Smart Ecosystems
in the universe of intelligence

Nicos Komninos
URENIO Research, Aristotle University of Thessaloniki

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There is plenty of evidence that the smart city is becoming the dominant urban development and planning paradigm and drives the transformation of cities and communities in the 21st century.

Question: How are cities evolve under this paradigm?

To address this question:

Introduction: We outline key aspects of the smart city paradigm

1. We examine **projects for smart citie**s from around the world

2. We go deeper into the **architecture** of complex smart city projects

3. Even deeper into the **determinants of effectiveness** of smart city projects

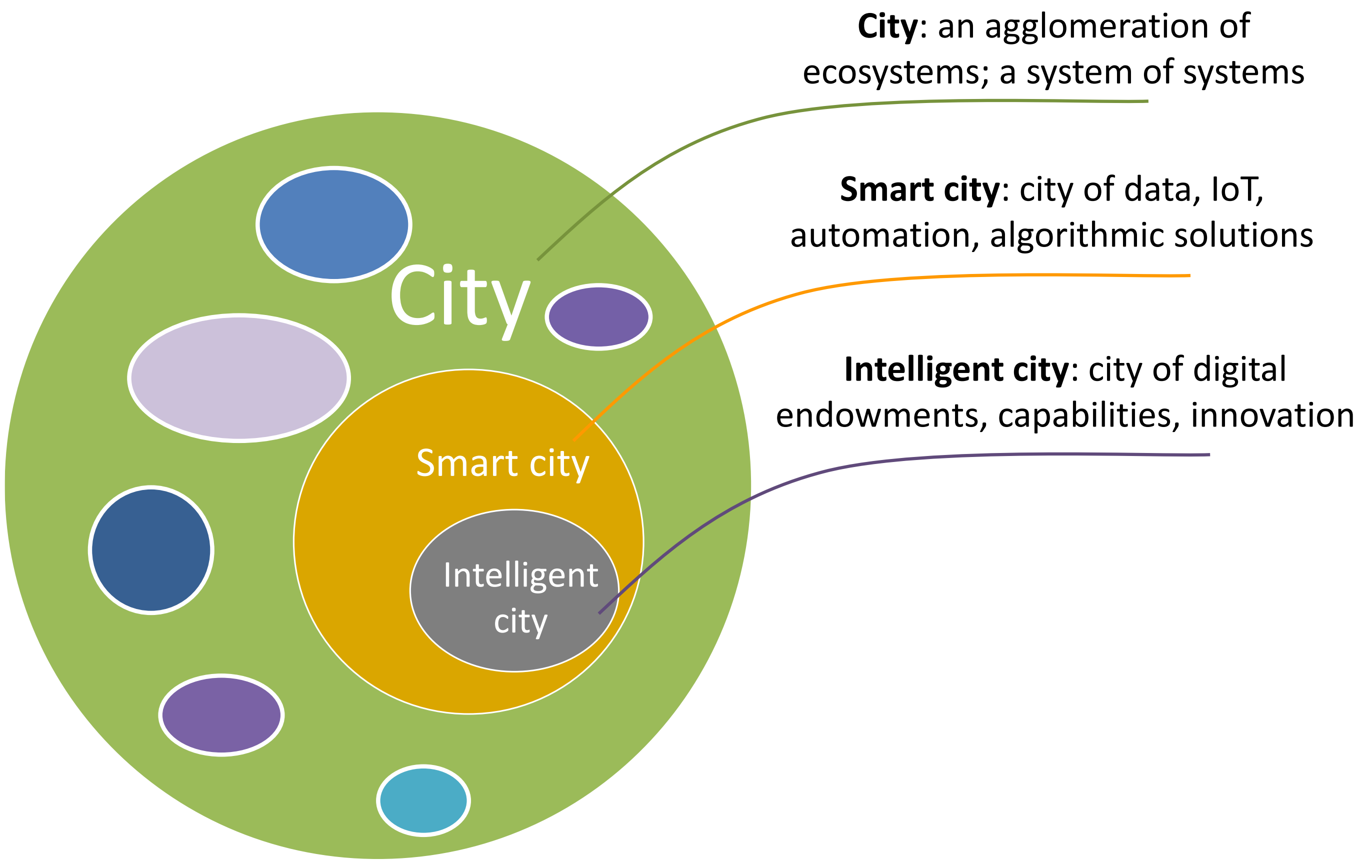
Conclusion: Transformation of cities under the smart city paradigm

Introduction and problem statement

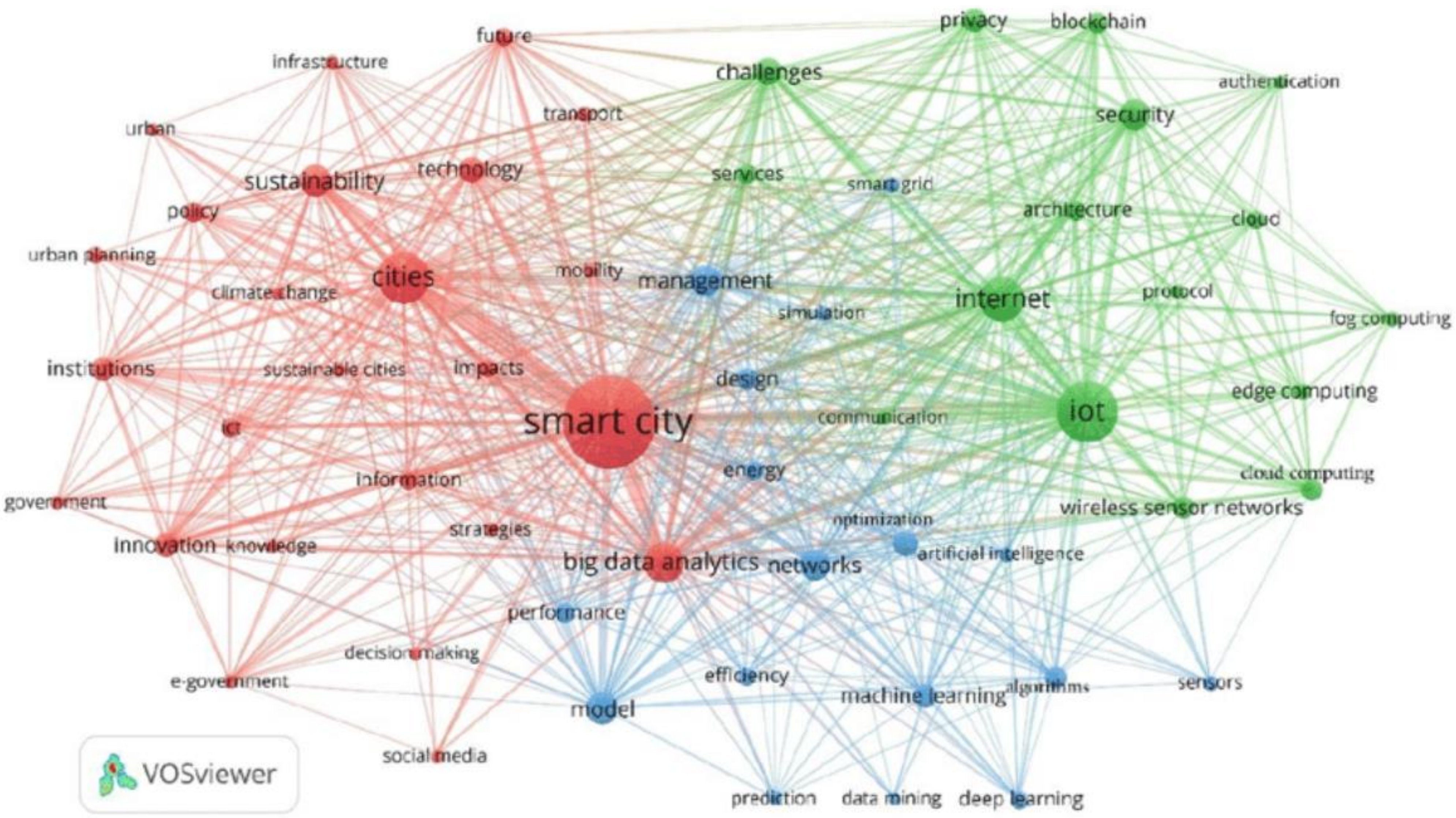
Three major concepts in the smart city paradigm

