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Inspire Policy Making with Territorial Evidence

DIGISER

Digital Innovation in Governance and Public Service Provision

Annex 1.2.2 Digital Maturity Report // April 2022

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FINAL REPORT //

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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:

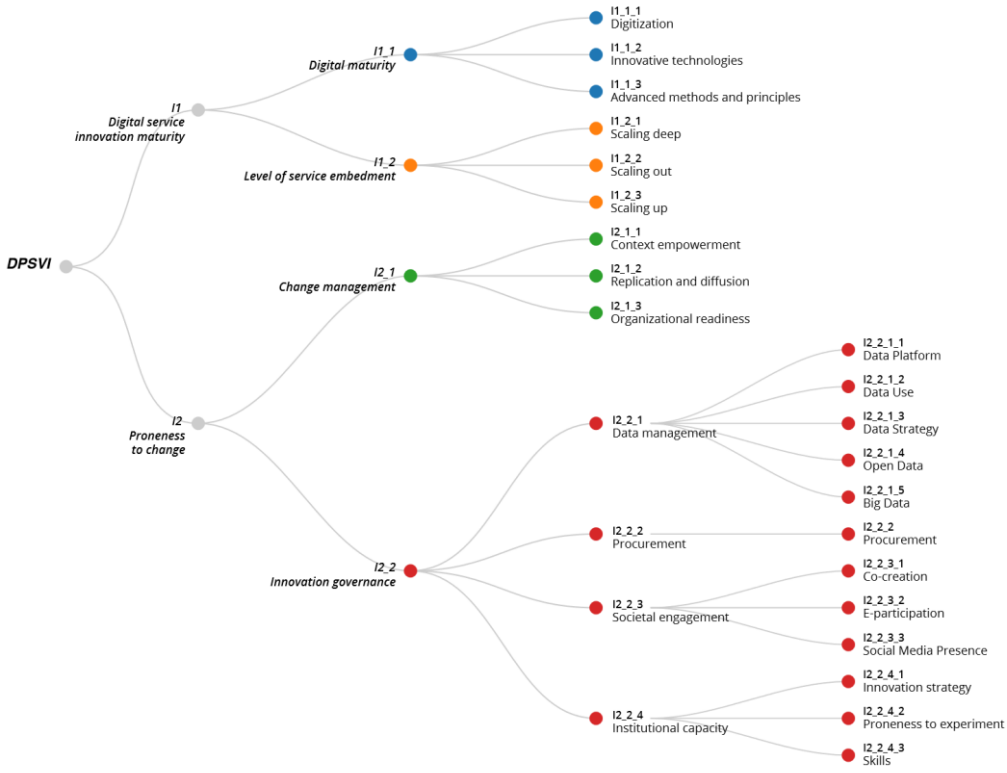


Figure 1 - DPSVI Structure

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	*Data Platform*	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	*Data Use*	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 DIGSURVEY'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.

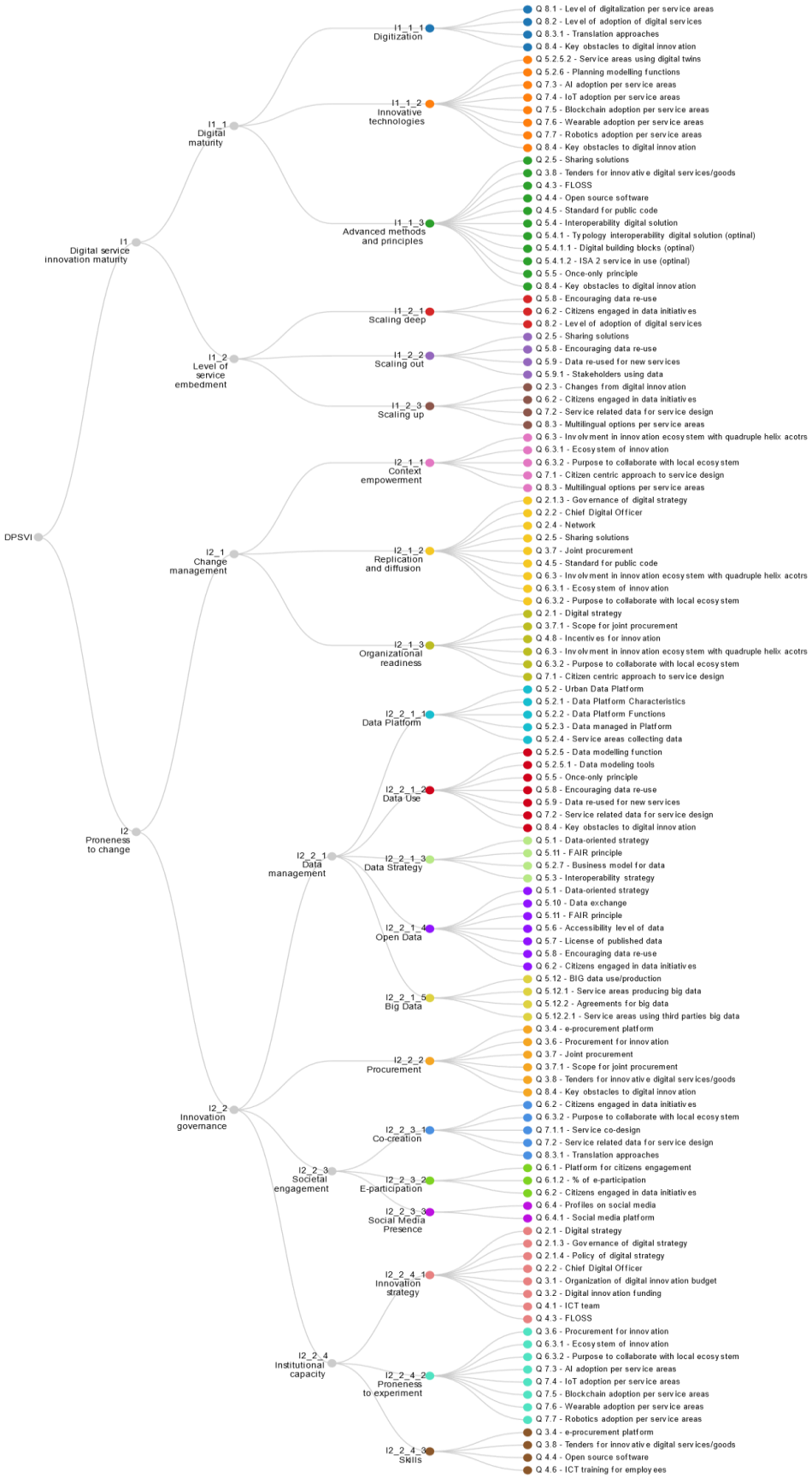


Figure 2 - DPSVI detailed structure – Questions

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* **i**ncludes 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
Indicates the code and the label of the index observed	*Indicates the type of index as either:* • DPSVI • SI	*Indicates the Index position in its Data model:* • Top • Intermediate • Bottom	*Indicates the sample that the data refers to* • All respondents • Reference sample	*Indicates the series showed in the charts and listed in the legend* • 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 level

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
Indicates the code and the label of the question observed	*Indicates the question typology and whether it is a matrix* • Single choice • Single choice - Binary • Single choice - Likert • Multiple choice • Matrix - Single choice • Matrix - Likert • Matrix - Multiple choice	*Indicates the sample that the data refers to* • All respondents • Reference sample	*Indicates the series showed in the charts and listed in the legend* • Capital cities • Reference sample • Population • GDPPC • Country	*Indicates the units in which the data are represented* • 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 Digital Maturity of European Cities

2.1 Definition of the index and exploration of its structure

Digital maturity mainly attains to the extent to which public administrations embrace new digital technologies and deliver innovative public services. It considers the distinction between mature and emerging technologies, acknowledging that the latter play a relevant role in describing the extent to which the public authority is challenged while developing new services. Digital maturity assesses the level of digitalisation of the public authority, intended not only as a shift toward digital technologies, but also encompassing the related organisational change. In this regard, Limassol has a low level of digital maturity.

This is an *Intermediate Level* Index, composed by three *Bottom Level* Indexes:

- **I1.1.1 - Digitisation:** It focuses on the degree of digitisation of pre-existing internal procedures either ancillary or directly related to public service delivery
- **I1.1.2 - Innovative technologies:** It explores the degree of adoption of innovative technologies (AI, blockchain, wearables, etc.)
- **I1.1.3 - Advanced methods and principles:** It analyses the level of consistency of methods and principles used to increase the digitalisation level of the public authority

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.

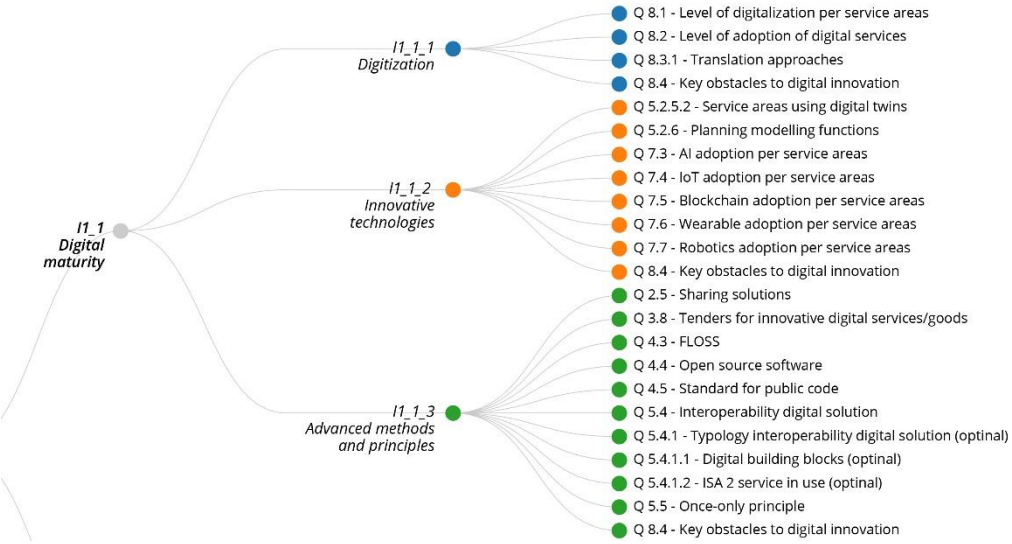


Figure 3 – Digital maturity - Index map (questions tree)

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

Question number and text	Question Type
2.5 Does your public authority benefit from sharing digital solutions, services or products with other public authorities?	Matrix - Multiple choice
3.8 Are the tenders for procuring innovative digital services/goods including the following requirements?	Multiple choice
4.3 Does your public authority encourage the use of Free/Libre and Open Source Software (FLOSS)?	Single choice - Binary
4.4 Does the authority's IT set-up offer the possibility to implement open source alternatives?	Single choice - Binary
4.5 In the case of open source software code, particularly its development and maintenance, is your public authority applying the Standard for Public Code	Single choice

Question number and text	Question Type
5.2.5.2 Specify for each service area the purposes of the integrated data modelling function (Local Digital Twins or similar) is used:	Matrix - Multiple choice
5.2.6 Please indicate to what extent your public authority is considering the integration of the Urban Data Platform with data modelling functions for real-world experience (Local Digital Twins or similar):	Single choice
5.4 Is your public authority making use of interoperable digital solutions or services (e.g. ISA2 programme, Connecting Europe Facility (CEF) Digital Building Blocks, OASC Minimal Interoperability Mechanisms (MIMs), FIWARE)?	Single choice - Binary
5.4.1 Which of the following are used?	Multiple choice
5.4.1.1 Which of the following CEF Digital Building Blocks does your public authority use?	Multiple choice
5.4.1.2 Which of the following ISA2 services does your public authority use?	Multiple choice
5.5 Does your public authority apply the once-only principle in its services?	Single choice
7.3 State for each service area if the adoption of Artificial Intelligence technology is planned, implemented, not planned or not applicable:	Matrix - Single choice
7.4 State for each service area if the adoption of Internet of Things (IoT) technology is planned, implemented, not planned or not applicable:	Matrix - Single choice
7.5 State for each service area if the adoption of the blockchain technology is planned, implemented, not planned or not applicable:	Matrix - Single choice
7.6 State for each service area if the adoption of wearable technology is planned, implemented, not planned or not applicable:	Matrix - Single choice
7.7 State for each service area if the adoption of robotics technology is planned, implemented, not planned or not applicable:	Matrix - Single choice
8.1 How would you describe the level of digitalisation of services provided by the public authority in the following service areas?	Matrix - Likert
8.2 When a public service is provided online as well as offline, how many users are choosing the digital option?	Matrix - Likert
8.3.1 How are the translations provided?	Multiple choice
8.4 Please indicate the key obstacles that your public authority is experiencing:	Matrix - Multiple choice

Table 5 – Digital maturity - Questions

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.

