



Inspire Policy Making with Territorial Evidence

FINAL REPORT //

DIGISER

Digital Innovation in Governance and Public
Service Provision

Annex 1.2.5 Data Management Report // April 2022

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Abbreviations

API	Application Programming Interface
DESI	Digital Economy and Society Index
DIGISER	Digital Innovation in Governance and Public Service Provision
DIGISURVEY	The survey deployed during DIGISER with 255 respondent cities
DPSVI	Digital Public Value Service Index
EAB	European Advisory Board
EDCI	European Digital City Index
EIF	European Interoperability Framework
ESPON	European Spatial Planning Observation Network
EU	European Union
EU ODP	European Union Open Data Portal
FUA	Functional Urban Areas
GDC	Green Digital Charter
GDP	Gross Domestic Product
GDPpc	Gross Domestic Product per Capita
GDPR	General Data Protection Regulation
ICC	Intelligent City Challenge
ICT	Information and Communications Technology
KPI	Key Performance Indicator
LAU	Local Administrative Units
LEA	Learning Technology Accelerator
NUTS	Nomenclature of Territorial Units for Statistics
OASC	Open and Agile Smart Cities
OECD	Organisation for Economic Co-operation and Development
OGD	Open Government Data
PA	Public Administration
PCP	Pre-Commercial Procurement
Q_	Question (in Digiser Survey)
R&D	Research and Development
SAB	Scientific Advisory Board
SAG	Scientific Advisory Group
SDGs	Sustainable Development Goals
SEM	Structural Equation Modelling
SI	Service area Index
T-LL	Triple-Loop Learning
ToR	Terms of Reference
UNDP	United Nations Development Programme
Reference Sample	It refers to 156 cities intended to be the best approximation attainable that could be considered as representative of the variety of European cities.

1 Introduction

This document present one part of the results of the analysis of the DPSVI, the Digital Public Service Value Index.

One of the main goals of DIGISER has been indeed the development of indicators capable of capturing and synthetically describing the performance of cities in the digital transition and their ability to drive this transition towards the creation of public value. This work resulted in the development of the DPSVI, Digital Public Service Value Index (DPSVI), that is reported in detail in the *Annex 1.1 Extended Methodology*.

In summary, the DPSVI is conceived as a multi-level composite index, nourished by primary data collected through a questionnaire (DIGISURVEY) targeting European cities.

These data have been processed and combined to feed a system of composite indicators that provide a synthetic assessment of the performance of cities in relation to complex phenomena underlying digital transformation in European cities.

1.1 DPSVI Definition and structure

The DPSVI and its other sub-indices are meant to be a concise **measurement of the performance of each city** with respect to several phenomena, that are explored through the combination and cross-checking of the answers to several single questions.

The core data model for the computation of the DPSVI, developed on top of the conceptual framework described in the *Annex 1.1 Extended Methodology*, is represented in the following picture:

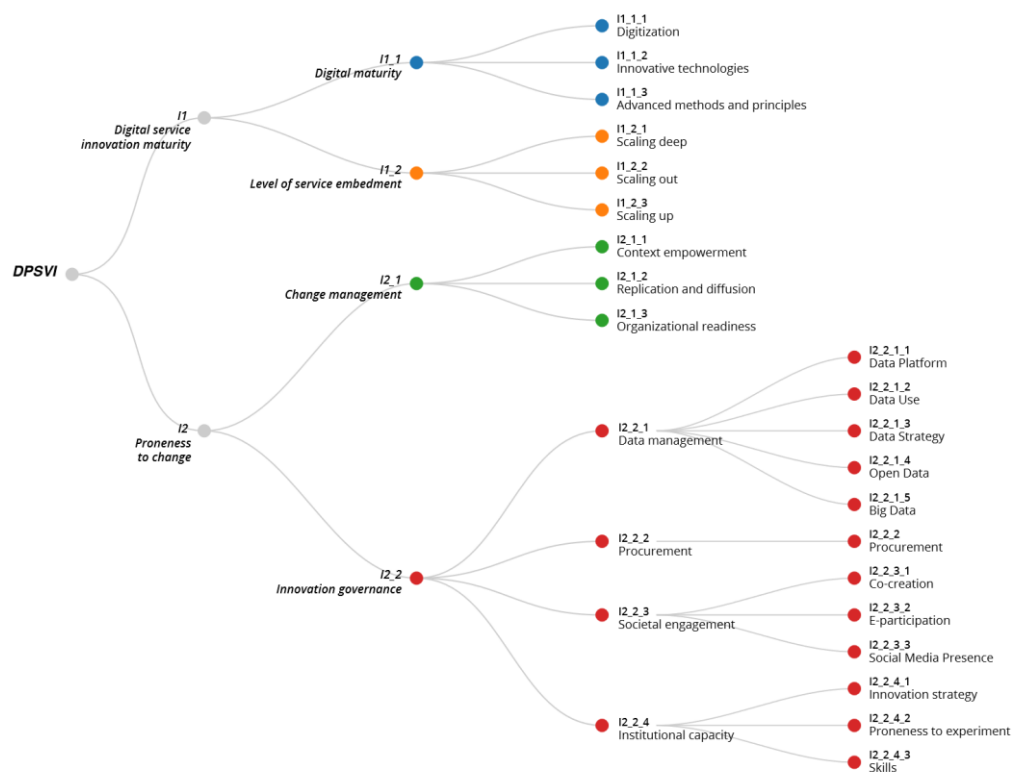


Figure 1 - DPSVI Structure

Overall, the DPSVI is composed of 31 Composite indexes that are organized in three groups (cfr. Table 1 - Composite indexes of DPSVI):

- 3 Top Indexes: are the apical indexes including the DPSVI itself and the two pillars (I1 DIGITAL SERVICE INNOVATION MATURITY and I2 PRONENESS TO CHANGE)
- 21 Bottom Indexes: the indexes directly generated on top of DIGISURVEY data
- 7 Intermediate Indexes: the other indexes in intermediate positions

Code	Label	Level	Description
I1	DIGITAL SERVICE INNOVATION MATURITY	Top	It explores the degree of penetration and maturity of technical and organizational innovation in public service delivery
I1_1	Digital maturity	Intermediate	It assesses the level of digitalization of the public authority, intended not only as shift toward digital technologies, but also encompassing the related organizational change, namely the delivery of innovative public services
I1_1_1	Digitization	Bottom	It focuses on the degree of digitization of pre-existing internal procedures either ancillary or directly related to public service delivery
I1_1_2	Innovative technologies	Bottom	It explores the degree of adoption of innovative technologies (AI, blockchain, wearables, etc.)
I1_1_3	Advanced methods and principles	Bottom	It analyses the level of consistency of methods and principles used to increase the digitalization level of the public authority
I1_2	Level of service embedment	Intermediate	It indicates the extent to which the innovation of services is pervasive and has already generated changes
I1_2_1	Scaling deep	Bottom	It indicates the extent to which the innovation of services is pervasive and has already generated changes in the local context, at societal level
I1_2_2	Scaling out	Bottom	It indicates the extent to which the innovation of services has already generated changes either by replicating successful innovations from other contexts or exported elsewhere the innovations experimented locally
I1_2_3	Scaling up	Bottom	It indicates the extent to which the innovation of services is pervasive and has already generated changes within the organization of the public authority
I2	PRONENESS TO CHANGE	Top	It assesses the inclination or readiness of the public authority to change and alter its behaviour, vision, procedures, and its preparedness to integrate and amplify innovations
I2_1	Change management	Intermediate	The capacity of public administrations to put in play a set of actions, norms, policies, and tools either to proactively support innovation in digital service development and provision, or to increase its capacity to detect and adopt innovation dynamics developed in different contexts (within the context, or towards or from other contexts).
I2_1_1	Context empowerment	Bottom	It measures the effectiveness of the strategies, developed by the public authority, to ensure impacts of innovation within in the local context, at societal level, e.g. instillation of cultural values oriented to innovation and change; encouragement for the development of sustainable relationships
I2_1_2	Replication and diffusion	Bottom	It measures the effectiveness of the strategies developed to ensure replicability in other contexts to the innovations experimented locally, so to impact a larger number of citizens or communities
I2_1_3	Organizational readiness	Bottom	It measures the effectiveness of the strategies developed to ensure impacts of innovation within the organization of the public authority
I2_2	Innovation governance	Intermediate	It refers to the way in which the public authority uses transversal administrative processes (data management, societal engagement, public procurement, capacity building) as a leverage to promote cross-sectoral digital innovation
I2_2_1	Data management	Intermediate	It assesses the innovation capacity of data management strategies used by the public organization
I2_2_1_1	<i>Data Platform</i>	Bottom	It assesses the features of the data platform and the consistency between data management strategy and its underlying technical infrastructure
I2_2_1_2	<i>Data Use</i>	Bottom	It explores, from an operational perspective, how data are used by the public administration for the purposes of evaluation and monitoring, delivery, and anticipation and planning.

Code	Label	Level	Description
I2_2_1_3	Data Strategy	Bottom	It investigates whether the definition and the embrace of governance models effectively set appropriate and favorable conditions for data-driven, data-informed, or data-aware decisions and services for creating public value.
I2_2_1_4	Open Data	Bottom	It provides an overview of the degree of application of open data principles, practices, and framework, that are meant to improve performance and efficiency of government services in general
I2_2_1_5	Big Data	Bottom	It refers to the capacity of the city to generate, manage and use big data
I2_2_2	Procurement	Bottom	It assesses the level of digitalization of the public procurement processes within the public authority and their orientation to digital innovation
I2_2_3	Societal engagement	Intermediate	It provides an overview of the intensity and level of digitalization of societal engagement policies, and their impact on public service design and innovation
I2_2_3_1	Co-creation	Bottom	It gives the level of involvement of the citizens in service design and innovation
I2_2_3_2	E-participation	Bottom	It refers to the level reached by the municipality in involving citizens and/or communities through digital platforms
I2_2_3_3	Social Media Presence	Bottom	It provides information about how pervasive is the communication via social media by the municipality
I2_2_4	Institutional capacity	Intermediate	It refers to the institutional capacity of the public authority in relation to the experimentation and consolidation of digital innovation
I2_2_4_1	Innovation strategy	Bottom	It provides information about the agenda setting and pursuing capacity in relation to digital innovation strategies
I2_2_4_2	Proneness to experiment	Bottom	It analyses the readiness to experiment new organizational settings and methods within the public authority
I2_2_4_3	Skills	Bottom	It assesses the availability, within the public authority, of skills as key to the management of digital innovation

Table 1 - Composite indexes of DPSVI

1.2 DPSVI Methodology

The computation of indexes followed three steps.

- **Mapping** In this first step the DIGISURVEY's questions and answers are mapped to the indexes
- **Standardization:** this second step aims at transforming each question mapped to an index in a standardized value on the scale 0,00-1,00, converting the raw answers provided by the cities into numerical values via data coding and/or standardization techniques.
- **Aggregation:** in this final step the standardized numerical values obtained from the questions are aggregated and combined into indexes according to the hierarchy established in the Data Model. The value of indexes corresponds to a weighted average of the values of the questions aggregated.

1.2.1 Mapping questions and answers

The first step of data processing has been the detailed mapping of questions to the 21 Bottom Indexes, that are the ones directly generated on top of the raw data collected with the Digisurvey, while the other indexes are resulting from a successive aggregation between composite indexes.

Figure 2 maps the detailed relation between the questions of the DIGISURVEY and the DPSVI structure and represents the logical basis for the statistical aggregation of data. Chapter 2 includes a detailed description of the branch analysed in this document.

It is important to clarify that in several cases only a limited number of answers (of a given questions) have been mapped to indexes. In this manner the same question could have been used more than once but considering each time only a limited set of possible answers to which has been attributed a different meaning (and consequently a different numeric value). In summary the same question could have been standardized in different manners according to the indexes to which it is associated.

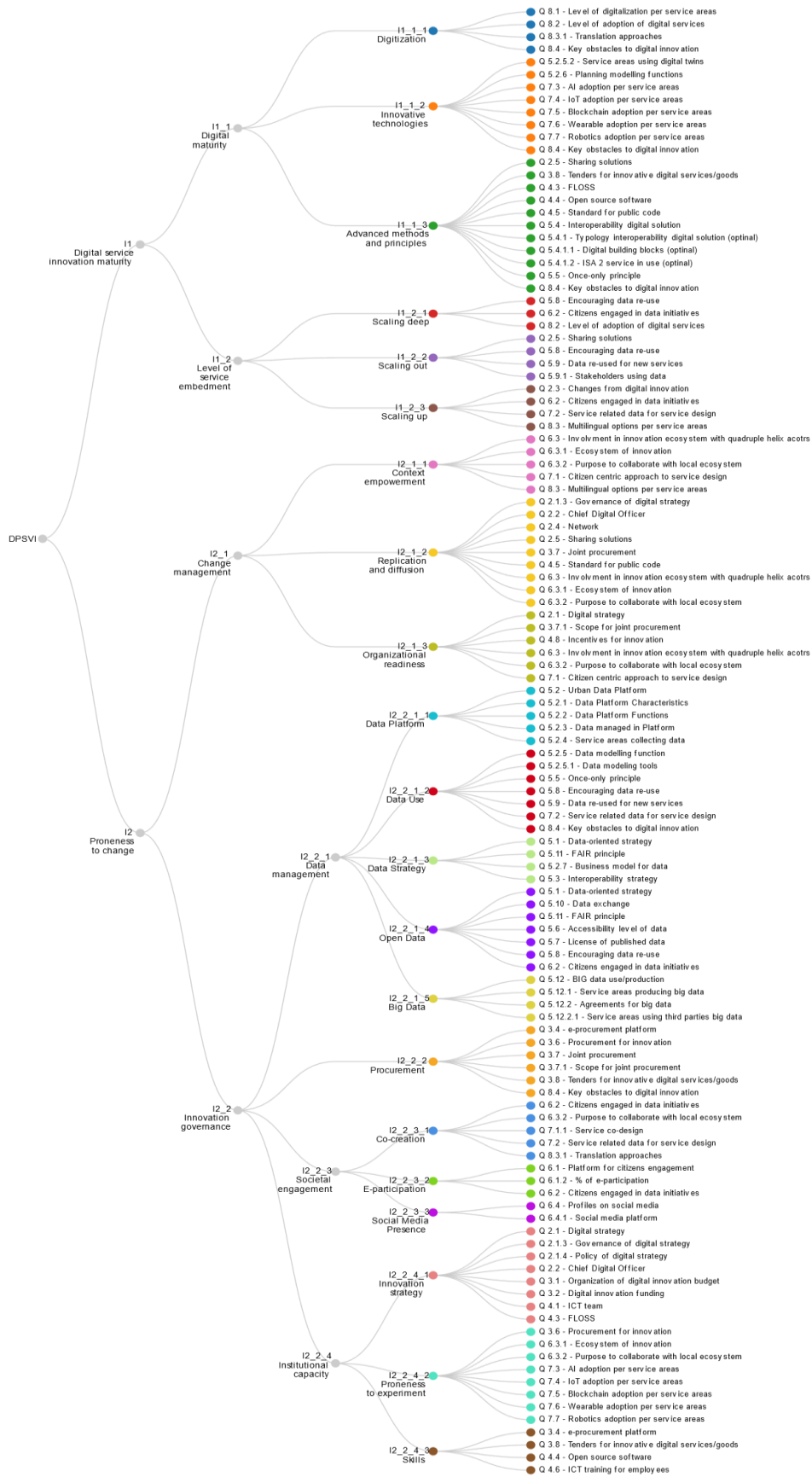


Figure 2 - DPSVI detailed structure – Questions

1.2.2 Standardization

To render the information gathered via the questionnaire processable via computational methods, each question, or group of answers, has been transformed into a number.

In practice, raw data have been replaced by a set of numerical values x_p , where $p = 1, \dots, P$ and P is the total number of questions, or groups of them.

This operation is usually performed in an ad-hoc way, given the specificities of each item of the questionnaire. Nevertheless, the following table provides a synthesis of the methods for data standardization adopted for each category of question.

Type of question	Standardization methods
Binary	Converted into dummy (0-1)
Single Choice	Converted to cardinal value (e.g., answer A = 1, answer B = 3, Answer 3 = 0)
Likert Scales	Converted to correspondent ordinal (e.g., Low = 1, Medium-Low = 2, Medium-High = 3, High = 4)
Multiple Choice / Matrix	Converted into dummies, then (weighted) sum, propaedeutic yes/no are dropped.
Scalars	Normalised using external values (population, size of municipality) if representative of relative phenomena
Matrix – Service Level	Converted into dummies, then summed by column (i.e., process level), finally normalised over number of digitalised services

Table 2 - Standardization methods overview

The *Annex 1.1 Extended Methodology* includes all the information related to the standardization process underlying the DPSVI, including the detailed map of answers to indices and the weight attributed to each answer for standardization purposes.

Before aggregating the numeric answers, these have been rescaled into a 0.00 –1.00 range, so to make them comparable. The mathematical operation that needs to be performed to move these different scales into a unique one, where 0 is the worst possible value and 1 is the best possible one, is the following:

$$x_p^{IT} = \frac{x_p - x_p^{min}}{x_p^{max} - x_p^{min}}$$

Where x_p^{IT} is the rescaled value, x_p is the original value mapped on a generic scale and x_p^{min} , x_p^{max} are, respectively, the minimum possible and the maximum possible value of datum x_p .

1.2.3 Aggregation

In this final phase the standardized values computed on top of the answers to DIGISURVEY questions, are aggregated via a mathematical procedure, with the goal of finally creating the indexes.

After having refined the data to be taken as input, in accordance with the standard literature for this kind of dimensionality reduction task, the indices are introduced as linear combinations of data, that is:

$$I = \frac{\alpha_{n_1^I} x_{n_1^I}^{IT} + \alpha_{n_2^I} x_{n_2^I}^{IT} + \dots + \alpha_{n_{N_I}^I} x_{n_{N_I}^I}^{IT}}{\alpha_{n_1^I} + \alpha_{n_2^I} + \dots + \alpha_{n_{N_I}^I}}.$$

The table published in chapter 2 illustrates the different relative weight attributed to each of the question composing the indexes presented in this document.

1.3 Technical note: how to read charts

This report includes a large number of charts and maps that are generated on top of the indexes that make up the DPSVI and in some cases referred to the same underlying questions. This chapter explains how to interpret the legend that accompanies the publication of charts and maps.

1.3.1 Key info for DPSVI charts and Maps

The charts used to represent DPSVI indexes are relatively simple, being limited to radars, columns, box plots. All charts include a legend reporting the following key information:

Index observed	Index type	Index level	Data Sample	Cluster
<i>Indicates the code and the label of the index observed</i>	<i>Indicates the type of index as either:</i> <ul style="list-style-type: none"> • DPSVI • SI 	<i>Indicates the Index position in its Data model:</i> <ul style="list-style-type: none"> • Top • Intermediate • Bottom 	<i>Indicates the sample that the data refers to</i> <ul style="list-style-type: none"> • All respondents • Reference sample 	<i>Indicates the series showed in the charts and listed in the legend</i> <ul style="list-style-type: none"> • Capital cities • Reference sample • Population • GDPPC • Country

Table 3 – Index charts legend

1.3.1.1 Index type

This information identifies the family of index, being either part of the DPSVI tree (Digital Public Value Service Index) or of the SI tree (Service Areas Index)

1.3.1.2 Index type

This information identifies the position of the index in its data model (cfr. Figure 1 - DPSVI Structure)

- **Top:** refers to the three apical indexes, built on top of all the other indexes:
 - DPSVI
 - Digital Service Innovation Maturity
 - Proneness to Change
- **Bottom:** refers to all the indexes generate directly from questions (cfr Figure 2 - DPSVI detailed structure – Questions)
- **Intermediate:** all the other indexes composed by indexes

1.3.1.3 Data sample

This information identifies the sample on top of which data are computed:

- The “**All respondents**” sample is composed by **all the 255 respondent cities** with the exclusion of duplicate questionnaire coming from the same authority (same city at the same administrative level).
- The “**Reference**” sample is composed by a **selection of 155 respondents**. The reference sample is intended to be the best approximation attainable that could be considered as representative of the variety of European cities.

