

Design of the Smart City Domain Concept in the Czech Republic

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Abstract: The concept of a Smart City is a highly debated topic worldwide, the main weakness of which is the broad diversification of the concept itself. Individual solutions show a high degree of inconsistency in the processes involved in the Smart City concept. In order to effectively design and operate the Smart City concept, it is essential to establish process domains defining the scope of activities and services, all in accordance with cybersecurity. The Smart City initiative has evolved from the vision of sustainable development defined in global strategy documents dating back to 1992 when Agenda 21 for the 21st Century was adopted at the United Nations Conference. The Czech Republic (then Czechoslovakia) has also committed itself to fulfilling the objectives set out in this document and, in particular, the latest update, Agenda 2030, is the basis of current national and regional strategies. The purpose of the paper is, based on an analysis of European and national development strategies and guidelines concerning Smart City, to design a unified domain model, together with the characteristics of the key areas representing the Smart City concept for the needs of higher territorial administrative units of the Czech Republic.

Keywords: smart city; smart region; development; domain model; Czech Republic; cybersecurity

JEL Classification: O21; O32; O44

1. Introduction

The concept of a Smart City (SC) is a very trending topic not only in the Czech Republic but all over the world. Despite the huge interest and attention paid to the concept, no uniformly accepted characteristics, clearly defining the key domains of SC and their content, has been published so far. However, there are many different definitions, views, and models for SC that attempt to do so (Eremia et al., 2017; Dustdar et al., 2017). In general SC is described as: "The use of modern technologies and the best possible approaches to improve the quality of life of residents." Conceptually, SC is also associated with the vision of sustainable development, which has a significant role in the current SC initiative, but terms "smart" and "sustainable" cannot be used interchangeably. A city can be sustainable without being smart, but it cannot be smart if it is not sustainable, which is why the term "smart sustainable cities" has emerged (Ahvenniemi et al., 2017). It is the vision of sustainable development, along with the rapid technological advances, mainly in ICT and IoT, that are the basis for the current SC concept.

Global, as well as regional development, is influenced by a large number of initiatives and megatrends, based on which national strategies are created. National strategic plans in the Czech Republic are being developed in full compliance with these global initiatives and documents. Following the example of current national documents, at the turn of 2020-2021, strategies began to emerge at the level of individual territorial administrative units, which will be analyzed in this paper. So far, the implementation of smart solutions is most visible at the level of cities. The *Modrožlutá kniha Smart Písek* (Svítek et al., 2015) is considered to be the very first SC strategy in the Czech Republic. Currently, there are already a large number of such documents, but it is certainly worth mentioning a very well developed strategy called *Strategy #BRNO2050* (2020).

2. Global and National Influences

Agenda 21 (United Nations Conference on Environment and Development, 1992) is the most important document that sets out a development plan for the 21st century not only for individual countries, but for the whole world, and which has a significant contribution in the current form of the SC vision in the Czech Republic as well. It is also applicable to smaller local authorities, as highlighted in chapter 28 - Local authorities' initiatives in support of Agenda 21, which calls on local and regional authorities to implement this global plan in the form of their own agenda (CENIA, 2017). As a result, a development programme called Local Agenda 21 (MA21, 2006) was created in the Czech Republic, under the direct responsibility of the Ministry of the Environment. MA21 is an instrument, that translates the principles of sustainable development into practice, designed for municipalities and individual territorial administrative units, and to ensure a good and sustainable quality of life and environment in a specific territory.

Other global plans were developed in direct relation to Agenda 21, the most important of which is the United Nations (UN) Millennium Declaration (2000), which consists of eight Millennium Development Goals (MDGs). These set out the content of the current UN global program for the upcoming years Agenda 2030 (*Transforming Our World: The 2030 Agenda for Sustainable Development*, 2015), the core of which is seventeen Sustainable Development Goals (SDGs) for the period 2015 to 2030. All strategic documents worldwide therefore should be developed in line with and in order to meet these seventeen goals. This also applies to documents aimed at supporting the SC initiative. In the EU it started with Europe 2020 (European Commission, 2010), also called Digital Agenda, which is a ten-year strategy aimed at promoting smart and sustainable growth. Based on this, international activities called Smart Cities and Communities in 2018, and a year later The European Innovation Partnership on Smart Cities and Communities (EIP-SCC) were established, thanks to which the concept for Smart Cities was given a basic structure (*Smart Cities Methodology*, 2018).

