SUSTech, Spring 2025

THE CITY AND TECHNOLOGY

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Center for Social Sciences

CONTENT OF TODAY'S CLASS

1. **Current practices**
   - Sustainable cities
   - Smart cities
   - Innovative cities
2. **Imagined futures**
   - Architecture & planning
   - Science Fiction

1.

SUSTAINABLE CITIES

CONTENTS

DISCUSSION

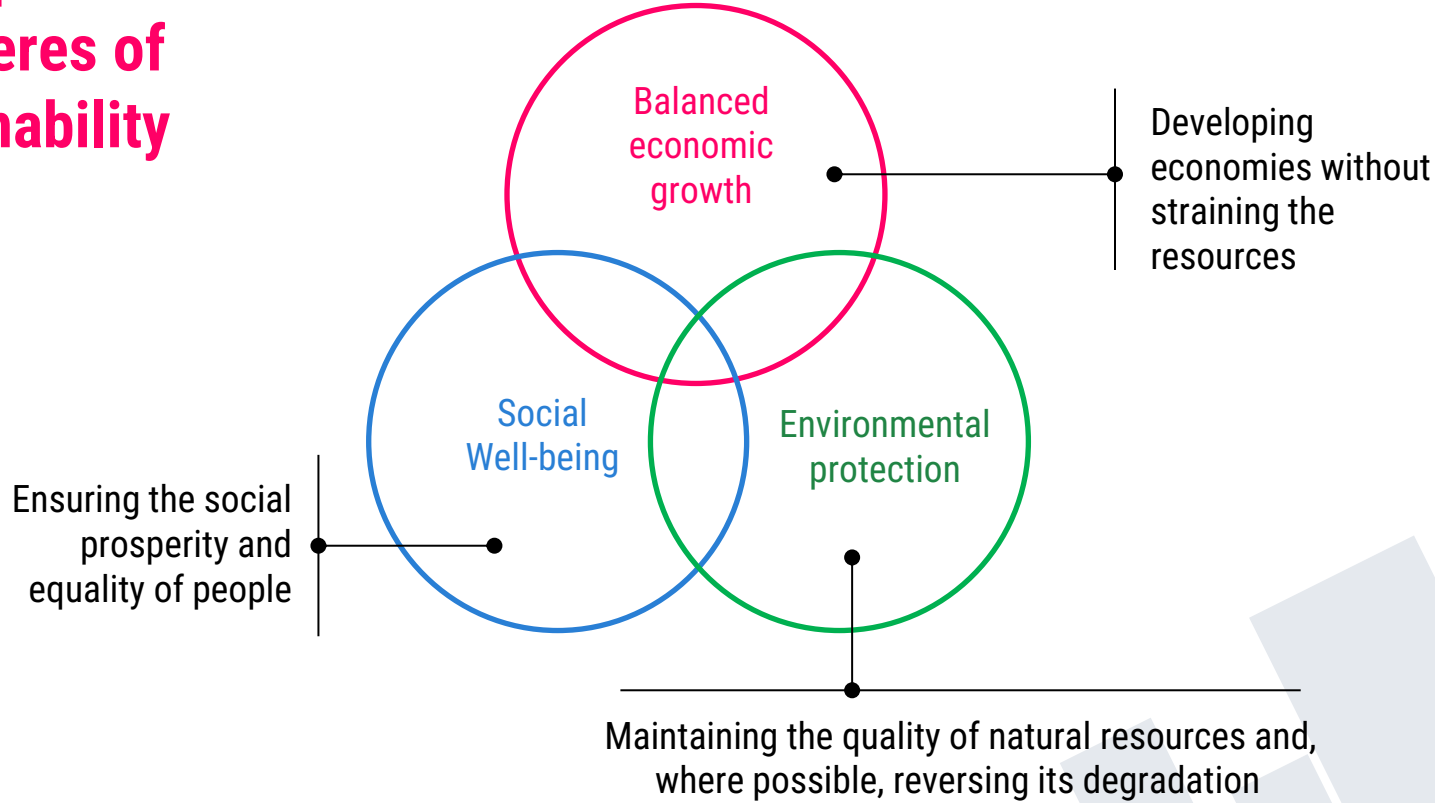
What does sustainability mean?

1.1 SUSTAINABILITY

Many different definitions of sustainability

- Multidisciplinary use and meaning
- A capability of a system to endure and maintain itself
- **Sustainable development** defined by the Brundtland Commission of the United Nations (March 20, 1987): "*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs*."

Three pillars or spheres of sustainability



Measures and Criteria for Social Sustainability

Agreement among scholars	Criteria considered
Complete consensus	Social equity; access to facilities and amenities; safety and security; social interactions
Semi-consensus	Health of the inhabitants; education; pride and sense of place; affordable housing; satisfaction with the neighborhood
Non-consensus	Democracy; human rights; social homogeneity; cultural heritage; attractive public realm

https://www.researchgate.net/figure/Measures-and-criteria-for-social-sustainability-Authors_tbl1_284836763

17 Sustainable Development Goals (SDGs) adopted by the UN in 2015

https://aer.eu/sustainable-development-goals-engaging-regions/

DISCUSSION

What should a “sustainable city” be like?

1.2 DEFINITIONS OF ‘SUSTAINABLE’ CITIES

- *Green cities*
- *Eco-cities*
- *Low-carbon cities*
- *Zero-carbon cities*
- *Resilient cities*
- *Sustainable cities*

An engineering, ecological definition of **sustainable cities**

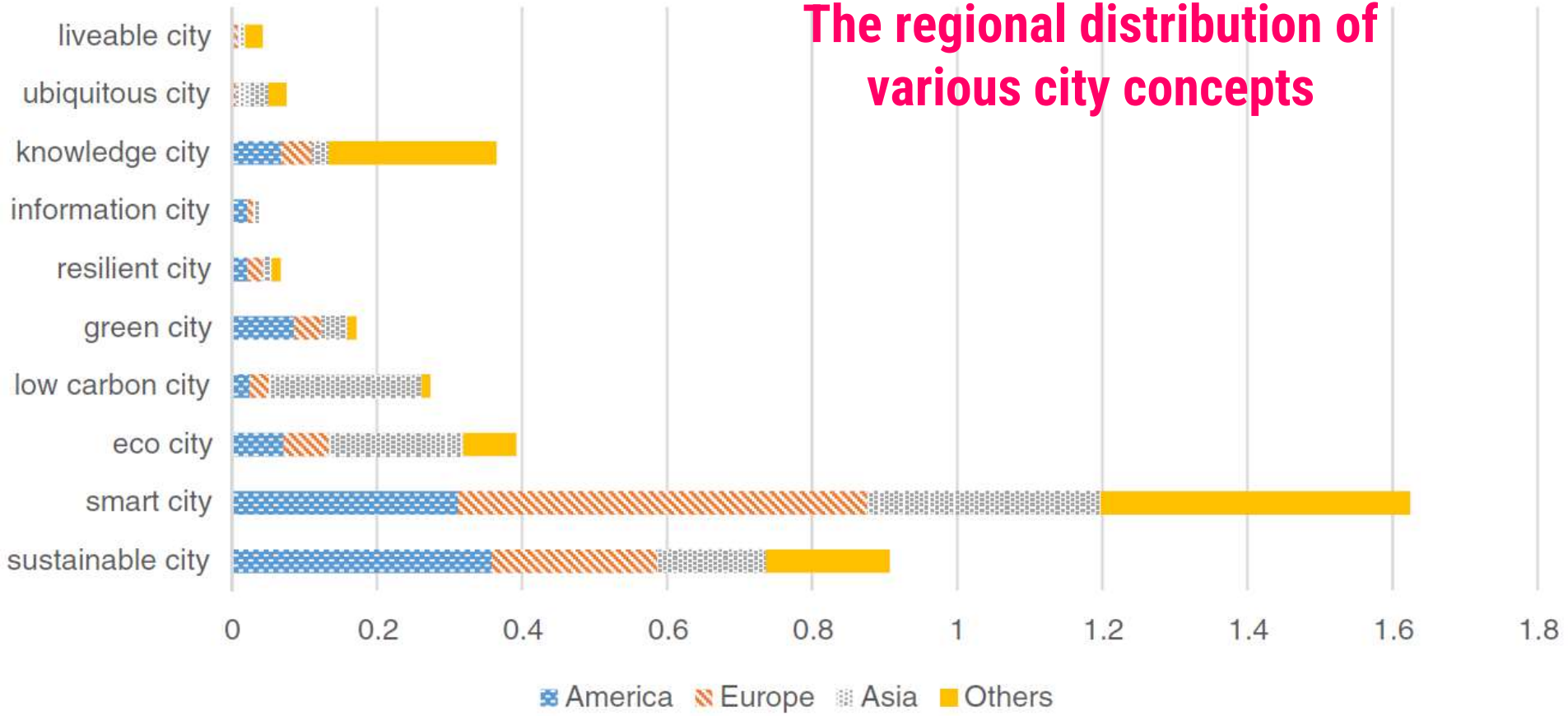
"the creation and responsible management of a healthy built environment based on resource efficient and ecological principles" (Mendler and Lazarus, 2006).

