



Mastère CréaCity



Cours « Smart City »

Introduction

Professeur Isam Shahrour

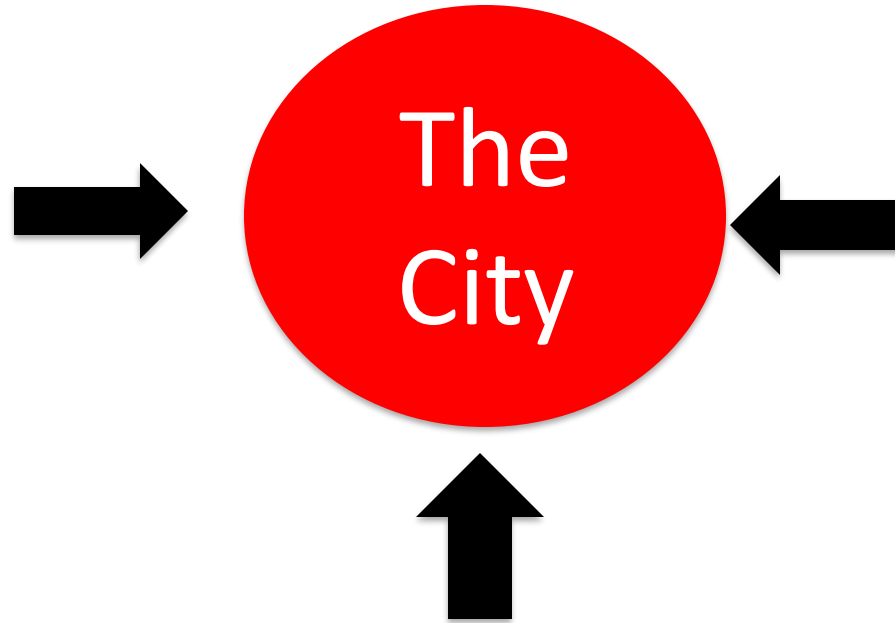
Laboratoire de Génie Civil et géo-Environnement

www.ishahrour.com

La ville s'effondre sous des pressions croissantes...

Built-Environment

- Aging
- Lack
- Adaptation to new challenges



Social and Economic

- Population growth
- Aging
- Poverty
- Unemployment
- Governance

Environment

- Congestion
- Climate change
- Flood, storms, fire
- Pollution

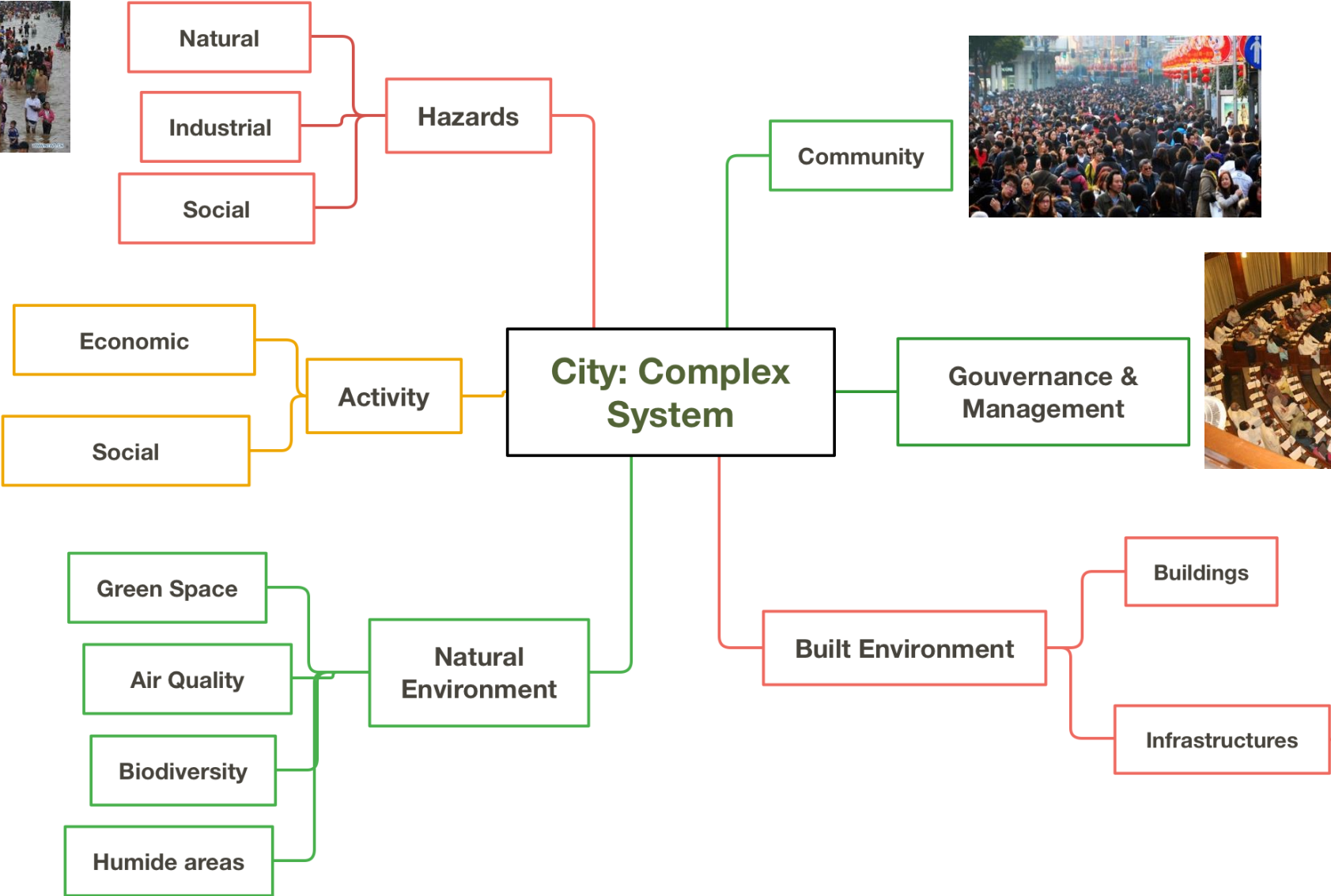
Hazards

- Natural
- Industrial
- Social

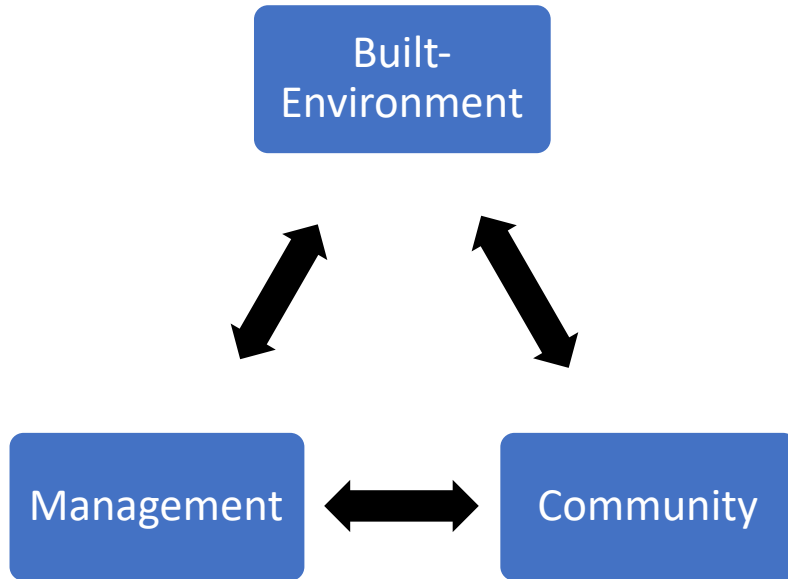
Congestion, pollution, déficit de services



La ville: Système très complexe



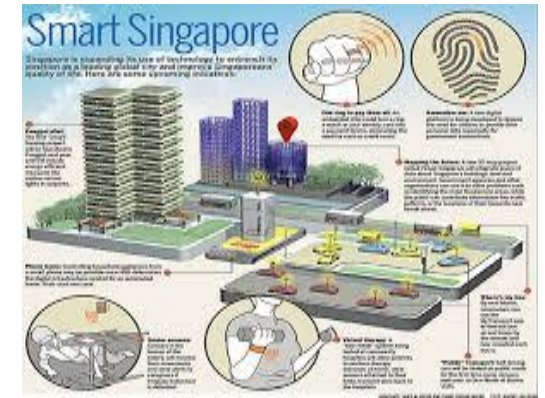
Nous avons besoin d'une innovation de rupture pour nos villes



Comment la solution Smart City pourrait-elle aider?



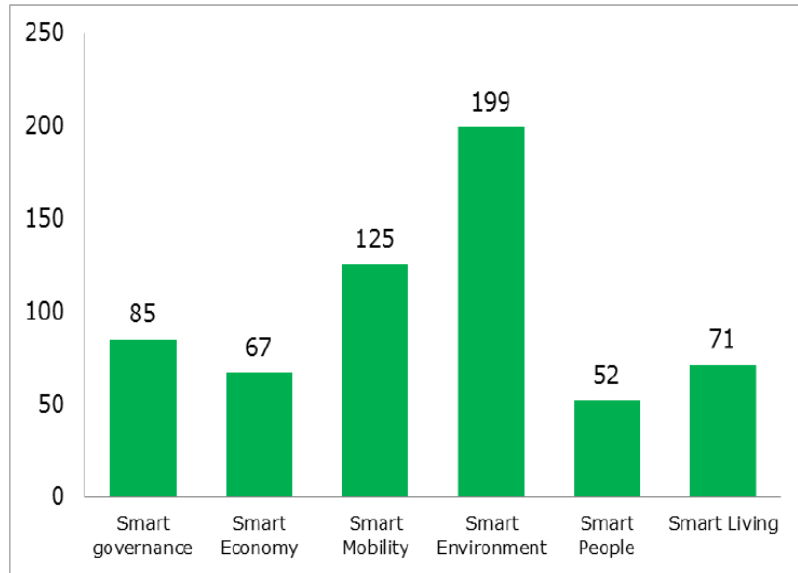
Large intérêt pour la Smart City



Europe

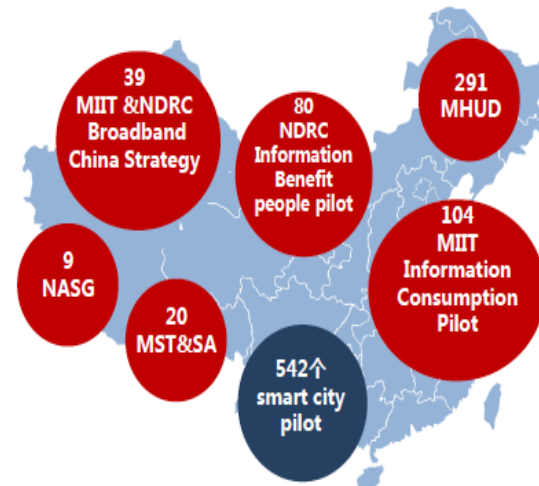


The number of Smart Cities in the EU presenting the six Smart City characteristics



China

The total pilot status of smart city in china



India

100 projects



REDESIGN

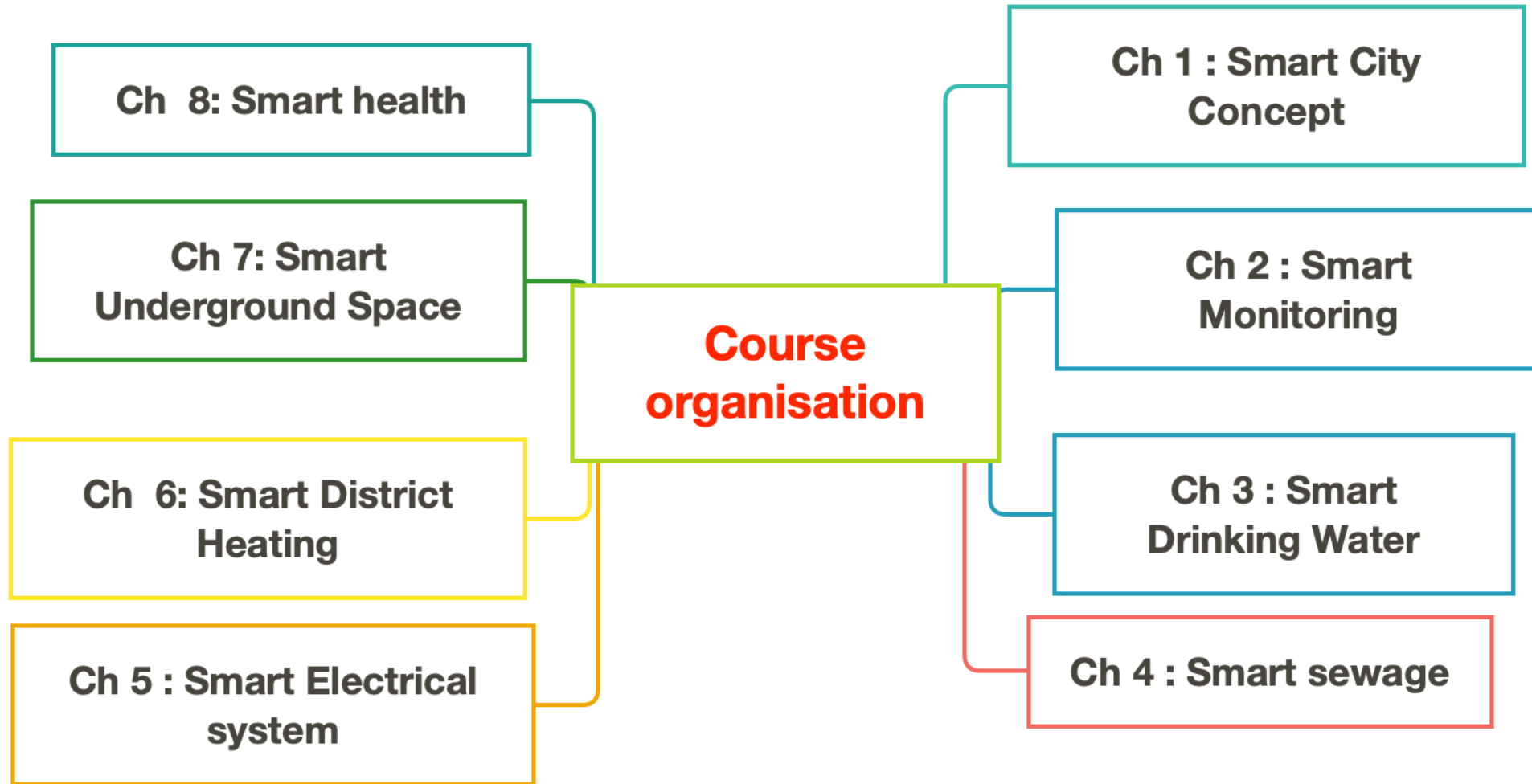
African countries want to turn their poor, overcrowded urban centers into "smart cities"

<https://qz.com/998970/kigali-vision-city-and-lagos-eko-atlantic-are-among-several-smart-city-initiatives-taking-off-in-africa/>

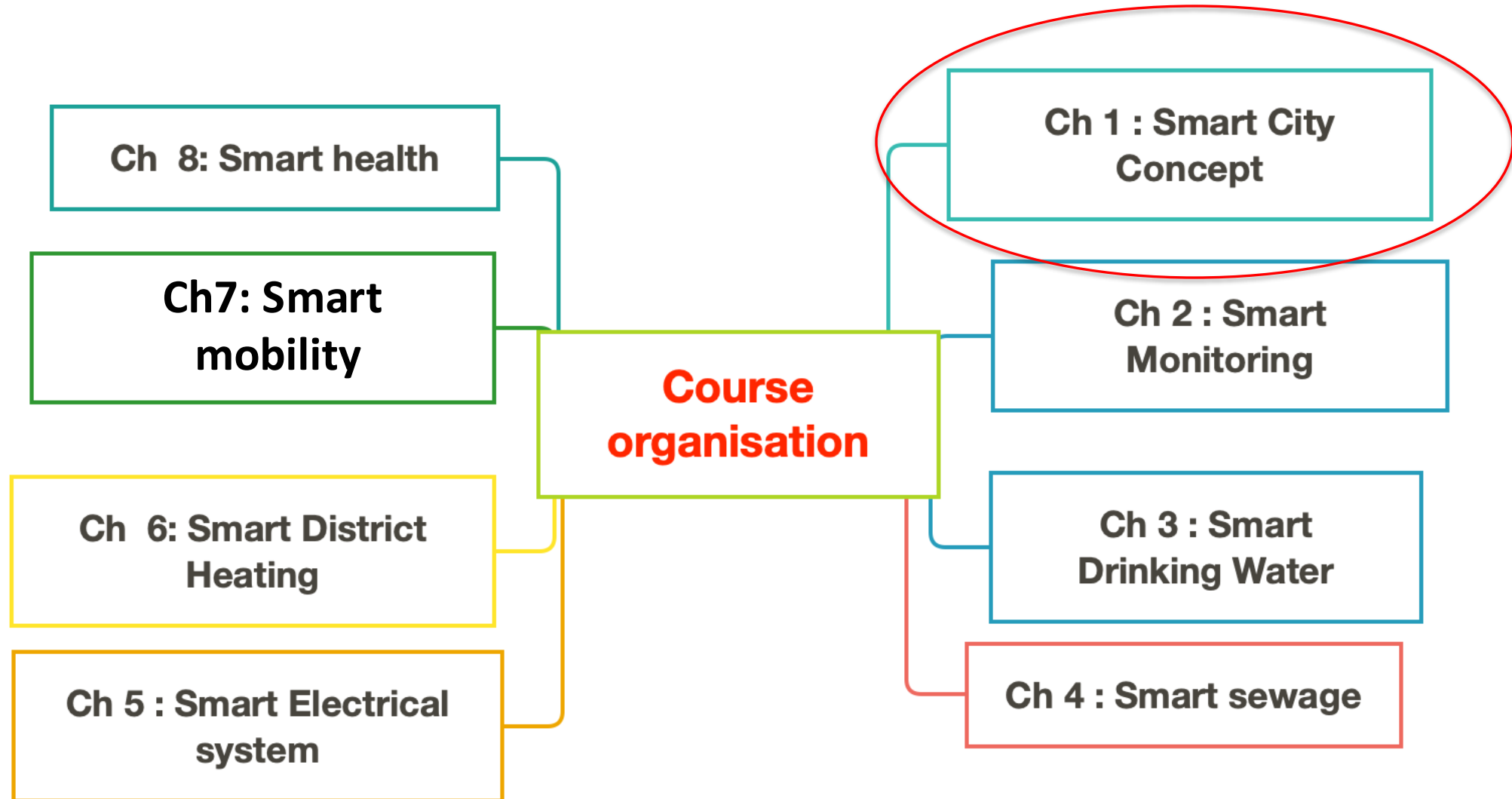
Objectif du cours:

- Comprendre ce concept et ses applications dans de nombreux domaines
- Comprendre son déploiement
- Essayer de l'appliquer à travers un projet innovant

Organisation de cours



Course organisation





Mastère CréaCity 2020 - 2021

Cours « Smart City »

Ch1: Concept Smart City

Professeur Isam Shahrour



Smart



- **Solution**
- Intelligence (Inspired from human)
- Eco- and socio- friendly (focus on human)

City



- What ?
- Why ?
- **Challenges ?**

3 Questions

Q1 : The Smart City Concept?

Q2: Smart City implementation ?