1.3.1.4 Cluster

Data can be grouped in clusters showed as series in the charts and listed in the legend. The cluster considered in the report could be the followings:

- **None:** no cluster, the data refers to the entire sample
- **Capital cities:** comparing the results of capital cities with all the other respondents.
- **Reference sample:** compared results of reference sample and all other respondents.

- **Population:** compared results among cities by population size
- **GDPPC:** compared results among cities by GDP per capita size
- **Country:** compared results among countries
- **Authority Type:** compared results among different types of local government
- **Case Studies:** 10 selected cities also surveyed through qualitative methods

In few cases cluster and possible answers can be switched, in this case the chart visualizes cluster class on the y-axis and the possible answers as chart series.

1.3.2 Key info for Q charts

In few cases the report presents charts referring to some of the questions that make up the indices. The charts used to present questions are relatively simple, being limited to bars and columns, represented in simple, stacked and 100% stacked formats.

All charts include a summary table reporting the following key information:

Question observed	Question type	Data Sample	Clusters	Value
<i>Indicates the code and the label of the question observed</i>	<i>Indicates the question typology and whether it is a matrix</i>	<i>Indicates the sample that the data refers to</i>	<i>Indicates the series showed in the charts and listed in the legend</i>	<i>Indicates the units in which the data are represented</i>
	<ul style="list-style-type: none"> • Single choice • Single choice - Binary • Single choice - Likert • Multiple choice • Matrix - Single choice • Matrix - Likert • Matrix - Multiple choice 	<ul style="list-style-type: none"> • All respondents • Reference sample 	<ul style="list-style-type: none"> • Capital cities • Reference sample • Population • GDPPC • Country 	<ul style="list-style-type: none"> • Count • Percentage

Table 4 – Question charts legend

1.3.2.1 Question type

Within the two macro-categories of simple and matrix questions it is possible to further distinguish between the following kind of questions, each one collecting data in a different manner:

Simple questions typologies:

- *Single choice – Binary:* One single choice between “Yes” or “No”
- *Single choice – Likert:* One choice among items in a Likert scale
- *Single choice:* One choice among all the possible answers
- *Multiple choice:* Possibility to select multiple answers

Matrix question typologies:

- *Matrix - Single choice:* Possibility to select just one answer (column) per row
- *Matrix – Likert:* Possibility to select just one answer per row. The columns are organized as a Likert scale
- *Matrix - Multiple choice:* Possibility to select multiple answers per row.

1.3.2.2 Data sample

This information identifies the sample on top of which data are computed. The samples used for the question charts are the same used for the Indexes (cfr. 1.3.1.3)

1.3.2.3 Cluster

Data can be grouped in clusters showed as series in the charts and listed in the legend. The cluster explored by the report are the same used for the Indexes (cfr. 1.3.1.4).

1.3.2.4 Value

The value indicates the units in which the data are represented along the x-axis.

The data could be represented as:

- *Count*: DPSVI number that select a particular answer
- *Percentage*: relative number of respondents that select that answer.

In the case of clustered bar charts, the percentage is based on the number of respondents to that specific question. In the case of 100% stacked bar, the percentage is based on the total number of selections received by that answer (row 's percentage). The percentage could also be based on the total number of selections received by the question.

2 Data Management in Public Policy and Services in European Cities

2.1 Definition of the indices and exploration of its structure

Data is one of the most valuable resources in today’s societies, economies, and governments, leveraging multi-level development. Coherently, effective data management strategy is becoming more and more an imperative towards better public services. Data is a powerful asset to guide governments to better design and tailor their processes of public service delivery.

The fast evolution of technologies continuously offers novel opportunities towards digital government, as well as towards transparency and openness. The production and access to data, services, and contents play a relevant role in digital transformation and maturity processes. They are enabled and facilitated, for example, by the presence of data platforms, the adoption of strategies for data use and reuse, and the presence of open data principles common to several governmental institutions. Accordingly, Data management is explored through five dimensions: Data platform, Data use, Data strategy, Open data, and Big data.

- **I2.2.1.1 Data platform:** It explores the features of the urban data platform, assessing both its technological complexity and its internalization in organizational procedures
- **I2.2.1.2 Data use:** It assesses the actual degree of use and reuse of data managed, exploring both the purposes and the methods for their exploitation, as well as the means implemented to make them accessible and reusable.
- **I2.2.1.3 Data Strategy:** It assesses the command of the public authority on data management strategies, assessing what kind of strategic frameworks are implemented
- **I2.2.1.4 Open Data:** It provides an overview of the degree of application of open data principles and practices
- **I2.2.1.5 Big Data:** It refers to the capacity of the city to generate, manage and use big data

2.1.1 Mapping Details

The following figure and table include the detailed list of the questions that have been mapped to this index and its sub-indexes, according to the methodology explained in Chapter 1.2.1.



Figure 3 – Data Management index composition (questions tree)

The following table includes the text of all questions used to create the Data Management Indexes and information about the type of questions.

Question number and text	Question Type
5.1 Does your public authority apply strategies to govern, collect, store and share city-related data across the public authority?	Single choice
5.2 Does your public authority operate / work with an Urban Data Platform to collect, manage, access and share data?	Single choice - Binary
5.2.1 What are the characteristics of your Urban Data Platform?	Single choice
5.2.2 Please select any additional functions the Urban Data Platform can perform:	Multiple choice
5.2.3 What types of data are integrated and managed in your Urban Data Platform(s)?	Multiple choice
5.2.4 To what extent do different service areas collect and share data?:	Matrix - Likert
5.2.7 Could you describe the business models used by companies linked to the Urban Data Platform (i.e. actually using data provided by the Urban Data Platform)?	Multiple choice
5.3 Has your public authority developed an Interoperability Framework or Strategy?	Single choice
5.6 What is the accessibility level of the data published through the data platform?	Multiple choice
5.7 What licenses are used to publish data openly on your data platform?	Multiple choice
5.8 How does the public authority encourage data re-use?	Multiple choice
5.10 To what extent are relevant data exchanged among service areas, departments, or units of your public authority?	Single choice
5.11 Is your public authority applying the FAIR principles?	Single choice
5.12 Is your public authority using or producing Big Data?	Single choice - Binary
5.12.1 If your public authority is producing/using its own Big Data, which service areas are covered?	Matrix - Multiple choice
5.12.2 Does your public authority have access to Big Data through agreements with third parties?	Single choice - Binary
5.12.2.1 If your public authority is using Big Data produced by third parties, which service areas are covered?	Matrix - Multiple choice
6.2 Does your public authority engage citizens in (open) data initiatives?	Multiple choice

Table 5 – Data Management related Questions in DIGISURVEY

The *Annex 1.1 Extended Methodology* to the DIGISER Final Report hosts a dedicated Appendix (Appendix I) with all the information related to the standardization process underlying the DPSVI, including the detailed map of answers to indices and the weight attributed to each answer for standardization purposes.

2.1.2 Aggregation details

The following table provides information regarding the weights attributed to each question in computing the value of the indexes presented in this report, according to the methodology presented in Chapter 1.2.3.

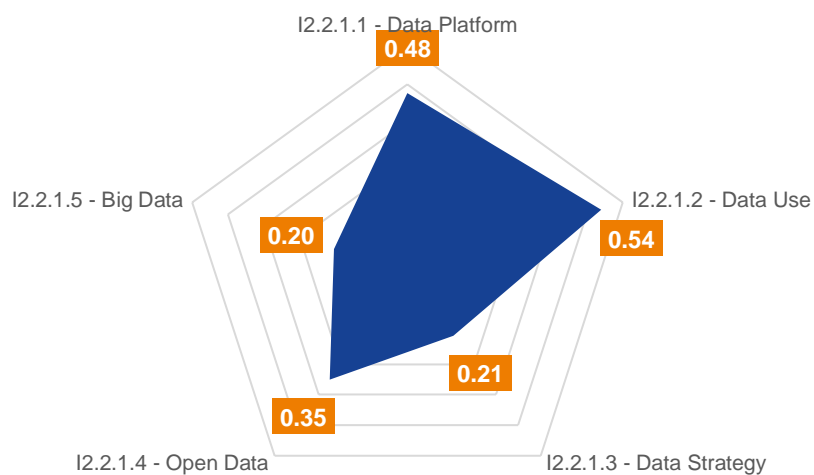
Q_#	I2_2_1_1	I2_2_1_2	I2_2_1_3	I2_2_1_4	I2_2_1_5
Q_5.1	-	-	100%	100%	-
Q_5.2	20%	-	-	-	-
Q_5.2.1	80%	-	-	-	-
Q_5.2.2	80%	-	-	-	-
Q_5.2.3	80%	-	-	-	-
Q_5.2.4	80%	-	-	-	-
Q_5.2.7	-	-	100%	-	-
Q_5.3	-	-	100%	-	-

Q_#	I2_2_1_1	I2_2_1_2	I2_2_1_3	I2_2_1_4	I2_2_1_5
Q_5.6	-	-	-	100%	-
Q_5.7	-	-	-	100%	-
Q_5.8	-	-	-	100%	-
Q_5.10	-	-	-	100%	-
Q_5.11	-	-	100%	100%	-
Q_5.12	-	-	-	-	20%
Q_5.12.1	-	-	-	-	40%
Q_5.12.2	-	-	-	-	8%
Q_5.12.2.1	-	-	-	-	32%
Q_6.2	-	-	-	100%	-

Table 6 – Data Management - Relative weight of underlying questions

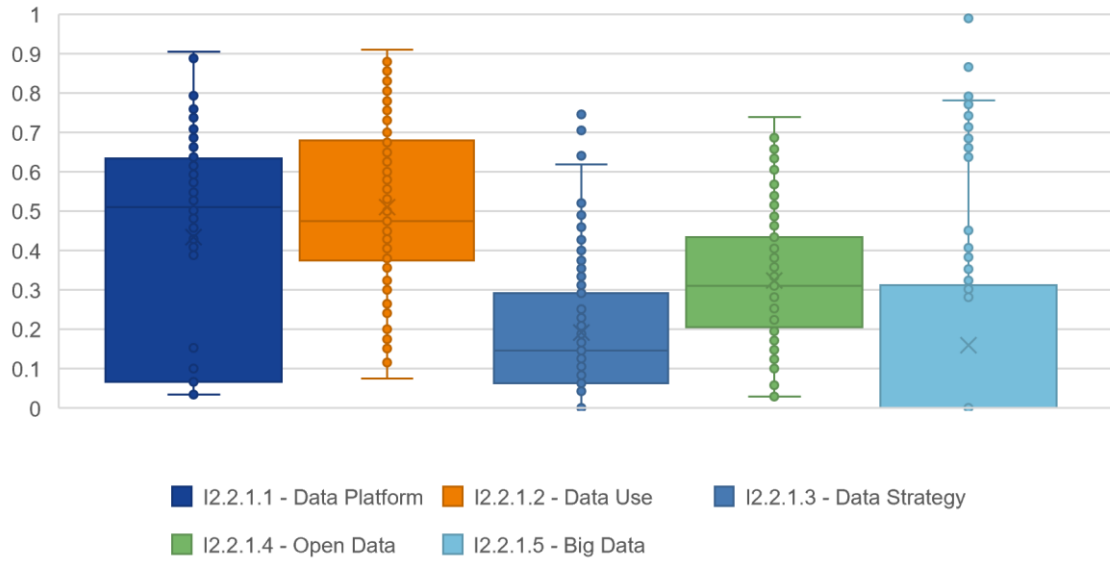
An extensive overview of the weights used to calculate the DPSVI is available in *Annex 1.1 Extended Methodology*.

2.2 Index overview



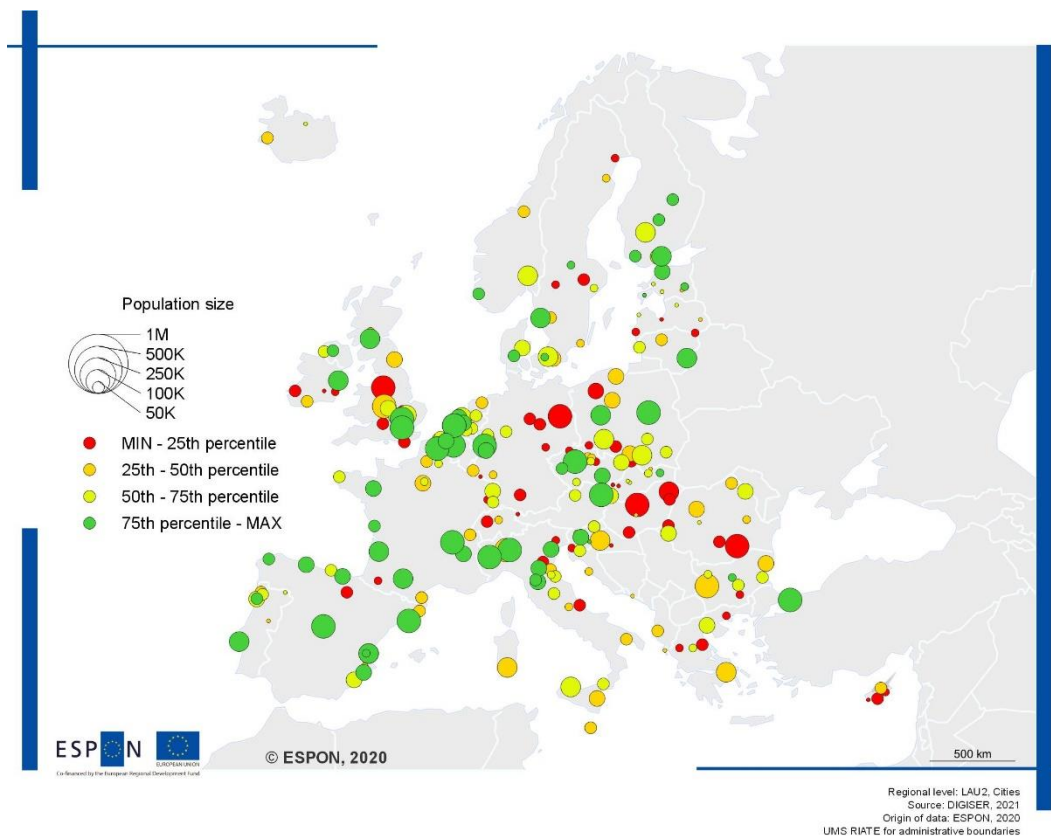
Index observed	Index type	Index level	Data Sample	Clusters
I2.2.1 – Data Management	DPSVI	Intermediate	Reference Sample	na

Figure 4 – Data Management overview

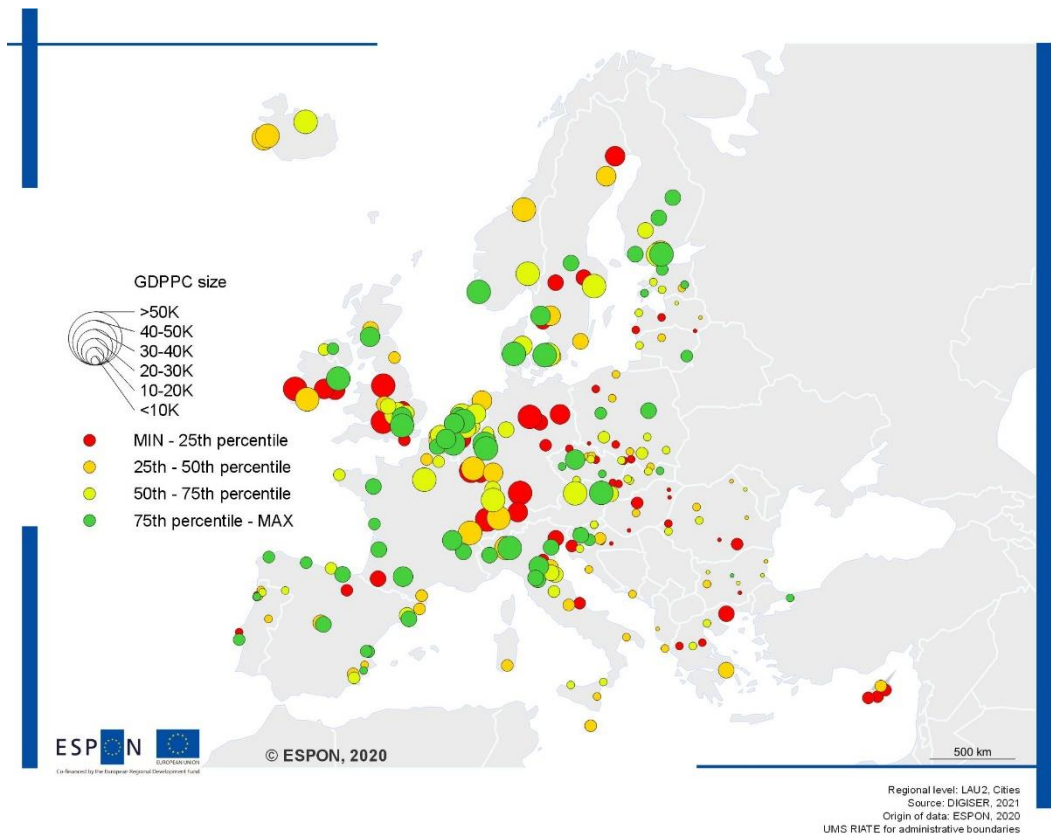


Index observed	Index type	Index level	Data Sample	Clusters
I2.2.1 – Data Management	DPSVI	Intermediate	Reference Sample	na