- Use land, material, energy and water resources efficiently
- Minimize ecological footprint and improve the health of (global) ecosystems
- Address health issues relating to the indoor environment

A more balanced notion of **sustainable cities**

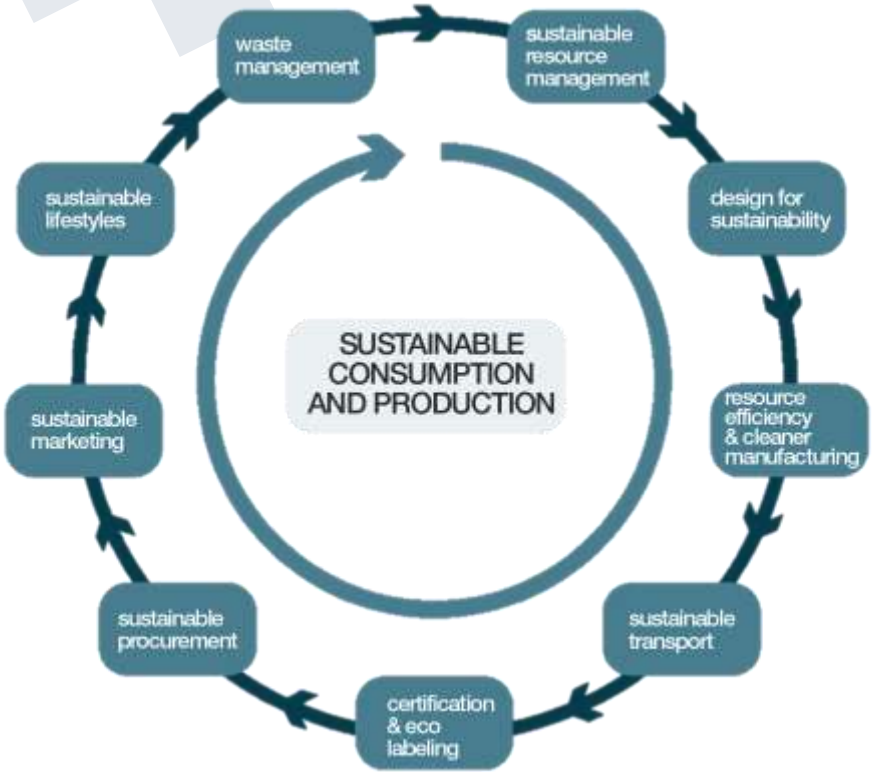
A city designed with consideration for social, economic, environmental impacts, and a resilient habitat for existing populations, without compromising the ability of future generations to experience the same.

The regional distribution of various city concepts



Fu, Y. & Zhang, X. (2017). Trajectory of urban sustainability concepts: A 35-year bibliometric analysis. Cities, 60: 113-123.

1.3 Major approaches of sustainable cities



- A strategy of indicators
- Green buildings
- Green transportation
- Circular economy (urban metabolism)

1.3 Approaches - A strategy of indicators

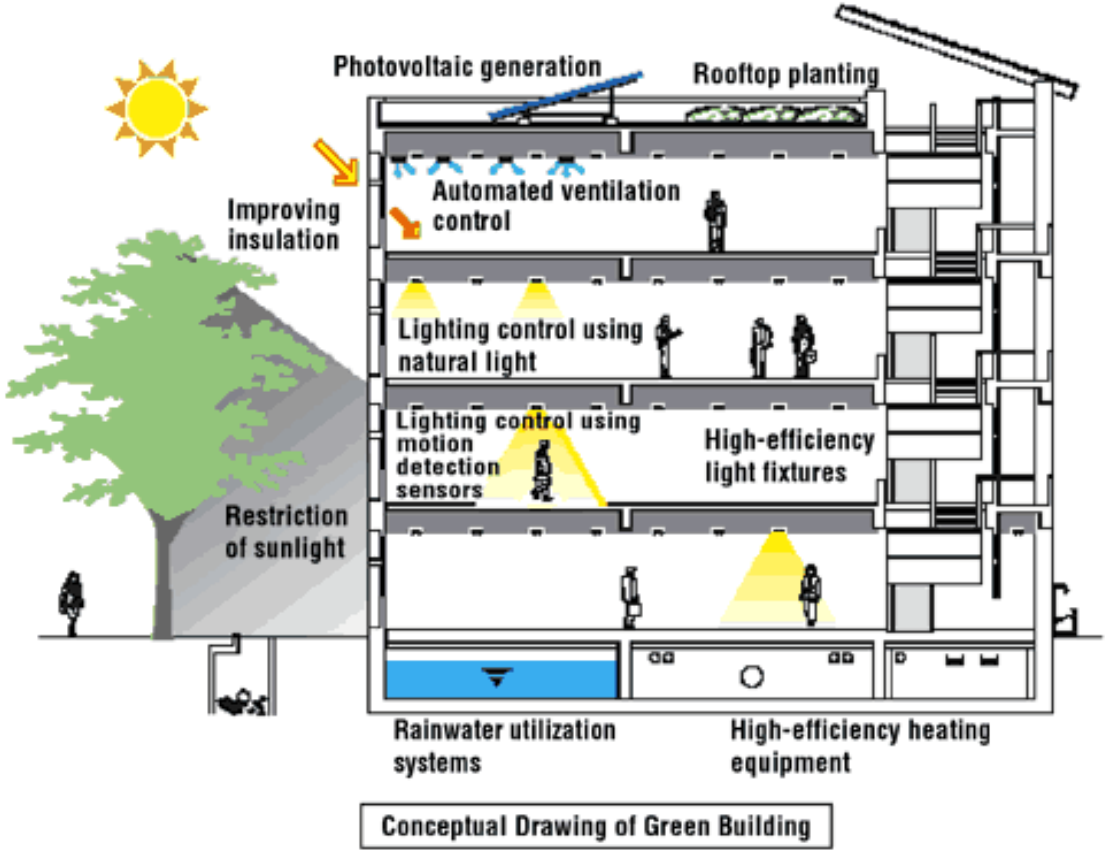
CLEAN WATER	CLEAN ENVIRONMENT	CLEAN ENERGY
ECOLOGY	GREEN BUILDING	CITY MANAGEMENT
100% potable tap water; 50% non-traditional resource	GREEN TRANSPORT	>20% renewable energy use; <150ton-c/mil US$ GDP
Domestic water use <120 L/d per capital	100% green building	Free recreational/sports facilities within walking distance of 500m; >20% public housing provision
Local plant index >0.7; Grade IV Water bodies	>90% green trips by 2020	100% barrier free accessibility
Green space > 12 m2 per capital	100% non-hazardous treatment; Ambient air quality to meet Grade II >310 d/yr	>50nos researches/engineers per 10000 labor force
Zero loss of natural wetland	Domestic waste generation < 0.8kg/d; Noise pollution 100% meet respective functional area standard	employment housing equilibrium index>50%
	> 60% overall recycling rate	100% coverage

A matrix of indicators of Tianjin Eco-city

Source: http://www.bbc.com/future/story/20120503-sustainable-cities-on-the-rise

1.3 Approaches - GREEN BUILDINGS

- Environmentally responsible and resource-efficient throughout a building's life-cycle



https://www.ecomena.org/salient-features-of-a-green-building/

20 Green Design Features for Buildings

1. Cogeneration, or combined heat and power	2. Fuel Cells	3. Solar Photovoltaic Panels	4. Solar Thermal Collectors	5. Central Chiller Plant
6. Geothermal Heating and Cooling	7. Rainwater Harvesting	8. Greywater / Blackwater Recycling	9. LED Lighting	10. Daylighting
11. Occupancy-Sensing Lighting Controls	12. Passive House	13. Energy Recovery Ventilation	14. Low-Flow Plumbing Fixtures	15. Micro Wind Turbine
16. HEPA Air Filtration	17. Peak Electric Load Shifting	18. CO2-Controlled Ventilation	19. Economizer Mode for Air Conditioners	20. Variable Speed Drives on Fans and Pumps

https://www.ny-engineers.com/blog/20-green-design-features-for-buildings

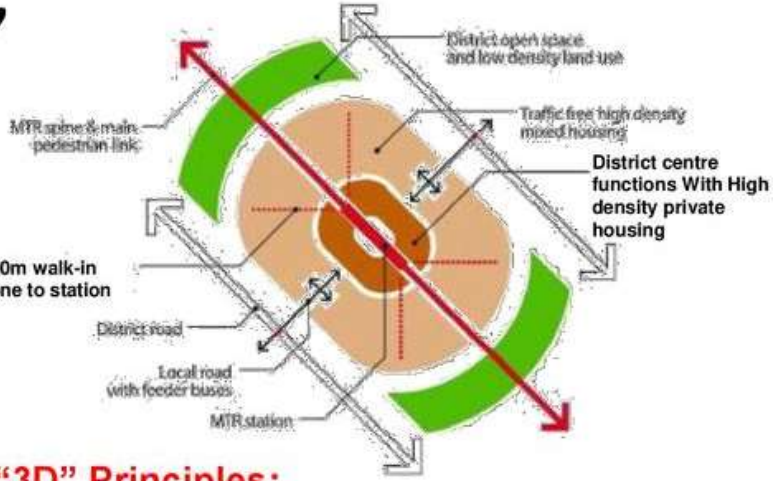
Different rating systems of green buildings

- LEED (US)
- BREEM (UK)
- DGNB (Germany)

1.3 Approaches - GREEN TRANSPORTATION

- Green Transportation or Sustainable Transportation comprises of those modes of transportation that do not depend on diminishing natural resources like fossil fuels → Rely on renewable energy sources.
- Very low impact on the environment
- Exemplar approaches:
  - Electric vehicles
  - TOD (transit-oriented development)
    - Issue with socio-spatial segregation and social justice

"TOD"



"3D" Principles:

- **High Development Density**
  Intensive and efficient land use within the station walk-in catchment area
- **Land Use Diversity**
  Enhance the life and vibrancy of the community
- **High-Quality Community Design**
  Seamless connection and interchange, segregation of pedestrian and vehicular traffic, greening environment

1.3 Approaches - Circular economy (urban metabolism)

» **Urban metabolism** (engineering definition): a model to facilitate the description and analysis of the flows of the materials and energy within cities

A schematic model of urban metabolism

https://www.moreno-web.net/comprendre-le-metabolisme-urbain/

1.3 Approaches - Circular economy (urban metabolism)

- Circular economy: "a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible“ (European Parliament. https://www.europarl.europa.eu/news/en/headlines/economy/20151201STO05603/circular-economy-definition-importance-and-benefits)

- Critique: An ideological agenda dominated by technical and economic accounts (Corvellec et al., 2021)
  - Depoliticization
  - Uncertain contribution
  - Limits in implementation

https://s3-eu-west-1.amazonaws.com/europarl/circular_economy/circular_economy_en.svg

DISCUSSION

Is it truly eco- or sustainable if you build an eco-city brand new?

