Smart cities: innovative digital services and solutions

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Abstract

The paper analyses European approaches to developing innovative digital services and solutions in the context of Association with the EU, ensuring sustainable development of cities and villages as well as cross-border and interregional interoperability. The need for territorial focus groups to define the data infrastructure for smart services in smart cities and to identify the innovative ICT systems needed for sustainable development is pointed out. It is proposed, in order to visualize territorial statistical information - to localize a set of key indicators of smart sustainable cities, developed by the Austrian Environment Agency (AOSA) and the International Telecommunication Union (ITU) in consultation with UN member states, as a tool to assess how smart and sustainable city development is, and as a starting point for specific decisions and measures to increase the level of urban sustainability.

Keywords: data visualization, innovative digital services, sustainable smart cities.

JEL classification: L86, R11, R58.

Introduction

"Smart City" is a concept for integrating several information and communication technologies (ICT) and Internet of Things (IoT solutions) to manage city assets. City assets include, among others, local information systems departments, schools, libraries, transport, hospitals, power plants, water and waste management systems, law enforcement and other public services. The goal of a smart city is to improve the quality of life by using urban informatics technology to improve service efficiency and meet the needs of residents. The path to smart cities goes back to the 1970s, when the first urban big data project was created in Los Angeles: "Los Angeles Cluster Analysis". The first smart city was probably Amsterdam, which created a virtual digital city in 1994. Things then accelerated in the mid-2000s when IBM and Cisco launched separate initiatives. In 2011, Barcelona hosted the first Smart City Expo World Congress, which has become an annual event reflecting the development of smart cities (History of smart cities).

The national "Strategy for Inclusive, Sustainable and Digital Economy until 2030" of the Republic of Moldova, in the chapter "Productive, Innovative and Competitive Enterprises" refers to the objectives of developing and implementing measures to optimize the institutional and resource base in strengthening the ecosystem for smart specialization in the chain "research-innovation-technology transfer-production"; adaptation of education and research programs development to the objectives of smart specialization.

In the context of above, we have highlighted relevant objectives that can include into the national concept of Smart Cities in Republic of Moldova:

- Digital city assessment and their needs;
- SME digitalization support tools estimation in order to adjust, capitalize and transform it into a comprehensive program that promotes new technologies and enhances the digital capacity of enterprises, including by encouraging partnerships with ICT companies and the education system;
- Development and implementation of the targeted and accelerated programs to provide digital skills to consumers of goods and services, including people in vulnerable groups.

The national spatial data infrastructure that is being implemented in the regions of the Republic of Moldova, according to the principles of the INSPIRE Directive, should be the key basis for the development of smart cities (Law No. 254 of 17-11-2016). Space (as well as time) is one of the main components of statistical production. European best practices show that geospatial data should be used for solving the problems related with the SDI (Spatial Data Infrastructure) as the most important aspect of cross-border cooperation of Smart Cities. They are necessary to properly reflect the location element in the different phases of statistical production - from the design, data collection and management to the dissemination phase - in order to structure and map statistical outputs, enabling a visual territorial perception of the data. Examples of best European practices in the creation and use of spatial data are:

1. The HARMO-DATA project (HARMO-DATA, 2014-2020), funded by the EU under the INTERREG VA Italy-Slovenia program for 2014-2020. It involves different stakeholders, target groups and end-users in three regions: Friuli-Venezia Giulia (Italy), Veneto (Italy) and Slovenia. The main objective of the project is to develop common solutions for better transboundary spatial data management - by harmonizing existing data, implementing a transboundary data platform and developing a common protocol for the harmonization of territorial data. The main uses of the project results are related to searching, browsing and downloading spatial data, and a harmonization model for spatial datasets is developed to apply the INSPIRE data specification. A common

spatial data platform has been created as an extension of the existing search/view/download platforms (metadata systems), updated and improved to give better access to open data for users from both Italy and Slovenia. A common spatial data platform HARMO-DATA as well as a joint protocol for cross-border spatial data harmonization has been formalized in a formal bilateral agreement.

2. The project, called SPATIAL (ASDE) for short, is aimed at creating a common strategy for sustainable management of the cross-border area between Bulgaria and Romania. It proposes a joint integrated approach for the whole cross-border region and focuses on specific functional areas. The project thus overcomes the constraints imposed by national borders.

