Smart city projects from around the world: The ecosystem as organising principle

There are numerous reviews on smart city plans and projects that allow undesstanding what various cities do to implement the smart city model. This is the case of the book *Technology and the city: Systems, applications and implications* authored by Tan Yigitcanlar and published by Routledge (2016). Tan reviewed ten cities in Asia, Europe, Middle East, USA, and Oceania that have implemented smart city strategies and projects, and outlined the diversity of innovations that have been introduced:

- Songdo, Korea is part of the national programme of economic development, focused on broadband networks, sensor-based solutions for smart living, offering a test-bed for RFID, and R&D on smart technologies.
- Tianjin, China, developed a smart city masterplan based on 26 KPIs, and solutions for eco-city ICTs, intelligent building management systems, and sensing technologies.
- Amsterdam, Netherlands, focused on ICTs for a better urban environment and reduction of CO_2 emissions, ICTs for user-engagement, and smart city projects for mobility, living, working, public space, and open data. Dominant is a retrofitting approach implemented through a series of physical-digital projects.
- Barcelona, Spain, has the area 22@Barcelona as a flagship innovation district; Sant Cugat for testing sensor-based parking, traffic jam avoidance, garbage collection, environment monitoring, street lighting; and solutions for smart buildings, smart grid, and smart metering.
- Mazdar, Abu-Dhabi, focused on the creation of a global clean technology cluster, electrified mass transit system, and energy metering systems. Also included is the MIST science and engineering research university developed in collaboration with MIT.
- Istanbul, Turkey, focused on ICTs for transport, the use of dynamic intersection signalling, and traffic data analytics; also, ICTs for earthquake monitoring with real-time alert and gas distribution control in case of earthquake events.
- Rio de Janeiro, Brazil. IBM installed an Intelligent Operations Centre with dozens of control systems for electricity, water, oil, gas, transport, traffic, smart meters for energy saving; a safety and emergency response system for crime prevention and policing using cameras and real-time analytics.
- San Francisco, USA, developed ICT solutions for sustainability, zero waste, recycling, CO_2 reduction; and applications for sustainability such as energy mapping, energy use challenge, honest buildings, open data and living labs for energy optimisation.
- Auckland, New Zealand, focused on ICTs for innovation in the sectors of energy, transport, waste, buildings, food, agriculture; digital learning and skills development, enterprise development, entrepreneurship of innovation-led companies.
- Brisbane, Australia, gave priority to ICTs for growth, knowledge-based development, knowledge precincts, and the Brisbane knowledge corridor; it also developed ICTs for sustainability that reduce energy consumption, CCTV cameras for road intelligence, traffic signals, and open Wi-Fi in parks and libraries.

There is great diversity of strategies and projects in the above ten cities. It appears that a major concern of smart city initiatives is growth, the creation of knowledge and innovation districts, clusters, and digital environments for business support. Very strong too is the concern for sustainable city infrastructures, improving energy efficiency, use of renewable energy, water savings, waste management and green transportation. These core orientations are coupled with projects for better living, e-health, education, safety and security. All these require good broadband infrastructure and in many cases sensor networks for data collection and real-time solutions.

More recent is the book "Smart City Emergence" edited by Leonidas Anthopoulos and published in the Elsevier Smart Cities series (2021). The aim of this book is to collect and present information from several cities around the globe with regard to their Smart City development. It presents how different cities have approached the Smart City; the vision that they defined for their SC and the problems they

wanted to solve with the corresponding smart solutions; the projects that were launched and the timeline for their development; the corresponding budgets and the implementation methodologies, etc.

Following a chapter on project management, 20 city reviews are included in the book that highlight how different cities have organised their smart city process. 45 authors contributed to these reviews and the cities are from all the continents. While some projects and initiatives are relatively simple, others require complex efforts of articulation between the public sector, private sector, and citizens, digital and non-digital systems. Renovation of urban areas, smart lighting and traffic lights, solutions for the development of a creative economy, coworking spaces, and projects for start-ups are among them.

An overview of the cities, projects and the domain of reference is given in the Table below. All cities have implemented also projects related to broadband networks, wi-fi, and open wi-fi. Broadband together with cloud computing form the basic infrastructure on which all other projects and services operate. Among the many conclusions that we can draw from this Table what styands out is the design of projects by city ecosystems. We can identify 16 ecosystems that fall into three groups

- Area-based ecosystems: district renewal, hub district (port / rail / airport), university campus, housing
- Activity-based ecosystems: startups and innovation, safety, living, health, education, tourism and hospitality, shopping, governance
- Network-based ecosystems: broadband, mobility, energy, environment, water, circular economy, recycling, waste

These three types of ecosystems have quite different locational behaviour: area-based ecosystems cluster spatially to form city districts, activity-based ecosystems spread throughout the city, and network-based ecosystems locate along the axis and transport networks.

