# THE ROLE OF OPEN DATA IN THE DEVELOPMENT OF SUSTAINABLE SMART CITIES AND SMART SOCIETY

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**Anastasija Nikiforova, PhD**

University of Tartu, Institute of Computer Science, Estonia

European Open Science Cloud, Task Force «FAIR metrics and data quality»

Expert of the Latvian Council of Sciences (1) Computer Science and Informatics, (2) Electrical Engineering, Electronics, ICT, (3) Social Sciences – Economics and Business

Associate member of the Latvian Open Technology Association

https://anastasijanikiforova.com/


TARTU ÜLIKOOL · UNIVERSITY OF TARTU · 1632

EUROPEAN OPEN SCIENCE CLOUD

# Bio

PhD in Computer Science – Data Processing Systems and Data Networking

Research interests include but are not limited to data management with a focus on **data quality, open government data**, Smart City, Society 5.0, sustainable development, IoT, HCI, digitization.

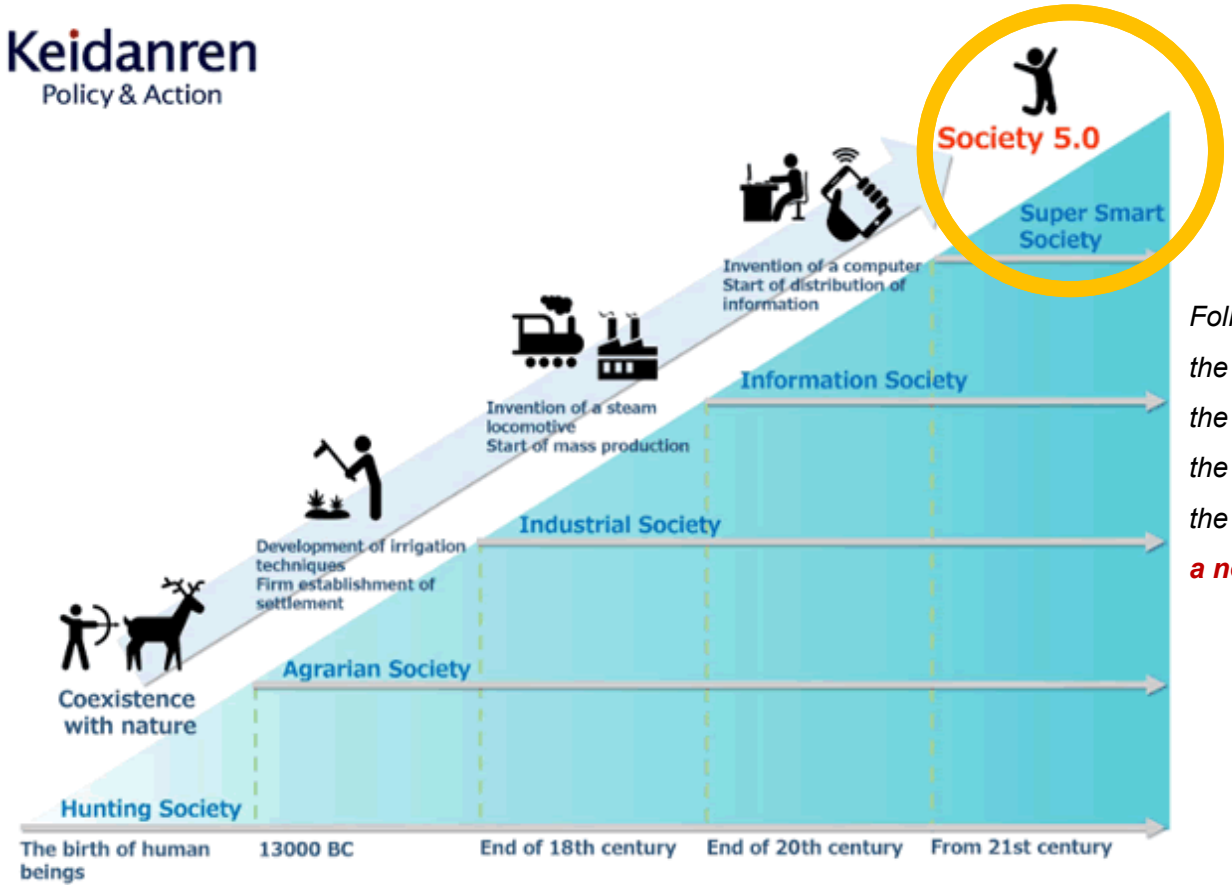
Most recent experience:

- Assistant professor at the **University of Tartu**, Institute of Computer Science
- **European Open Science Cloud** Task Force "*FAIR Metrics and Data Quality*"
- visiting researcher at the **Delft University of Tehnology,** Faculty Technology Policy and Manageme
- associate member of the **Latvian Open Technology Association.**
- expert of the **Latvian Council of Sciences** in (1) *Natural Sciences – Computer Science and Informatics*, (2) *Engineering and Technology-Electrical Engineering, Electronics, ICT*, (3) *Social Sciences – Economics and Business*
- expert of the ***COST – European Cooperation in Science & Technology***
- assistant professor & researcher in the Innovation Laboratory, Faculty of Computing, **University of Latvia**
- IT-expert at the **Latvian Biomedical Research and Study Centre, BBMRI-ERIC Latvian National Node**
- advisor for the Institute for **Social and Political Studies, University of Latvia**

# AGENDA

- ✓ **Society 5.0**
- ✓ **Open government data**
- ✓ ***OGD smartness***
- ✓ ***Transparency of open data ecosystems in smart cities***

# SOCIETY 5.0




*Following the hunting society (Society 1.0),*

*the agricultural society (Society 2.0),*

*the industrial society (Society 3.0), and*

*the information society (Society 4.0),*

*the far-reaching policies of Society 5.0 propose*

***a new transformation of contemporary ways of life.***

Image source: https://arcticanthropology.org/

Image source: https://globalbusinesscoalition.org/global-governance-news/b20-tokyo-summit-joint-recommendations-society-5-0-for-sdgs/attachment/figure-2-society-5-0-for-sdgs/

# SOCIETY 5.0

*«a way by which to guide and mobilize action in science, technology and innovation (STI) to achieve a prosperous, sustainable, and inclusive future»*

-- Japan, 5th Science and Technology Basic Plan

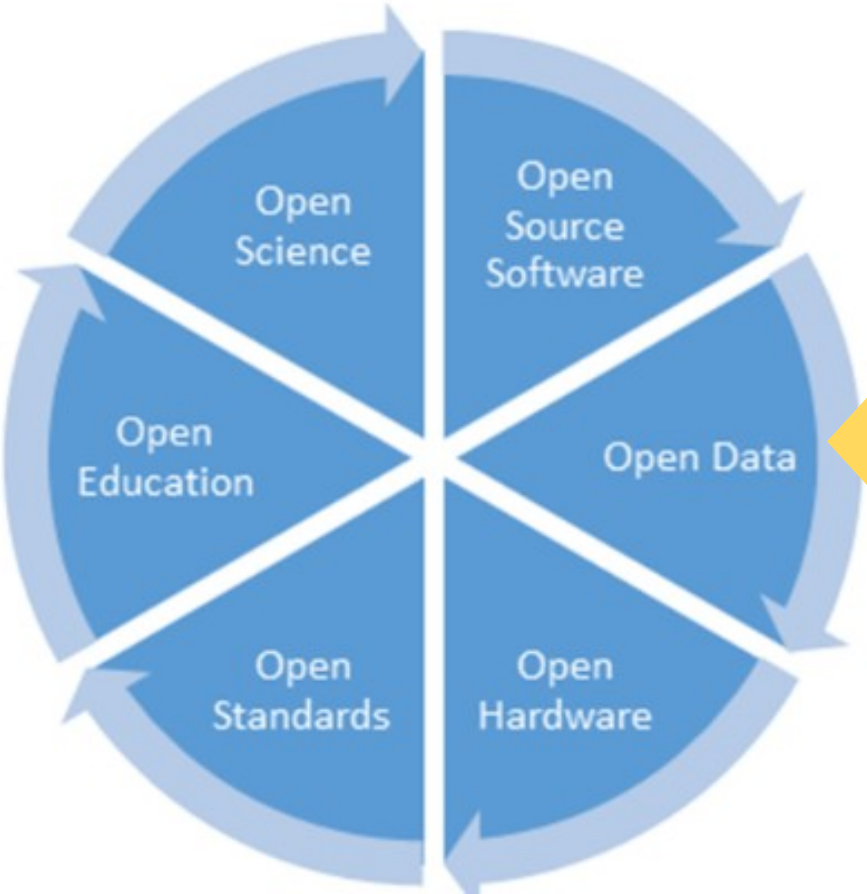
✓**Society 5.0 aims to resolve various modern social challenges by incorporating game-changing innovations such as the *Internet of things (IoT), robotics*, *AI* and *big data* into all industries and social activities.**

✓**Rather than a future controlled and monitored by AI and robots, technology is harnessed to achieve a *human-centred society* in which every person can lead an active and enjoyable life.**

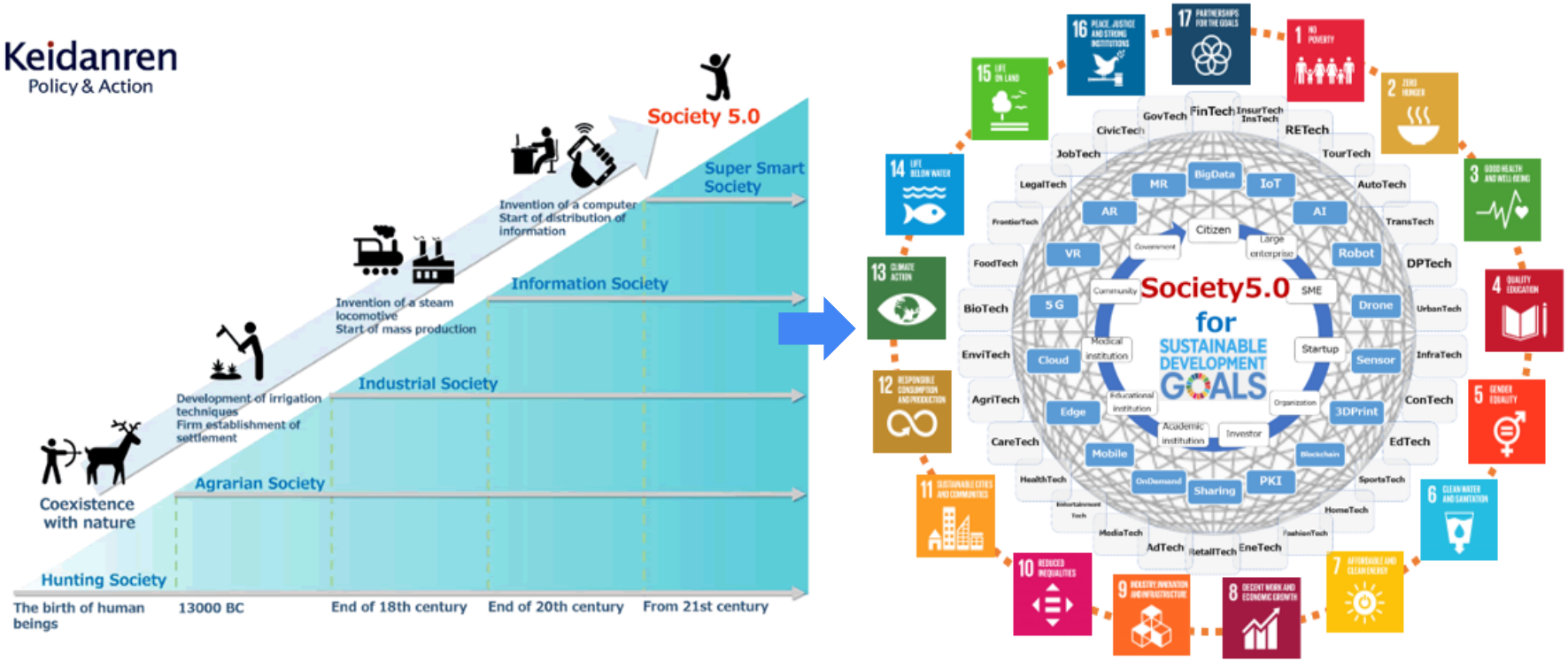
Source: https://www.japanhouselondon.uk/whats-on/2020/society-5-0-a-new-model-for-an-ageing-society-a-talk-by-professor-harayama-yuko/


