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Project Smart Danube Region

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Table of Content

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List of Abbreviations

SC – Smart City
EU- European Union
EC – European Commission
ICT – Information and Communication Technologies
UK – United Kingdom
IEEE - Institute of Electrical and Electronics Engineers
BIS – Business, Innovation and Skills
IoS – Internet of Services
IoT - Internet of Things,
IoP – Internet of People
IoE - Internet of Energy
HMI – Human Machine Interface
BIM – Building Information Management
CIM – City Information Management
MaaS – Mobility as a Service
CPS – Cyber-Physical System
CPSP – Cyber-Social-Physical System
PPP – Public Private Partnership
EPC – Energy Performance Contracting
PCAST - President's Council of Advisors on Science and Technology
AI – Artificial Intelligence
SCC – Smart City and Community

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1. Introduction

1.1. Objectives of this document

This study is part of activities within the EU Danube Transnational Programme – Interreg (http://www.interreg-danube.eu/). The aim of the study is to analyse existing ways of solving and shaping cities as well as entire Danube Region using the concept of so-called Smart City strategies.

The whole study will be parted into two deliverables:

Part I – Preliminary analysis and examples of Smart City initiatives

Part II – Final report

Part I (this document) focuses on collection and description of available documents, literature and contacts in given area. Firstly, strategies and goals of Smart Cities will be clarified and described. The emphasis will be put on connection of particular parts and orientation on quality of life of citizens and sustainability of the region.

Apart from the definition of the key words in this field, the examples and experiences from the Czech Republic and whole world will be introduced. Elements and utilities of Smart City will be also described for the cities of Plzen, Prague and Pisek. Apart from independent elements of Smart City local legislative and political approach will be also analysed. Among others legislation and policy of the European Union will be provided together with introduction of best practices from the world, their methods and experiences. Found approaches will be compared with the experiences from the Czech Republic.

Following part of the report, which will be delivered before the end of this year, will look into the current situation in the Danube Region. It will also verify common strategies and cooperation toward Smart Cities, and analyse and compare projects deployed and results achieved in countries in Danube basin.

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1.2. Definition of Smart Cities

Before we start looking into the particular projects and issues related to the Danube region, this section provides a brief introduction and the core concepts related to S*mart Cities* (SC). The objective is to gain a common understanding with respect to this field.

Nowadays, the term "***Smart Cities***" has gained on popularity in Europe as well as abroad. With the human population expected to grow from the current 7.3 Billion to more than 9 Billion by 2050, it is estimated that approximately 70% of the planet's inhabitants will also be living in an urban setting [1]. Therefore, it is imperative that future cities must be sustainable, environmentally sound, affordable, and shall provide citizens a high quality of life, including such things as habitat planning, essential services, goods, employment, culture and recreation, and safety.

There are really many different definitions of Smart Cities. In the following paragraphs, we provide just selected few that indicate the broad range of definitions.

Deakin and Al Wear [2] list four factors that contribute to the definition of a Smart City:

1. The application of a wide range of electronic and digital technologies to communities and cities,
2. The use of ICT to transform life and working environments within the region,
3. The embedding of such Information and Communications Technologies (ICTs) in government systems,
4. The territorialisation of practices that brings ICTs and people together to enhance the innovation and knowledge that they offer.

IBM defines a Smart City as "one that makes optimal use of all the interconnected information available today to better understand and control its operations and optimize the use of limited resources" [3].

Cisco defines Smart Cities as those who adopt "scalable solutions that take advantage of information and communications technology (ICT) to increase efficiencies, reduce costs, and enhance quality of life" [4].

Smart Cities Council [5] provides the following definition: "A Smart City is one that has digital technology embedded across all city functions."

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IEEE (Institute of Electrical and Electronics Engineers) Smart Cities: "A Smart City brings together technology, government and society to enable the following characteristics: Smart Cities, smart economy, smart mobility, a smart environment, smart people, smart living, smart governance." [6].

From the definitions above is clear that technological companies and technological institute IEEE focus very strongly on topics such as an internet of things, sensors, and technology in general. There are, however, other definitions that stress other aspects.

The UK Department for Business, Innovation and Skills (BIS) considers Smart Cities "a process rather than a static outcome, in which increased citizen engagement, hard infrastructure, social capital and digital technologies make cities more liveable, resilient and able to better respond to challenges." [7].

The European Commission [8] states that „A Smart City is a place where the traditional networks and services are made more efficient with the use of digital and telecommunication technologies, for the benefit of its inhabitants and businesses. With this vision in mind, the European Union is investing in ICT research and innovation and developing policies to improve the quality of life of citizens and make cities more sustainable in view of Europe's 20-20-20 targets."

Business Dictionary [9] defines Smart City as: "A developed urban area that creates sustainable economic development and high quality of life by excelling in multiple key areas; economy, mobility, environment, people, living, and government. Excelling in these key areas can be done so through strong human capital, social capital, and/or ICT infrastructure."

From just these definitions above, the reader can get the image of how extremely broad this field is. The IEEE, in its definition, states that Smart City brings together technology, government and society as a whole, and the key requirement is to meet the goals of six key areas. The Smart Cities Council only mentions ubiquitous digital technologies, but it does not say anything about goals and requirements. In contrast, the European Commission says traditional services and networks are delivered more efficiently with the help of technology for the benefit of its citizens. However, the definition is very strict and focuses only on urban functions. Business Dictionary, on the other hand, speaks of two key objectives,

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namely sustainable development and a high quality of life for citizens, and also mentions how this can be achieved. It was deliberately overridden by the Department for Business, Innovation and Skills definition, which says that the transformation of cities into Smart City is a series of processes to meet the objectives in key areas. It is with this definition that the authors are most inclined.