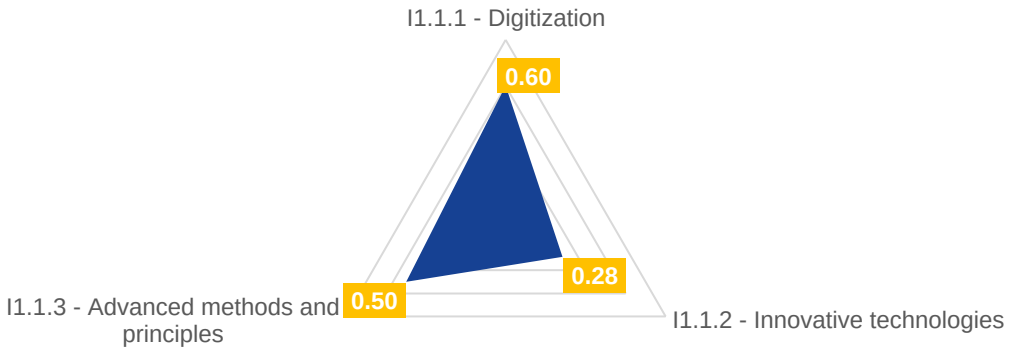
Q_#	I1_1_1	I1_1_2	I1_1_3
Q_2.5	-	-	100%
Q_3.8	-	-	100%
Q_4.3	-	-	100%
Q_4.4	-	-	100%
Q_4.5	-	-	100%
Q_5.2.5.2	-	100%	-
Q_5.2.6	-	100%	-
Q_5.4	-	-	20%

Q_#	I1_1_1	I1_1_2	I1_1_3
Q_5.4.1	-	-	60%
Q_5.4.1.1	-	-	10%
Q_5.4.1.2	-	-	10%
Q_5.5	-	-	100%
Q_7.3	-	100%	-
Q_7.4	-	100%	-
Q_7.5	-	100%	-
Q_7.6	-	100%	-
Q_7.7	-	100%	-
Q_8.1	30%	-	-
Q_8.2	30%	-	-
Q_8.3.1	10%	-	-
Q_8.4	30%	100%	100%

Table 6 – Digital Maturity - Relative weights used for aggregation

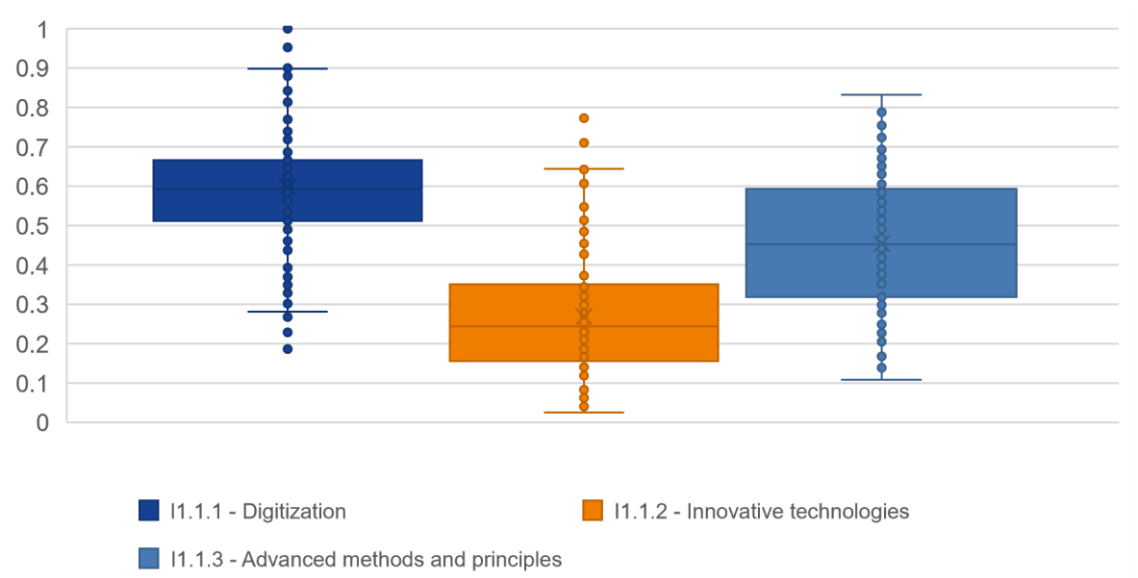
An extensive overview of the weights used to calculate the DPSVI is available in *Annex 1.1 Extended Methodology.*

2.2 Index overview



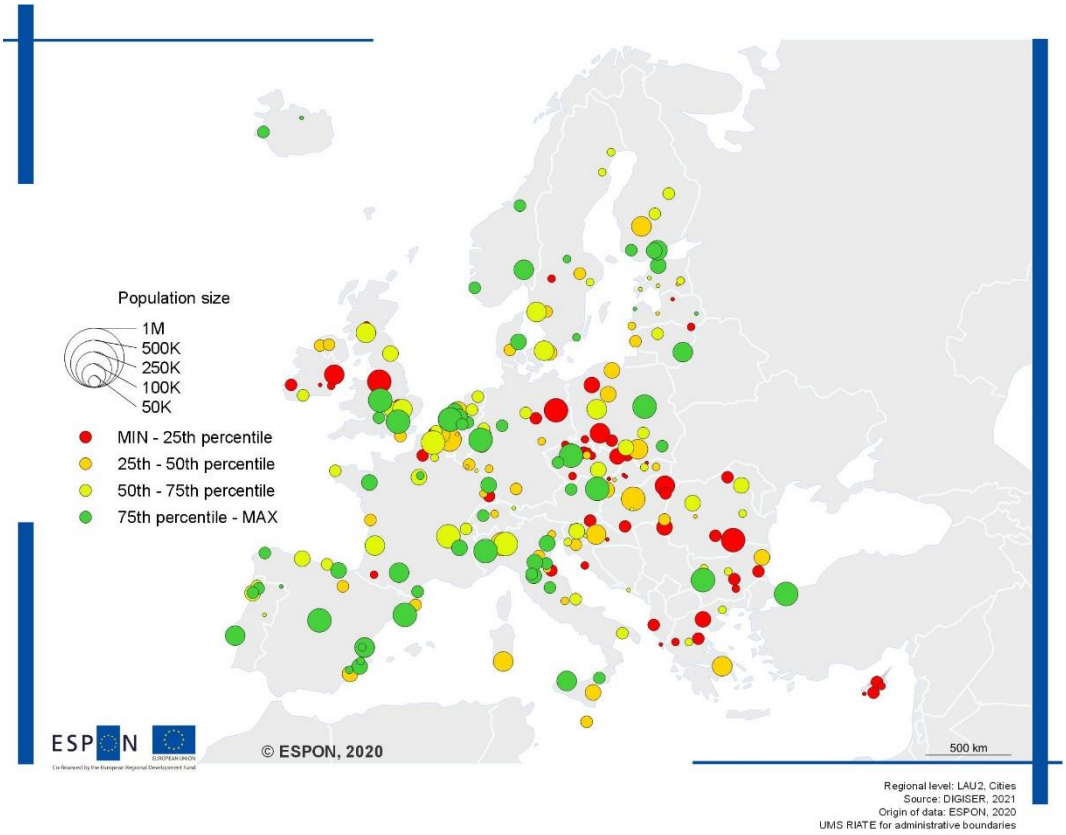
Index observed	Index type	Index level	Data Sample	Clusters
I1.1 – Digital Maturity	DPSVI	Intermediate	Reference Sample	na

Figure 4 – Digital maturity overview

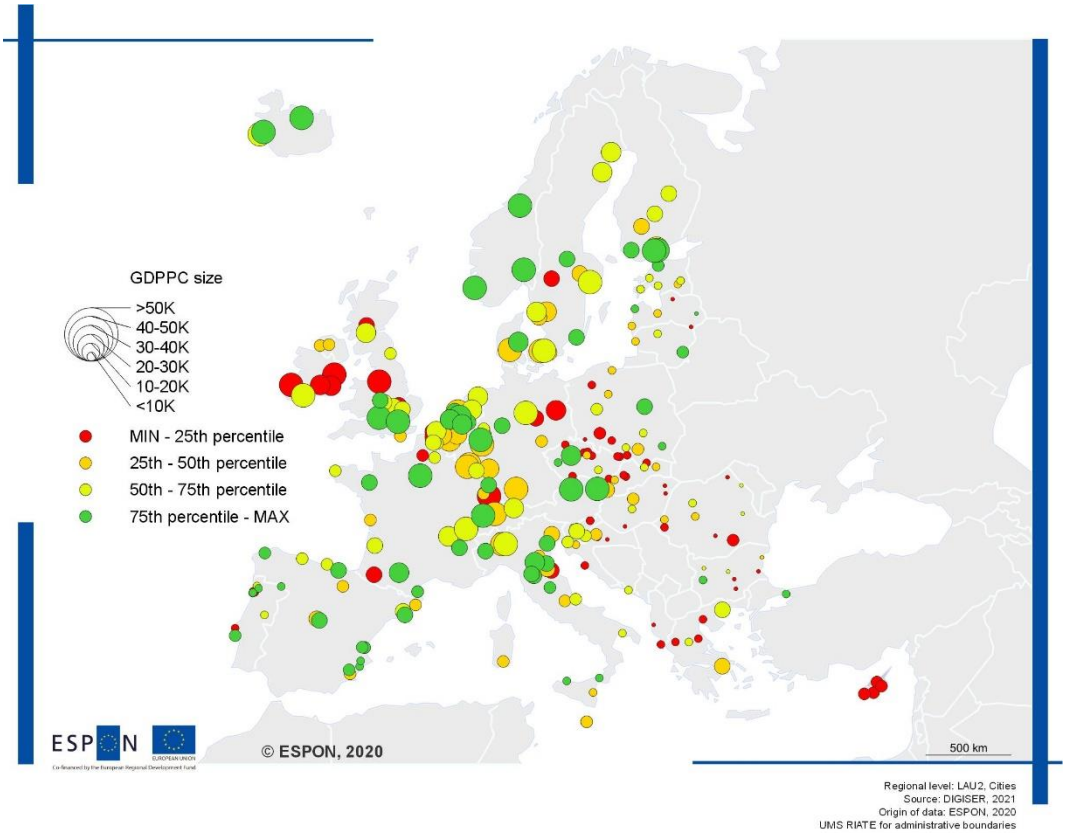


Index observed	Index type	Index level	Data Sample	Clusters
I1.1 – Digital Maturity	DPSVI	Intermediate	Reference Sample	na

Figure 5 - Digital maturity composition

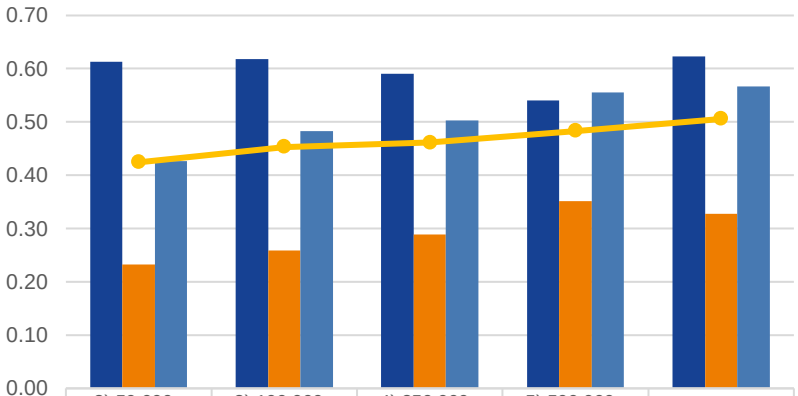


Map 1 – Digital maturity and population size



Map 2 – Digital maturity and GDPPC size

2.3 Population

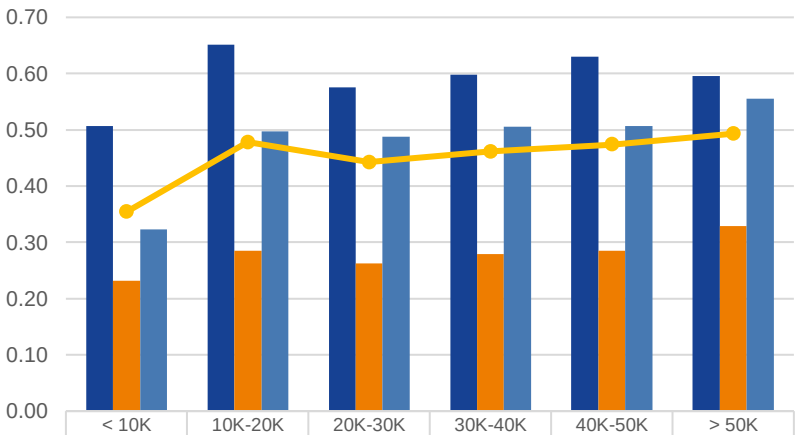


	2) 50.000 - 100.000	3) 100.000 - 250.000	4) 250.000 - 500.000	5) 500.000 - 1.000.000	6) > 1.000.000
I1.1.1 - Digitization	0.61	0.62	0.59	0.54	0.62
I1.1.2 - Innovative technologies	0.23	0.26	0.29	0.35	0.33
I1.1.3 - Advanced methods and principles	0.43	0.48	0.50	0.56	0.57
I1.1 - Digital maturity	0.42	0.45	0.46	0.48	0.51