Source: https://digital.thecatcompanyinc.com/b20magazine/tokyo-2019/society-5-0-updates-on-japanese-business-and-economy/

# OPENNESS




✓**Open data**, i.e., freely accessible, shareable, and usable data;
✓**Open science**, i.e., making scientific research and its dissemination accessible to all levels of the society;
✓**Open standards**, i.e., technology neutral specifications for hardware, software, or data developed through an open process;
✓**Open source software**, i.e., free and open collaborative software development;
✓**Open hardware**, i.e., physical products, machines and systems designed and offered by means of publicly shared information;
✓**Open education**, i.e., learning and teaching without barriers

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## DIGITAL TRANSFORMATION

X

## IMAGINATION AND CREATIVITY OF INDIVIDUALS

## PROBLEM SOLVING

## VALUE CREATION

https://digital.thecatcompanyinc.com/b20magazine/tokyo-2019/society-5-0-updates-on-japanese-business-and-economy/

# SMART CITY

✓**Smart City 1.0 – a city that uses ICT to collect data to improve its critical infrastructures and services' efficiency**

*(Hall et al., 2000; Harrison et al., 2010; Correia et al., 2022)*

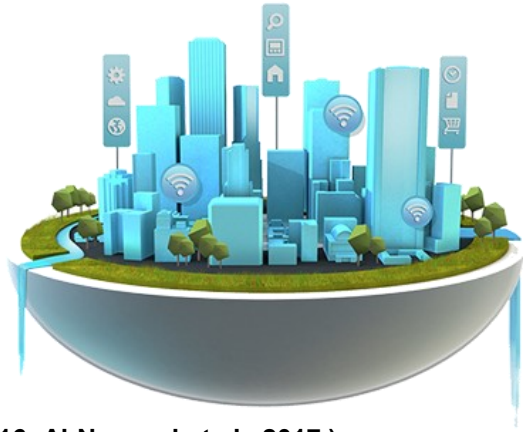
✓**Smart City 2.0 – a city that starts with the human capital, motivating citizens to create and flourish their lives, using ICT to increase the quality of life and the city's social, economic and environmental sustainability**

*(Angelidou, 2014; Mohanty et al., 2016; Hollands, 2008; Caragliu et al., 2009; Barrionuevo et al., 2012; Neirotti et al., 2014; Ahvenniemi et l., 2017; Correia et al., 2022).*

✓**Smart City 3.0 – a city that uses ICT to promote citizen engagement and active participation allows continuous interactions. the strategy is collaboratively created with citizens and relevant stakeholders**

*(Van der Van der Graaf et al., 2014; Albino et al., 2015; Trivellato, 2017; Correia et al., 2022)*

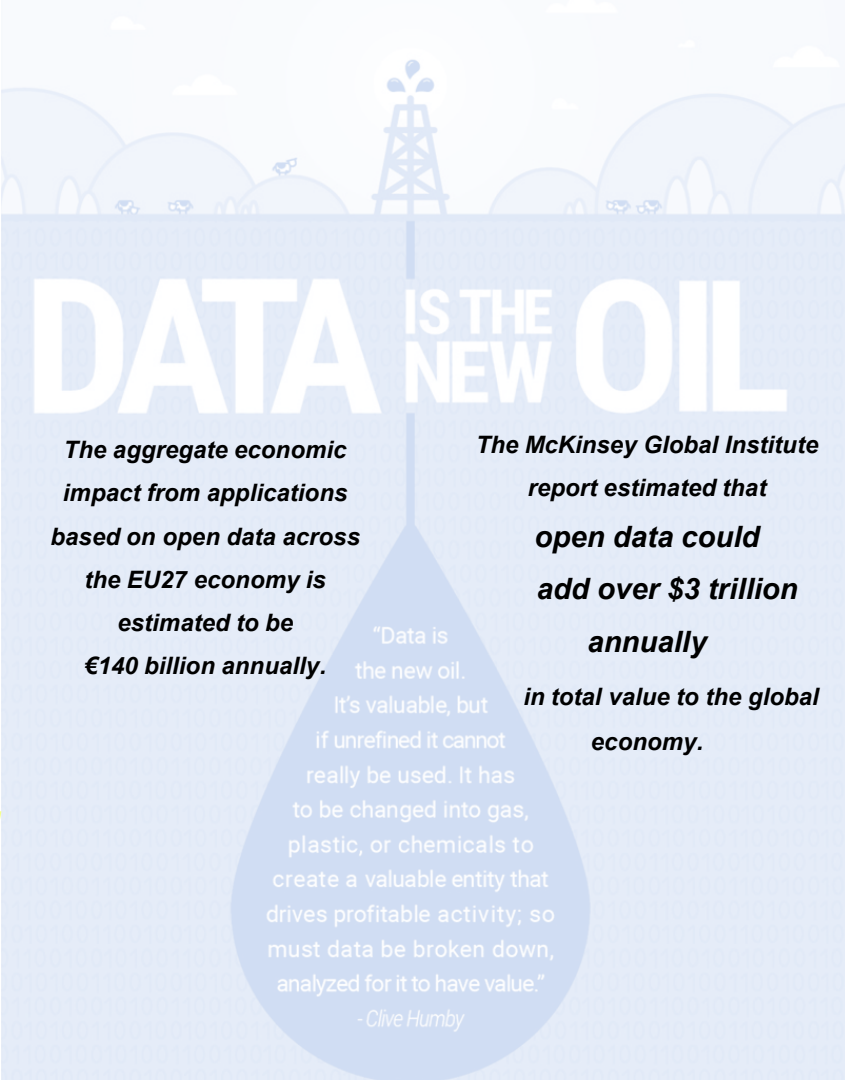
# SMART CITY 3.0



- ✓ The focus is on the inclusion of citizens in the co-creation and co-design of cities' processes and strategies to improve the policies' chances of success (Correia et al., 2022; Mainka et al., 2016; Al-Nasrawi et al., 2017,).
- ✓ smart cities should overcome inequality and social polarization (Correia et al., 2022; Hollands, 2008)
- ✓ the decision-making process must promote inclusion and reduce social barriers (Correia et al., 2022; Silva et al., 2018).
- ✓ the bottom-up participatory approaches play an essential role in assessing and developing Smart Cities

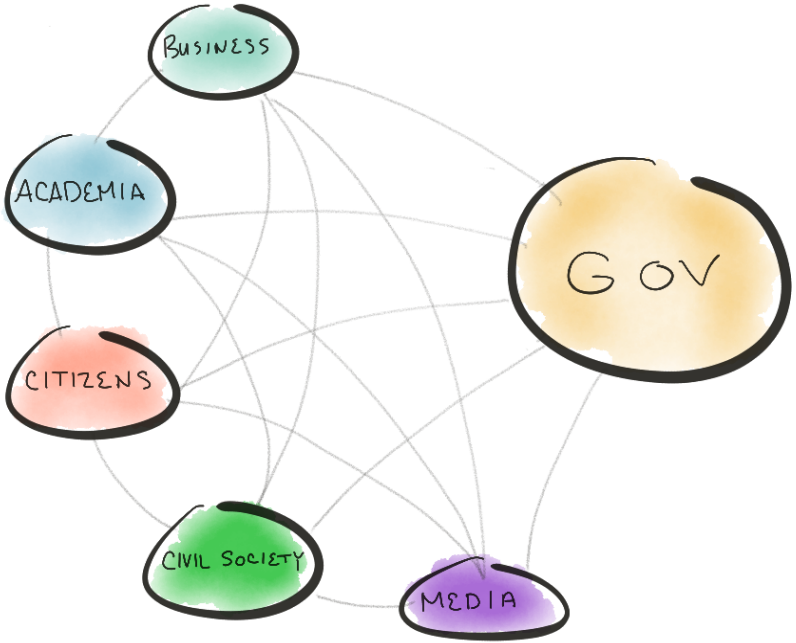
# OPEN DATA

***data that anyone can access, use and share***


***The aggregate economic impact from applications based on open data across the EU27 economy is estimated to be €140 billion annually.***

***The McKinsey Global Institute report estimated that open data could add over $3 trillion annually in total value to the global economy.***