Figure 5 - Data Management composition

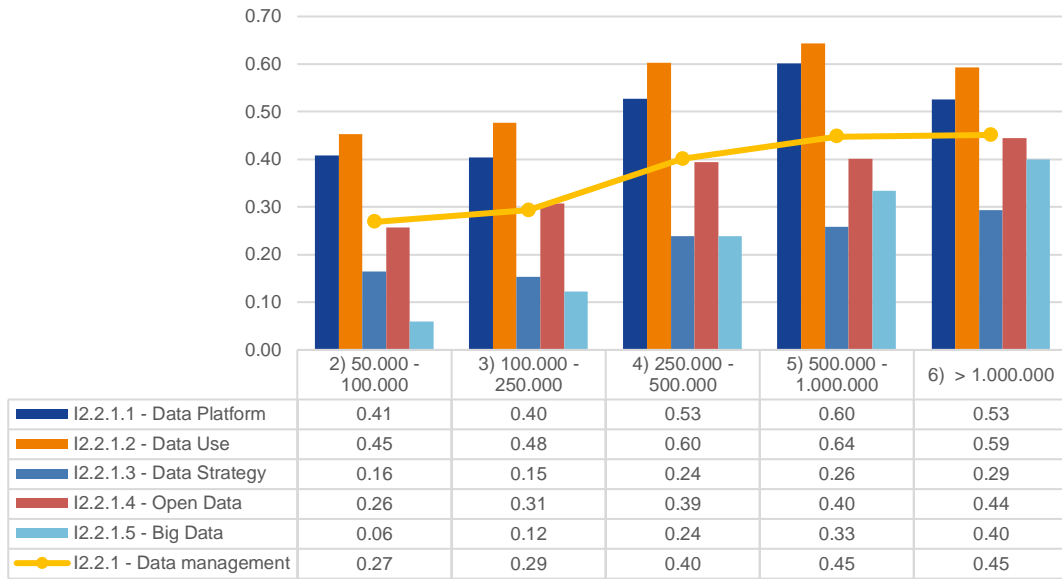


Map 1 – Data Management and population size



Map 2 – Data Management and GDPPC size

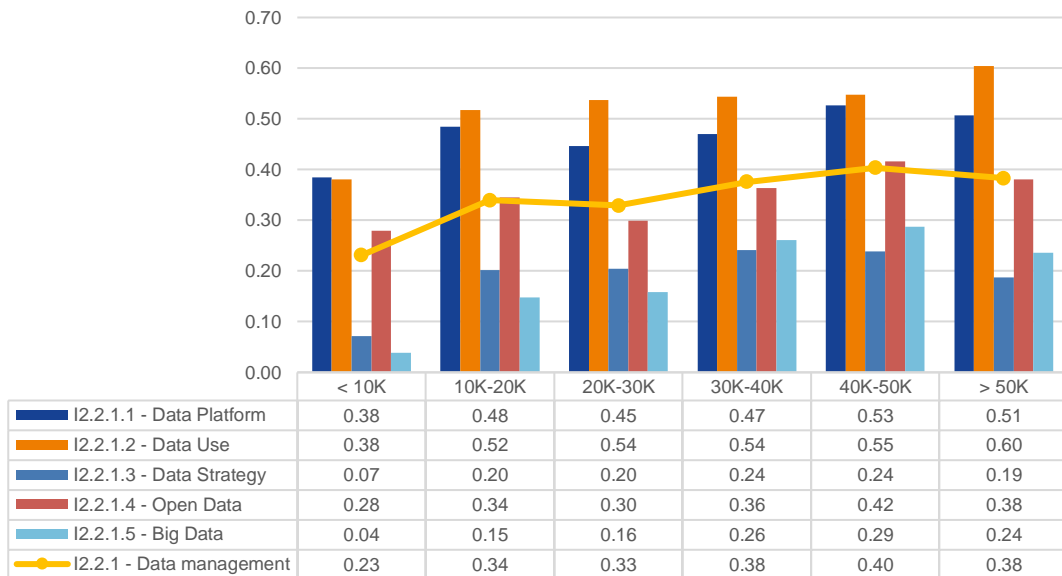
2.3 Population



Index observed	Index type	Index level	Data Sample	Clusters
I2.2.1 – Data Management	DPSVI	Intermediate	Reference Sample	Population

Figure 6 - Data Management by population

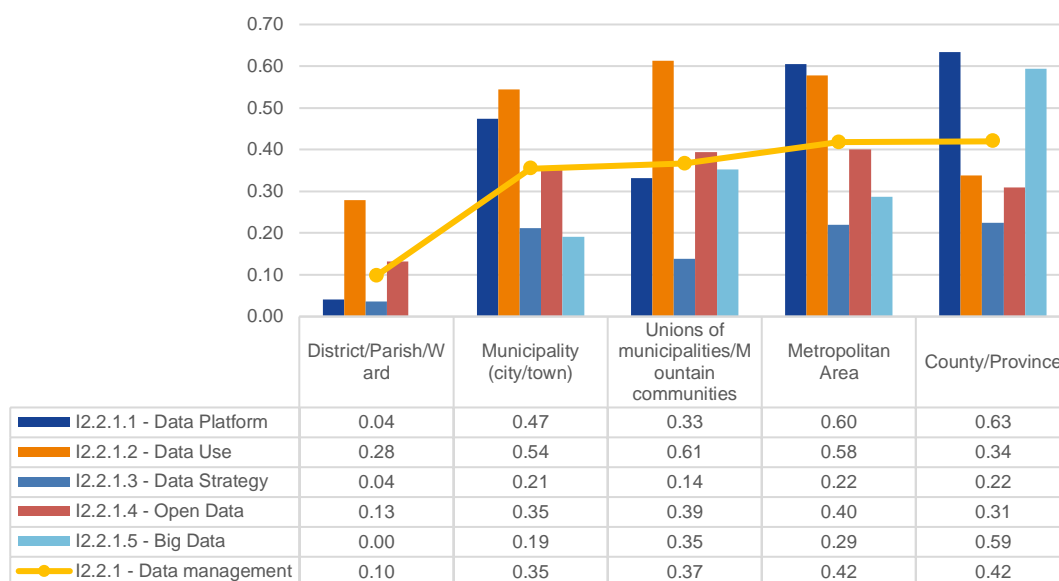
2.4 GDP per Capita



Index observed	Index type	Index level	Data Sample	Clusters
I2.2.1 – Data Management	DPSVI	Intermediate	Reference Sample	GDPPC

Figure 7 - Data Management by GDPC

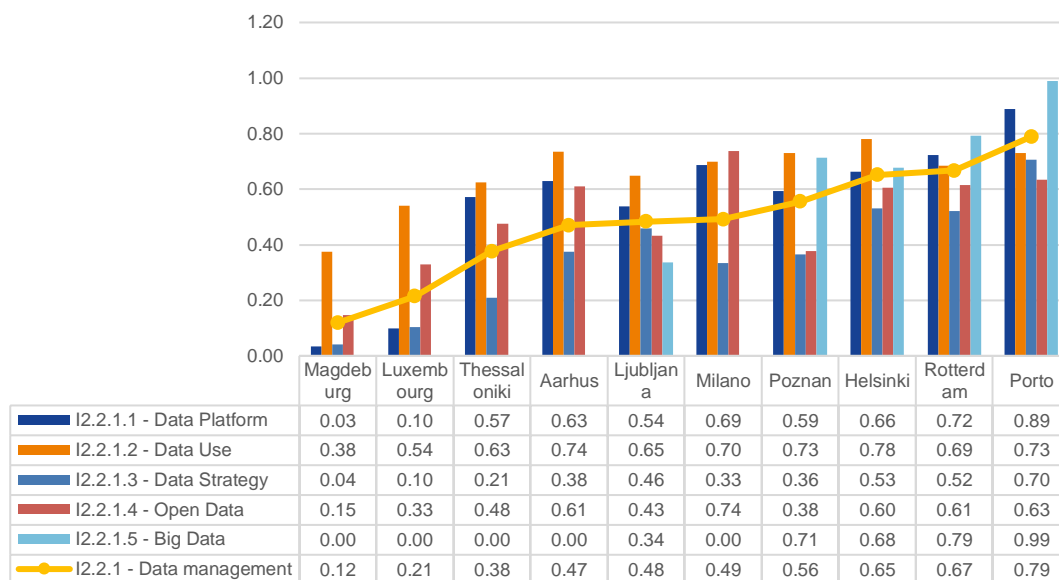
2.5 Authority Type



Index observed	Index type	Index level	Data Sample	Clusters
I2.2.1 – Data Management	DPSVI	Intermediate	Reference Sample	Authority type

Figure 8 - Data Management by authority type

2.6 Case Studies



Index observed	Index type	Index level	Data Sample	Clusters
I2.2.1 – Data Management	DPSVI	Intermediate	Case studies	na

Figure 9 - Data Management, case studies

2.7 Highlights

- In general, the index is composed of 5 sub-indices that measure different values. At the highest level it is evident that the indicator on the data platform covers a wider spectrum of possible values, while in other cases the values are concentrated in a limited oscillation buffer, recording homogeneous behavior patterns regardless of the characterization of the city.
- In the slides that analyze the index through different clusters it is visible that:
 - There is a correlation between the I_2.2.2 and the population, which is much more difficult to detect if we consider the aggregate results for GDPpc
 - Supra-municipal territorial authorities perform better than municipalities: if on the one hand this score could be biased by the limited number of respondents in these categories, on the other hand it is inferable that these entities had to fill the gap of own resources by associating or federating a part of the data management services, implementing more innovative methods for the management of these services.
- An interpretation at the highest level of the different behavior of the sub-indices could support the following hypotheses:
 - Most cities are equipped with a data platform although in most cases managed manually and not deeply integrated in digital service provision processes
 - Beyond technological integration, the use of data in the formulation and analysis of public policies and services is being consolidated as a general practice in several categories of cities, with the indicator I2.2.1.2 being higher than 0.5
 - The active governance of data management strategies remains a critical point, especially with regard to interoperability strategies and to the (limited) capacity to promote economic development and value generation through the exploitation of the economic potential of data
 - The open data indicator confirms that, at least at a formal level, openness principles have penetrated the culture and practice of the local public sector.
 - The very low result of the Big Data indicator (the lowest of the entire DPSVI tree) reveals not only a limited ability to manage the phenomenon, but also a very gap in knowledge and skills necessary to understand its terms and relevance.

3 Data Platform of European Cities

3.1 Definition of the indices and exploration of its structure

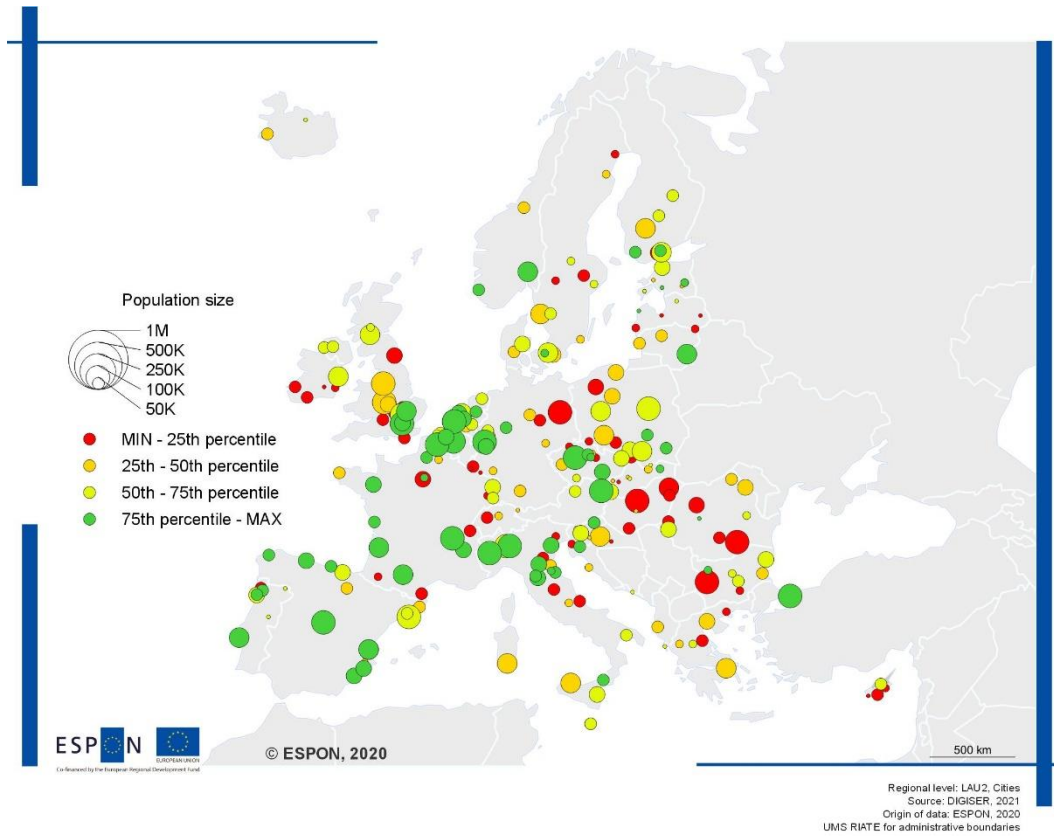
A data platform is a software platform used to manage and publish on the web the data collected and generated by public authorities or by different stakeholders of the city ecosystem, as for example public agencies, businesses, citizens or other organisations. The presence of a data platform mirrors an attention towards data sharing on the one side, and data management on the other. Indeed, the data platform can have functions that allow advanced data management, analysis, and visualisation.



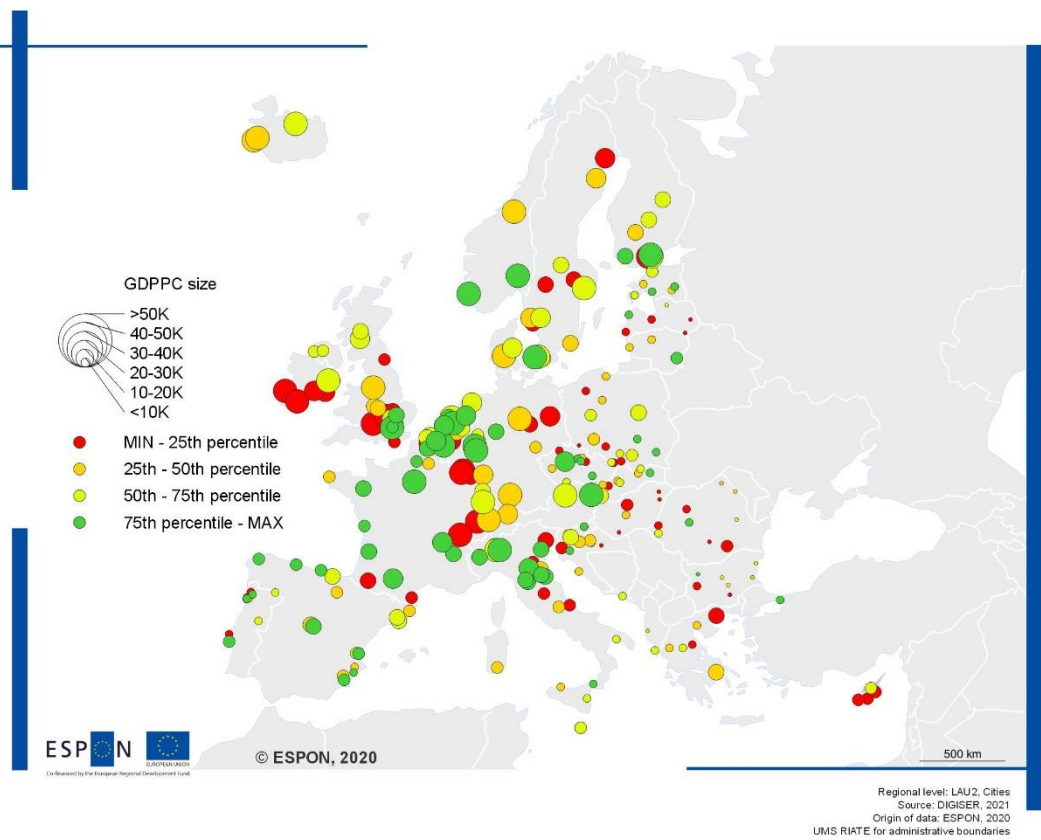
Figure 10 – Data Platform index composition (questions tree)

This is a *Bottom Level* index, composed by 5 questions, each one computed for a limited number of possible answers:

- **Q_5.2** Does your public authority operate / work with an Urban Data Platform to collect, manage, access and share data?
- **Q_5.2.1** What are the characteristics of your Urban Data Platform?
- **Q_5.2.2** Please select any additional functions the Urban Data Platform can perform:
- **Q_5.2.3** What types of data are integrated and managed in your Urban Data Platform(s)?
- **Q_5.2.4** To what extent do different service areas collect and share data?

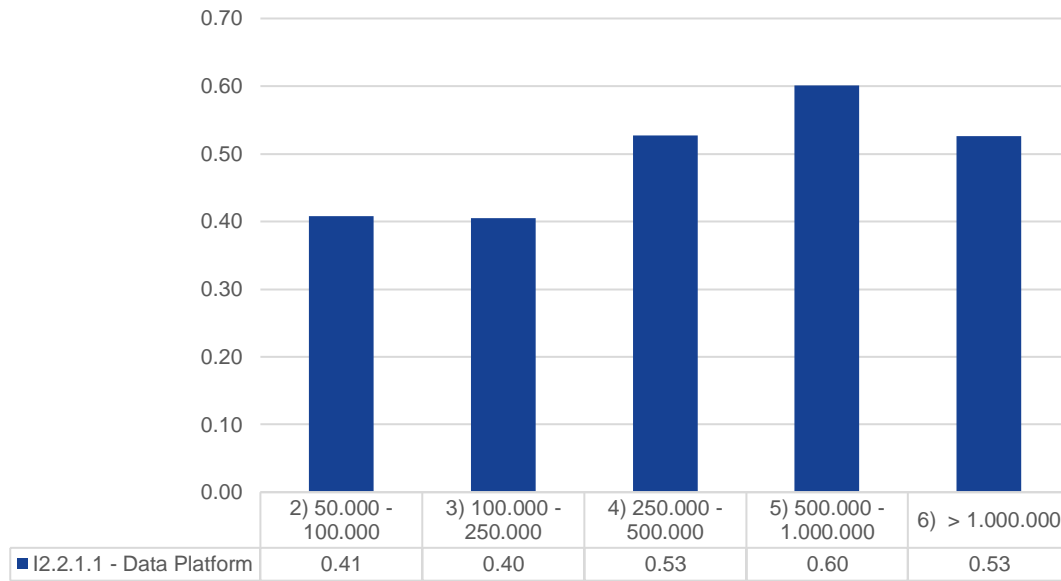


Map 3 – Data Platform and population size



Map 4 – Data Platform and GDPPC size

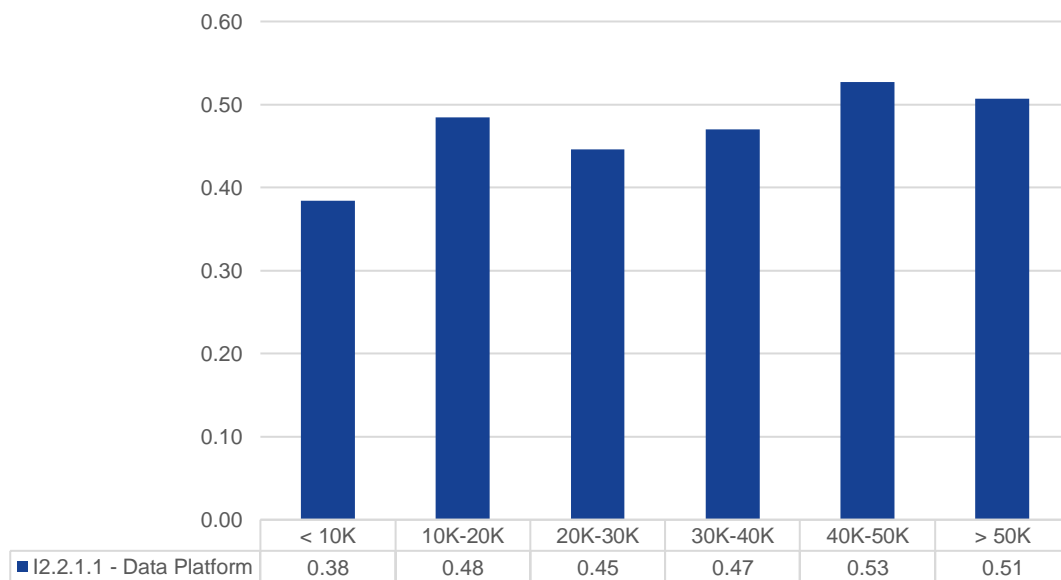
3.2 Population



Index observed	Index type	Index level	Data Sample	Clusters
I2.2.1.1 - Data Platform	DPSVI	Bottom	Reference Sample	Population

Figure 11 - Data Platform by population

3.3 GDP per Capita



Index observed	Index type	Index level	Data Sample	Clusters
I2.2.1.1 - Data Platform	DPSVI	Bottom	Reference Sample	GDPPC