Q3: Smart City indicators

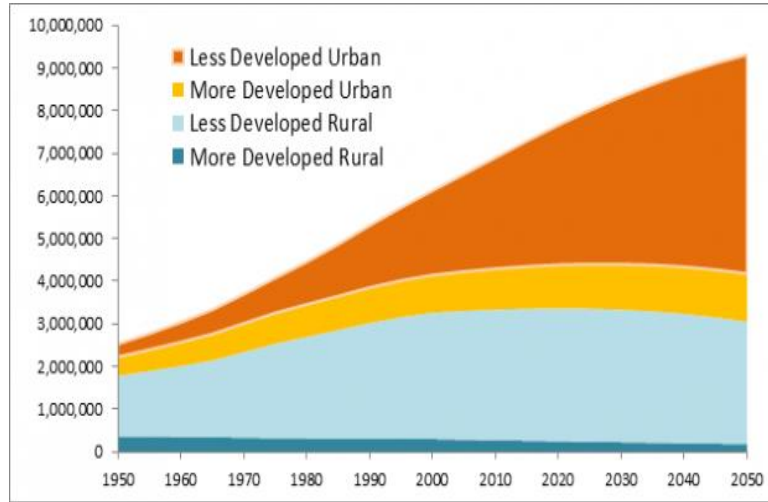
3 Questions

Q1 : The Smart City Concept?

Q2: Smart City implementation ?

Q3: Smart City indicators

Major challenges related to the city (physical, management, services,...)



1 Over **BILLION** people globally experience disability

1 in **7** people



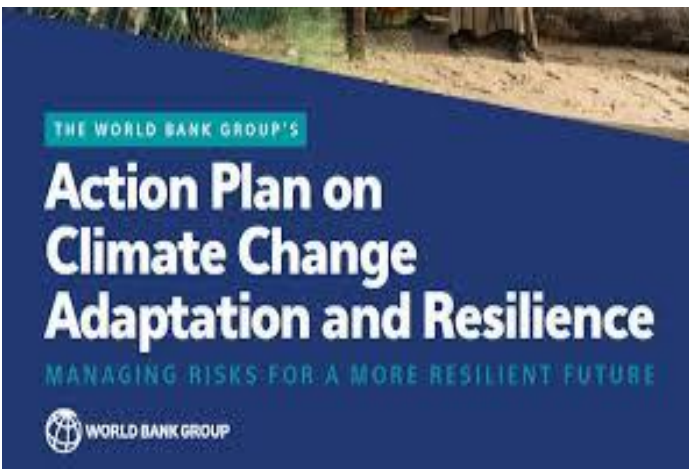
People with disabilities have the same health care needs as others

But they are:

2x more likely to find **inadequate** health care providers' skills and facilities

3x more likely to be **denied** health care

4x more likely to be treated **badly** in the health care system



AMERICA'S G.P.A. **D+** ESTIMATED INVESTMENT NEEDED BY 2020: **\$3.6** TRILLION

INFRASTRUCTURE GRADES FOR 2013

ENERGY	D+	SCHOOLS	D	PUBLIC PARKS & RECREATION	C-
TRANSIT	D	ROADS	D	RAIL	C+
PORTS	C	INLAND WATERWAYS	D-	BRIDGES	C+
AVIATION	D	WASTEWATER	D	SOLID WASTE	D
LEVEES	D-	HAZARDOUS WASTE	D	DRINKING WATER	D
DAMS	D				

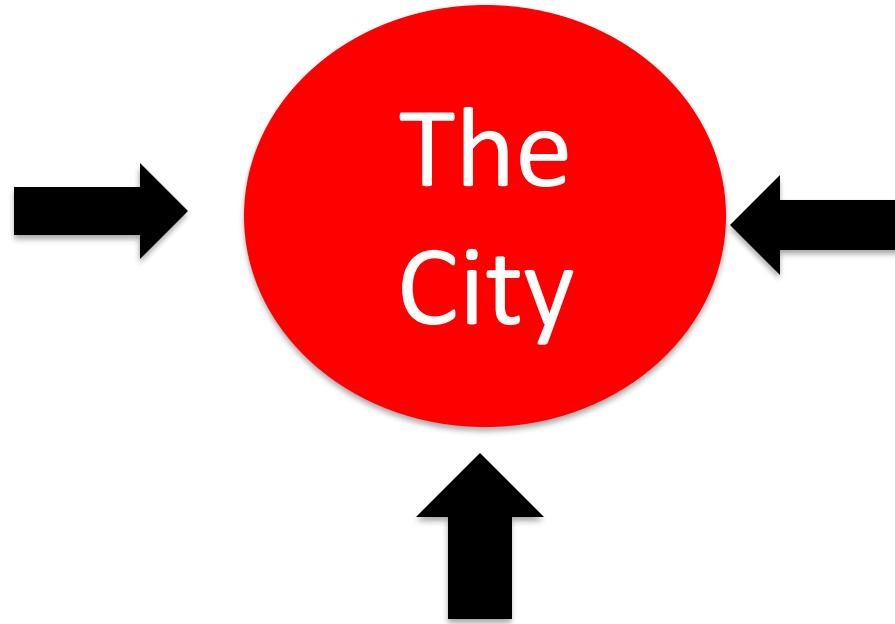
A: EXCEPTIONAL, B: GOOD, C: MEDIOCRE, D: POOR, F: FALLING
Each category was evaluated on the basis of capacity, condition, funding, future need, operation and maintenance, public safety, resilience, and innovation



City under increasing pressure ...

Built-Environment

- Aging
- Lack
- Adaptation to new challenges



Social and Economic

- Population growth
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- Unemployment
- Governance

Environment

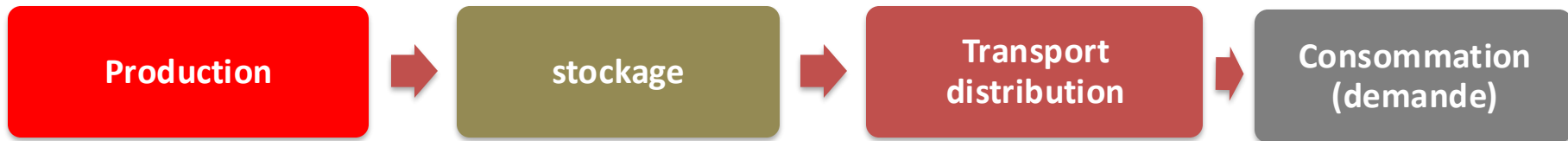
- Congestion
- Climate change
- Pollution

Hazards

- Natural
- Industrial
- Social

Défis de la ville : Adaptation à de nouveaux modèles

Exemple : Système électrique



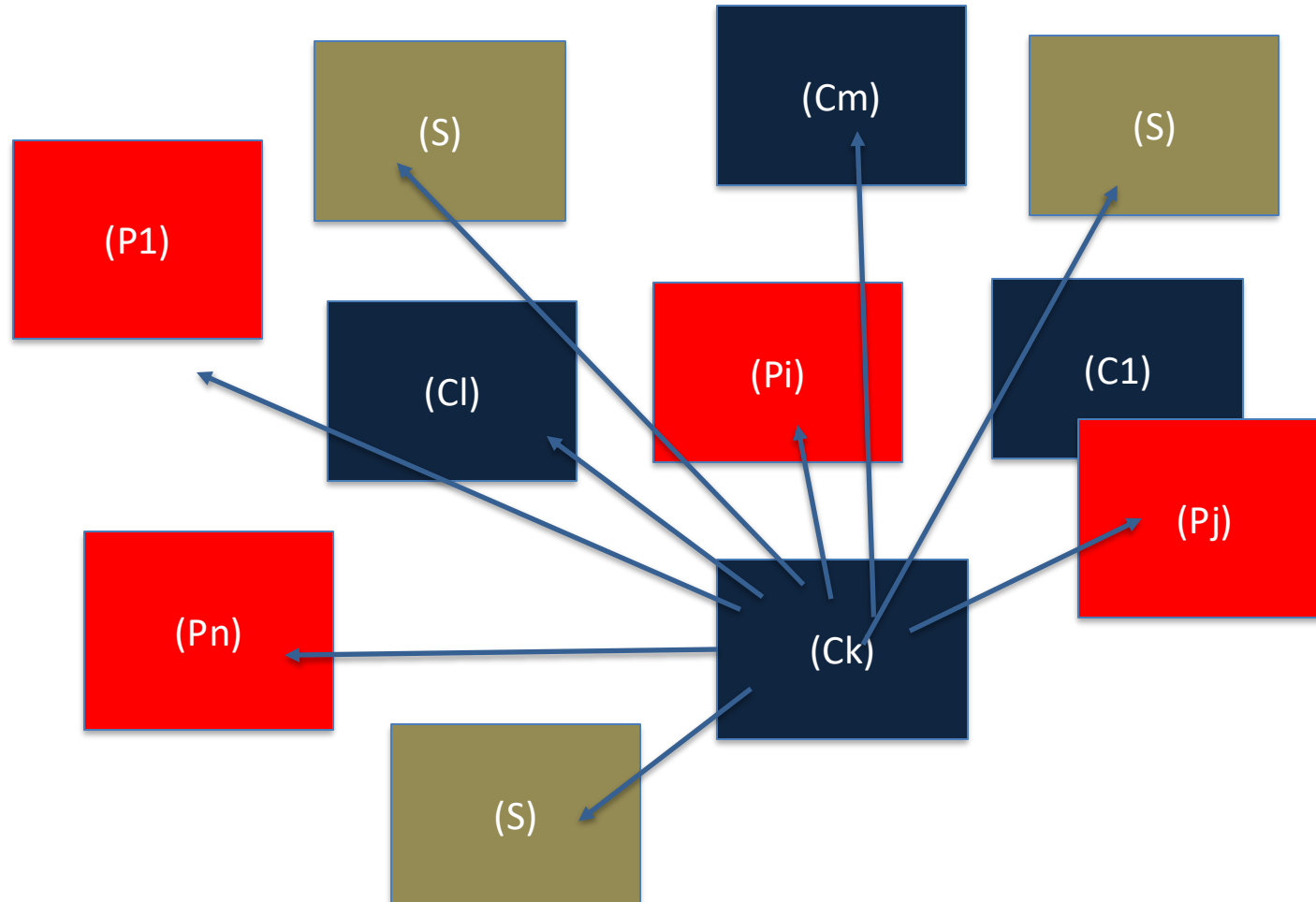
- Des infrastructures géantes
- Améliorer les performances de chaque phase

Systemes modernes

Consommation

Production

Stockage

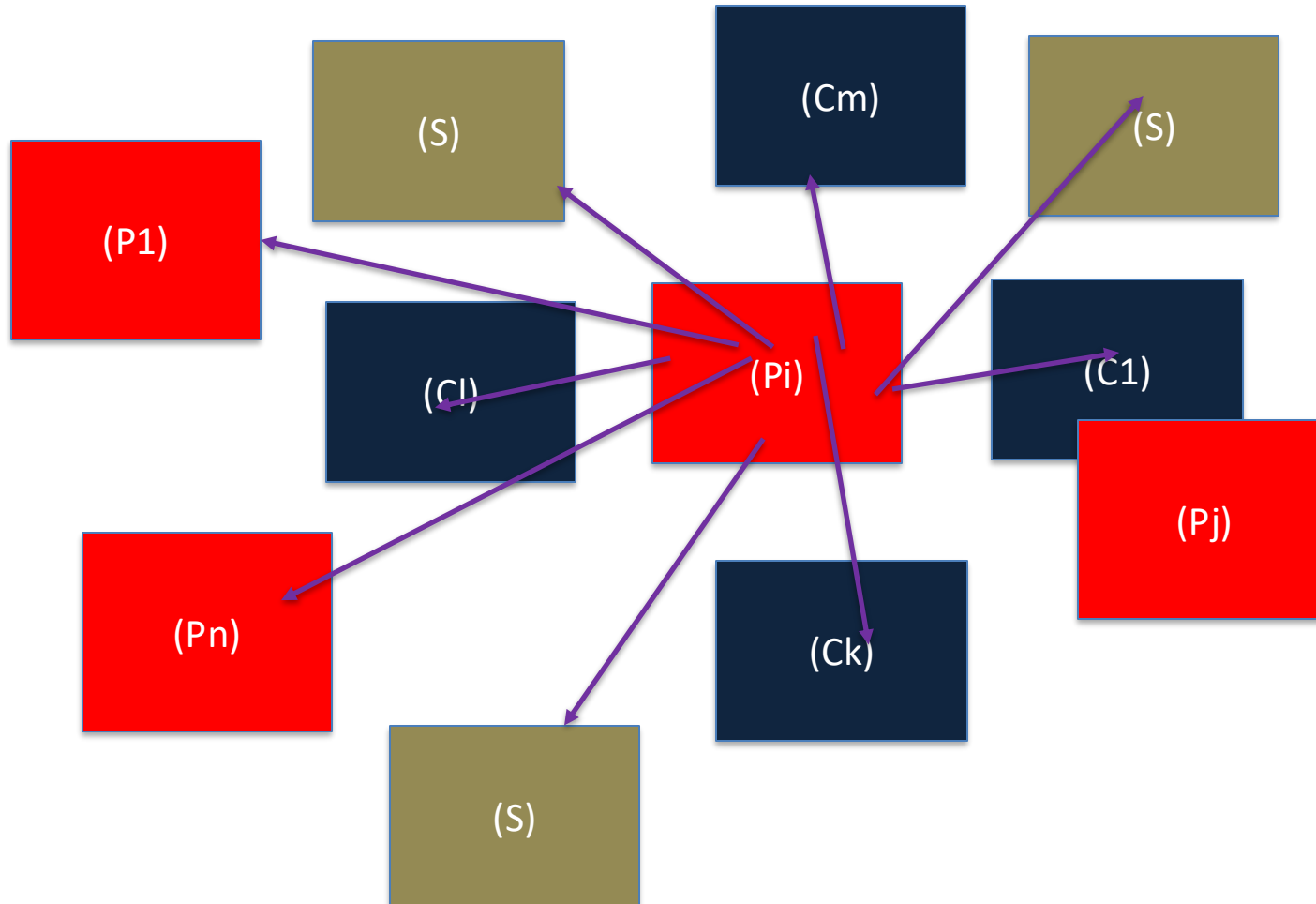


Systemes modernes

Consommation

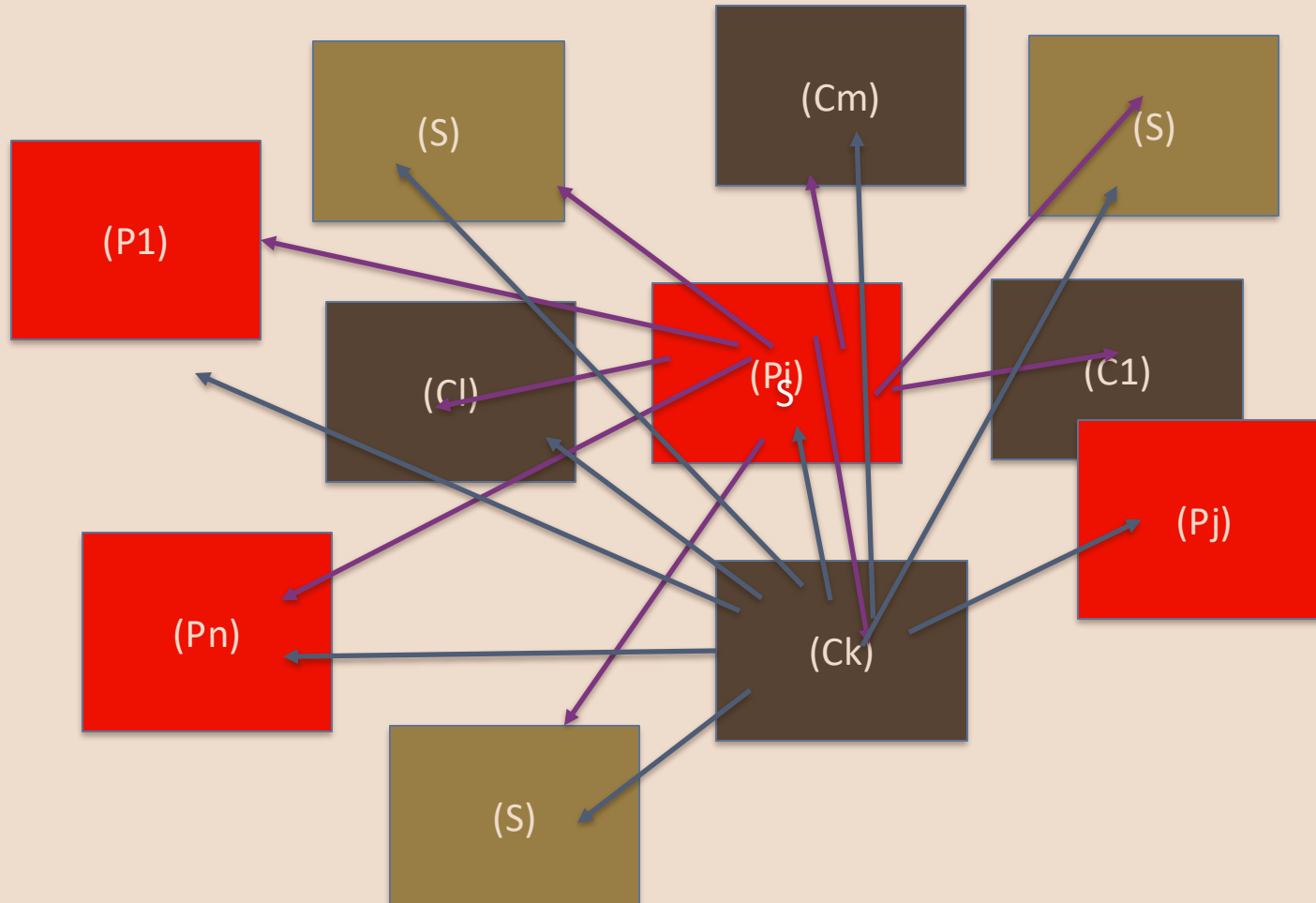
Production

Stockage



Systemes modernes

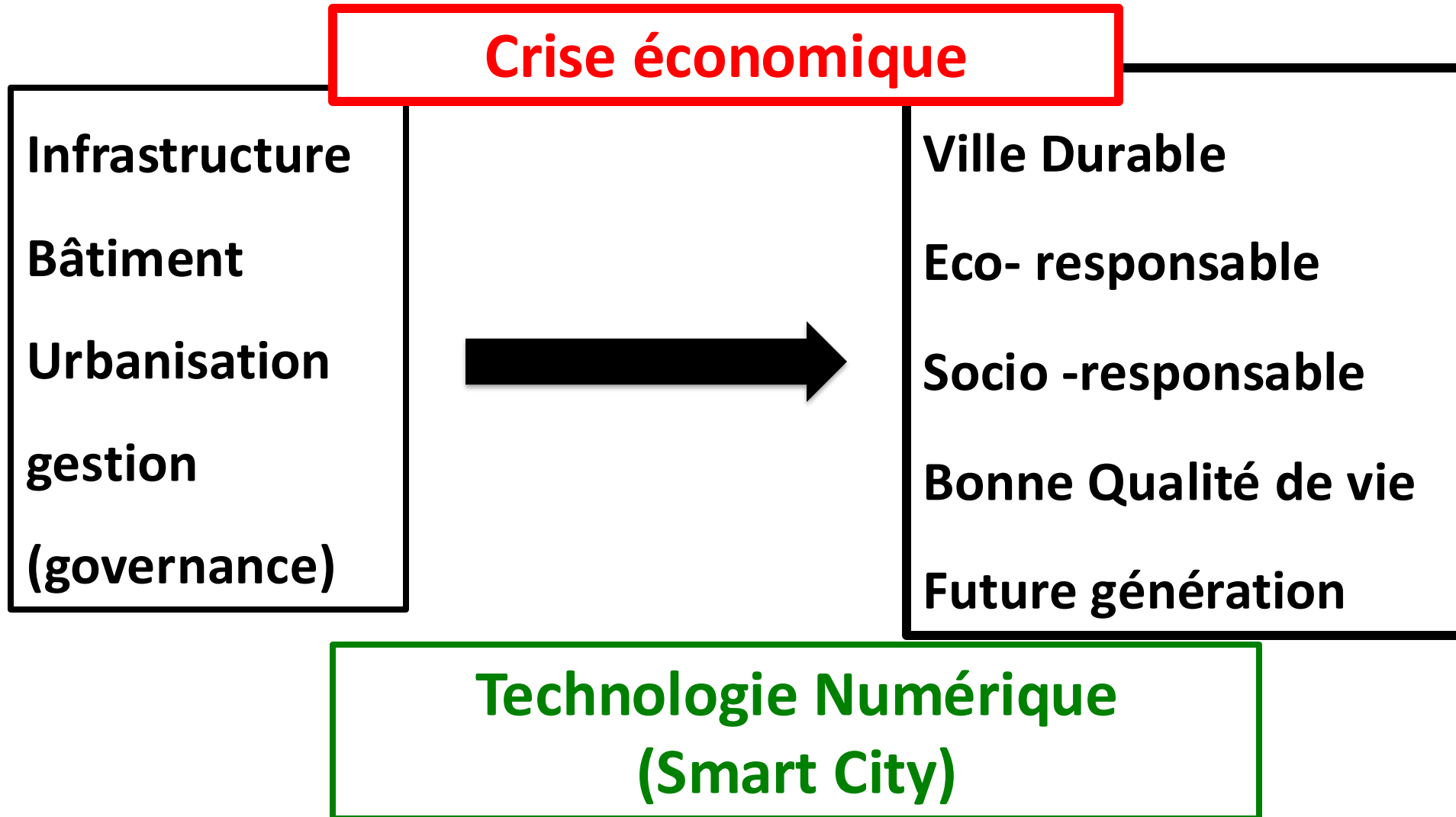
Systeme global de communication et de gestion de donnees