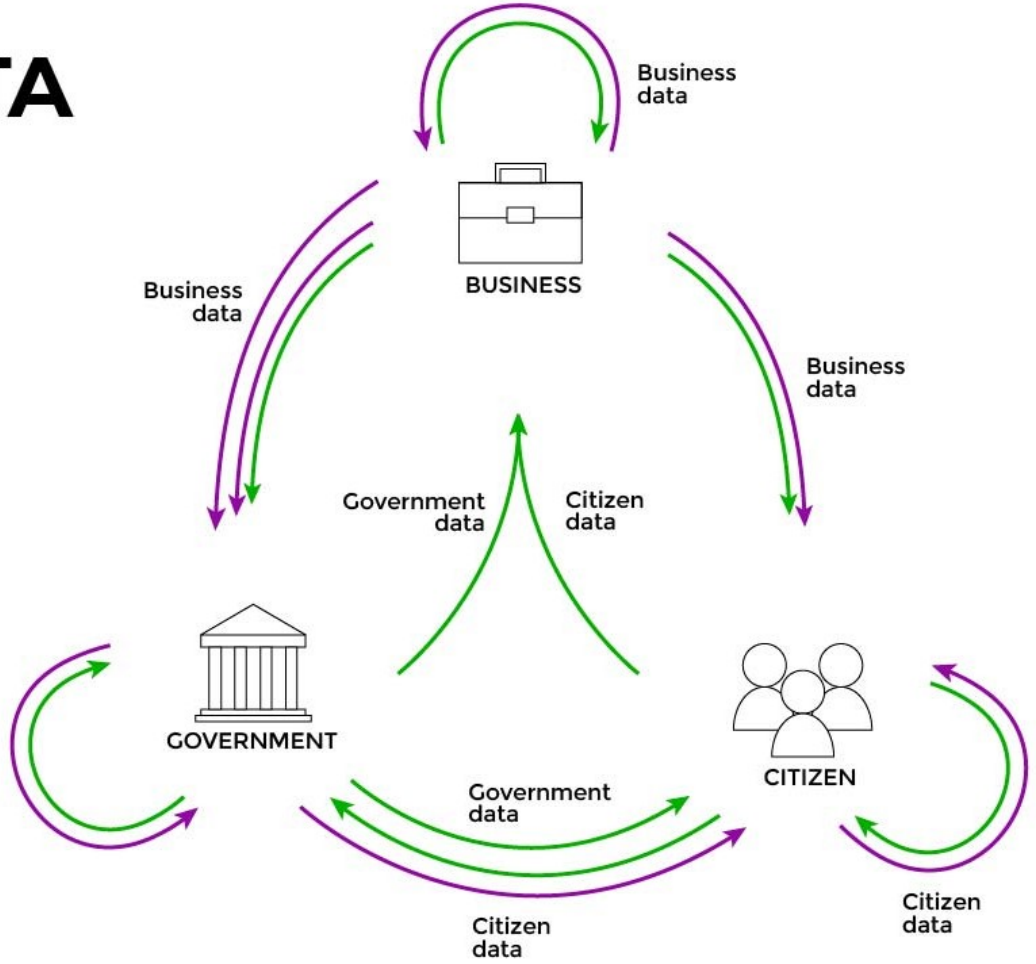


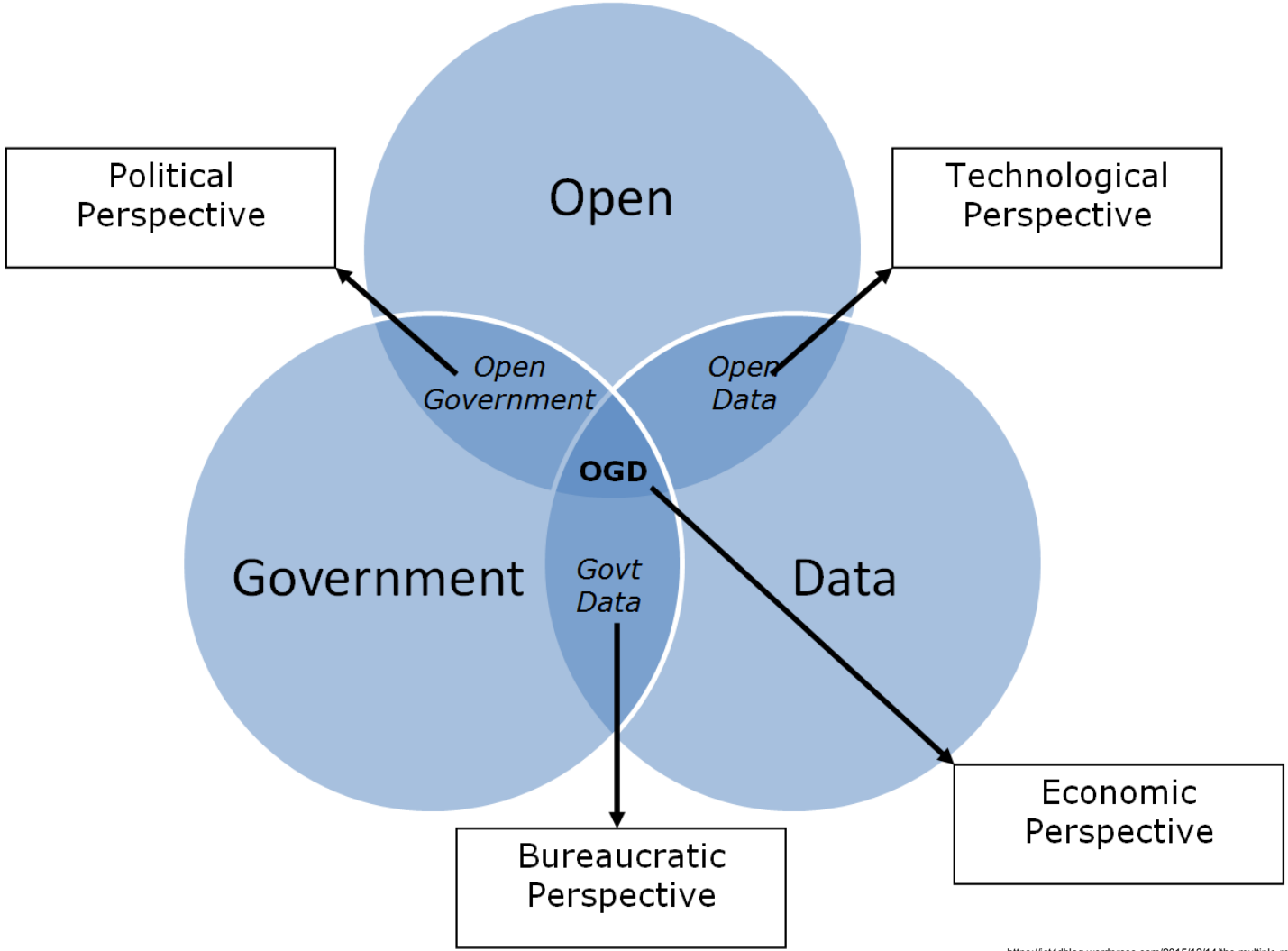

- ✓ **tracking events, identifying the situation, tracking the spread of the disease etc.**
- ✓ **data-driven decision-making**
- ✓ **planning, forecasting**
- ✓ **better understanding of decisions of the government, including tracking the decisions and restrictions introduced**
- ✓ **Improvement of the transparency, accountability and trust in government decisions to promote**
- ✓ **analysis of impacts, causes-effects and relationships**
- ✓ **development of data-driven solutions**
- ✓ **updating and / or enrichning other datasets**
- ✓ ***and for very many other purposes...***

Attēla avots: https://4.bp.blogspot.com/-VA_zM5jXPvk/VxbRtA0U2JI/AAAAAAAACnY/WKvyQnAwvBIQOsjjLF0-TchL3EtD-q-hQCLcB/s1600/actual%2Becosystem.png

# THE OPEN DATA ECOSYSTEM

— Supplies data to
— Uses data to deliver to
Source: Deloitte LLP






https://ict4dblog.wordpress.com/2015/12/14/the-multiple-meanings-of-open-government-data/

# OPEN DATA USE. GOVERNMENT (source: data.europa.eu)

## Supporting growing economies

To support the emergence of new data-driven businesses and the growth of existing ones, governments need to publish key datasets.
Governments also need to support data infrastructure that connects data with those who use it.
In return, governments are reaping the benefits of a growing data economy, such as in Finland where SMEs with access to open data grew 15% faster than those without.
Take me to the Finnish case study

## Improved service delivery

Governments need to balance the demands of growing populations with the need to tackle small-scale, local issues.
The availability of detailed open data is essential to improving delivery of services at the local level.
Some of these new services are available now:
Take me to mySociety
Take me to the Hungarian 'right to know' portal
Take me to Fix my Street Norway

## Cost savings

Open data allows governments to make savings in key areas such as healthcare, education and utilities.
In the UK, open data helped reveal £200 million of savings in the health service.
In France, energy data is being used to drive more efficient energy generation practices.
Show me the France energy data.
Open data can also bring transparency and accountability to budgets.

Source: https://data.europa.eu/elearning/en/module2/#/id/co-01

# OPEN DATA USE. COMMUNITY AND PUBLIC TRANSFORMATION

## Improving the way we move

Open data has the power to revolutionise the way we travel.
Within the Dutch transport industry, open data is helping a growing number of small companies to develop new services.
French app Tranquilien improves passenger comfort on transport and promotes efficient use of public transport by providing relevant information about empty seats, leaving times
A new Dutch app, winner of the prestigious Apps4Europe competition, helps disabled people to book travel assistance for their journeys using open data.
Open transport data saves commuters time, makes journeys more accessible and helps tourists to travel in unfamiliar cities.

## Improving the way we work

Open data is changing the way we work.
Open data reduces the time needed to find information and allows professionals to focus more of their time on productive activities.
OpenCorporates offers an open database of companies around the world, showing their networks, financial stability and environmental impact. This helps organisations learn more about prospective clients, providers and partners.

Take me to OpenCorporates
The Finnish Kannattaako kauppa service provides insights on the price development of real estate in the future, making it easy to compare houses and neighborhoods by price and population.

## Improving the way we govern

Open data is becoming a key source of evidence for governments in the policymaking process.
Public administration will gain the most from opening up data, with a value of 22 bn EUR in 2020. For agriculture, the arts and entertainment sector, the benefits expected are smaller with 379 million EUR each. They still have a lot of potential in these sectors but will take more time to reach the full potential.
They are also making the development of public policy more transparent and supporting dialogue between governments and citizens.
Data on key issues such as immigration, trade and budget cuts can be used to inform important policy decisions.
CityScale is a Ukrainian platform that provides Ukrainian citizens with relevant open data, such as on crime rates, health care, and air pollution.
Take me to London fire station analysis

# OPEN DATA USE. CULTURE AND ENVIRONMENT

## Environment

Open data helps farmers to improve yields and support a growing population without the need to destroy valuable habitats.
Plantwise are collecting open data to produce valuable information packs for farmers about plant health and threats from diseases. Take me to Plantwise
CIARD has produced a central repository of more than 1,500 open agricultural research collections worldwide, highlighting new research opportunities. Take me to CIARD

## Saving lives

Open data is helping to save lives. Open geographic data and aid statistics are being used by humanitarian groups to deliver targeted supplies in disaster zones.
Open mapping data helped disaster response teams target aid delivery during the 2010 Haiti earthquake. Haiti Open Street Map.
Open data was also used for responses to the Philippines typhoon in 2014.

## Culture

Open data is connecting people with important cultural issues and helping to shape a more informed debate around them.
OpenGLAM is helping to capture the heritage and cultural memories of groups in Germany, Switzerland and Finland. Take me to OpenGLAM.
The Open Data Institute is leading a global Data as Culture programme, with artists in residence re-examining the fundamental ways in which data is perceived. Take me to ODI Data as Culture

# OPEN DATA IN THE SCIENCE

**COVID-19 OGD → a SARS-CoV-2 virus transmission model based on human flow networks** → new perspectives + modeling of different scenarios + illustrating the evolution of and trends in the pandemic*.