Figure 12 - Data Platform by GIPC

3.4 Authority Type

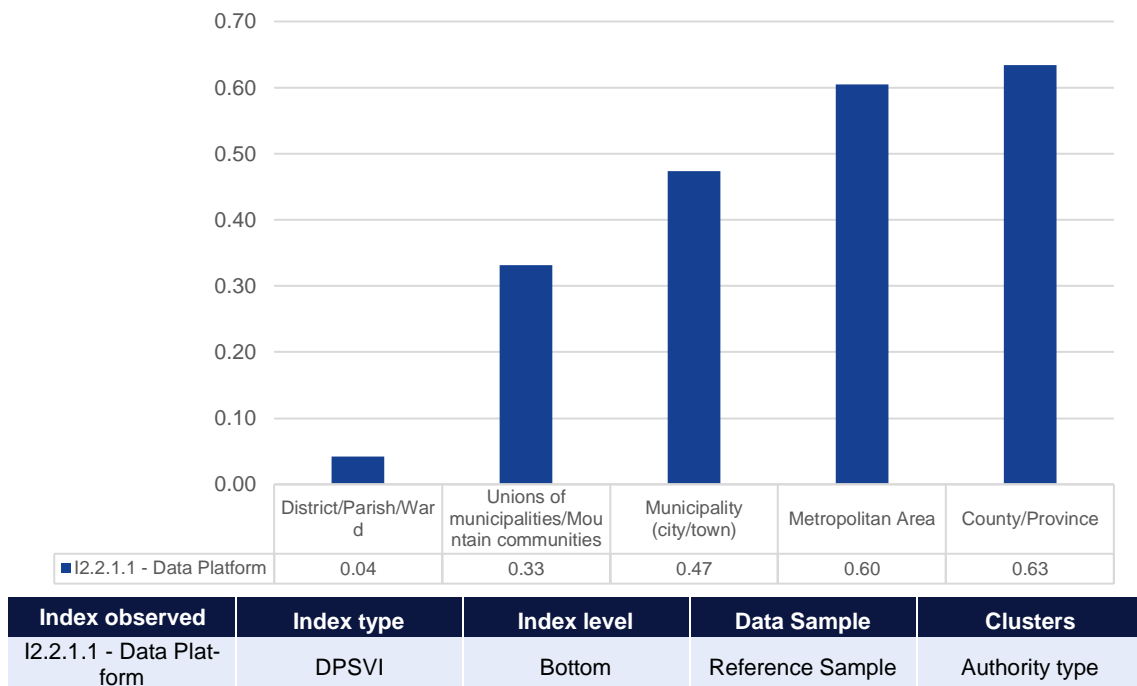


Figure 13 - Data Platform by authority type

3.5 Case studies

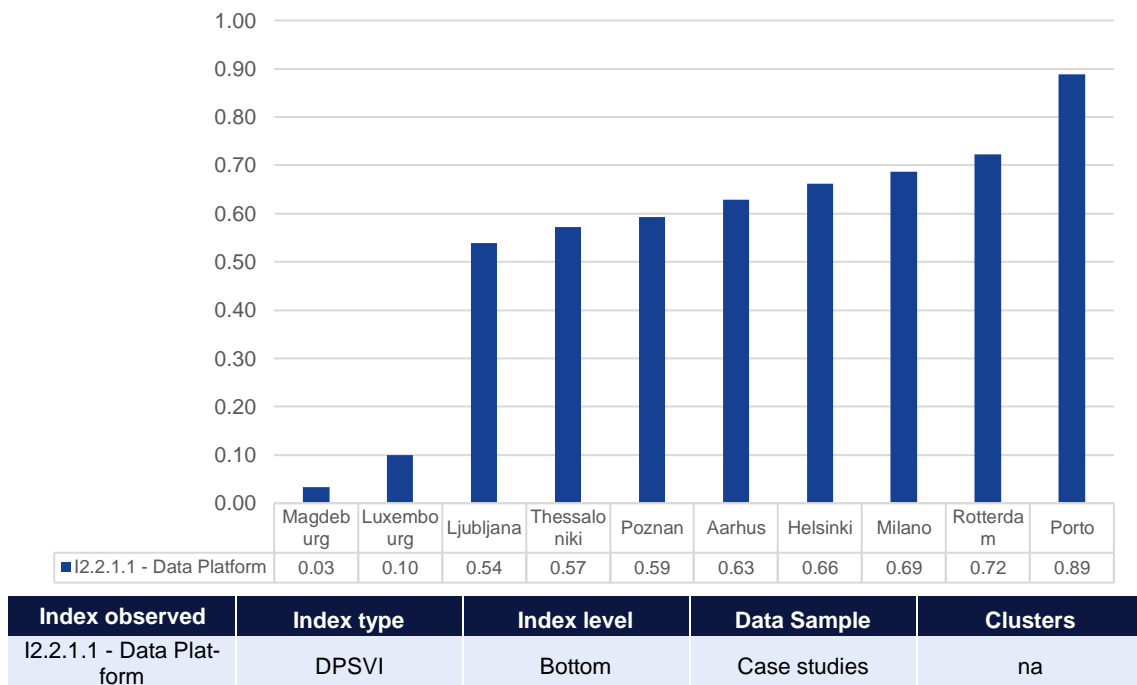
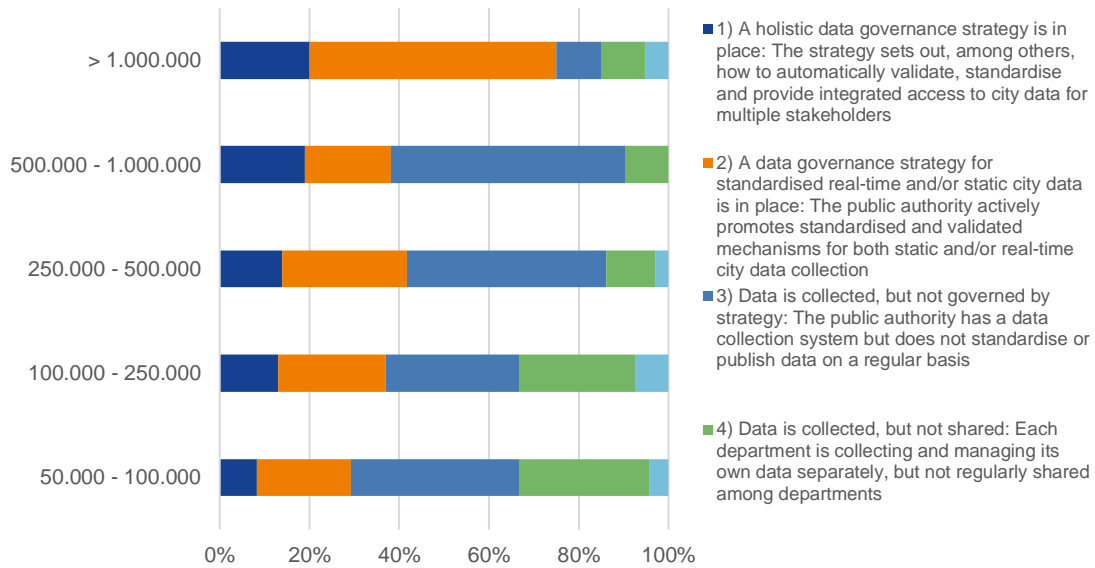


Figure 14 - Data Platform, case studies

3.6 Relevant question results

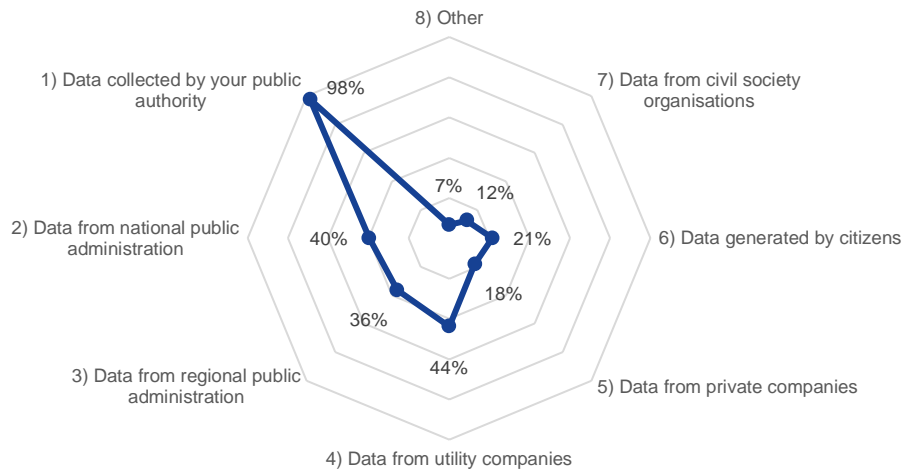
3.6.1 What are the characteristics of your Urban Data Platform?



Question observed	Question type	Data Sample	Clusters	Value
Q_5.2.1	Single choice	Reference Sample	Population	Percentage

Figure 15 – Types of Urban Data Platforms

3.6.2 What types of data are integrated and managed in your Urban Data Platform(s)?



Question observed	Question type	Data Sample	Clusters	Value
Q_5.2.3	Multiple choice	Reference Sample	na	Percentage

Figure 16 – Data Sources in Urban Data Platforms

3.7 Highlights

- This index penalizes that 22% of cities that do not use a data platform, which in this case will have a score of 0.
- For this indicator there are no significant correlations either with the population or with the wealth, with the different clusters that behave very differently from each other.
- Spatial trends show a concentration of cities in the last quartile in Britain and in Central Europe, while performances looks positive in the Iberian Peninsula, Belgium and the Netherlands, and northern Italy.
- The majority of cities are anyway equipped with a data platform, although in most cases these are tools that are poorly integrated and the standardization and automation processes remains very limited, except for cities over one million inhabitants (cfr. Q 5.2.1)
- Question Q 5.2.3 adds further details highlighting how for an extreme majority of cases the data platform is used to manage, share and publish data generated within the same administration, or data harvested from national or regional data portal. The publication of data from the private sector or other societal actors remains very limited, with the exception of public utility companies which in 44% of cases are a source of data published by the city.

4 Data Use of European Cities

4.1 Definition of the indices and exploration of its structure

Data is recognised as a strategic asset that can be leveraged to pursue public value. From an operational perspective, data can be employed for purposes, among the others, of evaluation and monitoring, delivery, and anticipation and planning. Data use explores this dimension observing how data are used by the public administration.

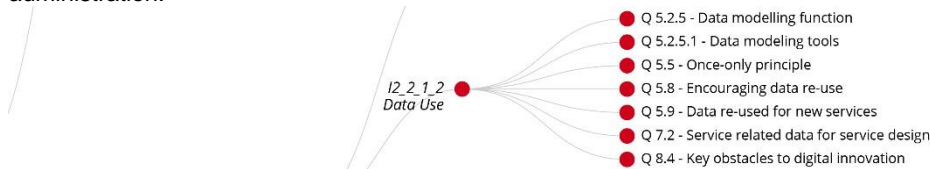
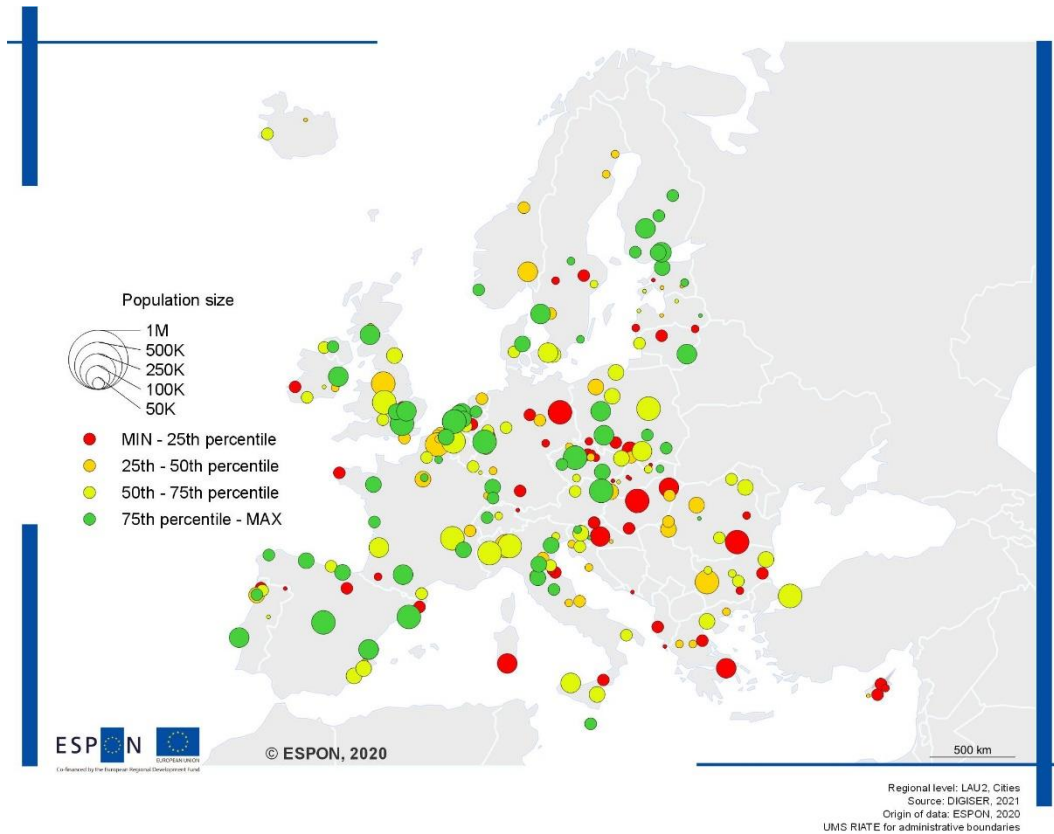


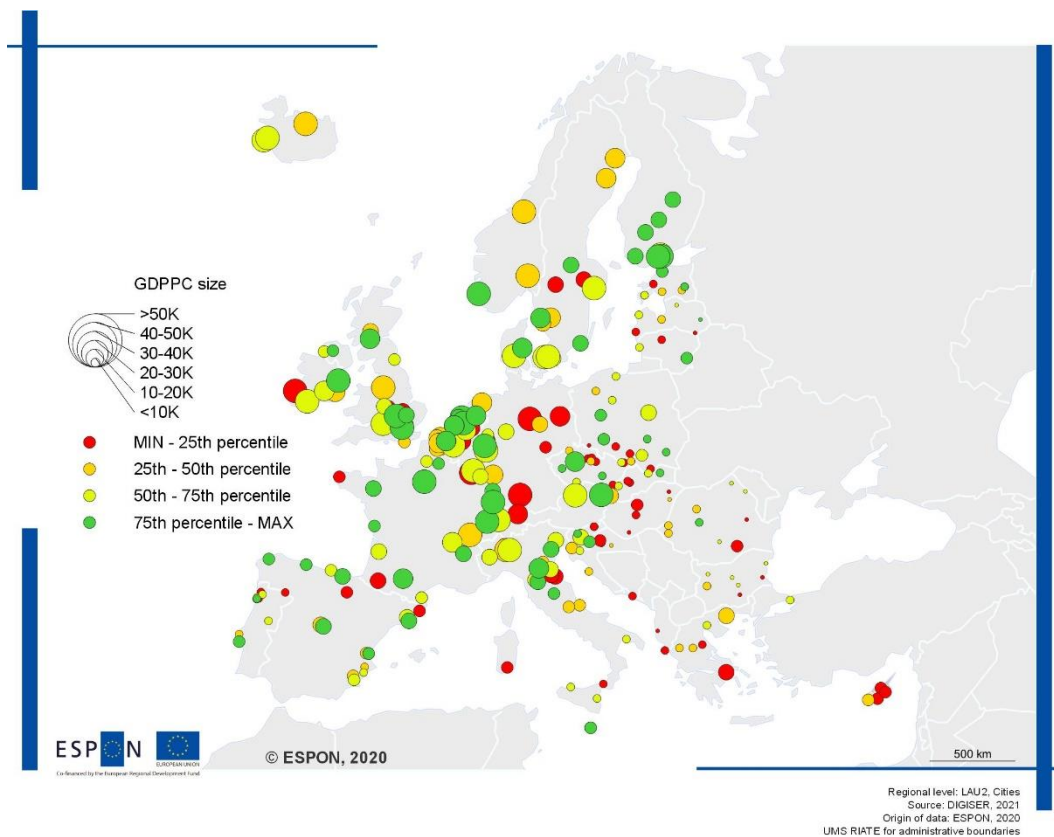
Figure 17 – Data use index composition (questions tree)

This is a *Bottom Level* index, composed by 7 questions, each one computed for a limited number of possible answers:

- **Q_5.2.5** Is your Urban Data Platform connected with a data modelling function for the production of large virtual environments to achieve a real-world experience (Local Digital Twins or similar)?
- **Q_5.2.5.1** What kind of data modelling tools is your Urban Data Platform integrated with?
- **Q_5.5** Does your public authority apply the once-only principle in its services?
- **Q_5.8** How does the public authority encourage data re-use?
- **Q_5.9** Has the shared data been re-used to create new services/solutions?
- **Q_7.2** Does your public authority use service-related data to improve your digital service offer in the following areas?
- **Q_8.4** Please indicate the key obstacles that your public authority is experiencing:



Map 5 – Data Use and population size



Map 6 – Data Use and GDPPC size

4.2 Population

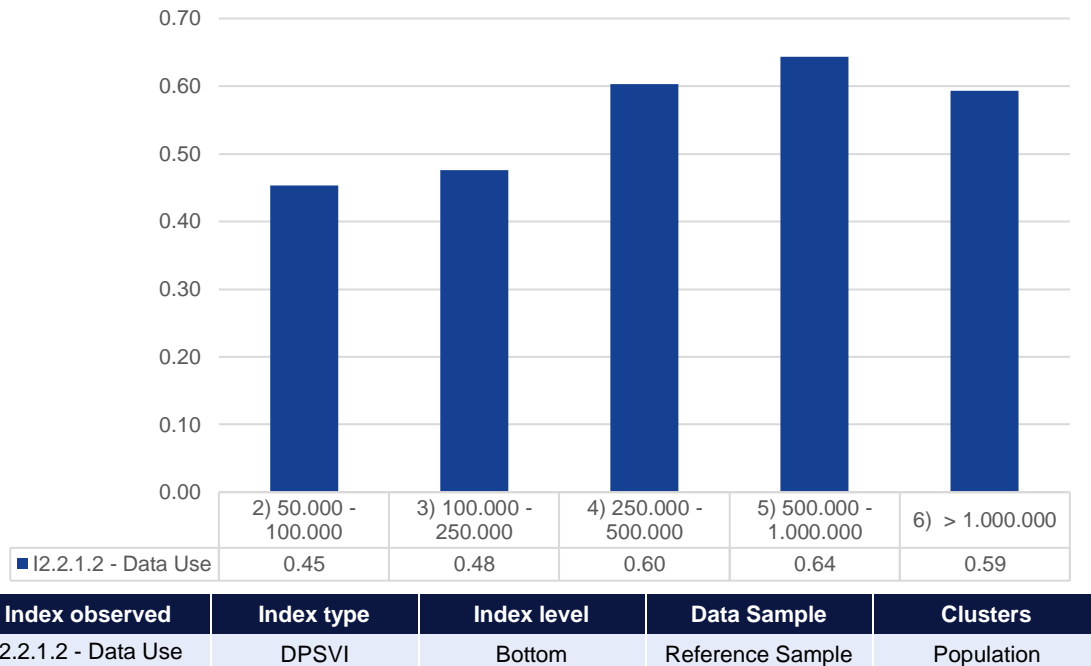


Figure 18 - Data Use by population

4.3 GDP per Capita

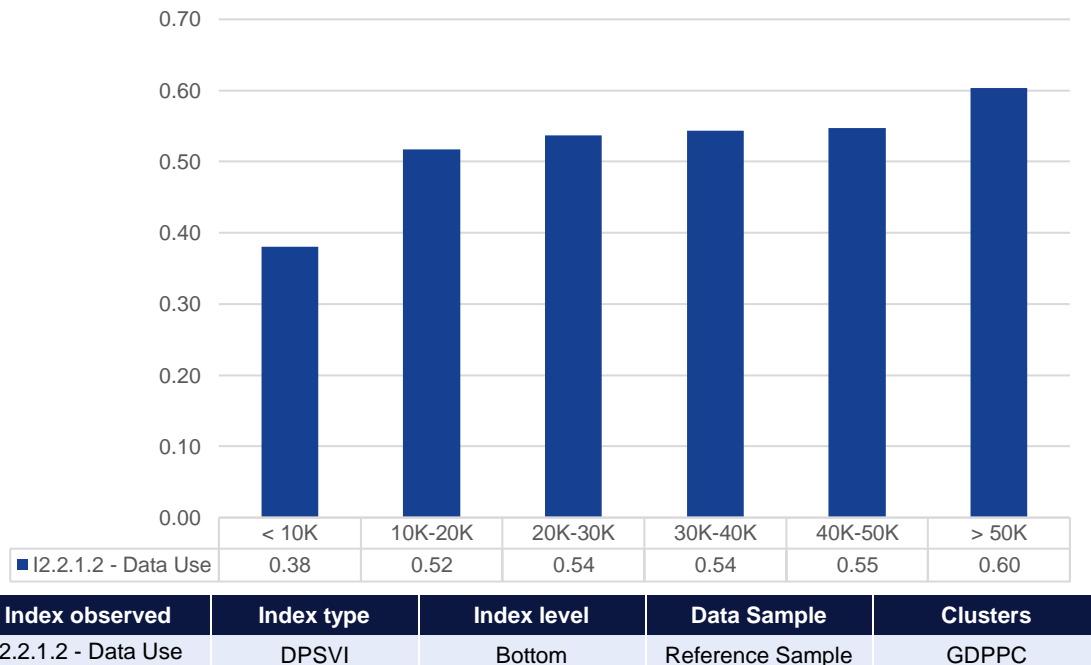
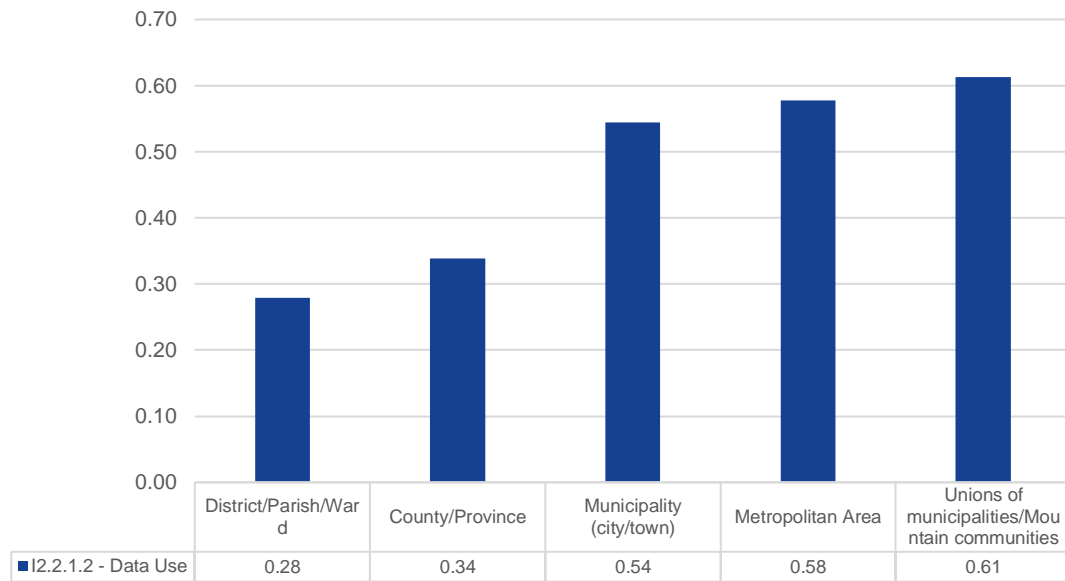


Figure 19 - Data Use by GDPPC

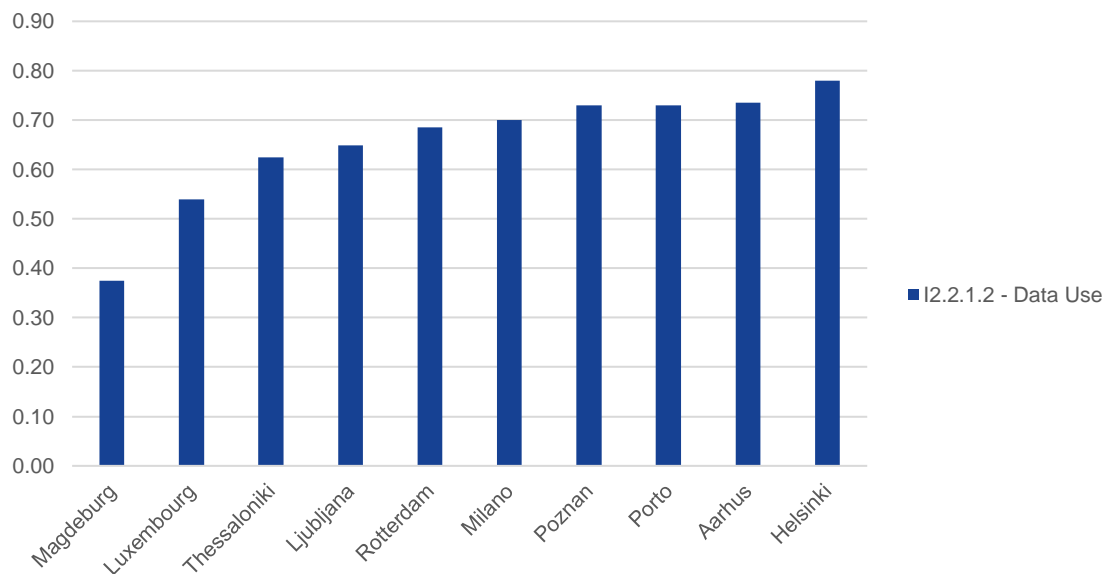
4.4 Authority Type



Index observed	Index type	Index level	Data Sample	Clusters
I2.2.1.2 - Data Use	DPSVI	Bottom	Reference Sample	Authority type

Figure 20 - Data Use by authority type

4.5 Case studies

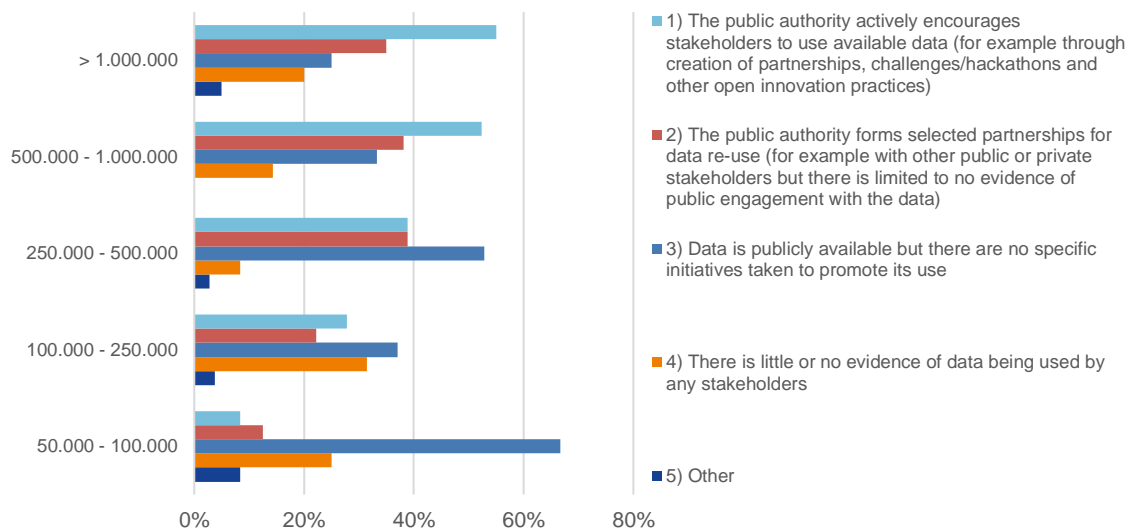


Index observed	Index type	Index level	Data Sample	Clusters
I2.2.1.2 - Data Use	DPSVI	Bottom	Case studies	na

Figure 21 - Data Use, case studies

4.6 Relevant question results

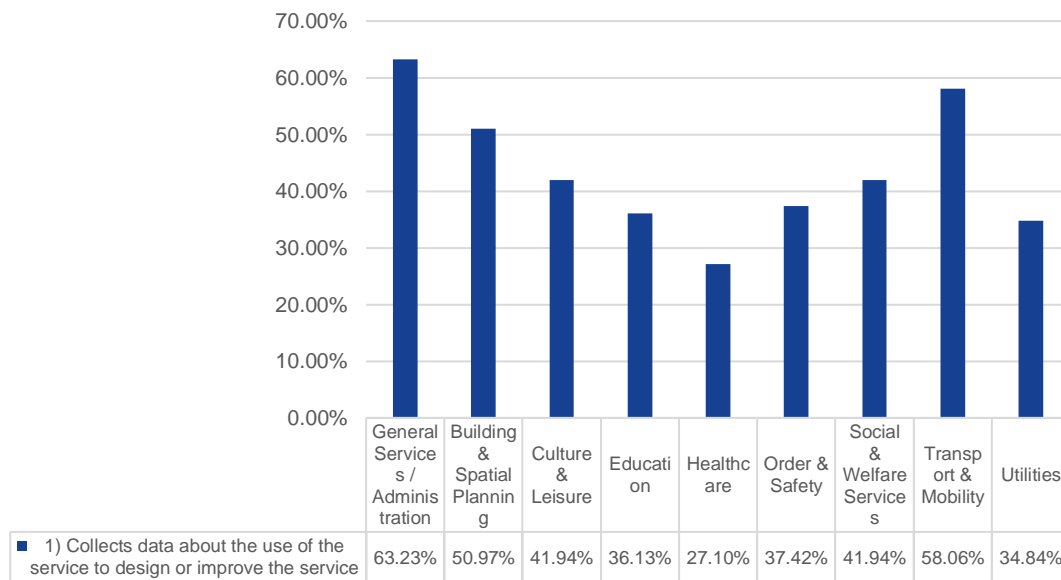
4.6.1 How does the public authority encourage data re-use?



Question observed	Question type	Data Sample	Clusters	Value
Q_5.8	Single choice	Reference Sample	Population	Count

Figure 22 – Incentives to Data Reuse

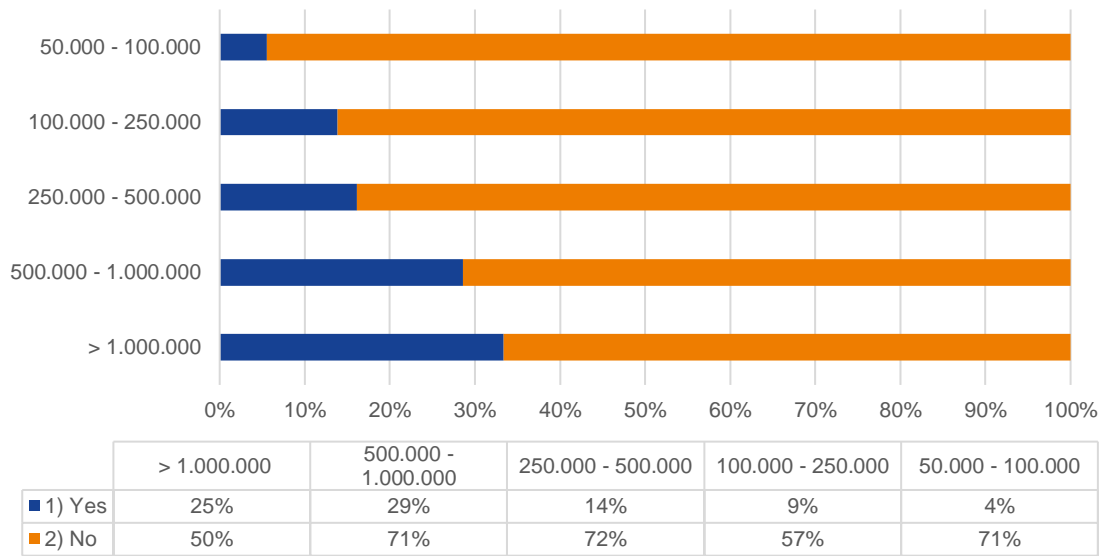
4.6.2 Does your public authority use service-related data to improve your digital service offer in the following areas?



Question observed	Question type	Data Sample	Clusters	Value
Q_7.2	Multiple choice	Reference Sample	Service area	Percentage

Figure 23 – Data Collection and Reuse for Service Areas

4.6.3 Is your Urban Data Platform connected with a data modelling function for the production of large virtual environments to achieve a real-world experience (Local Digital Twins or similar)?



Question observed	Question type	Data Sample	Clusters	Value
Q_5.2.5	Single choice - Binary	Reference Sample	Population	Percentage

Figure 24 – Digital Twins in European Cities

4.7 Highlights

- This indicator explores the degree of actual reuse of data both inside and outside the public authority, examining different patterns of data sharing and exploitation. It is one of the indicators that records the highest performance of the entire DPSVI tree, suggesting that in the opinion of the respondents the sharing and reuse of data has achieved satisfactory results, at least as regards the scaling up dimension within the organization.
- This indicator is directly related to both the population and the GDPpc. The aggregation of data by Authority type also suggests that sub-municipal entities have a lower data management capacity than cities and aggregations of municipalities (for the provincial scale the low number of respondents does not allow generalizations).
- The correlation with the population is evident in the analysis of questions Q5.8 and Q5.2.5. The first highlights how incentives for the reuse of data are limited to below 500,000 inhabitants. The second photographs the spread of digital twins among the cities interviewed, which remains limited to 14% of respondents, almost all concentrated in major cities.
- The answers to question 7.2 indicate that the service areas most involved in the collection and use of data are general services, transport and planning, with the data on utilities remaining particularly low.

5 Data Strategy of European Cities

5.1 Definition of the indices and exploration of its structure

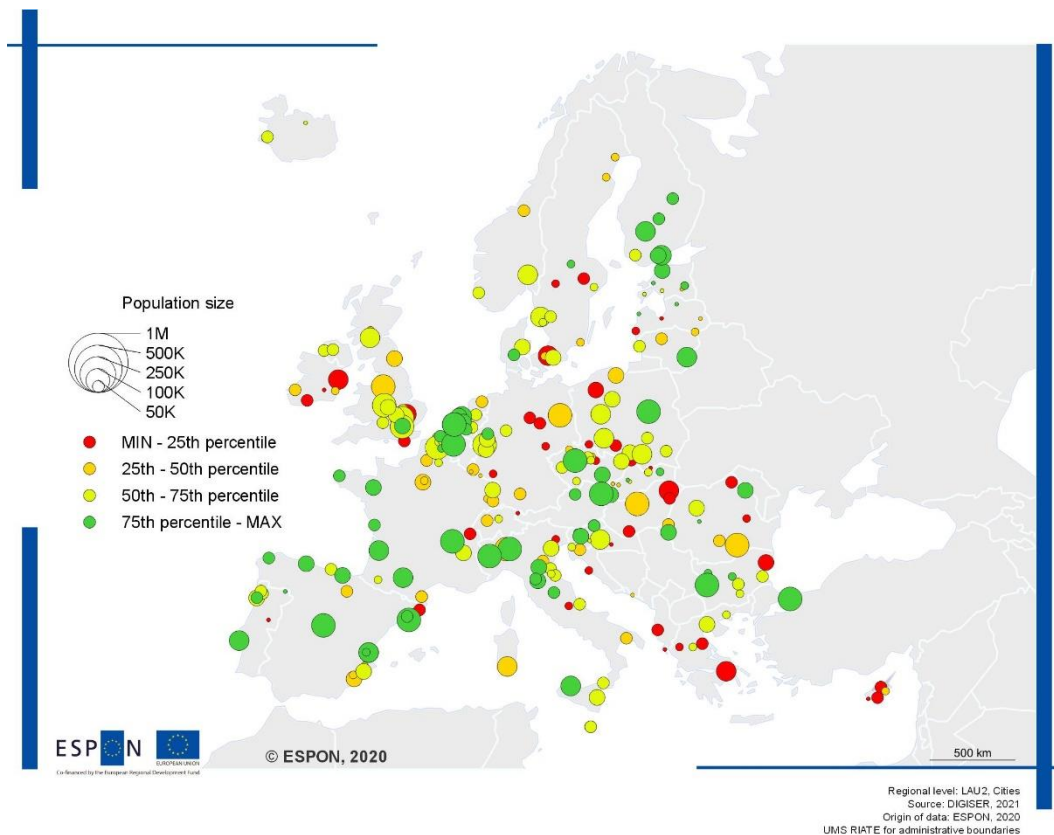
The use of data for public services can provide more efficient, effective and trustworthy service provision. Hence the relevance of defining and embracing governance models setting appropriate and favourable conditions for data-driven, data-informed, or data-aware decisions and services for creating public value.



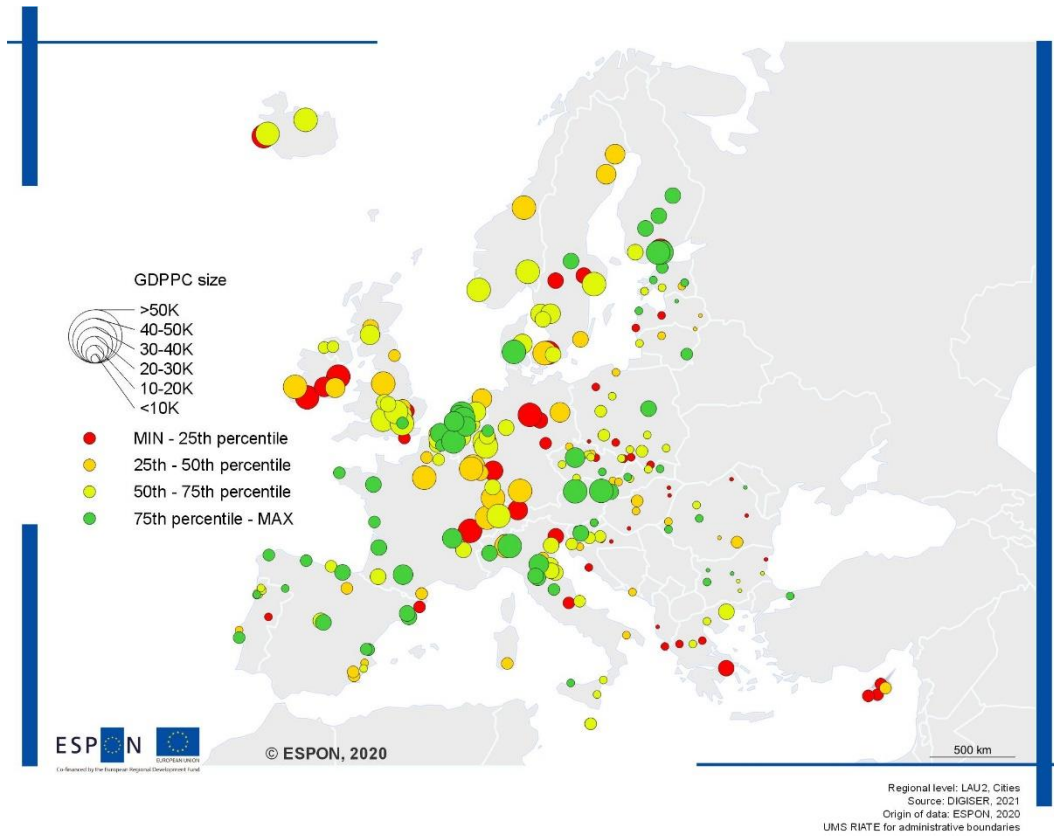
Figure 25 – Data Strategy index composition (questions tree)

This is a *Bottom Level* index, composed by 4 questions, each one computed for a limited number of possible answers:

- **Q_5.1** Does your public authority apply strategies to govern, collect, store and share city-related data across the public authority?
- **Q_5.2.7** Could you describe the business models used by companies linked to the Urban Data Platform (i.e. actually using data provided by the Urban Data Platform)?
- **Q_5.3** Has your public authority developed an Interoperability Framework or Strategy?
- **Q_5.11** Is your public authority applying the FAIR principles?