City, smart city, intelligent city

- **City**: a dense agglomeration of people, activities, infrastructures; a system of systems; an agglomeration of ecosystems
- **Smart city:** A subclass of the city, a city using digital technology and data. “Smart city” means “Exypnos city”, a city out of sleep, a city of awareness, IoT, sensors, data
- **Intelligent city**: A subclass of the smart city. Some smart cities develop problem-solving capabilities, innovation capabilities; sustain intelligent behaviours



The smart city: Three decades of research

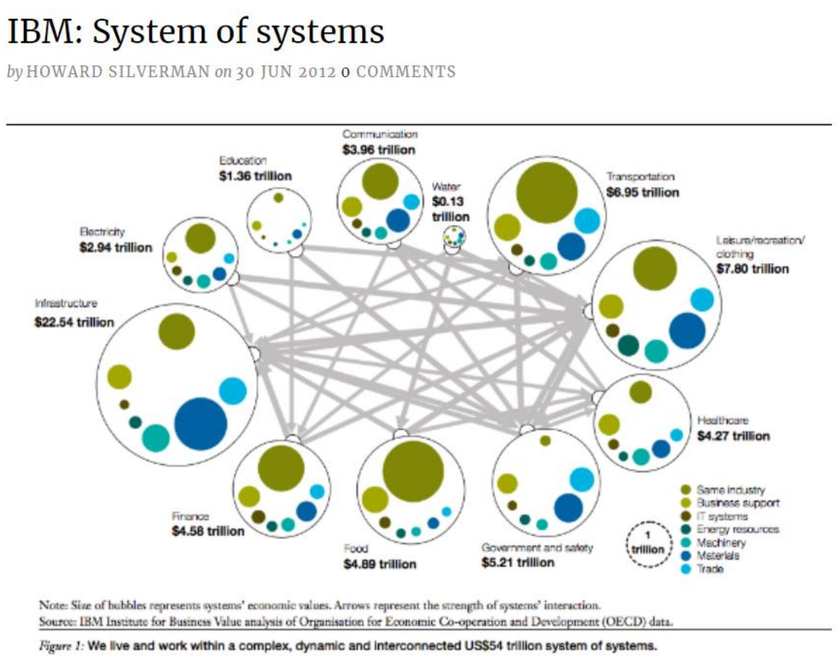


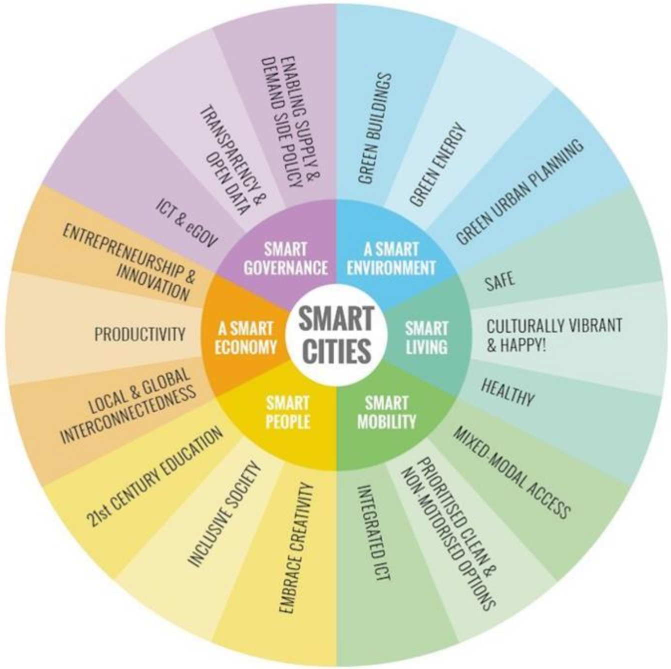
Three Decades of Research on Smart Cities: Mapping Knowledge Structure and Trends

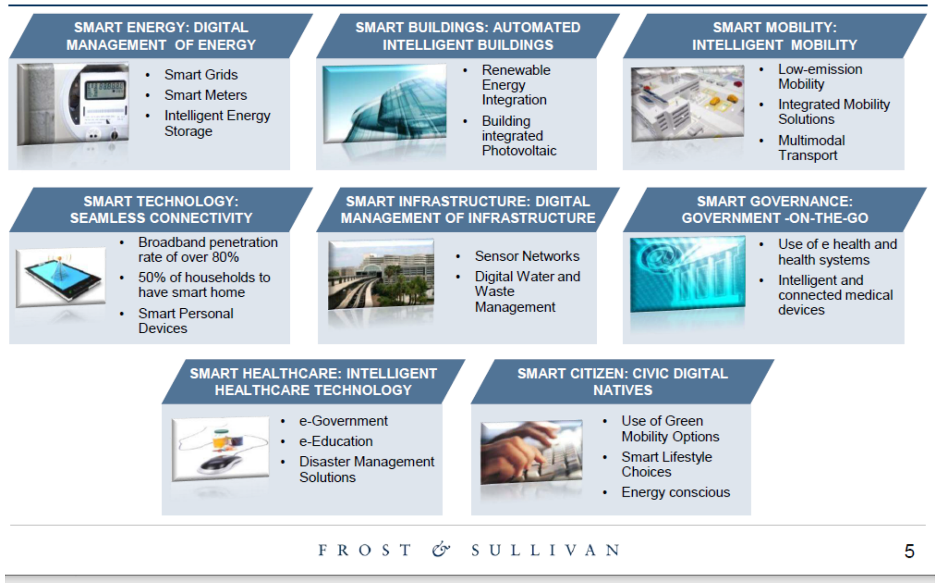
by Ayyoob Sharifi [1,*], Zaheer Allam [2], Bakhtiar Feizizadeh [3] and Hessam Ghamari [4,*]

https://www.mdpi.com/2071-1050/13/13/7140

Smart city: agglomeration of ecosystems under transformation







IBM Institute of Business Value (2010): IBM system of systems	Klingberg, D., & Bell, J. (2015). Smart cities habitat master planning framework. *Planning News*, *41*(6), 22	Frost & Sullivan (2020). Smart Cities: F&S value proposition

20 ecosystems (domains, subsystems) under transformation in the smart city

Area-based ecosystems, defined by districts & neighbourhoods	*1. City centre* *2. Marketplace* *3. Housing* *4. Public space / recreation* *5. Natural ecosystems* *6. Hub (port / rail / bus)*	**Vertical ecosystems,** defined by activities	*7. Manufacturing* *8. Food production* *9. Education* *10. Tourism, hospitality, etc.* *11. Culture and branding* *12. Public services & safety* *13. Government*	**Network-based ecosystems**, defined by utility and other networks	*14. Transportation* *15. Energy* *16. Water* *17. Waste* *18. Telecom, broadband* *19. Recycling* *20. Environment, emissions*