For the purpose of this study, we focus on the following aspects as key to Smart Cities: "*The primary goal of Smart City is to find a concept that will enable cities to deliver a sustainable development model, outstanding quality of life, safety and maximum energy efficiency. All of this with the help of state-of-the-art technologies.*"

Many changes are needed for cities to become more efficient, attractive, inclusive and competitive. This change will not only require a new paradigm in the way how cities look, but also a breakthrough in how cities, businesses, citizens and academia think and work together – the overall way of thinking. The transition towards smarter cities is about reinventing cities, such that citizens are no longer considered only as *users*, but also as *key stakeholders*. Technology should be no longer looked as a static asset, but as a *dynamic enabler*. Business is no longer viewed as a provider, but as a *partner*. The notion of urban evolution is replaced by *transformation*. Smart City solution cannot be bought. The transformation of cities into Smart City must be understood as a series of processes.

According to the Czech Environmental Law, a sustainable model is "such a development that preserves the present and future generations of the opportunity to meet their basic life needs, while not diminishing the diversity of nature and preserving the natural functions of ecosystems" [10].

Defining the concept of quality of life is very difficult itself, as each person's quality of life is different. If, however, we had to choose one definition, we tend to [11]: "Quality of life is the intangible aspects of life, i.e. health, social relations, the quality of the natural environment, existing living conditions and personal welfare."

1.3. What actually is a city

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If we want to transform a city to a Smart City, we need to understand what actually a city is. A city shall be viewed as a system composed of different subsystems essential for its functioning and performance, such as water, gas and electricity infrastructure, transportation, urban development and buildings, public services, healthcare, government and many others. These areas are typically considered to be independent, and different municipality agencies, as well as diverse research teams consider them as separate topics, with one joint aim: to create a city which is ***efficient, liveable and sustainable*** [12]. This concept is depicted in Fig. 1.

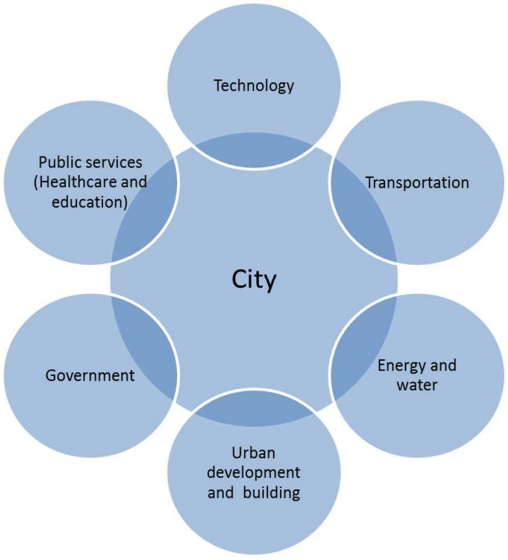

Fig. 1: Different subsystems composing the resulting perception of a city

In order to address the concept of Smart Cities, the researchers and decision makers have to look at particular subsystems and analyse them in details. The traditional view on the particular subsystems (only selection of the possible subsystems) is depicted in Fig. 2.

For each of them, the basis of the pyramid is composed of the resources (for example energy). To accommodate the demand, an infrastructure (for example pipelines etc.) must be available. On this infrastructure, different providers (for example electricity provider) offer their services, these are on the top of the pyramid. This is true for all particular subsystems.

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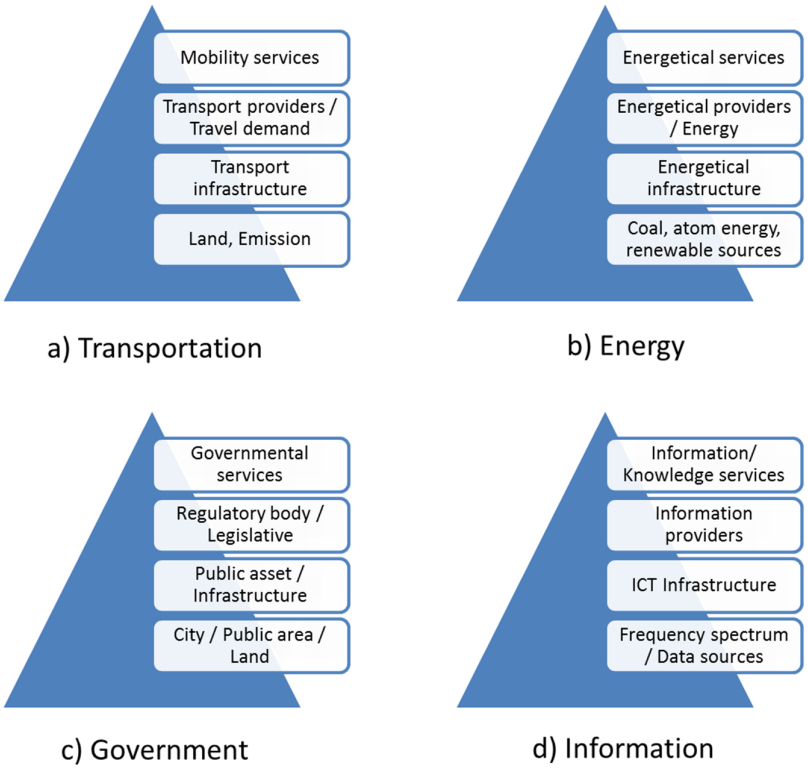

Fig. 2: Traditional view on selected Smart City subsystems

1.4. Basic characteristics of a Smart City

The physical structure of cities has historically been shaped by the need for space suitable for specific types of activities and transactions by their residents. These activities took place both inside, for that purpose, of objects built (object complexes), as well as in their closest private, semi-private or public space surrounding them and the system of streets that eventually connects them.