Map 7 – Data Strategy and population size



Map 8 – Data Strategy and GDPPC size

5.2 Population

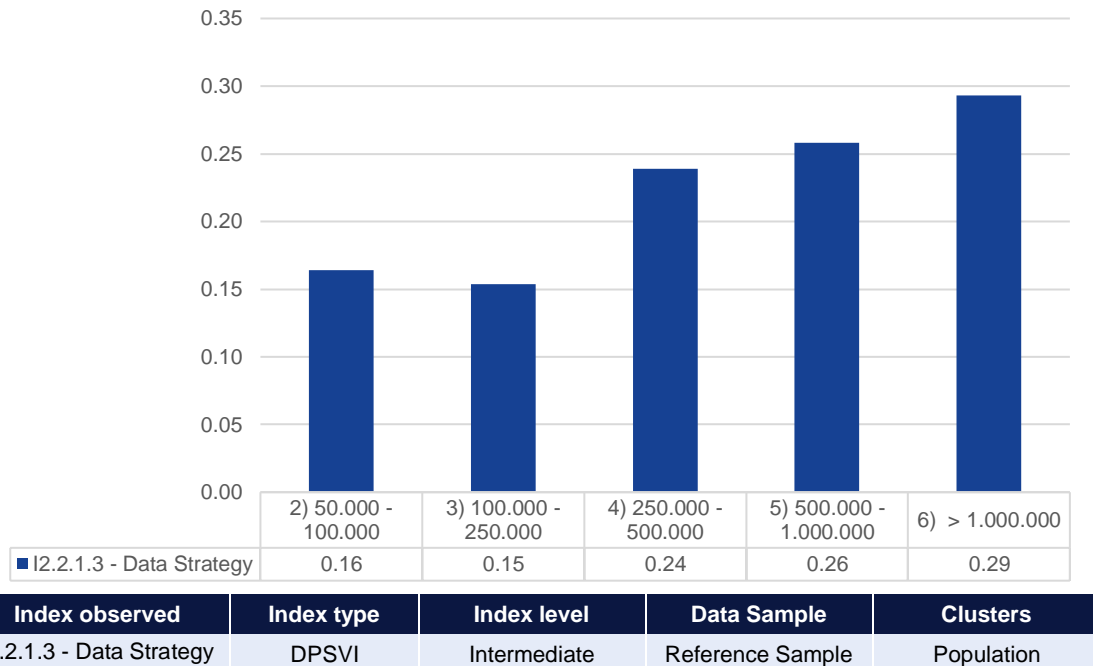


Figure 26 - Data Strategy by population

5.3 GDP per Capita

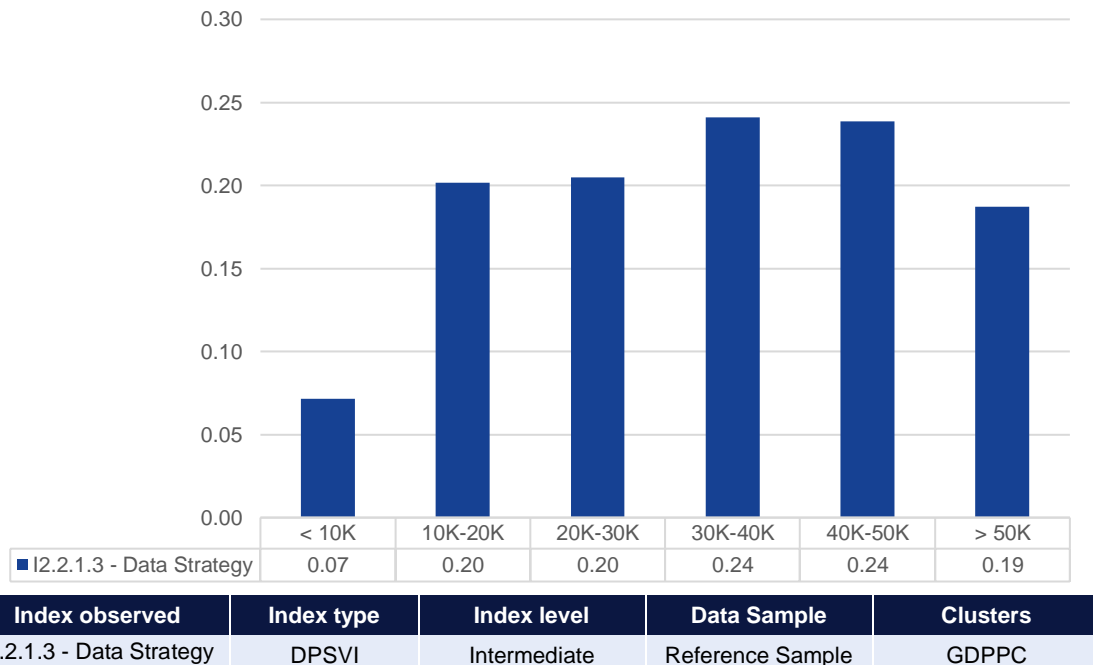
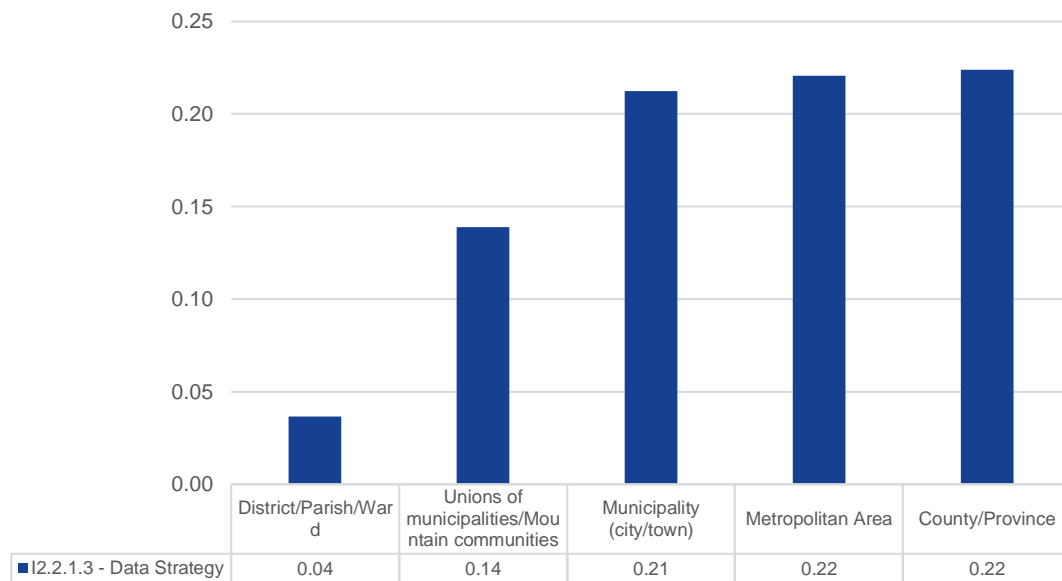


Figure 27 - Data Strategy by GDPC

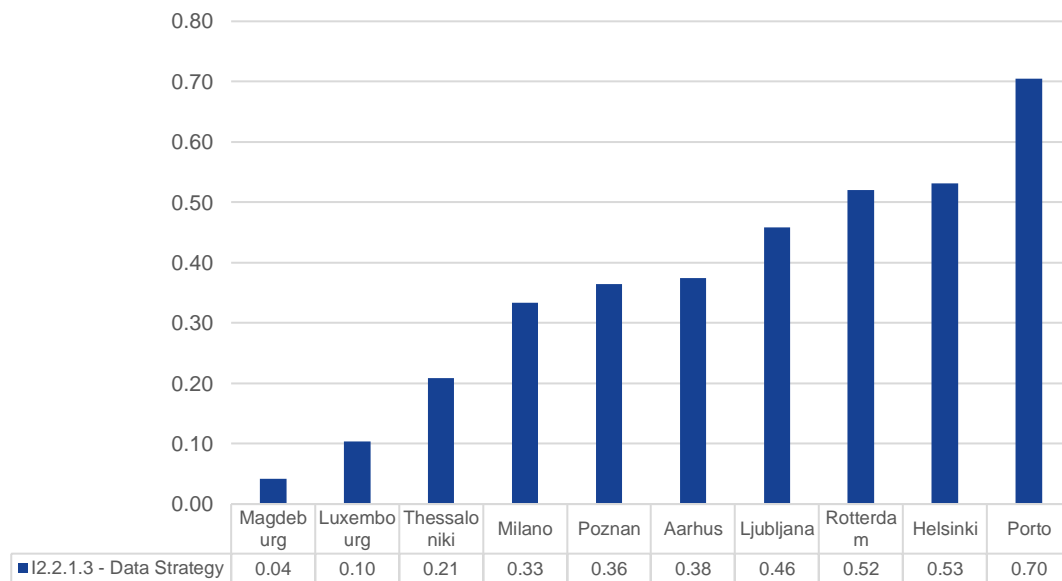
5.4 Authority Type



Index observed	Index type	Index level	Data Sample	Clusters
I2.2.1.3 - Data Strategy	DPSVI	Intermediate	Reference Sample	Authority type

Figure 28 - Data Strategy by authority type

5.5 Case studies

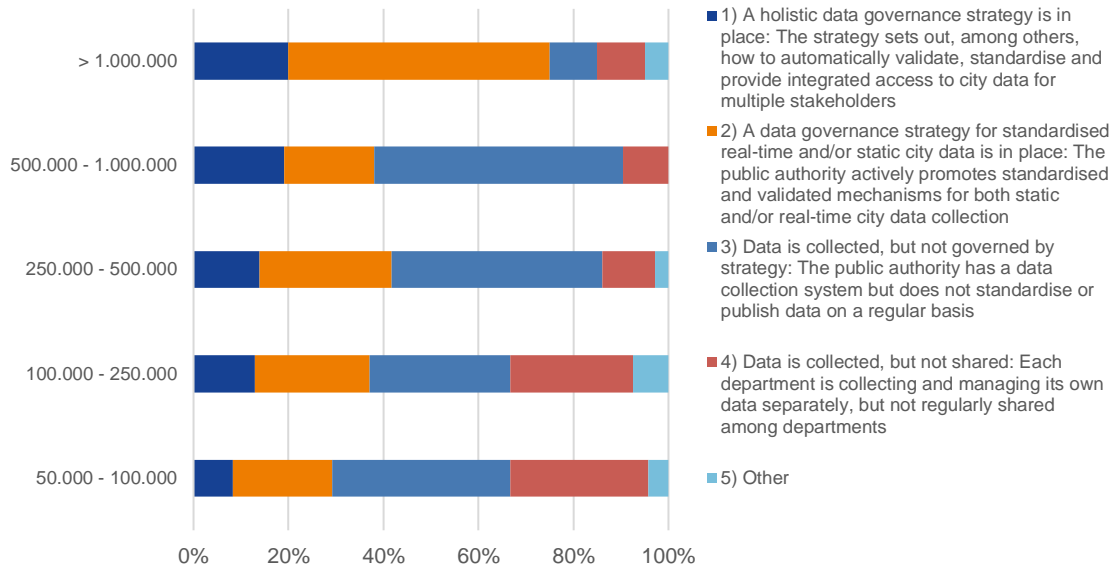


Index observed	Index type	Index level	Data Sample	Clusters
I2.2.1.3 - Data Strategy	DPSVI	Intermediate	Case studies	na

Figure 29 - Data Strategy, case studies

5.6 Relevant question results

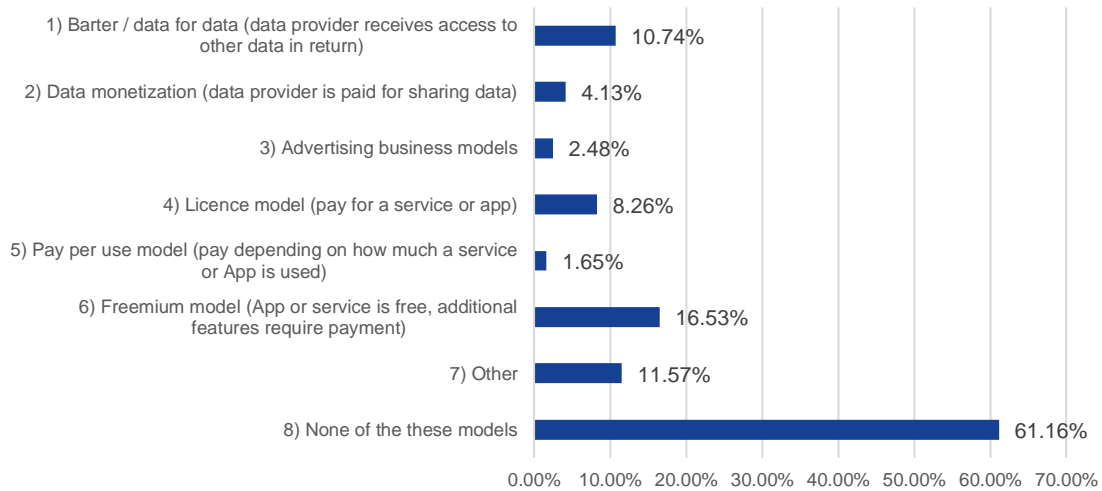
5.6.1 Does your public authority apply strategies to govern, collect, store and share city-related data across the public authority?



Question observed	Question type	Data Sample	Clusters	Value
Q_5.1	Single choice	Reference Sample	Population	Percentage

Figure 30 – Data Management Strategy

5.6.2 Could you describe the business models used by companies linked to the Urban Data Platform (i.e. actually using data provided by the Urban Data Platform)?



Question observed	Question type	Data Sample	Clusters	Value
Q_5.2.7	Multiple choice	Reference Sample	na	Percentage

Figure 31 – Data Business Models

5.7 Highlights

- This indicator analyzes the proactivity of cities in the implementation of data management strategies, focusing on the existence of interoperability framework, the kind of strategic approach used (holistic vs sectoral) and the data business models that these strategies proved capable to stimulate in the private sector.
- The low average performance of this indicator can be explained by observing the underlying questions.
 - In fact, only 21% of respondents say they have developed an interoperability framework (cf. Q_5.3).
 - Consistent with this data, only a small percentage of respondents declare to adopt a holistic data governance strategy structured around automated management and publication processes (See Q_5.1), while in a large majority of cases the practice of data management is limited to massive data collection & storage.
 - On the side of data business models (Q_5.2.7), the responses of the sample of the cities indagate portraits a limited capacity to interact and stimulate the economic exploitation of data.

6 Open Data of European Cities

6.1 Definition of the indices and exploration of its structure

The Open data dimension measures the ability of the public authority to adopt and operationalise principles and framework for open data that are meant to improve performance and efficiency of government services in general. The term open data, or Open Government Data identifies the information collected, produced, or paid by the public bodies and made available for re-use for any purpose, under licences which specify the terms of use. By sharing their datasets under open licences, public institutions are improving the availability of datasets for citizens, associations, innovators, and other stakeholders. Increased efficiency in public service operations and delivery can be gained through cross-sector data sharing. Easier and improved access to information, resources, and expertise can favour the economical sustainability of service provision, allowing for the development of innovative services and the introduction of new business models.

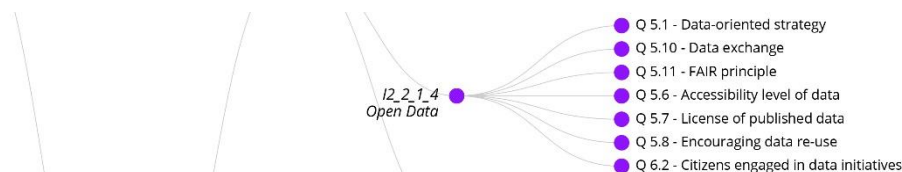
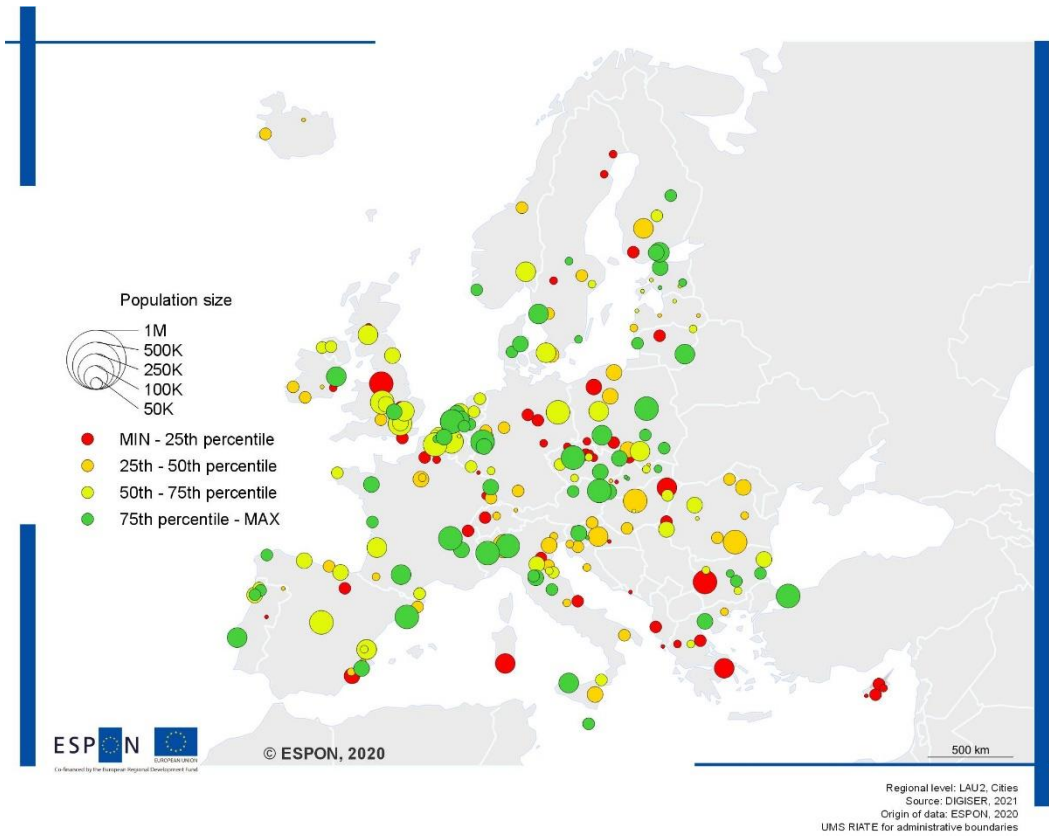