By taking a holistic approach and considering economic, social and environmental elements, the strategic nature of the project is underlined by the proposed activities:

- Identification of elements with potential, entrepreneurial discovery process (EDP);
- Identification of key issues/sectoral areas of analysis;
- Building an integrated and harmonized database;
- Development of a strategy for the whole cross-border region;
- Find ways of cooperation between authorities and citizens, and between all stakeholders on both sides of the Danube;
- A common approach to the implementation of investment projects under the European Union Danube Strategy and the European Structural and Investment Funds for the period 2014-2020.

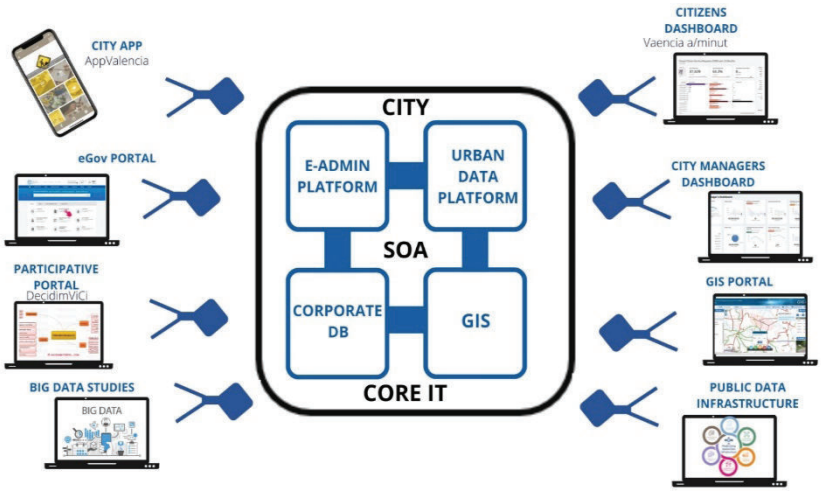
3. As an example of service-oriented architecture (SOA) and modular approach to software development is Valencia (Spain) Smart City Platform (VLCi Platform). Figure 1 reflects the model of Data Infrastructure for Smart Services. This model is based on providing services with standardized interfaces, remotely over standardized protocols (INSPIRE CONFERENCE, 2021).

These examples will be useful for implementation in the cross-border cooperation of the Republic of Moldova with Romania and Ukraine and the pilot municipalities of the development regions and the ATU, in context of the overall concept of Smart Connectivity for the «Three Seas» region is to expand digital components in key infrastructure, which in turn will support new business models and technologies.

It is proposed as the regional components of statistical production in the Republic of Moldova, to select the territorial space covered by the research project "Assessment of the potential for sustainable development of small towns in the Dniester river valley", under the UNDP (UNDP, 2018).

Data infrastructure for smart services

Figure 1



Source: (INSPIRE CONFERENCE, 2021)

The results of this research helped to initiate a dialogue and interaction between analysts and scientists working on both sides of the Dniester River. The overall objectives were to raise public awareness and encourage public debate on issues that represent examples of best practice and statistical data. Addressing these issues is necessary to identify necessary measures for sustainable urban development affecting people's quality of life, and to provide reliable data for effective decision-making. Research has shown that cities and communities in the Dniester valley face complex challenges such as climate change, housing quality, pandemics, energy efficiency and urban mobility. Through digital innovation, the technologies proposed in the article and the achievement of inter-regional, interoperable solutions, they can be developed into a nationally manageable S&T concept of "Smart Cities and Communities".

A smart city uses spatial data in various ways, including analytics and interaction of business and inhabitants. The results of the UNDP and EU thematic projects in the Dniester River valley provide a legal basis, in terms of international law, for building cross-border and inter-regional innovation interactions between settlements, small towns in border areas. The introduction of digital innovation services for localization of "SDCs" meets the recommendations for the harmonization of methodological approaches of Smart Specialization as well as the new EU initiative "Interregional

Innovation Investments" (I3 initiative). The aim of the innovation tool is to help participants in Smart Specialization Strategies (S3) to cluster, scale up and bring innovation to the European market. This will be achieved by supporting inter-regional partnerships (including quadruple helix stakeholders (Report for Committee of Regions) such as public authorities, private entities, research technology organizations and end users) to reduce the risks of collaboration, accelerate innovation project ideas and unlock private investment.