Watch video:

THE LINE | The City of the Future

(0’55”-5’20”)

By NEOM

https://www.youtube.com/watch?v=eoDR8wgoCM8

Discussion

- What are the key aims and approaches of the LINE? Do you think the LINE can achieve its set goals?
- What are the main challenges or issues the project has to address?

1.4 Main critiques

- **Eco-cities are often built brand-new**
  - Again, a form of sprawl
  - It consumes an enormous amount of resource.
  - While carbon footprint is reduced in the new eco-city, carbon footprints are increasing somewhere else. In other words, eco-cities' impact on the environment transcends the city and national borders and are massive.
- **Eco-cities are built often taking little or no consideration of local ecologies**
- **These projects are usually only affordable by the wealthy people – not socially just or sustainable.**

Main critiques

- Political-economy critique
  - Mere remedies of capitalism that is inherently crisis-laden
  - A "green stimulus" for capitalism (Jonas and While, 2009; Keil, 2009)
  - A tool of place-branding:
    - A mere spectacle?
    - The tacit rule of visibility
- Techno-rationality critique
  - *…This is a politics that "legitimizes itself by means of a direct reference to the scientific status of its knowledge" … This reduction of the political to the policing of environmental change … evacuates if not forecloses the properly political and becomes part and parcel of the consolidation of a postpolitical and postdemocratic polity…. (Swyngedouw, 2009: 602, quoting Žižek, 2006:188)*

https://www.thesmartcityjournal.com/en/articles/eco-innovations-eco-cities-eco-towns

2.
SMART CITIES

CONTENTS

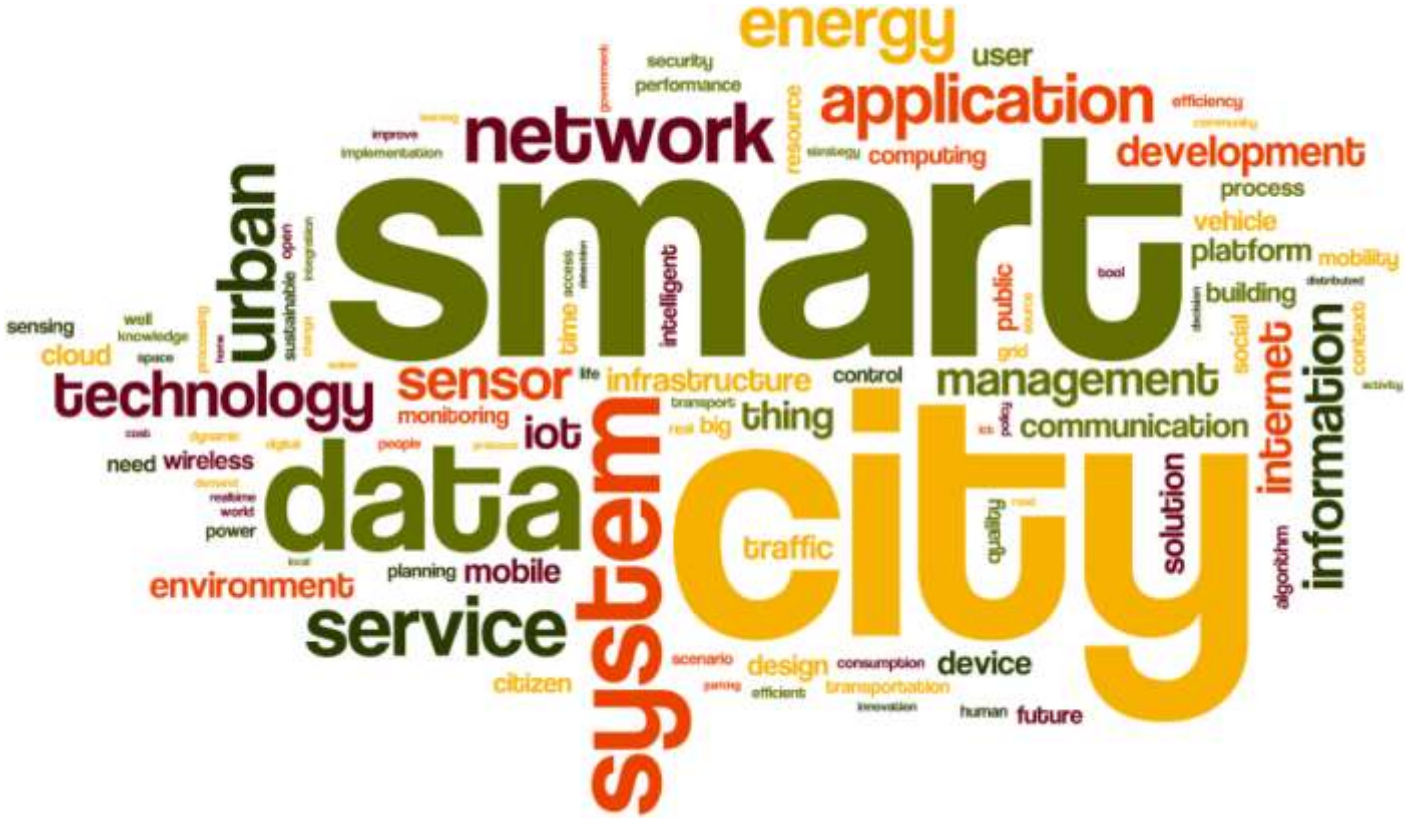
DISCUSSION

What should a “smart city” be like?

Top 100 words representing the smart city literature

identified using a topic modeling method

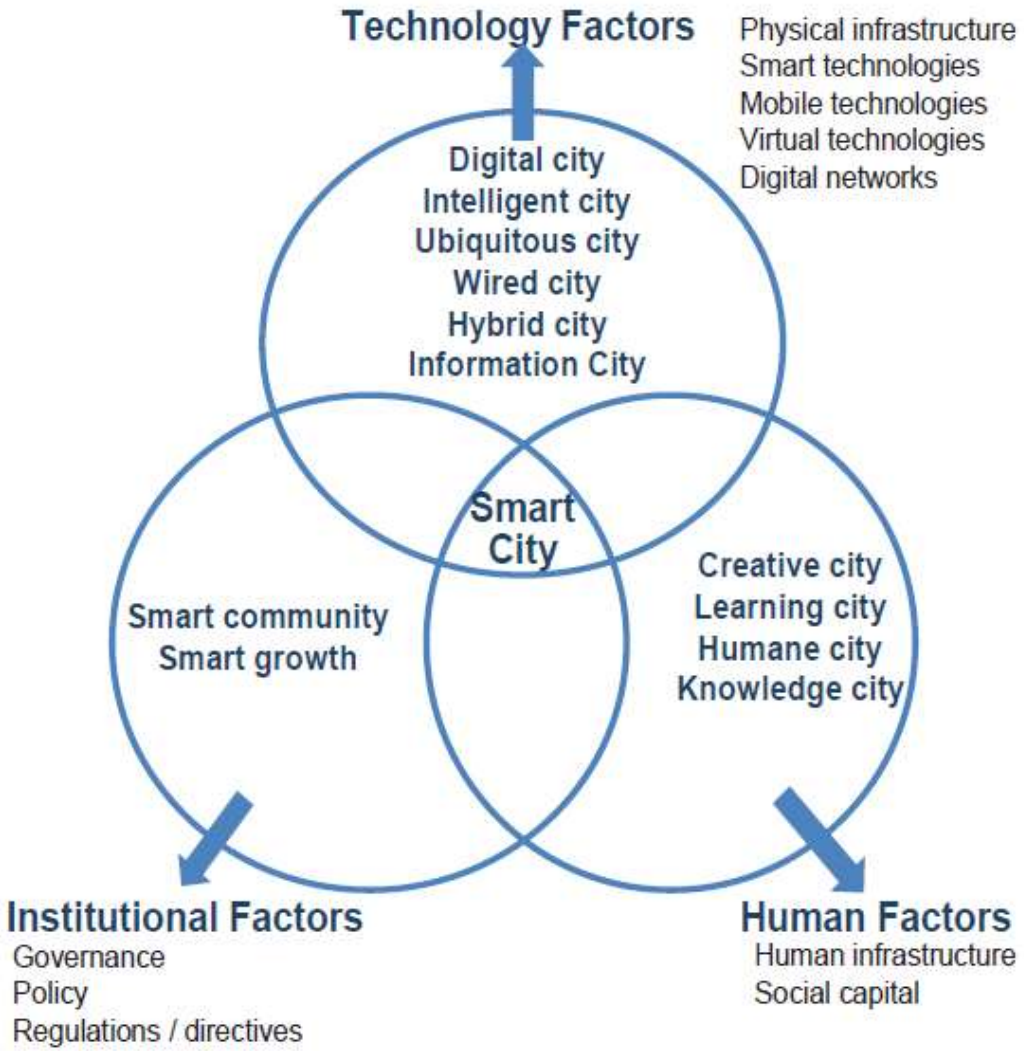
C. Lim, K.-J. Kim, P. P. Maglio (2018). Smart cities with big data: Reference models, challenges, and considerations. Cities, 82, 86-99. https://doi.org/10.1016/j.cities.2018.04.011.