Défis de la ville



On doit transformer notre ville



Crise économique

Infrastructure

Bâtiment

Urbanisation

gestion

(governance)

Ville Durable

Eco- responsable

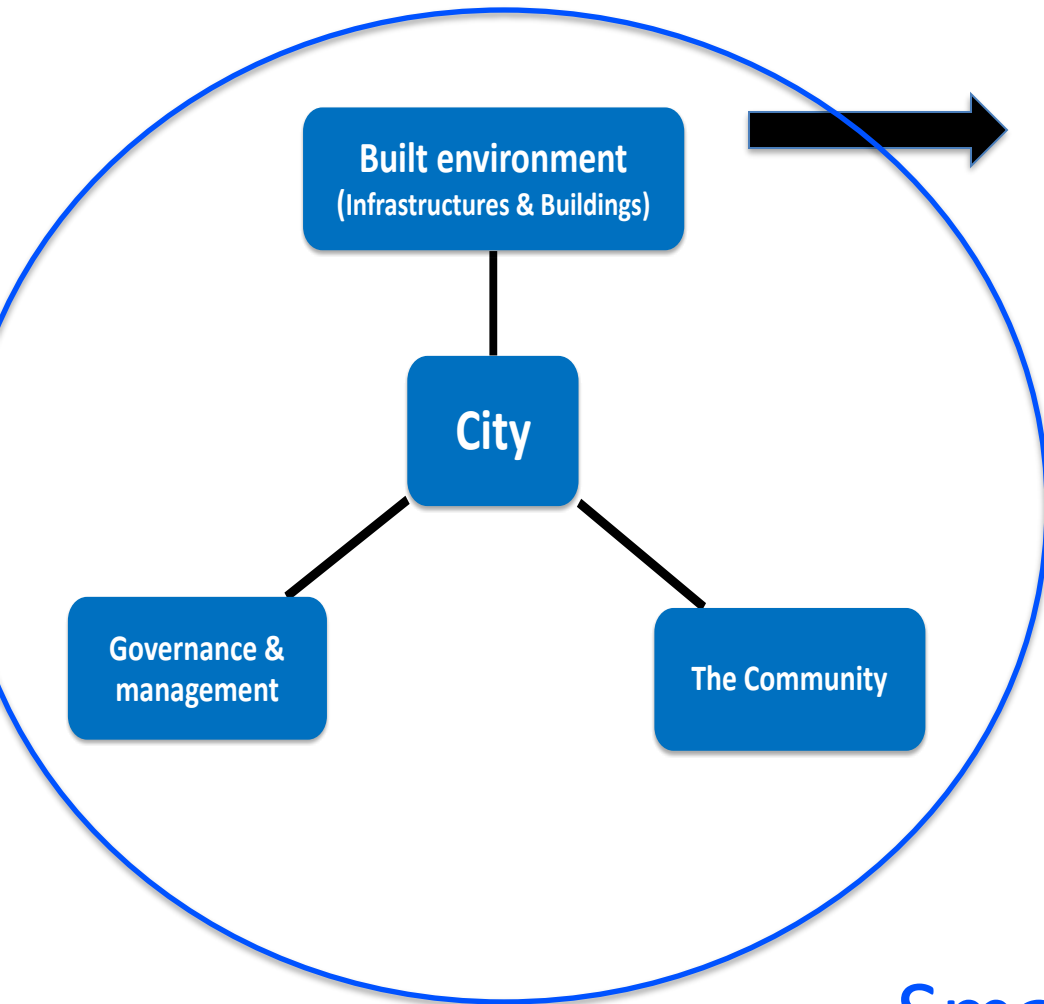
Socio -responsable

Bonne Qualité de vie

Future génération

Technologie Numérique
(Smart City)

Solution strategies



1) Renovation/update of infrastructures

- Takes long time
- Requires huge investment

2) Smart City solution

- Could be implemented rapidly
- Lower cost
- More efficient

Smart Solution: Do more with less

Smart Grid – NEMA Report (2011)

NEMA : Association of electrical and medical imaging equipment manufacturers (US)

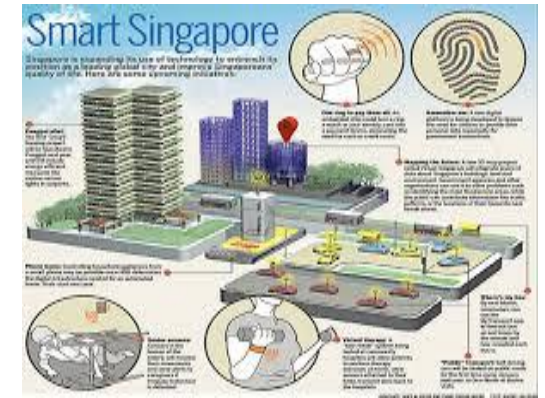
Smart Grid
Building on The Grid

2
volume

Smart Grid is the solution we desperately need to solve many global energy problems. Like the printing press, automobile, and light bulb before it, Smart Grid will change the course of human history. It is changing the way we think about and interact with our electrical system.



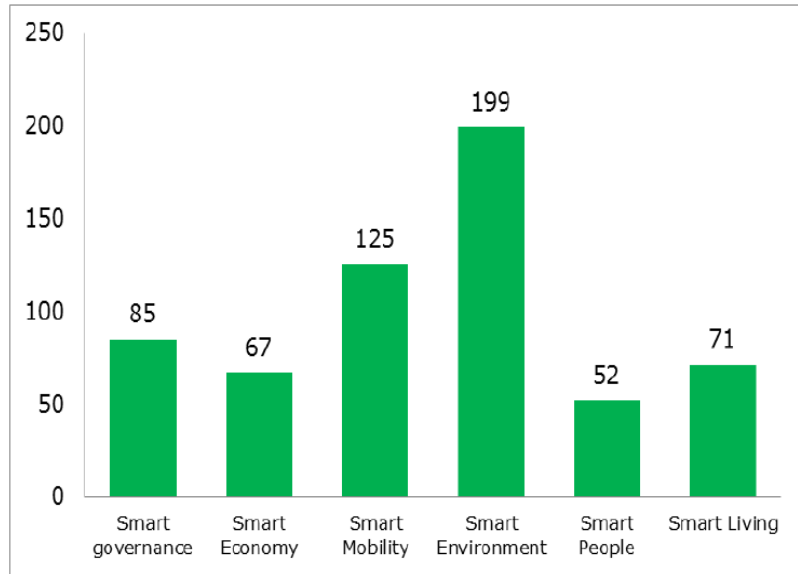
Smart City Concern



Europe

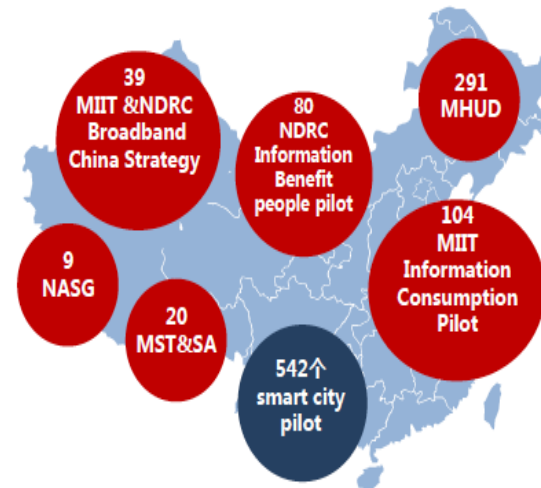


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100 projects

MODI'S 'SMART' VISION TAKES SHAPE

The urban development ministry has identified almost all the places where the NDA's 100 smart cities will come up

INTELLIGENT TRANSPORT

- Smart cards facilitate travel in multiple modes of public transport.
- Real-time transport displays can provide visibility and interaction on availability of public transport as well as the condition of traffic on routes.
- Smart cities have an integrated transit corridor, where Bus Rapid Transit corridors as well as suburban train networks are linked with pedestrian and cycle lanes. Furthermore, there are plans to carry people directly from point to point, with no stop at intervening stations.
- Digital parking meters send information to mobile phones when a space opens up.

SMART CITIES

WHAT THEY ARE AND HOW THEY WILL HELP

- Smart cities, in the most basic terms, are urban settlements that exploit technology to offer more structured and hospitable living conditions for residents.
- Information and Communication Technology (ICT) forms the backbone of smart cities and is the main tool to address common problems like congestion and waste of energy.
- Smart cities have a centralised control system which provides real-time inputs on availability of water, electricity, public transport, healthcare and education.
- Intelligent communication tools enable administrators to manage and respond to errors.
- Consumption of scarce resources like water and energy is streamlined through the use of technology.
- Better energy management systems help people automate energy-consuming systems in buildings.
- There is emphasis on the use of renewable sources of energy.

Seven smart cities each will be built in Rajasthan, Gujarat, Karnataka and Kerala.

Some smart cities are being developed by state with foreign assistance as part of the two-lane economic corridor (EMAC) work has already begun.

THE PRIME MINISTER'S DREAM PROJECT

The Narendra Modi government plans to build 100 smart cities across India and made an allocation of ₹700 crore to this end in the Budget 2014-15.

Cities such as Delhi, Hyderabad, Surat, Chandigarh, Bangalore, Mangalore, Jamshedpur, Mumbai and Chennai have launched initiatives for development of advanced communication systems, Metro networks, traffic management frameworks, smart meters, GPS for solid waste management, online water quality monitoring, online building plan approval schemes, etc.

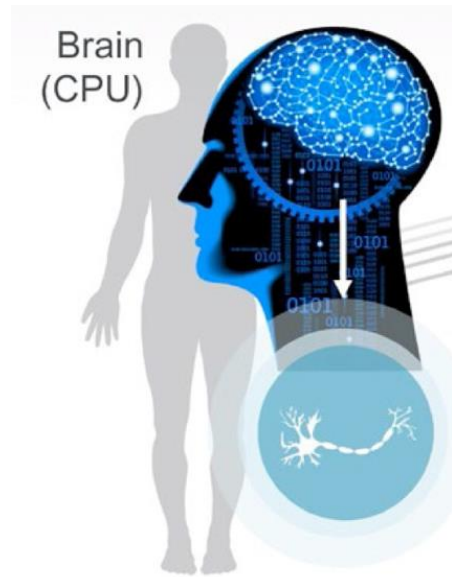


REDESIGN

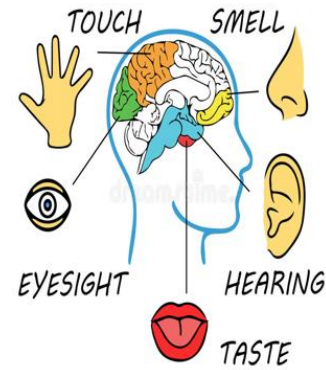
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Human Intelligence



Sensing



Cognitive

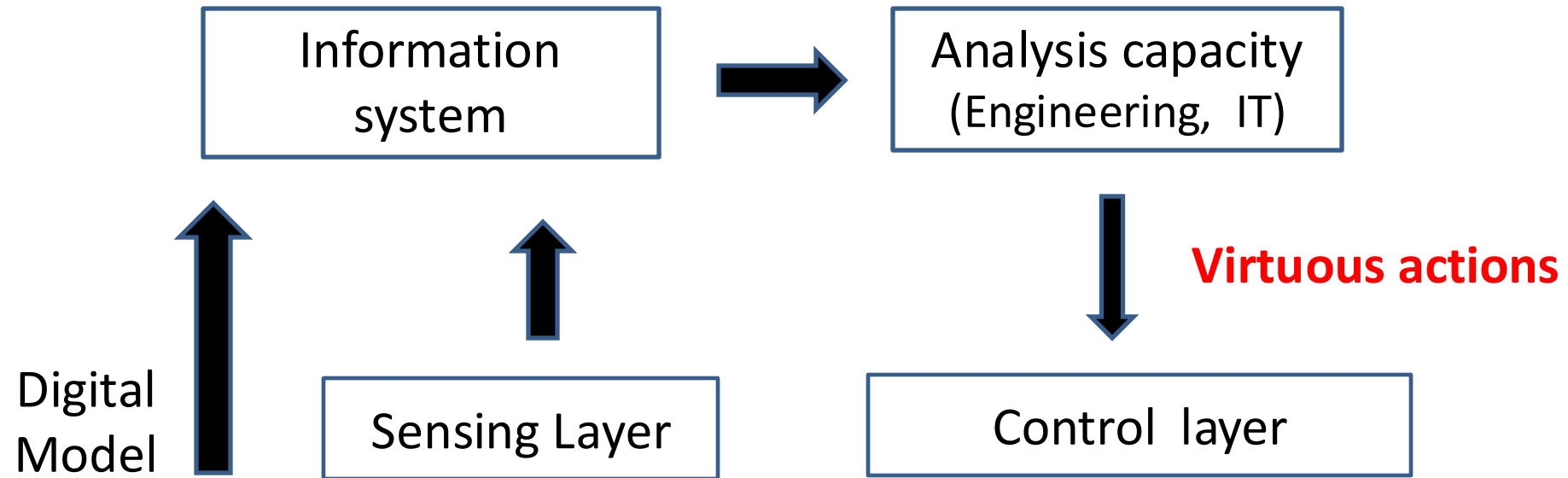


Actions



Experience (learning Capacity)

Intelligent system



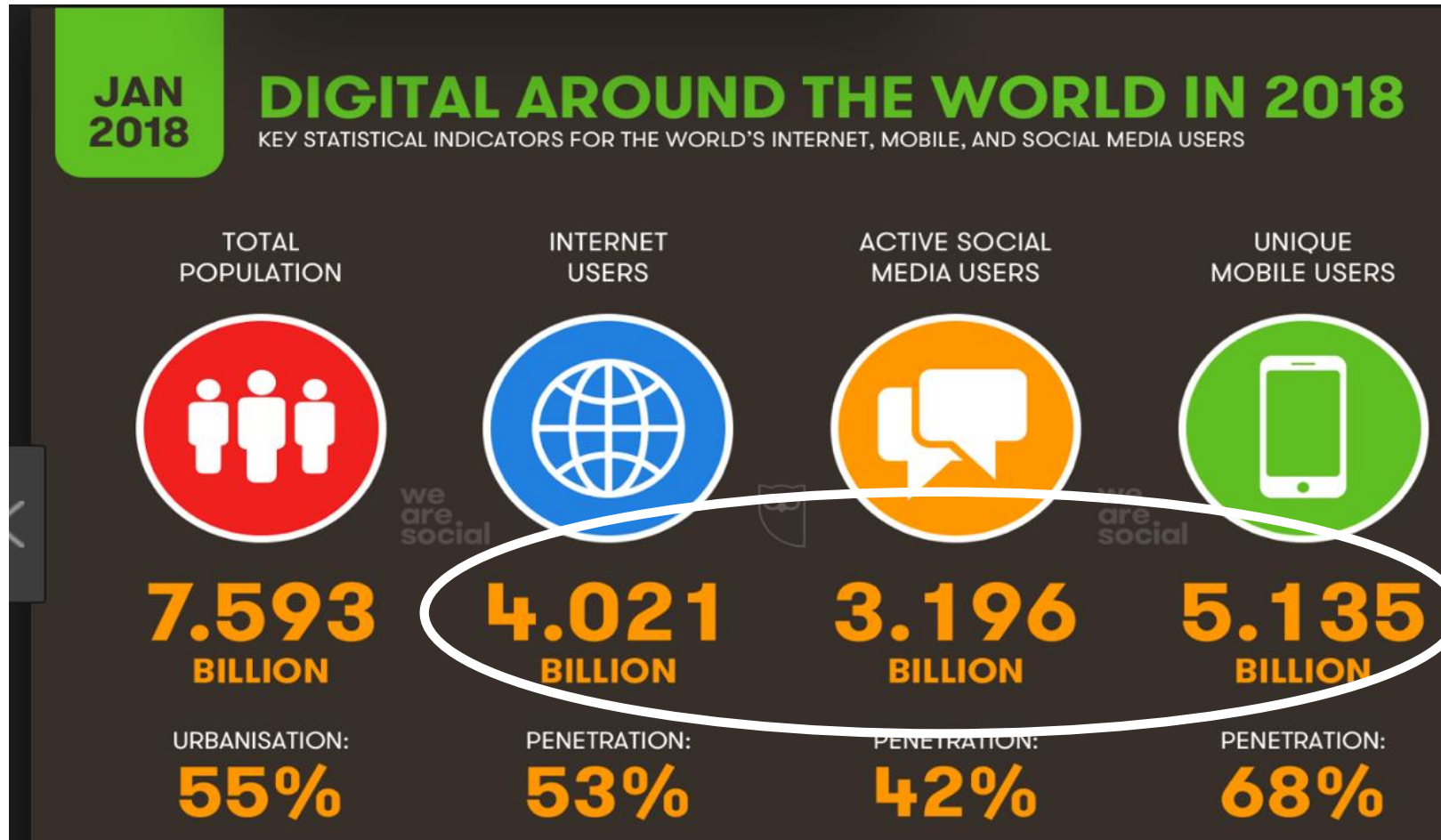
Role of the digital technology

Digital Technology: connect people and things



- Geo-Localized
- Connected (IoT Network)
- Storage and Analysis capacity
- Operate actions

Digital Technology: connect people and things



Smartphone: high sensing capacity

How Many Sensors are in a Smartphone?



