WOLAŃSKI

EVALUATION OF THE IMPLEMENTATION OF THE SMART CITY CONCEPT IN VISEGRAD GROUP COUNTRIES

FINAL REPORT

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GOAL, SCOPE AND METHODOLOGY

Developing cities into smart and sustainable environments remains one of the most significant challenges facing the European Union. Smart solutions can also contribute to improved socio-economic performance in situations of danger and uncertainty (e.g. SARS-CoV-2 pandemic). V4 countries are introducing Smart City solutions – but there is a need for massive and dynamic development. Therefore, we were motivated to investigate the practical applications of the Smart City concept in the public policies of V4 countries and aimed to identify transferable "good practices".

We proposed a set of three research questions that cover both strategic and project levels of the investigation:

- Q1: How has the concept of Smart Cities been implemented in key strategic programming documents in V4 countries?
- Q2: What are the good practices of Smart City projects in V4 countries?
- Q3: What factors and mechanisms increase the success rate of Smart City projects?

The research scope follows the dual nature of the research questions that address both the program and project levels.

The study's territorial scope covers cities along with their functional urban areas in countries of the Visegrad Group (Czech Republic, Hungary, Poland, Slovakia) that use different solutions to serve their people. The unit of analysis for Q1 was a strategic document, while for Q2 and Q3, we will analyze projects that are nested in specific urban areas.

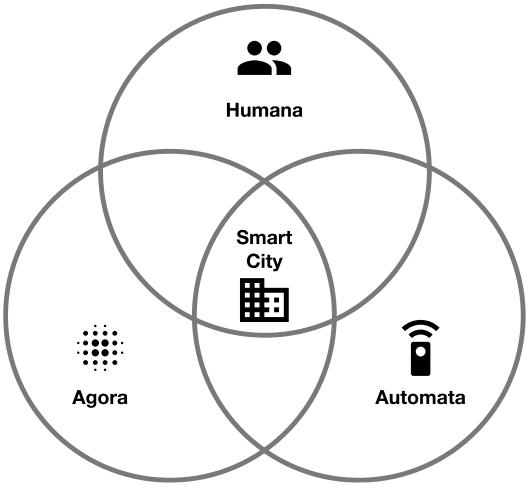
The thematical scope covers ten public policy areas (city management, business, environment, healthcare, transport, energy, science & education, tourism, culture, water and waste management). They were further broken down into 56 subareas related to the technologies applied in the projects.

The time frame covered by the study involves those solutions whose implementation or piloting phase has been finished between January 1, 2016, up to the time of implementation of this current study.

We had also identified challenges such as the multi-faceted nature of Smart Cities, the unclear unit of analysis as well as the comparative aspect of the analysis. Our research framework answers these challenges.

We propose three dimensions of Smart City as the highest common denominators to compare projects and identify good practice patterns:

- humana – the human dimension;
- automata – the technological dimension;
- agora – the collective dimension.



The process of our research was twofold, following the logic of our research questions. The first stream of our activities focused on the application of the Smart City concept at the level of strategic documents (Q1). The second stream of our research focused on the application of the Smart City concept at the level of the various projects. Those two streams of activities were conducted in parallel (Q2 & Q3).

The methodology involved the desk research of strategic documents and at least 4 interviews with Smart City or urban policy units within partner ministries of the V4 (for Q1) and desk research in the field of smart solutions, nethnography, individual interviews with owners and contractors as well as ethnographic research (for Q2 and Q3). All the analysis was conducted by the core team which was supported by national experts from the V4 countries. Recommendations proposed in this report were operationalised during Service Design online workshops with the international experts' team, alongside Polish national and local government representatives. The main products of the workshops are Annex VIII, Annex IX and Annex X covering proposition of support tools within Cohesion Policy.

Research tools were developed gradually, according to the findings of the consecutive stages of our study. Different templates were used for proposing good practices of Smart City projects, selecting smart projects for

case studies, writing in-depth case studies, and Qualitative Comparative Analysis.

To identify the success mechanisms for Smart City projects using the above-mentioned templates, we used the Qualitative Comparative Analysis (QCA) method to examine the data from all in-depth case studies. QCA allows for the mapping of different configurations of factors that would lead to the presence or absence of the final situation. In this research, there is a list of conditions that are necessary to make a smart project successful.

RESULTS

The application of the Smart City concept in strategic documents varies across V4 countries, taking into account the definitions, areas, and dimensions discussed. Every country presents a different level of concept maturity and a different approach (top-down, bottom-up, unified across the country or with room for the autonomy of the city). Various additional activities are also being undertaken in this area.

The conclusions on the role of strategic documents, drawn by the projects' stakeholders and by institutional respondents, differ in their nature. For the owners and contractors of smart solutions, the role of strategic documents was barely visible. On the other hand, representatives of partner ministries pointed out several success factors related to the strategic level: a uniform definition of the Smart City concept, a holistic approach, positive stimulation of participation, and awareness of technical issues.

Analysing the case studies pool led to useful conclusions concerning vital aspects of the solutions. For example, digital solutions applied throughout the V4 countries demonstrate solid progress in the field, but they are hardly cutting-edge innovations. Interconnectedness is a very desired feature of an ideal digital solution.

The budgets of the projects varied, ranging from large infrastructural investments to universally affordable subscriptions or license fees. Public support was not commonly used to finance smart solutions in V4, but if public support was included, most of the projects were financed by the EU Cohesion Policy. A smart solution can be financed at various stages, either in the development or implementation phase. Besides targeted financial support more conceptual expertise removing legal impediments and introducing some standardization would be required at a national level. It was often mentioned that the funding works as an incentive. Projects, which

received public funding, would not have ever been considered if it had not been for the funding.

Considerably more examples of smart solutions were identified in medium/large cities than small/medium cities. Not all smart solutions can be applied everywhere. Some products are only applicable in large agglomerations, while others work better in smaller cities.

The involvement of the institution's management is a necessary factor that increases a project's success. External participants quickly become discouraged by tedious processes. It is worth including them in exceptional and necessary moments of the process.

As expected, smart solutions turned out to be a useful tool in times of the pandemic (COVID-19), especially in the health, and public safety sectors as well as digitally facilitated access to services whether public or private.

The Qualitative Comparative Analysis confirmed some of the above-mentioned conclusions. There are three main paths of conditions leading to a solution that is plugged in the city ecosystem:

1. The city and other important stakeholders are engaged;
2. The solution is properly explained to the stakeholders, is supported by the city, and is user-friendly;
3. The other important stakeholders are engaged, the solution is properly explained to the stakeholders and is user-friendly.

CONCLUSIONS & RECOMMENDATIONS

Key observations from the study concern the peculiarity of the Smart City solutions, sound but not cutting edge innovativeness, the invisibility of the strategic level to owners and contractors, the lack of a holistic approach and uniform definition of the concept, different maturity stages of the projects, a modular approach to technology, legal barriers, as well as the success factors and COVID-19 immunity mentioned above. The pandemic generally did not affect the operation of the systems and their effects are also ensured during a time of remote work.

Some configurations of the factors were pointed out in the QCA method as key success factors, leading to the Smart City ecosystem. An interplay among context, technology and process matter - there is no one condition that is necessary or sufficient for the outcome. There are configurations of conditions for which we may be certain to observe an ecosystem. Four conditions are especially important: the project is supported by the city

during its implementation, engagement of other important stakeholders, the solution is user-friendly, and was adequately explained to the key stakeholders. A holistic, national approach to the Smart City concept was also mentioned as one of the success factors of solutions development. The lack of a central institution distributing funds and providing knowledge may significantly hinder the development process.

There are various types of key barriers that can be encountered. Smart city projects are substantially different from standard public projects co-funded by the Cohesion Policy, so they cannot be simply procured, but as the IT projects that they are, they need to be managed uniquely. The strategic level is also often invisible to owners and contractors of projects, but could serve as guidelines on what to do and what to finance it with. Lack of uniform definition of a Smart City (codified in a strategy or a legal act) was either mentioned as a barrier. In some countries, the projects, which obviously can be qualified as smart, are not called that way and as a result, the funding possibilities are unclear. Finally, legal regulations were also mentioned as barriers. Regulations limits possibilities for introducing new installations, applications, and services.

Based on the conclusions several recommendations at the strategic and operational level emerged. Suggestions for national authorities included providing comprehensive support, more flexible financing measures, equalization of funds distribution, and flexibility of legal regulations followed by further benchmarking with world leaders. A set of 10 support tools within the Cohesion Policy was also proposed, which covers ideas for the development of the Smart City concept in Poland in form of Urban Labs, contact points, universal solutions, investment funds, special programs, academies, or microgrants funds.

As far as cities' authorities are concerned, the following measures are advised: more sustainable projects for providing better interoperability, division of projects into smaller stages, necessary changes in the implementation process (e.g. experiments, constant improvement, close cooperation with providers), improvement of usability and friendliness of solutions, involvement of different stakeholder groups and developing competencies of offices to implement technology projects are advised.

Details on methodology of strategic documents' review, QCA and extended case studies, good practices catalogue, authors as well as conclusions and recommendations are included in the annexes to the report.

ABBREVIATIONS AND ACRONYMS

CAPEX	Capital expenditures
COVID-19	Coronavirus disease
EIP-SCC	European Innovation Partnership on Smart Cities and Communities
EU	European Union
EUR	euro
GDP	Gross Domestic Product
ICT	Information and communications technology
IT	Information technology
NGO	Non-governmental organisation
Q1, Q2, Q3	Question
QCA	Qualitative Comparative Analysis
S1, S2, S3, S4	Step
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2
ToR	Terms of Reference
UN	United Nations
V4	The Visegrad Group

1. INTRODUCTION

1.1. RATIONALE OF THE STUDY

Cities have always been the engines of human civilization[1] and, with the growth of the world's population, their role has dramatically increased in recent years. According to the UN estimates, in 1950, they were home to 30% of the population; in 2014, around 54%, and in 2050, as much as 66% of the world's population will live in urbanized areas[2]. The growing metropolitan areas bring dynamic opportunities for social and economic innovation but also challenges such as communication problems and congestion, increased demand for energy, and the pollution of the environment. Despite a common denominator, each city is unique and has problems specific to its environment. For example, in the largest Asian cities, the source of the main urban problems is the very high density of buildings and the young population, while Europe looks for ways to adapt urban spaces to the needs of an increasing but also ageing population[3].

Both academics and practitioners of urban development have been pointing out innovative modern technologies in addressing the most pressing challenges and tapping onto global urbanization opportunities[4]. The idea of using digital technologies to manage urban processes more comprehensively and sustainably, has been labelled as a "Smart City".

The Smart City concept is now recognised across the world, resulting in numerous urban initiatives in both developed and developing countries[5]. The European Union also recognized the importance of (...) developing the EU's cities into smart and sustainable

[1] E. Glaeser, Triumph of the City: How Our Greatest Invention Makes Us Richer, Smarter, Greener, Healthier, and Happier, NY: Penguin, New York 2001, A. Lees, The City: A World History (New Oxford World History), Oxford University Press, Oxford 2015

[2] World Urbanization Prospects. 2018 revision, The highlights, United Nations, Department of Economic and Social Affairs, New York 2018

[3] K. Kourtit, P. Nijkamp, "The New Urban World – the challenges of cities in decline", Romanian Journal of Regional Science no. 7/2013, 2013, p. 10

[4] D.V. Gibson, G. Kozmetsky, R.W. Smilor, "The Technopolis Phenomenon: Smart Cities, Fast Systems", Global Networks, Rowman & Littlefield Publishers, Washington 1992

[5] N. Komninos, C. Kakderi (Eds.), Smart Cities in the Post-algorithmic Era. Integrating Technologies, Platforms and Governance, Edward Elgar Publishing, Cheltenham 2012; Y.-M. Joo, T.-B. Tan (Eds.), Smart Cities in Asia. Governing Development in the Era of Hyper-Connectivity, Edward Elgar Publishing, Cheltenham 2020

environments – in social, economic, and environmental terms"[6]. This has been followed by numerous strategic documents at the local, regional, and national levels. In the Central European context, in 2019 the Visegrad countries signed an agreement on cooperation in promoting innovation in the Smart City area in Central Europe to create a single innovation market for public services. The number of Smart City initiatives is dynamically growing in V4 countries, although most of the projects are still in the pilot stage. Thus, there is a need for massive and dynamic development.

Although promising, the current Smart City idea has two challenges. First of all, it is multi-faceted, involving social, economic, environmental, housing, transport, and administrative issues, along with urban management. These characteristics align well with the multidimensional reality of urban processes but, at the same time, create different models of Smart Cities. They vary in terms of balance among technological, human and social aspects of a Smart City, as well as in terms of the roles assigned to public policy actors (e.g., highly centralized models of Asian Smart Cities, a corporate-driven model of some US cities, and more bottom-up collective model of European Smart Cities). Cities in Central Europe often take inspiration or even adapt solutions from global leaders. That however requires public managers to carefully consider what model underlies the specific Smart City initiative they want to follow and to what extent it fits their cultural and institutional context.

The second challenge of the Smart City concept is that it is predominantly discussed with a city as a unit of analysis. This approach is justified from the outcome perspective. Ultimately, it is a city as a functional space that needs its problems to be addressed. However, in public managers' everyday practice, the basic building block of public policy are projects. Thus, it is essential to understand how single, Smart City project can be developed, launched, and successfully delivered to contribute to the urban area's functional improvement, as well as to smoothly fit into the portfolio of other initiatives. This issue is even more pressing for public managers from Visegrad countries. Due to highly limited resources and multiple financing streams, they work with a patchwork of projects and smaller initiatives, trying to integrate them into urban policies.

Therefore, we were motivated to ask about the practical applications of the Smart City concept in the public policies of V4 countries. We aimed to identify good practices regarding Smart Cities in the Visegrad Group (V4) countries. We looked at both the strategic level of programming documents as well as the operational level of the individual Smart City projects.

[6] The opinion of the Committee of the Regions on 'Smart Cities and Communities – European Innovation Partnership' (2013/C 280/06).

The main audiences of our study are policy practitioners responsible for designing and implementing urban policies and public sector officers responsible for developing strategic documents for the new Cohesion Policy programming period.

We hope that our findings provide inspiration for new project ideas and areas, raise awareness about conditions that help to functionally integrate individual projects into an urban ecosystem, and facilitate the knowledge exchange within international partnerships amongst V4 countries.

1.2. GOAL AND SCOPE OF THE STUDY

In this study, we explored the practical applications of the Smart City concept in the public policies of the four Visegrad countries. We were interested in the strategic level of the policies, that is, the programming documents, the operational level, which means concrete projects executed in cities and towns, and the interplay between those two levels. We addressed them with three research questions that covered both strategic and project levels of investigation:

Q1: How has the Smart Cities concept been implemented in key strategic programming documents in V4 countries?

This exploratory question examined the language used in different countries to describe Smart City ideas and trace the assumptions and models of Smart Cities promoted by the strategic documents. Thanks to this, practitioners from V4 countries understand how the different, often competing visions and Smart City models are encoded in strategic documents and how they determined the practical applications.

Q2: What are the good practices of Smart City projects in V4 countries?

This exploratory question identifies a pool of project case studies. It illustrates the practical applications of the Smart City concept in a specific urban context, to specific policy challenges, with specific technologies in use. Practitioners gain from this an instructive overview of current developments and potential inspirations.

Q3: What factors and mechanisms increase the success of Smart City projects?

This explanatory question identified various projects' success paths – the configurations of factors and their interrelations (mechanisms) that increased the possibility of making the Smart City project successful. This insight equips the practitioners with a list of minimum conditions that have to be taken into account when designing and implementing effective Smart City projects.

The research scope followed the dual nature of the research questions that address both program and project levels. The study's territorial scope covered cities with their

functional urban areas in countries of the Visegrad Group (the Czech Republic, Hungary, Poland, Slovakia) that use different solutions to serve people.

The unit of analysis for Q1 were strategic documents, while Q2 and Q3 analysed projects nested in specific urban areas. Our study covered existing solutions in implementing the Smart City concept, that had been developed beyond the concept phase, and implemented in V4 cities. The time frame covered by the study involves solutions for which the implementation or piloting phase had been finished between January 1, 2016, up to the time of the implementation of this current study (March 2021).

The thematical scope covered ten public policy areas as provided by the Contracting Authority of this study: (1) city management, (2) business, (3) environment, (4) healthcare, (5) transport, (6) energy, (7) science & education, (8) tourism, (9) culture, and (10) water and waste management. They were further broken down into 56 subareas related to the technologies applied in the projects. They are presented in Annex III.