**real-time (!!!) open data → urban-sensing framework for fine particulate matters PM2.5** - Taiwan +29 countries → one of the largest deployment projects for PM2.5 monitoring in the world → collected data are released in real time and in an open data manner, which has contributed to the development of other products and services using data which has been made open, thereby **creating a chain of valuable open data-based solutions and services****

relationship between **COVID-19 open data and PM2.5 → a positive relationship between long-term PM2.5 exposure and the incidence of COVID-19 **.**

**air pollution open data catalog → detecting and treatment of one of the most important sleep disorders, Obtrusive sleep apnea (OSA)***.**




*López, V.; Čukić, M. A dynamical model of SARS-CoV-2 based on people flow networks. Saf. Sci. **2021**, 134, 105034

** Stieb, D.M.; Evans, G.J.; To, T.M.; Brook, J.R.; Burnett, R.T. An ecological analysis of long-term exposure to PM2.5 and incidence of COVID-19 in Canadian health regions. Environ. Res. **2020**, 191, 110052

***Yacchirema, D.C.; Sarabia, D.; Palau, C.E.; Esteve, M. A Smart System for Sleep Monitoring by Integrating IoT With Big Data Analytics. IEEE Access **2018**, 6, 35988–36001

****Chen, L.J.; Ho, Y.H.; Lee, H.C.; Wu, H.C.; Liu, H.M.; Hsieh, H.H.; Lung, S.C.C. An open framework for participatory PM2.5 monitoring in smart cities. IEEE Access **2017**, 5, 14441–14454.

# ROLE OF THE OPENNESS. O(G)D

- **COVID-19 OGD → a SARS-CoV-2 virus transmission model based on human flow networks** → new perspectives + modeling of different scenarios + illustrating the evolution of and trends in the pandemic*.
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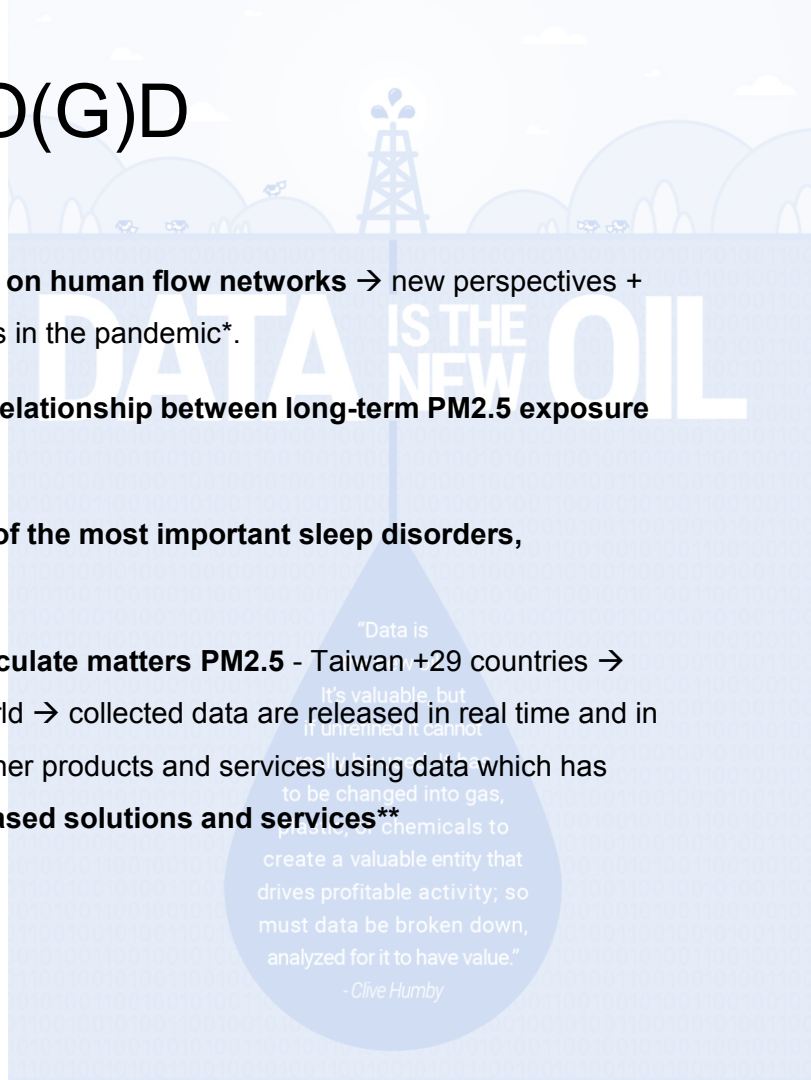
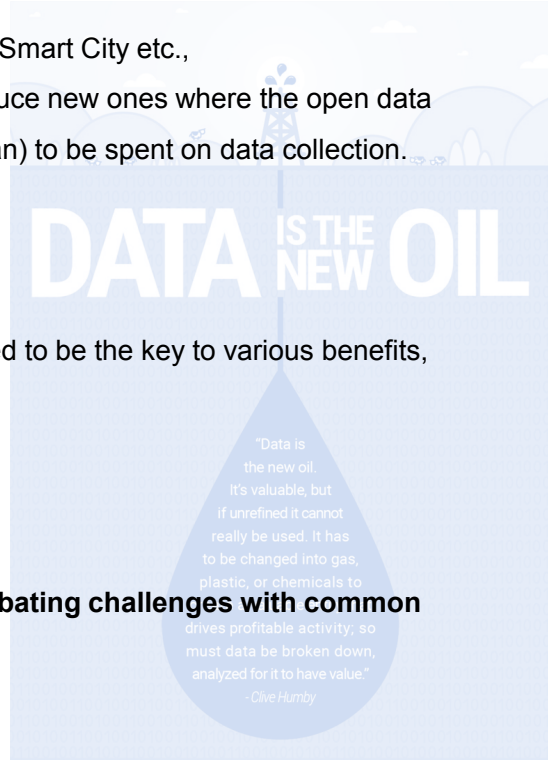


# ROLE OF THE OPENNESS. O(G)D

- The majority of studies found which actively utilize or promote open data can be classified in at least two general categories, where open data are used as:
  - an **input for new services**, such as (bio)medicine or healthcare, transport, environment, Smart City etc.,
  - a **tool to improve the algorithms** already developed, optimize solutions in use, or introduce new ones where the open data can be used as training data without the need for resources (both, time, money and human) to be spent on data collection.

- The way in which open (government) data are reused points to:
  - their potential by themselves as a resource and a tool, i.e. data opening can be considered to be the key to various benefits, both commercial and non-commercial,
  - their potential in regards to Society 5.0,
  - the more data become available, the more new application areas will be explored.

- **This, in turn, contributes significantly to the development of new cooperation and combating challenges with common forces**



# OPEN DATA IN THE SCIENCE. TOOL OR RESOURCE?

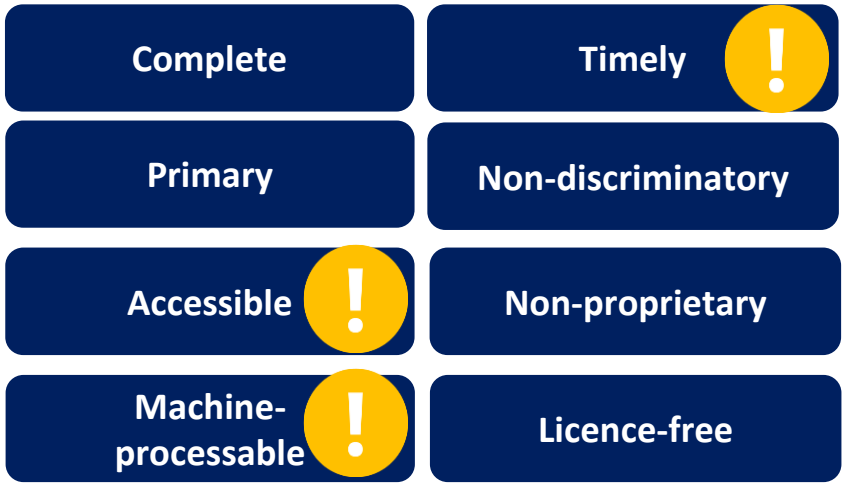
**INPUT DATA (RESOURCE)**
**New services, solutions etc.**

*Example: medicine, transport, environment, Smart City etc.*

**TOOL**
**Improvement of existing algorithms**

*Optimization of the existing algorithms, development of new algorithms (using as training data or supplementing data etc.).*

# OPEN DATA PRINCIPLES AND DATA QUALITY

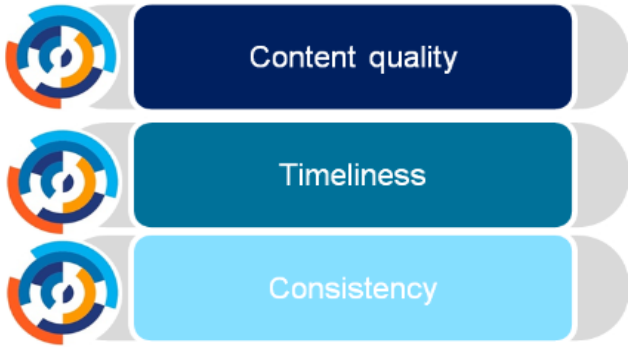



***AND WHAT ABOUT DATA QUALITY???***

- **OGD:** ***the quality aspect takes only the 4th place by popularity after policy, benefit and risk, although quality can impact these aspects.*** *(Klein et al., 2018)*
- **Data quality appears as one of most problematical dimensions for open data portals.** *(SunlightFoundation, 2007), (European Data Portal, 2018)*

*Def. II: «Quality» is a desirable goal to be achieved through management of the production process.*

*Def. III: «Data quality» is a relative concept, largely dependent on specific requirements resulting from the data use.*



# EFFECTS OF PREDICTORS OF CITIZENS' ATTITUDES AND INTENTION TO USE OPEN GOVERNMENT DATA

- ✓ **Brazil is one of the founding countries of the Open Government Partnership (OGP).**
- ✓ **De Souza et al. (2022): in Brazil, public value creation from open and 2.0 governments might be under threat! Brazilian citizens are not empowered enough to social control through open data**
- ✓ **Predictors of citizens' attitudes towards open government and government 2.0:**
  - ➢ **ease of use ***
  - ➢ **Usefulness ***
  - ➢ **intrinsic motivation**
  - ➢ **political satisfaction**
  - ➢ **government trust**
  - ➢ **intensity of internet use.**

*** education, income, and region influence the ease of use and usefulness of open data.**

**!!! public managers and political parties have "homework' to do to stimulate citizens' behavior towards OGD and government 2.0 - government portals quality and data transparency improvement**

*Source: de Souza, A. A. C., d'Angelo, M. J., & Lima Filho, R. N. (2022). Effects of Predictors of Citizens' Attitudes and Intention to Use Open Government Data and Government 2.0. Government Information Quarterly, 101663.*

# SMARTER OPEN GOVERNMENT DATA FOR SOCIETY 5.0:

# ARE YOUR OPEN DATA SMART ENOUGH?

***Nikiforova, A. (2021).***
***Smarter Open Government Data for Society 5.0: are your open data smart enough?***
***Sensors, 21(15), 5204.***