The Czech Republic has also committed itself to the goals set out in the Agenda 2030 and the Strategic framework Czech Republic 2030 (Kárníková, 2017) was created based on this fact. It is an overarching strategic development document issued by the Government of the Czech Republic. It is followed by the Regional Development Strategy of the Czech Republic 2021+ (SRR21+, 2019), which sets goals at the national level for a horizon of seven

years, i.e., for the period 2021 to 2027. The SRR21+ itself states that the main purpose of the document is to identify a specific approach based on the needs of individual regions and to identify specific interventions to balance competitiveness between them while supporting sustainable development.

Another key document is the *Innovation Strategy of the Czech Republic* (Havlíček, 2019) for the period 2019 to 2030. This is a strategic plan for the Czech Republic's policy in the field of research, science, development, and innovation, which aims to move the Czech Republic among the most innovative EU countries. In this context, the strategy also introduced a new brand, under which the Czech Republic presents itself at the international level, Czech Republic: The Country for the Future. It is the systematic support of research, science, and education that can help meet all the seventeen development goals from Agenda 2030. This area also plays an important role in the development of the SC initiative. Especially *National research and innovation strategy for the intelligent specialization of the Czech Republic 2021-2027* (RIS3, 2021) is a strategic document focused on the effective use of European and national resources to support research and innovation in priority areas set out in SRR21+.

In accordance with all the above-mentioned national and European documents, based on global trends and in order to meet the development goals, the Czech Republic has decided to include the Smart concept in strategic planning for the next years. The first document which serves as direct support for the implementation of the SC concept at the level of cities, municipalities, and higher administrative units, is *Smart Cities Methodology* (2018) from the Ministry of Regional Development, which is an update of the older *Methodology of the concept of intelligent cities* (Bárta et al., 2015). In the document, the primary goal of the SC is defined as "Ensuring a quality of life for residents, where modern technologies are used as a tool to influence the quality of life in the city, and subsequently to achieve the economic and social goals of the city."

Based on this methodology, and to fulfill the mentioned Innovation Strategy, RIS3 strategy, and measure No. 55 from the SRR21+, the current overarching document Smart Cities Concept (MMR ČR, 2021) was created. The document looks at the issue from the perspective of municipalities, cities, and higher administrative units and presents a proposal of areas for new solutions that will ensure a quality of life for citizens and competitiveness at the international level. The structure and content of the Smart Cities Concept also show the impact of the recent European Green Deal (European Commission, 2019), which affects all proposed areas, especially energy, the environment, and transport.

In accordance with this concept and all of the above-mentioned documents, new development and Smart strategies with the outlook for the following years, most often until 2027, were created in individual regions of the Czech Republic at the turn of 2020-2021. These documents, together with the already existing Smart strategies of some regions, are that are the main subject of investigation in this paper.

3. Analysis of Regional Development and Smart Strategies in the Czech Republic

In order to design a unified domain model for the SC concept, applicable in Central Europe and especially in the Czech Republic, an analysis of regional development and Smart strategies of thirteen of the fourteen official higher administrative units of the Czech Republic is carried out. The fourteenth region is the capital city of Prague, which was omitted from the analysis because it approaches strategic planning more from a city perspective and therefore differs from others in certain characteristics, such as the absence of rural areas and rural communities. The aim of the analysis is to find out whether the individual administrative units are involved in the implementation of the SC concept in their territory, or whether this concept is included in their respective development strategies for the current period. Furthermore, based on this analysis, identify the key domains of the SC and possibly propose new domains that should be part of the model. Finally, the proposed model is compared against individual analyzed strategies to verify its meaningfulness.