- Light
- Proximity
- 2 cameras
- 3 microphones (ultrasound)
- Touch
- Position
 - GPS
 - WiFi (fingerprint)
 - Cellular (tri-lateration)
 - NFC, Bluetooth (beacons)
- Accelerometer
- Magnetometer
- Gyroscope
- Pressure
- Temperature
- Humidity

19

Smartphones used as urban sensors

Available online at www.sciencedirect.com

  **ScienceDirect** **2017** **Procedia Engineering**

Procedia Engineering 199 (2017) 966–971
www.elsevier.com/locate/procedia

X International Conference on Structural Dynamics, EURODYN 2017

Smartphone data streams for bridge health monitoring

Thomas Matarazzo^{a*}, Mohammad Vazifeh^a, Shamim Pakzad^b, Paolo Santi^{a,c}, and Carlo Ratti^a

^a*Senseable City Lab, Massachusetts Institute of Technology, 77 Massachusetts Ave., Cambridge, MA 02139 USA*
^b*Department of Civil and Environmental Engineering, Lehigh University, 117 ATLSS Dr., Bethlehem, PA 18015 USA*
^c*Istituto di Informatica e Telematica del CNR, Via G. Moruzzi 1, 56124 Pisa, ITALY*

JOURNAL OF COMMUNICATIONS SOFTWARE AND SYSTEMS, VOL. 13, NO. 2, JUNE 2017 53

2017

Crowd-sensing our Smart Cities: a Platform for Noise Monitoring and Acoustic Urban Planning

Marco Zappatore, *Member, IEEE*, Antonella Longo, *Member, IEEE*, and Mario A. Bochicchio

Original scientific paper

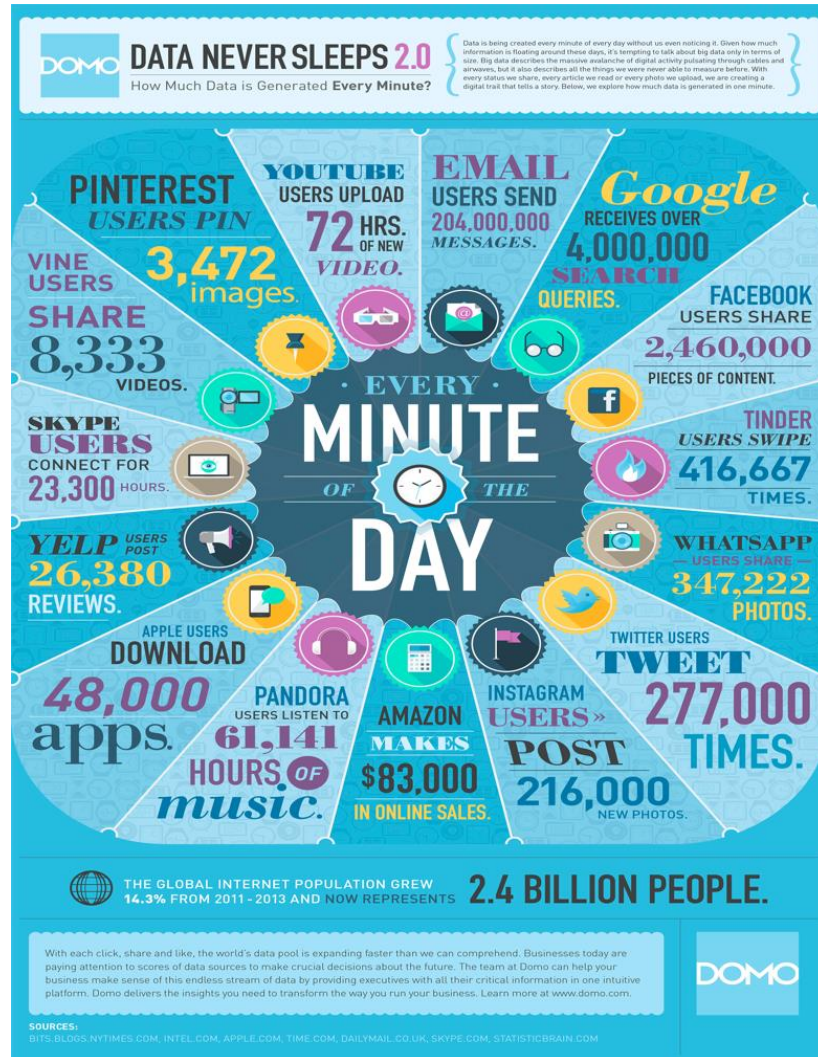
Sensors in your smartphone could make roads greener

September 14, 2017 by Helen Massy-Beresford, From Horizon Magazine, Horizon: The EU Research & Innovation Magazine



2017

Social Media: Semantic analysis



Geo-localized content



Semantic analysis

Useful anonymous information for the City management (emotional data included)

Recent papers: Social media & semantic analysis in urban studies

Semantic Analysis of Social Media

Timothy Baldwin **2014**



FACULDADE DE ENGENHARIA DA UNIVERSIDADE DO PORTO

2017

Social Media Text Processing and Semantic Analysis for Smart Cities

João Filipe Figueiredo Pereira

Developing Smart Cities Services through Semantic Analysis of Social Streams

2015

Cataldo Musto, Giovanni Semeraro, Marco de Gemmis, Pasquale Lops
Department of Computer Science - University of Bari Aldo Moro, Italy
{name.surname}@uniba.it

Int'l Conf. Internet Computing and Internet of Things | ICOMP'16 |

2016 ⁵⁵

Sentiment Analysis for Smart Cities: State of the Art and Opportunities

Kaoutar Ben Ahmed¹, Atanas Radenski², Mohammed Bouhorma¹, Mohamed Ben Ahmed¹
¹Abdelmalek Essaâdi University, Tangiers, Morocco
²Chapman University, Orange, CA 92866, USA

Video surveillance used as urban sensors



World : 350 millions (2016)
London : 500, 000 CCTV Cameras
China : 170 million CCTV cameras



- Real-time
- High sensing capacity (AI)

High capacity in data analysis and learning



Recent papers: Artificial Intelligence in urban studies

2014

Sci.Int.(Lahore),26(4),1495-1502,2014 ISSN 1013-5316; CODEN: SINTE 8

ARTIFICIAL INTELLIGENCE BASED TECHNIQUES FOR EARTHQUAKE PREDICTION: A REVIEW

Faisal Azam, Muhammad Sharif, Musarat Yasmin, Sajjad Mohsin
Department of Computer Science, COMSATS Institute of Information Technology, Islamabad, Pakistan
faisal@ciitwah.edu.pk, muhammadsharifmalik@yahoo.com, mussaratabdullah@yahoo.com,

Artificial Intelligence for Citizen Services and Government

2017



Hila Mehr
Harvard Ash Center Technology & Democracy Fellow

.....
August 2017

COMPUTING

Can Artificial Intelligence Predict Earthquakes?



2017

The ability to forecast temblors would be a tectonic shift in seismology. But is it a pipe dream? A seismologist is conducting machine-learning experiments to find out

.....

<https://www.scientificamerican.com/article/can-artificial-intelligence-predict-earthquakes/>

Available online at www.sciencedirect.com

  **ScienceDirect** **2015** **Procedia Engineering**

ELSEVIER CrossMark Procedia Engineering 119 (2015) 43 – 52 www.elsevier.com/locate/procedia

13th International Conference on Computing and Control for the Water Industry, CCWI2015

Cloud based machine learning approaches for leakage assessment and management in smart water networks

S. R. Mounce^{a*}, C. Pedraza^b, T. Jackson^c, P. Linford^d, J. B. Boxall^a

Recent papers: Big Data in urban studies

A review on application of data mining techniques to combat natural disasters

2016

Saptarsi Goswami^a, Sanjay Chakraborty^{a,*}, Sanhita Ghosh^a, Amlan Chakrabarti^b, Basabi Chakraborty^c

The role of Big Data in explaining disaster resilience in supply chains for sustainability

2017

Thanos Papadopoulos^{a,*}, Angappa Gunasekaran^{b,1}, Rameshwar Dubey^{c,2}, Nezhir Altay^{d,3}, Stephen J. Childe^e, Samuel Fosso-Wamba^f

The Resilience to Emergencies and Disasters Index: Applying big data to benchmark and validate neighborhood resilience capacity

2018

Constantine E. Kontokosta^{*}, Awais Malik



BIG DATA FOR CLIMATE CHANGE AND DISASTER RESILIENCE:

REALISING THE BENEFITS FOR DEVELOPING COUNTRIES

2015

Digital technology in the City

1) City Digital Model (2D, 3D, Semantic)



GIS, BIM, Civil 3D
Photogrammetry,
CityGML

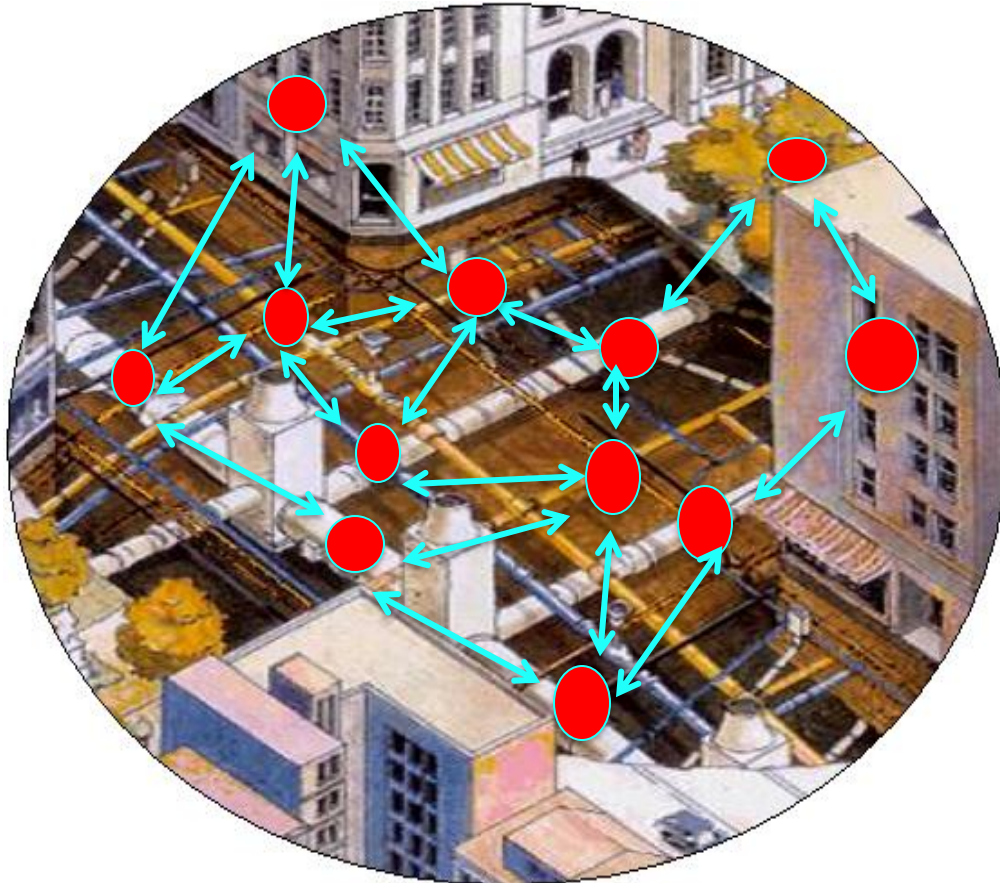


Digital model of the city

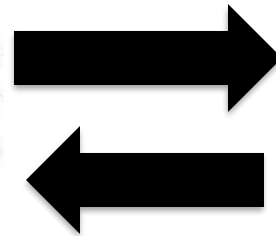
- Geo-reference
- Attributes
- Semantic

Digital technology in the City

2) Monitoring & control



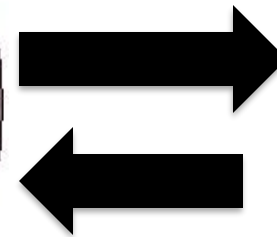
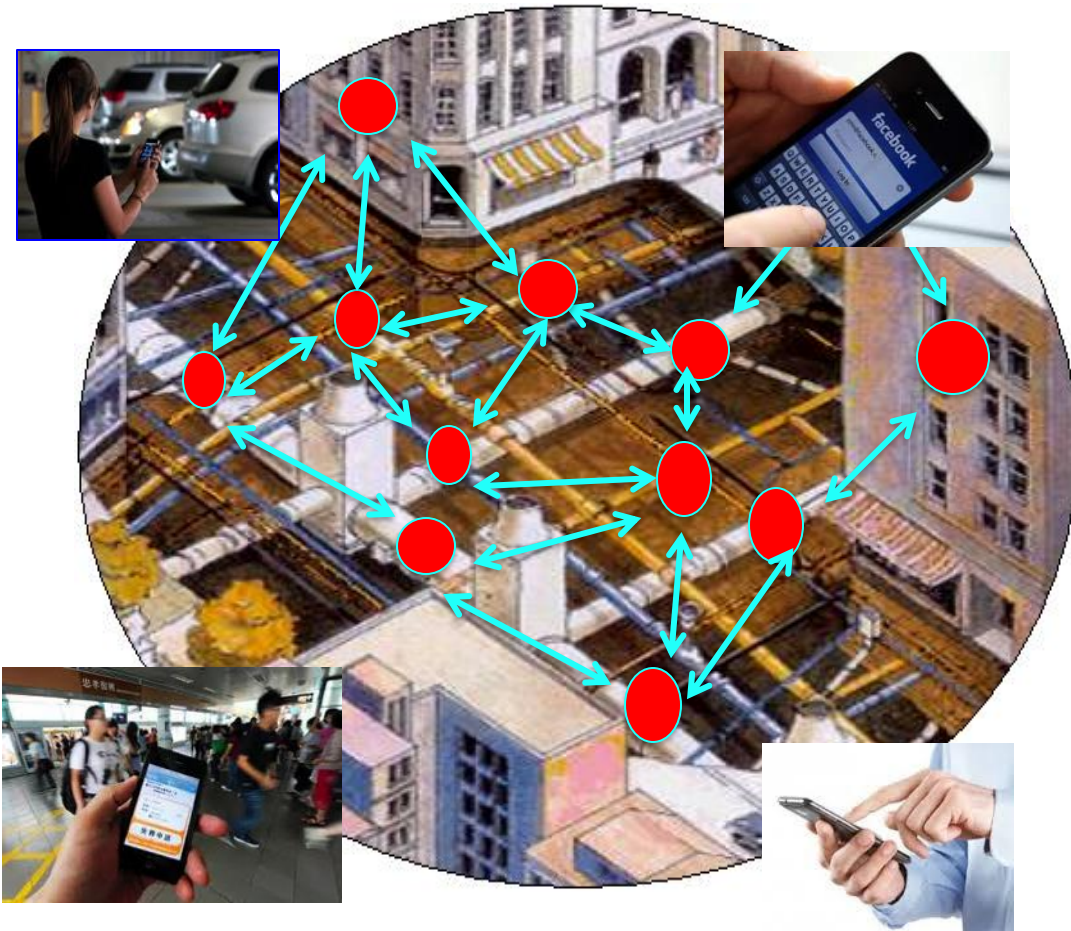
Real-time



- See
- Analyze
- Understand
- Operate actions:
 - Optimization
 - Security

Digital technology in the City

3) Interaction with the community



Governance



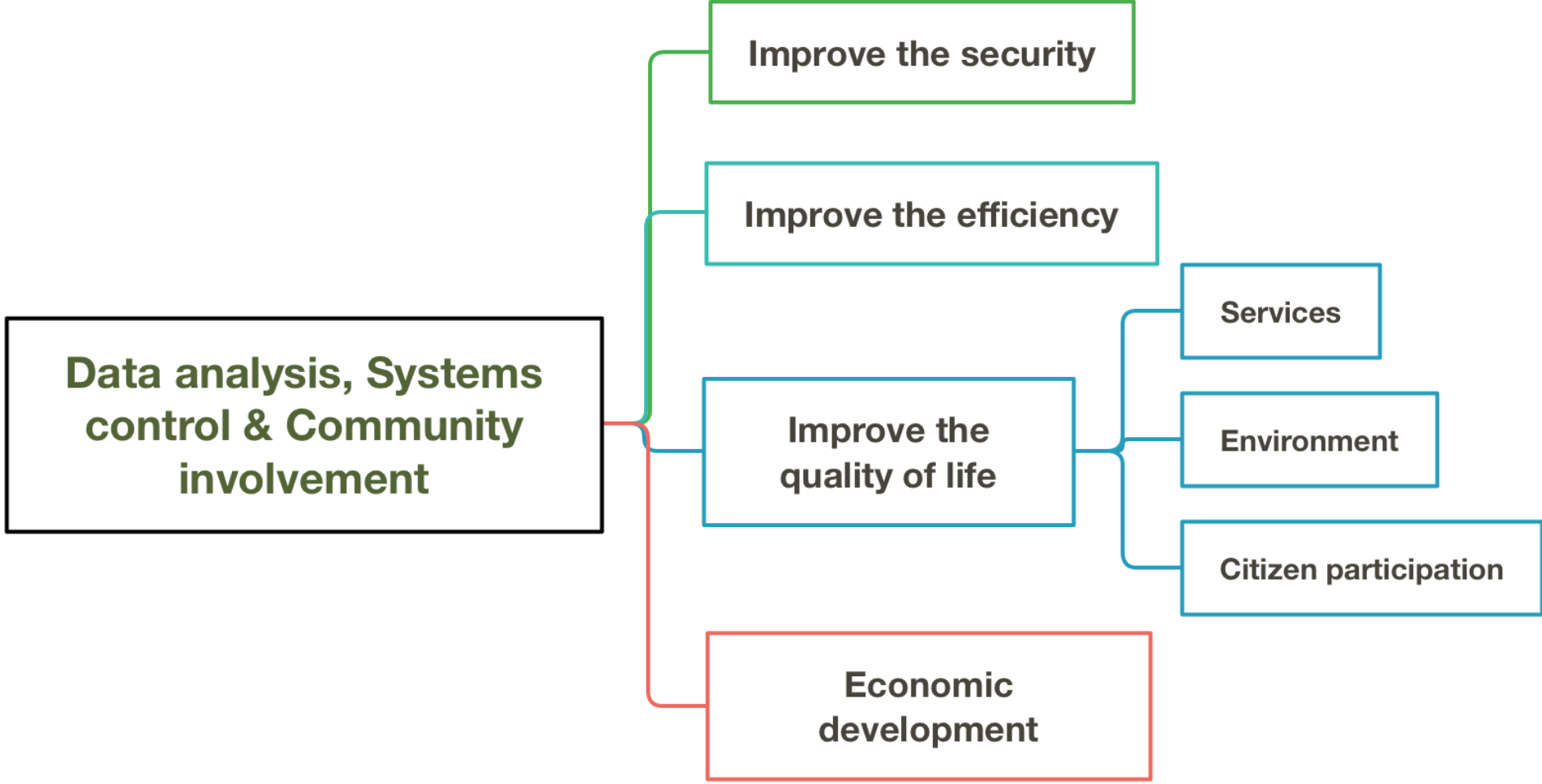
- See
- Analyze
- Understand
- Take collective decision
- Operate actions:
 - Optimization
 - Security

4) More data

The image is a collage of various elements representing data sources. At the top left is a weather icon with a sun, cloud, and rain. To its right is a photo of people wearing face masks. Further right is an aerial view of a busy city street with many vehicles. Below the weather icon is a circular graphic showing a network of red nodes and teal arrows. In the center, there are two server racks with orange arrows pointing up and down. To the right of the server racks is a photo of people looking at their smartphones. At the bottom right is a word cloud with terms like 'Social Network', 'connections', 'relationships', and 'analysis'. The background is a dark grey gradient.