Smart ecosystems

Concept	Types	Impact
An ***ecosystem*** is a **community of *organisms in conjunction with their environment***, working and interacting as a system. A ***smart ecosystem*** is a community of organisms in which physical and institutional ***linkages are coupled by digital interactions*** based on digital platforms, digital commons, networking technologies, (IoT, Blockchain, Web 2.0), virtual communities, smart environments	***Business ecosystems***, which centers on a firm, its supply chain and environment (also, entrepreneurial ecosystems, transaction ecosystems) ***Innovation ecosystems***, focused on innovation chains or new product development and the constellation of organisations that shape them (also, technology ecosystems, knowledge ecosystems) ***Platform ecosystems***, in which producers and customers collaborate, exchange and create value over a common platform	A simplified understanding of ***network effects*** is that they occur when a product or service becomes more valuable as usage increases ***Different Network Effects*** • Physical nodes • Common protocol • Personal utility networks • Market network • Marketplace, 2-sided • Platform, 2-sided • Asymptotic marketplace (flat curve) • Data network effect • Technology performance net eff. • Social network effect (language, trust, bandwagon) https://www.nfx.com/post/network-effects-manual/

Following these introductory clarifications on the smart city paradigm, we return to the question

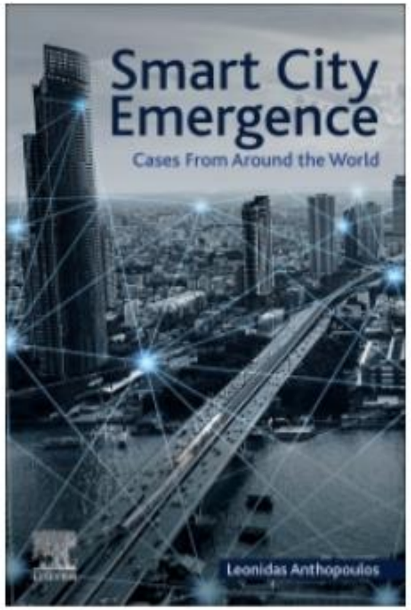
How cities evolve under the smart city paradigm?

We will refer to three papers of 2021 written in collaboration with my colleagues at URENIO Research

1. Smart city projects from around the world

Komninos, N., Tsampoulatidis, I., Kakderi, C., Nikolopoulos, S., and Kompatsiaris, I. (2022). **Projects for intelligent and smart cities: technology and innovation transforming city ecosystems**. In: Srikanta Patnaik, Siddhartha Sen, and Magdi S. Mahmoud, *Smart Village Technology: Concepts and Developments*. Springer.

A survey on SC projects from around the world



Smart City Emergence

1st Edition

Cases From Around the World

☆☆☆☆☆ Write a review

Editor: Leonidas Anthopoulos

eBook ISBN: 9780128165843
Paperback ISBN: 9780128161692

Elsevier, Smart City Series
Editors: Tan Yigitcanlar, Nicos Komninos, Mark Deakin

- Based on case studies presented in the book "Smart City Emergence" edited by L. Anthopoulos
- 20 case studies from Europe, US, south America, Asia, Africa. 17 cases included in the survey, having a good description of smart city projects
- Four main conclusions

The ecosystem is the main framework of smart city projects

SC projects per sector of activity or city ecosystem

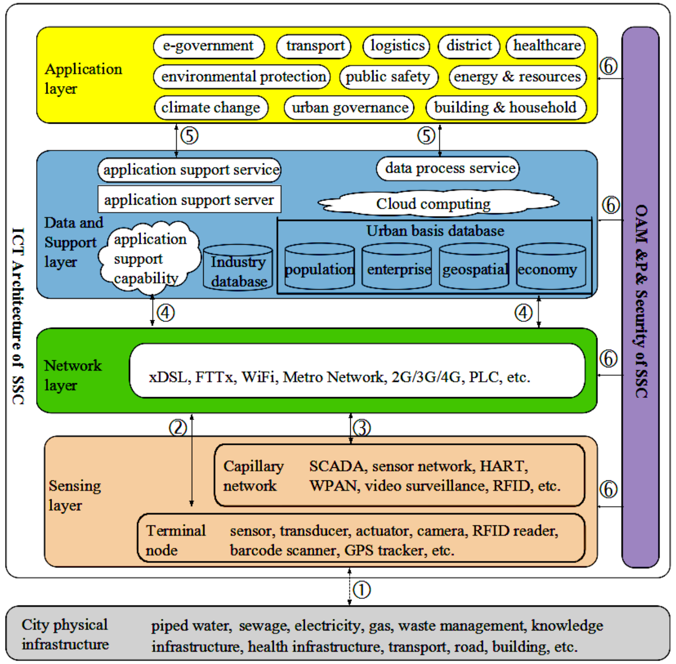
Type of ecosystem	City ecosystems	Frequency in sample cities	
		No of cities	*%*
Area-based ecosystems (3.49% of all ecosystems)	1. District renewal-Multi-use districts	1	5.88
	2. Hub district (port / rail / airport)	1	5.88
	3. City centre	-	-
	4. Technology district	-	-
	5. University campus	1	5.88
	6. Housing	-	-
	7. Public space / natural ecosystem	-	-
Activity-based ecosystems (45,35% of all ecosystems)	8. Governance	11	64.70
	9. Health	6	35.29
	10. Startups, innovation, skills	5	29.41
	11. Safety	5	29.41
	12. Living, quality of life	5	29.41
	13. Education	4	23.53
	14. Tourism, hospitality, shopping	3	17.65
	15. Manufacturing	-	-
	16. Culture, recreation	-	-
Network-based ecosystems (51,16% of all ecosystems)	17. Telecom, broadband	17	100.00
	18. Mobility	10	58.82
	19. Energy	8	47.05
	20. Environment	4	23.53
	21. Water	3	17.65
	22. Circular economy, recycling, waste	2	11.76

- A very clear message is setting smart city projects and solutions by ecosystem
- We can identify: 86 ecosystems in 17 cities. On average 5 ecosystems per city.
- They fall into 16 types of ecosystems, classified per (a) areas, (b) activities, and (c) networks.
- **Most frequently** projects related to network ecosystems (broadband, mobility, energy, etc., 51.16%); then follow those related to activities (economy, health, safety, etc., 45.35%); and a few only cities work with area-based ecosystems (district renewal, 3.49%).

Examining projects per ecosystem

Standardisation of smart city projects per ecosystem

Smart city governance projects	Smart city energy projects
1. Online administrative services to citizens	1. Smart metering in buildings, energy control and saving
2. Co-design of public services	2. Energy integrated: retrofitting, PV panels, RES, etc.
3. Citizen reporting, complaints, request to city administration	3. Smart grid and use of renewable energy
4. Citizen database and profile platform	4. District cooling and heating
5. Open data, data sharing with citizens and entrepreneurs	5. Smart public lighting
6. GIS data centre	6. Public electric vehicle charging
7. Digital payments	7. Energy-related platform and transactions
8. Integrated city management system, command centre	8. Data collection, mapping, and modelling of the energy system



Source: FG-SCC, I. T. U. T. (2015). Setting the framework for an ICT architecture of a smart sustainable city. *Focus Group Technical Specifications*, 49.

- There is **high diversity** of smart city projects across ecosystems. Per ecosystem, diversity is low and similar projects are to be found in across cities.
- **The same digital technologies** in different ecosystems lead to totally different projects.
- The **diversity of context**, actors, physical infrastructures, and social processes **prevails** over the homogeneity of digital technologies across ecosystems.