The first step is a basic analysis of the structure of development strategies in terms of formulation, number, and content of priority areas (PA, see Table 1). Already at this stage of the analysis, the first results appeared. The strategy of twelve of the thirteen reviewed regions is, at least to a minimum extent, in line with the SC concept. Six of these twelve regions even have a separate strategy for Smart Region development (marked in green in the Table 1) from earlier years. Just one region does not have a development strategy for the current period to match the terms of the current national documents. For this reason, this region is also omitted from the analysis, as its strategy is not relevant to the objective of the paper.

The number of PAs ranges from four, in Ústí nad Labem and Pardubice regions, to ten, in the case of the Central Bohemian Region, with the largest representation being six and seven PAs. Already from the name and formulation of individual domains in some strategies, the influence of the Czech Smart Cities Concept is clearly evident. These basic domains are often supplemented by areas typical for that region, e.g., spas in Karlovy Vary Region. Other regions, on the other hand, have followed the traditional SC domains proposed in the study Mapping Smart Cities in the EU (Manville et al., 2014) published by the European Parliament. Based on a similar analysis of European cities, it defined six core SC domains, namely: Smart Governance, Smart Economy, Smart Mobility, Smart Environment, Smart People, and Smart Living. The PAs defined in the strategies of the Zlín and Liberec regions are closest to this concept. The remaining regions have taken a different path in formulating the PAs, but they still cover all key areas thematically, although in some cases only in the form of specific objectives.

However, education, science, research, and innovation were generally represented in all regional strategies (marked in yellow in the Table 1). This is a consequence of the influence of the Innovation Strategy, mentioned in the introduction, more specifically the RIS3 strategy, which focuses on this area. This demonstrates the importance of this domain and also supports the claim in the Innovation Strategy that education, science, research, and innovation help with fulfilling all of the seventeen SDGs.

Table 1. Priority areas in individual regional development strategies – Part 1

| The development strategy of the Central Bohemian Regional District 2019-2024 | The “Smarter Region” concept for the Liberec Region | The Development Strategy of the Olomouc Region 2021-2027 | The strategy for the development of the Smart Region of the Zlín Region 2030 | The concept of Hradec Králové Region – Smart Region | The Karlovy Vary Region Development program 2021-2027 |
|--|---|---|--|---|---|
| Economic development, Science, and Research | Smart economic development and tourism | Economics and Innovation | Smart economy, smart business, innovation, tourism | Knowledge economy | Economically prosperous and attractive region |
| Human resources, Education | Smart education | Education and Employment | Smart people - education, community development, culture | Public space and housing | Education and sport |
| Transportation | Smart transportation | Sustainable mobility and transport infrastructure | Smart mobility | Transportation | Transportation |
| Energy infrastructure | Smart technical infrastructure | Environment and technical infrastructure | Smart energy | Energy | Environment, Agriculture, Energy |
| ICT infrastructure | Smart administration | Public administration, development management, and security | Smart public administration | Public administration | Territorial administration, protection, and development |
| Healthcare | Smart healthcare | Healthcare and social services | Smart housing, social services, and healthcare | Services | Healthcare and Social services |
| Social services | Smart social services | Sport, Culture, Tourism | Smart environment | Environment | Spa, tourism, and culture |
| Environment | Smart environment | | | | |
| Tourism | | | | | |
| Culture | | | | | |

Table 2. Priority areas in individual regional development strategies – Part 2

| Transformation plan of the Ustí na Labem Region 2021-2027 | The development strategy of the Pardubice Region 2021-2027 | The development strategy of the Vysočina Region 2021-2027 | Development Strategy of the South Moravian Region 2021+ | The development program of the South Bohemian Region 2021-2027 | The Development Strategy of the Moravian-Silesian Smart Region 2017-2023 |
|---|---|---|---|--|--|
| Business, Research, Innovation | Economics - knowledge economy, tourism, transport | Competitive economy and employment | Competitiveness, entrepreneurship, innovation, and research | Effective territory management and innovation | More enterprising and innovative region |
| Competent people and Smart Region | Human resources - education, quality of public services | Quality and affordable public services | Education, sports, and extracurricular activities | Mobility | More educated and more employed region (Education) |
| New energy and efficient use of resources | Territorial development and cooperation - public administration | Modern infrastructure and mobility | Transport infrastructure and accessibility | Energy | A more connected and smarter region (Transport, accessibility) |
| Revitalization of the territory | Environment - ecology and energy | Healthy environment and sustainable countryside | Healthcare and social affairs | eGovernment and digitization | Cleaner and greener region (Environment, energy) |
| | | Attractive cultural and historical heritage and tourism | Environment, technical infrastructure, rural development, and agriculture | Healthcare and Social services | A healthier and more cohesive region (Health and social services) |
| | | | Tourism and culture, public administration, civic amenities, and security (including cybersecurity) | Environment | More attractive and cultural regions (Culture and tourism) |