In order to discover new opportunities for regions and autonomous territorial communities in the field of smart specialization, as part of participation in new EU initiatives and programs, it is necessary to analyze their position in national, European and global value chains. Based on this analysis, regional smart specialization strategies should be coordinated not only with national priorities and programs, but also with the regions of other countries, as no one region has complete and comprehensive knowledge of all the opportunities for cooperation at regional, national and European level in their smart specialization areas (Report for Committee of Regions). This will require a focused approach to trans-regional cooperation, including related issues such as administrative responsibilities, risks and remit.

Spatial planning is essential to deliver economic, social and environmental benefits by creating a more stable and predictable environment for investment and development, guaranteeing development benefits to local communities and promoting the wise use of land and natural resources for development.

The process of spatial planning involves the use of databases developed by other organizations, both public and private. One way is through the creation of regional spatial observatories (Smart Specialization Strategies for Sustainable Development, 2015) working on behalf of a range of stakeholders from different sectors and linking and integrating data from all levels to provide regional and local situation analysis. In this context, a good example of transnational / cross-border cooperation of Smart Cities cluster initiatives - performing certain functions of spatial observatories - can be a good European practice of the Estonian Smart Cities Cluster (ESCC) (SPATIAL PLANNING). ESCC takes a holistic approach to smart cities, aiming to develop, deliver and export smart services and products based on ICT and mobile communications in the following priority areas - smart and green mobility, energy and environment, tourism, health and well-being, governance and public services. In terms of technology, the priority areas include digital and mobility technologies. The Estonian Smart Cities Cluster (ESCC) also runs Estonia's first functional living laboratory, which collects end-user feedback on new services and products developed by companies and research institutes.

The experience of Portugal (Statistics Portugal) in the production of geospatially referenced statistics could be an example of the development of geospatial information services based on official statistics in Europe. The practice of European counterparts will also be useful for potential innovative public-private partnerships in the Dniester River valley, for making adequate management decisions. Integration of geospatial data into the model of production of official statistics shows that the value of produced and disseminated statistical information is increasing. It will be possible to integrate "Smart Cities Indicators" into the production of official statistics of the Republic of Moldova, based on innovative technology ArcGIS (Babin, Tutunaru, Covalenco and Babina, 2021) - complex of geo information software products of American company ESRI (Figure 2). The experience of Statistics Portugal with the integration of geospatial data in different phases of statistical production shows new opportunity of cooperation of statistical offices and geospatial agencies in the process of transition to integrated approach to production.

Patterns ofC use of spatial data infrastructure spatial data infrastructure in the smart city and human settlements

Figure 2

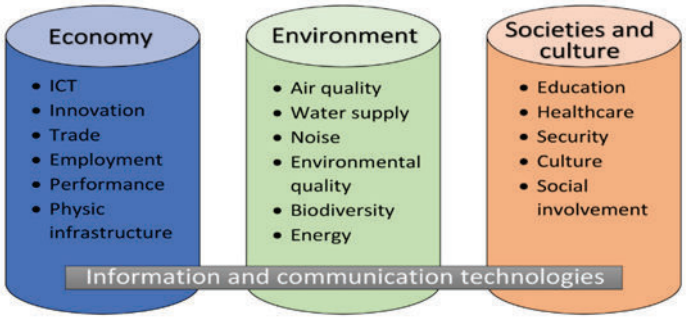
Source: (SDI)

The use of Smart City indicators has several purposes. Firstly, the indicators are a tool to assess a city's performance, so that it can recommend specific actions to be taken subsequently. Secondly, the indicators can be used as a tool to monitor cities' progress towards their sustainable development in the global framework of the Sustainable Development Goals (SDGs). The SDGs should not be seen as a 'fix for problems' but as a supportive tool that can help cities achieve more sustainable and smarter growth.

The current set of indicators is structured according to the following sections: area; theme; and typology (UNECE–ITU). The domains represent the more general aspects that form the basis for the indicator set. They correspond to the three main components of sustainability: economy, environment and society and culture. For each of these components, there is a separate view of progress and, when combined, a holistic view of a smart sustainable city emerges. A theme indicates a group of specific indicators that describe an area of potential development. Eighteen core themes have been identified and each indicator has been assigned to one specific theme. The typology of indicators indicates the "applicability" of the indicator itself.

Visual representation of the UNECE ITU Smart Sustainable Cities indicators

Figure 3



Source: (UNECE–ITU)

The next two types of indicators are defined and explained below:

- Core indicators can be used by all cities globally
- Additional indicators can be used by some cities depending on their economic potential, population growth, geographical location, etc.