Three types of smart city projects

CYBER-PHYSICAL PROJECTS transforming city areas (e.g. Sidewalk Toronto, Quayside project abandoned)

E-SERVICES: hundred of digital services for all domains and activities of cities

DATA COLLECTION & ANALYTICS: the city becomes a measured system. Data-modeling-forecasting

Type of projects and impact on city routines

Project type

Project type	No of cases	%
Creation of e-services	96	46,06
Data creation, monitoring, analytics	28	13,59
Complex cyber-physical projects	82	39,81
Total	206	100

Impact level

Digitalisation	Many projects just transfer activities from the physical to digital space. Underlying routines remain the same. Usual in online transactions and e-commerce.
Optimization	Adding data and analytics, projects improve / optimize activity routines. GPS guided behaviour, smart meters, automation in energy usage have this type of effect.
Innovation	More complex projects change radically activity routines, introducing new routines. This happens in new forms of mobility, car-sharing, car-pooling, micro-mobility, is smart systems of urban safety, in participatory governance.

2. High impact smart city projects: A universal architecture?

Komninos, N., Kakderi, C., Mora, L., Panori, A., and Sefertzi, E. (2021). **Towards High Impact Smart Cities: a Universal Architecture Based on Connected Intelligence Spaces**. Journal of Knowledge Economy. https://doi.org/10.1007/s13132-021-00767-0

SAFETY: Vision Zero to eliminate fatal traffic accidents in cities

What is **Vision Zero?**

Vision Zero is a strategy to eliminate all traffic fatalities and severe injuries, while increasing safe, healthy, equitable mobility for all. First implemented in Sweden in the 1990s, Vision Zero has proved successful across Europe — and now it's gaining momentum in major American cities.

Source: Vision Zero Network.

https://visionzeronetwork.org/about/what-is-vision-zero/

Table 8.2 Vision Zero implementation components

1. MAPPING	1.1	Data: Information collection and dataset creation
	1.2	Identification of high-injury network and risk areas
	1.3	Analytics: Fatalities and major injuries per areas and social groups
2. PEOPLE AND USER ENGAGEMENT	2.1	Reporting and witnessing by users
	2.2	Education: Develop a driving culture for Vision Zero
	2.3	Co-design of safety solutions with users
3. CITY DESIGN	3.1	Intersection re-design for visibility and safety
	3.2	Engineering solutions under the principles of VZ and WalkFirst
	3.3	Creation of arterial slow zones
4. INSTITUTIONAL MEASURES	4.1	Law enforcement
	4.2	Law and policy support VZ and reduce speed on city streets
	4.3	Training of officers on safety measures and recording of events
5. DIGITAL SPACES AND TECHNOLOGIES	5.1	Web-based information collection and dissemination
	5.2	Real-time watch and alert and transportation injury surveillance
	5.3	Car-pooling & car sharing for reducing travelled miles per capita
	5.4	Advanced video-based road-safety analytics
6. MONITORING AND ASSESSMENT	6.1	Definition of output and result indicators
	6.2	Dashboards, data recording and periodic reporting
	6.3	Analytics for assessment

MOBILITY: MaaS radically transforms urban transport

Movby - Local Friendly Mobility ...

We connect unused rides (bikes&boats) with people

Witkar takes you to places where public transport does not run, the so-called first mile and last mile. Witkar is a system of shared vehicles, runs at a safe city speed, and is suitable for individual transport.

Mobility-as-a-Service (MaaS) is the integration of multiple transportation services into a coordinated mobility service offered over **online platforms.**

“It combines different transport modes to offer a tailored mobility package, similar to a monthly mobile phone contract and includes other complementary services, such as trip planning, reservation, and payments, through a single interface (Hietanen, cited in Jittrapirom et al., 2017).

Felyx e-scooter sharing

Offering shared electric scooters as a new urban mobility concept

The Parkshuttle

An automated public transit system with selfdriving vehicles, operational since 1999!

ENERGY: Positive energy districts for the end of carbon

PEDs are carbon neutral city districts that export renewable energy

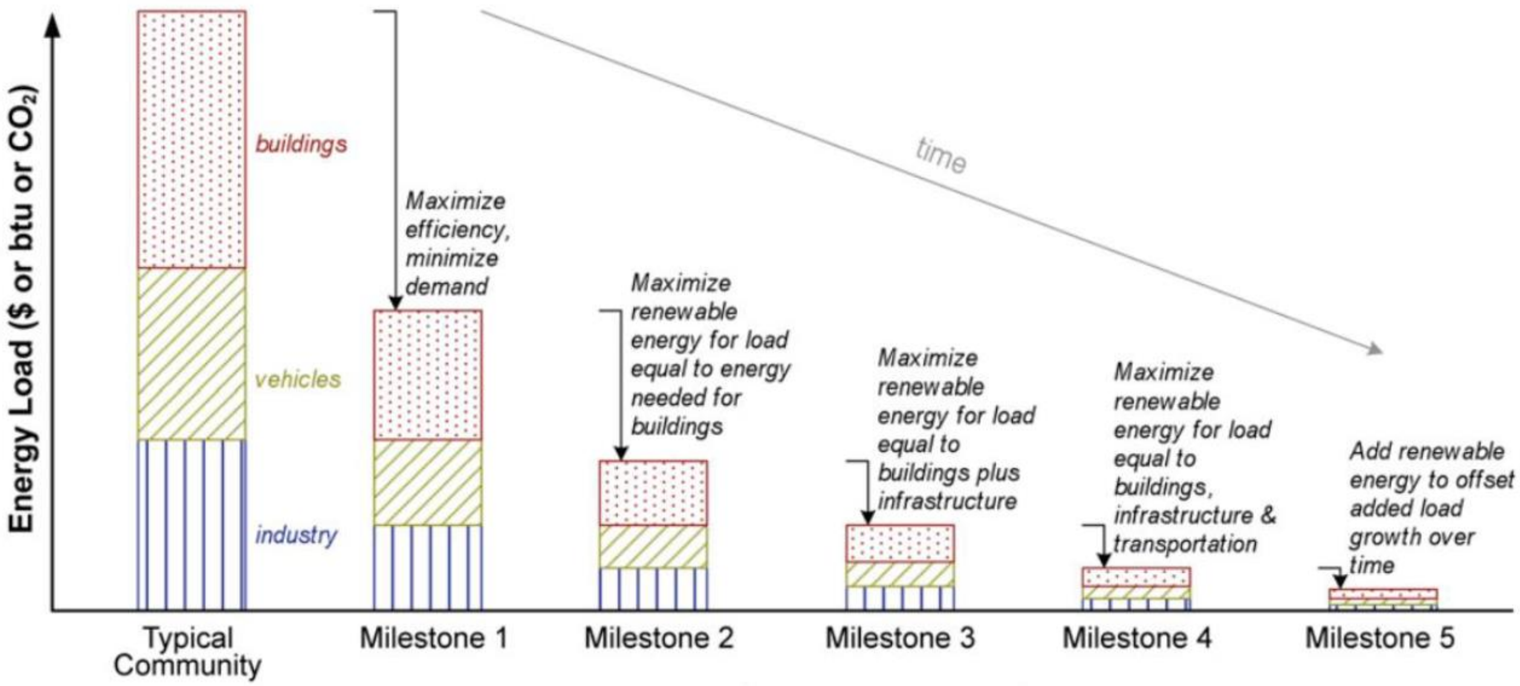
Emissions inventories to monitor, record, analyse urban emissions, and increase user awareness.

Renewable energy production is the fundamental mode towards carbon neutrality.

Smart grid and smart meters modernize the energy network adding new functionalities of user-producer coordination and load optimisation.

Smart home systems for energy saving and optimisation through automation.