1.1 Definitions of ‘smart’ cities

What comprise a smart city? – Various frameworks

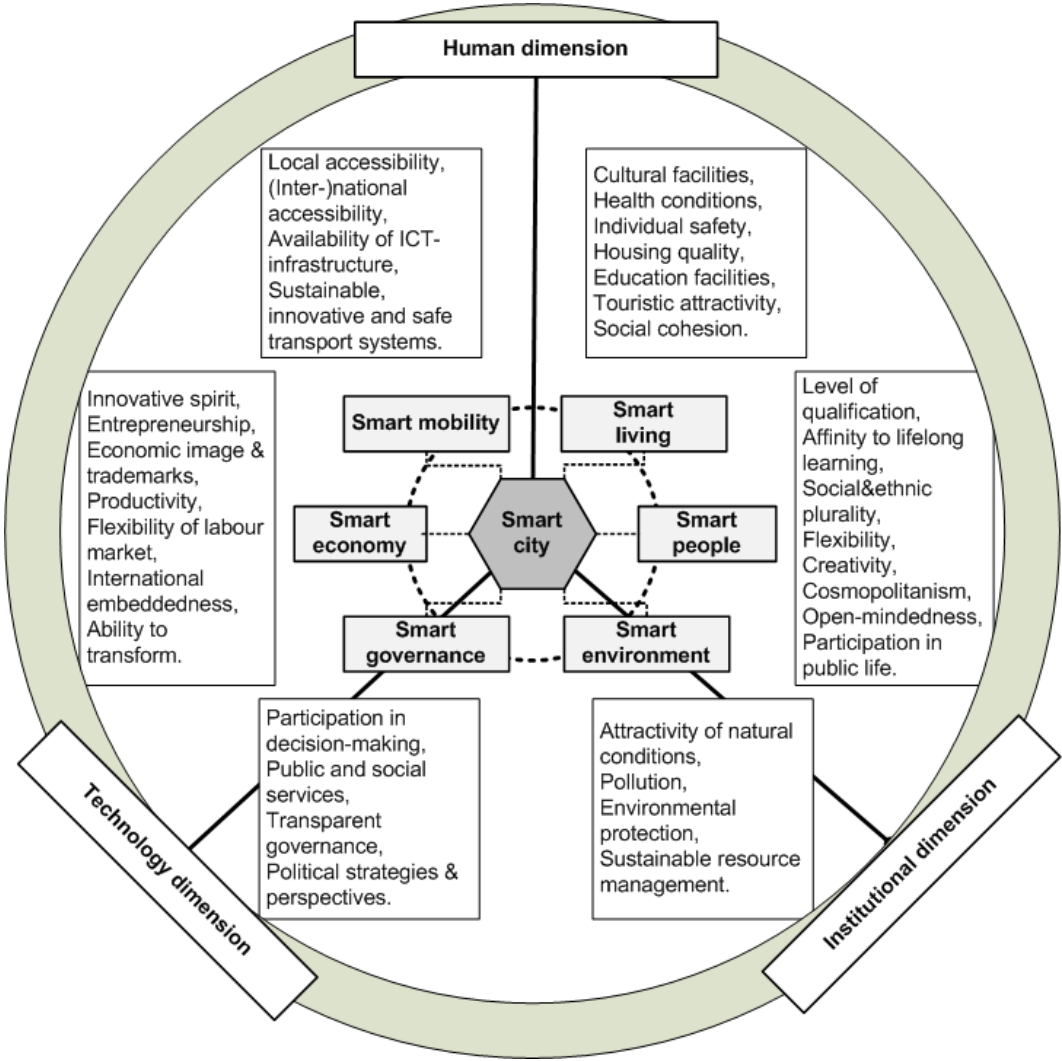
Taewoo Nam and Theresa A. Pardo. 2011. Conceptualizing smart city with dimensions of technology, people, and institutions. In Proceedings of the 12th Annual International Digital Government Research Conference: Digital Government Innovation in Challenging Times (dg.o '11). ACM, New York, NY, USA, 282-291. DOI=http://dx.doi.org/10.1145/2037556.2037602.



1.1 Definitions of ‘smart’ cities

What comprise a smart city? – Various frameworks

Pozdniakova (2017). THE CONCEPT OF ‘SMART CITY’: DIMENSIONS, CHARACTERISTICS AND MODELS. https://www.researchgate.net/publication/319529477_THE_CONCEPT_OF_'SMART_CITY'_DIMENSIONS_CHARACTERISTICS_AND_MODELS



"Smart Cities must be considered as systems of people who interact and use flows of energy, materials, services and financing to catalyse sustainable economic development, resilience, and a high quality of life; these flows and interactions are "smart" through the strategic use of ICT infrastructure and services within a transparent urban planning and management process that responds to the social and economic needs of the society".

- EIP-SC European Innovation Partnership on Smart Cities and Communities

"a 'smart city' means 'smart citizens' – where citizens have all the information they need to make informed choices about their lifestyle, work and travel options"

- Manchester Digital Development agency

"the effective integration of physical, digital and human systems in the built environment to deliver sustainable, prosperous and inclusive future for its citizens"

- The British Standards Institute (BSI)

"one that makes optimal use of all the interconnected information available today to better understand and control its operations and optimize the use of limited resources"

- IBM

A smart city is an urban area that uses different types of electronic Internet of things (IoT) sensors to collect data and then use insights gained from that data to manage assets, resources and services efficiently

- Wikipedia

Broad definitions **Data-driven definitions** **Citizen-centered definitions**

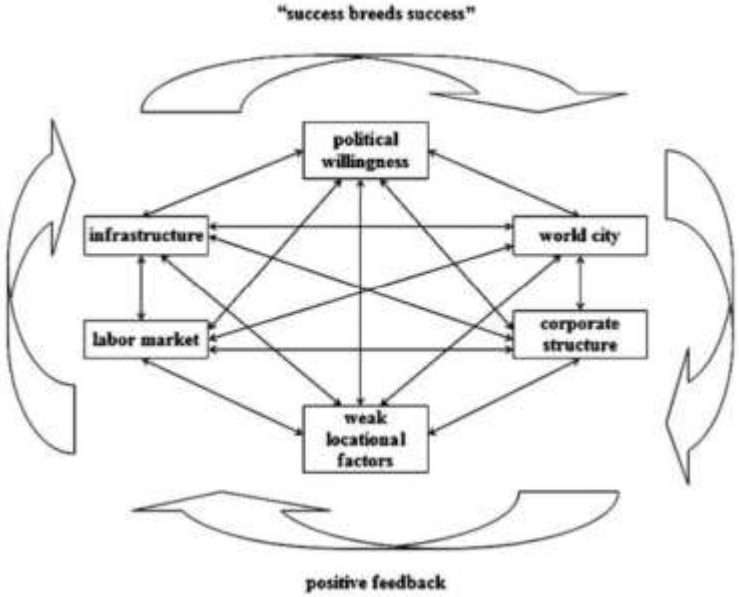
1.1 Definitions of ‘smart’ cities

Various notions of smart cities or alike

- *Knowledge cities*
- *Information cities*
- *Digital cities*
- *Cyber cities*
- *Ubiquitous cities*
- *Smart cities*
- *Intelligent cities*