To begin with, we can help analogy and imagine the city as a smart factory, including a created parallel virtual model that serves to manage processes according to Industry 4.0 concept and describe its 6 basic principles:

- **Modularity** - The Smart City has a modular arrangement (structure). Flexible adaptation of the city to change the order from the client is addressed by replacing an unsuitable individual module or by adding new modules meeting new requirements, such as transport or energy supply,

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- **Interoperability** - The city as a smart factory has interconnected parts of its cybersecurity system (CSPS), such as buildings, utilities, an integrated transport system, elements of public spaces such as public lighting, sorted waste containers, school complexes, hospitals, accommodation capacities, water distribution infrastructure, energy, social networks, commercial and logistical supply centres,
- **Virtualization** - The city is visually mirrored in its virtual copy. In this it is possible to monitor the physical processes of the city thanks to sensors directly connected to this virtual model. Individual activities can be simulated at individual physical levels,
- **Decentralization** - The possibility of decentralization of control allows the city to make autonomous decisions and to create alliances of different intelligent components for solving different situations,
- **Real-time decision-making** - City's control systems have the ability to make decisions in real-time on the basis of the data being collected and their immediate analysis,
- **Service Orientation** - Within an interaction between individual parts of the city, residents, visitors and business, the active offer of services is a vital business item that is offered through the IoS (Internet of Sevices) network,

The traditional view focuses strongly on the resources and infrastructure. Majority of the investments are done with respect to these issues. A new trend is clearly visible, for example in the field of information technologies, however, it shifts this view into so-called Service Oriented Architecture.

If we want to make a city smart (i.e. efficient, liveable and sustainable), we must focus on the services provided to its citizen’s, as schematically depicted in Fig. 3.

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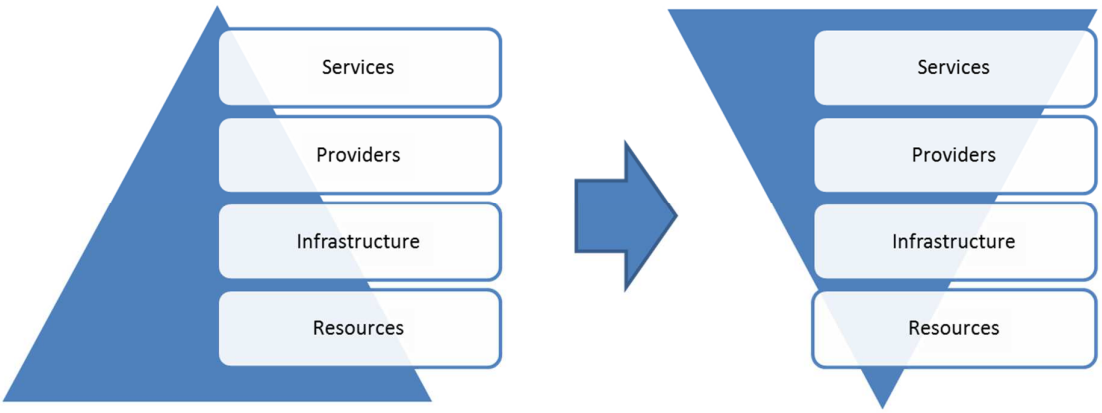

Fig. 3: Shift in perception towards the services provided to the citizens

The basic goal of Smart Cities approach is to use all available knowledge about the city to provide best services for different classes of inhabitants on limited infrastructure and with minimal resources [13]. In order to achieve its goals, the particular subsystems must cooperate to achieve synergic effect. It means that a Smart CitySmart City is a system where the whole is more than the sum of achievements from the particular subsystems [14].

The mechanism of urban systems development and the distribution of information inside and outside urban areas takes place in the cybernetic plane of a parallel virtual environment. The development of physical city structures is directly dependent on processes simulated and controlled by a virtual model. Similarly, processes, relationships and transactions between large urban structures, smaller towns and village settlements, various urban structures along transport infrastructure and the countryside can be observed.

2. Concept of Smart Cities

In Europe, the Smart City concept is a response to growing urbanization and, to a large extent, a further development step of the EU's regional policies, which have so far focused on promoting regions and cities. However, the continuing concentration of economic power in cities requires special access to solutions for the problems of today's cities, which are pushed by the demands of citizens to improve the environment while maintaining its economic performance ensuring a high quality of life. Massive investments to improve urban conditions are increasingly more

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complicated and strain urban budgets, which are not prepared, without an external impulse (state or for example the EU), to withstand implementation of such activities.

Smart City is involved in the process of improving the conditions in the city industry, universities and not just the city's capacities (human, financial). The city in this partnership de-facto creates the conditions for pilot projects that occur and search for solutions that benefit the citizens of the city, while seeking innovative economic models for their financing, and further expansion of the system.