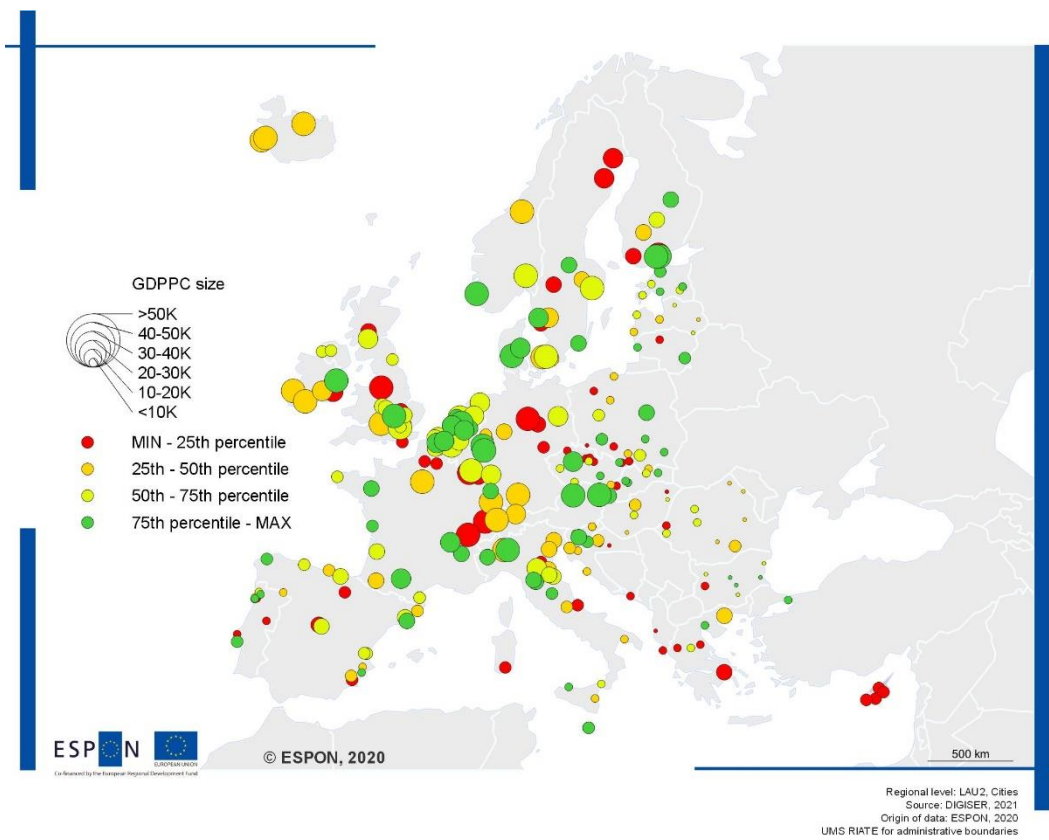
Figure 32 – Open Data index composition (questions tree)

This is a *Bottom Level* index, composed by 7 questions, each one computed for a limited number of possible answers:

- **Q_5.1** Does your public authority apply strategies to govern, collect, store and share city-related data across the public authority?
- **Q_5.6** What is the accessibility level of the data published through the data platform?
- **Q_5.7** What licenses are used to publish data openly on your data platform?
- **Q_5.8** How does the public authority encourage data re-use?
- **Q_5.10** To what extent are relevant data exchanged among service areas, departments, or units of your public authority?
- **Q_5.11** Is your public authority applying the FAIR principles?
- **Q_6.2** Does your public authority engage citizens in (open) data initiatives?



Map 9 – Open Data and population size



Map 10 – Open Data and GDPPC size

6.2 Population

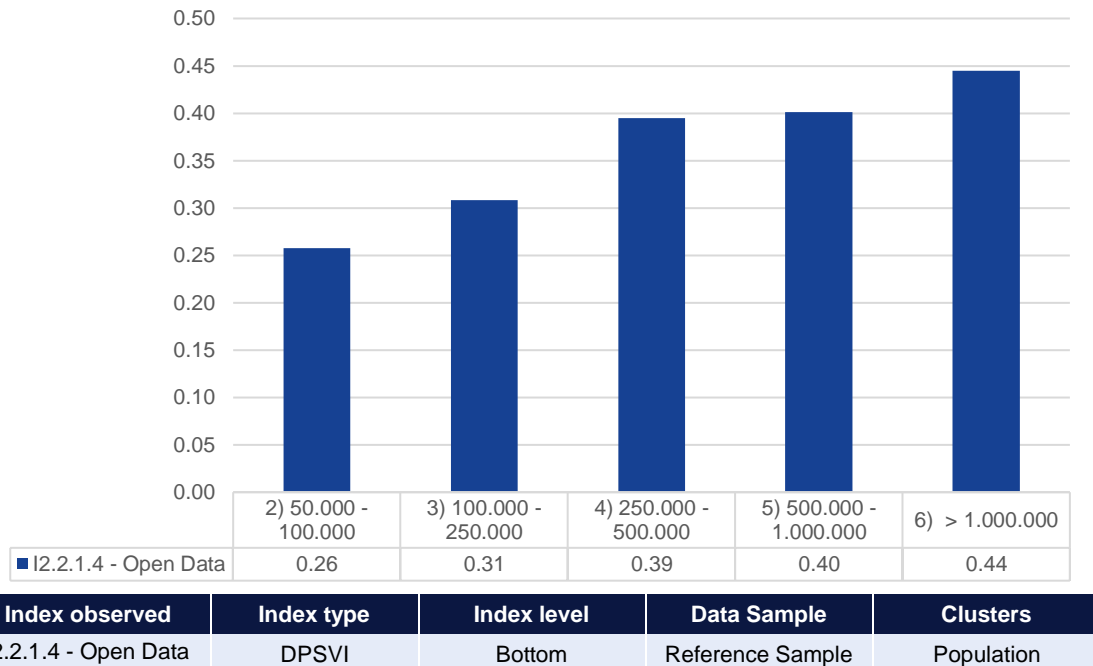


Figure 33 - Open Data by population

6.3 GDP per Capita

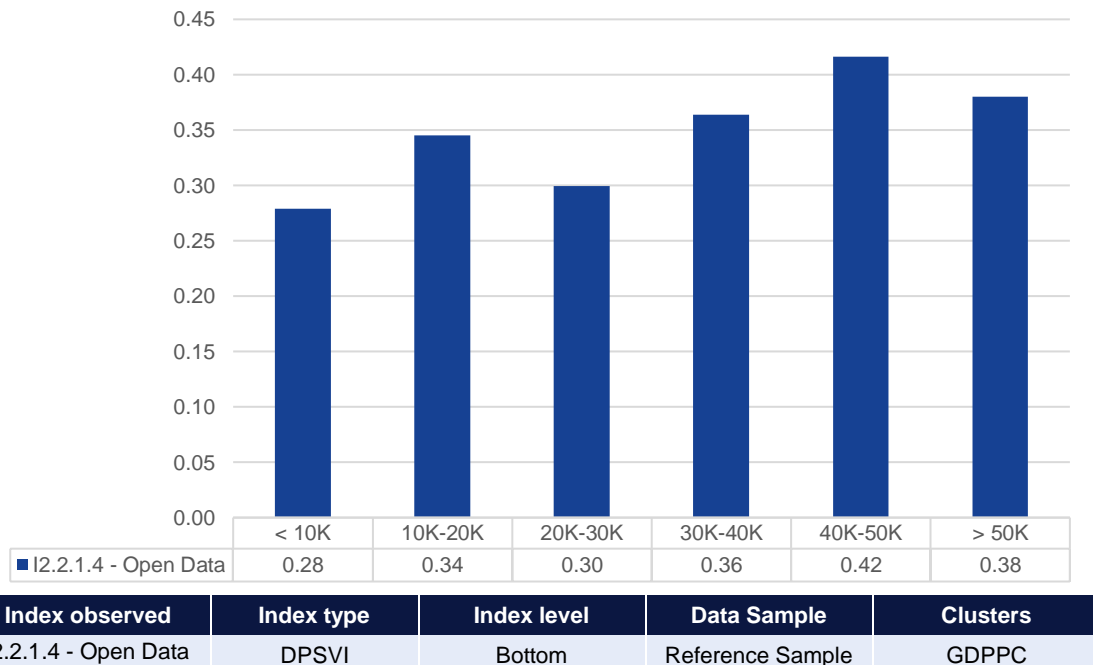
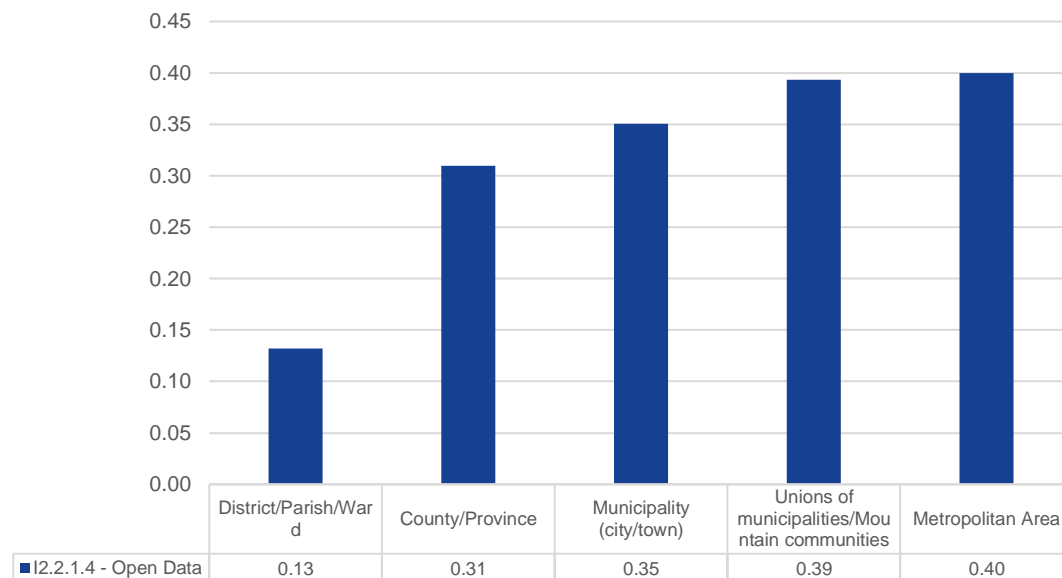


Figure 34 - Open Data by GDPC

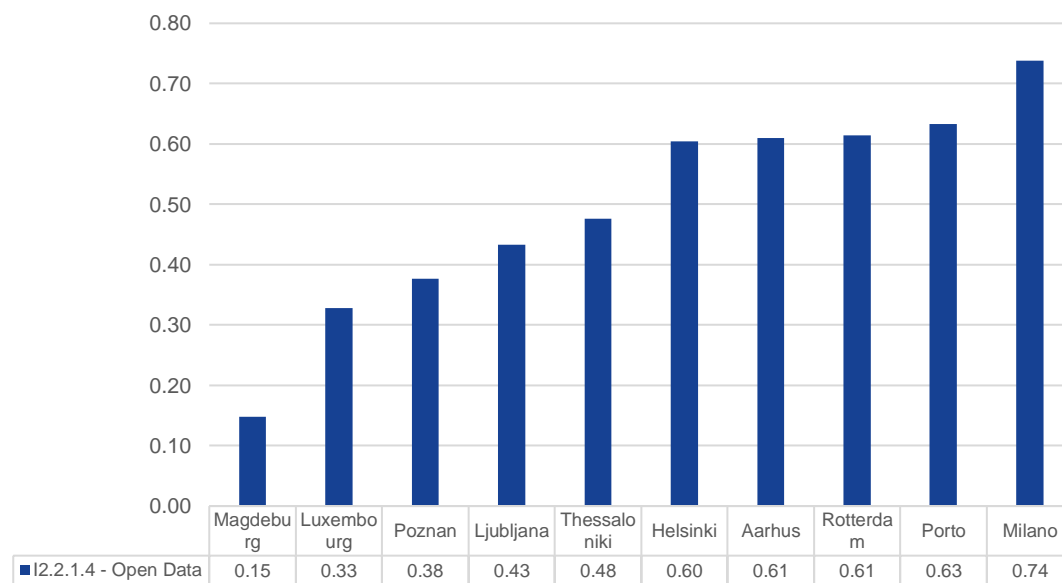
6.4 Authority Type



Index observed	Index type	Index level	Data Sample	Clusters
I2.2.1.4 - Open Data	DPSVI	Bottom	Reference Sample	Authority type

Figure 35 - Open Data by authority type

6.5 Case studies

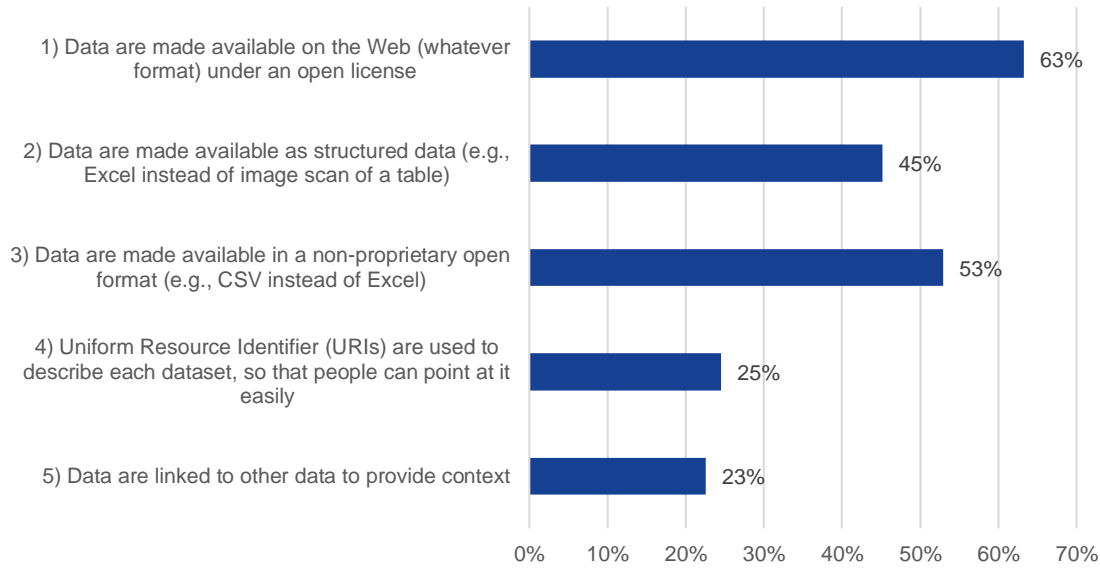


Index observed	Index type	Index level	Data Sample	Clusters
I2.2.1.4 - Open Data	DPSVI	Bottom	Case studies	na

Figure 36 - Open Data, case studies

6.6 Relevant question results

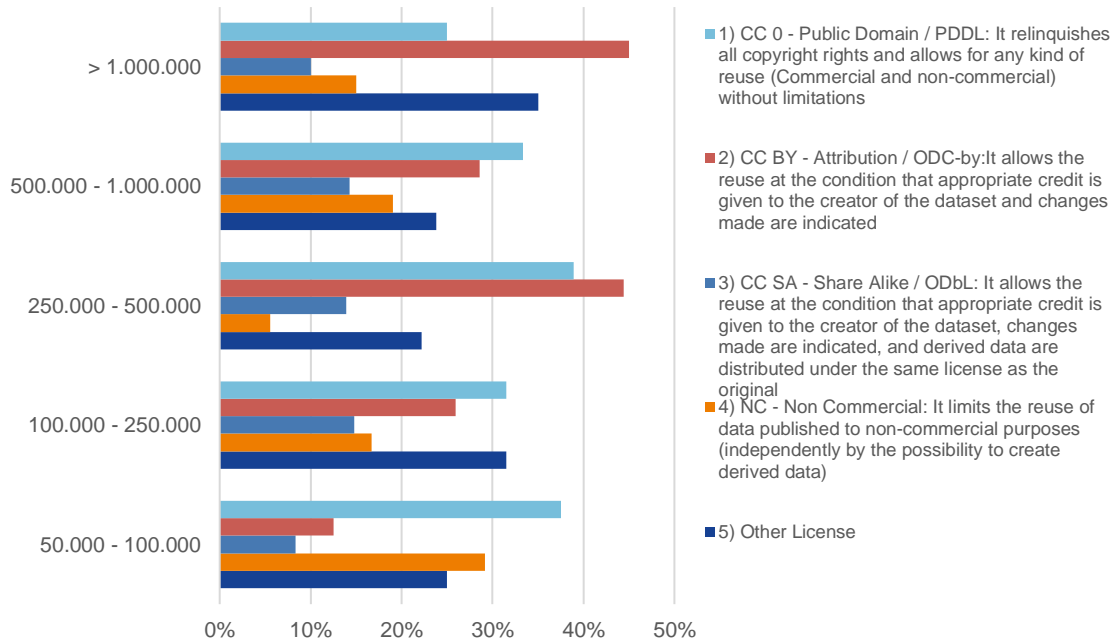
6.6.1 What is the accessibility level of the data published through the data platform?



Question observed	Question type	Data Sample	Clusters	Value
Q_5.6	Multiple choice	Reference Sample	na	Percentage

Figure 37 – Five Stars Accessibility implementation

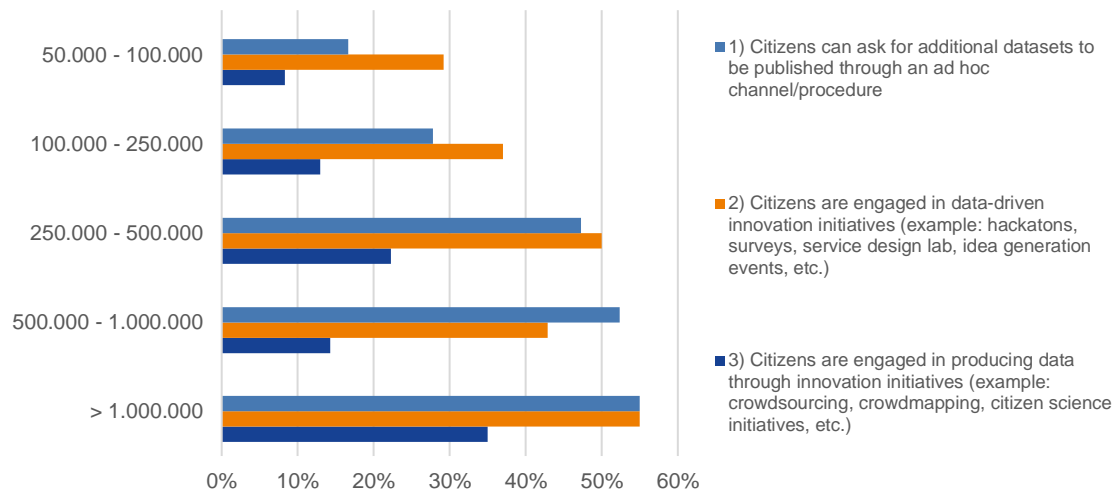
6.6.2 What licenses are used to publish data openly on your data platform?