Index observed	Index type	Index level	Data Sample	Clusters
I1.1 – Digital Maturity	DPSVI	Intermediate	Reference Sample	Population

Figure 6 - Digital maturity by population

2.4 GDP per Capita

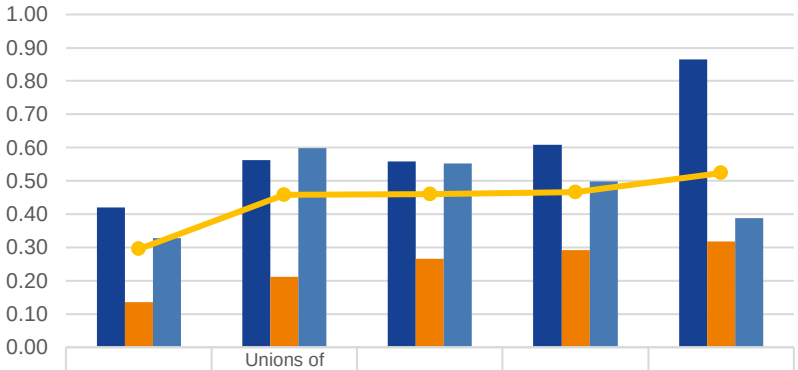


	< 10K	10K-20K	20K-30K	30K-40K	40K-50K	> 50K
I1.1.1 - Digitization	0.51	0.65	0.58	0.60	0.63	0.60
I1.1.2 - Innovative technologies	0.23	0.28	0.26	0.28	0.28	0.33
I1.1.3 - Advanced methods and principles	0.32	0.50	0.49	0.51	0.51	0.56
I1.1 - Digital maturity	0.35	0.48	0.44	0.46	0.47	0.49

Index observed	Index type	Index level	Data Sample	Clusters
I1.1 – Digital Maturity	DPSVI	Intermediate	Reference Sample	GDPPC

Figure 7 - Digital maturity by GDPC

2.5 Authority Type

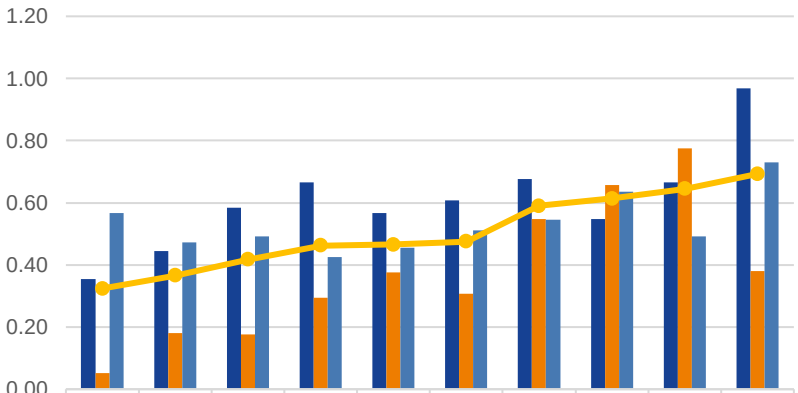


	District/Parish/ Ward	Unions of municipalities/ Mountain communities	Metropolitan Area	Municipality (city/town)	County/Province
I1.1.1 - Digitization	0.42	0.56	0.56	0.61	0.86
I1.1.2 - Innovative technologies	0.14	0.21	0.27	0.29	0.32
I1.1.3 - Advanced methods and principles	0.33	0.60	0.55	0.50	0.39
I1.1 - Digital maturity	0.29	0.46	0.46	0.47	0.52

Index observed	Index type	Index level	Data Sample	Clusters
I1.1 – Digital Maturity	DPSVI	Intermediate	Reference Sample	Authority type

Figure 8 - Digital maturity by authority type

2.6 Case Studies



	Thessaloniki	Magdeburg	Luxembourg	Ljubljana	Poznan	Milano	Aarhus	Porto	Helsinki	Rotterdam
I1.1.1 - Digitization	0.35	0.44	0.58	0.67	0.57	0.61	0.68	0.55	0.67	0.97
I1.1.2 - Innovative technologies	0.05	0.18	0.18	0.30	0.38	0.31	0.55	0.66	0.77	0.38
I1.1.3 - Advanced methods and principles	0.57	0.47	0.49	0.43	0.46	0.51	0.55	0.64	0.49	0.73
I1.1 - Digital maturity	0.32	0.37	0.42	0.46	0.47	0.48	0.59	0.61	0.64	0.69

Index observed	Index type	Index level	Data Sample	Clusters
I1.1 – Digital Maturity	DPSVI	Intermediate	Case studies	na

Figure 9 - Digital maturity, case studies

2.7 Highlights

- This indicator is composed of three elements that have quite different performances.
- In particular, the sub-indicator "Advanced Technologies", which investigates the degree of effective adoption of innovative technologies, achieves results far below the other two sub-indicators, which respectively explore the degree of digitization of services (understood as digital conversion, regardless of its organizational implications) and the experimentation of methodologies and principles.
- These two indicators achieve high results on average when compared with the averages of the other indicators that make up DPSVI.
- The box plots also indicate that the results of the sample cities are concentrated in a very limited oscillation buffer (+- 0.1) for all three sub-indicators.
- The Digital Maturity of surveyed cities seems to have a direct correlation with population size.
- There is no dependence on the value of the GDPpc, even if the cities below 10K € record on average scores much lower than those of the other groups.
- The maps show light spatial patterns, but it is possible to observe how the cities of the last quartiles are concentrated in Central and Eastern Europe.

3 Digitization of European Cities

3.1 Definition of the index and exploration of its structure

Digitizing services helps governments and public authorities meet citizens' expectations towards improved efficiency and resilience. The benefits lie in the fact that digital interactions diminish efforts for both citizens and public authorities, being less time-consuming and reducing administrative burden. However, to create seamless and satisfying experiences, public authorities need to undergo a challenging process of transformation. In light of this reasoning, it is considered the degree of digitization of pre-existing internal procedures either ancillary or directly related to public service delivery.

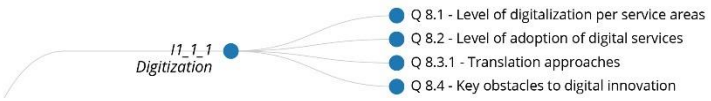
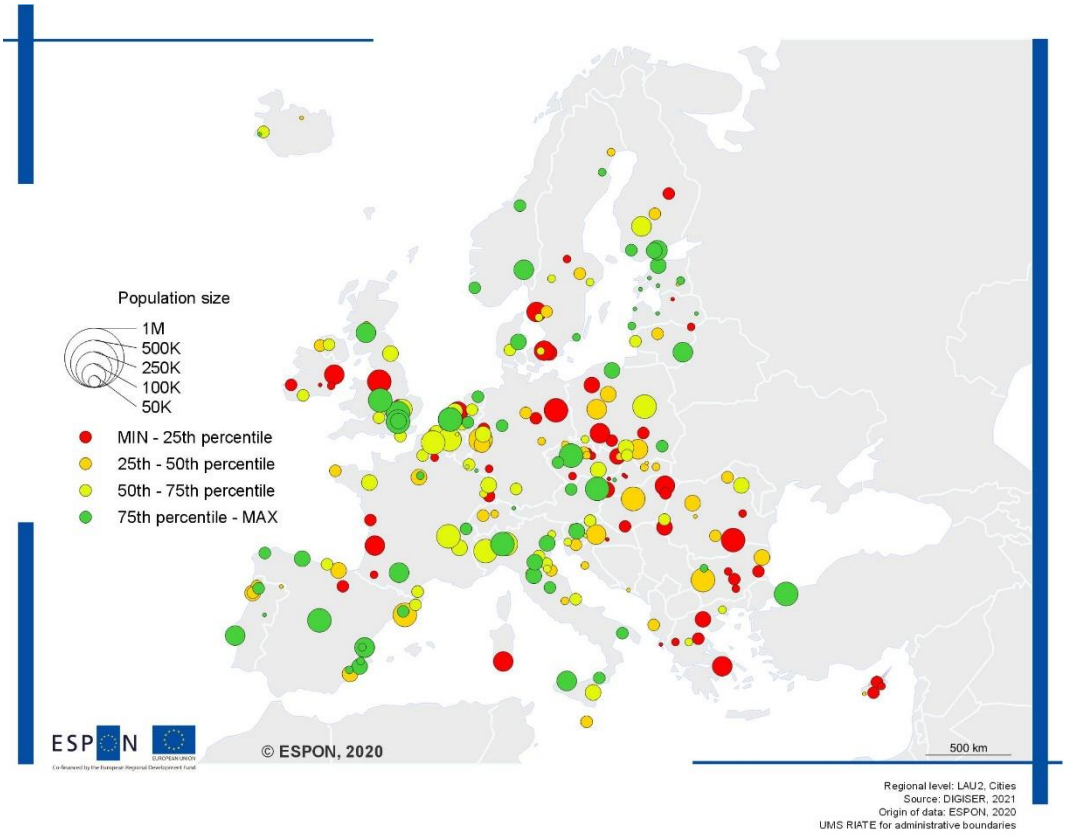


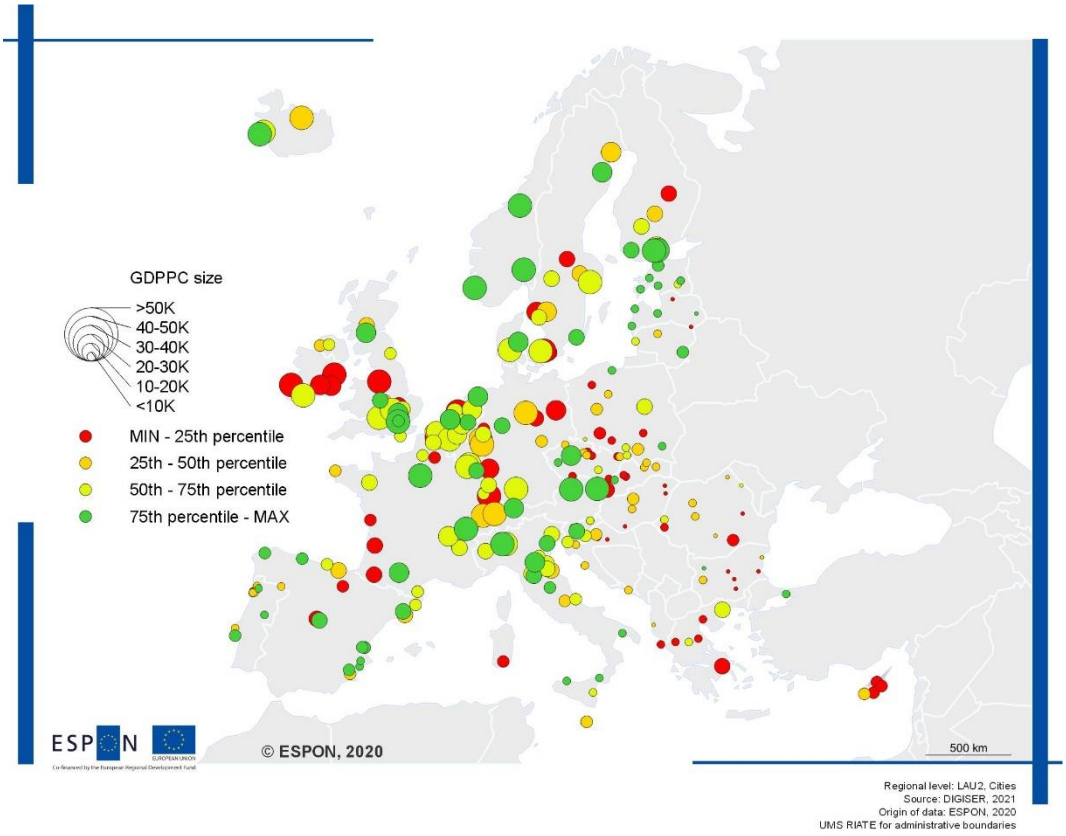
Figure 10 – Digitization index composition (questions tree)