BIG DATA

digital, images,
movies, audios



Smart Cities Barcelona



**Introduction to Montreal's Smart City Plan
by Montreal City Council Chairman Harout Chitilian, 2017**



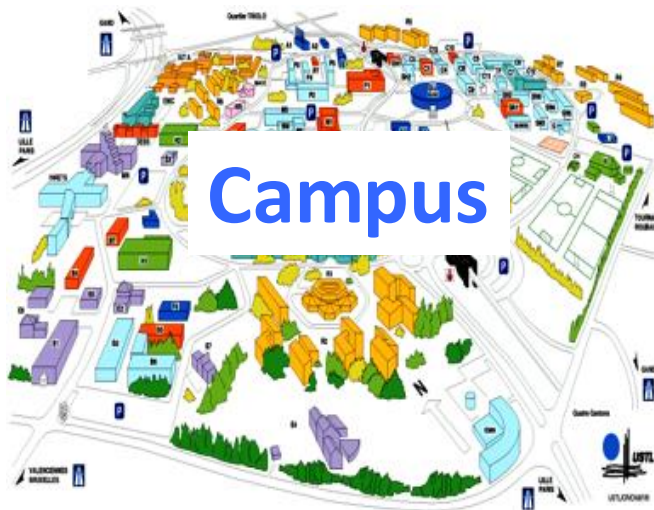
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Q3: Smart City indicators

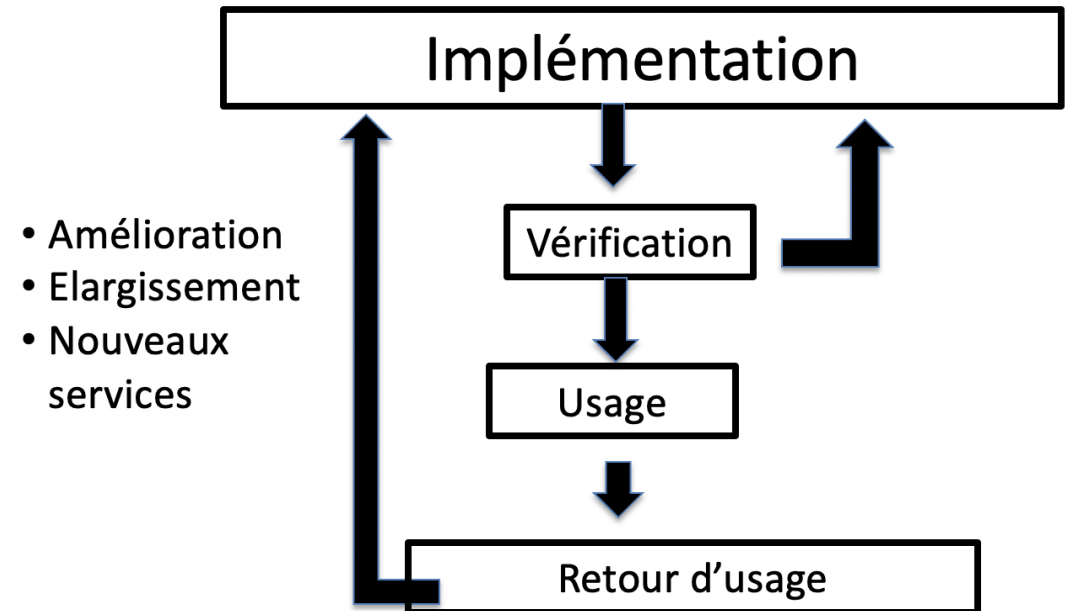
Smart city solution



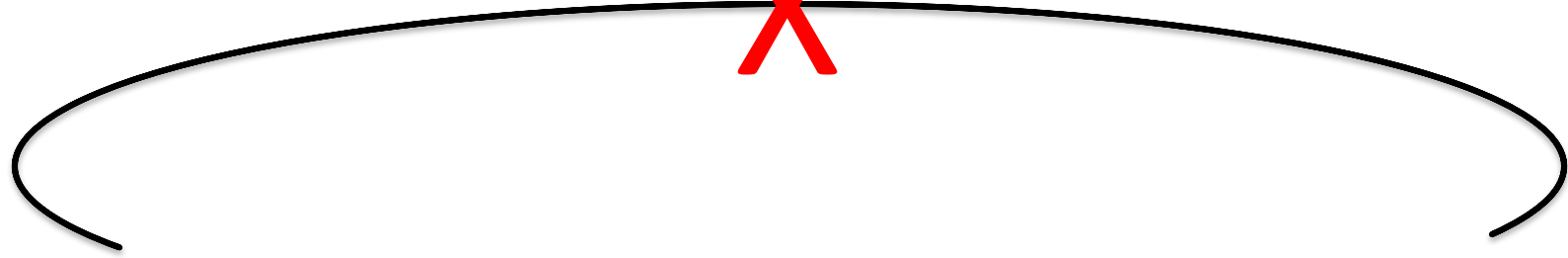
Construire un projet “Smart City”

The establishment of a Smart City is not a one stop process: it is a journey.

Procédure itérative



X



Information system

Big data: structured and unstructured data



Smart City Platform



Digital tools

(Analysis, graphic, user's interface)



IoT



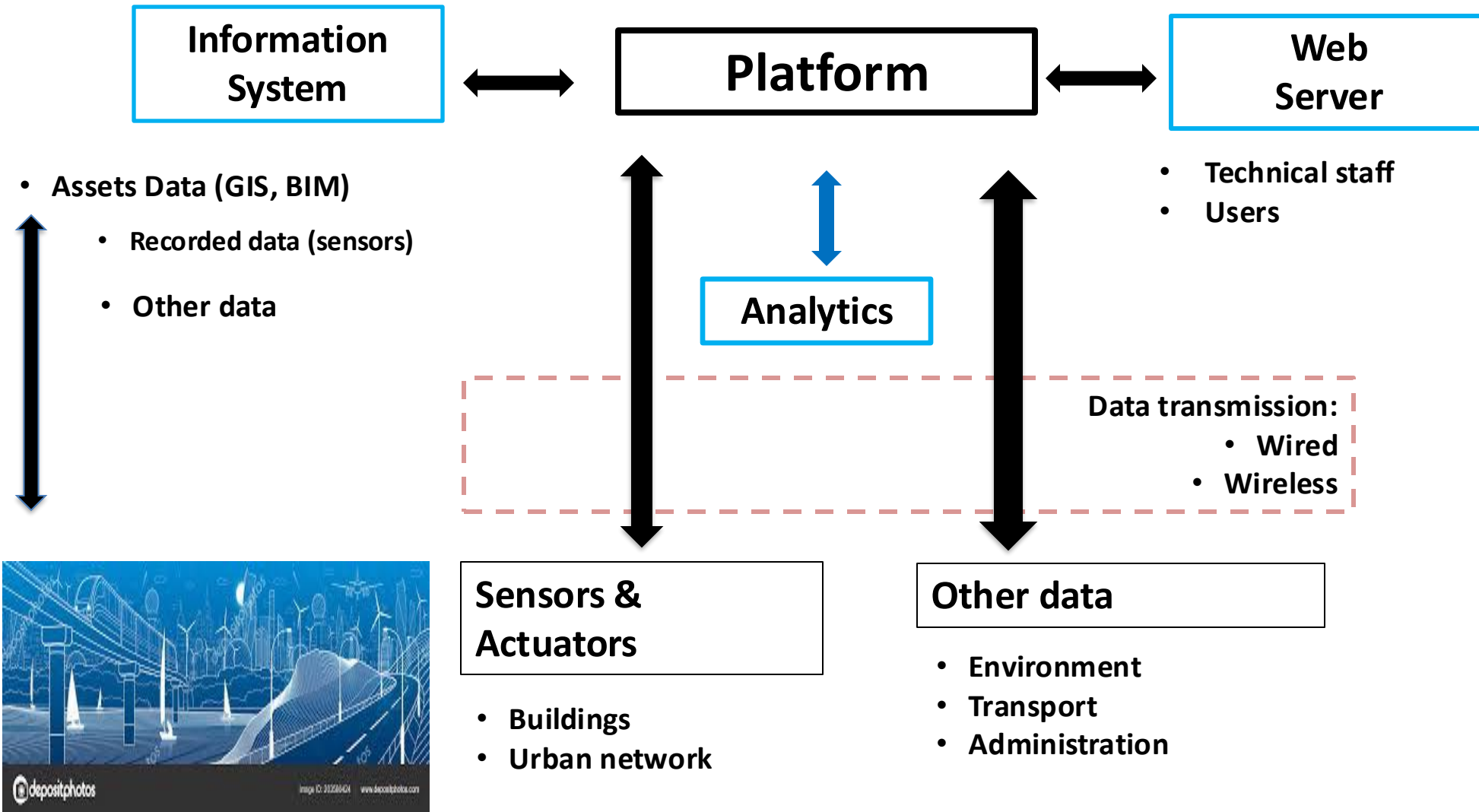
People

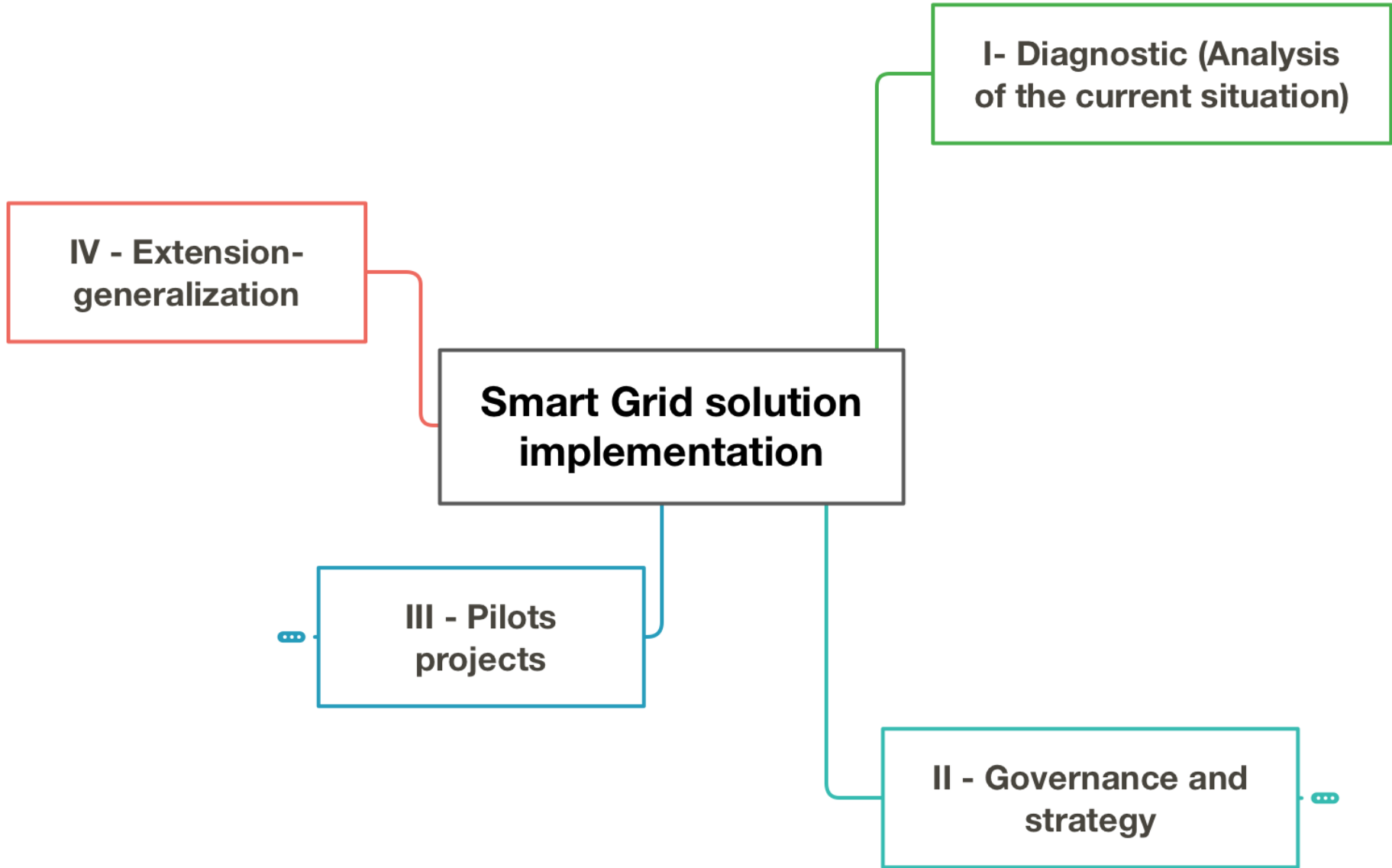


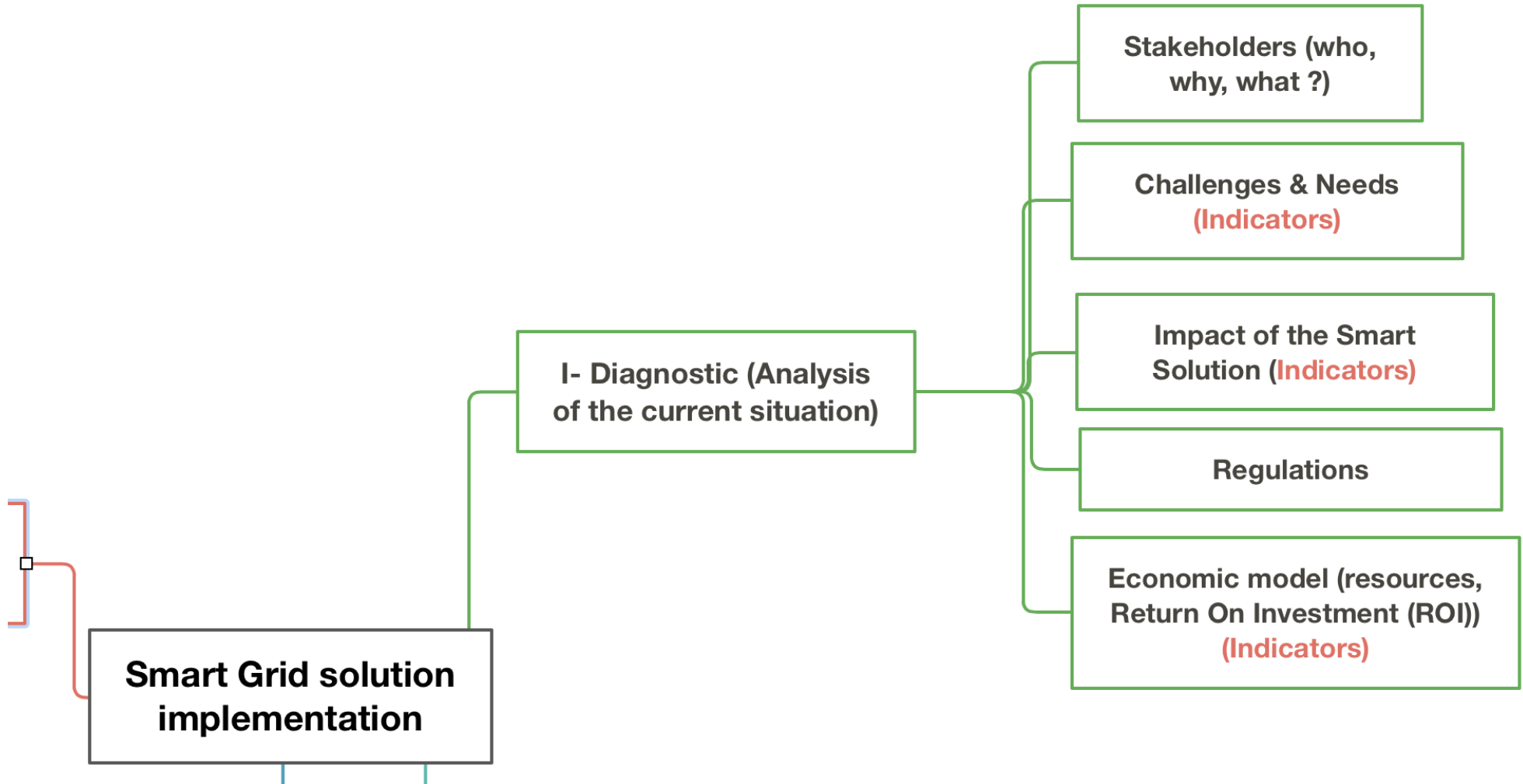
External sources

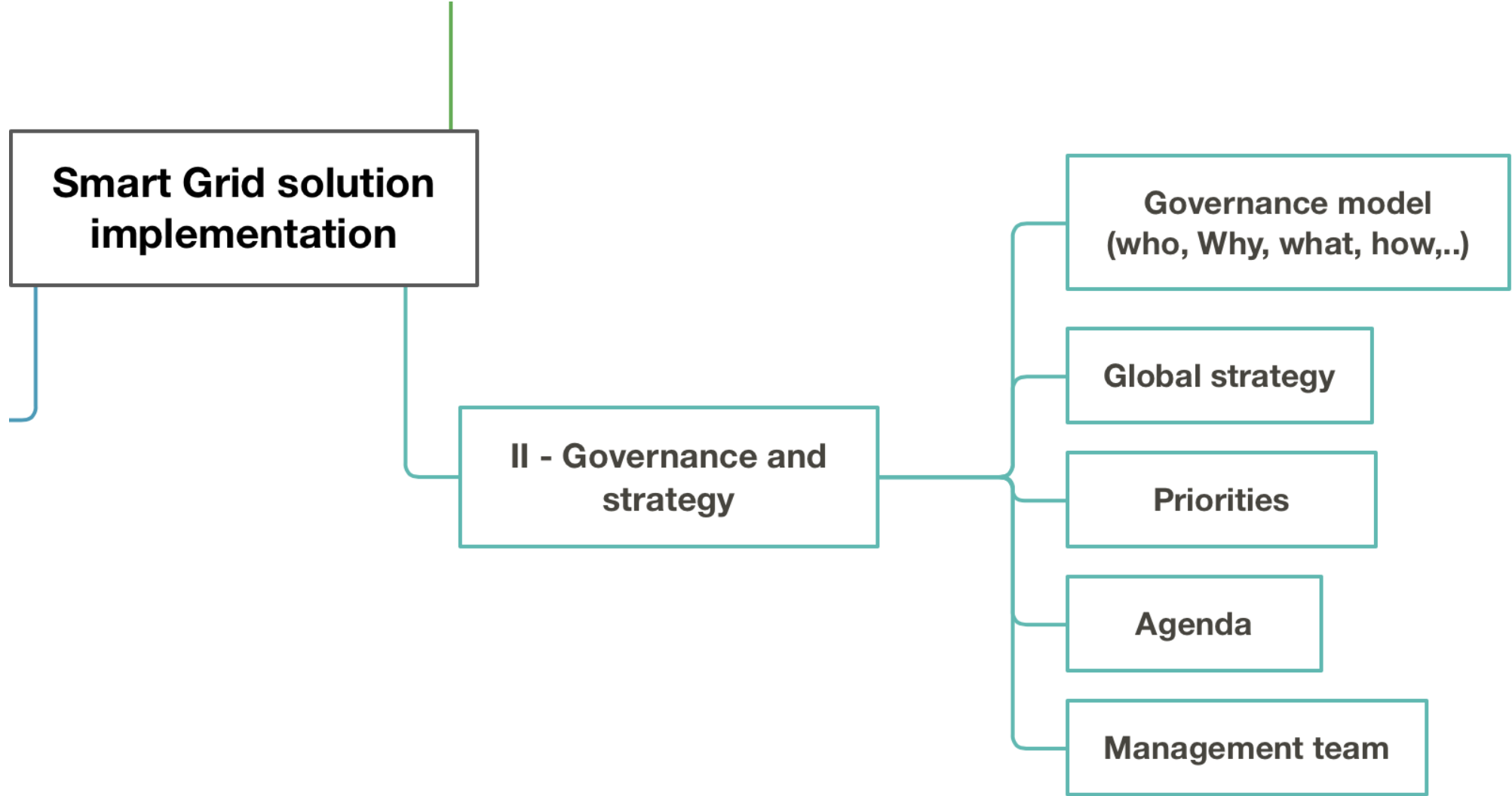
Sensing & control
Centralized & Distributed