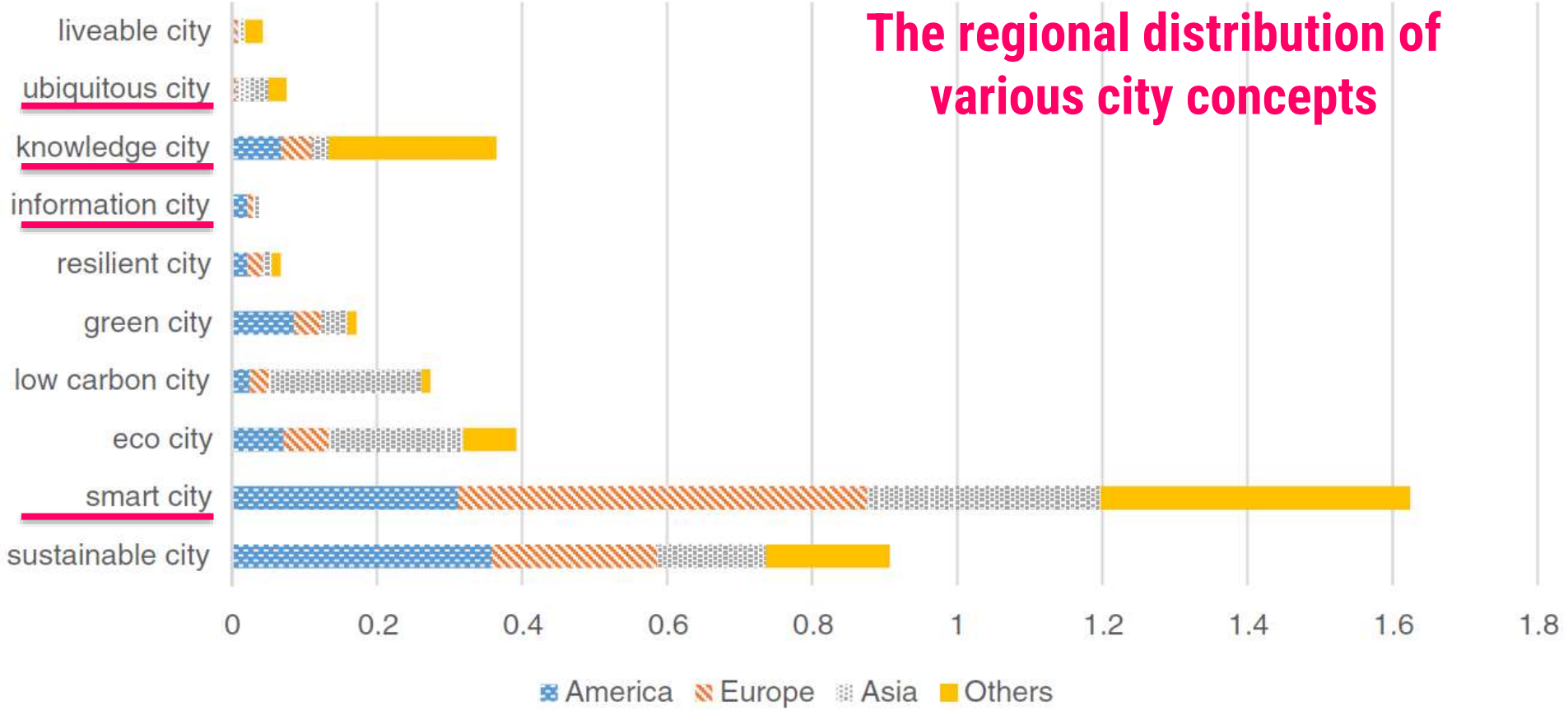
Definition	Main characteristics
Digital city	Emphasis on digital infrastructures (for communication and computing)
Ubiquitous city	Emphasis on ubiquitous access to public services through any connected devices. An extension of the digital city concept.
Information city	A notion popularized mostly by M. Castells; Emphasis on information infrastructure, global flows and control centers of information, etc., and knowledge economy.
Smart/Intelligent city	Emphasis on cognitive technologies, such as artificial intelligence and machine learning,

The development of an informational city from the perspective of network economics



Stock, W. G. (2011). Informational Cities: Analysis and Construction of Cities in the Knowledge Society. JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE AND TECHNOLOGY, 62(5):963–986, 2011

The regional distribution of various city concepts

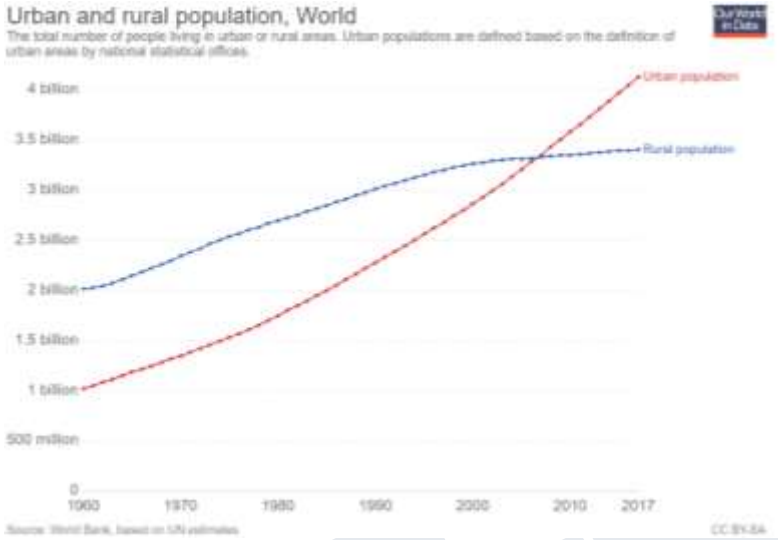


Fu, Y. & Zhang, X. (2017). Trajectory of urban sustainability concepts: A 35-year bibliometric analysis. Cities, 60: 113-123.

1.2 A BRIEF HISTORY

Historical context

- Increasing urban population and urban challenges
  - Cities consume between 60% and 80% of energy worldwide and are responsible for large shares of GHG emissions (UN, 2008)
- The spread of the Internet and the rise of the information and digital society, as well as AI technologies



https://ourworldindata.org/exports/urban-and-rural-population_v4_850x600.svg

1.2 A BRIEF HISTORY

Development trajectory

- The notion of smart city was first used in the 1990s, focusing on the significance of new ICT technologies to modern cities.
  - 1990s – 2010s: ICT
  - 2010s – Present: Big data and AI

technology-oriented	→	governance-oriented
efficiency- and effectiveness oriented	→	sustainability/resilience oriented
an urban labeling phenomenon	→	actual practices
a collection of discrete flagship projects	→	a sizeable market opportunity and a standard code of practice

IBM's smart city program

- 2005: part of IBM's Smarter Planet initiative, which promoted information-technology-driven urban change with city governments as clients or partners.
- 2007: a data analysis platform for municipal service management
- 2008: Global sub-prime mortgage crisis → Cities' concern with increasing competitiveness
- 2010: Smarter Cities Challenge

- Operation center projects,
  - e.g. a power distribution system in United Arab Emirates (2005)
  - e.g. Rio de Janeiro's Urban Operations Center for the 2014 FIFA World Cup and the 2016 Summer Olympic Games

Rio de Janeiro's Operations Centre

http://icities4greengrowth.in/casestudy/rio-de-janeiros-operations-centre-rio-de-janeiro-brazil

1.3 Main goals, approaches, and challenges

Main goals

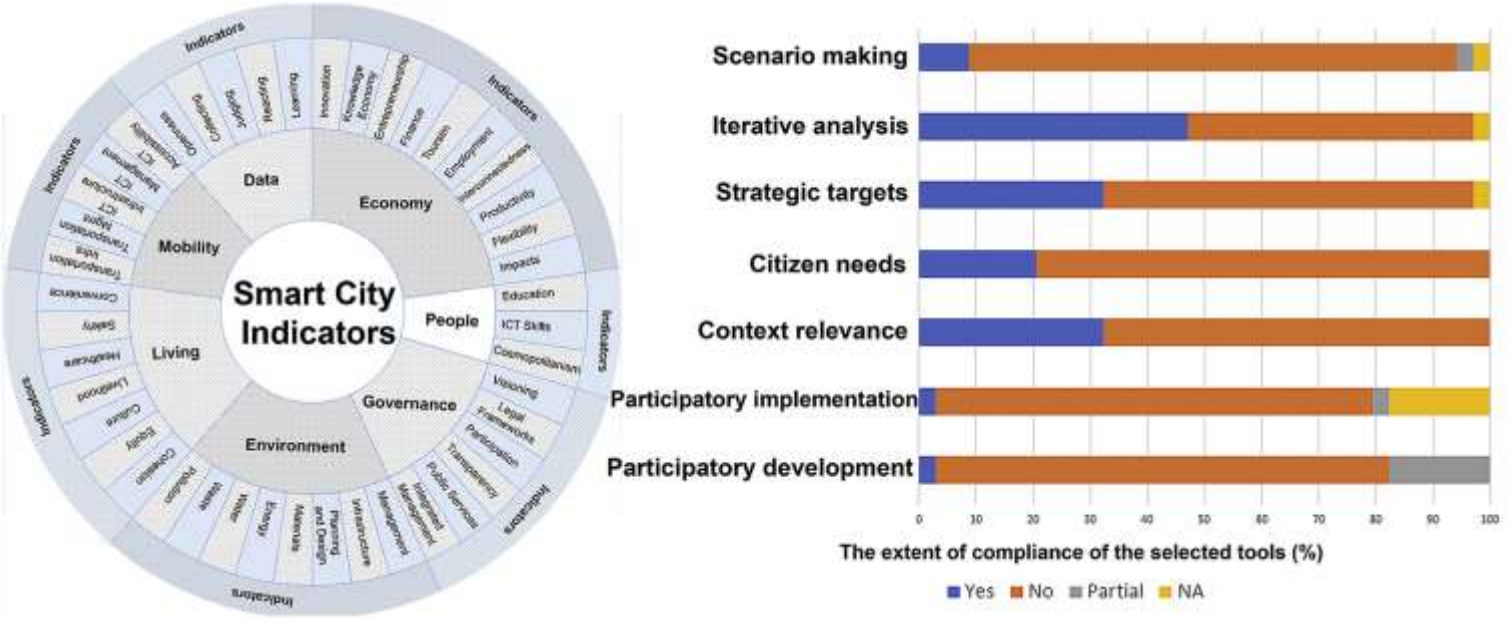
- **Safety**: Reducing accidents, injuries, fatalities, and emergency response times
- **Sustainability**: reducing CO2 emissions and other pollutants/contaminants
- **Efficiency**: Improving city operations and logistics to offset costs
- **Equality**: Creating ladders of opportunities for under-served or underprivileged areas and populations
- **Engagement**: Improving citizen engagement and social interactions

1.3 Main goals, approaches, and challenges

Essential technologies and strategies

- Also, a series of **indicators**
- Pervasive wireless connectivity
- Open, big data
- Internet of Things (IoT)
- Artificial Intelligence (AI)
- **Sustainable commerce models**
- ……

Indicators, indicators, indicators!!!