Nature-based solutions to remove CO2 emissions from the atmosphere.



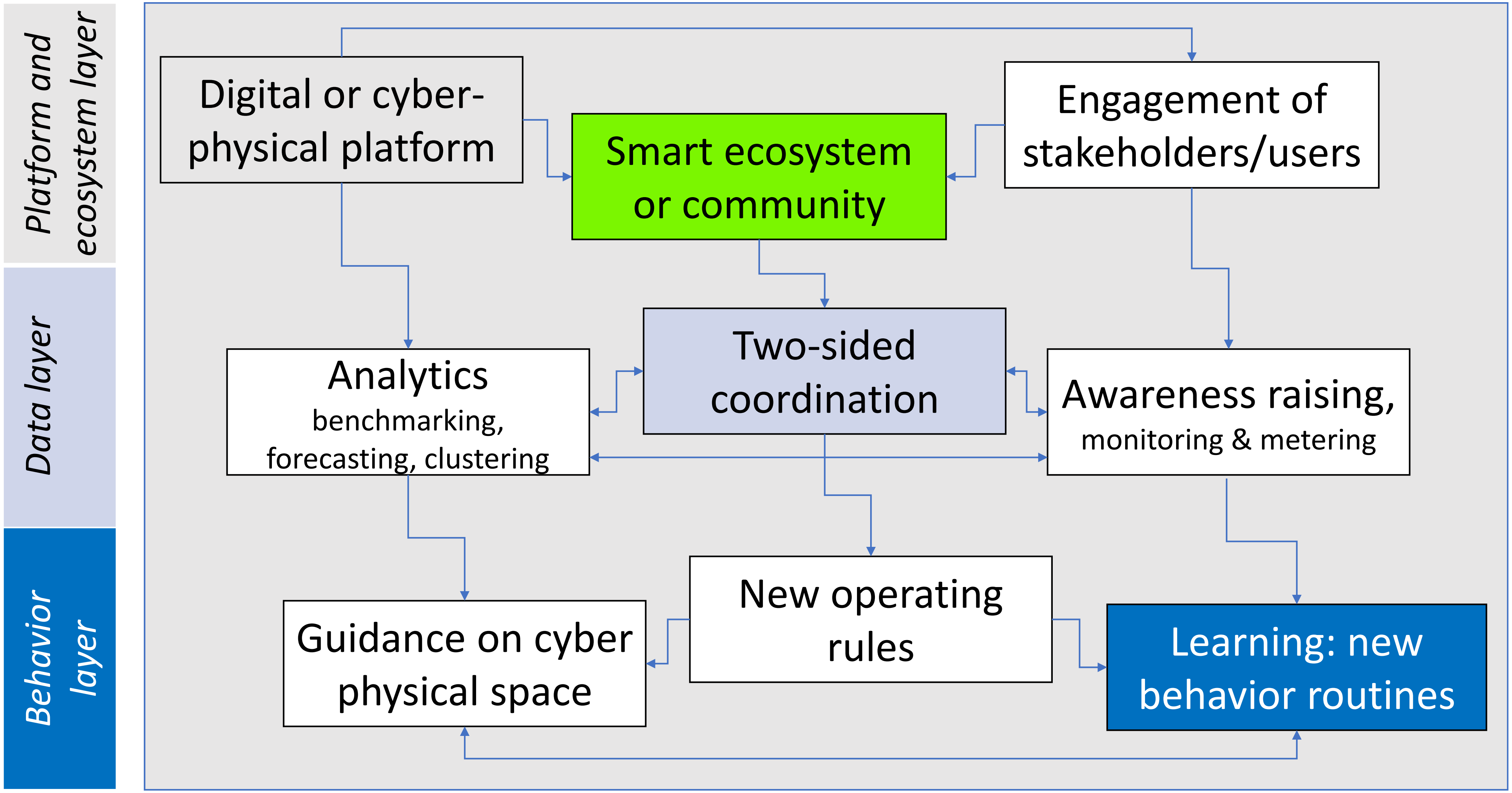
Carlisle, N., Van Geet, O., & Pless, S. (2009)

Common processes across safety, mobility, energy ecosystems

Table 1 Commonalities in smart city projects entailing a modification of activity routines

	Vision zero	Mobility as a service	Positive energy districts
Different activities and material base of each ecosystem	Activities related to safety	Activities related to mobility	Activities related to energy and the environment
	Material base: A collection of physical elements, buildings, and public urban equipment	Material base: A collection of different transportation means, public and private	Material base: A collection of renewable energy means and building retrofitting
Common functions supporting the modification of routines per ecosystem	Ecosystem building/community building	Ecosystem building/community building	Ecosystem building/community building
	Engagement of stakeholders and users	Engagement of stakeholders and users	Engagement of stakeholders and users
	New organizational and operating rules	New organizational and operating rules	New organizational and operating rules
	Awareness, user feed-back, measurement	Awareness, alternative choices, smart metering	Awareness, smart metering, inventories
	Two-sided coordination of producers and users	Two-sided coordination of producers and users	Two-sided coordination of producers and users
	Learning, new behavior patterns	Learning, new behavior patterns	Learning, new behavior patterns
	Benchmarking and injuries analytics in different parts of the city	Benchmarking and forecasting travel options and transport	Benchmarking energy production and usage patterns and analytics
	Guidance on physical and digital space	Guidance on physical and digital space	Guidance through metering and awareness
Specific to ecosystem functions supporting the modification of routines per ecosystem	Redesign of physical space of cities and transport infrastructure		Redesign: Nature-based solutions

A common 3-layer architecture



3. Net-zero energy districts: How effectiveness is produced

Komninos, N. (2021). **Net-zero energy districts: connected intelligence for carbon-neutral cities**. Presented at the conference *The Future of Liveable Cities*, Naples, 22 Nov. 2021 and at the conference *Technology City Resilience*, Shenzhen, 4 Dec. 2021

NZEDs: a decentralized transition to carbon-neutral cities

Net Zero Energy Districts (NZED) are city districts in which the annual amount of CO2 emissions released minus of emissions removed from the atmosphere is zero.

NZEDs constitute a major component of a new generation of “smart-green” cities based on a combination **of smart city technologies** and **renewable energy technologies**.

The aim of the paper is to assess to

(a) the **feasibility of transition** of city districts to NZEDs **based on local renewable energy** suitable for cities (which multiple net zero transition), and

(b) identify thresholds, which allow for a housing district to become a self-sufficient NZED, covering all energy needs by locally produced RE

A model for transition to NZED: Building blocks

Block A. District

Demographics
- Population
- Number of households
- Density

Land use
- Total area of the district
- Housing area
- Social care, education, culture, sports area
- Local retail and services area
- Road and parking area
- Green, gardens, urban forests area

City grid
- Number of building blocks on the grid
- Number of lighting poles on the grid
- Road length of the district grid

Building code
- Building Coverage Ratio
- Floor-Area Ratio
- Housing floor per capita
- Number of building floors

Mobility
- Number of commuting travels
- Average distance per commuting travel
- People using private car in commuting
- People using public transport in commuting-
- People using bicycle or work from home

Block C. Measures towards NZED

C1. Housing: energy efficiency by refurbishment

C2: Housing: energy saving by smart home solutions

C3. Public lighting: saving by smart systems

C4. Transport: green mobility & energy saving

C5. Smart grid and storage

C6. Local RE: Photovoltaic panels

C7. Local RE: Geothermal

C8. Nature-based solutions: Tree canopy

Block B. Energy usage & CO2

Energy consumption residential
- Energy consumption residential, total
- Energy consumption residential-Heating
- Energy consumption residential-Lighting & appliances
- Energy consumption residential-Domestic water heating
- Energy consumption residential-Cooking
- Energy consumption residential-Cooling
- Energy production renewable

C02 emissions residential, total

CO2 emissions per category of usage

Energy consumption streetlighting
- Total
- Lamp power per pole
- Street lighting system operating hours per year

Energy consumption in mobility
- Energy consumption in mobility by public transport
- Energy consumption in mobility by private car
- Energy consumption in mobility by electric car & micro-mobility

- CO2 emissions in mobility by public transport
- CO2 emissions in mobility by private car

Block D: Balancing energy and CO2

Energy	Residential energy saving	Mobility energy saving	Smart grid, storage, renewable energy
ΣE_B	Esav [C1 +C2]	Esav [C3+C4]	E_{RES} [C5+C6+C7]

CO2	Green mobility	Nature-based solutions
ΣC_{MOB}	-CO2 [C4]	-CO2 [C8]

Block C. Transition measures to NZED

Block C comprises processes and technologies for transition to NZED.