The Smart Cities concept is aiming on using modern technologies to synergize the various sectors (transport, logistics, security, energy, building management, etc.) regarding the energy performance and quality of life in the city.

When talking about Smart Cities, one cannot forget the construction industry, which is a major industry (**Construction 4.0**). In this example, it is possible to demonstrate that the concept of Industry 4.0 is applicable for example when ordering and supplying of typical and atypical structural elements, but also in the actual construction.

The applications of Smart Cities can be divided into to groups: **target specific applications** and **generic applications**. Target specific applications try to optimize energy consumption, improve air cleanliness, reduce noise, regulate transport, etc. On the contrary, generic applications support the **genetic code of a given territorial unit**, i.e. its own historical, cultural, ecological or aesthetic essence. The data obtained can be extended to other types of local units, such as smart village or smart regions.

2.1. Human factor

A key factor in all clever solutions is the human factor, on the part of the application management as well as on the part of its users. Therefore, we need to talk about **human interfaces** between technical systems and humans (typically called HMI), which should be intuitive and easy to understand for all categories of the city's population (children, disabled people, etc.). Interactions of human factor can be verified using different

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types of multimers on a selected sample of inhabitants and designing these systems as user friendly as possible.

From this point of view, the meaning of "smart" can be seen in a balanced relationship between man and the technical systems. Smart solutions must make cities more humane and not only technologically advanced. Intelligent teams, including experts in humanities (sociology, psychology, the environment, etc.), naturally arise around the issue of Smart Cities.

Social networks are an example of this interface, because they can ensure effective interconnection between different population groups, through targeted information to influence their behaviour and improve the two-way communication with the citizens and leadership.

2.2. Resistance

Great phenomenon of Smart Cities is the need to become **resistant (resilient)** against a variety of natural disasters, terrorist attacks, as well as cyber-attacks or power failures (black-outs). New technologies provide better prevention, based on a better understanding of individual processes in the city, as well as better intervention possibilities in the occurrence of these emergencies. Of course, these technologies can also be used to increase the availability of the fast rescue services in the city and for other **critical applications**.

The whole system of a Smart City must be designed with respect to its **gradual degradation (graceful degradation),** of its inoperative currencies of some of its parts. Although in this case, the system loses some of its functionality, it reconfigures itself in the way that the most important functions keep fulfilling their role. An example may be a transport system where, in the event of a failure of the central control panel sub-nodes are controlled autonomously. Even if you do not control the system drivers still have to keep track of the road traffic signs. Although, this is not an optimal way of managing of the traffic, traffic flow will not stop. After the central control is restored the system goes into its original configuration. Similarly, it is possible to proceed to the design of a comprehensive Smart City management system where there should be scenarios for different types of degradation.

2.3. Smart Grids

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The basic factor for the introduction of the concept of Smart Cities is sustainable development which means it must be environment friendly and minimize energy consumption but at the same time the city must remain competitive in long-term perspective. In this spirit, a new view on the power grid of the city emerges which corner stones (building, mean of transport, smart stop, etc.) are no longer mere user but can be energy source (solar panels) or energy storage (batteries). From this point of view, the flow in the power grid is also not one-way as it was in the past from source to application but are bi-directional taking into account the current operation of different power grid nodes. The energy grid must be suitably complemented with the information network embedded with control algorithms that optimize energy flow in the given territorial unit **(smart grids).**

2.4. Smart Buildings

One of the basic sub-nodes of the power grid is the building. **Smart Buildings** use information technologies for collecting knowledge about the operation of the buildings over their entire **life Cycle** and combine this information with external knowledge such as weather forecasts, the reaction of another building to a similar emergency situation, etc. This way information database of each building is created (**BIM – Building Information Management)** where this knowledge can be further combined to create knowledge base for whole street, district or even city (**CIM - City Information Management**). The complete knowledge base of the city must, of course, consist of delivered knowledge from other areas, typically such as transport, environment, security, water and waste management, health, etc. Only with their integration we can talk about a knowledge-based Smart City.

Since industrial objects or production plants are part of Smart Cities (regions), it is also necessary to look at the information interface with Industry 4.0 systems. Similar, situation concerns agriculture where **smart vertical farms** can be created, but also use of public space for those purposes.

2.5. Mobility and Logistics

Future development will require entirely new approach to **smart mobility** which is gradually becoming a **service (MaaS - Mobility as a**

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Service) with specific guaranteed parameters, such as it is today, e.g. by telecommunication operators.

Urban logistics (City Logistics) seem to be a new phenomenon based on the sharing of transport, means for transport outside and within the city. These principles apply, for example, to waste and to supplying of a particular area. Of course, there are on-line information on requirements and the possibility of sharing, for example, vehicles and logistics centres.

Autonomous means of transport using artificial intelligence algorithms to optimize the serviceability and logistics of the entire territory are a great future for Smart Cities. It goes without saying that these resources will use alternative fuels, probably electricity (**e-mobility**). It is not just about transporting people and goods but also about robotic vehicles designed for street cleaning, snow removal and other activities that people are doing today. Considerable development of transport systems can be expected, with autonomous drones and special types of fast lanes.

2.6. Management

New technologies enable better project management and public consultation - promoting **participatory methods** of citizens. Presentation of variant solutions can be solved using virtual simulation models, where the advantages and disadvantages of individual variants can be monitored and thus decide in more qualified way at the city management level. As a by-product, the documentation for the project plan, which should be retained for further phases of future project expansion.