Based on the area, theme and typology, each indicator is assigned a unit, which indicates how it will be measured; a definition, which states what it describes; and a number. "Key Performance Indicator Data Collection

Methodology for Smart Sustainable Cities", has been produced by the Uniting for Smart Sustainable Cities initiative (U4SSC). It states that in order to facilitate data collection by cities and ensure uniformity in reporting indicator values, a description of the following aspects has been developed for each indicator:

- rationale for the choice of the indicator;
- peculiarities of the interpretation of this indicator;
- information on the desired trends;
- the methodology for calculating the reported value;
- potential data sources.

UNECE-ITU Smart Sustainable Cities Indicators

Table 1

Area	Topic	№.	Indicator	Typology
Economy		1	C1.1.1 Internet access in households	core
		2	A1.1.1 Electronic devices penetration	core
			A1.1.2 Wireless broadband	
	T1.1 ICT infrastructure	3	Subscriptions	additional
		4	A1.1.3 Fixed broadband subscriptions	additional
		5	C1.2.1 R&D expenditure	core
	T1.2 Innovation	6	C1.2.2 Patents	core
		7	C1.3.1 Employment trends	core
		8	A1.3.1 Creative industry employment	additional
Society and Culture		46	C3.1.1 Students' ICT capability	core
		47	C3.1.2 Adult literacy trends	core
		48	C3.1.3 Higher education ratio	core
		49	A3.1.1 e-learning systems	additional

Source: elaborated by the author's used (U4SSC)

The Data Centre for the Sustainable Development Goals (SDGs) in Ireland could serve as a prototype (Ireland's SDG data hub) collaborative platform for reporting progress towards the goals and sharing information on related initiatives. The platform was developed through a partnership between ESRI Ireland and Ordnance Survey Ireland, the Central Statistical Office. Within a series of publications, IT4BA researchers intend to initiate a similar platform to localize the UN-ISE ECE Smart Sustainable Cities Indicators with city administrations and small medium-sized enterprises interested in modernizing e-public services and digital transformation processes in regional

economic sectors, and building inter-regional, transnational cooperation within the new EU initiatives and programs in which Moldova is a participant.

Content of the PESTLE (Political, Economic, Social cultural, Technological, Labor market, Environment) give to potential interested public and private organizations analysis tools of their position in national, European and global value chains, are looking for examples of «Best Practices» and partners in cross-border, interregional Smart Cities projects. Regional Smart Specialization strategies should be coordinated not only with national priorities and programs, but also with regions in other countries, in order to obtain necessary and comprehensive insights into all opportunities for cooperation at regional, national and European level in their Smart Specialization areas. Turning to the intentions of the Republic of Moldova and Ukraine to integrate into the Three Seas Initiative, our short study highlights another best practice of the Baltic Sea Macro-region. The cross-border FinEst Twins project (The FinEst Twins) which envisages the creation of a FinEst Centre for Smart Cities in Estonia that can mobilize all leading actors and stakeholders in Estonia and build strong long-term partnerships with their counterparts in the Helsinki region, leveraging the macro region's scientific knowledge, innovativeness and entrepreneurship. The FinEst Centre focuses on mobility, energy and the built environment, fused with governance and urban analytics and data, and aims to equal the world's leading research centers for smart cities. The FinEst Centre is developing a cross-border knowledge transfer infrastructure (Urban Operating Platform) through real-world pilot projects that can attract international experts and investment. It also acts as a springboard for exporting Finnish-Estonian knowledge and combined service solutions globally.

Conclusion

For effective implementation of Smart City and Smart Village concepts, we focus the attention of potential participants in innovation-public-private partnerships on:

- The need for a national Smart City and Smart Village reporting and data dissemination platform with the ability to monitor national indicators of smart sustainable cities and inform policy makers and citizens.

- Approaching to regional reporting and data dissemination platforms integrated into the National Platform, with the possibility of creating a single entry point for data correlation. At the same time, disaggregated data down to the lowest geographical level needs to be included for Smart Sustainable Cities and Smart Villages indicator data.

- Creating and updating sub-national data will promote local government and stakeholder accountability.

- A nationally recognized consulting mechanism needs to be established in the ICT and GIS spatial data infrastructure sectors to address geospatial information management, humanitarian assistance and disaster response issues in an integrated manner. The increasing availability, rapid growth of geospatial data requires adequate solutions at all levels of decision-making.

- The proposed solutions should comply with established international statistical standards.

- Ensuring interoperability is a prerequisite for electronic communication and exchange of information between different actors at different levels. Statistical and technical standards should be reflected in the data architecture.

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