There were three substantial challenges for the conceptual execution of this project. The first challenge was the nature of the Smart City concept. It is multi-faceted, and the literature is populated with a number of, often conflicting, definitions. This variety in perspectives on the Smart City concept is mirrored in projects practice. Thus, to address this challenge, we proposed the analytical framework that allowed us to grasp different perspectives and show the various distribution of accents among aspects of the Smart City.

The second challenge was the unit of analysis. The Terms of Reference focuses on the strategic documents and projects as two units of analysis. However, Smart City projects are usually part of a broader system - a Smart City initiative that addresses the functional aspects of urban areas. Thus, we decided to apply a nested approach, putting particular projects and program documents in their urban context.

The third challenge is related to the logic of comparison among projects. The Contracting Authority requested focusing the research on the population of projects that applies 56 different solutions in addressing the challenges of ten different policy areas and coming from four different countries. The international and multi-sectoral aspects added to the complexity of comparative dimensions and created a highly diversified population with no common denominator. Such highly diversified projects could not be objectively compared with each other using standard evaluative criteria (utility, efficiency, etc.). Thus, we proposed the three dimensions of Smart City (humana, automata and agora) as the biggest common denominators to compare projects and identify good practices patterns.

We propose the set of three research questions that cover both strategic and project level of investigation:

- Q1: How has the concept of Smart Cities been implemented in key strategic programming documents in V4 countries?
- Q2: What are the good practices of Smart City projects in V4 countries?
- Q3: What factors and mechanisms increase the success rate of Smart City projects?

We also identified challenges such as the multi-faceted issue of Smart Cities, the unit of analysis as well as the comparative aspect of the analysis. Our analytical framework may be the answer to these challenges.

1.3. METHODOLOGY

The Smart City is a multi-faceted phenomenon. There is no one dominant definition of the Smart City concept, while at the same time, there are competing ideas on Smart Cities.

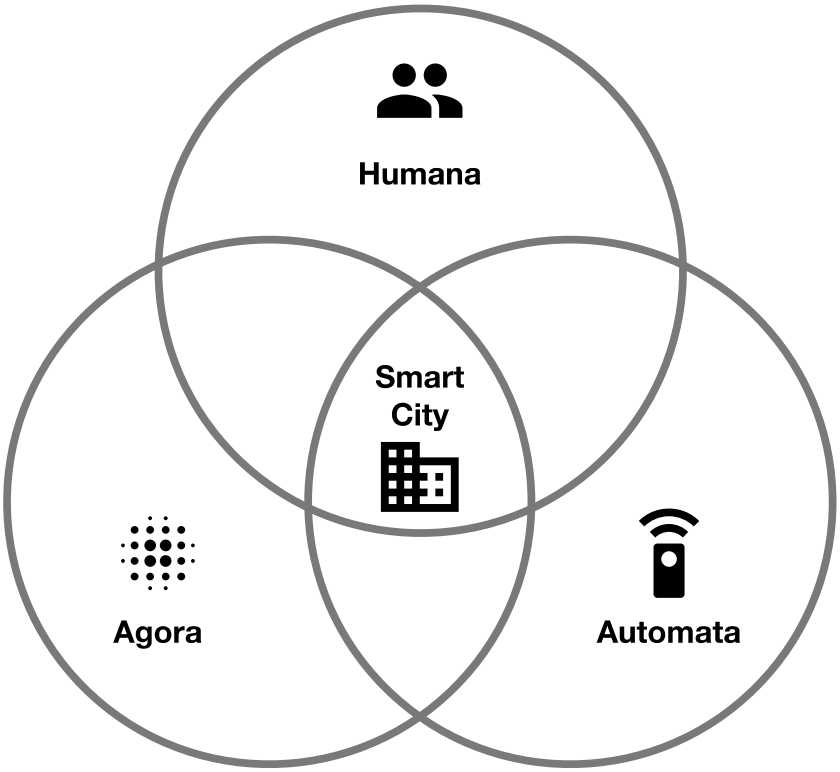
Therefore, as a starting point, we propose a broad definition that considers different pathways and models for the development of the Smart City, providing space for comparative analysis.

Smart Cities are urban environments where a digital approach to sustainable development has been introduced to reduce resource consumption, improve quality of life, and enhance economic competitiveness.

We follow this definition with a more detailed framework that allows for the bringing together of different Smart City aspects. The framework does not impose one model of a Smart City. Instead, it will enable mapping the degrees to which an individual Smart City initiative borrows from different aspects of the Smart City phenomenon.

Our analytical framework consists of three dimensions: Humana, Automata, and Agora. They underlay the functional and human dimension, technological dimension, and collective dimension of Smart Cities (ref. Figure 1).

Figure 1. Analytical framework



Source: own elaboration.

HUMANA means that the project addressed specific urban policy challenges and targeted the needs of particular users (including people with disabilities and socially vulnerable groups). This aspect also covers an increase in the accessibility of a given public service throughout the implementation of the project. This dimension describes the purpose of public policy actions. It is linked to the utility, impact, sustainability, and inclusiveness criteria of evaluation. It is grounded on the one hand in the classic literature on public policy and evaluation[7], and on the other hand, an emerging works on user-oriented policy design[8] and service design[9].

[7] B. G. Peters, G. Capano, M. Howlett, I. Mukherjee, M.-H. Chou, P. Ravinet, Designing for Policy Effectiveness. Defining and Understanding a Concept, Cambridge University Press, Cambridge 2018;
P. Rogers, S. Funnell, Purposeful Program Theory: Effective Use of Theories of Change and Logic Model, Jossey-Bass, San Francisco 2011

[8] C. Bason (Ed.), Design for Policy, Gower Publishing, Surrey 2014

[9] L. Kimbell, The Service Innovation Handbook: Action-oriented Creative Thinking Toolkit for Service Organizations, BIS Publishers, Amsterdam 2015;
B.G. Peters, Policy Problems and Policy Design, Edward Elgar Publishing, Cheltenham, Northampton 2018

AUTOMATA means that innovative technology was instrumental in making change and executing the initiative. This dimension describes the means of public policy. It is linked with the efficiency and effectiveness criteria of evaluation, and it is grounded in the literature [10] as well as in the official EU documents[11] on the use of information and communication technologies (ICT), integrated solutions, and open data.

AGORA means a certain degree of stakeholders' involvement during the implementation of an initiative. This dimension describes the process of public policy. It is linked with the inclusiveness and sustainability factors. The spectrum of involved stakeholders could vary (NGOs, final users, public agencies, private companies, networks, etc.). Also, the degree of involvement and the moments of involvement could vary. As the literature suggests, a co-production of public solutions can take the form of involvement in the design of the solutions, involvement in testing prototypes, financing the project, involvement in the delivery of the solution, and/or co-sharing of the project's data[12].

This Smart City dimension is grounded in the well-established literature on the co-production of public services[13], and an emerging body of evidence on collective urban policymaking and living labs[14].

We claim that an initiative to be recognized as a Smart City should touch upon all three framework components. However, it could include different degrees and configurations of each area. To put it simply, a project, to be recognized as a Smart City project, needs to: (a) aim at specific policy issues important for urban areas and targeting a concrete group of users; (b) apply technology as a problem-solving tool, (c) use a degree of co-production during its implementation (ref. Table 1).

[10] R.P. Dameri, C. Rosenthal-Sabroux, Smart City how to Create Public and Economic Value with High Technology in Urban Space, Springer, 2014

[11] https://ec.europa.eu/info/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives/smart-cities_en [available: 27.10.2020]

[12] T. Nabatchi, A. Sancino, M. Sicilia, "Varieties of Participation in Public Services: The Who, When, and What of Coproduction|", Public Administration Review 77(5), pp. 766-776.

[13] E. Ostrom, "Crossing the Great Divide: Coproduction, Synergy, and Development", World Development 24(6), 1996, pp. 1073-1087; D. Sześciło, "Samoobsługowe państwo dobrobytu. Czy obywatelska koprodukcja uratuje usługi publiczne?", Wydawnictwo Naukowe Scholar, Warszawa 2015

[14] M. Hossain, S. Leminen, M. Westerlund, "A systematic review of living lab literature", Journal of Cleaner Production 213, 2019, pp. 976-988, G. Nesti, Co-production for innovation: the urban living lab experience. Policy and Society, 37(3), 2018, pp. 310-325

Table 1. Dimensions of the Smart City project with definition and evaluation criteria

DIMENSIONS OF THE SMART CITY PROJECT	DEFINITION AND EXPLANATION	LINK WITH EVALUATION CRITERIA
Humana	Describes the PURPOSE of the project. The project addresses: (a) specific urban policy challenges and (b) targets the needs of particular users (including people with disabilities and socially disadvantaged groups).	Utility criterion Impact criterion Sustainability criterion Inclusiveness criterion Effectiveness criterion
Automata	Describes the MEANS of the project. The project applies an innovative technology that is essential for making the solution work.	Efficiency criterion Effectiveness criterion
Agora	Describes the PROCESS of the project. The project engages various stakeholders in various stages of the implementation process.	Inclusiveness criterion Sustainability criterion

Source: own study and literature review.

When it comes to the link of our framework with the evaluation criteria, two things should be noted. In the first place, all evaluation criteria are normative. However in our model, only one dimension – Humana - is normative while Automata and Agora are descriptive. That means that only in Humana's case, the more project is aligned with the users' needs, the higher is the quality of the project. Automata and Agora only describe the different ways and the extent to which technology is used, and cooperation is implemented. More collaboration or more technology does not necessarily mean a higher quality of the project. With that neutral framing of our dimensions, we will establish the configuration and degree of three dimensions that make good smart city projects.

Second, the Automata dimension is an essential condition (*sine qua non*) that needs to be fulfilled to name a project "smart." In other words, projects that do not have the technological component are not treated in our research as smart city projects.

We used our analytical framework throughout the whole project. For the analysis of strategic programming documents (research Q1), we followed this analytical framework to see what aspects are most common and how they are characterized in the programming documents and strategies related to Smart Cities.

For the research questions dealing with Smart City projects (Q2 and Q3), we translated the framework into a more detailed list of factors (templates for in-depth case studies) and used that list to identify the configuration of patterns that determines the success of Smart City project.

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We propose three dimensions of a Smart City as the common denominator in order to compare projects and identify good practice patterns:

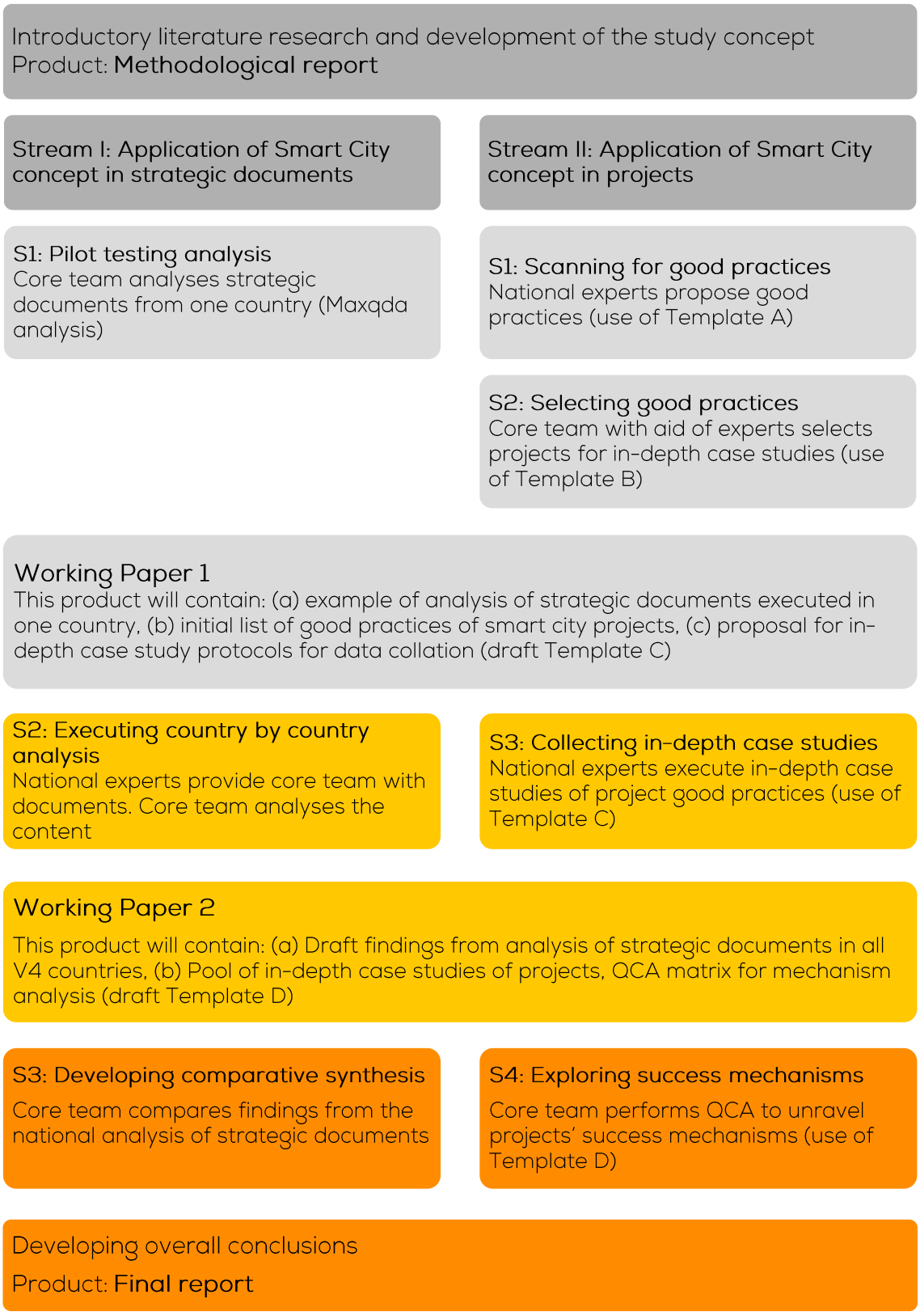
- Humana – the human-oriented dimension;
- Automata – the technological dimension;
- Agora – the collective dimension.

1.4. STRUCTURE OF THE REPORT

The process of our research was twofold, following the logic of our research questions. The first stream of our activities focused on the application of the Smart City concept at the level of strategic documents (ref. Chapter 2). The second stream of our research focused on the application of the Smart City concept at the level of projects (ref. Chapter 3). Those two streams of activities were conducted in parallel and were integrated into the last stage – lessons for Cohesion Policy (ref. Chapter 4).

The summary of our research process is presented in Figure 2. The detailed methods for data collection are analysis are discussed in the chapters devoted to the specific research questions.

Figure 2. Scheme of the research process



Source: own study.

2. THE APPLICATION OF THE SMART CITY CONCEPT IN THE STRATEGIC DOCUMENTS

The research question that guided this section of the project is the following:

Q1: How has the concept of Smart Cities been implemented in key strategic, programming documents in V4 countries?

The analytical process consisted of three steps:

- Step 1: Pilot testing analysis;
- Step 2: Executing country-by-country analysis;
- Step 3: Developing comparative synthesis.

Details on the research process, methodology and results are described in Annex II. Firstly, the most important EU and Polish documents were analysed to clarify the methodology as well as find initial results. Secondly, documents from other V4 countries were verified according to the clarified methodology. The final step of the process was providing a comparative synthesis of the 4 countries leading to relevant conclusions and recommendations. The whole analysis was held in a 'top-down' direction, starting from the study of assumptions and priorities at the EU level, moving on to the national and local levels.

The general methodology consisted of coding with the use of a specific tool, a quality content analysis programme (MAXQDA). Along the research process, different words and terms were sought, starting with the terms "smart city" or "smart" during pilot testing analysis and ending with synonyms of these words while preparing the country-by-country analysis. Based on the pilot testing analysis the methodological assumptions were specified for country-by-country analysis and supplementary questions for a more qualitative insight were formulated. The pilot testing analysis referred to 50 documents outlined in the methodological report (most of them obligatory for the study), whereas the next step was based on 65 documents, including documents proposed by national experts as well as those suggested by various stakeholders in the course of the study.

Additionally, we aimed at a minimum of 4 interviews with representatives of urban policy or Smart City government units, according to the established scenario. Finally, 7 individual or group interviews were conducted. One was conducted in Slovakia, two in Hungary, and four in Poland (unsuccessful contact attempts with a representative from the Czech Republic). All of the respondents were representatives of national ministries dealing with Smart City issues or associated with other governmental organisations and initiatives.

2.1. THE SMART CITY CONCEPT IN THE STRATEGIC DOCUMENTS

The application of Smart City concept in strategic documents varies across V4 countries, taking into account the definitions, areas, and dimensions of the concept discussed.