# SMARTER OPEN GOVERNMENT DATA FOR SOCIETY 5.0: ARE YOUR OPEN DATA SMART ENOUGH?

- **60 countries → 51 OGD portal**
- **Method: usability test**
- **Data: real-time, sensor-generated and COVID-19 – high-value data, meet Society 5.0 and Industry 4.0 trends**

  - ✓ ***1.Are the open data related to the topic under question ({sensor; real-time; COVID-19}) published, i.e., available?***
  - ✓ ***2.Are these data available in a machine-readable format***
  - ✓ ***3.Are these data current, i.e., regularly updated?***
  - ✓ ***4.Is API ensured for these data (most importantly for real-time and sensor data)?***
  - ✓ ***5.Have they been published in a timely manner?***
  - ✓ ***6.What is the total number of available data sets?***
  - ✓ ***7.Does the open government data portal provides use-cases/showcases?***
  - ✓ ***8.Does the open government portal provide an opportunity to gain insight into the popularity of the data?***
  - ✓ ***9.Is there an opportunity to provide feedback, comment, suggestion or complaint?***
  - ✓ ***10.Is the artifact, i.e., feedback, comment, suggestion or complaint, visible to other users?***

| Aspect Examined/Question Asked | Value Type |
|---|---|
| **General** | |
| Total number of data sets | number |
| Whether the portal allows statistics on the popularity of data sets, i.e., number of views, downloads, reuses, rating etc. | Boolean + nature |
| Whether the opportunity to provide a feedback, comment, suggestion or complaint is provided? | Boolean + nature |
| Whether the feedback, comment, suggestion or complaint left for data set is visible for other users? | Boolean |
| Are showcases/use-cases available? | Boolean + number |
| **Real-timeopen government data** | |
| Are real-time generated open data available on the OGD portal? What is the total number of real-time open data sets? | Boolean + number * * if the first answer is = 1 |
| Are real-time generated data sets updated frequently? | {−1, 0, 1}—1—yes/0—not always/−1—no |
| Are real-time generated data sets provided in a machine-readable format? | {−1, 0, 1}—1—yes/0—not always/−1—no |
| Is API available? | {−1, 0, 1}—1—yes/0—not always/−1—no |
| Are showcases/use-cases available? How many? | Boolean + total number |
| **Sensor generated open government data** | |
| Are sensor generated data available on the OGD portal?What is the total number of sensor generated open data sets? | Boolean + number * * if the first answer is = 1 |
| Are sensor generated data sets updated frequently? | {−1, 0, 1}—1—yes/0—not always/−1—no |
| Are sensor generated data sets provided in a machine-readable format? | {−1, 0, 1}—1—yes/0—not always/−1—no |
| Is API available? | {−1, 0, 1}—1—yes/0—not always/−1—no |
| Are showcases/use-cases available? How many? | Boolean + total number |
| **COVID-19** | |
| When was 1st case of COVID-19 identified? Where the data on the 1st case is obtain from [52] | date |
| Are the open data on COVID-19 available on the OGD portal? What is the total number of COVID-19-related open data sets? | Boolean + number * * if the first answer is = 1 |
| When was the term COVID-19 first mentioned in OGD portals data set? | date |
| When was the 1st COVID-19-related open data set released? | date |
| Were the data published in a timely manner? Comparison of the first case (FC) against open data availability (ODA)—date of the release of the first data set * * comparison of [52] and OGD portal | {−1,0,1}—1—"in less than 2 weeks", 0—"in a month",−1—"more than in a month" |
| Are COVID-19 related data sets provided in a machine-readable format? | {−1, 0, 1}—1—yes/0—not always/−1—no |
| Are COVID-19 related data sets updated frequently? | {−1, 0, 1}—1—yes/0—not always/−1—no |
| Is API available? | {−1, 0, 1}—1—yes/0—not always/−1—no |
| Are showcases/use-cases available? How many? | Boolean + total number |

# SMARTER OPEN GOVERNMENT DATA FOR SOCIETY 5.0: ARE YOUR OPEN DATA SMART ENOUGH?

- ✓ **40 out of 51 OGD portals provide open data related to COVID-19,**
- ✓ **32 portals provide real-time data**
- ✓ **29 provide sensor data.**

*many countries are trying to follow the latest trends and provide data that could be important for their users in transforming into innovative solutions and services that create value for both the economy and the society, including moving towards the Smart City and the Smart Society **BUT** some countries have not yet opened these data.*

- ✓ Although in general, “smarter” data and higher quality data are often typical for highly developed countries, which follow the trends of Smart Cities at both economic, political and social levels, for many countries this relationship is less obvious:
  - ✓ developed countries can demonstrate weak results in terms of data provision and their usability, while less developed countries can be characterized by relatively competitive results;
  - ✓ among the countries that have already opened these data, the majority of portals have gaps in the usability of these data in terms of their machine-readability, the unavailability of API, and the timeliness and frequency of updates.

***Partial compliance with Society 5.0 trends (users needs and intentions)***

# SMARTER OPEN GOVERNMENT DATA FOR SOCIETY 5.0. SOME RESULTS

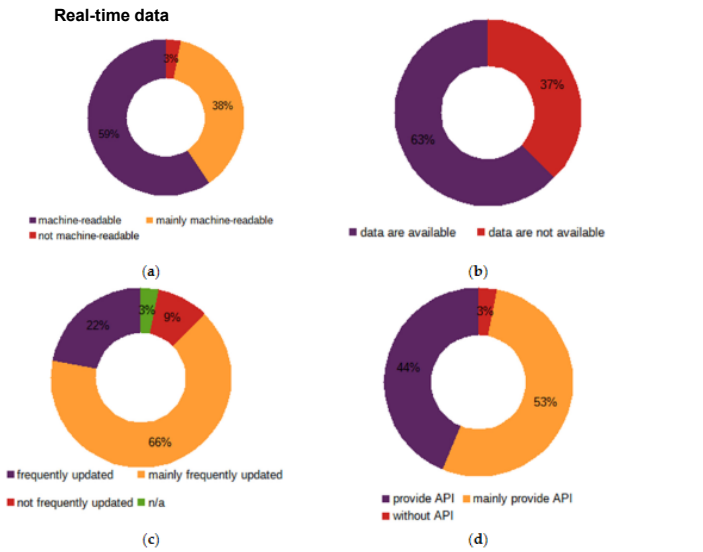



**Figure 2.** (**a**) Real-time data availability on 51 OGD portals; (**b**) Real-time data machine-readability; (**c**) Real-time currency, i.e., frequency of updates; (**d**) API presence.

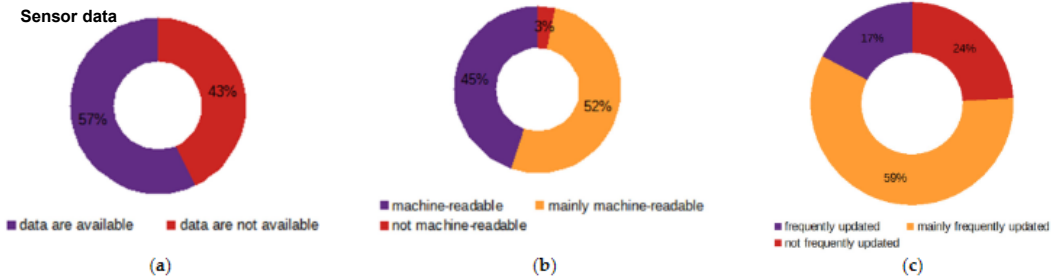



**Figure 3.** (**a**) Sensor data availability on 51 OGD portals; (**b**) Sensor data machine-readability; (**c**) Sensor data currency, i.e., frequency of updates.

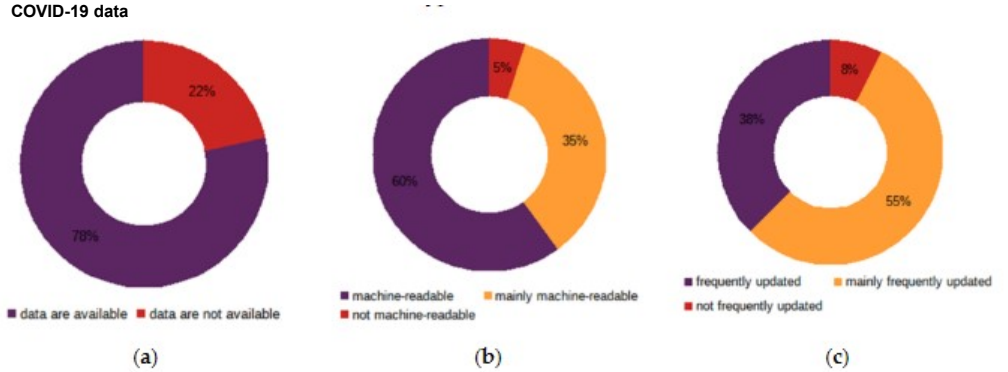
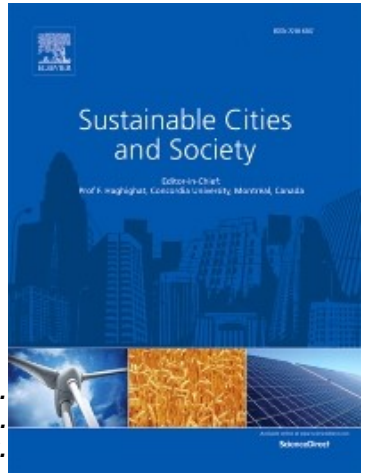



**Figure 4.** (**a**) COVID-19 data availability on the OGD portals; (**b**) COVID-19 data machine-readability; (**c**) COVID-19 data currency, i.e., frequency of updates.

For more details see:
Nikiforova, A. (2021). Smarter Open Government Data for Society 5.0: Are Your Open Data Smart Enough?. *Sensors*, *21*(15), 5204.