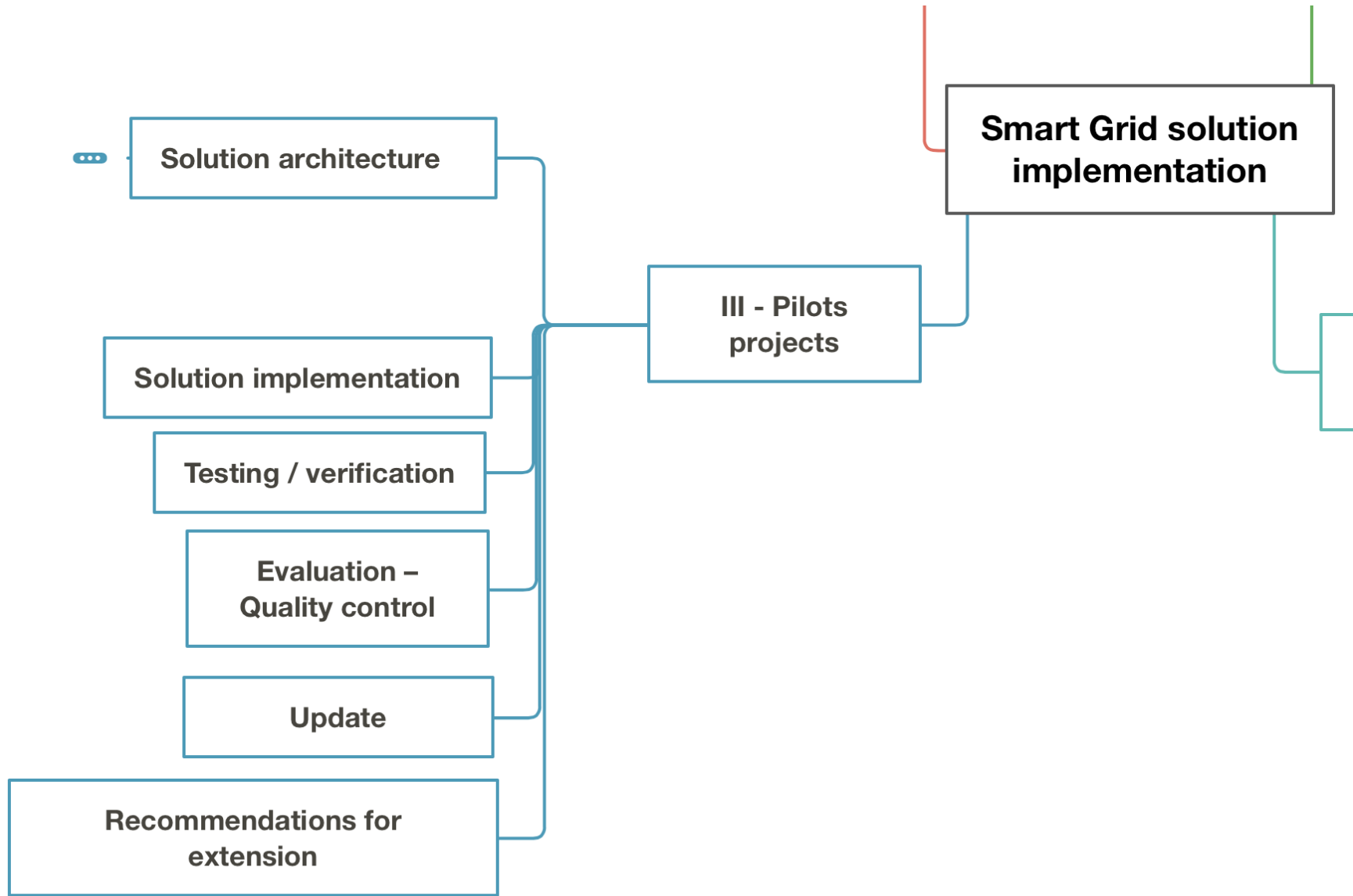
Smart city system

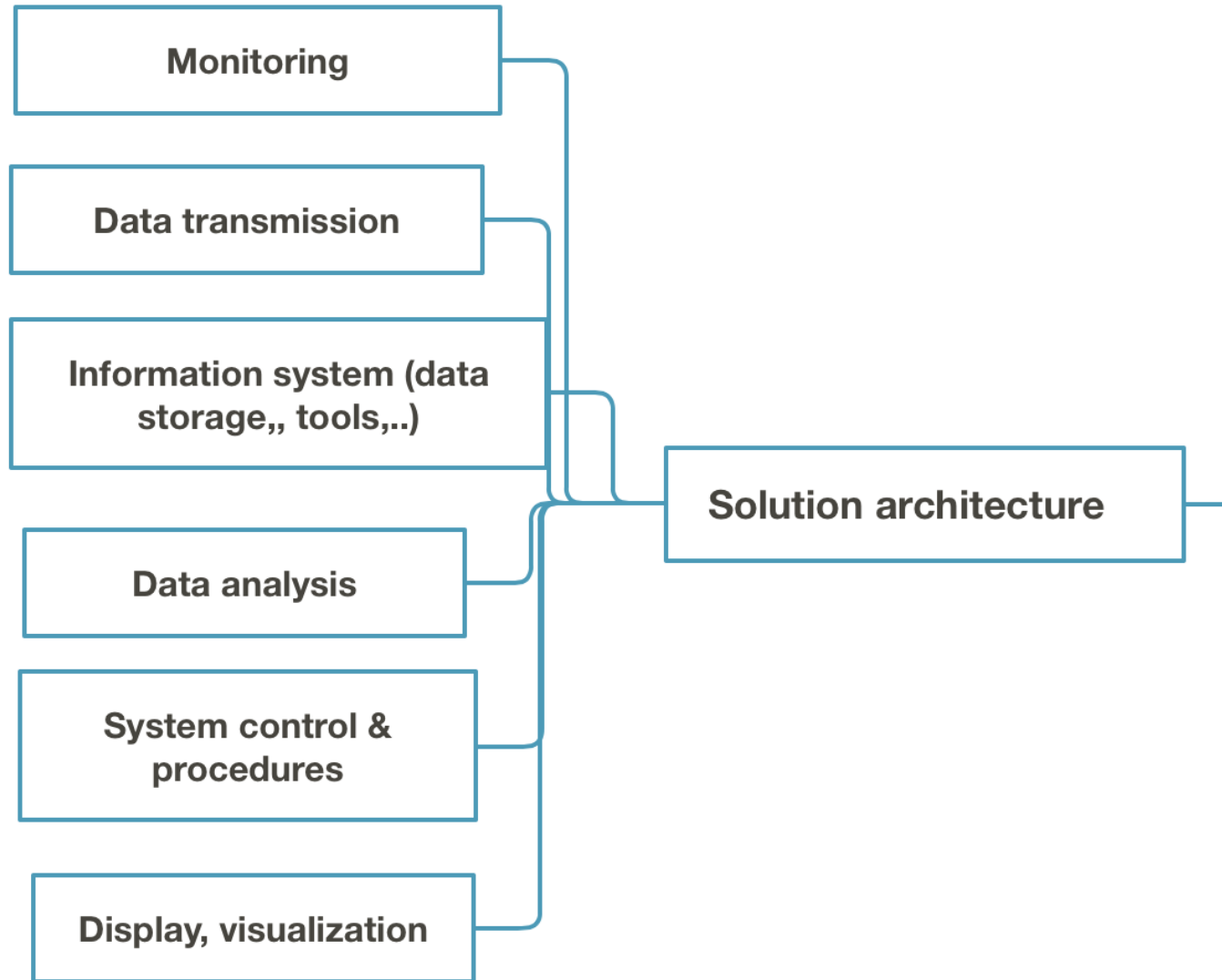


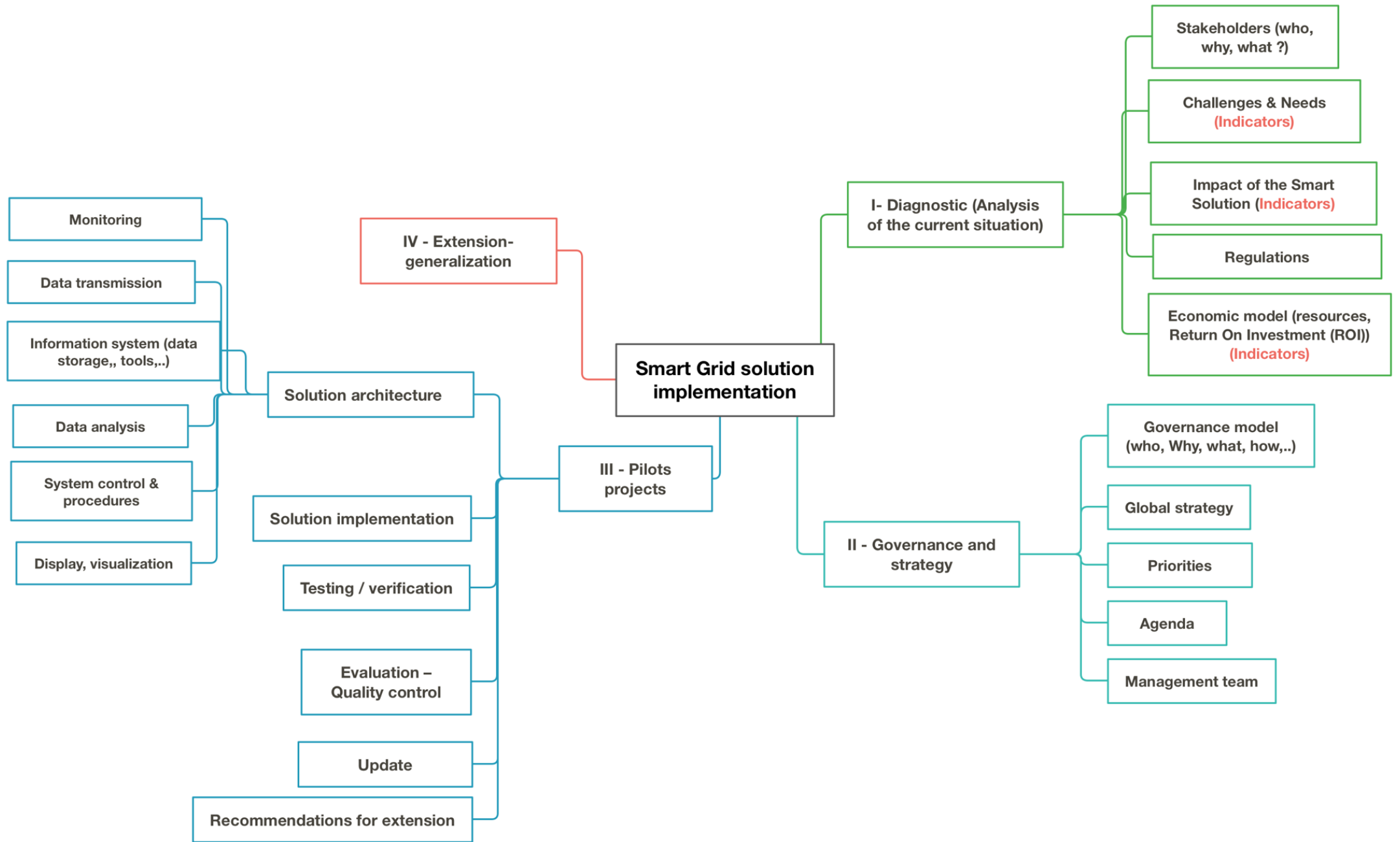












Optimization

Improves systems' efficiency

Data-based (Knowledge)

(Real-time & historical)

Smart City

Security & Resilience

- Rapid action in case of abnormal event
- Learning from events

Comprehensive

(technical, social, economic,..)

Governance:

Democratic, transparent, citizens' participation

Savings in the construction and in running costs largely cover expenses of the smart system implementation

Reprise à 10:00

3 Questions

Q1 : The Smart City Concept?

Q2: Smart City implementation ?

Q3: Smart City indicators



European project

A green graphic detailing the project. It includes the 'CITY keys' logo, a description of the project's timeline, a list of research institutes and partner cities, and a central radar chart with various smart city icons. At the bottom, there are logos for the participating organizations and cities.

The project started in February 2015 and runs until January 2017.

Research institutes
VIT (coordinator, Finland),
AIT (Austria),
and TNO (Netherlands)

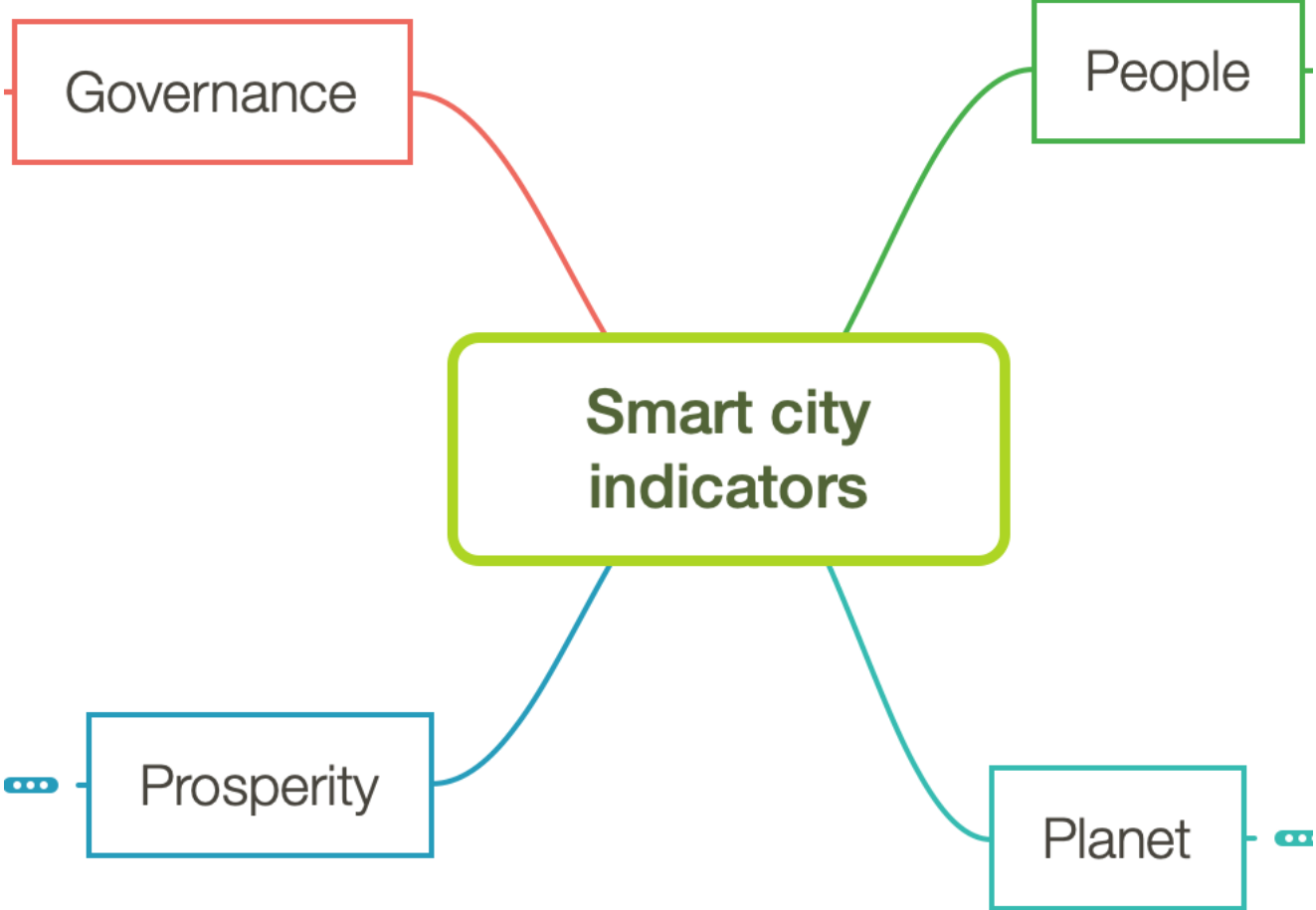
cooperate with EUROCITIES
and five cities: Rotterdam,
Tampere, Vienna, Zagreb,
and Zaragoza.