In comparison with the rest of the countries, Hungary represents a strong, experienced, and mature point of view. It has the most unique organisational structure on the national level among all the V4 countries. First of all, there is an institution that is responsible for the Smart City issue and is partially dependent on the government (the Lechner Knowledge Centre, Lechner Tudásközpont[15]). Secondly, in Hungary, there is an official definition of the Smart City concept in the law[16]. There is also plenty of strategic documents which do not mention the Smart City concept specifically but at the same time, they concern different aspects of the digital development of the country. Finally, Hungary is also the only country where the documents provide little reference to the Smart City concept in English[17]. All the above-mentioned factors create an image of Hungary as a country that is aware of how the Smart City concept should work. The local level of Hungarian strategic documents represents the bottom-up approach. However, the policymakers are aware of the strong lobbying of the technology companies as well as the need for constant improvement in this field.

The existence of the concept at a national level is also a characteristic feature for the Czech Republic. The fact contributes to the coherence of documents and development possibilities in this area. The holistic approach adopted in the Czech Republic has both strategic and operational features. It appears in different forms, starting from various documents and methodologies, through publicly available support via the website and contact point, ending with direct support at conferences and workshops. At the national level, all documents can refer to the concept implemented by the ministry. The holistic and unified approach adopted at the national level is also reflected in the documents at the level of cities. All the analysed cities, whether they adopted the Smart City strategy or not, present their issues and actions in a very practical manner. The differences between those documents result from the local specifics[18].

[15] http://lechnerkozpont.hu/

[16] According to the Hungarian Government Decree No. 56/2017, issued in the Official Gazette on 20th March 2017.

[17] Okos város (ang. smart city).

[18] However, the project team was not able to verify and consult those conclusions with the representatives of the Czech partner ministry (lack of an individual interview due to independent reasons).

Slovakia has adopted similar measures to those in the Czech Republic, but the perception of the concept is less intense. Although the country has not adopted a Smart City strategy and the concept is not defined at a national level, the work is in progress[19] and the idea is getting more approval and understanding. There are already existing documents concerning Smart City issues, however, they did not meet the needs of potential users. Apart from strategic documents, Slovakia has undertaken similar actions to the Czech Republic in terms of implementation of the Smart City concept (a governmental website, a separate governmental position, a contact point). When it comes to the documents on the local level, the lack of one national understanding of the Smart City concept allowed the cities to create their own approach to them being smart. Local strategies differ in forms and content, even though they are becoming more comprehensive and represent the awareness of the local government.

In Poland, the Smart City issue is covered fully only in one national strategic document, which is National Urban Policy 2023. The concept is understood as a goal of urban development and technology is rarely mentioned. On the contrary, all other strategic and programming documents use the term as a slogan, without much practical coverage. The area of intervention seems to be energy, as smart grids are being specified frequently. What distinguishes local documents from national documents is the participatory approach (agora). In this context, the Smart City is intelligently managed, consisting of the institutional efficiency of the local government, social participation with its inhabitants as initiators of change, cooperation with science and business. It is worth stressing that all analysed cities have based their diagnoses and strategies on the results of consultations with the inhabitants (surveys, diagnostic walks). This shows that the understanding of the concept in Poland is twofold, fluctuating between the solely technological (automata) and the city-centred (humana and agora) approach, e.g. expressed in the Human Smart Cities programme.

Contrary to the national and local documents, in EU documents, relatively little attention is paid to the subject of Smart Cities. The entire development process of knowledge- and the technology-intensive economy is described as smart. However, the documents of the EIP-SCC (an EU initiative devoted to Smart Cities and communities) concern the entire practical understanding of the Smart City concept and contain practical guidelines for its development, in particular, the dimension of social participation and citizen involvement (agora).

The various approaches to the Smart City concept are presented in Table 2.

[19] Information obtained from the interview with a representative of the Slovak partner ministry.

Table 2. Comparative synthesis of the Smart City issue in the strategic documents in V4 countries

	POLAND	CZECH REPUBLIC	SLOVAKIA	HUNGARY
	NATIONAL LEVEL			
Definition	The only definition of the Smart City concept is included in National Urban Policy 2023, where the vision of the city is additionally described as part of the "smart city" concept. The topic of Smart Cities appears quite a slogan, without much discussion or practical coverage.	There is one definition of the Smart Cities concept, valid nationwide: “the term Smart Cities means the concept of strategic management of a city, or municipality or region”. All other documents refer to this definition which accounts for their overall coherence.	There is no definition agreed for the whole country in Slovakia. The definitions presented in documents focus on all 3 dimensions of the Smart City concept (automata, humana and agora). What is characteristic of one of the Slovak definitions, there is a greater emphasis on the contribution of business in creating smart solutions.	There is an official definition of the Smart City concept in the law. A smart city is a settlement or a group of settlements, which develops its natural and built environment, digital infrastructure, and the quality and economic efficiency of its locally available services by adopting novel and innovative information-technologies, sustainably, through the increased involvement of its residents.

	POLAND	CZECH REPUBLIC	SLOVAKIA	HUNGARY
Areas	In most of the documents reviewed the emphasis is put on energy (smart grids). Other areas requiring intervention are safety, good access to high-quality public services, including health services, labour market, housing offer, leisure activities, cultural offer, environment, and public transport or attractive public spaces.	The greatest application of the concept is required in the field of transport, energy, and ICT, but also in other areas such as waste management, water management, e-government, and crisis management.	Frequently mentioned areas are government/self-government, mobility, healthcare, education, energy and the environment. There is an unusual emphasis on building.	There is also no specific emphasis on particular issues or areas of intervention. The idea of a Smart City can be applied in every field of city development, to any of the identified problems.

	POLAND	CZECH REPUBLIC	SLOVAKIA	HUNGARY
Dimensions (humana, agora, automata)	The only definition from National Urban Policy 2023 focuses on all three dimensions. In most cases, "smartness" is understood as the development of technological solutions (automata). There is little emphasis on humana and agora in the older versions of the documents, more emphasis on the new ones.	Modern technology (automata) is understood as a tool to influence the quality of life in the city. To ensure a good quality of life (humana) for residents is the primary objective of the Smart Cities concept. It is stated that synergies occur between the various activities and public services that make the city functional (agora).	The existing strategic documents rarely mention the idea of Smart City. The definitions presented in documents focus on all 3 dimensions of the Smart City concept. Smart Cities are treated as urban areas where information and communication technologies (automata) are used as a tool to solve complex problems (humana).	Technological and intelligent service solutions (automata) are only tools for more complex goals of quality of life (humana), efficiency, ecological and economic sustainability that, when used in conjunction (agora) with other tools, can work successfully. A separate document focusing on the issue of stimulating participation (agora) has been issued.
Document types	National Urban Policy 2023 No handbooks nor methodological documents	Many coherent strategic and programming documents Methodological documents (concerning smart cities and project financing)	A Smart City strategy at the national level is supposed to be published in June 2021 Methodological documents (concerning smart cities and project financing)	Handbooks, methodological and strategic documents specific for the Smart City concept

	POLAND	CZECH REPUBLIC	SLOVAKIA	HUNGARY
Additional activities	National initiative and associations of cities National competitions (e.g. Human Smart Cities, Local Development Programme)	Working Group for Smart Cities– cooperation at the national level Smart Cities website and contact point Conferences, workshops	Smart Cities website and contact point Smart City Index	The Lechner Knowledge Centre (Lechner Tudásközpont)
	LOCAL			
Definition	A more participatory approach (agora) is presented. Smart solutions are understood as specific technological solutions to the diagnosed problems.	At the local level, the provisions in the strategic documents of the Czech Republic also usually refer to the Smart Cities concept supervised at the national level.	The lack of one holistic understanding of the Smart City concept allowed the city to create its own approach to them being smart. Local strategic documents seem to be focused on the quality of life (humana) with a little assistance of technological solutions (automata).	The official definition is used.
Areas	The areas in which it would be desirable to implement smart solutions have been clarified	More emphasis is put e.g. on the safety, resilience and governance issues.	Administration, transport, energy, environment, social infrastructure	The local specificity is widely underlined. The projects and funding sources should be

	POLAND	CZECH REPUBLIC	SLOVAKIA	HUNGARY
	and smart solutions are understood here as specific technological solutions to the diagnosed problems.		and public policy management are frequently mentioned.	identified for the city specifically. Strong interest in housing, settlements, and the real estate market is shown.
Dimensions (humana, agora, automata)	Large emphasis on humana and agora - all analysed cities have based their diagnoses and strategies on the results of consultations with the inhabitants (surveys, diagnostic walks). The importance of a participatory approach is highlighted in the strategies. Agora is also expressed under urban labs (i.e. Gdynia, Rzeszów)	The understanding of the dimensions' role in creating a smart city is consistent with the national documents. The strategy consultation processes included interviews with residents as well as seminars with the city representatives (agora).	Local strategic documents seem to be focused on the quality of life (humana) with a little assistance of technological solutions (automata).	Little information is provided on the particular ICT (automata) that can be used in projects within the Smart City concept. Generally the documents put even greater emphasis on the agora dimension than the official definition.
Document types	Smart city and development strategies	Mostly smart city strategies	City development strategies (only 2 cities call themselves smart)	Mostly smart city strategies

Source: own study.

2.2. ROLE OF STRATEGIC DOCUMENTS IN SHAPING SMART CITY PRACTICE

Although there is much reference to the Smart City concept in the strategic documents of all V4 countries, they were rarely mentioned by the stakeholders of the analysed projects (ref. Annex II).

OWNERS AND CONTRACTORS

Only 19 out of the analysed 56 smart solutions received noticeable public support, but most of them (16) were co-financed by the European Union. The contribution of the stakeholders to the project analysis (mostly interviews and additional netnography) provided only three aspects of the role of strategic documents in shaping Smart City practice.

The first aspect was the role of **EU policy** (expressed in strategic and programming documents) and the availability of funding resulting from it. It was often mentioned that the funding works as an incentive. Such projects would not have ever been considered if it had not been for the funding. EU policy is also a kind of a guide how to build a smart and sustainable city. Countries and cities often have to comply with the required EU norms. Implementation of renewable forms of energy production, intelligent management of the accumulated rainwater resources and all other ideas aiming at reduction of environmental burden are in a priority position for the EU. Such projects contribute to the overall achievement of European goals[20].

National involvement in the project was also mentioned by the stakeholders. As before, it also referred to funding. However, it is worth stressing that the funding programme was focused on specific unsatisfied city needs (e.g. professional development of municipally maintained museum institutions[21]). Yet, there was no reference to a strategic document in the interview which can lead to a conclusion that the role of national strategic documents was barely visible.

As far as **city involvement** is concerned, it was noticed more frequently by the owners and contractors of smart solutions. They indicated that it was important to the project's success on multiple levels.

[20] Ref. H11 Miskolc geothermal district heating, S09 Control of emission in US Stell Kosice, P30 Intelligent retention system Bumerang Rzeszow, P51 PV on 35 high-rise building Wroclaw.

[21] Ref. H38 Gyula Castle.

Some projects were simply outlined in the Smart City strategy, some of them were prepared and implemented by a Smart City department within the city council, whereas other projects resulted from a long-term vision of a Smart City[22].

Summing up the above statements, it is worth stressing that the role of strategic documents was unclear to the stakeholders of smart solutions. None of the respondents pointed out in an interview that the provisions facilitated or hindered the project realisation. The documents served as guidelines on what to do and what to finance it with.

INSTITUTIONAL STAKEHOLDERS

The interviewees from national partner ministries were much more sceptical when discussing the Smart City issue. They presented four success factors for a smart solution from the strategic point of view, which some of the documents are lacking.

In the first place, they mentioned the existence of a **uniform definition** of a Smart City (in a strategy or a legal act) as an undeniable advantage for the development of the concept. In some countries, the projects, which obviously can be qualified as smart, are not called that way and as a result, the funding possibilities are unclear. What is more, such a definition guarantees the coherence of a local strategy with a national one. Later the coherence may influence the allocation of funding for a project. The process of writing and consulting a strategy, especially its aspect of financial stability, is very expensive and time-consuming. That is why the coherence of the strategy with the basis of a uniform definition is the key to successful Smart City performance.

Another success factor was a **holistic, national approach** to the Smart City concept. The lack of a central institution distributing funds and providing knowledge may significantly hinder the development process. It was often stated that the distribution of funding among cities of different sizes has been uneven. Only the biggest cities, which are financially and mentally capable of implementing a smart solution anyway, have benefitted from the Smart Cities support programmes. The instructions for the city council should involve practical and applicable instructions, not scientific deliberations. Additionally, wherever there is one institution responsible for dealing with the issue of Smart Cities, both on the national and local level, it is easier to prevent lobbying activities of technological companies. Many policymakers are aware of the phenomenon and they recognize the risks related to it. As there is no holistic approach currently applied, it is also impossible to force the private solutions market to adapt to

[22] Ref. C05 Golemio, S19 Meteostation in Prešov, P60 Smart City Poznan App.

the needs of cities. Nowadays, it is still more likely that the conditions of solutions' implementation are defined by the contractors, not the owners.

Furthermore, the approach should also be of a **participatory nature**. Innovative, smart solutions are usually considered high-risk solutions. The answer to the challenge is an advanced diagnosis of inhabitants' needs and conducting consultation processes (e.g. via urban labs). Due to the elements taken into account, local strategies are getting gradually better. The more the policymakers investigate the needs of inhabitants, the more suitable strategies and projects are executed. In the end, there is less chance of failure. Lack of the requirements concerning the participatory approach has been called a drawback for the development of the Smart City concept.

Last but not least, the **awareness of technical issues** affecting the development of the Smart City concept should also be included among the success factors. Smart solutions will never perform properly without a transmission network (broadband or 5G).

CONCLUSIONS

For the above-mentioned reasons it was impossible to state whether the provisions of strategic documents influence the success of a smart solution. The right step was to place the issue of city vision and support in the QCA analysis as one of the success factors. Detailed explanation on the role of city support and vision in shaping particular good practices is covered in the following parts of the report (ref. part 3.2).

The application of the Smart City concept in strategic documents varies across V4 countries, taking into account the definitions, areas and dimensions discussed. Every country presents a different level of the concept maturity and a different approach (top-down, bottom-up, unified across the country or with room for autonomy of the city). Various additional activities are also being undertaken in this area.

The conclusions on the role of strategic documents drawn by the projects' stakeholders and by institutional respondents differ in their nature. For the owners and contractors of smart solutions the role of strategic documents was barely visible. On the contrary, representatives of partner ministries pointed out several success factors related to the strategic level: a uniform definition of the Smart City concept, a holistic approach, positive stimulation of participation and awareness of technical issues.

In order to investigate the role of shaping Smart City practices, the inclusion in city vision or strategy was considered as a success factor in the QCA analysis.

3. APPLICATION OF SMART CITY CONCEPT AT PROJECT LEVEL

The research questions that guided this section of the project are the following:

Q2: What are the good practices of Smart City projects in V4 countries?

Q3: What factors and mechanisms increase the success of Smart City projects?

The analytical process consisted of four steps:

- Step 1: Scanning for good practices;
- Step 2: Selecting good practices;
- Step 3: Collecting in-depth case studies;
- Step 4: Exploring success mechanisms.

First, national experts proposed the initial pool of good practices and provided short descriptions for them. The core team with the aid of national experts selected 56 projects for in-depth case studies, according to a specific methodology of assessment. Later national experts executed in-depth case studies of project good practices, including interviews and 10 case studies focused on the user perspective, covering advanced methodology (ethnographic studies etc.). The full methodology of extended research of cases is presented in Annex V.

In the final part of the process, the core team performed the QCA analysis to unravel the projects' success mechanisms. Details on the methodology and results of the QCA analysis are presented in Annex IV.

3.1. IDENTIFIED POPULATION OF GOOD PROJECTS

Good practices collected in this study were identified by teams of national experts in the field of smart city solutions (ref. Annex VI for the experts' profiles). Diversity of the experts' backgrounds allowed for a successful mixture of academic and professional perspectives leading to more in-depth penetration of the smart city environments in all Visegrad countries. The proposals submitted by the experts needed to be justified based on the conceptual framework translating three pillars of an ideal smart solution, i.e. agora, automata, and humana, into a set of descriptive analyses guided by research questions compiled in the project fiches (i.e. Templates A and C). Experts were asked to propose the best projects identified in their countries according to 10 public policy domains broken down into area-specific digital solutions covering 56 fields of the matrix (ref. Table 3). Only projects that either finished or demonstrated the first tangible effects were considered in the study.