# TRANSPARENCY OF OPEN DATA ECOSYSTEMS IN SMART CITIES:

# DEFINITION AND ASSESSMENT OF THE MATURITY OF TRANSPARENCY IN 22 SMART CITIES




*Lnenicka, M., Nikiforova, A., Luterek, M., Azeroual, O., Ukpabi, D., Valtenbergs, V., & Machova, R. (2022). Transparency of open data ecosystems in smart cities: definition and assessment of the maturity of transparency in 22 smart cities. Sustainable Cities and Society, 103906.*

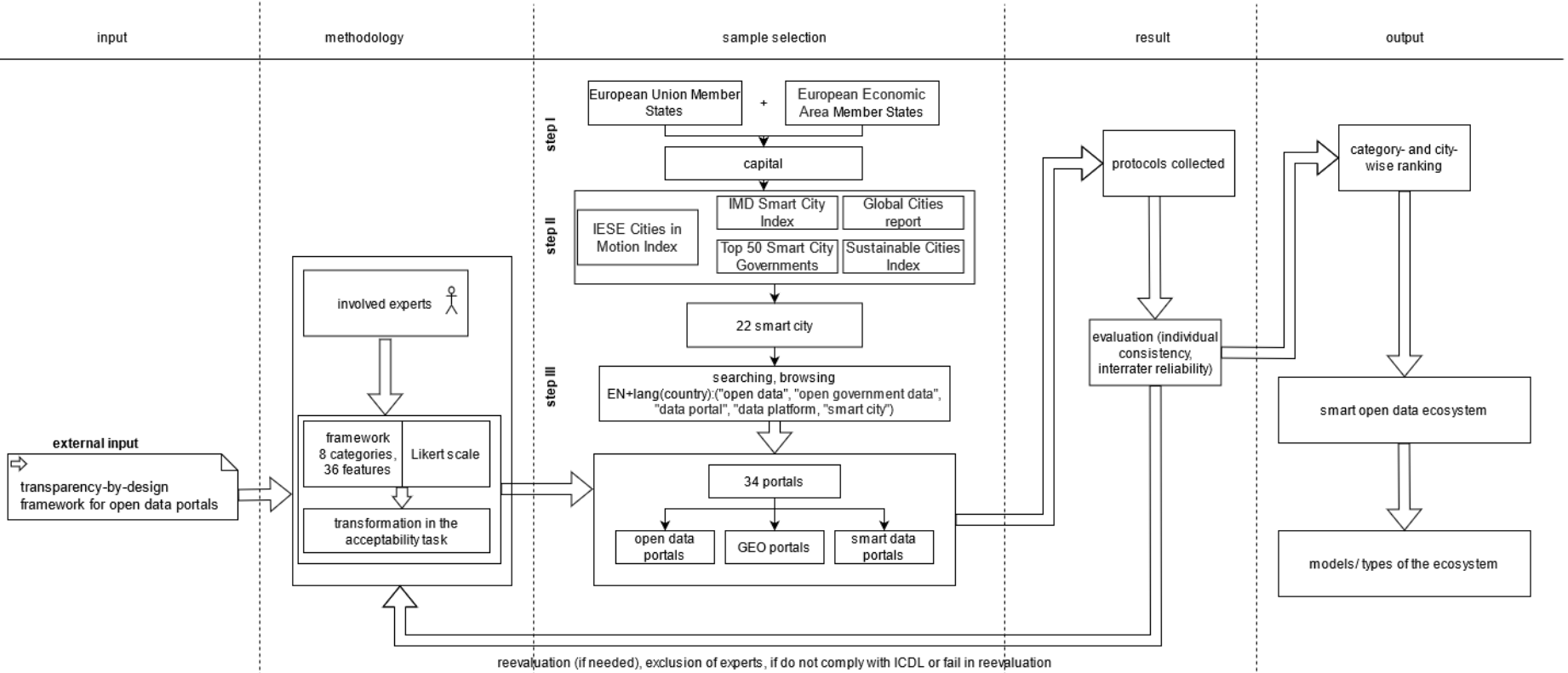
# TRANSPARENCY OF OPEN DATA ECOSYSTEMS IN SMART CITIES

- ✓ **Definition and assessment of the maturity of transparency in 22 smart cities**
- ✓ **Focus on the issue of the transparency maturity of open data ecosystems seen as the key for the development and maintenance of sustainable, citizen-centered, and socially resilient smart cities.**

  - ✓ ***Investigation of smart city data portals' compliance with the transparency requirements***
  - ✓ ***Four levels of maturity are defined to assess transparency of smart city data portals***
  - ✓ ***Expert assessment is used to assess the transparency of 22 smart city data portals – 34 in total.***
  - ✓ ***Smart city portals are ranked determining their level of transparency maturity.***
  - ✓ ***Open data ecosystem is conceptualized and 5 types of current ecosystems are identified.***

Read more -> Lnenicka, M., Nikiforova, A., Luterek, M., Azeroual, O., Ukpabi, D., Valtenbergs, V., & Machova, R. (2022). Transparency of open data ecosystems in smart cities: definition and assessment of the maturity of transparency in 22 smart cities. *Sustainable Cities and Society*, 103906.

# TRANSPARENCY OF OPEN DATA ECOSYSTEMS IN SMART CITIES



# TRANSPARENCY OF OPEN DATA ECOSYSTEMS IN SMART CITIES

- ✓ **Various performance measurement and maturity models are used to overview the smart cities - their current state, strengths and weaknesses, and provide city leaders recommendations and guidelines towards its development.**

- ✓ **Each model consists of different domains (dimensions), phases, and corresponding indicator(s) used to assess the city's performance and maturity.**
  **The main difference - their theoretical orientation and focus on the selected domain(s) and a sample of cities.**

Overview of smart cities' positions in selected rankings.

| City | IESE 2020 | TOP 50 SCG 2021 | IMD SCI 2020 | GCI 2019 | SCI 2018 |
|---|---|---|---|---|---|
| Amsterdam | 8 | 10 | 9 | 20 | 12 |
| Athens | 96 | n/a | 99 | n/a | 75 |
| Berlin | 7 | 23 | 38 | 14 | 18 |
| Bratislava | 62 | n/a | 76 | n/a | n/a |
| Brussels | 41 | n/a | 60 | 12 | 47 |
| Bucharest | 103 | n/a | 87 | n/a | n/a |
| Budapest | 74 | n/a | 77 | 62 | 57 |
| Copenhagen | 6 | 35 | 6 | 45 | 11 |
| Dublin | 33 | 26 | 34 | 46 | 20 |
| Helsinki | 22 | 5 | 2 | n/a | n/a |
| Lisbon | 32 | 48 | 73 | n/a | 82 |
| Ljubljana | 99 | n/a | n/a | n/a | n/a |
| Luxembourg | n/a | n/a | n/a | n/a | n/a |
| Madrid | 25 | n/a | 45 | 15 | 21 |
| Nicosia | n/a | n/a | n/a | n/a | n/a |
| Paris | 3 | n/a | 61 | 3 | 15 |
| Prague | 39 | n/a | 44 | 48 | 23 |
| Riga | 85 | n/a | n/a | n/a | n/a |
| Rome | 67 | n/a | 101 | 36 | 40 |
| Sofia | 116 | n/a | 89 | n/a | n/a |
| Stockholm | 14 | 50 | 16 | 39 | 2 |
| Tallinn | 55 | 12 | 59 | n/a | n/a |
| Valletta | n/a | n/a | n/a | n/a | n/a |
| Vienna | 18 | 9 | 25 | 25 | 5 |
| Vilnius | 65 | n/a | n/a | n/a | n/a |
| Warsaw | 54 | n/a | 55 | 55 | 54 |
| Zagreb | 98 | n/a | n/a | n/a | n/a |
| London | 1 | 3 | 15 | 2 | 1 |
| Oslo | 12 | 27 | 5 | n/a | 8 |
| Reykjavik | 5 | n/a | n/a | n/a | n/a |
| Zurich | 11 | 45 | 3 | 30 | 6 |

**IESE Cities in Motion Index**
**Top 50 SCG - Top 50 Smart City Governments, 2021**
**IMD SCI - IMD smart city index**
**GCI - global cities index**
**SCI - sustainable cities index**

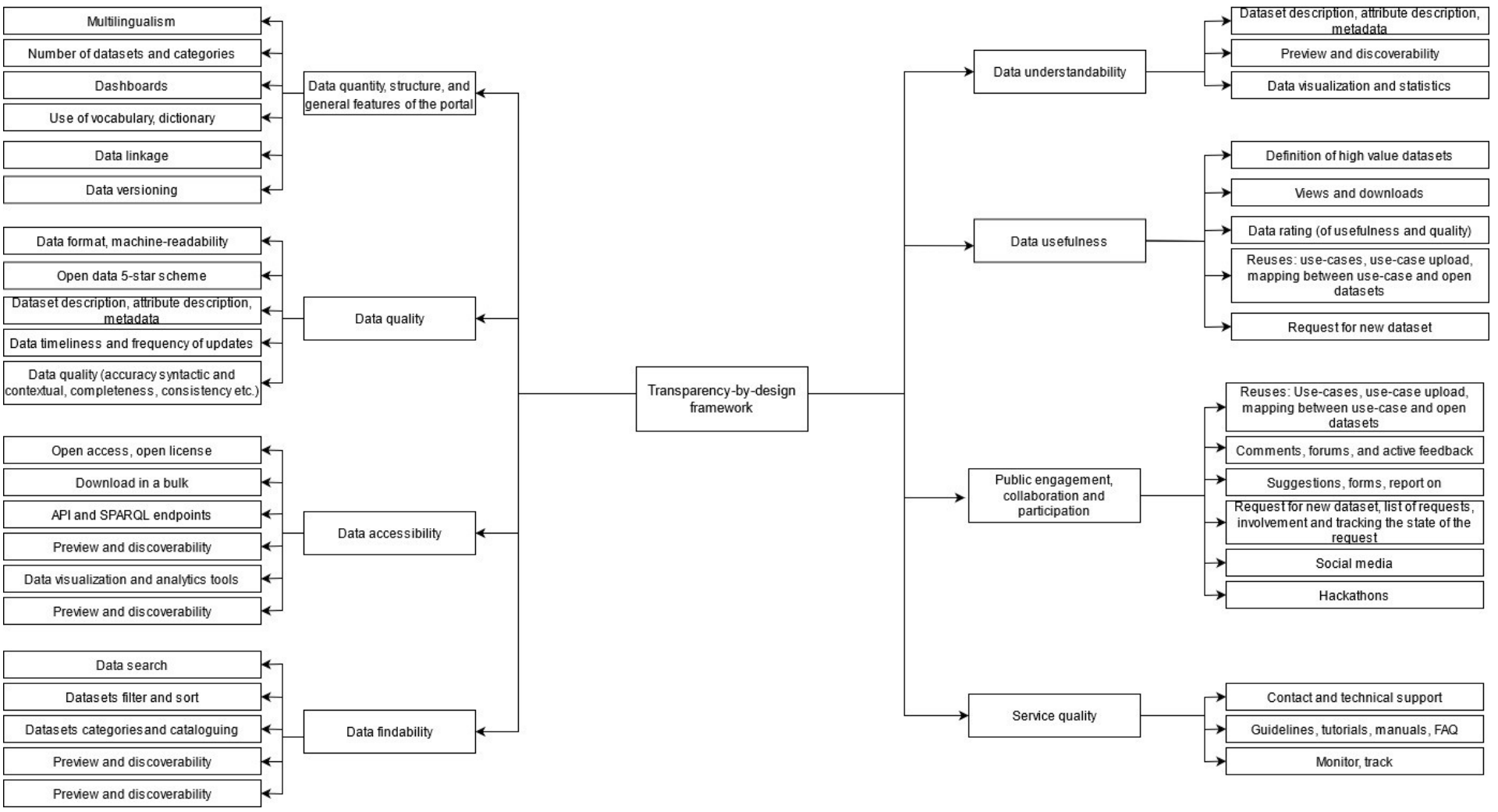
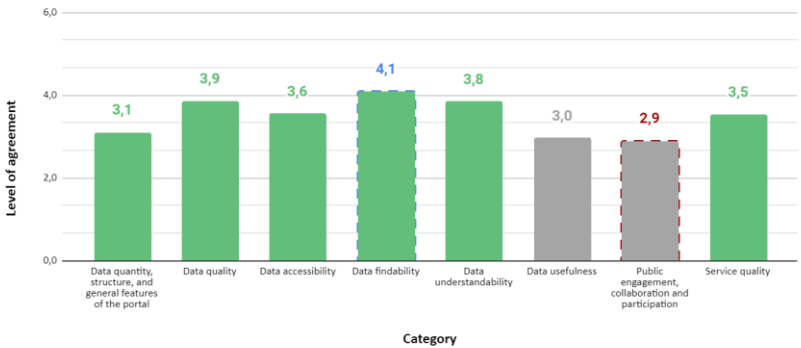
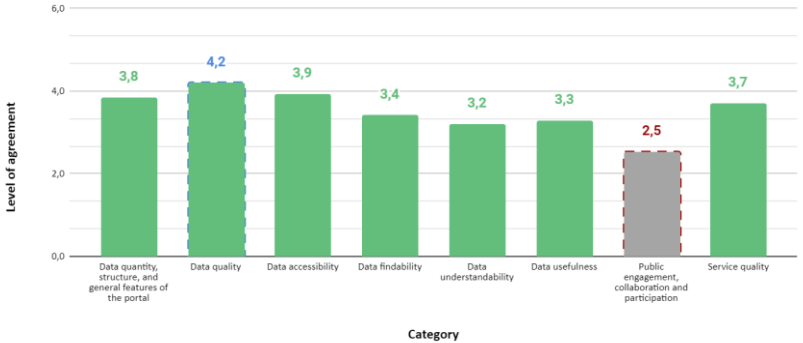