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

- **Q_8.1** How would you describe the level of digitalisation of services provided by the public authority in the following service areas?
- **Q_8.2** When a public service is provided online as well as offline, how many users are choosing the digital option?
- **Q_8.3.1** How are the translations provided?
- **Q_8.4** Please indicate the key obstacles that your public authority is experiencing:

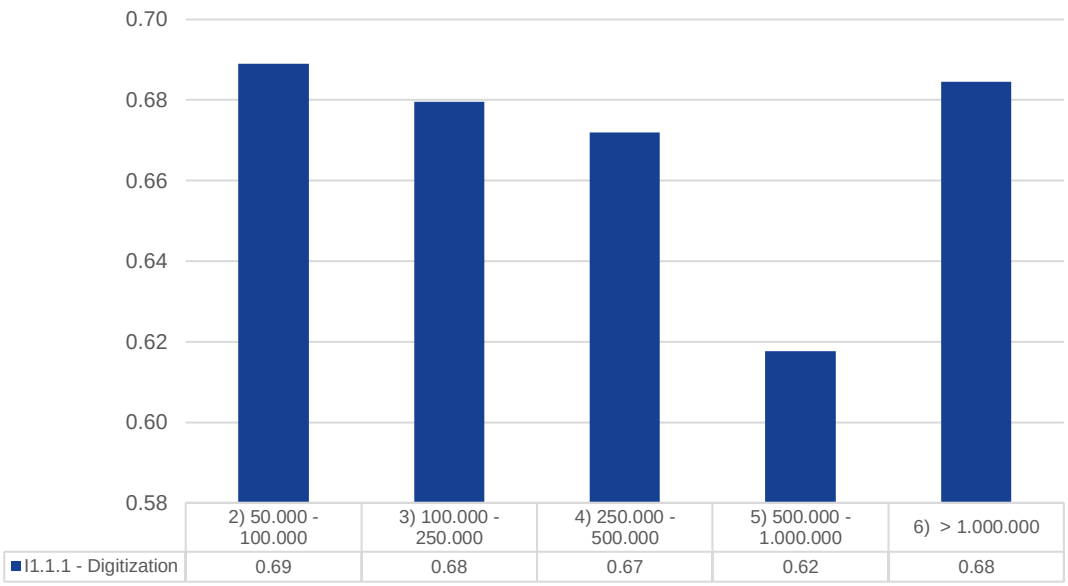


Map 3 – Digitization and population size



Map 4 – Digitization and GDPPC size

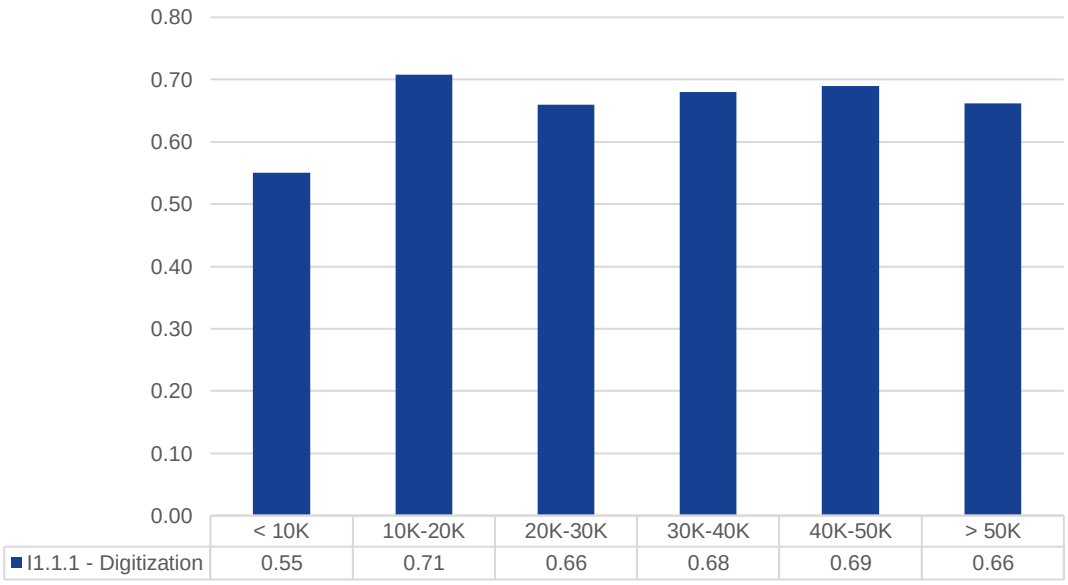
3.2 Population



Index observed	Index type	Index level	Data Sample	Clusters
I1.1.1 - Digitization	DPSVI	Bottom	Reference Sample	Population

Figure 11 - Digitization by population

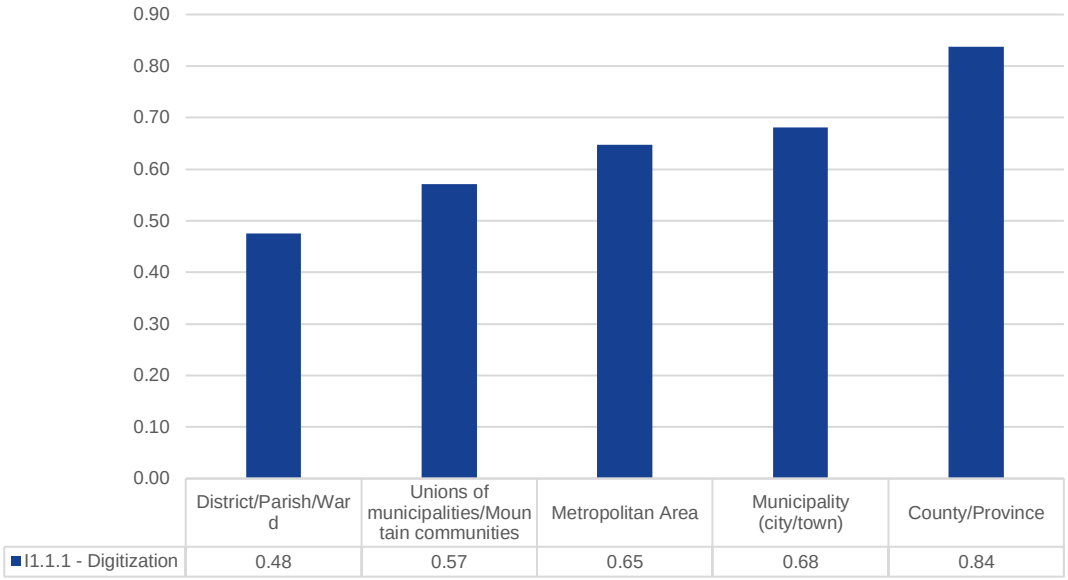
3.3 GDP per Capita



Index observed	Index type	Index level	Data Sample	Clusters
I1.1.1 - Digitization	DPSVI	Bottom	Reference Sample	GDPPC

Figure 12 - Digitization by GDPC

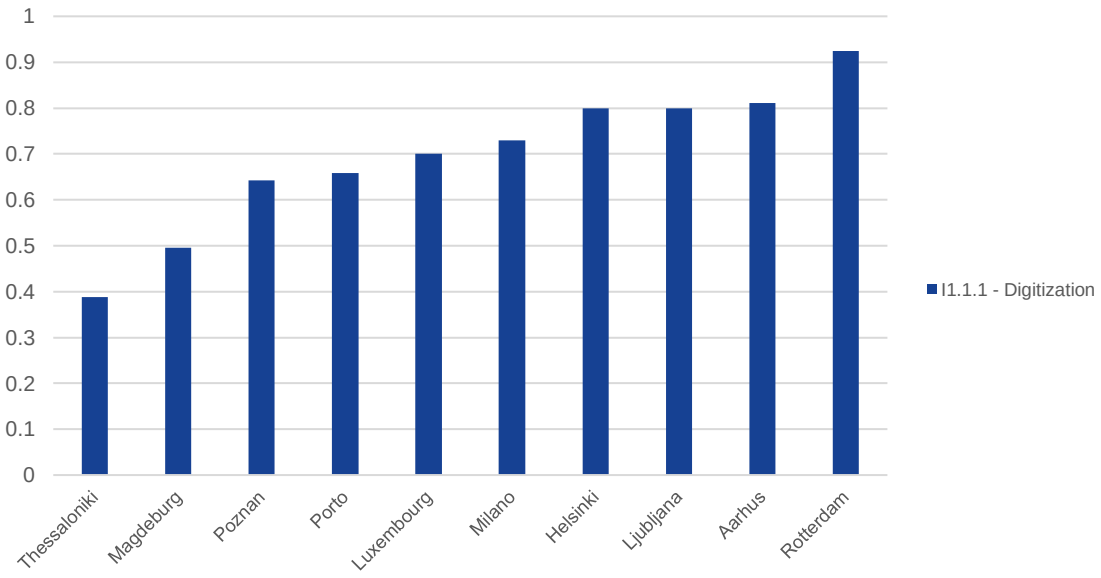
3.4 Authority Type



Index observed	Index type	Index level	Data Sample	Clusters
I1.1.1 - Digitization	DPSVI	Bottom	Reference Sample	Authority type

Figure 13 - Digitization by authority type

3.5 Case studies

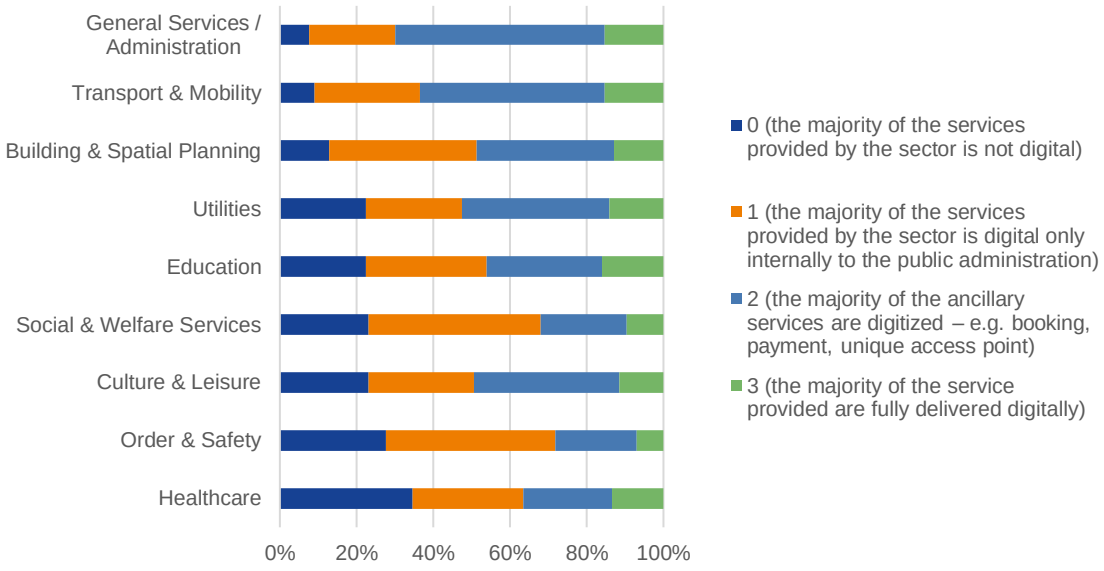


Index observed	Index type	Index level	Data Sample	Clusters
I1.1.1 - Digitization	DPSVI	Bottom	Case studies	na

Figure 14 - Digitization, case studies

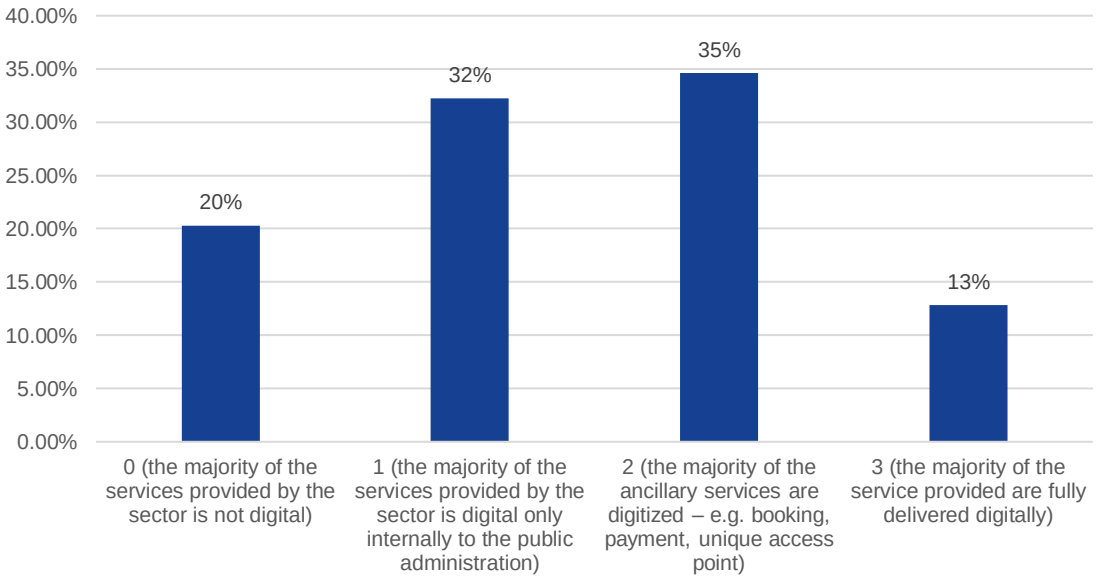
3.6 Relevant question results

3.6.1 How would you describe the level of digitalization of services provided by the public authority in the following service areas?