A. Sharifi (2019). A critical review of selected smart city assessment tools and indicator sets. Journal of Cleaner Production, 233, 1269-1283

Connectivity

There are more than 30 different connectivity options with different bandwidth, range, cost, reliability, and network-management features.

Connectivity

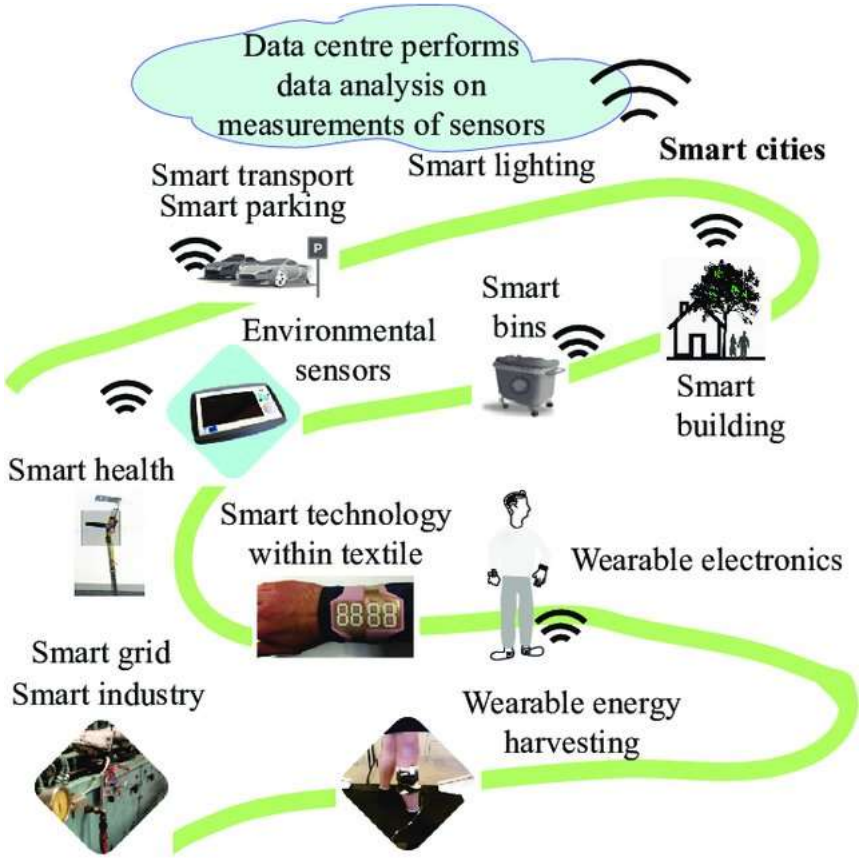
Connectivity

Four categories of connectivity solutions

- Unlicensed: cheap yet relatively unstable, small range
- Low power, wide area (LPWA): long battery life, extensive range, reliable, still in the early stages of deployment,
- Cellular: High reliability, available, cost, and power consumption
- Extraterrestrial: e.g. satellites; high range, highest cost

Sector	Potential use cases	Bandwidth	Range	Reliability	Willingness and ability to manage a network	Noncellular short range	LPWA[1]	Cellular and other long range
Automotive	Over-the-air updates, predictive maintenance	Primarily low, high for entertainment content	Medium–long	High	Low	● Wi-Fi/Bluetooth for in-car connectivity		● Deliver content to vehicle
Manufacturing	Operations optimization, predictive maintenance	Low	Short–medium	High	Low		● Connectivity within factories	
Defense	Asset management, remote monitoring	Medium	Long	High	Medium			● Satellite for connectivity in remote locations
Agriculture	Yield optimization, asset management	Low	Short	High	Low		● Sensor monitoring in fields	● Satellite if there's no coverage
Mining	Predictive maintenance, operations	Low	Medium–long	High	Low–medium		● Sensor monitoring and machine control	● Fiber to reach mines
Construction	Predictive maintenance, operations optimization	Low	Short	Medium	Low	● Site connectivity, geofencing		
Oil and gas	Predictive maintenance, production optimization	Low	Medium–long	High	Low–medium		● Sensor monitoring	● Private cellular network possible
Insurance	Patient monitoring, asset management	Low	Long	Medium	Low			Public LTE is sufficient and deployed for use cases
Healthcare	Remote monitoring, safety	Low	Short–medium	Medium	Low	● Deployed today and can be used to locate positions		
Cities	Traffic control, security	Low	Medium–long	High	Low–medium		● Sensor connection and device control	● Private LTE deployed only in select cities
Utilities	Asset management, remote monitoring, energy management	Low	Long	High	Low		● Meter connections	● Select utilities utilizing private networks
Travel, transport, and logistics	Predictive maintenance, logistics optimization, automation	Low	Long	High	Low	● Cargo tracking	● Cargo tracking	● Private network on ships
Consumer	Productivity optimization, personalization, energy monitoring	Medium–high	Short	Medium	Low	● Consumer devices		● Consumer devices

https://www.mckinsey.com/featured-insights/internet-of-things/our-insights/the-future-of-connectivity-enabling-the-internet-of-things



A smart city intelligent environment using IoT to connect elements and provide services

Balsamo, Domenico & Merrett, Geoff & Zaghari, Bahareh & Wei, Yang & Ramchurn, Sarvapali & Stein, Sebastian & Weddell, Alex & Beeby, Stephen. (2017). Wearable and autonomous computing for future smart cities: Open challenges. 10.23919/SOFTCOM.2017.8115596.

Sustainable commerce models based on and for the smart city

- Subscription-based models offer a way to monetize hardware and software used to build smart infrastructures and spread out expenses moving away from a huge one time CAPEX (capital expenditures) spend.
  - Expensive medical equipment like MRI scanners, for example, can be sold at a cost-per-scan basis rather than as a one-time upfront expense for hospitals.
  - Affordable subscriptions to fleets of vehicles shared between owners who may choose from an array of custom options.

1.3 Main goals, approaches, and challenges

- Together, smart city technologies are optimizing infrastructure, mobility, public services, and utilities.
- **Various smart solutions for cities**