**Fig. 2.** Constructs of the transparency-by-design framework.

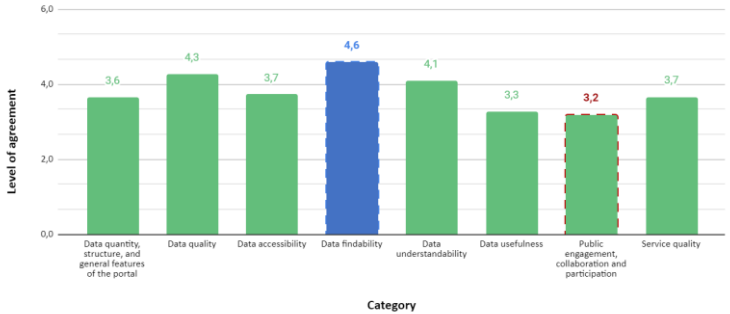
# TRANSPARENCY OF OPEN DATA ECOSYSTEMS IN SMART CITIES: MEAN VALUES FOR OPEN DATA PORTALS (BY CATEGORY)




**Mean values for geodata portals (by category)**

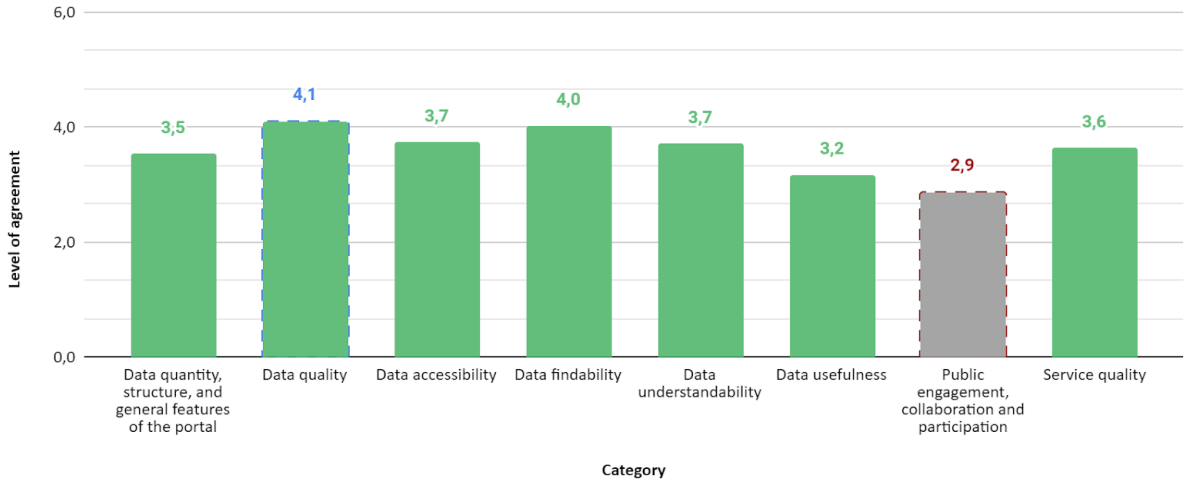



**Mean values for smart data portals (by category)**




**Mean values for open data portals (by category)**

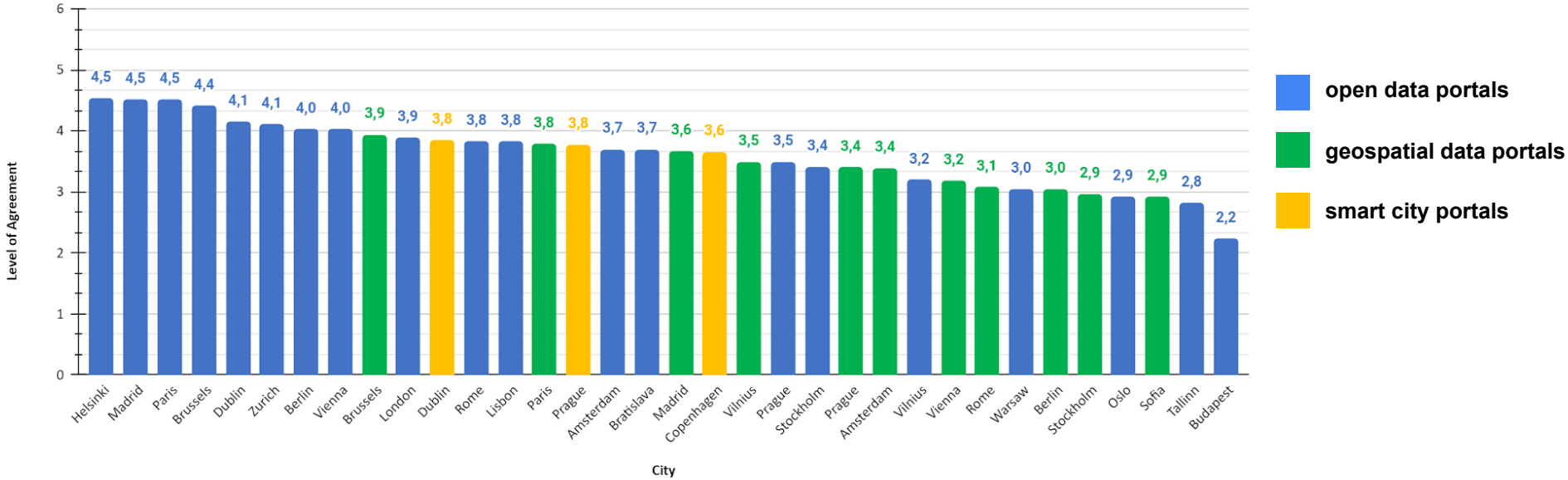
# TRANSPARENCY OF OPEN DATA ECOSYSTEMS IN SMART CITIES: MEAN VALUES FOR ALL PORTALS (BY CATEGORY)




- ✓ **the best result is demonstrated by data quality*** dimension with 4.1 points, followed by data findability (4 points).**
- ✓ **The most negative result that can be seen as the most critical - public engagement, collaboration and participation.**
- ✓ **This is followed by data usefulness (3.2), data quantity, structure and general features of the portal (3.5), service quality (3.6), data understandability (3.7), and data accessibility (3.7), which although have been assessed as partly fulfilled, still have less than 4 points of 6.**

- ✓ **Changes and improvements should be subject to all dimensions and corresponding features**
- ✓ **!!! public engagement, collaboration and participation should become central.**
- ✓ **This is not only due to such low results but also due to the importance of this category, in the light of data portals of all types, i.e., open, geodata, and especially smart data portals. Otherwise, if there are no features supporting public engagement, collaboration and participation or the respective features are not well implemented, there are very minor chances for any changes, value creation and meeting the objectives of the initiatives concerned.**

# TRANSPARENCY OF OPEN DATA ECOSYSTEMS IN SMART CITIES: MEAN VALUES FOR ALL PORTALS (BY CITY)




- ✓ **Three smart cities - Helsinki, Madrid, and Paris, have demonstrated relatively high results with an average result. All portals belong to open data portals.**
- ✓ **Although the results for the open data portals of Madrid and Paris are expected because the corresponding countries are constant leaders in the context of the maturity of open data (portal) (Open Data Maturity Report), Helsinki is something that is not so self-evident, particularly given that the above-mentioned report states that Finland is among six countries, which were moved down from fast-trackers to followers.**
- ✓ **!!! cities and smart cities can develop more rapidly compared to the whole country, when resources, both human- and financial, are allocated wisely.**

# TRANSPARENCY MATURITY LEVELS OF THE OPEN DATA ECOSYSTEM

| Level | Description | Points |
|---|---|---|
| Level 1 (Developing) | There are no formal procedures for publishing open (government) data, and the transparency efforts fall to each data provider (publisher). This results in missing relationships between the components of the ecosystem and no or low engagement of stakeholders. | 0–1.5 |
| Level 2 (Defined) | There are formal procedures for publishing open (government) data to be followed. These procedures are defined, documented, and communicated. Although the data infrastructure is implemented, the processes of involving stakeholders to reuse open data are lacking. | [1.5]–3 |
| Level 3 (Managed) | There are standardized processes to be followed in the open government and transparency vision achievement. Open data ecosystem and its components are mainly automated. Stakeholders are active in the ecosystem and provide feedback to improve it. | [3]–4.5 |
| Level 4 (Integrated) | Procedures are based on best practices. Components and relationships between them are optimized for the city's environment and the requirements and needs of involved stakeholders, which are constantly being identified and monitored. | [4.5]–6 |

# DEFINITION OF THE OPEN DATA ECOSYSTEM IN THE SMART CITY CONTEXT

- ✓ **The key asset of the open data ecosystem is the data → the first step in the definition's formulation is to introduce the concept of the data-centric and data-driven infrastructure in the smart city context. This infrastructure can be defined as «*a collection of online data sources providing city-level data for free in open formats and under open licenses for everyone to be reused*»**
- ✓ **Its main components: data portals, platforms, and other data repositories in the smart city and its administration and other public authorities, which provide OGD, and OBD, OCD, and OSD, which are provided by other stakeholders and freely available for reuse.**
- ✓ **The data sources cover every data provider, who publishes data under open data principles. They do not include institutions, which have their own, separate tools/policies/approaches to providing data.**
- ✓ **The key data sources at the smart city level:**