The combined effect of these technologies can offset all CO_2 emissions produced by using fossil energy.

All measures of block C (C1-C8) have an impact on variables of Block B related to energy usage and CO_2 emissions.

Included are 8 types of measures applied at different spatial entities of the district:

C1. Housing: energy saving by building refurbishment
C2. Housing: energy saving by smart city solutions

C3. Public lighting: energy saving by smart city lighting
C4. Transport: Green mobility, e-vehicles, m-mobility

C5. Smart grid and storage
C6. Local RE: Photovoltaic panels
C7. Local RE: Heat pumps and geothermal heat pumps

C8. Nature-based solutions: Trees and CO_2 offset

The impact of each measure is estimated either analytically (C3, C6, C8) or by previous pilots and experiments (C1, C2, C4, C7)

Block D. Documentation of transition to NZED

Energy balance	Carbon balance
[Total energy consumption in housing, street lighting, mobility by public transport and electromobility] - [energy saving from smart system measures to NZED] < [renewable energy generated by PV panels]	[CO2 emissions in mobility by private vehicles using fossil fuels] < [CO2 removed by nature-based solutions]

The overall model we use for this analysis can be described by using the following equations:

$$\sum E - \sum E_S < E_{RE} \qquad (1)$$

Where $\sum E$ refers to the total energy consumption in housing (E_R), street lighting (E_{SL}), mobility (E_M) including private cars (E_{MPC}), public transport (E_{MPT}) and electromobility (E_{MEV}); $\sum E_S$ refers to energy savings from heating (E_{H-S}), lighting and appliances (E_{LA-S}), smart city lighting (E_{SL-S}) and electric mobility (E_{EV}); and E_{RE} refers to the energy generated by PV panels.

And

$$C_{MPC} < CO2_a \qquad (2)$$

Where C_{MPC} refers to the CO2 emissions from mobility by private car; and $CO2_a$ to the capacity of CO2 absorption by tree canopy in a district.

Simulations: cities in southern, central, northern Europe

BLOCK A

Code	Name	Measurement unit	Value
	Demographics		
P	Population	Physical person	5,000
AP	Active population as % of total	Working person	40
H	Number of households	Household	1,500
D	Density	Persons/Hectare	100
	Land use		
At	Total area of the district	Hectare	50
Ah	Housing area, 50% to total	Hectare	25
As	Social care, education, culture, sports area, 0% of total	Hectare	0
Ar	Local retail and service		
Ar	Road and parking area		
Ag	Green, gardens, urban		
	City grid and public lig		
Bb	Number of building blo		
Pl	Number of lighting pol		
Rlg	Road length of the dist		
	Building code		
BCR	Building Coverage Rati		
FAR	Floor-Area Ratio		
Hfpc	Housing floor per capi		
Bnf	Number of building flo		

BLOCK B

Residential energy consumption

Code	Name	Measurement unit	Value	Breakdown	Unit
P	Population	Person	5,000		
EPC	Energy consumption total per capita	kWh/year	30384		
ERPC	Energy consumption residential per capita, % of total	Percentage	26.30%		
ERT	Energy consumption residential, total	kWh/year	**39,954,960**		
EH	Energy consumption residential-Heating	Percent of total	63.60%	25,411,355	kWh/year
ELA	Energy consumption residential-Lighting & appliances	Percent of total	14.10%	5,633,649	kWh/year
EDWH	Energy consumption residential-Domestic water heating	Percent of total	14.80%	5,913,334	kWh/year
EC	Energy consumption residential-Cooking	Percent of total	6.10%	2,437,253	kWh/year
ECL	Energy consumption residential-Cooling	Percent of total	0.40%	159,820	kWh/year

ption in households by type of end-use

676
0.25
6.69
,841

BLOCK C

C1	**Housing: energy saving by building refurbishment**	**Energy reduction coefficient (x)**	**Energy consumption residential total (kWh)**		**Energy consumption residential-Heating (%)**			**Energy saving**	
	Energy saving for heating (EH-S)	0.2	39,954,960		63.60%			**5,082,271**	kWh
C2	**Housing: energy saving by smart city solutions**	**Energy reduction coefficient (x)**	**Energy consumption residential total (kWh)**		**Energy consumption residential-Lighting & appliances (%)**			**Energy saving**	
	Energy saving for lighting and appliances (ELA-S)	0.1	39,954,960		14.10%			**563,365**	kWh
C3	**Public lighting: energy saving by smart city lighting**	**Energy reduction coefficient (x)**	**Energy consumption street lighting (kWh)**					**Energy saving**	
		0.5	776,841					**388,420**	kWh

		Population	% workers	% mode (z)	Average travel dist	NumTravels	kWh/km or CO2/km	Value	Units
C4	**Transport: Green mobility, energy and CO2 emission**								
	Mobility by public transport	5,000	40%	15%	10	500	0.1	150,000	kWh
	Mobility by electric vehicles	5,000	40%	50%	10	500	0.2	1,000,000	kWh
	Mobilily e-micromobility	5,000	40%	10%	10	500	0.05	50,000	kWh
	Total e-mobility							1,200,000	
	CO2 emissions in mobility by private car	5,000	40%	15%	10	500	0.19	285,000	Kg

C5	**C5. Smart grid and energy storage**
	Saving and RE support included in other measures

		PV area: buildings +	PV coverage	PV surface	Power per sm	DC system	Yearly production	Unit

District | **Athens-100** | Frankfurt-100 | Helsinki-100 | Athens-120 | Frankfurt-56 | Helsinki-43 | Frankf-PCE2 | Hels-PCE2

Simulations: Feasibility of transition to NZED

Energy		**Athens-100**			**Frankfurt-100**			**Helsinki-100**	
Energy consumption									
Residential	39,954,960			57,469,445			72,480,170		
Public lighting	776,841			732,529			710,052		
Mobility	1,200,000			1,200,000			1,200,000		
Energy saving									
C1: Building refurbishment		5,082,271			7,310,113			9,219,478	
C2: Smart home solutions		563,365			810,319			1,021,970	
C3: Smart city ligthing		388,420			366,264			355,026	
C7: Heat pumps		10,963,641			15,769,616			19,888,559	
Renewable energy generation									
C6: PV panels			31,118,964			20,115,406			19,342,450
Total energy	41,931,801	16,997,697	31,118,964	59,401,974	24,256,313	20,115,406	74,390,222	30,485,033	19,342,450
Energy balance in NZED (kWh)		**6,184,861**			**-15,030,255**			**-24,562,739**	
CO2									
C4: CO2 emissions	285,000			285,000			285,000		
C8: CO2 capture		298,200			298,200			298,200	
CO2 balance in NZED (Kg)		**13,200**			**13,200**			**13,200**	

Energy usage		24,934,103			35,145,661			43,905,189	
RE surplus or gap		36.39%			-42.77%			-55.94%	
Energy saving		40.54%			40.83%			40.98%	
RE/energy needs		124.80%			57.23%			44.06%	

NZED is feasible in Athens, but not feasible in Frankfurt and Helsinki. The same outcome is for cities in southern Europe (Madrid, Rome), central Europe (Lyon, Munich, Vienna) and northern Europe (Stockholm). Reducing density or increasing power conversion efficiency NZEDs become feasible throughout Europe.