4. Design of Unified SC Domain Model

The results of the analysis show a total of six domains, which we afterwards expanded by one more domain to a total of seven key domains for the implementation of solutions from the SC concept from the perspective of higher administrative units. Based on the proposed model, there are five vertical domains representing the basic areas of interest on which the regional administration should focus. These are complemented by two horizontal cross-cutting domains, namely Systematic science, research, education, and innovation, which emerged from the analysis as vital, and Cybersecurity, which was added to the model. Both cross-cutting domains strongly support and influence the processes and services in all other domains. It can be stated that they are the key to all future implementations, and therefore the regions should pay special attention to them.

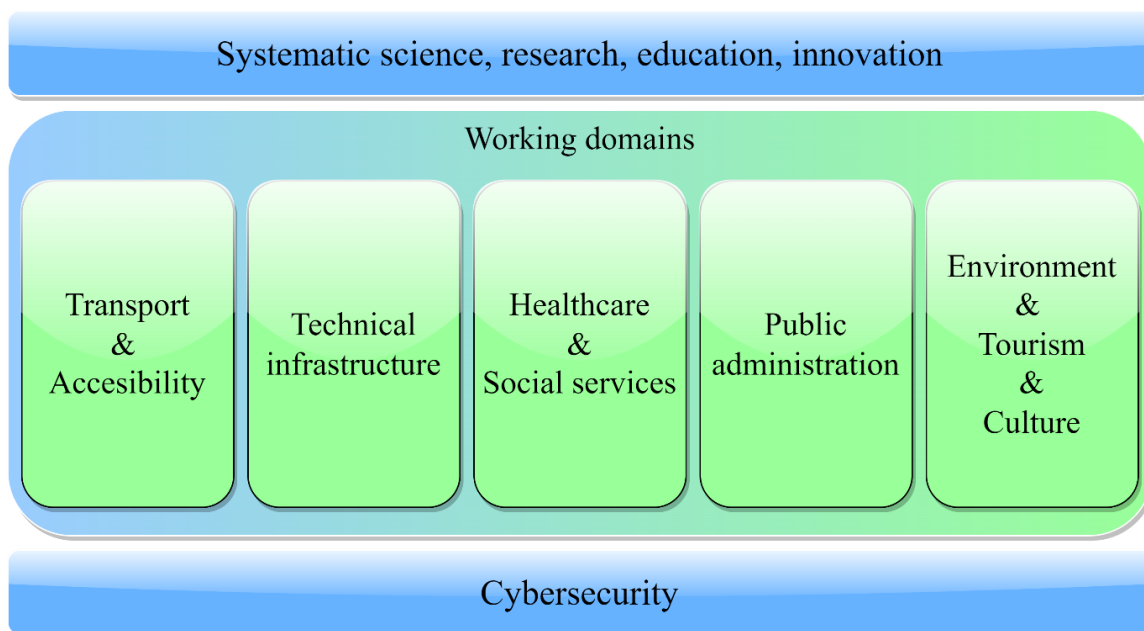


Figure 1. Scheme of proposed domains of the Smart City concept

The first cross-cutting area is, in all analyzed regions, based on regional RIS3 strategies. The supporting tool for growth and capacity development in the field of research, development, innovation, and know-how at the regional level is currently the program called Smart Accelerator II, which is part of the Operational Program for Research, Development, and Education (OP RDE) from the Ministry of Education and Physical Education. All regions are part of and benefit from this program, especially in the form of financial support. Specific activities typical for this domain are support for all levels of the education sector, talent development, improving the equipment of schools, laboratories, etc., support for the innovation environment, new solutions, small businesses and startups, coaching programs, and public awareness, digital education and more.