Smart traffic

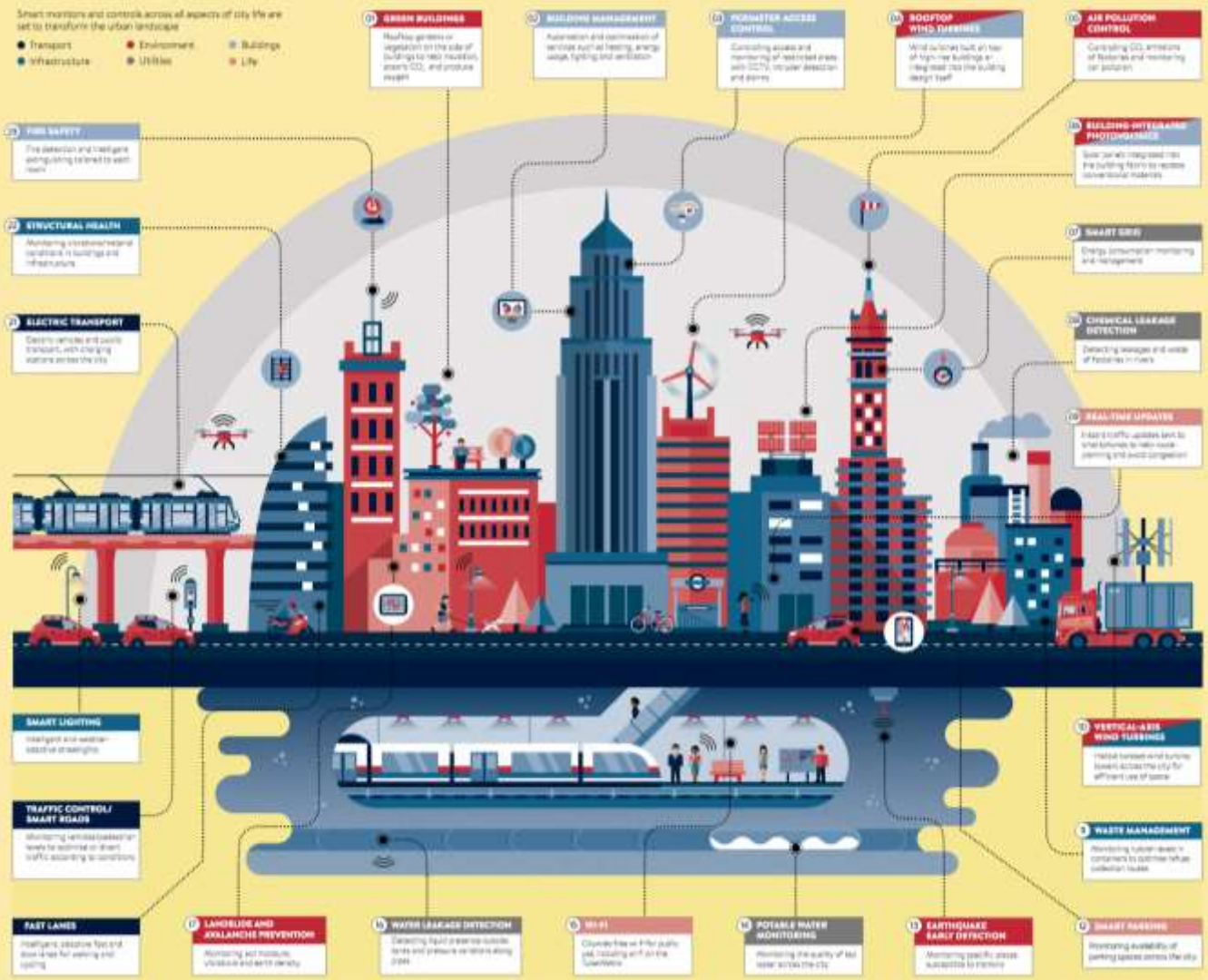
Smart grid

Smart garbage

Smart shopping

Smart governance

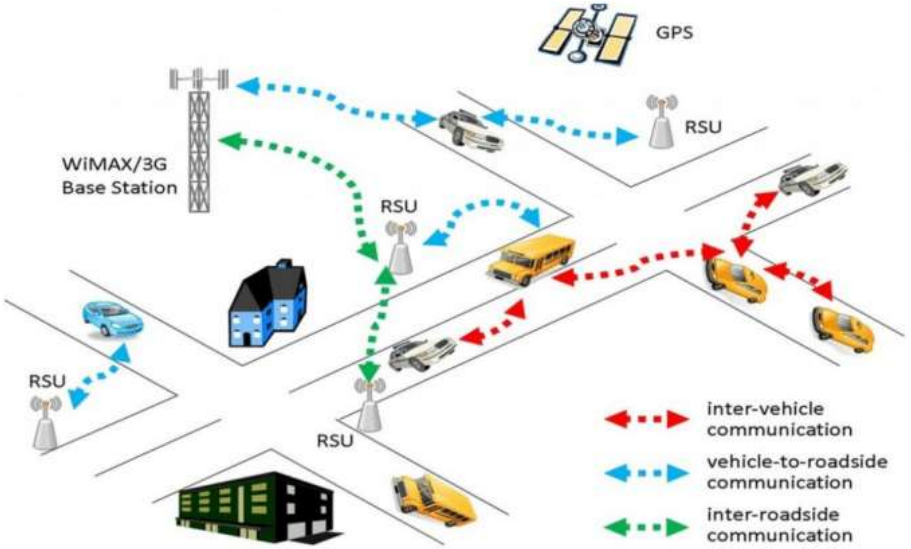
SMART SOLUTIONS FOR CITIES



https://www.visualcapitalist.com/wp-content/uploads/2017/08/smart-cities.html

Smart Traffic

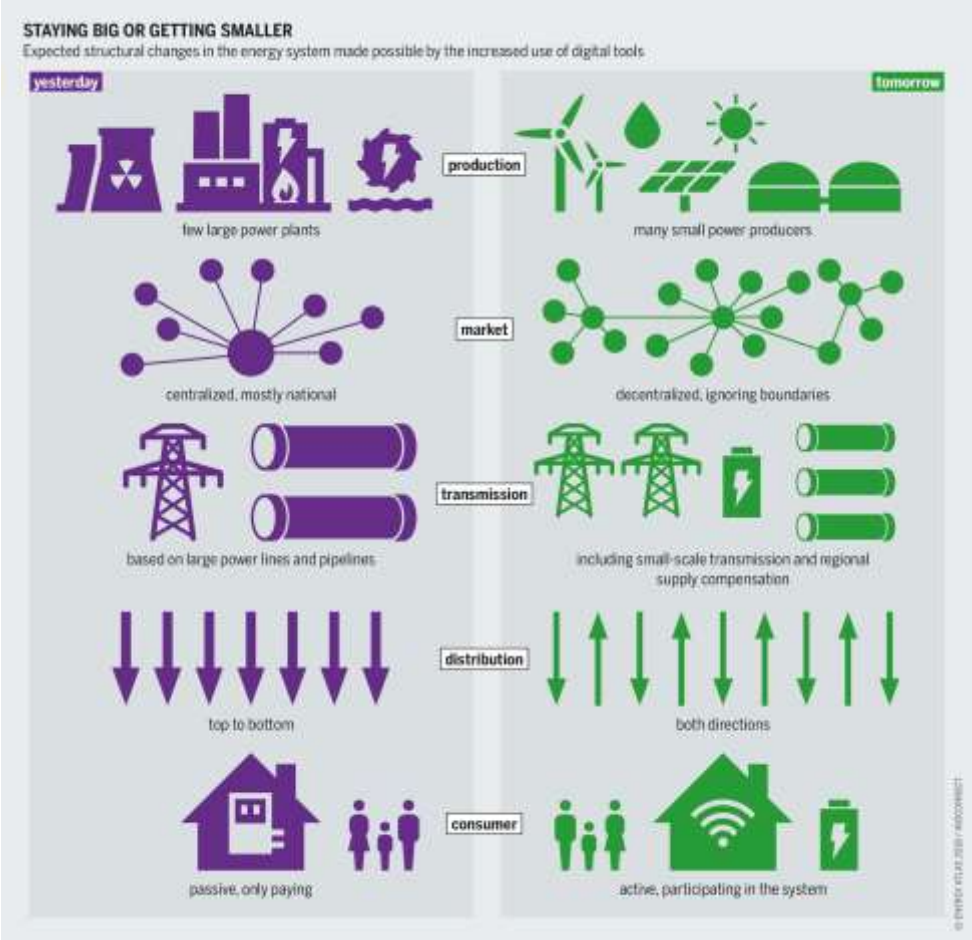
https://menafn.com/1099794070/Insights-On-Advanced-Traffic-Management-for-Smart-Cities-Market-Report-2020-2026-Global-And-Regional-Perspective-Market-Share-Revenue-Sales-Channel-Production-And-Consumption-Analysis



https://www.researchgate.net/figure/Example-of-an-Intelligent-Transport-System-ITS-scenario-1_fig3_304998579

Smart Grid

- Smart grid solutions: From centralized power generation and distribution to distributed generation (e.g., solar panels) and responsive power distribution and management



https://en.wikipedia.org/wiki/Smart_grid

Smart Garbage Cans at BU

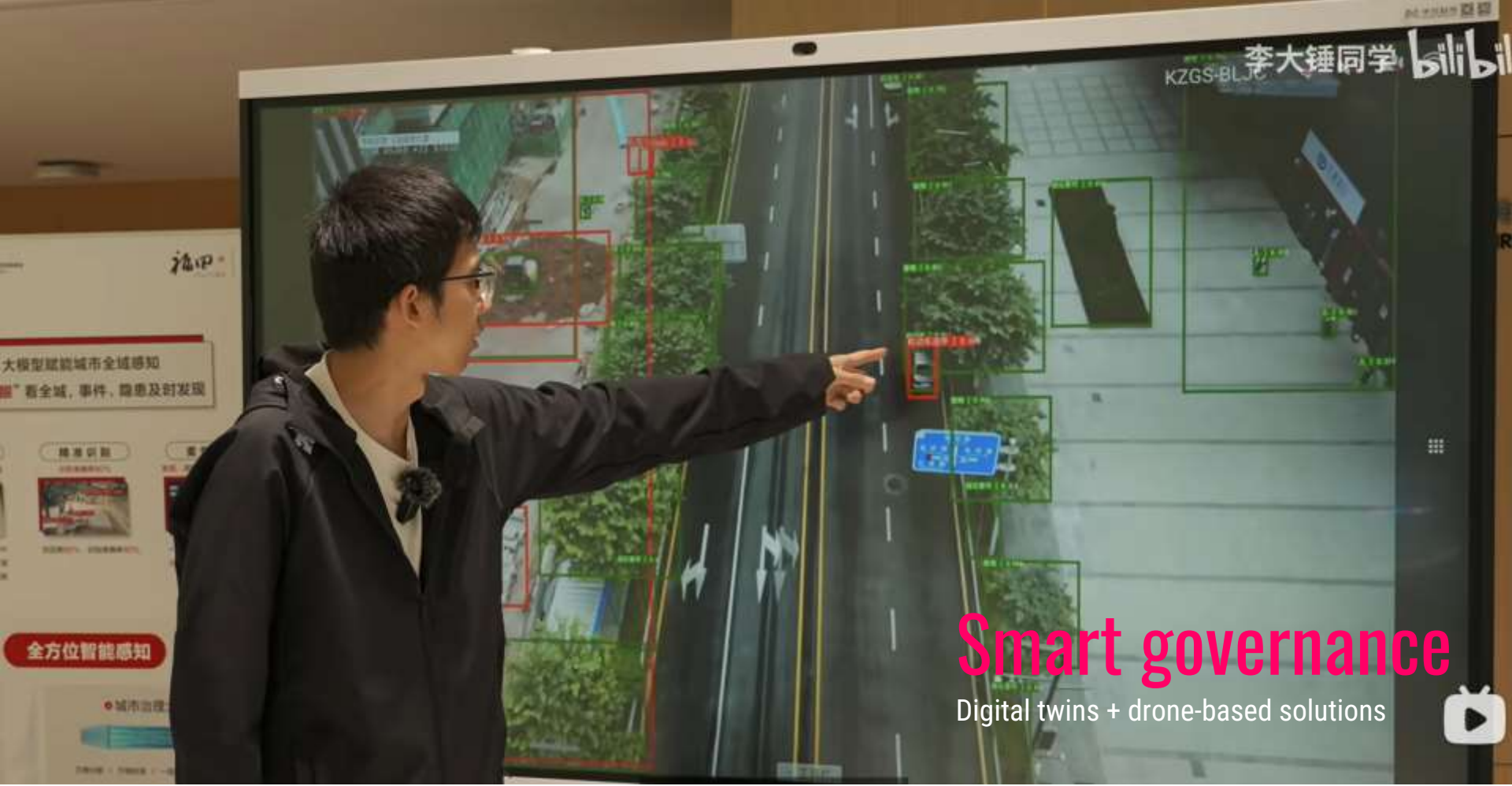
These compacting trash receptacles are self-powered, harnessing the sun's rays for 100% of their energy needs. The units take up about the same space as traditional trash bins, but have five times the capacity for trash. Through a wireless connection, collection vehicles are alerted when Bigbelly receptacles are full. Bigbelly trash compactors have reduced on-campus trash collection from 14 times/week to an average of 1.6 times/week. Solar compaction has reduced fuel use and associated greenhouse gas emissions by 80%.