Smart Cities Management uses a variety of sensors, starting with physical detectors, and ending with space imaging (weather prediction, city temperature maps or emission maps). It should be noted that even a vehicle or a mobile phone in this concept becomes an intelligent sensor providing important data. The public lighting infrastructure can, for example, realize a sensory network while ensuring the availability of telecommunication services throughout the city.

From a technical point of view, the Internet of Things (**IoT**), Internet of People (**IoP**), Internet of Energy (**IoE**) or Internet of Services (**IoS**) will be increasingly used.

From the theoretical point of view, there is an example of Cyber-Physical System (CPS) or, in the case of Smart City, a **cyber-social-physical**

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system (CSPS). These tasks can be solved with help of the Theory of Complex Systems.

Large-scale **data processing (Big Data)** is increasingly used by supercomputers, including cloud-computing. City management, thanks to current data, moves from the original predefined dynamic plans to adaptive control algorithms that ensure the coordination of entire territorial units. Different simulation tools are used to validate individual strategies. In virtual space it is much easier to model responses to different types of extraordinary events. Verified strategies can then be projected into real life city management through actuators, which can be both, the physical infrastructure facilities and navigation, as well as assistance services.

Nowadays, there are multiple methods how to measure "smartness" of the city - the **Smart City index**. It is about evaluating of the digitization of different city processes, evaluating sub-functional areas such as mobility, energy, security, or assessing information links between smart service operators and their users. Based on different methodologies, the annual ranking of the top 10 Smart Cities in the world takes place at the global level. It is interesting to mention, that in the top positions of those we can see repeatedly the same cities in different order, regardless of the type of methodology that has been used. It is a sign that their approach to the topic is correct.

2.7. New Business Models

Current technologies allow the emergence of **new business models** based on sharing, such as bike-sharing or car-sharing. This creates the whole field of the **shared economy**.

Even in the new domain, it is still possible to use proven business models. **Public-Private Partnership (PPP)** is a public service funded and operated through a partnership between a public organization and one or more private companies. For some forms of PPP (sometimes referred to as Private Financial Initiative, PFI), the required capital is provided by a private investor on the basis of a contract with the contracting authority. This private investor, the concessionaire, on the basis of the concession contract continues to provide the requested public service for a contractual term. His investment is being gradually payed by the contracting authority for this service while taking into account its quality (for example, in the case of unpaid transport infrastructure), or granting the private partner the right to

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collect payments for the provision of the service directly from users (for example, for tolled infrastructure).

The **Energy Performance Contracting (EPC)** method is based on the financing of energy-saving investment projects, i.e. facilities for the supply and utilization of energy (usually heat and electricity) in buildings and other objects, from achieved energy savings. In this case, the costs associated with the implementation of the project are borne by the contractor. It also bears full responsibility for the appropriate choice of technology, delivery and subsequent operation. The ways in which the project can be financed can be different - bank loans or other sources

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3. Smart Cities in the World, Europe and the Czech Republic – Best Practices

In the following chapter, examples of Smart City solutions in the world, Europe and the Czech Republic will be provided. First part of this chapter will describe current situation in a Smart City development in the world, which can be divided into three areas of the main interest in the above phenomenon. Generally, three different trends in approaches or expectations are visible in distinct areas of the world, particularly the North America region, Eurasia and the European Union. These differences, although subtle, come from different starting points of cities in the given region, different cultural and economic conditions and different expectations of the citizens. At the end, we will take a closer look into examples in the Czech Republic.

Based on the distinction above, this chapter and the examples have the following structure:

1. Smart Cities in the World
    a. The North America region with the U.S. as a regional leader,
    b. The Eurasia with China emerging as the regional leader,
    c. The European Union member states,
2. Smart Cities in the Czech Republic.

3.1. Smart Cities in the World

3.1.1. The North America region with the U.S. as a regional leader

The North America and the U.S. especially predominantly focused transformation of their cities in improving the government – citizen relation and information flow. With this regard huge leap of digitalization in cities have been achieved lately.

The importance and economic opportunities coming from the Smart City field were also recognized on the local and federal level which led to dynamic growth of the field. Few examples worth mentioning included BOSTON311APP [15].

It allows citizens to report to the municipality on virtually any issue they spot in their region. Moreover, on the other end they can also browse through reported issues and find out about problems newly emerged in the

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city. This simple tool empowers citizens and gives them impression of real influence and connection with their city while at the same time it helps administration to recognize all the problems in the city.

On the other hand, there is the bright example of New York City, which has been for many consecutive years recognized as one of the top 10 smartest cities in the world in numerous rankings performed according to specific standards and rules [16][17]. One of the reasons for that is that New York City ties its economy to technology. As former mayor Michael Bloomberg said: "The future of the global economy, in every industry, is tied to technology – and the future for cities that recognize this fact is very bright." The city's road map to digital change included not only the appointment of a digital officer in 2011, but a digital roadmap comprising open government, citizen engagement, education, industry collaboration, and public access.