Transition to NZED and connected intelligence

Model and simulations for assessing the transition to NZED show the overall outcome, but also how different measures / practices (density, consumption per capita, climate, mobility pattern, technology) contribute to the outcome.

We can relate measures and outcomes

The transition to NZED needs a combination of human, collective, and machine intelligence

Human behaviour

- Developing a prosumer culture
- Investing in renewable energy
- Using of electric vehicles and e-micro-mobility
- Sharing energy in the district

Community behaviour

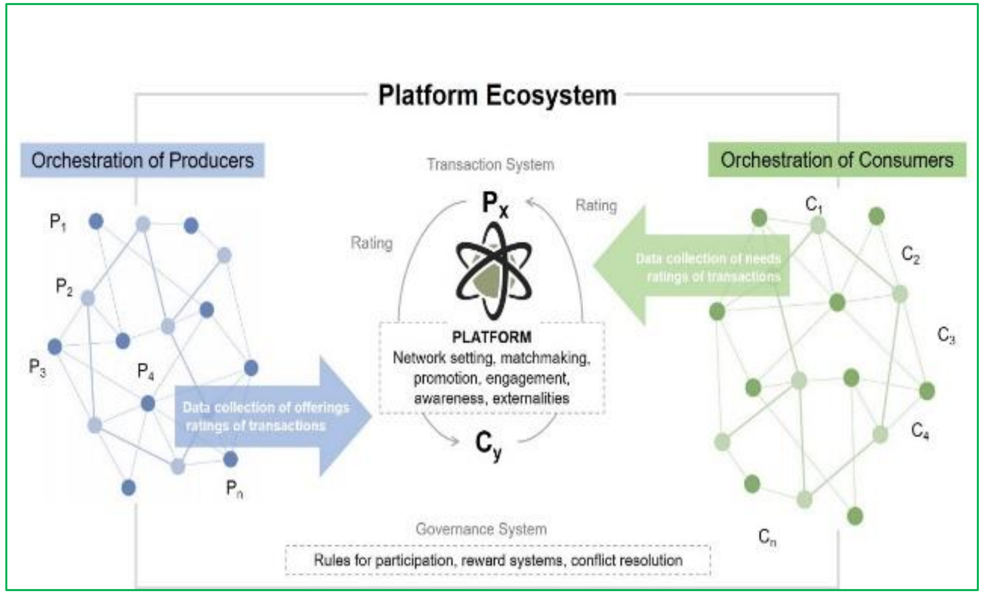
- Setting energy communities
- Control of population density
- Planning rules for solar panel installation
- Development of smart grid in the district
- Sharing energy under barter exchanges
- Upgrading public transport to electromobility

Machine capabilities

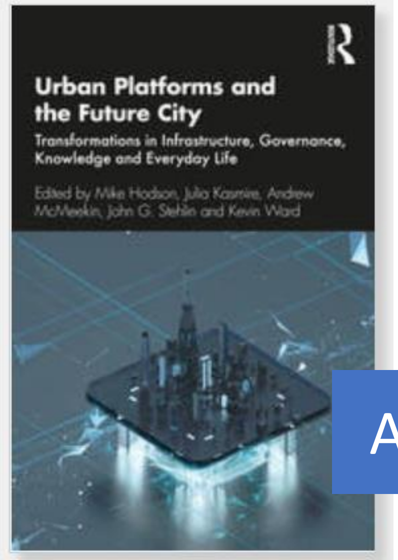
- Smart city systems, smart grid, and smart meters
- Platforms for local energy transaction
- Making available performance data and analytics
- Energy optimisation and automation algorithms

Conclusion: Transformation of cities under the smart city paradigm

Smart ecosystems drive the transformation of cities

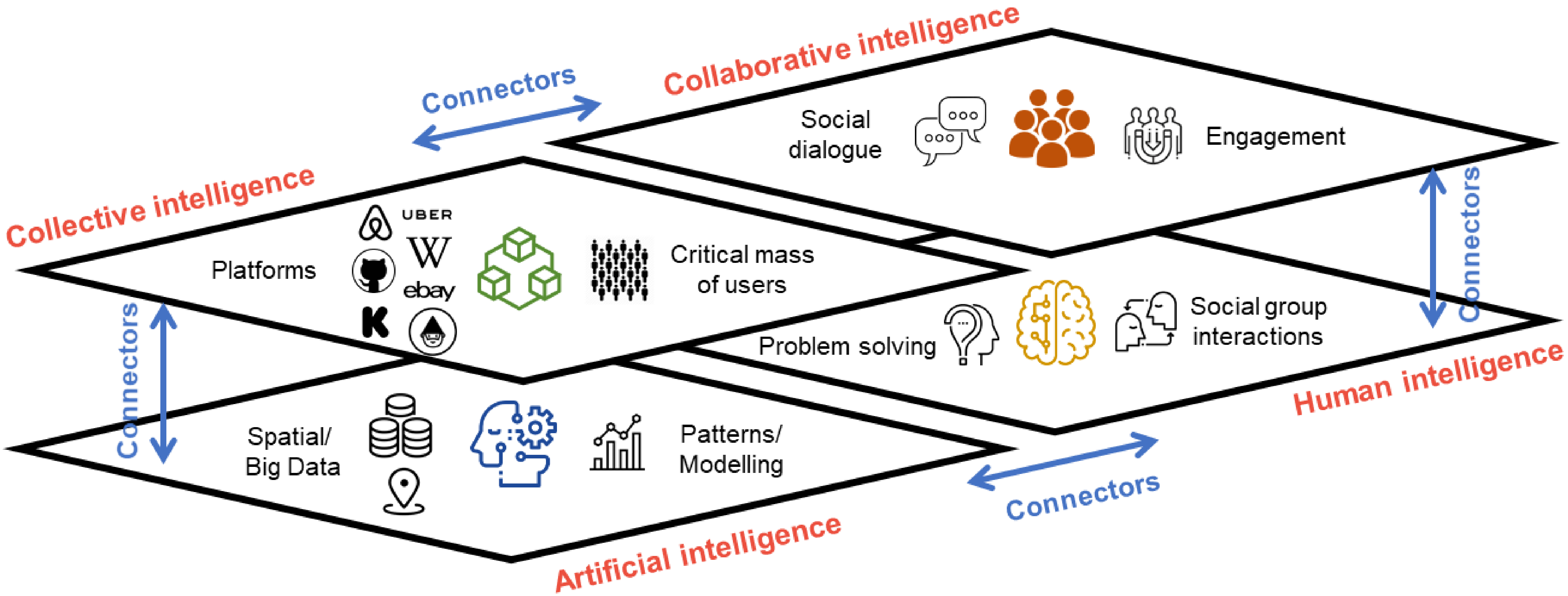


- **Digital platforms** enable any city ecosystem to evolve to **platform-ecosystem or smart ecosystem**
- DP are technological building blocks (that can be technologies, products, or e-services) that act as a foundation **on top of which a group of interdependent actors** (called complementors), develop inter-related products, technologies and services.
- DP create collaborative **business models** that allow multiple participants (producers, consumers) to connect, interact with each other, create and exchange value, create ecosystems.