The ecosystem perspective in the making of smart cites justifies the system of (eco)systems understanding of cities. Challenges, problems, stakeholders, and activities differ from one ecosystem to another. Ecosystems define the context and the dynamics of change. Usually many projects, independent or integrated, are needed to change an ecosystem. Still, the smart city implementation landscape is fragmented in vertical markets (energy, mobility, governance, real-estate, etc.) with little interoperability and exchange. Smart city projects follow this fragmentation, and the ecosystem of reference defines the type of intervention, the solutions and know-how available, and the potential for change.

The next generation of smart cities sould deal with this fragementation, developing platforms with higher interoperability and common solutions across city ecosystems.

Smart city projects by ecosystem

City	Sector / ecosystem	Projects
Evora (Portugal) Smart City of Evora	***Energy***	● Smart meters, smart homes ● Smart grid ● Public lighting ● EV charging ● Data collection & modelling of energy system
	Environment	● Reduction of CO2 emissions ● Building retrofitting ● Solar thermal and solar PV ● Recycling ● Promotion of cycling ● Traffic restrictions ● Biofuel buses
Torino (Italy)	***Mobility***	● Bike-sharing ● Plan bicycle path

Smart City of Torino		● EV sharing ● Car-sharing service ● Car-pooling ● Traffic zone regulation (restriction) ● Traffic monitoring
	Environment	● District renewal ● Smart squares
	Startups, innovation, skills	● Social innovation / startup support ● Youth employment ● Support for public goods and services
	Living, safety, health	● Citizen awareness solutions ● Safety solutions ● Active aging
	Tourism	● Information sharing ● Points of interest, city tourism ● Torino as a platform
	Governance	● Health services from home ● Opening of public spaces to citizens ● Co-designing public services
	Energy	● Energy action plan: retrofitting, PV panels, RES, LED ● IoT in schools for energy metering and saving
Leuven (Belgium) Smart City Leuven	***Mobility*** (under optimization of streams)	● Last mile delivery vehicles ● Semi-autonomous bus shuttle ● Bike-sharing ● Policing of shop and parking by sensors
	Energy (under optimization of streams)	● Smart city lights and sensor network ● Smart energy grid - interoperability ● Smart energy in building
	Governance	● Data platform for city administration ● Open data to share data with citizens and entrepreneurs ● Digital Citizen: a digital profile of each citizen
	Health	● Living Lab for health(care) innovations ● E-Health site ● Vital City-innovative initiatives for active lifestyle ● Testing wearables to improve health
	Education	● University student collaboration ● Working environment for knowledge workers ● Start-ups in residence
Vienna (Austria) Smart City of Vienna	***Energy***	● ICT integration for buildings and electrical grid Wien-Aspern (Grid, RES, and storage) ● Wien energy. Use of block-chain for transactions ● Clean heat, stable power grid. Excess electricity to heat ● Energy monitoring and intelligent plant control in Airport ● Urban Cool Down. Summer cooling in urban districts
	Education	● Make your city smart: toolkit for do-it-yourself building ● Vocational orientation of future jobs, robotics, apps, RES ● Digital agenda Vienna. Interactive development of ideas ● Digital city: ICT education
	Governance	● Sag's Wien application. Report to the city administration ● e-Government online services, registration, e-signature
	Mobility	● Smart traffic lights ● Car sharing, e-cars
	District renewal	● Renovation of former industrial sites, central station, Danube bank, residential areas, and other
Amsterdam (The Nethedlands)	***Digital city***	● IoT and sensors ● Digital infrastructure