Out of 165 projects proposed in the first stage of the identification process, all being unequivocally regarded as good practices, 56 smart solutions were selected by the voting procedure to constitute the final poll. Voting was conducted by all experts participating in the study and aimed at elaborating the best possible version of the matrix given the country quota (40% for Poland to 60% for Czechia, Slovakia and Hungary altogether) and how fitting the proposal was in each particular policy/technology field of the matrix. Although these prerequisites have been met in the voting, as a result of some perturbations that occurred during the field research due to the COVID-19 pandemic situation the ratio assumed in the study has slightly changed. The final version of the matrix contains 26 projects from Poland, 11 from Hungary, 10 from Slovakia, and 9 from Czechia (ref. Table 3). Among these projects, 10 were subject (selected one for each area, but some of them were interdisciplinary by covering few areas at once) of even further investigation of user perspective, including additional methods such as in-depth interviews with final users, questionnaires, and netnography. Other than that they were also investigated with standard tools like all selected projects, which envisaged conducting interviews with project owners and contractors.

All projects have been analysed and described systematically and are enclosed in this report (ref. Annex III).

Table 3. Selection of smart solutions recommended as good practices in V4 countries

1. CITY MANAGEMENT	2. BUSINESS & ENTREPRENEURSHIP	3. ENVIRONMENTAL PROTECTION	4. HEALTHCARE	5. TRANSPORT
E-documentation, e-government C05 Golemio Prague	Circular economy P04/P46 Individual Waste Segregation System Ciechanów EXTENDED STUDY	Air quality monitoring technologies P57 Let's end with smog in Poznań	Remote emergency response systems C25 Zachranka EXTENDED STUDY	Intelligent transport infrastructure (car parks, PT stops) C15 Parking and traffic system Kvasiny plant
E-notifications and alerts P60 Smart City Poznan APP	Sharing economy P47 Mobility budget – Vooom	CO_2 emission control technologies P08 Vehicles for environmental protection Warsaw	Remote diagnostics and patient monitoring P70 Polish anti COVID-19 app EXTENDED STUDY	Traffic tracking and management systems H10 BKK Futar Budapest
Direct communication systems of inhabitants with local authorities P59 Urban Lab Gdynia EXTENDED STUDY	Data security systems P49 ChainDoc Toruń	Water quality monitoring technology P65 Microtox water biomonitoring Poznań	Health system e-documentation H08/H27 National eHealth infrastructure	Diagnosis systems of technical condition for roads and bridges S19 Meteostation in Prešov
Mobile applications activating residents P01 iVoting Jaworze	*Geofencing* for business P66 Placeme.pl	Sensors detecting leaks of harmful substances S09 Control of emission in US Steel Košice	Communication systems with doctors and consultants P67 Znanylekarz.pl (Known Doctor)	Toll collection and parking systems P62 E-control SPPN Warsaw
Systems for cybersecurity C26 E-services from Azure for Czech citizens'	Intelligent buildings S07 Lidl logistics center Sered	Environmental control systems H06 Tree register Budapest	Technologies for home medical care S14 Smart solution for seniors living alone	Autonomous vehicles for public transport H41 Automatic metro line M4 Budapest EXTENDED STUDY
Building security systems P71 BVMS for Polin Museum	E-Services for business C13 Data driven factory management Mlada Boleslav Skoda	Green buildings P09 Konrad Bloch Office building	Health care analysis systems P38 Visual Crowd Detector	

Incident Response Systems C01 Drones for IRS Pilsen EXTENDED STUDY	Chatbots and AI assistants P69 Chatbot Mat InPost	Recycling technologies S08 Žiar waste recovery center	Drones for the transport of blood and medical devices during accidents P39 aiRPAS Rescue	
6. ENERGETICS	**7. SCIENCE & EDUCATION**	**8. TOURISM**	**9. CULTURE & ACTIVISION OF INHABITANTS**	**10. WASTE, WATER & SEWAGE MANAGEMENT**
Smart Grid P50 Smart Heat Distribution Network Warsaw	E-learning H13 Mozaweb – digital school applications	Intelligent ticketing systems P23 Gdansk Resident Card	Technologies for the reconstruction of monuments in virtual reality S31 Spis Castle in VR	Technology for water storage P30 Intelligent retention system Bumerang Rzeszów
Energy storage H11 Geothermal smart district heating Miskolc	E-school management and e-registers C09 Smart keychain Kolin	Bots-guides H15 Pocket Guide EXTENDED STUDY	Augmented reality technologies (AR) in cultural facilities H38 Interactive elements in Castle of Gyula	Sewage treatment technologies C14 Sewareg recycle Prague
Charging stations for electric vehicles P18 E-public transport in Zielona Góra EXTENDED STUDY	Gamification technologies in education P21 Trashbusters	Interactive tourist routes P41 Your Warsaw 1918/2018	Intelligent infrastructure for disabled people P34 Totu Point Poznań	Flood control systems H40 Solar pump Kartya street Budapest
Intelligent urban lighting H12 Eclipse smart lighting system Szank	Interactive classroom equipment H14 Ujbuda education program Budapest	Luminous and multimedia visualisations S28 White nights Košice and Bratislava	3D visualisation technologies in museums S30 House of Marina EXTENDED STUDY	Water distribution systems C07 Smart water meters Brno
Photovoltaic systems P51 PV on 35 high-rise buildings Wrocław	Virtual student databases and educational progress analysis systems P68 Librus EXTENDED STUDY			Waste collection and sorting technologies S35 Who recycling more paying less

DIGITAL SOLUTIONS

The diversity of policy fields and technologies presented in the matrix makes it a considerable obstacle to compare one project to another. The other aspect challenging the comparison is mixing the typically business and public activities among fields of the matrix (see e.g. geofencing, e-services for business, etc.).

However, there are some cases in this poll that seem to be similar in some ways. The similarities are mostly embedded in technology applied in the project (e.g. drones, VR, e-registers, smog sensors installed on vehicles, intelligent waste bins, or IoT traffic sensors). Some of them stem from the policy field itself, if too broad a definition was proposed and similar technologies were fitting various purposes.

Instead of being a drawback of this analysis, those similarities, i.e. overlapping technologies, may serve important conclusions regarding the current technological landscape across Visegrad countries. This landscape does not vary significantly nor it is overly innovative in terms of world-scale or breakthrough innovations. Although some technologies may be applied in an inventive manner and be tailored to local needs, they seem to be repeatable and rather market-driven than originally developed through an individual collaboration between project owner and contractor.

When it comes to the variety of technological solutions applied in the projects, they may be categorized in the following way:

- sensors and other tools serving real-time data collection;
- open data platforms;
- applications ensuring better access to public/private intelligence and services;
- intelligent infrastructure and automatization;
- visual technologies.

These categories are not disjoint and one project may fit into more than one category (ref. Table 4). Despite previous remarks on technological similarities observed between countries and lack of individual approach, the assembled projects broken down by technological categories show solid progress and up-to-date market solutions applied in V4 cities.

Table 4. Smart solutions in V4 smart city projects

TECHNOLOGICAL SOLUTION	APPLICATIONS IN PROJECTS
Sensors and real-time data collection	• **Sensor for waste container loads**: S35, S08, P04; • Weather conditions sensors: S19, • **Human motion sensors:** S14, P38, P66, P71, C25 • **Sensors detecting leaks or flow of substances** S09, C01, C07, H40, P30, P65 • **Sensors tracking geo positions in real time:** H10, P39, P70 • **IoT sensors:** P62, C13, C15 • **Sensors detecting objects:** P34
Open data platforms	• **Interdisciplinary public data:** C05, C26, P60 • **Geo-data:** H08 • **Enhancing citizen participation in democratic process:** P01, P59
Better access to services through applications	• **Interdisciplinary:** C26, P60, P66, P23, C07 • **Domain-related:** – Health: C25, P67, P70, H08/27, – Transport and parking: P47, – Education: P60 – Business: P66, P69, – Tourism: H15, P41 • **API or interconnectedness highlighted:** P23, C07, H15, P66, P47, P60, H08/27, P70, P69, P68, C5, P60, P50, P41, P34
Intelligent infrastructure & automatization	• **Vehicles**: H41, P18, P08 • **Facilities:** S08, H11, H40, P51, P09, C13 • **Grids:** P50, H11, H40, C14
Visual technologies	• **VR:** H38, S31 • **Multimedia:** S28.

Source: own study.

One of the important digital aspects brought up by the experts interviewed in this study rests upon the interconnectedness of technology (mostly referring to software) applied in the project. While these characteristics may apply to all assembled case studies, they turned out to be significant in at least 15 good practices.

This feature means that the digital solution co-operates well with the other systems and ideally is built upon a modular structure that enables exchanging its old or inflexible modules to more functional ones. It prevents the technology from outdating and helps it evolve. Thus this feature affects the sustainability of the project rather profoundly. In doing so it may also prevent the unfavourable vendor lock-in effect in some cases.

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Digital solutions applied throughout the V4 countries demonstrate a solid progress in the field, but they are hardly cutting-edge innovations.

Interconnectedness is a very desired feature of an ideal digital solution, as it affects the sustainability of the project and prevent the unfavorable vendor lock-in effect.

SIGNIFICANCE OF THE PUBLIC SUPPORT AND THE 2021-2027 COHESION POLICY OBJECTIVES

In some ways, the classification of projects assembled in the study according to the EU Cohesion Policy Objectives is of a secondary character considering their assignment to specific policy and technology fields ordered by the original matrix. Anyway, as seen from the project owner perspective we could cluster the projects mostly around two EU Cohesion Objectives i.e. 'greener, low carbon Europe' and 'greater social dimension'. Even if projects meeting the objective of 'more competitive and smarter Europe' seem to be relatively less numerous in our classification as this category contains mostly projects proposed by the private sector, it could probably expand with the change of perspective. Undoubtedly, it depends which part of the project is to be financed from public sources, whether the development of the digital solution by the contractor company or its application by the project owner, the public entity in most cases. Both situations occurred under the 2014-2020 EU financial perspective (ref. Table 5).

Table 5. 2021-2027 EU Cohesion policy objectives in V4 smart city projects

EU POLICY OBJECTIVES	APPLICATIONS IN PROJECTS
A more competitive and smarter Europe through the promotion of innovative and intelligent economic transformation	• P69, C13, C26, S07, P66, P49, P60, C05, C15 **(9 projects)**

EU POLICY OBJECTIVES	APPLICATIONS IN PROJECTS
A greener and low-carbon Europe	• P47, P08, H10, P04/46, P57, P51, S35, C07, H12, P18, H40, H11, C14, P50, P30, C14, S08, P09, H41, H06, S09, P65, S19 **(23 projects)**
A Europe with a greater social dimension	• P68, S28, S30, H14, P21, P41, P24, C09, H15, H38, S14, P01, P67, P59, H08/27, P70, C25 **(24 projects)**
A well-connected Europe	• P62

Source: own study.

As already mentioned in the report, they were not very frequent. Only 19 out of the analysed 56 smart solutions received noticeable public support, including 16 solutions co-financed by the European Union (ref. Table 6). Typically, great and costly infrastructure projects were supported by the public, including EU sources. However, there are many examples of relatively small solutions in terms of financial engagement, and their cost relies on the form of the product e.g. software license, subscriptions in apps. An excellent example are e-registers that are offered to public schools individually for less than 1000 EUR per annum (e.g. P68 Librus).

Table 6. List of EU operational programmes engaged in the development of solutions

PROGRAMME	PROJECT NAME
Operational Programme Human Resources Development (Hungary)	H08/27 National e-health infrastructure
Operational Programme Informatisation of Society (Slovakia)	S31 Spiš Castle in Virtual Reality
Operational Programme Infrastructure and Environment (Poland)	P18 E-bus Zielona Góra P30 Bumerang Rzeszów

PROGRAMME	PROJECT NAME
Operational Programme Smart Growth (Poland)	P39 Drones in search and rescue P47 Mobility budget Vooom
Operational Programme Transport (Hungary)	H41 Automatic metro line M4 Budapest
Operational Programme Technical Assistance (Poland)	P59 Urban Lab Gdynia
Operational Programme Quality of Environment (Slovakia)	S09 Control of emission in US Steel Kosice
Cohesion Fund (not specified strict operational programme)	H10 BKK Futar H12 Smart lighting system Szank S35 Who recycling more paying less
European Regional Development Fund	H11 Miskolc geothermal heating P09 Konrad Bloch office building P62 E-control SPPN Warsaw S08 Žiar Waste Recovery Centre

Source: own study.

Generally, three messages come from field study regarding the public support for smart solutions, both affecting their affordability and financial sustainability in the future:

- If the public funds are supporting large and expensive projects, their financial sustainability and cost of exploitation need to be taken into careful account. Currently, there are no examples of projects abandoned in our study since all projects are regarded as good practices and were examined in the field study. Some examples have been included in the first stage and we found them not working in practice (e.g. national health application).
- The bigger and more ambitious the digital solution, the more expensive and riskier. It is therefore worth considering the modular approach towards the project, implementation in stages, interchangeability, and interconnectedness of the

solution applied. The very good examples of such successful solutions may be found in the study for projects: H08/27 National e-health infrastructure, C26 E-services Azure, H41 Automatic Metro line in Budapest.

- The public support expected by the contractors is not entirely about the funding itself. Given the weight of legal and systemic impediments noticed in the study, as well as the relative maturity of some solutions presented in the study, it is now more vital to create the necessary standards for ubiquitous digital solutions in the public services environment. The national conceptual guidelines or frameworks would allow some digital solutions to be either properly introduced (e.g. P59 UrbanLab) or successfully evolve (e.g. P60 Librus) while ensuring the flexible conditions for competitiveness and low-exploitation costs as we discussed in case of the interconnectedness of technological solution.

Taking into account incomplete and even scarce information on the projects' budgets, we have to be very cautious with conclusions.

! Budgets of the projects are varied ranging from large infrastructural investments to universally affordable subscriptions or license fees. Public financing, including 2014-2020 EU funds, was not commonly used to finance smart solutions in V4. At the same time, 16 projects were funded from EU budget.

A smart solution can be financed at various stages, either development or implementation phase. Besides targeted financial support more conceptual expertise removing legal impediments and introducing some standardization would be required at national level.

CITY-TIERS AND PROJECT LOCATIONS

When comparing the location of the projects according to the city size or tier it would be useful to agree on notions like a small, medium, and large city concerning the differences in both demography and characteristics of urban network observed across Visegrad countries. However introducing the non-separate classification as presented in Table 7 allows us to avoid this discussion. In terms of spatial application of smart solutions - especially in public services or infrastructure - there is no practical need to define the separate spatial categories in absolute terms. It is not to say that the spatial scale of solution poses no real difference, but there can be easily introduced four categories to exhaust the issue of the spatial scalability of smart solutions in V4 countries:

- solution designed for small to medium cities;

- solution designed for medium to large cities;
- solution useful only in large cities and their functional areas;
- an aspatial solution where location or scalability of the project is of little importance.

It came as no surprise in the study that the overwhelming majority of the solutions originated in medium to large cities, while as many as seven projects were located specifically in small to medium cities. There are of course different reasons explaining this observation. Some of the reasons, like e.g. better mental and financial capacity of larger cities resulting in their better access to innovation, were already discussed in the literature overview. The factor was confirmed by the observations made in this study. Some experts even highlighted the necessity to target the support offered by public policy measures towards the group of small and medium cities, considering their disadvantage and a certain saturation of smart solutions in larger urban units. This has been confirmed also indirectly by the financial arguments, because large cities were able to finance their smart investments mostly with their own financial resources.

Table 7. City size in V4 smart city projects

CITY SIZE	APPLICATIONS IN PROJECTS
Small and medium cities	• **Matter-of-fact implementation**: H12, P21, P04, P01, C15, C07 **(6 projects)** • **Could be useful**: H08/27* **(1 project)**
Medium and large cities	• **Matter-of-fact implementation:** P18, C07, C01, H38, H11, P39, P47, H41, H40, H15, H14, H10, H06, P65, P62 P41, P39, P38, P34, P23, P09, P08, C14, C05 **(24 projects)**
Only large cities and their functional areas	• **Could be useful:** P47, H41, H10, P38, P23, C05 **(6 projects)**
Non spatial approach	• **Matter-of-fact implementation:** C25, C26, H08/27, P70, P69, P68 **(6 projects)** • **Could be useful:** S14, S30, S28, S09, S07, P66, P60, H07, H38, H15, P41, H14, H15, H13, H08/27, P70, P69, P68, P65, P39, P34, P21, C26, C15, C13, C01, C07, C09, C14, P01, P09 **(31 projects)**

Source: own study.

Apart from this, another interesting categorization might be discussed in terms of the project location. There have been two types of projects occurring in the study, where:

- spatial scalability or location was important,
- spatial scalability or location was not important.

In the first case, the factor of scalability of the solution worked interestingly in both ways. For obvious reasons, some solutions are designed only for the large cities and their agglomerations. Among the examples of projects where this precondition was highlighted were projects referring to:

- the infrastructure that is present only in the biggest cities such as automatic metro lines etc.;
- the demographic or market capacity that is adequate only in the biggest cities such as car-sharing services (congestion) or visual crowd detectors;
- a need for mapping certain aspects or services due to the 'incomprehensible' spatial scale or complexity of the biggest cities like e.g. tree registers, open data portals, etc.