Question observed	Question type	Data Sample	Clusters	Value
Q_8.1	Single choice - Likert	Reference Sample	Authority type	Percentage

Figure 15 – Digitization in service areas



Question observed	Question type	Data Sample	Clusters	Value
Q_8.1	Single choice - Likert	Reference Sample	Authority type	Percentage

Figure 16 – Digitization of public services

3.7 Highlights

- This indicator measures the degree of digitization of services (regardless of eventual related organizational transformations) and reports a high average score.
- However, question 8.1 indicates that if it is true that a good part of the services are on the path of digitization, on the other hand most of these services are digitized only minimally, while in most of the cases digitization has concerned only ancillary services (35%) or only the digitization of internal procedures (32%).
- The maps for this indicator identify a particularly positive trend in the Baltic area and Central Europe, while the most fragile areas seem to be concentrated in south-eastern Europe.
- This indicator shows no clear correlation with the population of the city and the relationship with the GDPpc is also weak and only the group of cities with GDPpc below 10K € seems to record values much lower than the other groups.

4 Innovative technologies of European Cities

4.1 Definition of the index and exploration of its structure

The introduction and effective adoption of innovative technologies such as AI, blockchain, wearables, robotics and so on, provide institutions with higher transformative potential. Most Countries are taking action to stimulate the use of innovative technologies in their public services. A relevant example of innovative technology is data modelling, as the process of examining datasets to derive conclusions from the information they contain. Integrating data modelling can define and order consistent, high quality, structured data for policy scenario visualisations, policy impact prediction and monitoring, or for evaluating policy options. When available, however, the presence of data modelling functions requires a favouring organisational culture, together with data analytics and machine learning skills to govern the simulation models and gain knowledge from it.

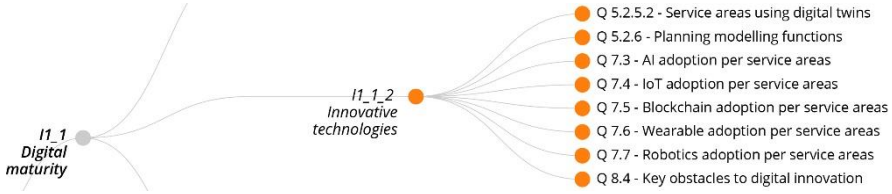
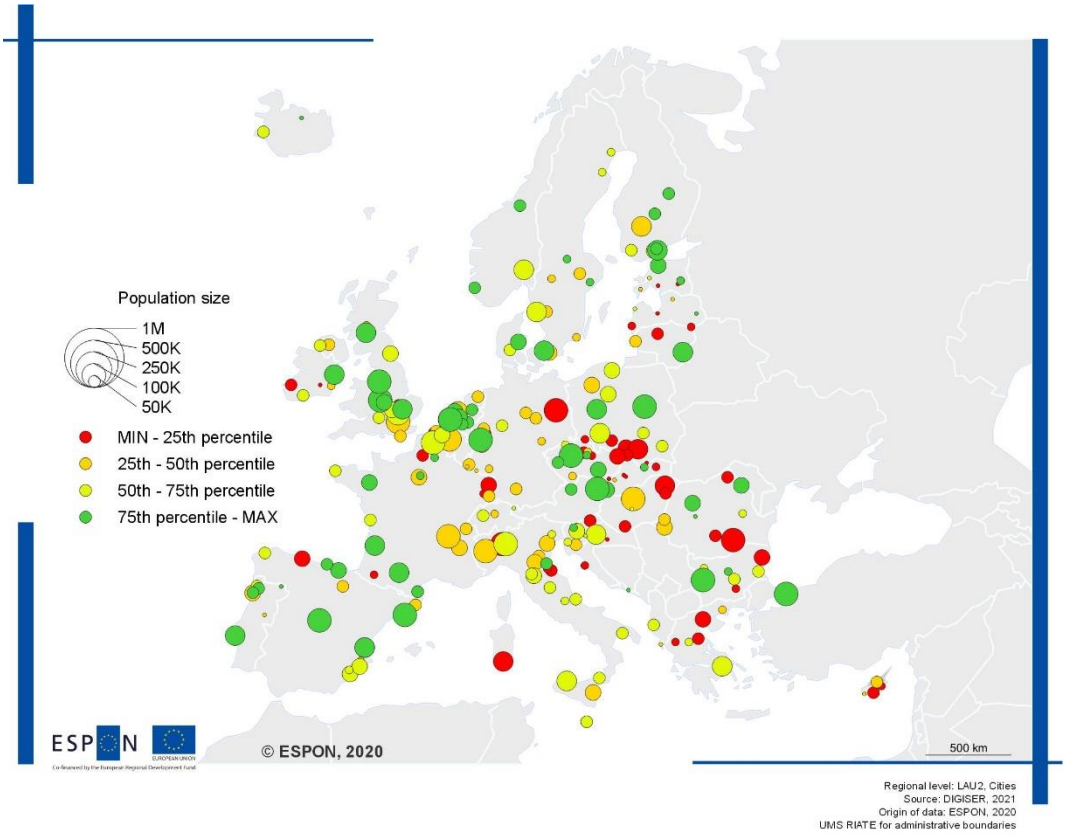


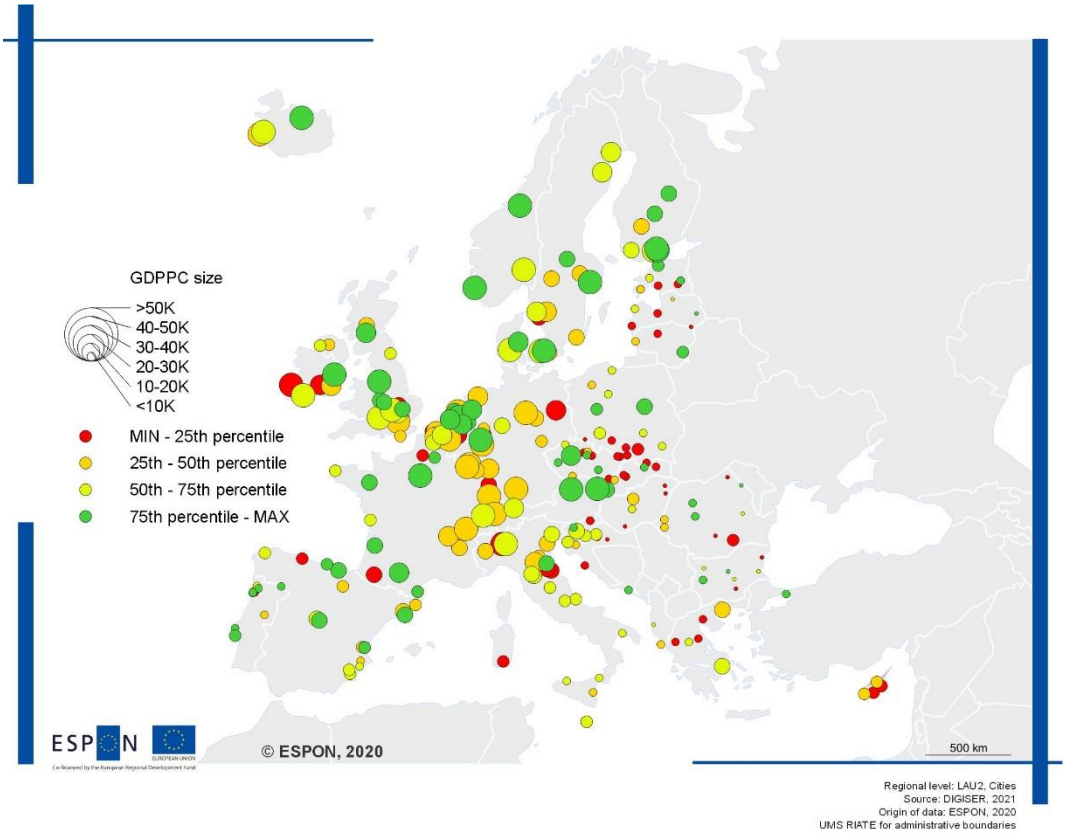
Figure 17 – Innovative technologies index composition (questions tree)

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

- **Q_5.2.5.2** Specify for each service area the purposes of the integrated data modelling function (Local Digital Twins or similar) is used:
- **Q_ 5.2.6** Please indicate to what extent your public authority is considering the integration of the Urban Data Platform with data modelling functions for real-world experience (Local Digital Twins or similar):
- **Q_ 7.3** State for each service area if the adoption of Artificial Intelligence technology is planned, implemented, not planned or not applicable:
- **Q_ 7.4** State for each service area if the adoption of IoT technology is planned, implemented, not planned or na:
- **Q_ 7.5** State for each service area if the adoption of the blockchain technology is planned, implemented, not planned or na:
- **Q_ 7.6** State for each service area if the adoption of wearable technology is planned, implemented, not planned or na:
- **Q_ 7.7** State for each service area if the adoption of robotics technology is planned, implemented, not planned or na:
- **Q_ 8.4** Please indicate the key obstacles that your public authority is experiencing:

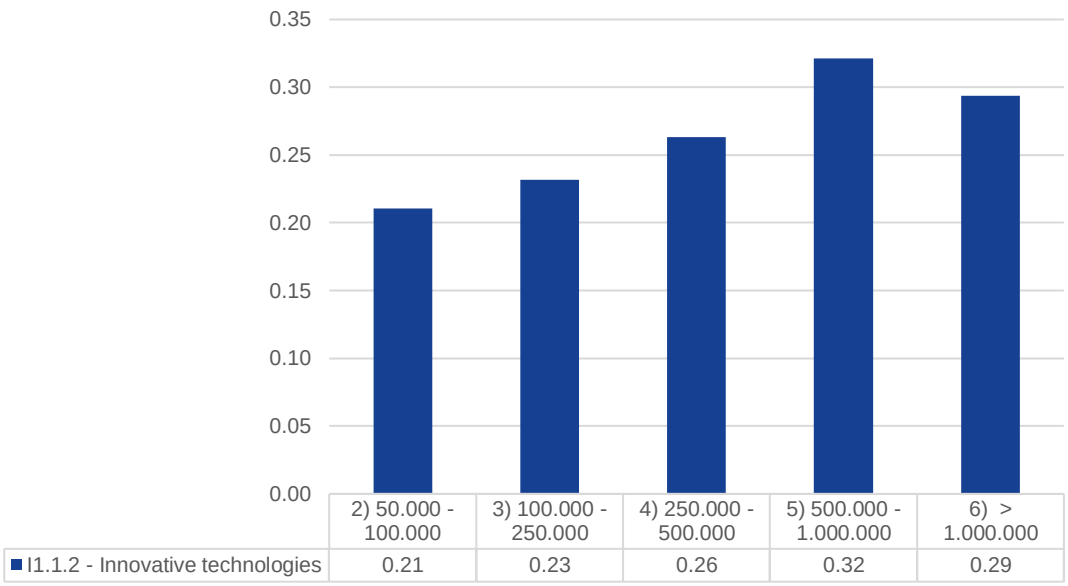


Map 5 – Innovative technologies and population size



Map 6 – Innovative technologies and GDPPC size

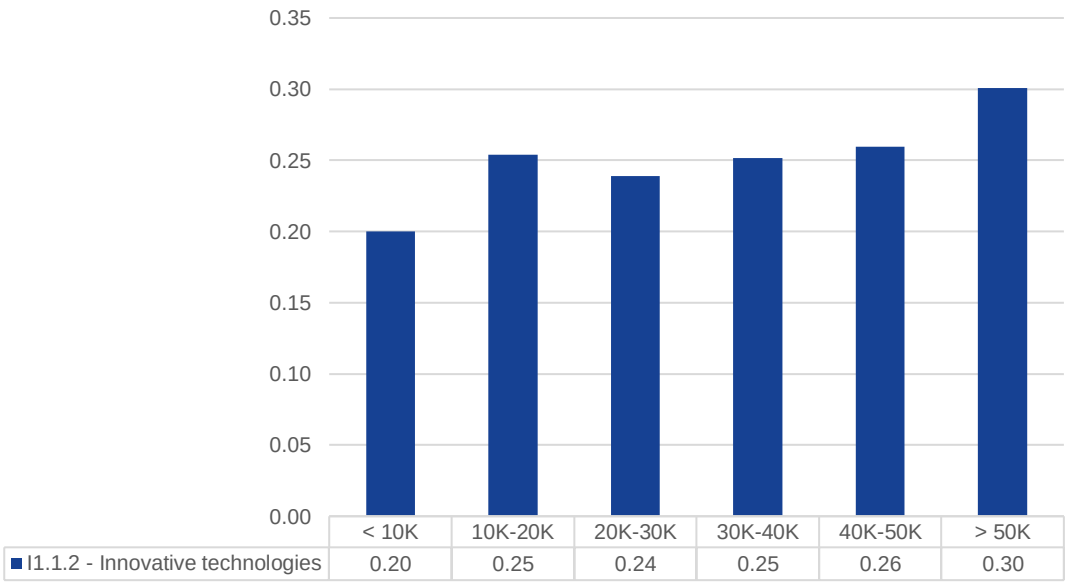
4.2 Population



Index observed	Index type	Index level	Data Sample	Clusters
I1.1.2 - Innovative technologies	DPSVI	Bottom	Reference Sample	Population

Figure 18 - Innovative technologies by population

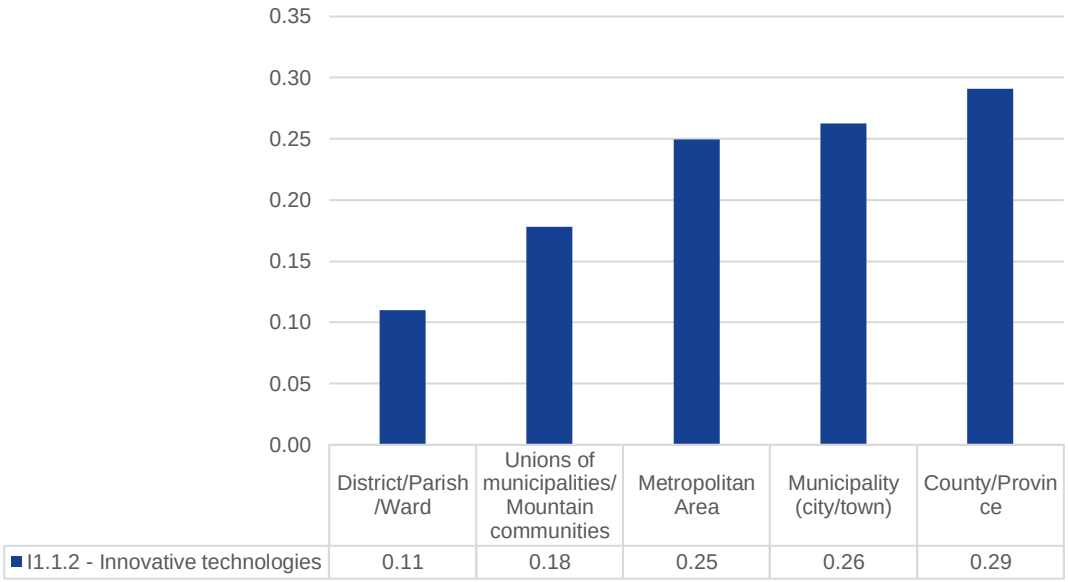
4.3 GDP per Capita



Index observed	Index type	Index level	Data Sample	Clusters
I1.1.2 - Innovative technologies	DPSVI	Bottom	Reference Sample	GDPPC

Figure 19 - Innovative technologies by GDPC

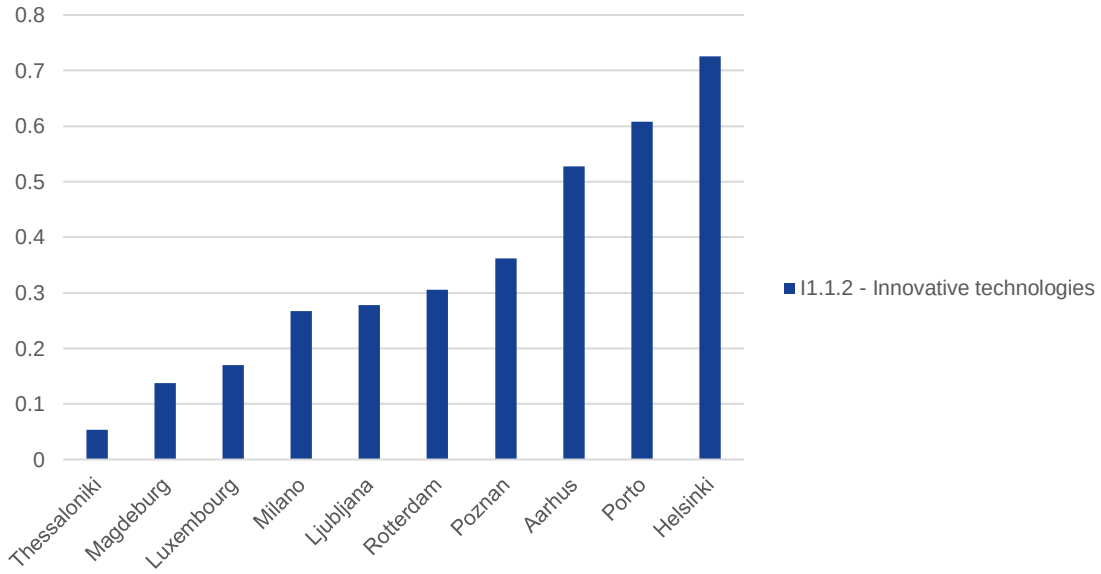
4.4 Authority Type



Index observed	Index type	Index level	Data Sample	Clusters
I1.1.2 - Innovative technologies	DPSVI	Bottom	Reference Sample	Authority type

Figure 20 - Innovative technologies by authority type

4.5 Case studies

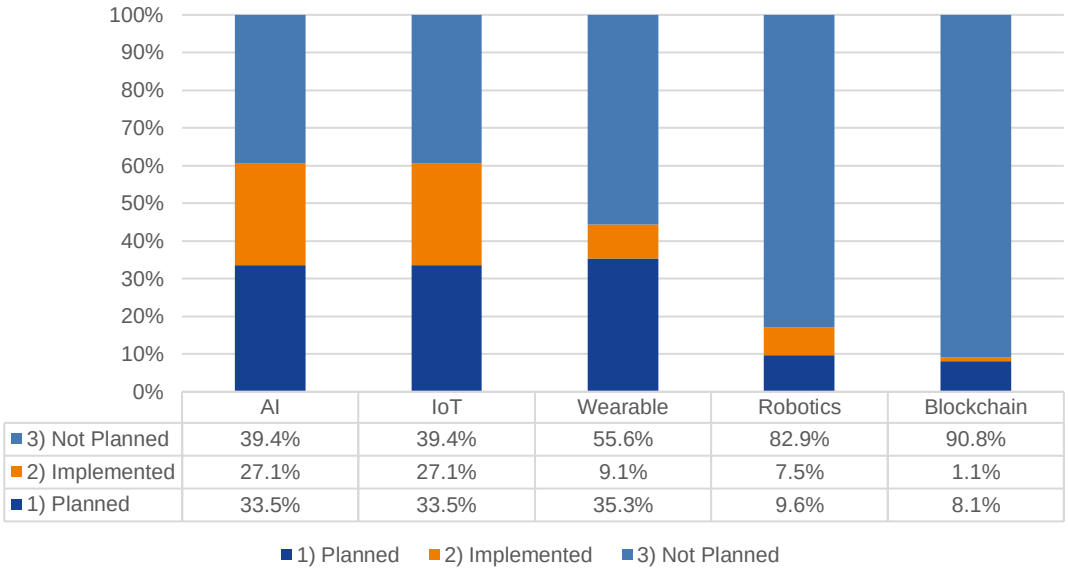


Index observed	Index type	Index level	Data Sample	Clusters
I1.1.2 - Innovative technologies	DPSVI	Bottom	Case studies	na

Figure 21 - Innovative technologies, case studies

4.6 Relevant question results

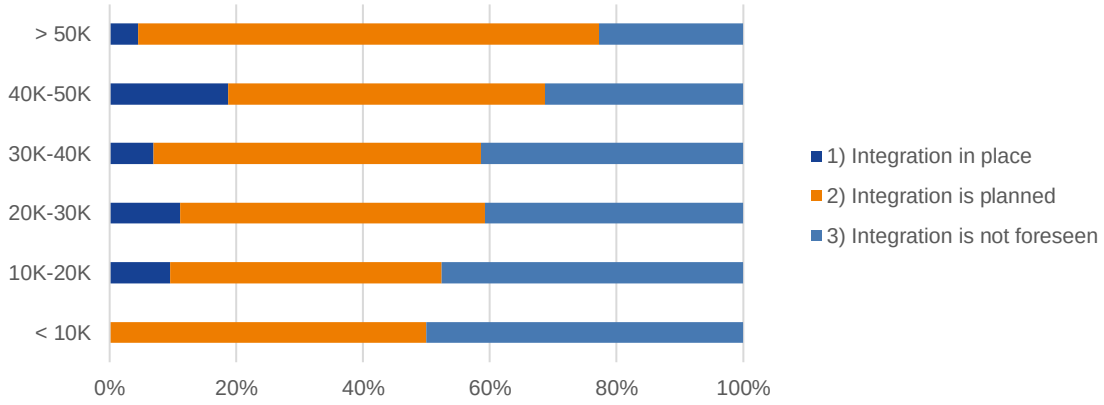
4.6.1 State if the adoption of this technology is planned, implemented, not planned or not applicable



Question observed	Question type	Data Sample	Clusters	Value
Q_7.3 - Q_7.7	Single choice	Reference Sample	Authority type	Percentage

Figure 22 – Adoption of Advanced Technologies

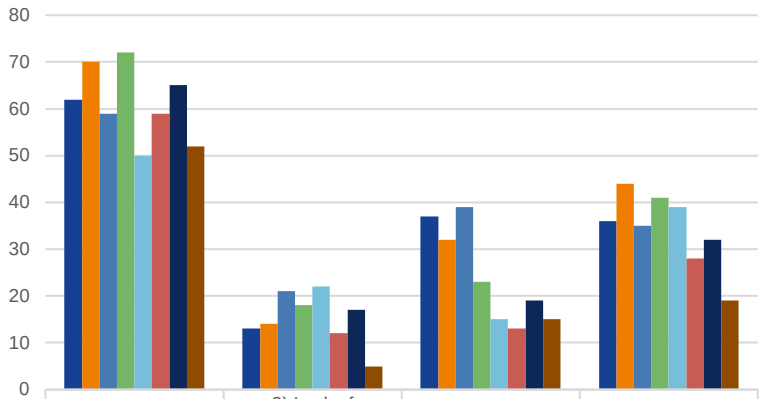
4.6.2 Please indicate to what extent your public authority is considering the integration of the Urban Data Platform with data modelling functions for real-world experience (Local Digital Twins or similar)