http://www.bu.edu/cpo/what-we-do/waste-management/

https://www.sohu.com/picture/293278021

Smart Shopping

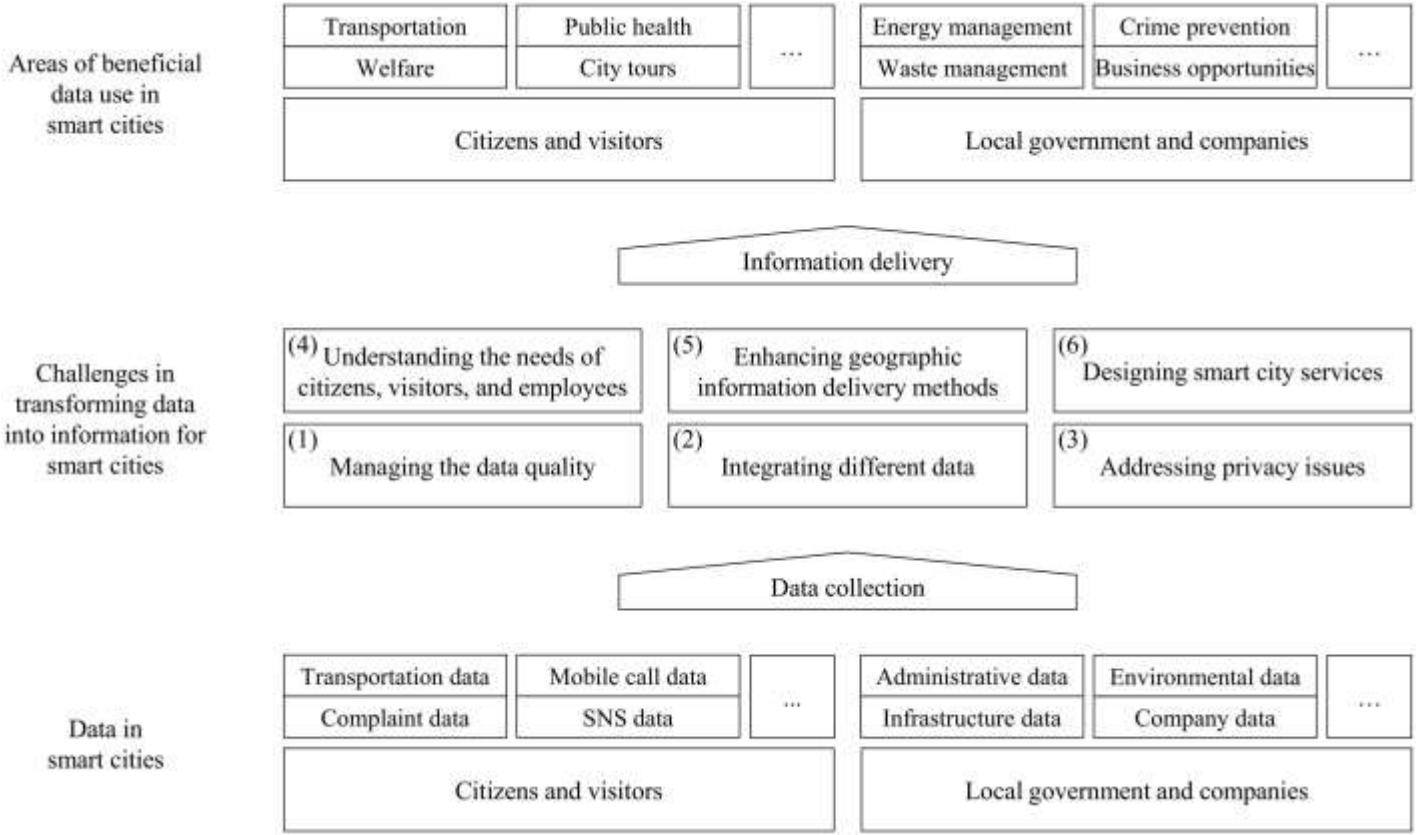
Unmanned grocery stores in China



https://www.bilibili.com/video/BV1m34y1c7Y7/?spm_id_from=333.1387.favlist.content.click&vd_source=2339ccc0bfaf8cd8af2d04b9fb8a1935

3. Challenges

- Availability: actionable, real-time, and reliable access to data
- Integrity: reliable and accurate data
- Confidentiality: Steps must be taken to prevent unauthorized disclosure of sensitive information.
- Accountability: Users of a system must be responsible for their actions.



Challenges in transforming data into information for smart cities

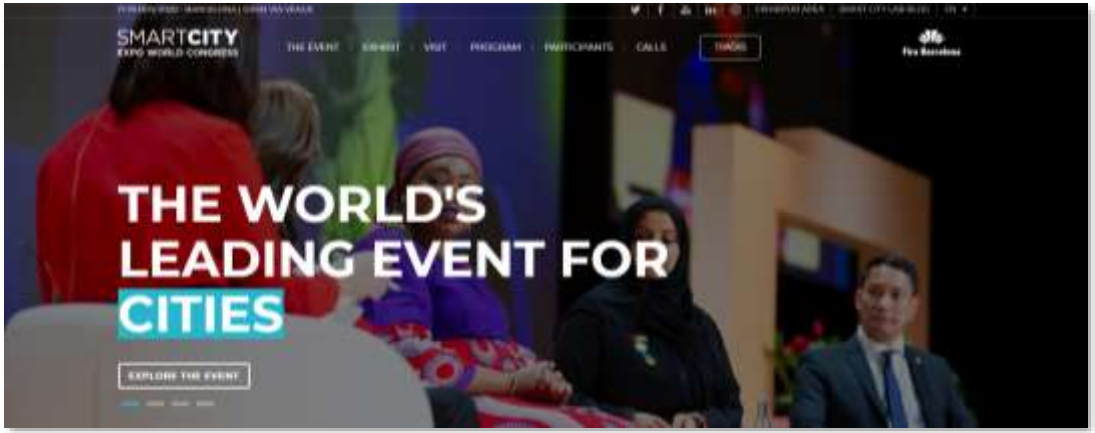
C. Lim, K.-J. Kim, P. P. Maglio (2018). Smart cities with big data: Reference models, challenges, and considerations. Cities, 82, 86-99. https://doi.org/10.1016/j.cities.2018.04.011.

Smart Cities Council

https://smartcitiescouncil.com/

Smart City Expo World Congress

http://www.smartcityexpo.com/en/home



DISCUSSION

Do you prefer to live in a smart city or not? Why?

Top-down v.s. Bottom-up

Technology-centered v.s. People-centered

2.4 Main critiques

- Concern with security, privacy, and freedom
- Political economy critique:
  - Smart cities are often
    - Marketing tools of local governments for the purpose of city-branding or place promotion
    - Therefore, an instrument of capitalist accumulation
  - Smart cities often have little concern with social inequality and justice
- Techno-rationality critique: Expert-centered, post-political solutions

https://www.theatlantic.com/technology/archive/2011/03/is-there-a-downside-to-intelligent-cities-or-smart-cities/72068/

A scholar's critique of IBM's smart city initiative

Throughout their promotional literature and other documentation, 'smart' equaled 'efficient' equaled 'beneficial'. Who benefited, and where in a city those benefits were located, remained ambiguous, as did the meaning of 'efficiency'.

Alan Wiig (2015) IBM's smart city as techno-utopian policy mobility,
City: analysis of urban trends, culture, theory, policy, action, 19:2-3, 258-273

5 critiques of the Smart City push

It creates a control-oriented approach that gives access to a few people

It promotes a technocratic approach to city planning and government

It creates brittle and hackable urban systems

It runs the risk of creating a surveillance-state reliant on profiling

It pushes a narrative of algorithms as being free of biases

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QUESTIONS?

If you have any questions about the course, write them down. Feel free to ask me in the QQ group or via email. You can also bring your questions to our next class.

END OF CLASS

SEE YOU NEXT WEEK.