In this study, we identified six projects which are best suited for the biggest cities (Table 7). Surprisingly however there were also projects seemingly more successful in small and medium cities like waste collection through intelligent waste containers (implemented in Nizny Hrusov in Slovakia and Ciechanów in Poland). In the case of these projects, the cost of upgrading the solution to the biggest scale might turn out too expensive at least for now, considering the current market values of the solution. In the case of another project – digital national e-health infrastructure in Hungary, although the project was implemented ubiquitously across the country, the project owner observed that it brings the biggest advantages to the smaller cities where the health services were more dispersed than elsewhere.

As already mentioned, we have noticed a considerable group of digital solutions for which the spatial scale or the location of implementation is of little difference. This a quite numerous groups of 31 projects. It encompasses solutions introduced mainly in ubiquitous services, both public such as e.g. health or education, and private such as tourism. It may well apply to ubiquitous infrastructure whether public, like e.g. solutions for water and sewage systems or private like e.g. intelligent buildings.

!

Considerably more examples of smart solutions were identified in medium/large cities than small/ medium cities.

Not all smart solutions can be applied everywhere. Some products are only applicable in large agglomerations, while others work better in smaller cities.

USER-PERSPECTIVE IN THE STUDY

An appropriate level of involvement of the institution's management is a necessary factor that increases a project's success. The presence of management representatives in projects greatly facilitates and accelerates their implementation. The representatives of the institution's management might act as patrons of technology projects; it is worthwhile for them to be included by the content team at crucial moments of project implementation, such as inauguration, critical decision-making, elimination of management barriers, and promotion. A good example of the involvement of public decider is the project Gdańsk Resident Card (P23). Close contact, full engagement and constantly responding to the managerial and context needs are counted by project owners as one of the important factors of project success.

It is worthwhile for the administration to treat every digital project as a "product" that needs to be continuously improved, adapted to users' changing reality and evolving needs. Its implementation should be the beginning of a process of continuous testing and improvement of the solution. Therefore, it seems necessary to allocate a large part of the budget to the stage of maintenance and development of projects after their official implementation on the market. In the implementation process, it is essential to create a suitable help desk, which enables current contact with the users, solving problems, and quickly reacts to the solution's noticed shortcomings.

An interesting case that emphasized the necessity of professional customer services is Individual Waste Segregation System (SISO) in Ciechanów (P04/P41). Education activities and accessible Customer Service Office turned out to be extremely effective in convincing the residents of the proposed solution. Those activities enable to reach the level of 98% of residents segregate waste.

Involving users in the planning and implementation of technology solutions is vital because it ensures that the users' perspective is included in new technology solutions, which increases the chance that they will be positively received on a broader scale. Users should be involved in every technology project at three stages:

- in the case of the project, it is recommended to include users at the stage of designing the solution concept, verifying and consulting the appropriateness of solutions about the needs, expectations, and potential of potential users.
- at the stage of piloting technological prototypes of solutions, where users test the solutions and provide the necessary feedback to improve the solutions and prepare them for implementation
- at the implementation stage, it is worth providing a help desk facilitating communication with the users.

At the design and pilot stage, the involvement of participants in the project should be judiciously estimated. External participants quickly become discouraged by tedious processes. It is worth including them in exceptional and necessary moments of the process. Good examples of user involvement are project Photovoltaic installation on 35 high-rise resident buildings (P51). Project managers contacting the residents in order to identify 'citizen leaders' who would pass on information about the project. Due to this approach of involving local leaders most people who have learned about the solution accept the arguments and enter a dialogue.

SMART SOLUTIONS IN COVID-19

When it comes to the challenge posed rather unprecedentedly to the cities by the recent pandemic situation the public health domain seems to be the most sensitive issue. Frankly, telemedicine naturally comes first to mind as an immediate answer to the problem. There were several excellent examples of such smart solutions in medicine identified in the study:

- H08/27 National Healthcare system: unification of all health services in one system.
- P70 ProteGoSafe: tracking social contacts of the diseased person. It was related to COVID-19.
- C25 Záchranka (transl. Ambulance) app brings emergency calling to a new, smarter, and time-saving level. Using the app in an emergency makes the whole process faster and more effective.
- S14 Monse: an emergency system for seniors enabling them to call for help with the use of sensors.

Considering public safety issues due to severe pandemic restrictions two other valuable solutions are worth underlining:

- P38 Visual Crowd Detector - The project was aimed to create a tool for detecting clusters of people. It was related to COVID-19. The system was designed to indicate groups of people in real-time.
- P60 Smart city app (e-alerts)- The application may be useful in sending the alerts to citizens in a certain area.

If not in the frontline, then decidedly significant were solutions proposed in the areas where the access to services was painfully restricted. They referred to both public and private services:

- P68 Librus- E-register, a tool supporting remote education in times of pandemics.
- P69 InPost chatbots- a tool supporting massive shipments of goods in times where the access to traditional commerce was much inhibited.

The other way to classify the smart solutions useful in times of pandemic would be to divide the projects discussed in this section into projects developed specifically to target COVID-19 (e.g. P38 and P70) and the other projects that turned out useful even if they were developed regardless.

Involvement of the institution's management is a necessary factor that increases a project's success.

External participants quickly become discouraged with tedious processes. It is worth including them in exceptional and necessary moments of the process.

As expected, smart solutions turned out to be a useful tool in times of the pandemic (COVID-19), especially in health, public safety and digitally facilitated access to services whether public or private.

3.2. SUCCESS FACTORS EMERGING FROM THE LITERATURE AND PRACTICE

Each of the projects was assessed with regard to different success factors emerging from both preceding lectures of literature and analysis of the functioning of each project. The success factors were divided into three groups, regarding (ref. Table 8):

- context of the project regarding legal matters and the question of city's support is vital to possible functioning of the project;
- the solution itself: whether it is user-friendly, tailored, or standard-ready, if the project and its data are open. It was also considered whether the technology used is something unprecedented so far in the country or is it an already known solution adapted to local needs;
- process of creation, implementation, and testing of the project: factors concerning financing and involvement of stakeholders and public participation during different stages of the project.

Table 8. List of conditions for the QCA analysis.

CONDITION	CALIBRATION
CONTEXT_01 The project supported by the city during implementation (besides the financial aspect, mentioned below)	0 - not supported by the city during implementation 0,7 - supported by the city during implementation without broader vision & strategy 1 - supported by public administration within broader vision & strategy
CONTEXT_02 Legal context impedes implementation	0 - No 1 - Yes
SOLUTION_01 Tailored-made solution	0 - Solution is not tailored-made (standard-ready, corporate standard, ready- made) 1 - Solution is tailored-made (for the local resources and context, done with local providers, etc.)

CONDITION	CALIBRATION
SOLUTION_02 Open solution	0 - Solution is not open (vendor lock in) 1 - Solution is open (e.g. other companies can use the solution)
SOLUTION_03 User-friendliness of the solution (incl. interface, inclusiveness etc.)	0 - Solution is not user friendly 0,3 - Solution is rather not user friendly 0,7 - Solution is rather user friendly 1 - Solution is user friendly
SOLUTION_04 Available data	0 - No data is available 0,6 - Data available for the project team 1 - Data available for the project team and other stakeholders (i.e. open data)
SOLUTION_05 New technology	0 - Old technology (available in the country) 0,6 - Old tech used in a new way 1 - New technology (not available in the country)
PROCESS_01 Engagement of EU funds	0 - No 1 - Yes
PROCESS_02 Engagement of private capital	0 - No 1 - Yes
PROCESS_03 Engagement of public support other than EU funds	0 - No 1 - Yes

CONDITION	CALIBRATION
PROCESS_04 Engagement of local community/users	0 - No 1 – Yes
PROCESS_05 Engagement of other important stakeholders	0 - No 1 - Yes
PROCESS_06 Adequate explanation of the solution to key stakeholders	0 - No 1 – Yes
PROCESS_07 Engagement of stakeholders at the co-designing stage	0 - No 1 – Yes
PROCESS_08 Engagement of stakeholders at the testing stage	0 - No 1 - Yes

Source: own study and desk research.

PROJECT SUPPORTED BY THE CITY DURING IMPLEMENTATION / STRATEGY & CITY VISION

City's support - besides the financial aspect - may be crucial to the success of a project during its implementation as the local government usually knows their area best and can provide important information on local conditions, at the same time being possible to encourage the realisation of the project by ensuring support of local institutions.

For the project to be well-fitting for the specific city, it should be supported by the city's strategy and vision and that was the factor that was assessed within this evaluation. Instead of trying to create a smart city by adopting "smart" projects with no broader vision, the real smart cities need to implement a knowledge-intensive and creative strategy, which would then lead to enhancing the socio-economic, ecological, logistic,

and competitive performance[23]. The strategy for a digital or smart city identifies the changes that occur in both national and global political, legislative, and economic landscapes, and considers the impact of social and technological changes[24].

Thanks to the introduction of local-level smart city strategies, cities are capable of engaging various constituents in the innovation process on a much broader range of activities, fostering citizen-centric governance, which results in well-established smart city ecosystems. The cities are then more flexible in exploring and adjusting a variety of business and governance models, choosing and adjusting the ones which would maximize their own profit[25]. What's important is that more often than not, the timeframe of policies and decisions - e.g. about backing a project, is limited to the current political cycle, which makes it difficult to fulfil long-term obligations and ambitions the city has committed itself to. Due to the long-lasting impact and lengthy preparation time of smart city projects, and the community involvement in co-design, co-financing, and co-realisation of plans, genuine long-term perspective beyond the political cycle, agreed upon with the stakeholders, is key to successful integrated planning and implementation of smart city projects and ensures the political consistency and the fact that short-term actions including smart city projects contribute to long-term aims and help cities to fulfil their obligations[26].

Strategic planning also makes the urban problems become ones of manageable size and known nature, and the goals to be set according to local needs. This makes the introduction of smart city projects need less effort-intensive knowledge and sets up a favourable climate for the purposes of becoming smart, making it simpler to assess the viability of specific smart city solutions and services in local real-life contexts[27]. As contemporary urban development relies on modern digital technologies, smart city vision and strategy envisions the future state of the city utilizing digital technologies. Smart city strategy sets strategic guidelines on how a city must develop and integrates

[23] K. Kourtit, P. Nijkamp, "Smart Cities in the Innovation Age", Innovation: The European Journal of Social Science Research 2012, pp. 93–95

[24] M. Hämäläinen, A Framework for a Smart City Design: Digital Transformation in the Helsinki Smart City, Entrepreneurship and the Community: A Multidisciplinary Perspective on Creativity, Social Challenges, and Business, Springer 2020, p. 5

[25] M. Angelidou, Smart city policies: A spatial approach, Cities 41, Elsevier 2014, p. S4

[26] J. Borsboom-van Beurden et al., Smart City Guidance Package, European Commission, 2016, p. 6

[27] M. Angelidou, op. cit., p. S4

digital technologies to diverse urban infrastructures to enhance sustainable city design and performance[28]

However, strategic planning for smart city development remains hard to implement as a method of development coming into life only for the last two decades and relating to still largely unexplored and interdisciplinary fields. Creation and implementation of a smart city strategy is also quite a complicated process for which cities tend to linger as there is a need to align the smart city strategy with the complex web of policy agendas already operating at the government level[29].

LEGAL CONTEXT IMPEDING IMPLEMENTATION

Legal conditions on any level may rule out a solution completely if there is no or little political will to change them. If a smart city project is introduced in a country with no impedance of law in implementation it may turn out to be non-transferable to another country or city if any law prohibits a specific mechanism composing the project. Knowledge of laws, directives, or restrictions is also required. Technologies and new services also interfere in public affairs, and this area also needs to be addressed by legislation so that no problems arise in the future or so that it is possible to appeal to a certain body[30]. It is widely stated that existing regulatory and legal frameworks from the local level to the European are acting as obstacles, rather than enablers, in the transition towards positive energy districts and climate-neutral cities of the future, with initiatives forming to change this situation and propose regulation changes focused on best practices in cities, industry, research and societal stakeholders that engage in transdisciplinary demonstration and innovation activities[31].

TAILORED-MADE SOLUTION

A well-constructed and local-fitting strategy can identify issues concerning an area and create a model for constructing and achieving aims for overcoming the issues and developing the area. In the same way, if local needs are diagnosed correctly and thoroughly (or adopted from an existing strategy), a smart solution can be made which would pose as an accurate response to all ills of the city.

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[28] M. Hämäläinen, P. Tyrväinen, "Improving Smart City Design: A Conceptual Model for Governing Complex Smart City Ecosystems", In Bled eConference 2018

[29] M. Angelidou, op. cit., p. S4

[30] M. Lebiedzik, "Application of the Global Concept of Smart City at the Local Level of the Karviná District", Sustainability 12, 2020, p. 3

[31] https://www.smartcitiesworld.net/opinions/opinions/breaking-down-regulatory-barriers-is-key-to-achieve-smarter-cities- [Accessed 22.04.2021]

Only a solution adjusted to a city's situation, concerning various aspects of its functioning - economic, social, or environmental - can become a successful solution. If it is a standard-ready solution, the implementation may be partial or even may not work at all as unexpected local conditions might come up during any of the stages and wreck any chance of success of the smart city project, or the project might be a solution to a project which is not even present in a particular city and won't have any effect on its functioning. The creation of a project as an external blueprint, not reflecting local priorities and circumstances may also result in problems with ownership of the plans, cooperation of stakeholders and so suboptimal choices might be made given local specificities[32]. Every city is unique, with its own historical development path, current characteristics and future dynamics[33].

A very basic, but a well-explaining example of why solutions should be tailored to an area which it would affect is the case of Masdar and Brasília, which are planned cities, introducing numerous smart solutions into life. Adaptation of ideas introduced in a city which is in whole created in planners' minds and working according to their calculations would surely be very troublesome when trying to implement the same solution in a thousand-year-old city, which has been developing according to its own, very specific rules and has a completely different nature than the aforementioned Masdar, e.g. in the construction of transportation system, social structure or the green and blue infrastructure[34].

OPEN SOLUTION

An open smart city solution is a direct method to course it for using it in other cities. Not being blocked by copyrights, a solution can be easily adjusted to function under varied conditions. Also, thanks to disclosing all the details of a solution it would be better understandable when broken down into prime factors, and it is possible for people external to its authors to create fixes, extras or plugins, making the technology even more appealing to citizens or government. The openness of the solution also provides system interoperability and integration of systems and infrastructures[35].

[32] J. Borsboom-van Beurden, op. cit., p. 28

[33] A. Koźlak, M. Pawłowska, "Mobility-as-a-Service for Improving Mobility in Smart Cities – a Comparative Analysis of Selected Cities", Research Papers of Wroclaw University of Economics and Business 63, 2019, p. 34

[34] M. Wolszczak, P. Krąż, "Smart living in the Krakow smart city", Contemporary problems and research directions in geography 7, 2019, p. 158

[35] T. Nam, T. Pardo, Smart City as Urban Innovation: Focusing on Management, Policy, and Context, 2011, p. 187

Studies found that open-source solutions for smart cities can more easily manage and scale IoT projects.

Open solutions are also needed as the "vendor lock-in" phenomenon jeopardises the development of smart cities. It is a key issue facing modern cities today for municipalities to avoid being locked into technology from a single provider, and to ensure they are free to transition to the most convenient products and services for citizens offered by competitors. Smart projects are mainly based on customised systems, which cannot be interconnected and, even if this were possible, it would not be economically viable and so governments are seeking solutions that are open[36].

USER-FRIENDLINESS OF THE SOLUTION

As people are the protagonists of a smart city, who shape it through continuous interactions, for the solution to be successful, its final users need to be encouraged to use it and able to use it with ease, making it more convenient for users to function in the city[37]. Therefore, the solution has to appeal to them, have a comprehensible interface and simultaneously be as accessible, utilizable and understandable as possible[38] - including people of different characteristics, including the matter of technological literacy. Inclusiveness of the solution entails taking proportionate measures to ensure that access to digital services, skills and knowledge is equal regardless of gender, age, physical ability, or level of income. It also ensures that people with relevant skill sets are informing and actively participating in shaping the smart city[39].

AVAILABLE DATA

A smart city is based on intelligent exchanges of information that flow between its many different subsystems. This flow of information is analysed and translated into citizen and commercial services. The city will act on this information flow to make its wider ecosystem more resource-efficient and sustainable. The information exchange is based on a smart governance operating framework designed to make cities sustainable.