Amsterdam Smart City (hundreds of initiatives at https://amsterdamsmartcity.com/ A few are included)		• Promotion of various advanced technologies (Blockchain, 5G, AI, Drones)
	Energy	• Energy atlas. Open data map and RES usage • Energy transition • Smart grid • Energy saving at home in city neighbourhoods • Next-generation renewable energy digital platform
	Mobility	• Mobility as a service • City logistics • Bicycle sharing • Autonomous vehicles • Crowd monitoring • Electric vehicles
	Circular city	• Building and construction • Public awareness • e-Waste • Make the circular economy and the upcycle visible • Design-driven solutions to waste and consumerism • New products from used pieces of plastics & metal
	Governance and education	• Transition from smart to inclusive city • Up-scaling • Input-output modelling for smart city development
	Citizen and living	• Public participation • Living labs • Healthy urban living • Sharing economy • Social entrepreneurship • Clean air monitoring
Trikala (Greece) Smart City of Trikala	***Mobility***	• Smart parking and parking analytics • Municipal fleet management • Fleet analysis with vehicles position and routes • Traffic lights monitoring for malfunction
	Energy	• Smart lighting, upgrade to LED and motion sensors
	Waste	• Smart bins with sensors installed
	Water	• Smart water metering
	Environment	• Sensor-based monitoring and metering
	Governance	• Public wi-fi • End-to-end city management system • GIS geospatial information • Complaint registration and mobile app • Public consultation • Digital payments
Smart Cities in Korea A common model for all cities: ICT based growth ecosystems in cities	***Governance***	• Gov with government agents • Citizen cooperation • Public-private partnership • Integrated policy legal system
	Startups, innovation, skills	• Innovation led sustainable growth • Innovative start-up • Spaces for innovative job creation • Clustering • Spread of innovative ideas
	Education	• Innovative education
	Mobility, Energy & Environment, Health, Safety,	• ICT infrastructure • Smart city technologies • Integrated infrastructure with ICT • Open data • Big data

	Welfare	● Data sharing and integration
Hangzhou (China) Dream Town Internet village	***Startups, innovation, skills***	● Attraction of high-quality overseas talents in ICT, biomedicine, RES, financial services ● Applications of e-business, software design, information services, big data, security, animation design ● Start-up support ● Start-up incubators and mentoring ● Grants: creative digital tickets (vouchers) ● Angel village, interaction with VC ● Collaboration and use of Alibaba infrastructure
Changsha (China)	***Government***	● e-Services for social insurance, taxation, police
	Mobility	● e-Services for information and ticketing ● Transport cloud for information, coordination, service delivery
	Commerce	● e-Services for shopping and online payment
	Health	● e-Services in hospitals for medical service, payment
	Tourism	● Hotel reservation, tourism venues, e-payment
	Safety	● Fire protection ● Police cloud big data platform ● Police analytics and prediction
Pune (India) Smart City of Pune	***Energy***	● Smart grid and solar panels
	Water	● Smart metering
	Mobility	● e-Buses ● Electric Rickshaw / Electric Tuk-Tuk in Pune ● ICT-enabled bus ● Smart parking ● Adaptive traffic management
	Safety	● CCTV ● IT connectivity
Nara (Japan) Smart City of Nara	***District renewal***	● Smart campus ● Smart housing district ● Smart grid and solar panel ● Solar thermal ● Energy management platform ● Data centre
Singapore (Singapore) Smart City of Singapore	***Health***	● Elderly mobility using robotics ● App citizen wearables encouraging exercise ● Health monitoring at home ● Health related analytics
	Living	● App: User engagement on environmental issues ● App: Understand living conditions at home
	Mobility	● Access to public transportation ● Mobility analytics ● Smart parking ● Autonomous mobility testing
	Government	● Citizen database platform-interaction with gov. ● Access to numerous public services ● Open datasets ● Platform for sharing ideas
	Startups, innovation, skills	● Financial database of business opportunities ● Digital transactions for citizens and businesses ● Digital training programs and fellowships ● Digital tools for innovative development ● Platforms for academic collaboration ● Business grants portal
Newark (US)	***Government***	● Data analytics platform (B2B, B2C, open gov data, crime, vacant lots, employment)

Smart city of Newark		● Industrial analytics platform ● Smart city governance analytics
Quayside Toronto (Canada) Sidewalk Labs' Waterfront Toronto (before being abandoned)	***District renewal***	● Self-driving shuttles ● Robot delivery ● Spaces showcasing new technologies ● Dynamic, reconfigurable pavement, allowing different uses and activities throughout the day ● Building envelope technologies (raincoats) ● Responsible Data Use Framework
Porto Alegre (Brazil) Porto Alegre Smart City	***Governance***	● Integrated command centre ● GIS data centre ● Bio-monitoring (trees, plant, pollutants) ● Training telecentres for literacy and digital inclusion ● Smart city innovation centre
	Health	● Real-time monitoring of hospital bed occupation ● Sharing patient information ● Telemedicine, primary diagnoses
Johannesburg (South Africa) Smart city of Johannesburg	***Safety***	● Crime reporting application ● 911 response application ● Kitestring – check-up and emergency alert
	Mobility	● Intelligent Transport System ● Interactive application – real time transport
Tunis (Tunisia) Smart City of Tunis	***Startups, innovation, skills***	● Digital entrepreneurship ● Digital innovation services ● Offshoring – place promotion ● IT promotion
	Governance	● Administrative services to citizens ● User-centric governance ● Platform for data exchange and interoperability

Source: Based on city reviews of the book
Anthopoulos (2021). Smart City Emergence: cases from around the world. Elsevier