CITY keys
Smart City
performance measurement system

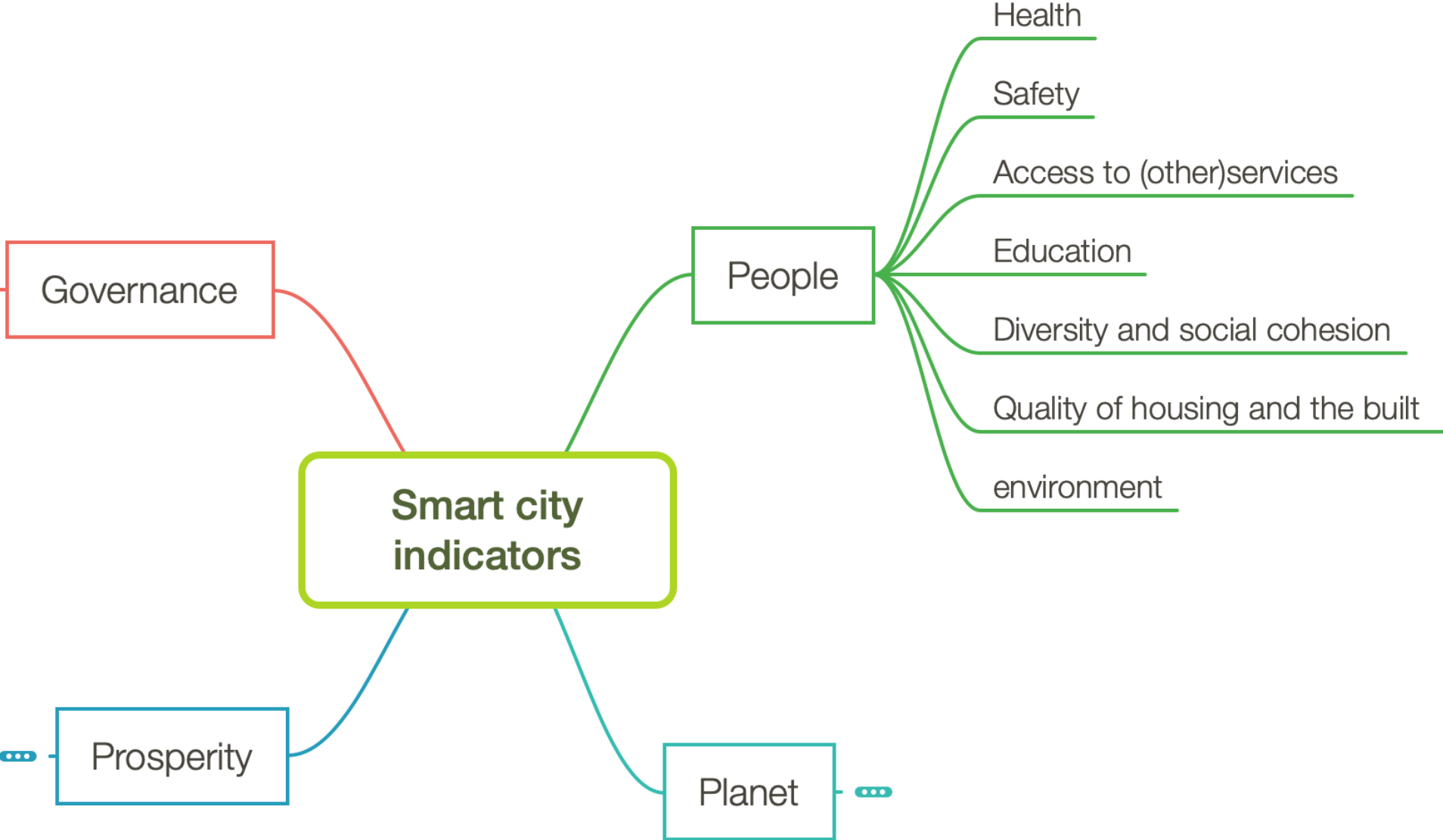
A central radar chart with five axes, each ending in a green icon representing a smart city domain: a building with a Wi-Fi signal, a leaf, a person, a smartphone, and a solar panel. The chart has concentric green rings, indicating performance levels across these domains.

VIT **AIT** **TNO**
EUROCITIES **SMART CITY WIEN**
Zaragoza **Vienna ahead** **City of Vienna**

Smart City indicators



Smart City indicators



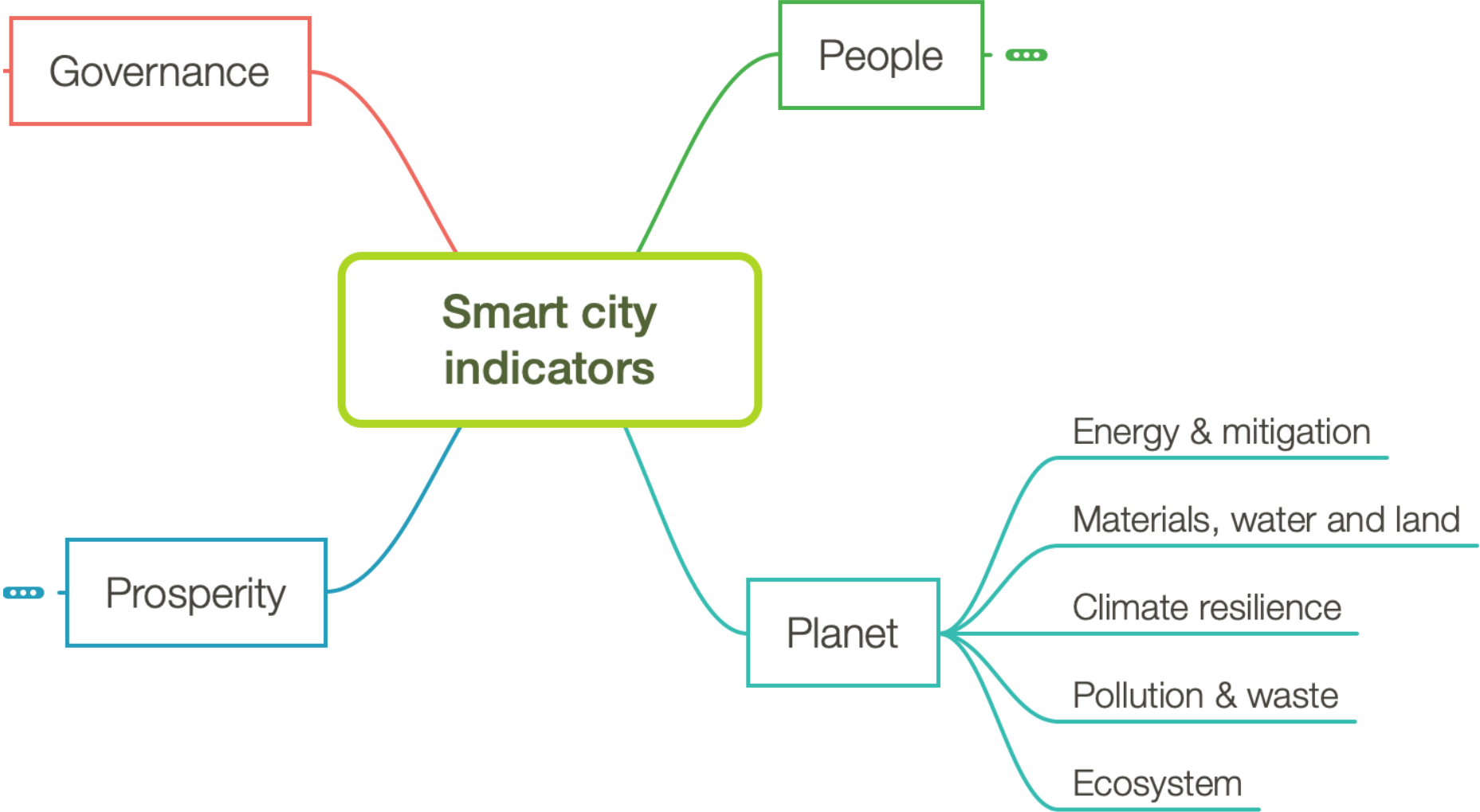
3.2.1 Health

Indicator title	Indicator unit	Definition
Improved access to basic health care services	Likert	The extent to which the project has increased accessibility to basic health care
Encouraging a healthy lifestyle	Likert	The extent to which the project encourages a healthy lifestyle
Waiting time	% in hours	Percentage reduction in waiting time due to project

3.2.2 Safety

Indicator title	Indicator unit	Definition
Reduction of traffic accidents	% of fatalities	Percentage reduction of transportation fatalities due to the project
Reduction in crime rate	% of crimes	Percentage reduction in number of violences, annoyances and crimes due to the project
Improved cybersecurity	Likert	The extent to which the project ensures cybersecurity
Improved data privacy	Likert	The extent to which data collected by the project is protected

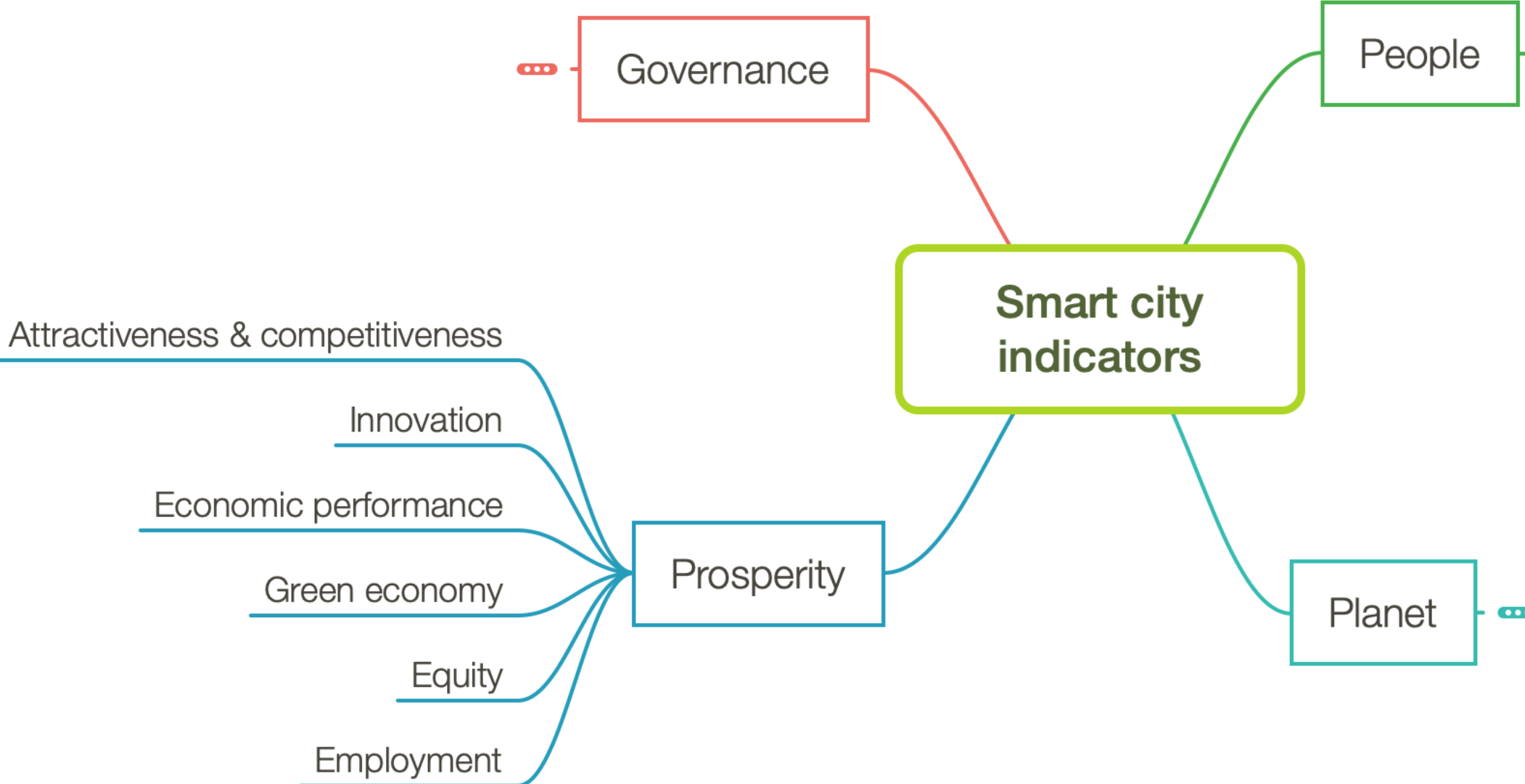
Smart City indicators



3.3.1 Energy & mitigation

Indicator title	Indicator unit	Definition
Reduction in annual final energy consumption	% in kWh	Percentage change in annual final energy consumption due to the project for all uses and forms of energy
Reduction in lifecycle energy use	% in kWh	Reduction in life cycle energy use achieved by the project (%)
Reduction of embodied energy of products and services used in the project	Likert	The extent to which measures have been taken to reduce the embodied energy of products used in the project
Increase in local renewable energy production	% in kWh	Percentage increase in the share of local renewable energy due to the project
Carbon dioxide emission reduction	% in tonnes	Percentage reduction in direct (operational) CO ₂ emissions achieved by the project.
Reduction in lifecycle CO ₂ emissions	% in tonnes	Percentage reduction in lifecycle CO ₂ emissions achieved by the project
Maximum Hourly Deficit	MHDx	The maximum yearly value of how much the hourly local demand overrides the local renewable supply during one single hour
Local freight transport fuel mix	% in kms	The ratio of renewable fuels in the local freight transport fuel mix in the

Smart City indicators



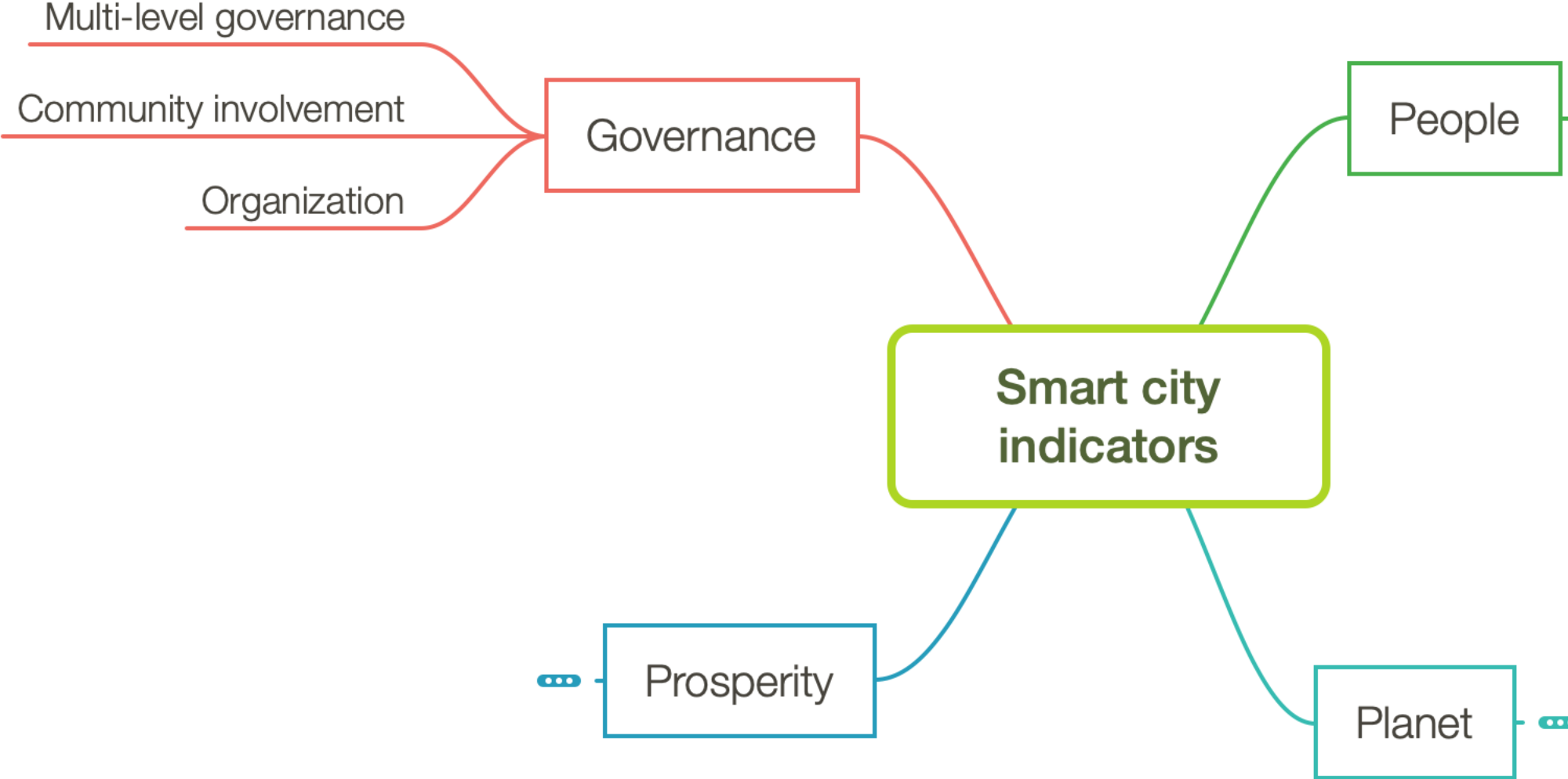
3.4.3 Green economy

Indicator title	Indicator unit	Definition
Certified companies involved in the project	% of companies	Share of the companies involved in the project holding an ISO 14001 certificate
Green public procurement	Likert scale	The extent to which GPP criteria were taken into account for the procurement processes related to the project
CO2 reduction cost efficiency	€/ton CO2 saved/year	Costs in euro's per ton of CO2 saved per year

3.4.5 Innovation

Indicator title	Indicator unit	Definition
Involvement of extraordinary professionals	Likert	The extent to which the project involved professionals normally not encountered in these type of projects
Stimulating an innovative environment	Likert scale	The extent to which the project is part of or stimulates an innovative environment
Quality of open data	# stars	The extent to which the quality of the open data produced by the project was increased
New startups	# of startups	The number of startups resulting from the project
Improved interoperability	Likert scale	The extent to which the project has increased interoperability between systems

Smart City indicators



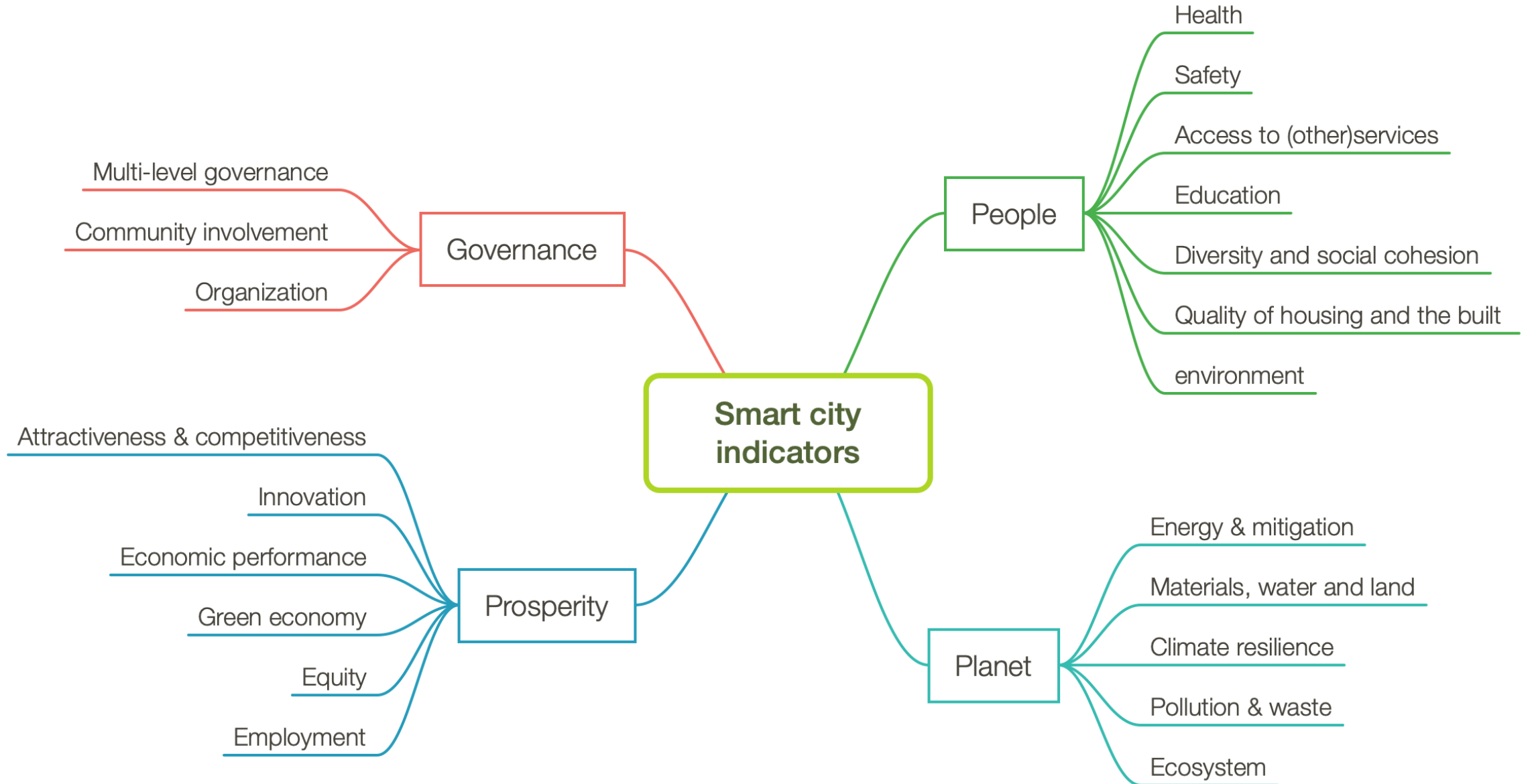
3.5.1 Organisation

Indicator title	Indicator unit	Definition
Leadership	Likert scale	The extent to which the leadership of the project is successful in creating support for the project.
Balanced project team	Likert scale	The extent to which the project team included all relevant experts and stakeholders from the start
Involvement of the city administration	Likert scale	The extent to which the local authority is involved in the development of the project, other than financial, and how many departments are contributing
Clear division of responsibility	Yes/no	Has the responsibility for achieving the social and sustainability targets been clearly assigned to (a) specific actor(s) in the project?
Continued monitoring and reporting	Likert scale	The extent to which the progress towards project goals and compliance with requirements is being monitored and reported
Market orientation	Likert scale	The extent to which the project was planned on the basis of a market analysis

3.5.2 Community involvement

Indicator title	Indicator unit	Definition
Professional stakeholder involvement	Likert scale	The extent to which professional stakeholders outside the project team have been involved in planning and execution
Bottom-up or top-down initiative	Yes/no	Has the project idea originated from the local community?
Local community involvement in planning phase	Likert scale	The extent to which residents/users have been involved in the planning process
Local community involvement in implementation phase	Likert scale	The extent to which residents/users have been involved in the implementation process
Participatory governance	% of people	Share of population participating in online platforms

Smart City indicators



Local government KPIs that measure the success of a smart city project

Smart Economy

- Growth of technology and science parks.
- Number of new start-ups per year.
- Unemployment rate.
- Number of jobs created per year.
- Unemployment rate in technology and creative sectors.