The matter of creation and later availability of data is significant as the used smart city technology can both provide data that can be further analysed by the creating party leading to crucial changes in the functioning of the city which the project is concerned

[36] http://www.remourban.eu/News--Events/News/Smart-Cities-Vs-Locked-In-Cities.kl [Accessed 22.04.2021]

[37] V. Albino, U. Berardi, R. Dangelico, "Smart Cities: Definitions, Dimensions, Performance, and Initiatives", Journal of Urban Technology, 2015

[38] M. Wolszczak, P. Krąż, op. cit., pp. 170-171

[39] T. Lauriault, R. Bloom, J. Laurialt, Open Smart Cities Guide, OpenNorth, 2018, p. 14

of. At the same time, if the data is open, it can be later used by other entities for numerous purposes, producing a possibility for smart development of the city in various fields of activity.

Applying modern smart city technologies to diverse smart city infrastructures helps to accumulate exponentially historical and real-time data from heterogeneous city domains and activities[40]. A smart city infuses information into its physical infrastructure to improve conveniences, facilitate mobility, add efficiencies, conserve energy, improve the quality of air and water, identify problems and fix them quickly, recover rapidly from disasters, collect data to make better decisions, deploy resources effectively, and share data to enable collaboration across entities and domains. A city that monitors and integrates conditions of all of its critical infrastructures can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens[41], employ information technologies with real-time analysis that encourages sustainable economic development[42].

Open city data is not only used by the city's government, but also other stakeholders such as citizens, application developers, and third-party organizations that exploit open city data for personal or public purposes[43]. The presence of open data sets indicates the efforts of a city to foster innovation, and their willingness to co-create with other parties[44]. Also, engaging citizens to collect data by themselves solves the difficulties that public actors have due to their limited resources. Considering the easy access to technology, citizens can in many cases collectively generate the data that they require, without governmental intervention[45].

[40] J. Schleicher, M. Vögler, C. Inzinger, S. Dustdar, "Modeling and management of usage-aware distributed datasets for global Smart City Application", Ecosystems. PeerJ Computer Science 3, 2017, p. 115

[41] P. Hall, "Creative Cities and Economic Development", Urban Studies 37, 2000, pp. 633-649

[42] T. Nam, T. Pardo, Conceptualizing Smart City with Dimensions of Technology, People, and Institutions, 2011

[43] U. Aguilera, O. Peña, O. Belmonte, D. López-de-Ipiña, "Citizen-centric data services for smarter cities", Future Generation Computer Systems 76, 2017, pp. 234-247

[44] R. Matheus, M. Janssen, "How to Become a Smart City? Balancing Ambidexterity in Smart Cities", ICEGOV '17: Proceedings of the 10th International Conference on Theory and Practice of Electronic Governance, 2017, p. 406

[45] I. Capdevila, M. Zarlenga, "Smart City or smart citizens? The Barcelona case", Journal of Strategy and Management 8, 2015, p. 11

Capabilities to process and analyse the city data are needed so that the data is useful for actors in smart city ecosystems[46]. Along with human capabilities, data engineers and scientists, technologies such as data analytics and AI speed up data processing and enhance data integrity and accuracy[47].

NEW TECHNOLOGY

Smart city generally refers to the search and identification of intelligent solutions which allow modern cities to enhance the quality of the services provided to citizens[48]. Smart cities must integrate technologies, systems, services, and capabilities into an organic network that is sufficiently multi-sectorial and flexible for future developments, and moreover, open access[49]. Different approaches to the smart city idea focus more on the technological aspect or its effect on other aspects. Some of the solutions use technology, which is already well-known, some consist of its clever application in a new way, and some use a completely new technology, not known before in the country. Each of these solutions has different pros and cons, concerning interoperability, security, reliability, being comprehensible, transferable or possible to create social or economic effect[50].

ENGAGEMENT OF PRIVATE CAPITAL AND PUBLIC SUPPORT

Major (upfront) investments are needed to successfully deliver smart city initiatives. Funding and financial resources are critical for the smart city initiatives. Both public and private investment organizations fund the smart city projects of various scales. Funding programs are available for infrastructure development, capacity building, and research and innovation activities.

An appropriate division of engagement of capital effects in an efficient implementation of the project, overcoming issues concerning financing - both within the problems of

[46] M. Khan et al., "Smart city designing and planning based on big data analytics", Sustainable Cities and Society 35, 2017, pp. 271-279

[47] S. Srivastava, A. Bisht, N. Narayan, "Safety and security in smart cities using artificial intelligence", 7th International Conference on Cloud Computing, Data Science & Engineering-Confluence, 2017, pp. 130-133

[48] R. Giffinger et al., Smart Cities: Ranking of European Medium-sized Cities, Centre of Regional Science in Vienna, 2007

[49] N. Komninos, "Intelligent Cities: Variable Geometries of Spatial Intelligence", Intelligent Buildings International 3, 2011, pp. 172–188

[50] https://theconversation.com/smart-cities-worlds-best-dont-just-adopt-new-technology-they-make-it-work-for-people-124939 [Accessed 22.04.2021]

start-up companies and insufficient public funds[51]. A favourable situation for projects is to be possible to be funded by both private companies (private participation, public-private participation and other forms of cooperation) and municipalities, with possible external support[52].

In European settings, as digital urban development is one of the priority agendas, the smart city support can be allocated through the EU to improve infrastructures - such as transport and water networks and waste management - as well as to improve the energy efficiency of buildings. Globally, international organizations, such as United Nations Industrial Development Organization, provide funding for sustainable environmental development, such as green industries, sanitation, and waste management[53].

PUBLIC PARTICIPATION AND ENGAGEMENT OF IMPORTANT STAKEHOLDERS

An essential element to the proper functioning of a smart city project is the balanced cooperation of all important stakeholders during all stages[54], even though the stakeholders are often driven by conflicting interests[55]. Those stages include co-commissioning (activities aimed at strategically identifying and prioritizing needed public services, outcomes, and users), co-designing (activities that incorporate "the experience of users and their communities" into the creation, planning, or arrangements of public services), co-delivery (joint activities between state and lay actors that are used to directly provide public services and/or to improve the provision of public services) and co-assessment (monitoring and evaluating public services)[56].

It is necessary to identify the different groups of actors involved in and responsible for the project, as well as to consider the potential social groups that may have benefited from the initiatives. It is important to pay attention to the role, demands and

[51] R. Díaz-Díaz, L. Muñoz, D. Pérez-González, "Business model analysis of public services operating in the smart city ecosystem: The case of SmartSantander", Future Generation Computer Systems 76, 2017, pp. 198-214

[52] M. Flynn, S. Hamilton, The Alliance Approach to Smart Cities. An innovation framework for financing, partnership, procurement, and governance, Deloitte, 2018

[53] M. Hämäläinen, A Framework for a Smart City Design: Digital Transformation in the Helsinki Smart City, Entrepreneurship and the Community: A Multidisciplinary Perspective on Creativity, Social Challenges, and Business, Springer 2020, p. 9

[54] C. Alexopoulos, G. Pereira, Y. Charalabidis, L. Madrid, "A Taxonomy of Smart Cities Initiatives", ICEGOV2019 Conference, 2019, p. 283

[55] M. Angelidou, op. cit., p. S3

[56] T. Nabatchi, A. Sancino, M. Sicilia, "Varieties of Participation in Public Services: The Who, When, and What of Coproduction", Public Administration Review 77, pp. 766–776

responsibilities of each group. These groups or 'pieces' are both independent and interdependent at the same time, because each one has autonomy in the process, although they may not be solely responsible for it. The relationship between these four groups cannot be disjointed or operate only according to economic interests, under penalty of invalidating or hindering the progress of the project as developers improve the quality of life. The actors connect more or less according to self-provisions, and according to the local share of actions and situations[57].

In order to better analyse the advances and demands of the project, each stakeholder (local governments, research institutions, grassroots movements, technology vendors, property developers, etc.) possesses a piece of the jigsaw puzzle but must be willing to put it in place[58]. Citizens should also participate in the consumption but also in the design of the technology co-creating as producers themselves, the socially beneficial outcome[59]. Potentially, research institutes can be very important partners for cities. They can be an important catalyst for new smart city projects, by using research funding for the exploration of possibilities for establishing projects, testing out specific methods or technologies, or experimenting in living labs.

Stakeholder engagement can provide valuable insights about the assets and the needs of the city, increase public acceptance of the smart city venture and elevate the 'smartness' of the city to a whole new level, leveraging human capital and collective intelligence[60]. Wide, early and in-depth stakeholder engagement is needed to achieve agreement on the final aim of the project and the proposed measures, and to tie in other benefits important to the users and owners of the buildings and infrastructures. Co-design, co-creation and co-production are therefore quintessential features of integrated planning and implementation[61]. The participation of citizens in the decision-making processes of a local government is an integral part of all dimensions of the smart city concept and can be seen as an all-embracing idea of the concept.

[57] M. Batista, T. Fariniuk, "Mechanisms of the Smart City: A Case Study of Smart City Búzios, Brazil", plaNext – Next Generation Planning 4, 2017, p. 33

[58] J. Borsboom-van Beurden, op. cit., p. 18

[59] I. Calzada, "Critical Social Innovation in the Smart City era for a City-Regional European Horizon 2020", Journal of Public Policies and Territories 6, 2013, p. 5

[60] M. Angelidou, op. cit., p. S9

[61] J. Borsboom-van Beurden, op. cit., p. 18

A municipality, which is not based on the real interests of its citizens and other stakeholders, cannot be seen as a genuine fulfilling vision of a smart city concept[62].

Nearly all successful smart city projects are founded upon collaboration in the triple (public-government, private-industry and academia-university[63]) or quadruple helix "public-private-people" consisting of local administrations, research institutes, industry, and citizens, local businesses and other actors[64].

OUTCOME

The project should not only be a successful standalone solution, but also needs to be plugged into the city's system of functioning, working together with its other elements. Not only the full life cycle of planned investments in the built environment should be taken into account, but also the entire community, which is influenced by them, addresses and facilitates these issues. This prevents smart city projects from failing during preparation or at the start and increases their success rate during implementation[65].

A smart city is about the synergy between technology and its citizens - without smart people, smart city development will not run well, and intelligent societies are urgently needed as the main driving force of the digital economy which is expected to produce a change in the future of the economy[66]. The utilization of networked infrastructures should improve economic and political efficiency and enable social, cultural and urban development, having an impact on the quality of life of citizens and aiming to foster more informed, educated, and participatory citizens[67].

[62] F. Kucera, "Smart Government as a Key Factor in the Creation of a Smart City", 13th Annual International Bata Conference for Ph.D. Students and Young Researchers, 2017, p. 347

[63] I. Calzada, op. cit., p. 15

[64] J. Borsboom-van Beurden, op. cit., p. 37

[65] Ibid., p. 17

[66] H. Fridayani, Rifaid, "Smart City as A Tool to Achieve Sustainability City Case Study: Sleman Smart Regency Implementation, Indonesia", Jurnal Tata Sejuta 5, 2019, p. 4

[67] R. Hollands, Will the Real Smart City Please Stand Up? Intelligent, Progressive or Entrepreneurial?, City 12, 2008

3.3. PROJECTS SUCCESS PATHS AND MECHANISMS – RESULTS OF QCA ANALYSIS

The conducted analysis showed that only a few solutions described in the report were functionally plugged into urban/city ecosystem needs. While this outcome is of great importance, conditions leading to it were investigated with the qualitative comparative analysis. It should be highlighted that the results of the analysis are relevant most of all for the analysed cases. Any generalisation of results should discuss the similarity of scope conditions.

The 15 conditions taken into account belong to three categories: contextual conditions, technology conditions (automata) and process conditions (agora). The conditions are presented in Table 8. Next to the name of the conditions in the right column uppercase abbreviation is presented. It will be used while discussing the results.

Table 9. Categories and conditions included in QCA analysis

CATEGORIES	LOWER-ORDER CONDITIONS
Contextual conditions	The project supported by the city during the implementation CIT
	Legal context impedes implementation LEG
Technology conditions	Tailored-made solution TAI
	User-friendliness of the solution FRD
	Open solution OPE
	Available data AVL
	New technology NJU
Process conditions	Engagement of EU funds EU
	Engagement of private capital PRI
	Engagement of public support other than EU funds PUB
	Engagement of local community/users USE
	Engagement of other important stakeholders STA

CATEGORIES	LOWER-ORDER CONDITIONS
	Adequate explanation of the solution to key stakeholders EXP
	Engagement of stakeholders at the co-designing stage COD
	Engagement of stakeholders at the testing stage EST

Source: own study.

The collected evidence confirms the importance of taking into account all three categories of conditions. There is no one condition that is necessary or sufficient for the outcome. To put it simply – an interplay among context, technology and process matter. At the same time, there are configurations of conditions for which we may be certain to observe it.

Four conditions are especially important: CIT (The project supported by the city during implementation), STA (Engagement of other important stakeholders), FRD (User-friendliness of the solution) and EXP (Adequate explanation of the solution to key stakeholders). The outcome may be observed for the four groups:

I. All four conditions are present (CIT,STA,FRD and EXP)

There are 15 cases in this group. One of the projects is the P04 Individual Waste Segregation System. Segregation of municipal waste in multi-family housing is a great challenge for local governments. The city (factor CIT) and the technological partner T-Master were engaged in introducing non-contact containers for waste segregation, which are very user-friendly (FRD). Its main advantage comes from the lack of anonymity – a unique code for each household to use the container was given and citizens were explained how to use the new system (EXP). The system was prepared in close cooperation with the company collecting waste and the estate administrator on which the containers were mounted (STA). The city receives information on how much waste is generated by residents and can take preventive measures to increase recycling levels. The system's operation has been called a great success by increasing the level of waste segregation from 10 to 90% and 83% of surveyed residents declared they would not want to return to the previous system.

II. CIT and STA are present (but FRD and EXP are not present)

One of 10 cases in the group is a project P01 iVoting Jaworze. The system provides two primary tools for voting through the Internet - poll and consultation -using blockchain technology. The application was designed by Carbonet Sp. z o.o. More than a dozen scientists were involved in the work on the project, including those from the

Częstochowa University of Technology, Wrocław University of Technology, as well as employees of several Warsaw universities (STA). Most of them deal with the subject of cryptography and blockchain architecture in their scientific work. One of the success factors of the project was the personal involvement of the commune's head (Jaworze County) in the project and his desire to implement a modern tool in the county, which in the long run has a chance to become a norm when it comes to contact between the office and the residents. Those elements contributed to the positive outcome of the project.

III. CIT, FRD and EXP are present (but STA is not present)

Among 2 projects from the III group, there is P62 E-control SPPN Warsaw. The project's objective was to design and implement a remote system of verification parking fees in the city parking zone. Two electric cars (Nissan Leafs) equipped with cameras and sensors automatically scan the license plates of cars parked in the city parking zone to validate parking fees. The idea of the project was created by ZDM (Road Traffic Authority of Warsaw), developed and discussed during technical dialogue (CIT). The remote system of verification parking fees in the city parking zone is easy to operate by the ZDM (FRD). Key stakeholder employees had training sessions that allowed them to run the system without any problems (EXP). The system is plugged into the road management ecosystem and use data from parking payment systems, so the outcome was set as 1.

IV. STA, FRD and EXP are present (but CIT is not present)

The last IV group includes 2 projects. P51 Photovoltaic installation on 35 high-rise residential buildings is one of them. The project’s objective was to reduce the costs of one of the most significant burdens for the residents: electric power supplying common parts of buildings. The Housing cooperative initiated the project – Wrocław-Południe – co-initiator and owner of the solution, while Talo Energy sp. Z o.o. carried it out. Voivodeship Fund for Environmental Protection and Water Management in Wrocław (WFOŚiGW) provided Prosumer Program. It was an opportunity to fund the installation from its resources (STA). Consultations with residents were organized to convince them that it is worth investing in renewable energy technologies. The majority favoured the installation. Some even became ambassadors of the project (EXP). Nevertheless, the city was not directly involved in the project (no CIT). Those elements contributed to the positive outcome of the project, which is reducing the bills for energy consumption by common parts of building up to 85% and have an impact on the city environment by reducing CO2 emissions to the atmosphere by 600 t.

Out of 56 cases, the outcome was observed in 34. The model including the four described above conditions explains the occurrence of the outcome in 29 cases. There are 2 deviant cases that meet the conditions from the model and for which the outcome was not observed. One of them is project P09 Konrad Bloch office building. The project's objective was to build a building that meets the needs of Katowice by developing post-industrial areas for investment. The building was to be as user-friendly as possible and provide users with very comfortable working conditions. From the very beginning, the City of Katowice supported the project. Among other things, the spatial development plan for the city has been changed so that the investment in post-industrial areas was possible at all (CIT). An important partner of the investor was the Passive and Energy-Efficient Construction Cluster. They obtained funds for several study trips. GPP Business Park employees could visit many interesting energy-efficient buildings in the world and took part in international conferences and symposia on passive construction. The knowledge gained in this way was used at the design and construction stages of the office buildings (STA). Nevertheless, the project has no connection with other cities systems and more significant impact on the functioning of the whole city, so the outcome was set as 0.

