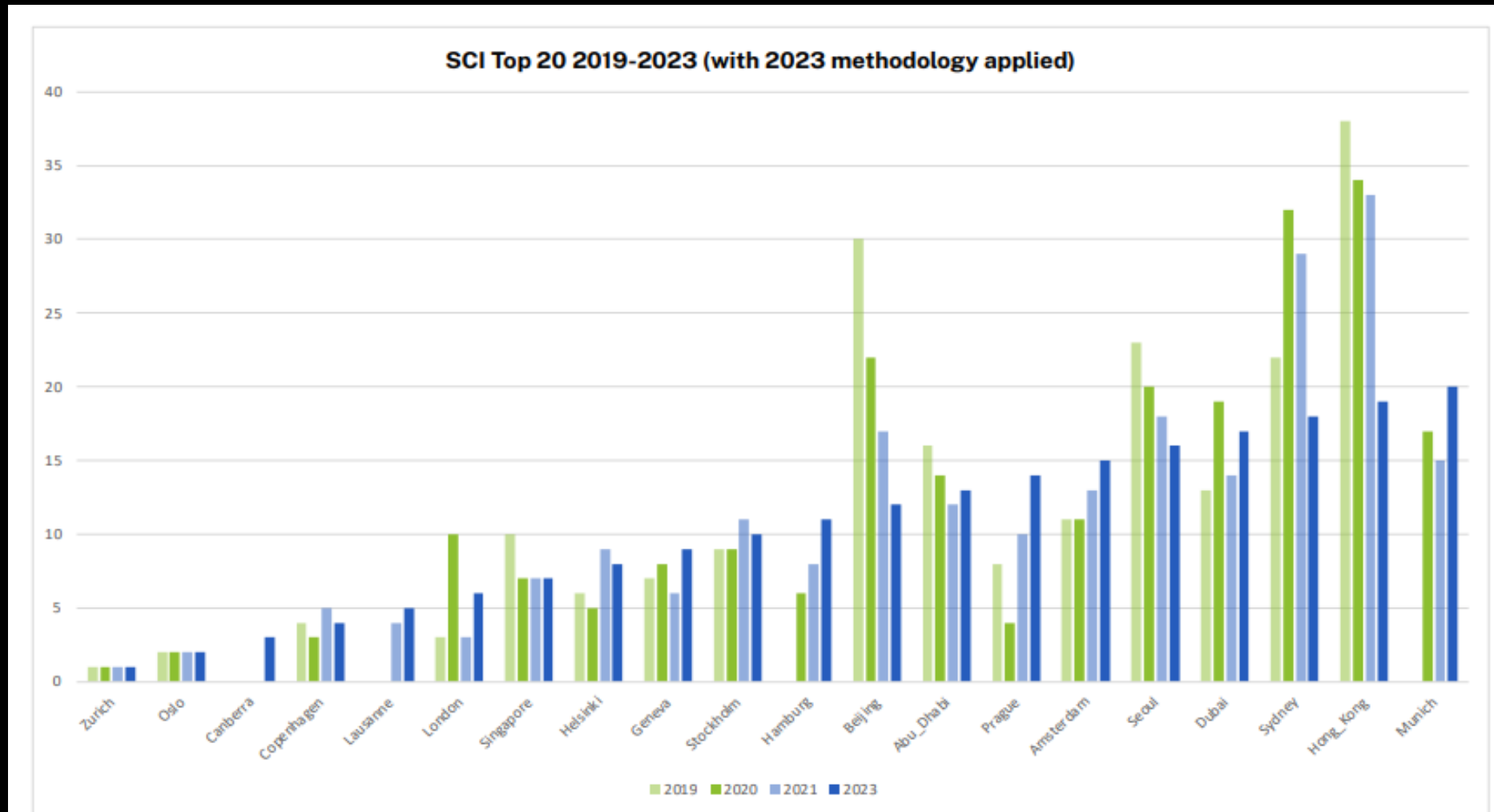


Figure 21: Diagrams of a successful Smart City and a successful initiative



Smart City –rankings in 2019-2023 (IMD World Competitiveness Center 2023)



Typical elements of visionary leadership

- Develop a Vision Statement and Share and Communicate a Vision to Stakeholders
- Develop a Short Vision Slogan and Challenge Others
- Always Seek Small and Big Improvements Toward a Vision Showing Enthusiasm
- Challenge a Process If Results Are Not Satisfying
- Share the Vision with Other Key Stakeholders and Help Them Reach Milestones
- Be Detailed Enough with Good Examples to Implement Vision in Reality - Build a Roadmap "from Vision to Action"
- Use Vision as a "Empowering Resource Magnet" during Tangible and Intangible Resource Mobilisation of Vision Implementation
- Improve Human Performance Gradually Towards Reaching Vision with Communication, Motivation and Feedback Mechanisms
- Celebrate Success Steps Towards the Vision
- Use Numbers and Narratives in Visionary Communications