Local government KPIs that measure the success of a smart city project



<https://www.urbansolutions.es/en/blog/95-big-data-and-smart-cities/130-local-government-kpis-that-measure-the-success-of-a-smart-city-project>

Smart city indicators

- Smart Economy
- Smart Mobility
- Smart environment
- Smart people
- Smart Living

Local government KPIs that measure the success of a smart city project

Smart Governance

- Implementation of electronic systems to regulate the administration-citizen relationship.
- Number of infrastructures with connected sensors.
- Amount of online information available to city inhabitants.

Local government KPIs that measure the success of a smart city project

Smart Mobility

- Number of electric vehicle charging stations.
- Number of public Wi-Fi zones.
- Number of public transportation journeys per year.
- Kilometers of bike lanes per 100,000 inhabitants.
- Percentage of the territory with broadband internet coverage.

Local government KPIs that measure the success of a smart city project

Smart environment

- Number of intelligent street lamps.
- Water pollution levels.
- Noise pollution levels.
- Percentage of energy consumed coming from renewable energies.
- Rate of chronic respiratory diseases per 100,000 inhabitants.
- Proportion of solid waste that is recycled.

Local government KPIs that measure the success of a smart city project

Smart people

- Number of computers per student.
- School dropout rate.
- Percentage of the population with a university degree.
- Use of ICT in education.
- Adequacy of local training to meet the demands of the labor market.
- Accessibility to educational resources.

Local government KPIs that measure the success of a smart city project

Smart Living

- Average waiting time at medical centers.
- Average emergency service response time.
- Gini coefficient of economic inequality.
- Index of energy poverty.
- Suicide rate per 100,000 inhabitants.
- Rate of violent crime per 100,000 inhabitants.
- Implementation of online health services.
- Level of cybersecurity.

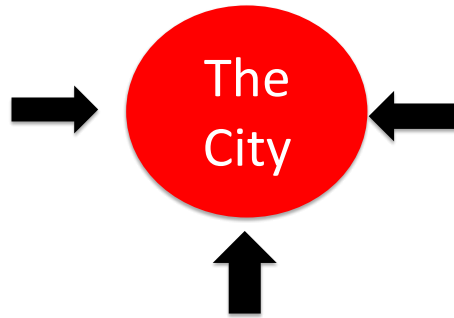
Summary and conclusion

Smart city: Intelligent solution to cope with the city challenges

City under increasing pressure ...

Built-Environment

- Aging
- Lack
- Adaptation to new challenges



Social and Economic

- Population growth
- Aging
- Poverty
- Unemployment
- Governance

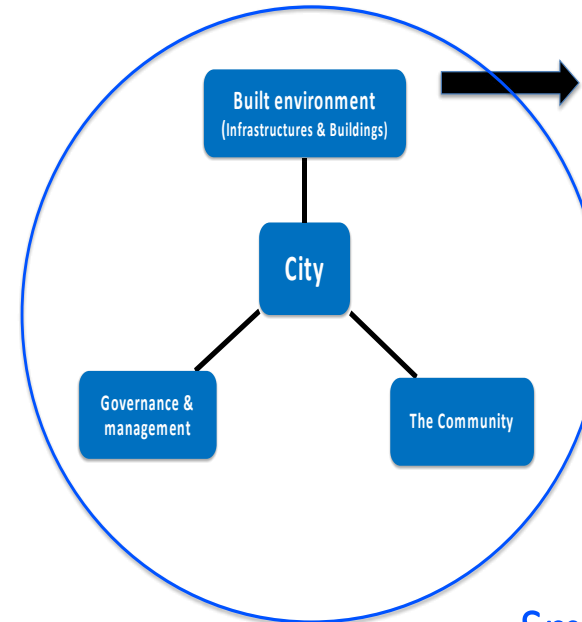
Environment

- Congestion
- Climate change
- Pollution

Hazards

- Natural
- Industrial
- Social

Solution strategies



1) Renovation/update of infrastructures

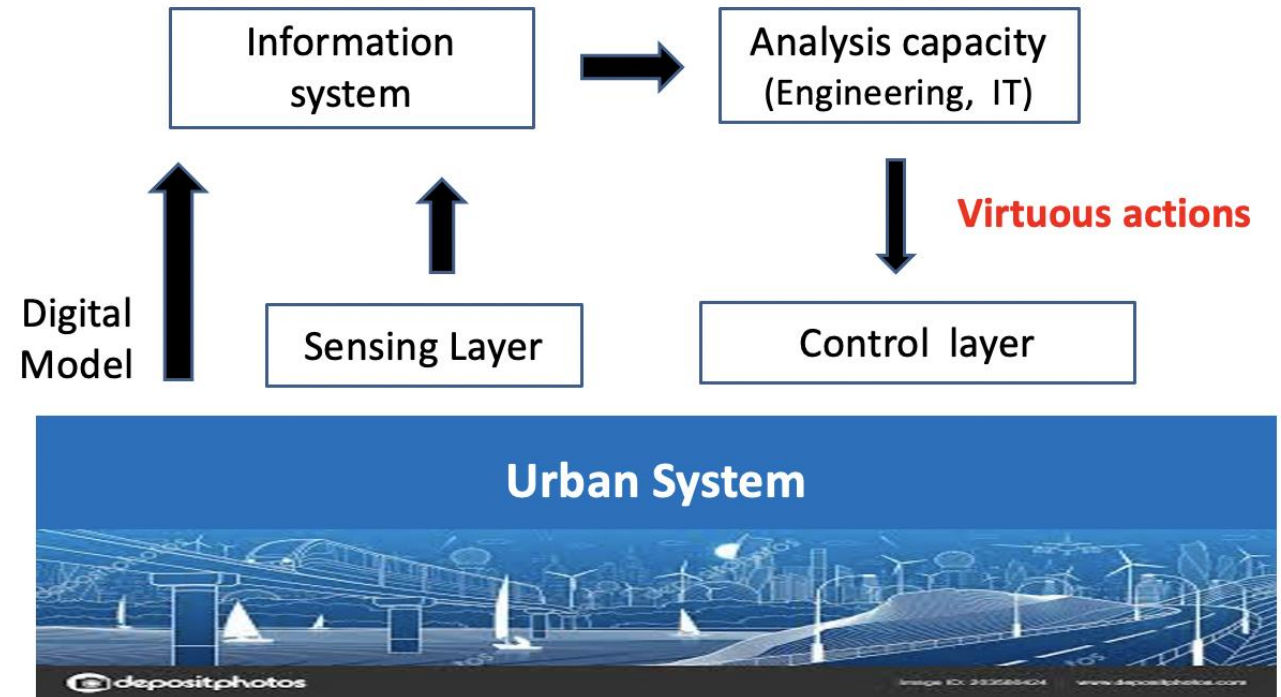
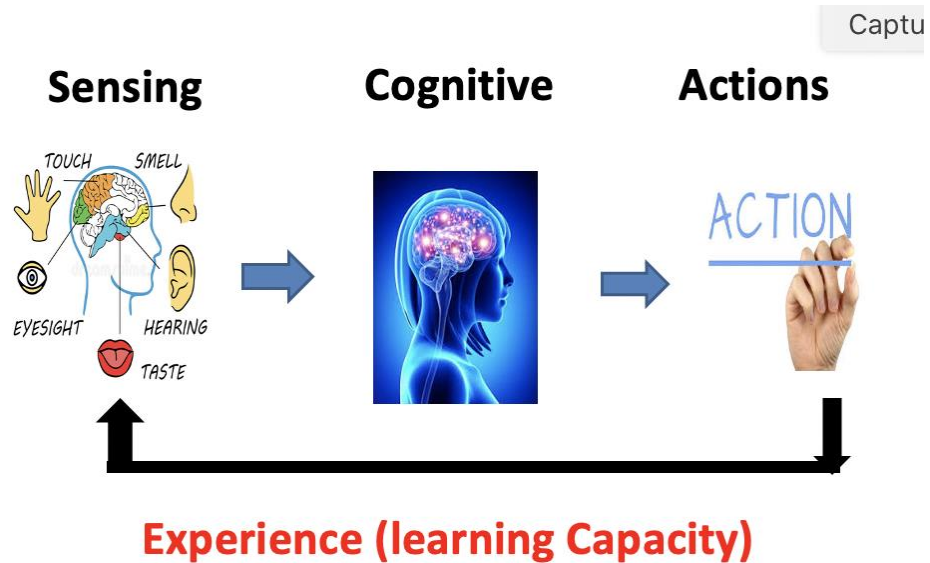
- Takes long time
- Requires huge investment

2) Smart City solution

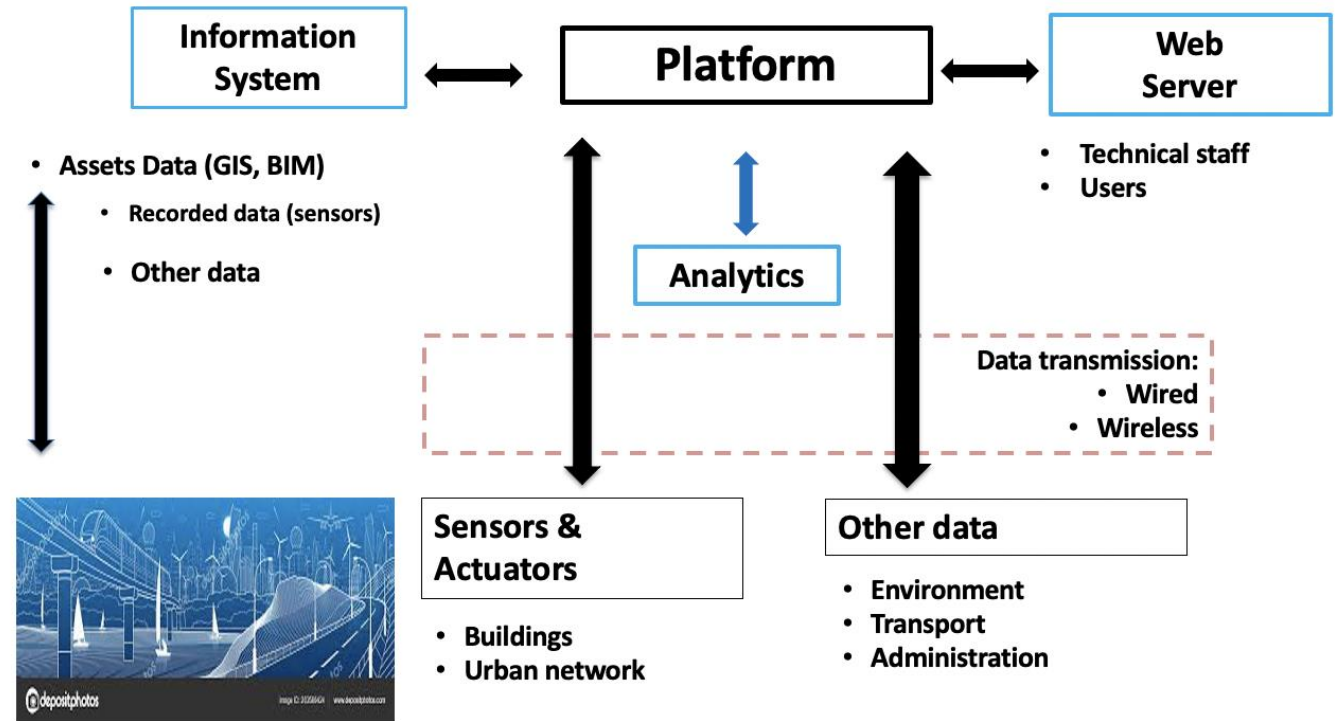
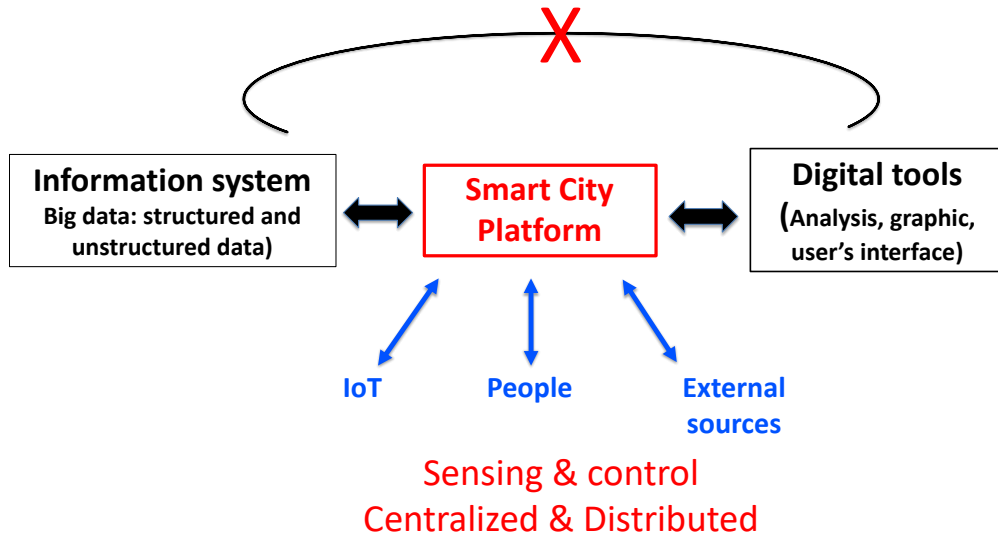
- Could be implemented rapidly
- Lower cost
- More efficient

Smart Solution: Do more with less

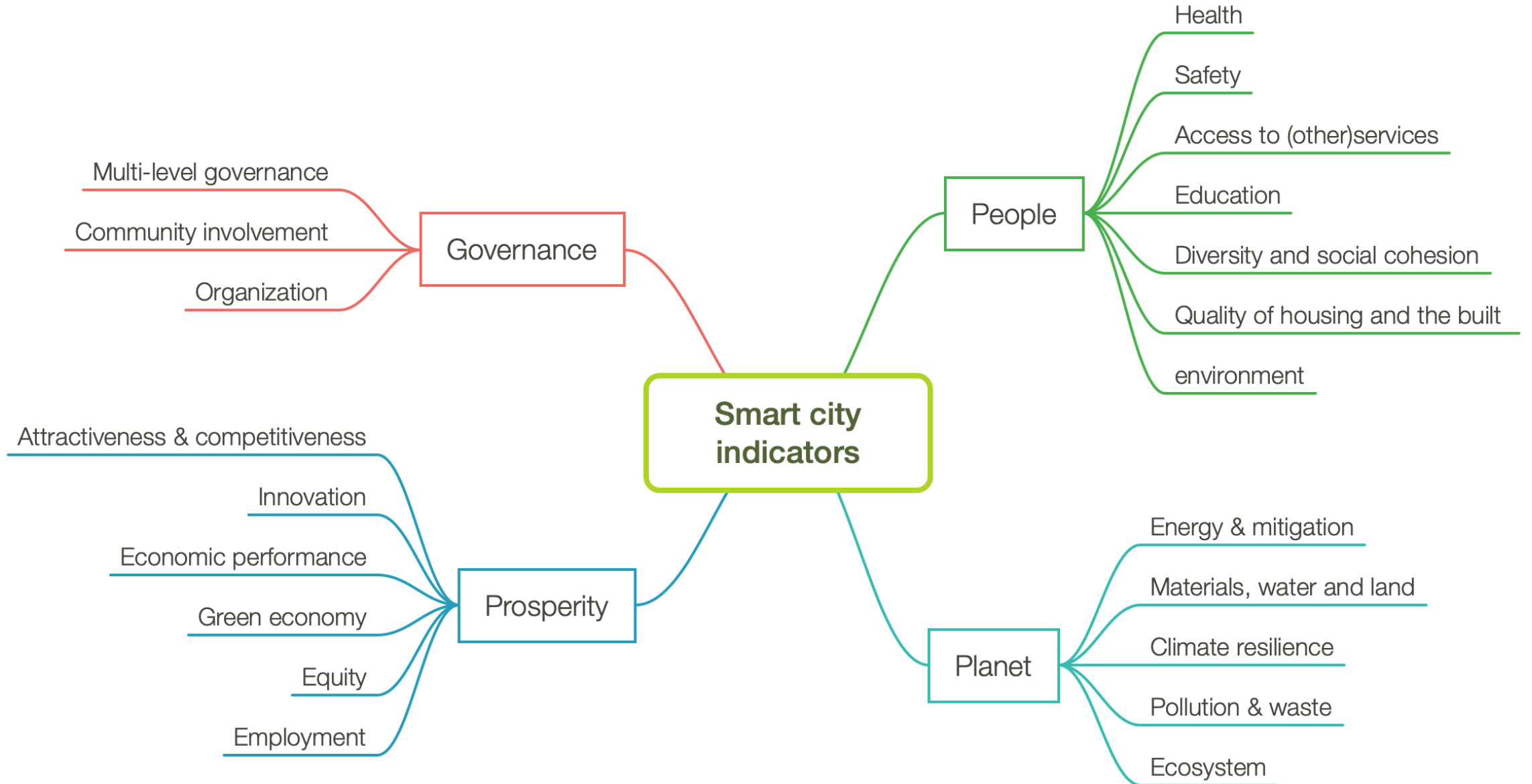
Inspired from Human Intelligence



Smart City: Based on data collection and analysis



Need for smart city indicators



Le marché de la smart city en France [Cathy Alegria]



Merci pour votre attention