Taking perspective of a federal level, according to President's Council of Advisors on Science and Technology (PCAST) [18] special focus in the USA is currently put on following issues:

i. **Implementation and Integration of Newest Technologies into Economics of the City and its each Integral Part:**
   - Transportation
   - Energy
   - Buildings and Housing
   - Water
   - Urban Farming
   - Urban Manufacturing

ii. **Transforming of Urban Development Districts:**
   - „Green" Districts
   - Convenient, Accessible, „Mobile" Districts
   - Connected „inclusive" districts

iii. **Data-Enabled Pilot Projects**

iv. **There is identified clear and urgent need for Urban Science Profession and Degrees in order to meet the challenge of rapidly evolving and growing in size and complexity cities**

3.1.2. The Eurasia with China emerging as the regional leader

Second important region to mention in the context of the Smart Cities is the Eurasia with focus on the far east. According to Deloitte, there are about 1000 Smart City pilot projects ready for or under construction, and more than 500 of them are in China. Their approach is inspired by South Korea, Japan and Taiwan and Singapore, however, scale of their investments and

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undertaken projects is unprecedented. Technologically advanced countries identified their chance of balanced development and invested in Smart City technologies a decade ago, which granted them prestigious positions in Smart City rankings around the world for number of consecutive years [17].In Asian area, main focus is put on smart technologies, Artificial Intelligence tools and IoT very broadly. However, common denominator is drive for efficiency. The public sector tries to deliver better services through fewer resources while businesses and citizens demand more. This has driven governments to focus on building smarter and more sustainable cities, which are powered by technologies that are able for them. It is a necessary development due to rapid urbanization and rising expectations. To provide insights into the development of smart and sustainable cities in ASEAN and the Asia-Pacific, The Economist Intelligence Unit [19] established an Expert Advisory Board and conducted a survey of 2,000 citizens in 20 cities across ASEAN (Bandung, Bangkok, Danang, Davao City, Ho Chi Minh City, Jakarta, Kuala Lumpur, Manila, Siem Reap, Singapore and Yangon) and Asia-Pacific (Auckland, Chennai, Hong Kong, Melbourne, Mumbai, Seoul, Shanghai, Taipei and Tokyo). The key findings from the research are as follows:

- **Smart City initiatives are rising in importance and citizens want more of them,**
- **Connectivity is central to both supply and adoption,**
- **A wide variety of perceived benefits,**
- **A lack of information is the biggest impediment to greater usage,**
- **Partnerships are needed to seize the full benefits.**

In the survey conducted on over 2000 citizens from 20 Asian cities [20] over 82% say that their city should create more Smart City initiatives although it remains unclear which ones should be undertaken (figure 4).

Citizens and government realize that although new technologies and connectivity are the most commonly means of achieving the Smart City status, the most pursued advantages are Economical efficiency of cities and improvement of environmental conditions in and around the cities.

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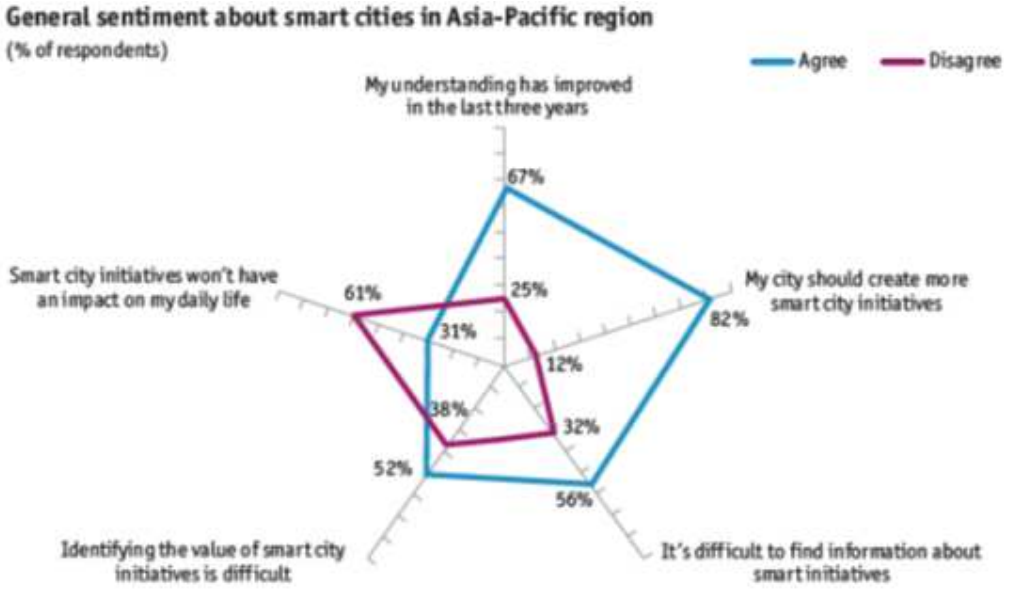

Fig. 4: Demand for more initiatives, but unclear on which ones [19]

Number of international experts' alert [21], that there may be different level of demand and desire for changes and Smart City innovations depending on information spread among citizens. "Demand may come automatically in Singapore (…) But in places such as Siem Reap you need to educate people and advertise benefits. If Smart City initiatives are presented as technical and abstract, then adoption will be a challenge."
Last major concern in the Asia-Pacific region is cyber security of data. Together with deployment of new technologies and introducing them into Smart City everyday life, it is very important to take into consideration and meet all security need of citizens. All of these measures shall be built in from the beginning in any Smart City initiative.

In 2016 the Economist [19] provided a large scale survey among citizens of what is considered the smartest cities in Asia, about "Who should lead Smart City development?"

The most common belief in this matter is, that the National government should take lead on Smart City initiatives (35%) followed by city government (28%) and combination of private and public sector (25%).