Question observed	Question type	Data Sample	Clusters	Value
Q_5.7	Multiple choice	Reference Sample	Population	Percentage

Figure 38 – Data licensing

6.6.3 Does your public authority engage citizens in (open) data initiatives?



Question observed	Question type	Data Sample	Clusters	Value
Q_6.2	Multiple choice	Reference Sample	Population	Percentage

Figure 39 – Engagement in Data Initiatives

6.7 Highlights

- The Indicator on Open Data portrays a decidedly positive situation in European cities, where the grammar and practices of open access seem to have penetrated the culture and administrative procedures without great distinctions of scale and wealth, as is evident from the graphs that break down the data for these types of clusters.
- Q_5.6, inspired by Tim Berners Lee's well-known open data accessibility classification system, indicates that about half of respondents reach at least the 3-stars level, which presupposes the online publication of machine readable data in a non-proprietary format and under an open license.
- Q_5.7 explores in detail the type of open licenses most used, which turn out to be those with features of "Public Domain" and "attribution", while the "copyleft" licenses remain of fairly limited diffusion. The use of licenses developed ad hoc is also not marginal, while the dissemination of licenses that limit the reuse for commercial purposes of published data would require further investigation.
- If cities are cross-fertilized by open access principles, the degree of active engagement of citizens in data initiatives remains limited to largest cities.

7 Big Data of European Cities

7.1 Definition of the indices and exploration of its structure

The potential of big data in the public sector is enormous. Governmental daily activities such as those related to the management of social benefits, the collection of taxes, national health and education systems, traffic monitoring, and the issuing of official documents generate vast amounts of data. Furthermore, sensors can collect massive amounts of data. Such data can be used for creating more efficient and effective policies, for prediction of behaviours or events, such as crime or fires. *Big data* specifically observes the attitude of the public administration towards the use and production of big data, and their relation to service areas, and finally the presence of agreements for their production or purchase from third parties.

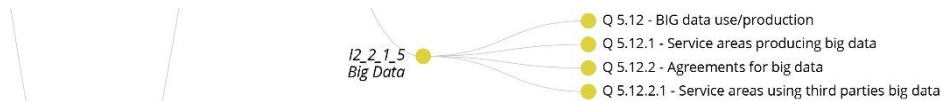
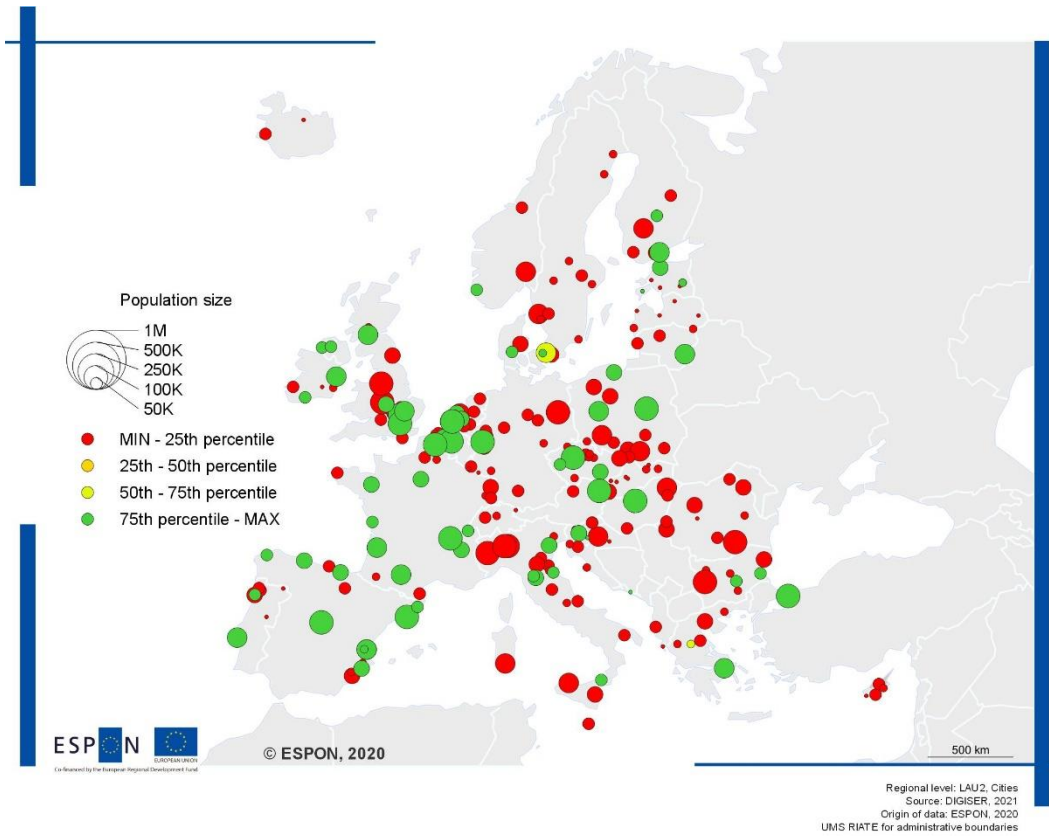


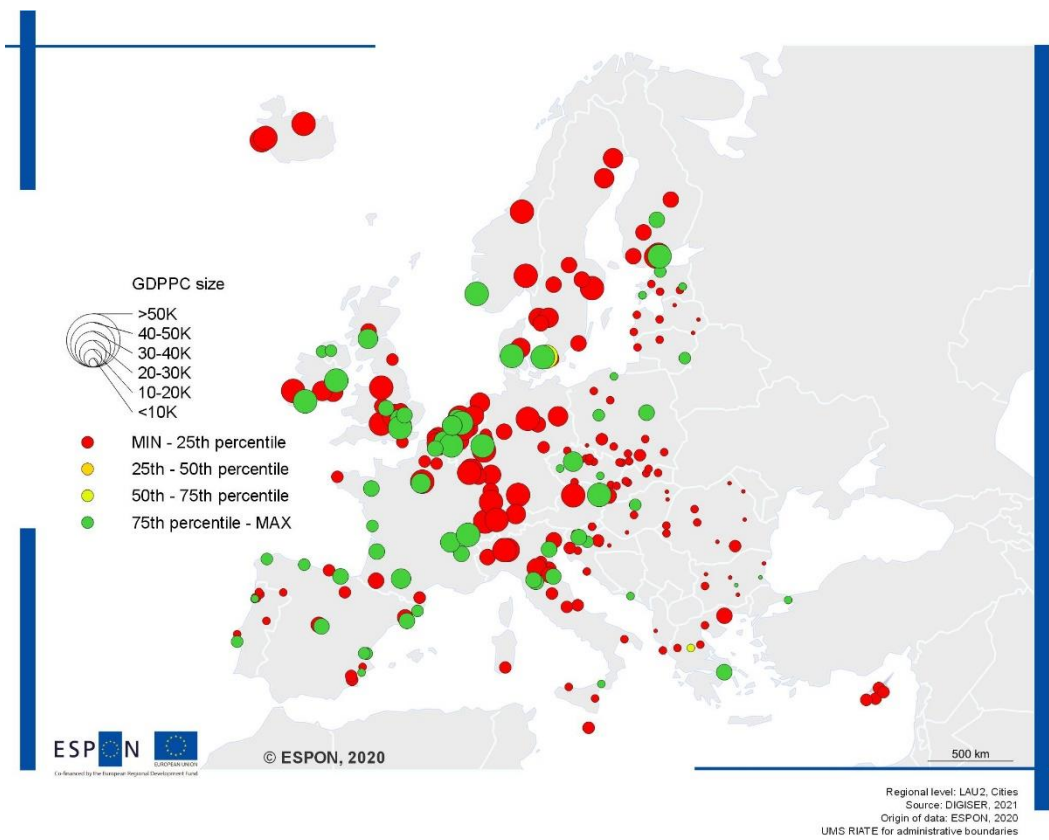
Figure 40 – Big Data index composition (questions tree)

This is a *Bottom Level* index, composed by 4 questions, each one computed for a limited number of possible answers:

- **Q_5.12** Is your public authority using or producing Big Data?
- **Q_5.12.1** If your public authority is producing/using its own Big Data, which service areas are covered?
- **Q_5.12.2** Does your public authority have access to Big Data through agreements with third parties?
- **Q_5.12.2.1** If your public authority is using Big Data produced by third parties, which service areas are covered?



Map 11 – Big Data and population size



Map 12 – Big Data and GDPPC size

7.2 Population

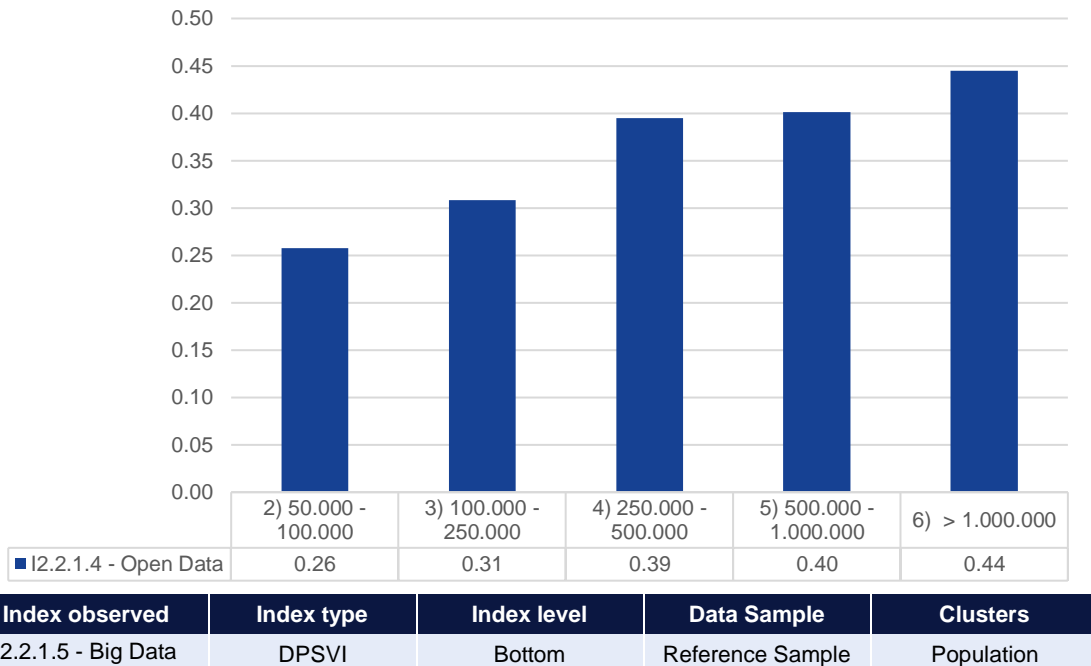


Figure 41 - Big Data by population

7.3 GDP per Capita

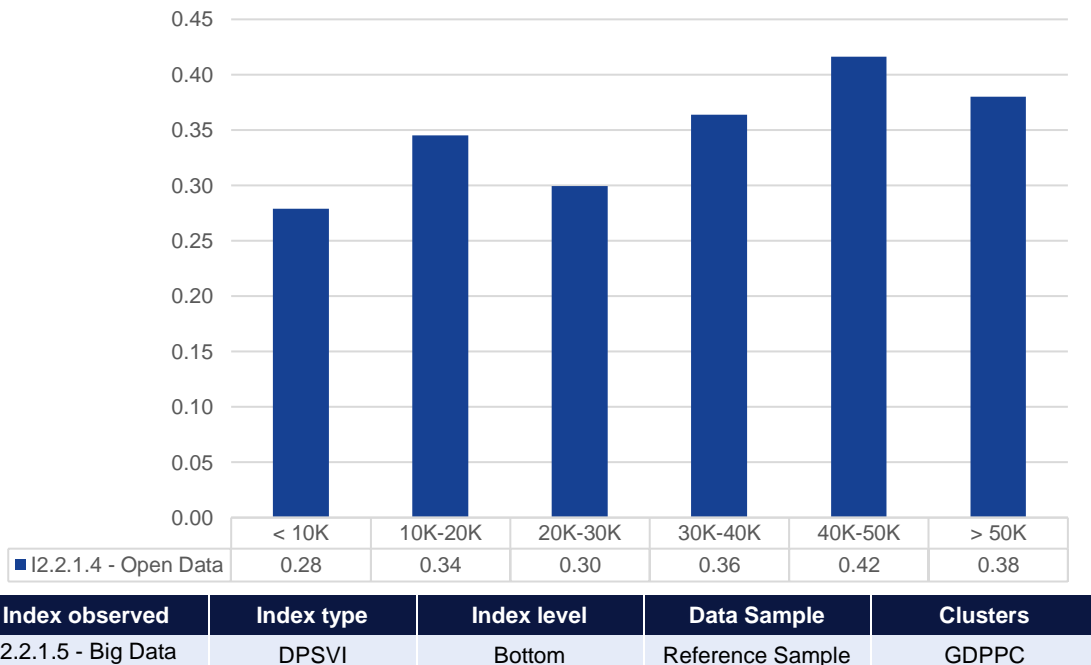
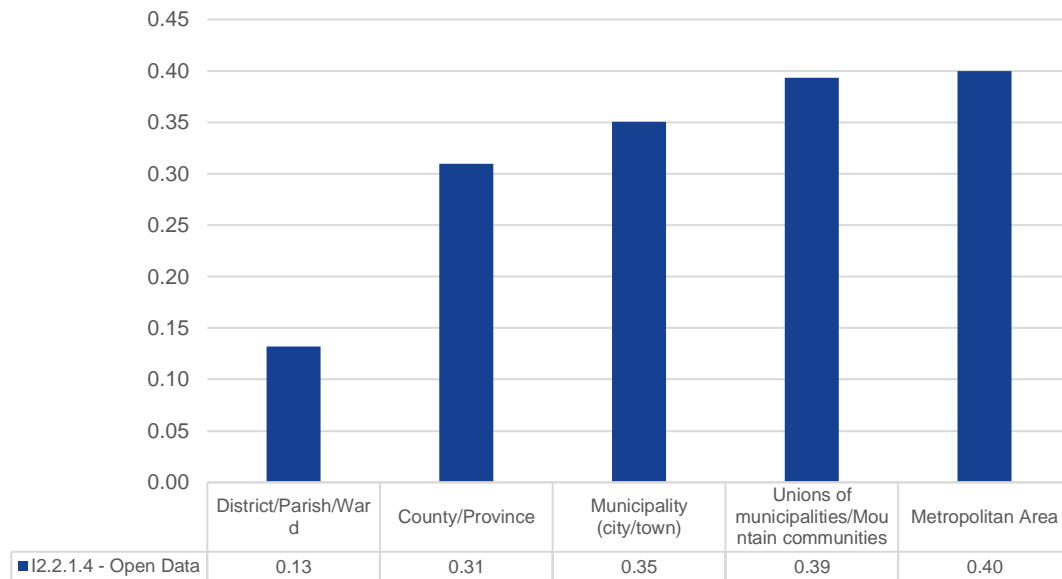


Figure 42 - Big Data by GDPC

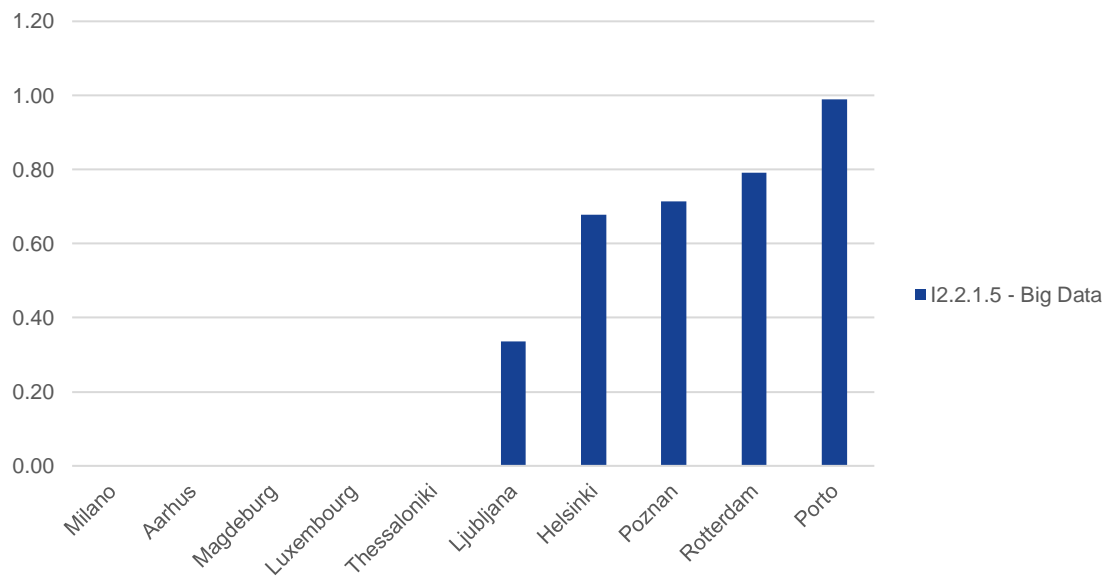
7.4 Authority Type



Index observed	Index type	Index level	Data Sample	Clusters
I2.2.1.5 - Big Data	DPSVI	Bottom	Reference Sample	Authority type

Figure 43 - Big Data by authority type

7.5 Case studies

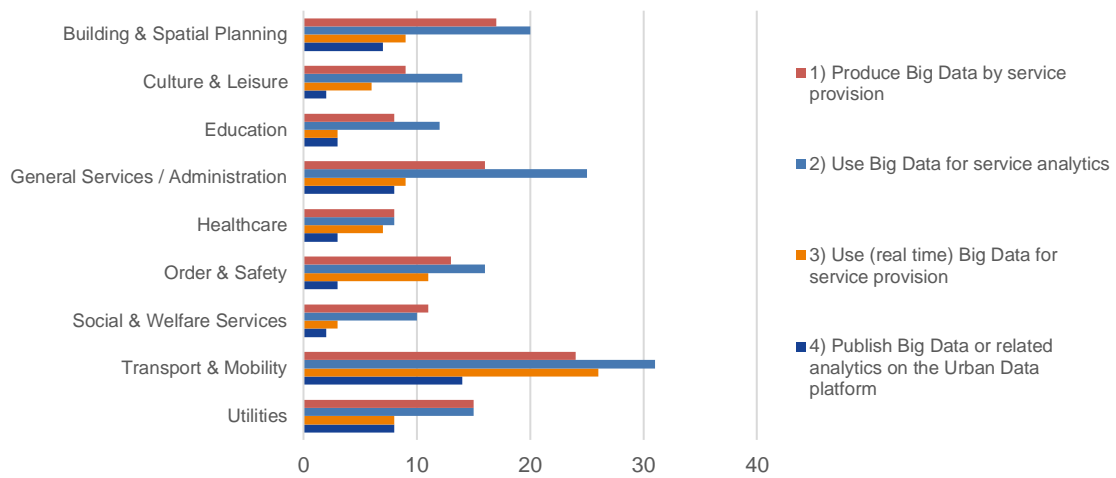


Index observed	Index type	Index level	Data Sample	Clusters
I2.2.1.5 - Big Data	DPSVI	Bottom	Case studies	na

Figure 44 - Big Data, case studies

7.6 Relevant question results

7.6.1 If your public authority is producing/using its own Big Data, which service areas are covered?



Question observed	Question type	Data Sample	Clusters	Value
Q_5.12.1	Single choice	Reference Sample	Authority type	Percentage

Figure 45 – Big Data Management for Service Areas

7.7 Highlights

- This indicator is the one that records the lowest scores of the entire tree, with only 35% of cities answering positively to the main question: Is your public authority using or producing Big Data? This question could also be considered as a proxy to investigate the very understanding of the phenomenon by the respondents, and the low result opens the hypothesis that there is still a lot of confusion around the topic of Big Data in cities, and a limited ability to control its management.
- The breakdown by Service Areas offers some further food for thought, where sectors such as transport and general administration stand out where the automation of interactions is more advanced.



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