  **(1) open data portal – publishes OGD and reuses, provides features to work with them etc.,**

  **(2) smart data portal – publishes data relevant to smart services and smart projects,**

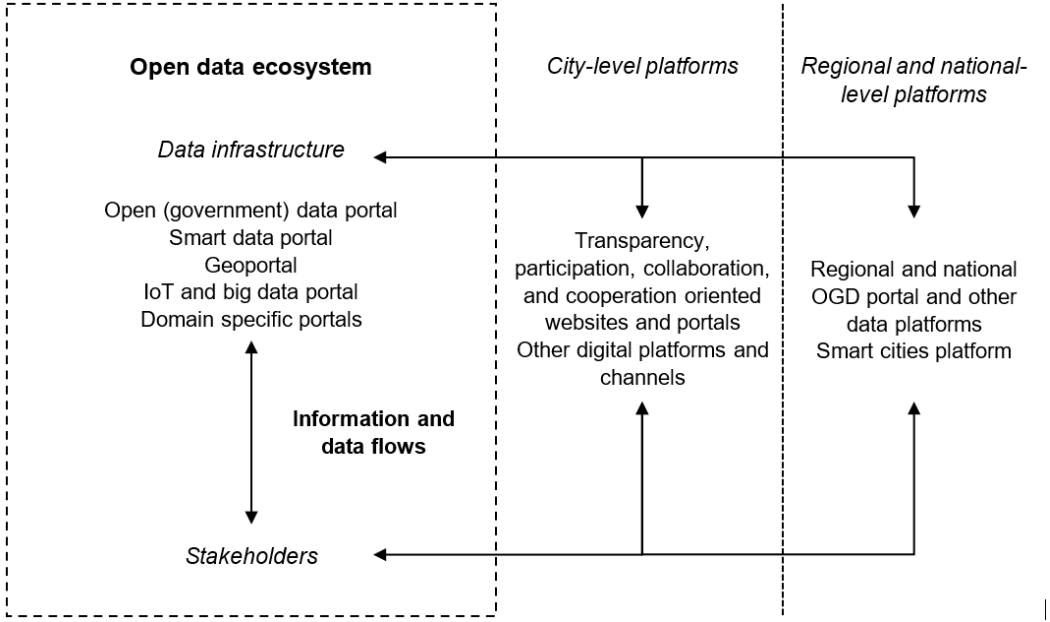
  **(3) geodata portal – publishes spatial data in open formats, provides features and services to work with them,**

  **(4) IoT and big data portal – provides raw data and data streams,**

  **(5) domain-specific portals such as smart education, smart transportation, smart energy etc.**

- ✓ **The dynamics of the infrastructure is driven by information and data flows between these components that are represented by datasets' requests, downloads, their processing, sharing etc. The intensity of these actions limits or enhances the flows in the ecosystem.**

# COMPONENTS AND RELATIONSHIPS OF THE OPEN DATA ECOSYSTEM IN THE SMART CITY CONTEXT




**Concepts that should be considered since they affect/shape the ecosystem:**

1) **stakeholders and their roles,**
2) **phases of the data lifecycle, in which a stakeholder participates in the ecosystem,**
3) **technical and technological infrastructure,**
4) **generic services and platforms,**
5) **human capacities and skills of both providers and consumers,**
6) **smart city domains (thematic categories) as the targeted areas for data reuse,**
7) **externalities having an effect on goals, policy and resources,**
8) **level of (de)centralization of data sources – development, restrictions,**
9) **perception of importance and support from public officials,**
10) **user interface, user experience and usability.**

# TRANSPARENCY OF OPEN DATA ECOSYSTEMS IN SMART CITIES

**The open data ecosystem in the smart city context can be defined as**

***«systematic efforts to integrate ICT and technologies into city life to deliver citizen-centric, better-quality services, solutions to city problems with open data published through the data-centric and data-driven infrastructure.»***

- ✓ **It can also be viewed as a part of the transition to the knowledge economy.**
- ✓ **It is also a part of a local e-government system, and it is usually considered as one of the e-government services.**
- ✓ **Generally, all these approaches to smartness and smart open data services evolved from the concept of e-government and respective websites that have been upgraded to meet the needs of smart cities.**

****** The definition is established based on the knowledge and experience of the experts involved and observations made during the study.***

# TRANSPARENCY OF OPEN DATA ECOSYSTEMS IN SMART CITIES: 5 TYPES OF ECOSYSTEMS

- ✓ **The definition of the open data ecosystem and its description aims to be general and includes all components we found.**
- ✓ **However, there can be identified some variations of this ecosystem based on the predominant components of the data-centric and data-driven infrastructure.**

| Type of data ecosystem | Description |
|---|---|
| Type 1 | The city's OGD portal is the center of the data infrastructure and all OGD including those labeled as smart are published and centralized through it. For this type of open data ecosystem, other websites that had previously provided open data or other services to access public sector information have been replaced by the OGD portal. The focus is on datasets, providing features to work with them, reuse them, and making all data requests transparent at one place. |
| Type 2 | This type of ecosystem also usually has the OGD portal as the central point but there are also other portals and platforms that publish open data. The smart data portal and online city dashboards focusing on different dimensions such as transport, health, air quality etc. are important components of this type of ecosystem. |
| Type 3 | A decentralized type of the ecosystem that includes many components such as OGD portal, smart data portal, geodata portal etc. However, it increases the complexity of the ecosystem that is more difficult to manage and less usable for stakeholders. |
| Type 4 | The smart city portal focused on projects and services is usually the center of this type of ecosystem but providing data and appropriate features to reuse them is not the priority. Most services are developed by public sector organizations, research institutions or businesses and then provided to citizens. |
| Type 5 | In addition to the city's OGD portal there are other transparency-, participation-, collaboration-, and cooperation- oriented websites and portals to support the formation and improvement of relations between stakeholders. This type of ecosystem is focused on processes to improve open data reuse |

**** The definition is established based on the knowledge and experience of the experts involved and observations made during the study.*

# RECOMMENDATIONS FOR IMPROVING THE MATURITY LEVEL

- ✓ **The definition of the open data ecosystem and its description aims to be general and includes all components we found.**
- ✓ **However, there can be identified some variations of this ecosystem based on the predominant components of the data-centric and data-driven infrastructure.**

| Current and targeted levels | Recommendations |
|---|---|
| **Level #1 to Level #2** | ✓ define formal procedures for publishing open (government) data,<br>✓ document and communicate these procedures with stakeholders,<br>✓ establish relationships between the components of the ecosystem,<br>✓ establish or improve engagement of stakeholders. |
| **Level #2 to Level #3** | ✓ identify and implement actions and/or activities to involve stakeholders and encourage them to reuse data,<br>✓ ensure possibility to provide feedback, collect it and use for defining agenda,<br>✓ determine the current and improve the level of automation of the open data ecosystem and its components. |
| **Level #3 to Level #4** | ✓ ensure that procedures are based on the best practices,<br>✓ constantly identify and monitor stakeholders and their needs,<br>✓ optimize components and relationships between them for the city's environment and the requirements and needs of involved stakeholders. |

# TRANSPARENCY OF OPEN DATA ECOSYSTEMS IN SMART CITIES

(1) a benchmarking framework to assess the level of transparency of open data ecosystems in smart cities consisting of 36 features has been developed by adapting transparency-by-design framework for open data portals by Lnenicka & Nikiforova (2021);

(2) the developed framework has been applied to 34 portals representing 22 smart cities, allowing determination of the level of transparency maturity at (i) general, (ii) individual, and (iii) group levels;

(3) four-level transparency maturity model has been defined to allow the classification of the portal as (1) developing, (2) defined, (3) managed, and (4) integrated, thereby allowing to identify key issues to be transformed into corrective actions to be included into agenda and navigate to the set of more competitive portals;

(4) the portals have been ranked based on their transparency maturity, thereby allowing more successful portals to be identified in order to be used as an example for improving overall or feature-wised performance by providing recommendations for the identification and improvement of current maturity level and specific features;

(5) an open data ecosystem in the context of a smart city has been conceptualized and its key components were determined considering the data-centric and data-driven infrastructure and other components and relationships, using the system theory approach;

(6) on the basis of the dominant components of data infrastructure, five types of current open data ecosystems have been defined, thereby opening up a new horizon for research in the area of sustainable and socially resilient smart cities by means of open data and citizen-centered open smart city governance.

# CONCLUSIONS

- ✓ **open data became a daily phenomena.**
- ✓ “**open science**” as “making findings available to the (scientific) audience by means of articles, preferably OA”, **<u>is not enough!</u>**
- ✓ **Society 5.0 requires some more advanced guidelines to be defined and involved**
- ✓ **Openness (open data + open science) is**
  - ✓ **one of the crucial drivers of a sustainable economy and real transformation of the society, science, government**
  - ✓ **a creativity bridge in developing a new ecosystem in Industry 4.0 and Society 5.0**
  - ✓ **allows solving problems that were not central research objects to the original data holders, improve previous results, establish cooperation to tackle challenges together.**

# CONCLUSIONS

**BUT! In order to get these benefits:**

**✓the data ~~should~~ must be qualitative,**

**✓the data should be valuable and "smart "(in line with "high-value data" term in both PSI Directive and country-specific sense)**

**✓portal – usable and user-friendly,**

**✓service – supportive,**

**✓policy – active, effective and efficient.**

**So ask yourself** ***- am I promoting openness? and how can I promote openness to change the world?***

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**(include but are not limited)**

- ✓Intelligent systems in crisis emergency management
- ✓Machine Learning, Artificial Intelligence and Big Data management for Public Sector
- ✓Privacy, security and legal Informatics - AI and Law
- ✓Open (Government) Data: transparency, trust, co-creation and Open Innovation
- ✓Linked (Open) Data
- ✓Semantic E-government applications
- ✓Distributed ledgers & Blockchains: governance, decentralized autonomous organizations (DAO)
- ✓Digital transformation and Society 5.0
- ✓Public Sector Knowledge Representation
- ✓Decision Support Systems (DSS) in Digital Governance
- ✓Natural Language Processing
- ✓Multimedia and multilingual systems
- ✓Cybersecurity

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**Submission Deadline: May 30, 2022**
Notification Due: June 30, 2022
Final Version Due: July 30, 2022

Accepted papers presented at the EGETC2022 will be published in the proceeding published by **Springer** in Communications in Computer and Information Science (CCIS) series *(approval pending...)*

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A short list of best papers will be invited for a post-conference publishing in **Government Information Quarterly** (GIQ), Elsevier (Q1, Cite Score: 11.6, IF: 7.279) and **Technological Forecasting and Social Change**, Elsevier (Q1, Cite Score: 12.1, IF: 8.593)

***Thank you for your attention!***

## Contact information:


**Website:** https://anastasijanikiforova.com/

**Email:** nikiforova.anastasija@gmail.com

**LinkedIn:** https://www.linkedin.com/in/anastasija-nikiforova-466b99b3/


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