The second deviant case was project H40 Solar pump Budafok-Tétény. The innovation provides a solution for the municipality and the urban management department to a problem they have had no efficient answer to before. The citizens do not have to worry about having their gardens flooded after heavy rainfall, and no need for them to react in any way (EXP). The Municipality of Budafok-Tétény, the 22nd district of Budapest, is the owner of the project (CIT). The system was installed by the private company Packers Energo Light Kft. in 2018 in the 22nd district of Budapest in Kártya Street, which is the deepest point of the district, forming a small valley, highly exposed to floods during rains. The system automatically pumps all the water, which could cause flood over to the river next by, without any necessary human intervention (FRD). However, the project has no connection with other cities systems and greater impact on the functioning of the whole city, so the outcome was set as 0.

To sum up, the model clearly proves the importance of adequate engagement of all important stakeholders for the successful plugging in of the solutions into urban/city ecosystem needs. CIT (The project supported by the city during implementation), STA (Engagement of other important stakeholders), FRD (User-friendliness of the solution) and EXP (Adequate explanation of the solution to key stakeholders) appear as the crucial conditions for this outcome.

However, other conditions are also important. Engagement of stakeholders at the co-designing stage (COD) and Engagement of stakeholders at the testing stage (EST) are one of the possible ways of ensuring the Engagement of other important stakeholders (STA). All conditions related to the technological aspects of the solution (TAI, OPE, AVL, NEW) are also important. They are not included in the abovementioned model because they are closely related to four conditions connected to stakeholders (CIT, STA, FRD, EXP). These results suggest that proper engagement of all important stakeholders is very often translated into adequate technological aspects of the solution.

The lack of influence of source of financing comes as surprise. Private financing (PRI) does not enhance the occurrence of the outcome. However, this result may stem from the specificity of the cases under study and should not be generalized automatically on other solutions.

4. LESSONS FOR COHESION POLICY

4.1. KEY OBSERVATIONS COMING FROM THE STUDY

The comparative research conducted in Visegrad countries at project level and strategic documents level, allows us to put forward ten key conclusions.

(1) PECULIARITY OF SMART CITY PROJECTS

Smart city projects are substantially different in characteristics from standard public projects co-funded by Cohesion Policy. They can incorporate physical infrastructure or equipment for vehicles with devices, but the core value of these projects is data - an intangible product. Thus, Smart City solutions should not be simply procured, but as IT projects they need to be managed in a unique way - connecting strategic vision and agile execution. This requires anticipation of high risk, highly-qualified and properly remunerated teams also from urban administration, which is particularly challenging for smaller cities. Those projects are also not as expensive as building standard infrastructure elements and can provide additional functionality for currently existing structures in the city.

Source: good practices analysis

(2) SOUND BUT NOT CUTTING-EDGE INNOVATIVE

The reviewed population of projects provides a spectrum of sound initiatives that address urban challenges with well-implemented technological solutions. However, it has to be pointed out that these good practices are not breakthrough, cutting-edge innovations. Those solutions with similar functionalities were already implemented in other parts of Europe and the World and often procured as ready-made solutions formed by multinational companies. Thus, smart cities projects in V4 look rather as urban standards than pioneering attempts.

Source: good practices analysis

(3) STRATEGIC LEVEL INVISIBLE TO OWNERS AND CONTRACTORS

The role of strategic documents was unclear to the stakeholders of smart solutions. None of the respondents (owners or contractors) pointed out during interviews that the provisions facilitated or hindered the project realisation. The documents served as guidelines what to do and what to finance it with.

Source: strategic documents review, good practices analysis

(4) LACK OF HOLISTIC SUPPORT OF SMART CITY INITIATIVES

The holistic, national approach to the Smart City concept was mentioned as one of the success factors of solutions development. The lack of a central institution distributing funds and providing knowledge may significantly hinder the development process. It was often stated that the distribution of funding among cities of different sizes has been uneven. Only the biggest cities, which are financially and mentally capable of implementing a smart solution anyway, have benefitted from the Smart Cities support programmes.

Source: strategic documents review, good practices analysis

(5) TYPES OF PROJECTS: SCOUTS VS. MAINSTREAM

We observed two types of projects in the reviewed population. First are the initiatives that are pilots, which means that they are developing a pilot solution. We call them "scouts" since their goal is to explore and test possible directions of application. The second group is initiatives that are scaling up or mainstreaming already developed solutions. We call them "mainstream" since they aim to fledge the solution in the specific urban area fully.

Source: good practices analysis

(6) CONFIGURATIONS THAT LEAD TO ECOSYSTEM

All reviewed projects were examples of good smart city projects. However, in our research, we were especially interested in those projects that become functionally plugged into the urban ecosystem. We have identified three configurations of factors that make a good smart city project plugged into an urban ecosystem:

- The project should be supported by the city during implementation AND the engagement of important stakeholders should be present;
- The project should be supported by the city during implementation AND the solution should be user-friendly AND purpose of the solution should be adequately explained to the key stakeholders;
- The project should engage important stakeholders AND the solution should be user-friendly AND the solution should be adequately explained to key stakeholders.

Source: QCA

(7) TECHNOLOGY LIKE LEGO BRICKS

Several interviewed practitioners raised the issue of a modular approach to technology. Basically, they see smart city solutions as built from smaller technology components, like “Lego bricks” that can be composed in different ways and replaced with new but compatible elements. This idea tries to address at least two challenges of smart city solutions. First, it allows avoiding overall dependence on one technology provider. Second, it allows for adaptation to technological developments and progress, and not being locked in in an obsolete solution. In that context, interviewees pointed out the role of the public administration (central level) in providing standards and compatibility across projects and city locations.

Source: good practices analysis

(8) LACK OF UNIFORM DEFINITION

The existence of a uniform definition of a Smart City (codified in a strategy or a legal act) was mentioned during interviews as an undeniable advantage for the development of the concept. In some countries, the projects which obviously can be qualified as smart are not called that way and as a result, the funding possibilities are unclear.

Source: strategic documents review

(9) LEGAL REGULATIONS ARE BARRIERS

Regulations limits possibilities for introducing new installations, applications and services. Industry-specific regulations (regarding e.g. spatial planning, engineering, public transport) contain a standard catalogue of solutions that have been implemented for several decades and sometimes leave no room for innovative solutions or require special adaptation. For this reason, implementation of solutions take more time or even cities resign from taking up some Smart City initiatives.

Source: good practices analysis

(10) SMART CITY IS IMMUNE TO THE PANDEMIC

The pandemic generally did not affect the operation of the systems and their effects are also ensured during times of remote work. Inhabitants, by using digital services, can even faster adapt to a changing reality. At this point, it is necessary to distinguish solutions providing remote diagnostics, which allow for the minimizing the interpersonal contacts.

Source: good practices analysis

4.2. LESSONS FOR NATIONAL STRATEGIC PLANNING

The key recommendations from the study for the national governments are described in Annex VII. They include five main observations.

(1) PROVIDING COMPREHENSIVE SUPPORT

Support of Smart City concept development should not be a typical Cohesion Policy CAPEX support. Development of local supply by the private sector and competencies of public administration are the key to the highest levels of innovation. Smart City support needs to include improving competencies in cities, including trainings, study visits, pilots or co-financing teams. Implementation of solution could be supported by special units responsible for Smart City at national and local levels. Standards of digital public services and delivery of Smart City solutions should be also worked out. Support should be proceeded by more innovative and customized solutions that from V4 ecosystem solutions could be exported, not just bought ready-made solutions.

(2) MORE FLEXIBLE FINANCING

Local supply of smart solutions may be developed by investment funds, accelerators or incubators, but also by proper scale of public procurement – not too big, but also not too small. As they are often projects of high risk, they require more flexible financing measures, such as conducting pilots, implementing projects by partnerships of cities or even capital entries. This could be achieved e.g. by a dedicated financial instrument that would finance and coordinate cooperation between developers and the cities in the pilot phase of new solutions.

(3) EQUALIZATION OF FUNDS DISTRIBUTION

Support should be targeted both to metropolises and small or medium-sized cities. However, actions in both areas should be different. Large cities areas can handle simple Smart City projects, so for them, innovative initiatives generating new solutions should be additionally supported. This could be provided by network work, know-how exchange or outsourcing of some tasks. In the case of small or medium-sized cities support should focus on the implementation of already well-known solutions that have been successfully implemented in other areas. Smaller authorities should also cooperate with each other and create common competence centres in order to achieve a proper critical scale. One of the important factors during implementation, which should be always addressed is the promotion of the project, especially in small communities.

(4) LEGAL REGULATIONS FLEXIBILITY IS NECESSARY

There is the necessity of conducting separate benchmarking with the best countries in the world in case of implementation of the Smart City concept, especially regarding flexibility for new solution implementation. This process in specific areas faces legal barriers, which have not been resolved in the countries of the V4 group – in each country cities act differently to implement a specific solution. Although, it must be reminded that there are also significantly different legal contexts among countries outside of Europe.

(5) FURTHER BENCHMARKING WITH WORLD LEADERS

Benchmarking within the V4 countries has not provided enough detailed information on effective Smart City ecosystem support by national governments, both in terms of legislation (see above), as well as of organisation and financing measures. Therefore legal and organisational systems of Smart City leaders like Singapore, South Korea, Finland or Switzerland could be researched and compared with V4 group solutions, in order to find further operational recommendations.

(6) PROPOSITION OF SUPPORT TOOLS

Current support programmes were defined as not sufficient for the appropriate development of the Smart City concept in Polish cities. 10 new support tools, which should be run within EU Cohesion Policy, were proposed. Among them is the network of Urban Labs, pilotage of preparation of Smart City concepts in cities, Smart City contact point, creation of universal Smart City solutions, investment fund in Smart City start-ups, STEP programme for Smart City, additional points in the assessment of smart solutions during application for funds, Gov-tech for Smart City, Smart City academy and special microgrants fund. Descriptions of all propositions in detail are covered within Annex X.

4.3. LESSONS FOR CITIES AND THEIR PROJECTS

Six key recommendations emerged from the study for the local authorities. They are described in detail in Annex VII.

(1) MORE SUSTAINABLE PROJECTS THROUGH BETTER INTEROPERABILITY

One of the important digital aspects brought up by the experts interviewed in this study rests upon the interconnectedness of technology (mostly referring to software) applied in the project. While these characteristics may not be applicable to all assembled case studies, it turned out to be significant in at least 15 good practices. This feature means that the digital solution co-operates well with the other systems and ideally is built upon a modular structure that enables exchanging its old or inflexible modules to more functional ones. It prevents the technology from outdating and helps it evolve. Thus this feature affects the sustainability of the project rather profoundly. In doing so it may also prevent the unfavourable vendor lock-in effect in some cases.

(2) DIVIDING PROJECTS INTO SMALLER BLOCKS/MODULES/PHASES

It is recommended to divide projects into smaller blocks/modules/phases, because of the rapid technology development. Each module should be easily replaced by new solutions, so the standards for that should be specified and provided by the contractors.

(3) IMPLEMENTATION BY EXPERIMENTS, CONSTANT IMPROVEMENT AND CLOSE COOPERATION WITH PROVIDERS

Smart City projects are not just like infrastructure projects, so we can clearly specify all wanted elements and technologies. In most cases, cities are aware of the needs and functionalities that should be addressed by the new solution, but cannot cover the knowledge about the technology and physical layer of the solution. Because of that, new implementations should be conducted in form of pilotage, partnership or technical dialogue. Projects should never be closed, but constantly improved also by using options, supplementary orders and framework contracts. SPVs and common development with private contractors are also good practices. Those elements will increase the probability of projects success.

(4) IMPROVING USABILITY AND USER-FRIENDLINESS OF TECHNOLOGICAL SOLUTIONS

An important aspect of technological projects is making sure that technological solutions are created with the user experience. They should be easy and friendly to use. Lack of logic and complexity of interfaces is why a decrease in interest and use of digital services might occur.

Therefore, when implementing technological solutions, it is worth adopting an evolutionary approach consisting of testing and developing new solutions e.g., software versions on a small group of users, and then setting the project and successively expanding it on a larger scale.

Every innovative project should be implemented in 3 stages:

- designing and testing a prototype solution,
- experimental testing and improvement of the solution,
- implementation and development of the solution.

It is worth involving developers, technology experts, designers and UX researchers who will pay special attention to the usability and friendliness of different interfaces.

(5) INVOLVEMENT OF DIFFERENT STAKEHOLDER GROUPS

Decision-makers

An appropriate level of involvement of the institution's management is a necessary factor that increases a project's success. The presence of management representatives in projects greatly facilitates and accelerates their implementation. We suggest that representatives of the institution's management act as patrons of technology projects; it is worthwhile for them to be included by the content team at crucial moments of project implementation, such as inauguration, critical decision-making, elimination of management barriers, and promotion.

Users

Involving users in the planning and implementation of technology solutions is vital because it ensures that the users' perspective is included in new technology solutions, which increases the chance that they will be positively received on a broader scale. Users should be involved in every technology project at three stages:

- in the case of the project, it is recommended to include users at the stage of designing the solution concept, verifying and consulting the appropriateness of solutions about the needs, expectations, and potential of potential users.
- at the stage of piloting technological prototypes of solutions, where users test the solutions and provide the necessary feedback to improve the solutions and prepare them for implementation
- at the implementation stage, it is worth providing a help desk facilitating communication with the users.

At the design and pilot stage, the involvement of participants in the project should be judiciously estimated.

External participants quickly become discouraged by tedious processes. It is worth including them in exceptional and necessary moments of the process.

(6) IMPROVING THE COMPETENCE OF OFFICES TO IMPLEMENT TECHNOLOGY PROJECTS

In the face of challenges related to staff competencies, migration of specialists to the private sector and siloed organizational structures, we recommend two types of actions:

- the implementation of consulting and training projects in the form of *learning by doing* (gov-tech or gov-lab) by carrying out a technology project from identifying the problem to planning and implementing the projects. It contributes to improving the competence of officials, development of a path for the Tech projects implementation and use of technical dialogue procedures in the procurement of technology.
- In the training and advisory process, apart from employees of digitalization departments, employees of other units should also be involved to spread the knowledge about the application of technology in the whole organization and not only in one team. This approach helps to overcome the resistance against new, modern ways of doing standards tasks. This fear appeared in iVoting in the project among the officials that need to learn a new attitude for consultations.

It is also worth realizing that public organizations may not always be adequately prepared for efficient and independent implementation of complex technological projects despite training and advisory activities undertaken. In projects financed by the cohesion policy, it is worth allowing the possibility of funding the costs of technical advisors - IT specialists cooperating with offices to implement e-services. Such support would be an essential solution, especially for smaller offices.