This domain has a large overlap with the second horizontal area of Cybersecurity. The concept of Smart Cities is entirely built upon the use of appropriate and modern technologies and is strongly influenced by global megatrends, such as the Internet of Things (IoT), OpenData, BigData, artificial intelligence, and more. However, as the technologies evolve

and their use grows, so do the threats and the level of risk. With this, the need to secure these solutions not only at the level of individual implementations but also at the level of the entire SC is growing in importance. The more surprising was the finding that the issue of cybersecurity was almost non-existent in regional strategies. Two exceptions are Karlovy Vary and Zlín regions. Other strategies included only mentions and claims that cybersecurity is important or that the threats need to be taken into account. However, they did not contain any specific measures, activities, or at least visions, together with reference to national documents dealing with this issue. The Zlín region paid the most attention to cybersecurity, and its strategy included specific goals and visions, together with ongoing or already implemented projects. It should be noted that the Cybersecurity domain does not only include security implementations and measures. It is here that these two horizontal areas intersect. Education, public awareness, and regular training of responsible people and employees are also very crucial.

Clear boundaries cannot be drawn for other domains either. Even though they are shown separately, their scope also overlaps. A typical example is air quality from the Environment domain and the issue of transport or even energy. Their representation in the form of individual domains is only for the sake of better clarity and simplicity. Examples of solutions from the Transport and Accessibility domain are, for example, smart parking, smart bus stops, smart public transport, vehicle sharing, electromobility, monitoring and evaluation of traffic, increasing the attractiveness of public transport, and more. Two major areas are included in the Technical infrastructure domain, namely Energy and ICT technologies. These include a high-speed data network, maximum IoT coverage, regional data, and analytical centers, digitization support, eGovernment in terms of technologies, smart buildings, smart lighting, renewable energy sources, smart grid, cogeneration of energy, and more. Great benefits for residents bring the domain of Health and Social services, which can contain improving the quality of care services, eHealth, mHealth, prevention and prediction with the use of appropriate technologies, homecare, support for sports activities, support for young families, immediate assistance systems, improving integrated rescue system services and more. The domain of Public administration is important mainly because it plays an important role in the implementation of solutions in other domains and the SC concept in general. However, from the point of view of citizens, this is the area of eGovernment, communication within the municipality, electronic services, OpenData, portals for citizens, and so on. The last domain, that could be described as the image of the region at the interregional and international level is the Environment, Tourism, and Culture. Environmental quality is closely linked to the whole SC concept and represents, for example, improving air quality, waste management, protection against elements, circular economy, waste and rainwater management, green infrastructure, renewables, regeneration of brownfields (land and real estates that are underutilized or neglected) and others. In the case of Culture and Tourism, it is about the promotion of the region, taking care of historical monuments, support of culture, etc.

5. Cybersecurity and Smart City

As mentioned above, the area of cybersecurity is an integral part of the design, implementation, management, and operation of all systems operated within the SC concept, and its goal is to ensure adequate parameters in the area of Confidentiality, Integrity, and Availability (CIA) of individual data assets that are part of the SC. A detailed framework for cybersecurity management across the EU is defined by Directive (EU) 2016/1148 of the European Parliament and of the Council (2016) – Concerning measures for a high common level of cybersecurity across the Union and the related Proposal for a Directive of the European Parliament and of the Council: on measures for a high common level of cybersecurity across the Union (2020), repealing Directive (EU) 2016/1148. Specific procedural and technical solutions at the EU level are set by the European Union Agency for Cybersecurity (ENISA) established by Regulation (EU) 2019/881, repealing Regulation (EU) No 826/2013. ENISA defines standards and recommendations for addressing current vulnerabilities and associated risks, as reported in Risk Management Standards (Eckmaier et al., 2022) and Guideline on security measures under the EECC (Milenkovic et al., 2020b). Then, in terms of the SC domains defined above, there are important publications on individual cross-cutting topics, such as energy and solutions for its time synchronization, where ENISA has issued a set of recommendations called Power sector dependency: Attacks against time-sensitive services (Stergiopoulos et al., 2020) for addressing risks in this area. Last but not least, ENISA also addressed the issue of security measures for 5G technology in its publication 5G supplement to the guideline on security measures under the EECC (Milenkovic et al., 2020), which has a high potential within the SC concept (Chuang & Tseng, 2021; Gohar & Nencioni, 2021; Zhao et al., 2021).