A growing literature about cities, platforms and ecosystems

The effectiveness of smart ecosystems comes from networking capabilities: **Connecting different types of intelligence**

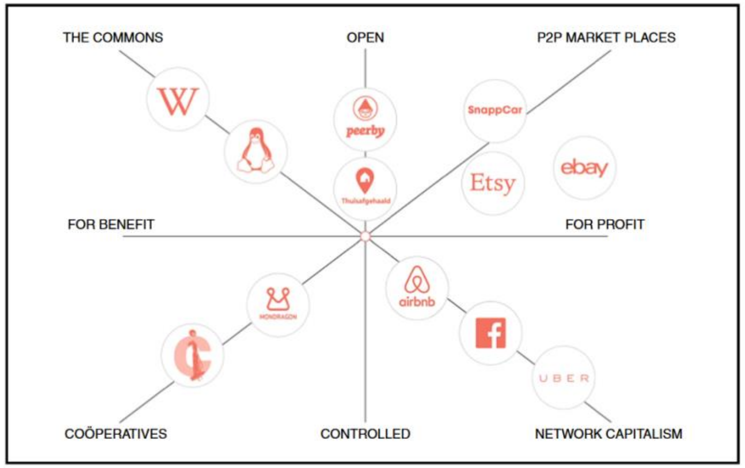


Find optimal connectivity in different settings and ecosystems

Komninos, N. & Panori, A. (2019)

Networking of capabilities enable **innovation in behaviour routines**

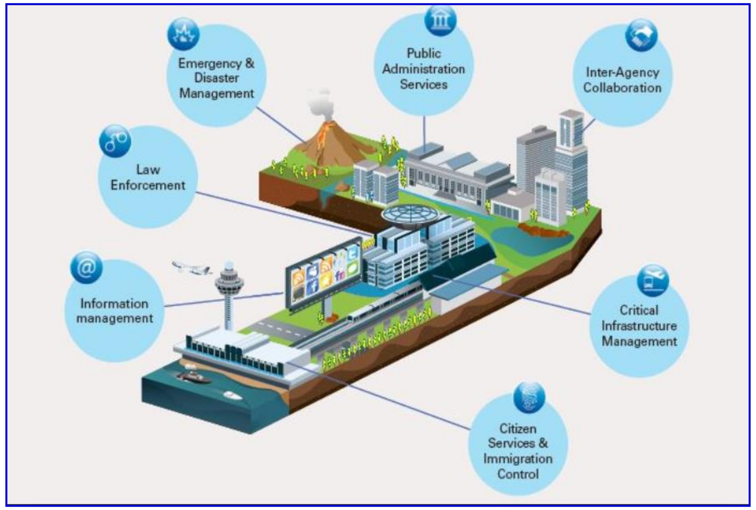
SHARING
and disruptive innovation



Πηγή: Oskam, J., & Boswijk, A. (2016)

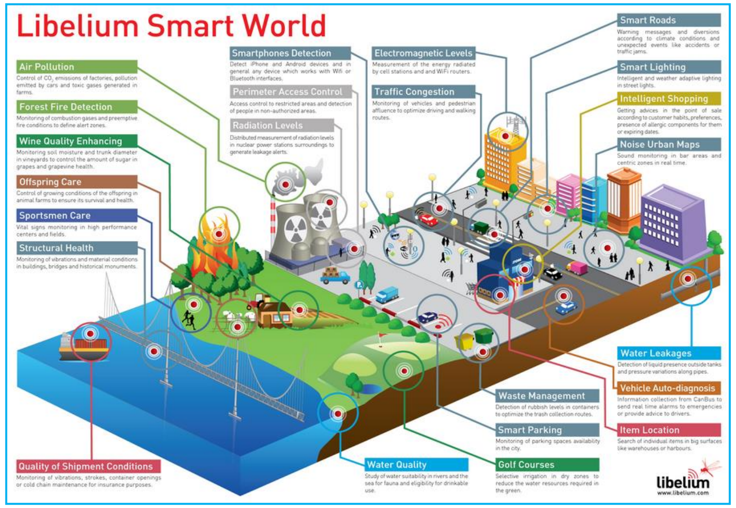
- **Sharing economy: New growth models**
- Prosumer behaviour
- Business growth platforms
- P2P / demand driven production

ENGAGEMENT
and social innovation



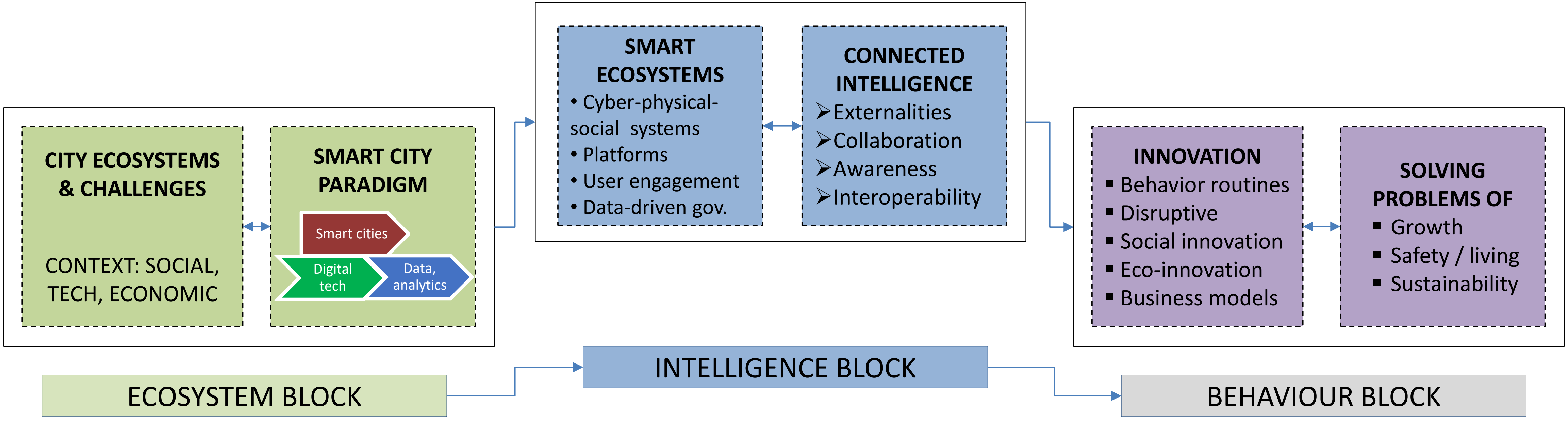
- **Social innovation and citizen engagement not-for-profit**
- Motivation of behaviour for participation and change
- Collective / engagement-based safety systems in cities

AWARENESS
innovation for sustainability



- **Sensor networks, real-time alert**
- Behaviour adaptation to environmental conditions
- Awareness and solutions against pollution, CO2 emissions, climate change, in favour of saving energy and resources

Transformation of cities under the smart city paradigm



Area-based ecosystems	• City centre • Marketplaces • Housing districts • Public space / recreation • Natural ecosystems • Hub (port / rail / bus)	**Vertical ecosystems**	• Manufacturing • Food production • Education • Tourism, hospitality • Culture and branding • Safety • Government	**Network-based ecosystems,**	• Transportation • Energy • Water • Waste • Telecom, broadband • Recycling • Environment

Question: How to invent solutions for radical change in all ecosystems of cities?

Thank you!