Question observed	Question type	Data Sample	Clusters	Value
Q_5.2.6	Single choice	Reference Sample	Authority type	Percentage

Figure 23 – Digital Twins Integration

4.6.3 Please indicate the key obstacles that your public authority is experiencing



	1) Lack of adequate finance	3) Lack of availability of suitable offers on the market	4) Limited access to data	9) Lack of adequate IT infrastructure
Adopting an Urban Data Platform	62	13	37	36
Adopting data modelling tools and software (local Digital Twins or similar)	70	14	32	44
Integrating AI in public services	59	21	39	35
Integrating IoT in public services	72	18	23	41
Integrating Blockchain in public services	50	22	15	39
Integrating Wearables in public services	59	12	13	28
Integrating Robotics in public services	65	17	19	32
Activating or getting engaged by innovation ecosystem	52	5	15	19

Question observed	Question type	Data Sample	Clusters	Value
Q_8.4	Multiple choice	Reference Sample	Authority type	Percentage

Figure 24 – Main Obstacles to Digitization

4.7 Highlights

- This indicator explores the level of actual use and integration of innovative technologies, focusing on AI, IoT, Blockchain, Wearables, Robotics, and Digital Twins, considered as proxies of a broader group of brand new technologies.
- As exemplified by the answers to questions 7.2-7.7, the degree of diffusion of innovative technologies remains very limited with the exclusion of AI and IoT, which are already implemented by about 27% of respondents. Also question 5.2.6. on the level of adoption of Digital Twins pictures a limited penetration (with only 7% of respondents that actually implemented one).
- This explains why the average score of the index remains low for most of cities. The best performing cities are concentrated in central-northern Europe, while almost all cities located in the south-east record lower performances.
- The indicator has loose correlations with both the population and GDPpc (hypothetically a relevant variable). In this second case the cities between 10K and 50K € of GDPpc (which represent the largest majority of respondents) have substantially the same results.
- The analysis of the answers to question 8.4, although with significant differences depending on the specific technology considered, indicates that respondents identify the lack of adequate financial resources as the main obstacle to the adoption of innovative technologies (on average 39% of respondents), followed by the unreadiness of digital infrastructures (22%) which represent a pre-condition for advanced digitization.

5 Advanced methods and principles of European Cities

5.1 Definition of the index and exploration of its structure

Digital transformation is radically affecting service delivery practices, and advanced approaches raised citizens' expectations regarding the access to information. In parallel, they are encouraging the public authority to progressively rely on standards and shared solutions for an open governance, in order to encourage an optimised management and re-use of resources. This dimension analyses the consistency of the methods and principles used to increase and better orient digitalisation in the public sector. To achieve an high score, a set of good practices need to be implemented: from the use of standards for data and sharing collection, to the availability of information in multiple languages and procedural transparency.

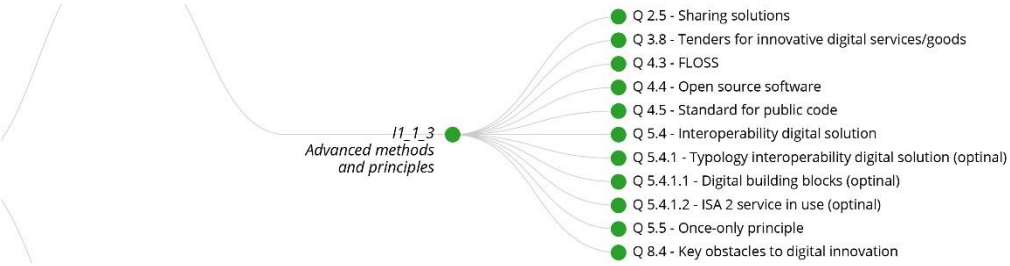
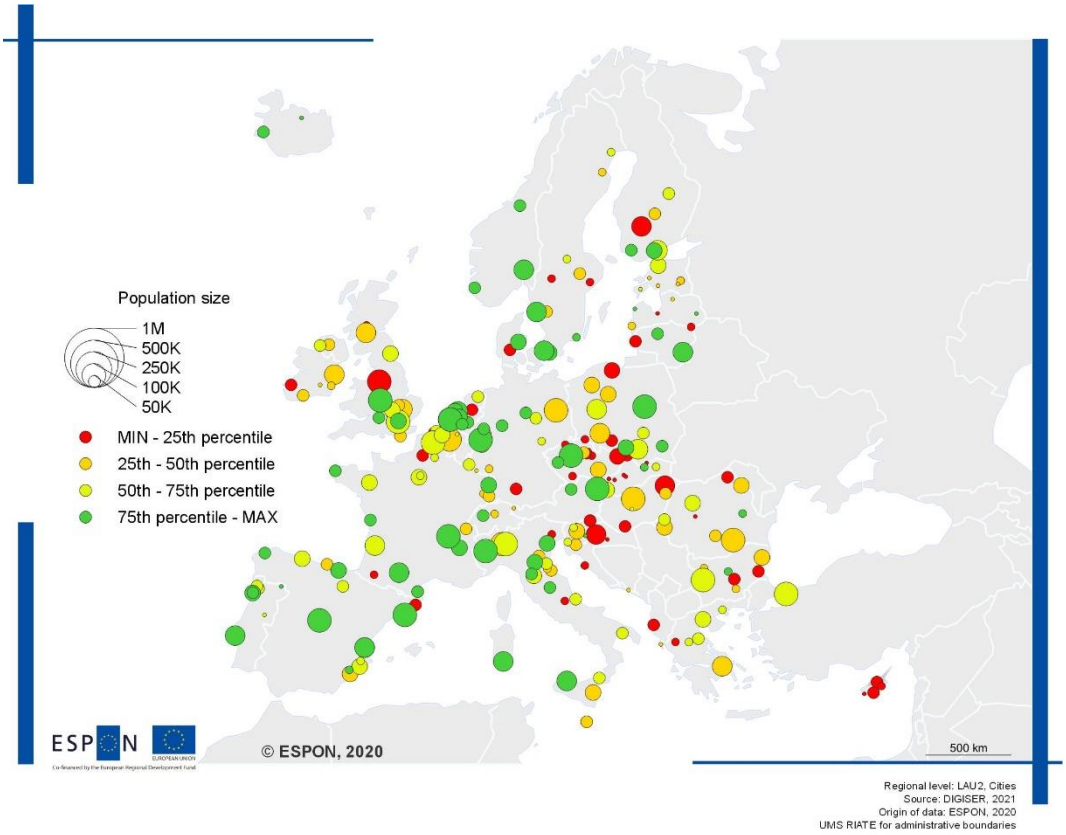


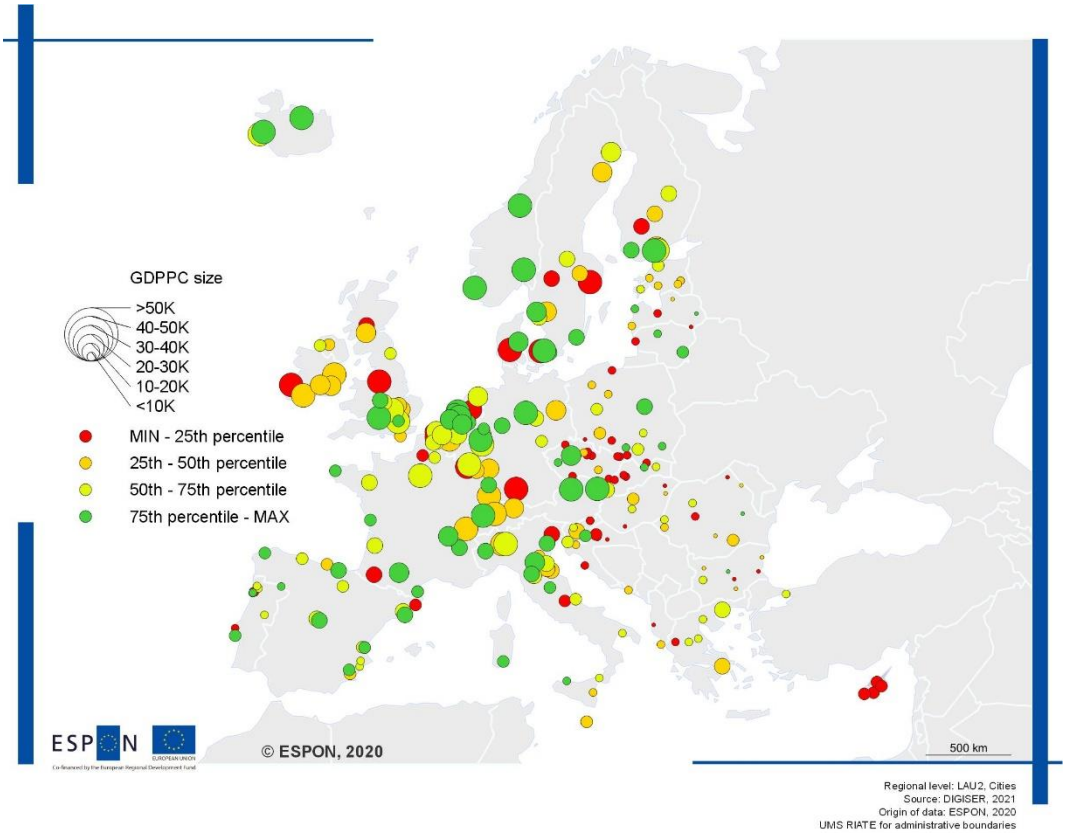
Figure 25 – Advanced methods and principles index composition (questions tree)

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

- **Q_2.5:** Does your public authority benefit from sharing digital solutions, services or products with other public authorities?
- **Q_3.8:** Are the tenders for procuring innovative digital services/goods including the following requirements?
- **Q_4.3:** Does your public authority encourage the use of Free/Libre and Open Source Software (FLOSS)?
- **Q_4.4:** Does the authority's IT set-up offer the possibility to implement open source alternatives?
- **Q_4.5:** In the case of open source software code, particularly its development and maintenance, is your public authority applying the Standard for Public Code?
- **Q_5.4:** Is your public authority making use of interoperable digital solutions or services (e.g. ISA2,CEF, MIMs, FIWARE)?
- **Q_5.4.1:** Which of the following are used?
- **Q_5.4.1.1:** Which of the following CEF Digital Building Blocks does your public authority use?
- **Q_5.4.1.2:** Which of the following ISA2 services does your public authority use?
- **Q_5.5:** Does your public authority apply the once-only principle in its services?
- **Q_8.4:** Please indicate the key obstacles that your public authority is experiencing:

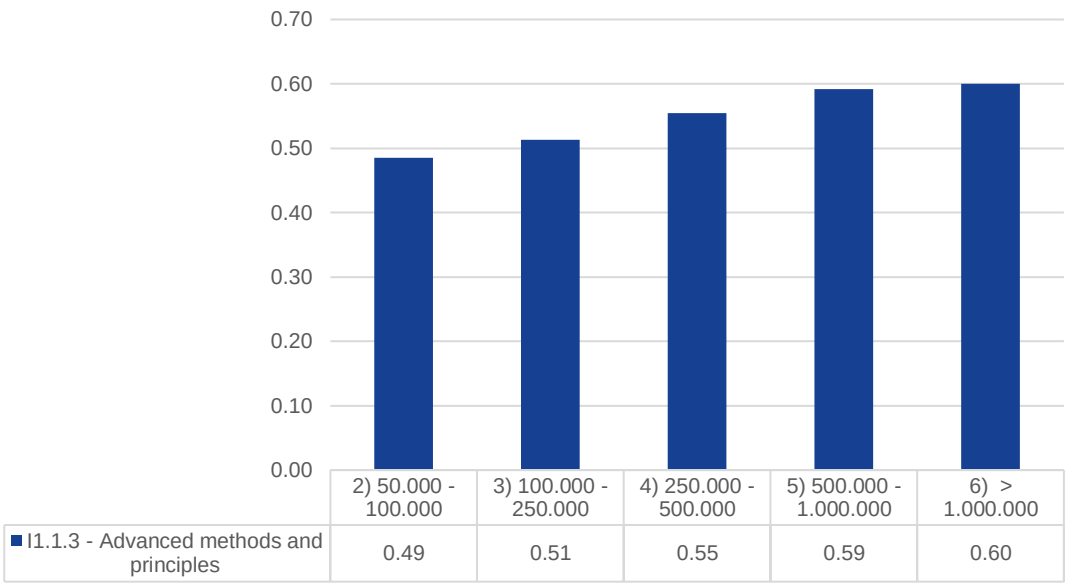


Map 7 – Advanced methods and principles and population size



Map 8 – Advanced methods and principles and GDPPC size

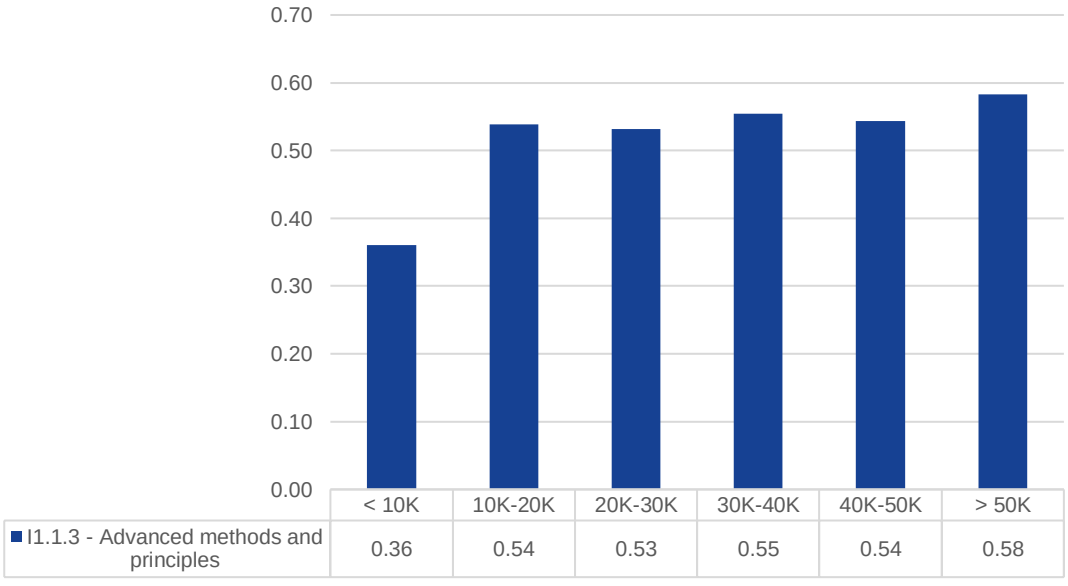
5.2 Population



Index observed	Index type	Index level	Data Sample	Clusters
I1.1.3 - Advanced methods and principles	DPSVI	Intermediate	Reference Sample	Population

Figure 26 - Advanced methods and principles by population

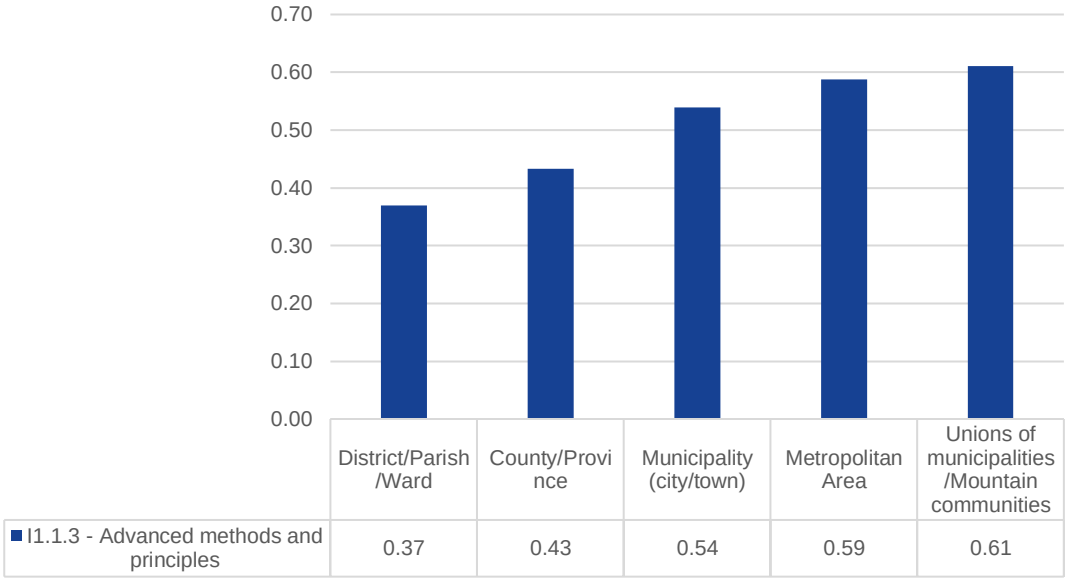
5.3 GDP per Capita



Index observed	Index type	Index level	Data Sample	Clusters
I1.1.3 - Advanced methods and principles	DPSVI	Intermediate	Reference Sample	GDPPC

Figure 27 - Advanced methods and principles by GDPC

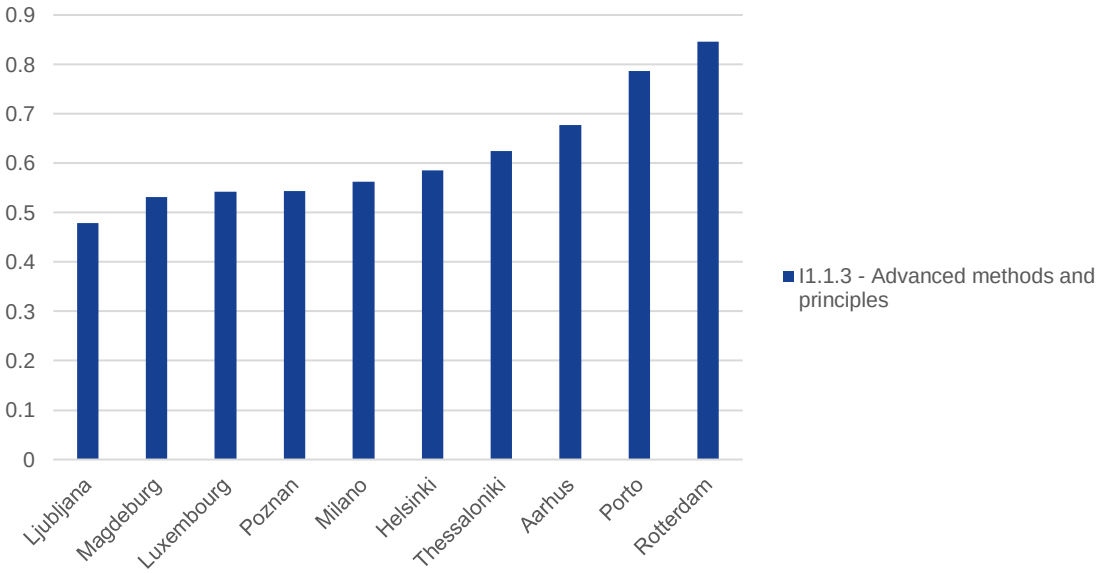
5.4 Authority Type



Index observed	Index type	Index level	Data Sample	Clusters
I1.1.3 - Advanced methods and principles	DPSVI	Intermediate	Reference Sample	Authority type

Figure 28 - Advanced methods and principles by authority type

5.5 Case studies

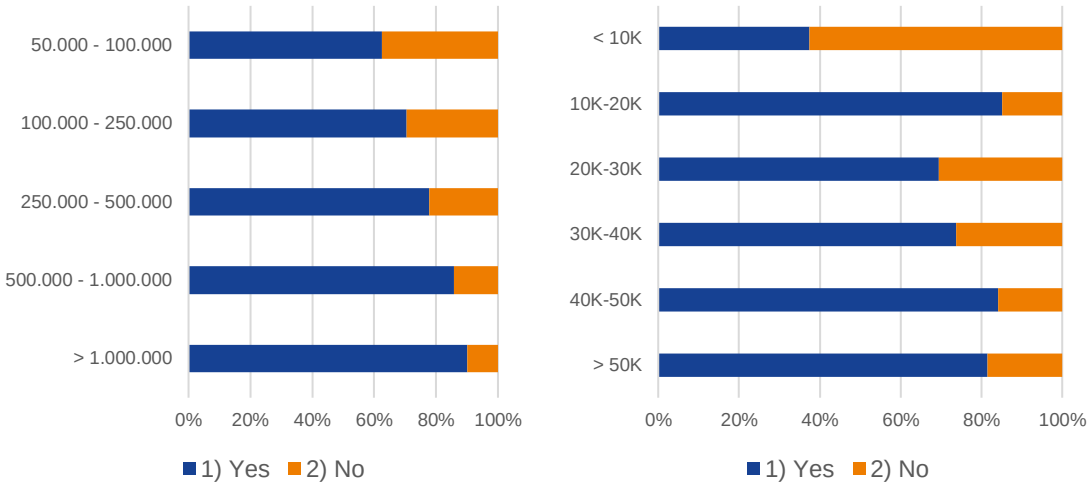


Index observed	Index type	Index level	Data Sample	Clusters
I1.1.3 - Advanced methods and principles	DPSVI	Intermediate	Case studies	na

Figure 29 - Advanced methods and principles, case studies

5.6 Relevant question results

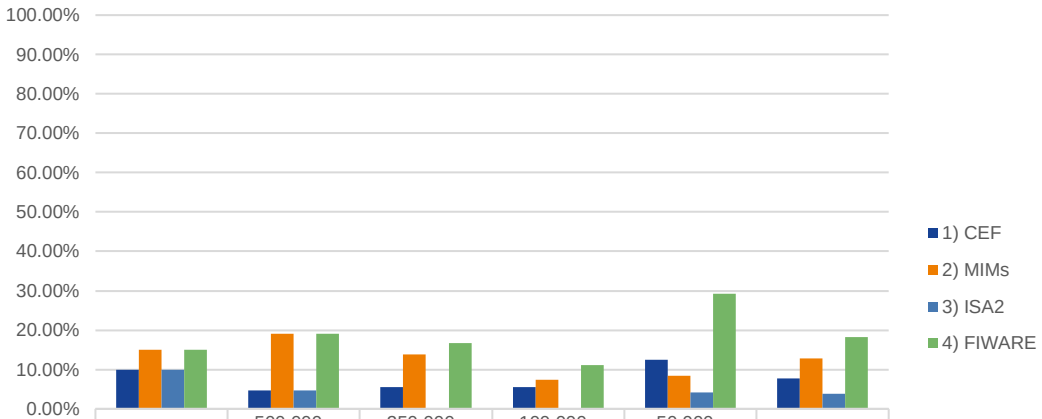
5.6.1 Does the authority's IT set-up offer the possibility to implement open source alternatives?



Question observed	Question type	Data Sample	Clusters	Value
Q_4.4	Single choice - Binary	Reference Sample	Population/GDPPC	Percentage

Figure 30 – Open Source Alternatives

5.6.2 Is your public authority making use of interoperable digital solutions or services (e.g. ISA2,CEF, MIMs, FIWARE)?



	> 1.000.000	500.000 - 1.000.000	250.000 - 500.000	100.000 - 250.000	50.000 - 100.000	Average
1) CEF	10.00%	4.76%	5.56%	5.56%	12.50%	7.67%
2) MIMs	15.00%	19.05%	13.89%	7.41%	8.33%	12.74%
3) ISA2	10.00%	4.76%	0.00%	0.00%	4.17%	3.79%
4) FIWARE	15.00%	19.05%	16.67%	11.11%	29.17%	18.20%

Question observed	Question type	Data Sample	Clusters	Value
Q_5.4	Multiple choice	Reference Sample	Population	Percentage

Figure 31 – Diffusion of Interoperability Frameworks

5.7 Highlights

- This indicator focuses on the embedment of approaches and methodologies inspired by the paradigm of open innovation, focusing on elements such as the accessibility and availability of open-source technologies and the measures and initiatives taken to ensure standardization and interoperability between the digital services deployed.
- Looking at the indicator as a whole, it is noted that the significant correlation with the population is not reflected in an equally important correlation with the GDPpc, even though for the latter a threshold above 10K remains visible. This difference is also evident in the case of the single question 4.4 concerning the availability of open-source alternatives which - on average - is offered by 75% respondent cities to their civil servants.
- The map of this indicator also deviates from the general trend that sees South-Eastern Europe underperforming, while in this case many southern cities are in the first quartile.
- The results of the questions of block 5.4 explore in detail the diffusion of standards and frameworks for interoperability which, as evident from the graph, are still of very limited diffusion. Only FIWARE has significant levels of diffusion (in particular a large diffusion within small cities that would deserve further in-depth exploration), followed by OASC MIMs. The interoperable building blocks developed and made available to cities (in most cases at no cost) in the context of important European initiatives such as CEF and ISA2 have a very limited diffusion.

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