An integral part of the Smart City concept, according to the analysis, are eGovernment systems, i.e., public administration using modern electronic tools that will make public administration more citizen-friendly, accessible, efficient, faster, and cheaper. Among other things, its aim is to ensure that citizens can handle official matters at any time and from anywhere with an Internet connection using the maximum level of digitization, thanks to which most public agendas can be handled electronically without the need to go to the office. This entails the need to implement an EU-wide recognized electronic identity that will allow uniform access for authentication and authorization across the EU. Ensuring an adequate level of cybersecurity for both the agendas and the aforementioned generally available Internet connection is a necessary part for the full implementation of the eGovernment principles.

Another important part is undoubtedly to ensure the availability of integrated rescue system (IRS) services, which for its effective operation uses not only communication systems, automatic location systems, but also, for example, intelligent traffic management systems, status information, and throughput of individual routes, available online and with the appropriate level of confidentiality. Another key area of an SC is also intelligent, reliable, and safe management of energy systems, especially the distribution of electricity, gas, and water. Approaches to ensuring maximum diversification of these resources and their ecological context form the point of view of the European Green Deal, also belong to this area. The

framework for ensuring the cybersecurity of all the above-mentioned components of the SC concept is defined by the Czech national legislation, in particular Act No. 181/2014 Coll. (Cybersecurity law), Decree No. 82/2018 Coll. (Decree on Cybersecurity), Act No. 127/2005 Coll. (Electronic Communications Act), Act No. 240/2000 Coll. (Crisis Act), Decree No. 317/2014 Coll. (Decree on significant information systems and their determining criteria), and a Government Regulation No. 432/2010 Coll. (Government decree on criteria for determining a critical infrastructure element). This national legislative framework applies to defined systems included among the so-called “critical information infrastructure” or “important information systems” which are identified in Directive (EU) 2016/1148. However, the forthcoming change in Proposal for Directive (EU) 2016/1148 from 2020 makes it more than obvious that it will be necessary to expand the group of these specific systems and to include secondary systems, which may play the role of a source of information or be processors of information. To achieve this goal, it is necessary to build a comprehensive data model. Based on the security classification of data, it is then necessary to build a multi-level system to ensure cybersecurity. Considering the specifics of the data of the individual domains of the SC concept, providing comprehensive and systematic education and considering the requirements defined by the ISO/IEC 17799:2000 standard, safe operation of the SC concept as a whole will be achieved.

6. Conclusions

The aim of the article was to design a domain model based on the analysis of relevant national and regional development strategies. The analysis itself confirmed that a major problem of the Smart City concept is the high degree of diversification of its conception, and that this is not a problem that occurs only at the international level, but also at the level of higher administrative units. Based on the results of the analysis, five working domains were identified, representing the different Smart City areas of interest from the perspective of higher administrative units, and one cross-cutting domain, which supports the overall development of the Smart City concept and is the basis for all future implementations. This initial model, containing a total of six domains, was further complemented by an additional horizontal domain providing Cybersecurity, addressed across all processes and services of the defined model. Another strength of the proposed model is the possible implementation of process management using the PDCA cycle, where the “Plan” phase is applied within the Systematic science, research, education, and innovation domain, i.e., outputs from this domain serve to verify existing conditions and set Smart City goals. The “Do” phase, the implementation of the created plan, is implemented in individual working domains. The “Check” phase has its place within the Cybersecurity domain, the aim of which is not only to verify security but also partial functionalities and impacts on working domains. And lastly, the “Act” phase is again being implemented in the first domain, as it aims to find mitigation measures based on the previous phase. This makes the proposed model resistant to implementation errors and ensures its continuous improvement. In the end, these seven domains were validated against the analyzed development strategies to verify the validity and meaningfulness of the proposed model.

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Conflict of interest: none

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