3.2. The European Union member states

Last region clearly distinctable for its approach to Smart Cities is the EU. The European commission identifies Smart Cities as a way to achieve

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sustainability, balanced development and higher quality of life in the cities. According to the EC [22] following actions are suggested from the governance perspective:

Manage the shift towards a collaborative operating model. Static and public administration-centred governance systems collide with the integrated SCC solutions approach. Collaboration must be favoured at different levels, specifically:

- **Integrating solutions enhancing coordination at city-governance level.** The analysis of SCC cases has shown that there is still a limited share of integrated solutions, as these tend to be developed at sectorial level. Although reasons are numerous, the separation at city government and planning level hinders coordination and collaboration among departments. This could be resolved by creating a centralized coordination office for integrated SCC solutions and by supporting city planning with appropriate tools/guidelines for SCC strategies and initiatives;
- **Strengthening multi-stakeholder partnerships at all levels.** SCC solutions are complex; they require the public sector to partner with private parties, which have the interest, capacity and skills to develop the projects. Thus, the governance of cities as well as that of specific SCC solutions should enhance the participation of the different parties, in particular private companies and universities/research centres;
- **Enabling framework conditions for new business models**. Flexibility should be ensured in shaping roles and responsibilities related to SCC solutions. The public sector may consider taking charge of the management of project design and initial phases, but should ensure that this is done by maximising the involvement of the private sector and – potentially – users/universities, etc.

- **Establish a blueprint for an open, city-wide, service-oriented, interoperable IT platform,** which would provide an agreed architecture on which city partners and suppliers can converge over time and establish a multi-level competitive landscape at the platform, services and application layers.
- **Manage data:** data ownership and management is key in any digital process. As integrated SCCs make extensive use of data, which is

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collected, processed and shared in real-time, it would be advisable to **ensure that data is as free as possible.** Indeed, the more information is available, the higher the opportunities to use it for solutions. However, **data must be protected, controlled and assessed in terms of quality.**

I. FINANCING

Rationalize the supporting role of the EC to SCC projects, depending on whether these can potentially generate revenues or not. In order to increase efficiency in the allocation of public resources, it is recommended that a clear distinction should be made between projects that are developed for RDI purposes and those that are not. RDI projects – including small-scale projects contributing to larger scale ones – should necessarily be supported via grants, as it is unlikely that they could pay back the investments made. Conversely, SCC projects that aim to be replicable – and hence commercially viable – entail neither the risk level of RDI projects, nor the purpose, but are business oriented. Therefore, it is recommended that an assessment and definition of the various SCC project types be carried out, in order to organize the support the EC can provide.

Centralize EU competences and roles both for the provision of grants and forms of financing and other support (e.g. technical assistance). There are a number of opportunities that support SCC initiatives. The number of different sources and opportunities may create complexity in achieving an efficient support to SCC projects. A single entity managing the different possible types of support would facilitate the allocation of resources, the access to them as well as the selection of the most appropriate support for each case. Considering that not all sources of support are directly managed by the EC (i.e. some funds are managed at local level) this recommendation may be complicated to realise. However, it could still be possible to envisage the involvement of a single, centralised intermediate entity managing or co-managing the support at least at national level.

Create forms of technical assistance for project design and implementation. SCC projects do not require the same type of support (e.g. commercial-oriented solutions should not be supported with grants, etc.). It is expected that a relevant number of projects would not necessarily require capital to be granted, but could rather benefit more from assistance in designing and implementing the project. Hence, the recommendation

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consists in considering the creation of a dedicated Technical Assistance Unit (similar to ELENA for energy projects) that could support stakeholders from SCC project origination to development. This is relevant in particular for those projects that can potentially be replicated, and therefore be of commercial value. Further, although the ELENA initiative is expected to soon embrace the mobility sector as well, there is no Technical Assistance model currently active, which goes beyond (or across) sectorial boundaries. Oppositely, it has been widely reported that SCC solutions tend to integrate energy, transport and ICT domains. Potentially, a coordinated and infra-sector Project Development Assistance (PDA) could be effective filling the current gaps arising from the current silo approach to Technical Assistance.

Develop business accelerators in the field of SCC initiatives, bringing together private and public investors and entrepreneurs. A central role that the Commission might want to play supporting SCC projects and initiatives is to make easier and more efficient for all interested players to share their contribution, increasing SCC projects' odds of success. However, these parties are often limited in their potential involvement due to uncertainties and risks related to such innovative projects. Different activities could be envisaged:

- Creating a physical space for stakeholders to meet at specific dates, but also through on-line platforms that facilitate cooperation and co-development;
- Sharing practices and recommendations on the basis of experiences, to target future efforts on the success stories;
- Using the European Innovation Partnership on Smart Cities and Communities (EIP-SCC) as an effective tool convening: cities – large and small; with industry – large and small; with investors of all types; and trusted associations, academics and intermediaries;
- Organising dedicated sessions within SCC-related events for project promoters to open discussions on their projects with potentially interested private and public investors.

Support solutions to enable smaller companies and small-scale projects to receive appropriate finance. Further opportunities are yet to be consolidated in the new investment environment. Among the most promising opportunities, **investment platforms ensure access to**

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finance to small-size promoters involved in SCC solutions. These are co-investment arrangements – which can be supported by EFSI – that aim to reduce transaction costs and provide for more efficient risk allocation through the aggregation of thematic-focus (or geographic-focus) investments.