5. ANNEXES

Annex I. Short report

Annex II. Overview of the Smart City issue in V4 documents

Annex III. Good practices catalogue

Annex IV. QCA methodology and results

Annex V. 10 cases extended methodology

Annex VI. Authors

Annex VII. Conclusions & Recommendations

Annex VIII. International workshop summary

Annex IX. National workshop summary

Annex X. Proposition of support tools within Cohesion Policy

6. SOURCES

Aguilera, U., Peña, O., Belmonte, O., López-de-Ipiña, D., "Citizen-centric data services for smarter cities", Future Generation Computer Systems 76, 2017, pp. 234-247

Alawadhi, S., Aldama-Nalda, A., Chourabi, H., Gil-Garica, J.R., Leung, S., Mellouli S., Building understanding of Smart City initiatives, Proceedings of 11th IFIP WG 8.5 International Conference, EGOV 2012, Kritinsand 2012, pp. 40-54

Albino, V. et al., "Smart Cities: Definitions, Dimensions, Performance, and Initiatives", Journal of Urban Technology, 2015

Alexopoulos, C., Pereira, G., Charalabidis, Y., Madrid, L., "A Taxonomy of Smart Cities Initiatives", ICEGOV2019 Conference, 2019, p. 283

Ambrosetti, A., Smart Cities in Italia: un'opportunità nello spirito del Rinascimento per una nuova qualità della vita, 2012

Angelidou, M., Smart city policies: A spatial approach, Cities 41, Elsevier 2014, p. S4

Anthopoulos, L., "Smart utopia vs smart reality: Learning by experience from 10 Smart City cases", Cities 63, 2017

Baculakova, K., Selected Aspects Of Smart City Concepts: Position Of Bratislava, Bratislava 2020

Bamberger, J. J. M., Vaessen, J. L., Raimondo, E. R. R., Dealing With Complexity in Development Evaluation: A Practical Approach, SAGE Publications, Inc., 2015

Bason, C. (Ed.), Design for Policy, Gower Publishing, Surrey 2014

Batista, M., Fariniuk, T., "Mechanisms of the Smart City: A Case Study of Smart City Búzios, Brazil", plaNext – Next Generation Planning 4, 2017, p. 33

Bell, D., The coming of post-industrial society, Heinemann, London 1974

Bibri, S.E., "Generating a vision for smart sustainable cities of the future: a scholarly backcasting approach", European Journal of Futures Research, 2019

Borsboom-van Beurden, J. et al., Smart City Guidance Package, European Commission, 2016, p. 6

Braun, T., et al., "Security and privacy challenges in Smart Cities", Sustainable Cities and Society 39, 2018

Bulu, M., “Upgrading a city via technology”, Technological Forecasting & Social Change no. 89/2014, p. 65

Calzada, I., “Critical Social Innovation in the Smart City era for a City-Regional European Horizon 2020”, Journal of Public Policies and Territories 6, 2013, p. 5

Capano, G., Howlett, M., Ramesh, M., Virani A. (Eds.), Making Policies Work. First- and Second-order Mechanisms in Policy Design, Edward Elgar Publishing, Cheltenham 2019

Capdevila, I., Zarlenga, M., “Smart City or smart citizens? The Barcelona case”, Journal of Strategy and Management 8, 2015, p. 11

Caragliu, A, and Del Bo, C., “Smartness and European urban performance: Assessing the local impacts of smart urban attributes”, The European Journal of Social Science Research 25(2), 2012, pp. 97-113

CIGI, Searching for the Smart City's Democratic Future https://www.cigionline.org/articles/searching-smart-citys-democratic-future [available: 26.10.2020]

Correia, L.M., Wünstel, K., “Smart Cities applications and requirements”, White Paper of the Experts Working Group, Net!Works European Technology Platform, 2011, pp. 9-31

Dameri, R.P., Rosenthal-Sabroux, C., Smart City how to Create Public and Economic Value with High Technology in Urban Space, Springer, 2014

de Santis, R., Fasano, A., Mignolli, N., Villa, A., “Smart City: fact and fiction”, MPRA Munich Personal RePEc Archive, MPRA Paper nr 54536, 2014, p. 3

Díaz-Díaz, R., Muñoz, L., Pérez-Gonzáleza, D., “Business model analysis of public services operating in the smart city ecosystem: The case of SmartSantander”, Future Generation Computer Systems 76, 2017, pp. 198-214

Dirks, S., Keeling, M., Dencik, J., How smart is your city?, IBM Institute for Business Value, New York 2009, pp. 4-10

Doctorow, C., “The case for ... cities that aren't dystopian surveillance states”, The Guardian, 2020

Duşa, A. QCA with R: A Comprehensive Resource, 2018

Dvir, R., Pasher, E., “Innovation engines for knowledge cities: An innovation ecology perspective”, Journal of Knowledge Management 8(5), 2004, pp. 16-27

EC, The making of a Smart City: best practices across Europe, 2017

EC, The opinion of the Committee of the Regions on 'Smart Cities and Communities — European Innovation Partnership' (2013/C 280/06).

England, P., "Managing urban water in Australia: The planned and the unplanned. Management of Environmental Quality", An International Journal 20(5), 2009, pp. 592-608

European Commission Portal on Smart Cities https://ec.europa.eu/info/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives/smart-cities_en

Evaluation of V4 cities in the area of Smart City, http://smartpolis.eit.bme.hu/?page_id=153

Fernandez-Vazquez, A., et al., Analysis and comparison of Smart City initiatives, Zaragoza 2017

Flynn, M., Hamilton, S., The Alliance Approach to Smart Cities. An innovation framework for financing, partnership, procurement, and governance, Deloitte, 2018

Fridayani, H., Rifaid, "Smart City as A Tool to Achieve Sustainability City Case Study: Sleman Smart Regency Implementation, Indonesia", Jurnal Tata Sejuta 5, 2019, p. 4

Gassmann, O., Introducing Digital Innovation to Cities, Emerald Publishing Limited, 2019

Gerrits, L., Verweij, S., "Critical Realism as a Meta-Framework for Understanding the Relationships between Complexity and Qualitative Comparative Analysis", Journal of Critical Realism 12 (2), 2013, pp. 166-82

Gibson, D.V., Kozmetsky, G., Smilor R.W., "The Technopolis Phenomenon: Smart Cities, Fast Systems", Global Networks, Rowman & Littlefield Publishers, Washington 1992

Giffinger, R. et al., Smart Cities: Ranking of European Medium-sized Cities, Centre of Regional Science in Vienna, 2007

Glaeser, E., Triumph of the City: How Our Greatest Invention Makes Us Richer, Smarter, Greener, Healthier, and Happier, NY: Penguin, New York 2001

Gontar, B., et al., Deployment of Smart City concepts in Poland. Selected aspects, Organizacijų vadyba: sisteminiai tyrimai 67, 2013, pp. 39-51

Gorgol, N., „Idea Smart City a przeciwdziałanie degradacji miast", Budownictwo i Architektura 16(2), Cracow 2017

Gorzelak, G., et al., Regional development, regional policy, Forum Obywatelskiego Rozwoju, Warsaw 2018

Hall, P., "Creative Cities and Economic Development", Urban Studies 37, 2000, pp. 633-649

Hämäläinen, M., A Framework for a Smart City Design: Digital Transformation in the Helsinki Smart City, Entrepreneurship and the Community: A Multidisciplinary Perspective on Creativity, Social Challenges, and Business, Springer 2020

Hämäläinen, M., Tyrväinen, P., "Improving Smart City Design: A Conceptual Model for Governing Complex Smart City Ecosystems", In Bled eConference 2018

Hollands, R., Will the Real Smart City Please Stand Up? Intelligent, Progressive or Entrepreneurial?, City 12, 2008

Hossain, M., Leminen, S., Westerlund, M., "A systematic review of living lab literature", Journal of Cleaner Production 213, 2019, pp. 976-988

http://www.remourban.eu/News--Events/News/Smart-Cities-Vs-Locked-In-Cities.kl [Accessed 22.04.2021]

https://theconversation.com/smart-cities-worlds-best-dont-just-adopt-new-technology-they-make-it-work-for-people-124939 [Accessed 22.04.2021]

https://www.smartcitiesworld.net/opinions/opinions/breaking-down-regulatory-barriers-is-key-to-achieve-smarter-cities- [Accessed 22.04.2021]

Husar, M., Social Innovations in Smart Cities – Case of Poprad, 2019

Illari, P. M. K., Williamson, J., "What is a mechanism? Thinking about mechanisms across the sciences", European Journal for Philosophy of Science 2, 2012, pp. 119-135

Janurova, M., et al., "Koncept Smart Cities Ve Veřejné Správě V České A Slovenské Republice", Geografické informácie 22 / 2018 / 1, 2018

Joo, Y.-M., Tan, T.-B. (Eds.), Smart Cities in Asia. Governing Development in the Era of Hyper-Connectivity, Edward Elgar Publishing, Cheltenham 2020

Khan, M. et al., "Smart city designing and planning based on big data analytics", Sustainable Cities and Society 35, 2017, pp. 271-279

Kimbell, L., The Service Innovation Handbook: Action-oriented Creative Thinking Toolkit for Service Organizations, BIS Publishers, Amsterdam 2015

Komninos, N., "Intelligent Cities: Variable Geometries of Spatial Intelligence", Intelligent Buildings International 3, 2011, pp. 172–188

Komninos, N., Kakderi, C. (Eds.), Smart Cities in the Post-algorithmic Era. Integrating Technologies, Platforms and Governance, Edward Elgar Publishing, Cheltenham 2012

Kourtit, K., Nijkamp, P., "Smart Cities in the Innovation Age", Innovation: The European Journal of Social Science Research 2012, pp. 93–95

Kourtit, K., Nijkamp, P., "The New Urban World – the challenges of cities in decline", Romanian Journal of Regional Science no. 7/2013, 2013, p. 10

Koźlak, A., Pawłowska, M., "Mobility-as-a-Service for Improving Mobility in Smart Cities - a Comparative Analysis of Selected Cities", Research Papers of Wroclaw University of Economics and Business 63, 2019, p. 34

Kramers, A., Hojer, M., Lovehagen, N., Wangel, J., "Smart sustainable cities – Exploiting ICT solutions for reduced energy use in cities", Environmental Modelling & Software no. 56/2014, 2014, pp. 52-62

Kucera, F., "Smart Government as a Key Factor in the Creation of a Smart City", 13th Annual International Bata Conference for Ph.D. Students and Young Researchers, 2017, p. 347

Lauriault, T., Bloom, R., Laurialt, J., Open Smart Cities Guide, OpenNorth, 2018, p. 14

Lebiedzik, M., "Application of the Global Concept of Smart City at the Local Level of the Karviná District", Sustainability 12, 2020, p. 3

Lee, J.H., Phaal, R. and Lee, S.H., "An integrated service-device-technology roadmap for Smart City development", Technological Forecasting & Social Change 80(2), 2013, pp. 286-306

Lees, A., The City: A World History (New Oxford World History), Oxford University Press, Oxford 2015

Lengyel, I., A kutatás-fejlesztés és a versenyképesség térbeli összefüggései a visegrádi országokban, 2016

Lopes, I., et al., Can a small city be considered a Smart City?, 2017

Martins, J., The Wired Society, Prentice-Hall, New York 1978

Masik, G., et al., “Smart City strategies and new urban development policies in the Polish context”, Cities 108, 2021

Matheus, R., Janssen, M., “How to Become a Smart City? Balancing Ambidexterity in Smart Cities”, ICEGOV '17: Proceedings of the 10th International Conference on Theory and Practice of Electronic Governance, 2017, p. 406

Meijer, A., and Bolivar, M., “Governing the Smart City: a review of the literature on smart urban governance”, International Review of Administrative Sciences 2016 82(2), pp. 392-408

Mercer, Quality of living city ranking 2019

Mora, L., et al., “Strategic principles for Smart City development: A multiple case study analysis of European best practices”, Technological Forecasting and Social Change, 2019

Mukhametov, D., “Smart City: From the Metaphor of Urban Development to Innovative City Management”, TEM Journal 8(4), Financial University under the Government of the Russian Federation, Moscow 2019, pp. 1247-1251

Nabatchi, T., Sancino, A., Sicilia, M., “Varieties of Participation in Public Services: The Who, When, and What of Coproduction”, Public Administration Review 77(5), 2017, pp. 766-776

Nam, T., Pardo, T., “Conceptualizing Smart City With Dimensions of Technology, People, and Institution”, Proceedings of 12th Annual International Conference on Digital Government Research, New York 2011, pp. 282-290

Nam, T., Pardo, T., Smart City as Urban Innovation: Focusing on Management, Policy, and Context, 2011, p. 187

Neirotti, P., “Current trends in Smart City initiatives: some stylized facts”, Cities 38, June 2014, pp. 25-36

Nesti, G., Co-production for innovation: the urban living lab experience. Policy and Society, 37(3), 2018, pp. 310-325

Niaros, V., Introducing a Taxonomy of the “Smart City”: Towards a Commons-Oriented Approach?, Ragnar Nurkse School of Innovation and Governance, Tallinn University of Technology, Estonia; P2P Lab, Ioannina, Greece 2016

Noworól, A., Smart governance and metropolitan dimension, Case for Krakow, Poland, Jagiellonian University, Cracow 2018

Oana, I.E, Schneider, C.Q., Thomann, E., Qualitative Comparative Analysis (QCA) using R: A Gentle Introduction, 2019

Oana, I.E., Schneider C.Q., "SetMethods: An Add-on R Package for Advanced QCA", The R Journal 10(1), 2018, pp. 507-533.

Ostrom, E., "Crossing the Great Divide: Coproduction, Synergy, and Development", World Development 24(6), 1996, pp. 1073-1087

Pattyn, V., Molenveld, A., Befani, B., "Qualitative Comparative Analysis as an Evaluation Tool: Lessons From an Application in Development Cooperation", American Journal of Evaluation 40(1), 2019, pp. 55-74

Peters, B. G., Capano, G., Howlett, M., Mukherjee, I., Chou, M.-H., Ravinet, P., Designing for Policy Effectiveness. Defining and Understanding a Concept, Cambridge University Press, Cambridge 2018

Peters, B. G., Policy Problems and Policy Design, Edward Elgar Publishing, Cheltenham, Northampton 2018

Ragin, C., Redesigning Social Inquiry: Fuzzy Sets and Beyond, University of Chicago Press, Chicago 2008

Ragin, C., The Comparative Method: Moving Beyond Qualitative and Quantitative Strategies, University of California Press, 1987

Rihoux, B., Configurational comparative methods (QCA and fuzzy sets): complex causation in cross-case analysis, in: H. Keman, J. Woldendorp (Eds.), Handbook of Research Methods and Applications in Political Science, Edward Elgar Publishing, Cheltenham 2016, pp. 383-400

Roblek, V., "The Smart City of Vienna", Smart City Emergence, 1st Edition: Cases from Around the World, 2019

Rogers, P., Funnell, S., Purposeful Program Theory: Effective Use of Theories of Change and Logic Model, Jossey-Bass, San Francisco 2011

Rubinson, C., Gerrits, L., Rutten, R., Greckhamer, T., "Avoiding Common Errors in QCA: A Short Guide for New Practitioners", COMPASS Research Network, 2019, pp. 1-6.

Rubinson, C., Rutten, R., Greckhamer, T., Avoiding Common Errors in QCA: A Short Guide for New Practitioners, 2010

Ruohomma, H., et al., "Towards a Smart City Concept in Small Cities", Technology Innovation Management Review, 2019

Sancino, A., et al., "Leadership in, of, and for Smart Cities – case studies from Europe, America, and Australia", Public Management Review, 2020

Schleicher, J., Vögler, M., Inzinger, C., Dustdar, S., "Modeling and management of usage-aware distributed datasets for global Smart City Application", Ecosystems. PeerJ Computer Science 3, 2017, p. 115

Schneider, C.Q., Wagemann, C., Set-Theoretic Methods for the Social Sciences. A Guide to Qualitative Comparative Analysis, Cambridge University Press, 2012

Schreiner, C., International Case Studies of Smart Cities, Rio de Janeiro 2016

Shanghai Manual A Guide for Sustainable Urban Development in the 21st Century, United Nations Bureau International des Expositions, Shanghai 2010, p. 228

Sikora-Fernandez, D., "Smart city jako nowa koncepcja funkcjonowania i rozwoju miast w Polsce", RESEARCH PAPERS of Wroclaw University of Economics nr 339, Wroclaw University of Economics, Wroclaw 2014

Sindhu, U., Balaouras, S., Dines, R.A., Hayes, N.M., Nelson, L.E., Helping CIOs Understand „Smart City" Initiatives: Defining the Smart City, Its Drivers, and the Role of the CIO, Forrester Research, Inc., Cambridge 2010, pp. 2-17

Smart Cities World, AcceliCITY Resilience Challenge finalists announced, 2020

Srivastava, S., Bisht, A., Narayan, N., "Safety and security in smart cities using artificial intelligence", 7th International Conference on Cloud Computing, Data Science & Engineering-Confluence, 2017, pp. 130-133

Sześciło, D., „Samoobsługowe państwo dobrobytu. Czy obywatelska koprodukcja uratuje usługi publiczne?", Wydawnictwo Naukowe Scholar, Warsaw 2015

Toffler, A., Third Wave, Bantam Book, New York 1984

Tuan-Yee, C., Smart Cities: Concepts, Perceptions and Lessons for Planners, MIT 2013

UrbanTide, Overview of the Smart Cities Maturity Model, 2016

Vidiasova, L., et al., "Smart Cities Prospects from the Results of the World Practice Expert Benchmarking", Procedia Computer Science 119, 2017, pp. 269-277

Visvizi, A. (Ed.), Smart Cities: Issues and Challenges, p. 235

Walravens, N., "Mobile business and the Smart City: Developing a business model framework to include public design parameters for mobile city services", Journal of Theoretical and Applied Electronic Commerce Research 7(3), 2012, pp. 121-135

Wolszczak, M., Krąż, P., “Smart living in the Krakow smart city”, Contemporary problems and research directions in geography 7, 2019, p. 158

World Urbanization Prospects. 2018 revision, The highlights, United Nations, Department of Economic and Social Affairs, New York 2018

Zong, J. et al., Evaluation guide for green and Smart Cities, China National Institute of Standardization, Beijing 2019

Zwick, A., et al., “Public engagement in Smart City development: Lessons from communities in Canada’s Smart City Challenge”, Canadian Geographer, 2020