As underlined in multiple projects described in [23], participatory approaches to City Design yields major benefits, even though there is little consensus on what exactly these benefits are.

Possibilities to involve citizens and communities to ensure SCC solutions are:

- **Enable community empowerment for the development of sustainable business models,**
- **Integrate citizens, businesses and communities into the entire project cycle, from development to implementation of integrated scc solutions,**
- **Create an open innovation ecosystem between different experimentation set-ups.**

The analysis shows that there is no single element that represents more than others an obstacle or an enabler to the roll-out of SCC solutions. Instead, it is the joint action of different elements that would limit or facilitate the possibility for a project to be successfully implemented at a higher scale or in other contexts. These refer to the i) technological context (the presence of a technological support network for the SCC solution to function); ii) the socio-cultural context (the ability to respond to citizens' needs and make them a part of developing the solution); iii) the political-institutional context (level of required support from the public administration); and the iv) economic-business context (which refers to the business models and relative environment). The presence of an ecosystem, which is able to converge political institutions, investors, industry players and – to the extent required – citizens, facilitates the implementation of projects that have been successful elsewhere.

An effective way for a solution to succeed has proven to be testing it on small groups of citizens and stakeholders, adapting it and then scaling it to the whole city.

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While demonstration projects seem to be a good tool to cope with the risk of project failure, which would otherwise be an obstacle for a public administration to endorse innovative Smart City solutions, they also represent the risk of being endless tests, which never reach an operational status. The safe area represented by research projects does not have to lead to endless demonstrators, which may represent a form of failure in themselves if the specific solution does not become economically viable or if it keeps being based on different small projects without scaling up to the operational phase. On the other end, demonstration projects may serve the need of showing quick gains and encouraging stakeholders in taking actions.

Vast EU initiatives aiming on the reduction of member states pollution and improve of environment quality are 20-20-20 Work frame aiming on maximizing an economical growth of the region while minimalizing energy consumption, and increasing renewable energy contribution to the energy production market.

Energy wise EU stated that major effort should be concentrated on the challenge to reduce energy use and pollutions, while maintaining economic performance of each region.

Cities are widely challenged in wiser energy use [24], [25].

„all EU countries are required to use energy more efficiently at all stages of the energy chain, from production to fuel consumption"

The 20-20-20 challenge - 20% GHG reduction, 20% renewable energy, 20% energy consumption reduction until 2020.

Although on EU level there is number of initiatives and efforts, there is fairly little endeavours on national level.

3.3. The Czech Republic

Smart City in the Czech Republic is becoming rapidly more popular. Currently many cities are trying to implement Smart City projects. However, the successful projects prove to be rather sporadic. Lack of competent experts involved, lack of pilot projects and good examples from other cities are reasons, which cause insufficient progress in Smart City projects. In accordance with research carried by the Czech-German Business and Industry big differences were found between knowledge in cities and villages in relation to Smart City. 120 cities and villages were involved in the research and the research was performed during about two weeks. It

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was found out that cities have better approach to Smart City than villages, for 67 % of villages do not have any knowledge about Smart City term and they investigate it less than a year. In addition, only 5 % of them has a professional coordinator or a person who is responsible to develop concrete projects of Smart City. In contrast, nearly 60 % of cities have dedicated coordinator for Smart Cities. From the research, it emerged that projects are mainly focused on an improvement of quality of life, reduction of operating costs of cities, while they also deal with possibility of involvement of public. Current projects are mainly focused on Information and Communication Technologies, Traffic, Energy, Intelligent Street Lightning or Open Government. Telemedicine or car-sharing are overshadowed. As the main problem related to implementation of Smart City projects emerge lack of finance, lack of experts and their knowledge in commercial sector, which are necessary and insufficient coupled with insufficient administration system [26].

3.3.1. Methodology of Smart City projects

The ministry for Regional Development of the Czech Republic assigned to work the **Methodology of Smart City projects for the Czech Republic**, which mainly describe how cities could deal with Smart City projects. The Methodology describes application of Smart City in the main areas which are traffic, power engineering and ICT.

3.3.2. Financing projects

Financing is one of the key component, which is necessary to accomplish Smart City projects. Due to financing of Smart City projects the **Methodology of Financing** was created. This document deals with possible sources of financing. These sources could be **European sources** (ESIF-**European Structural and Investment Funds**), Program Interreg Central Europe, Interreg Danube, Urbact III, HORIZON 2020, Program LIFE, CEF 2014 – 2020, Europe for citizens, PF4EE, EIB), **national sources** (Technologic Agency of the Czech Republic, Program Alfa, Program Epsilon, PANEL 2013+, **The Green Savings Program**) and other possible solutions.

3.3.3. Smart City in chosen cities

The Smart City term and its idea is very popular and orotund topic in the Czech Republic. Number of Czech cities follow the idea of digitalization and smart utilization of existing information systems to improve the quality of life and sustainability of their region. There are really many cities in the

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Czech Republic that have certain Smart City agenda. We can mention for example (but definitely not exclusively) the following Smart Cities[27][28]: Prague, Brno, Pardubice, Usti nad Labem, Jihlava, Plzen, Pisek, Mlada Boleslav, Kolin or Zlin.

From the list above, we focus in more details on the following: Prague, as a capital of the Czech Republic with a dedicated agenda on Smart Cities; Pisek, as the first city in the region to prepare a Smart City agenda; and Pilsen, for advanced state-of-the-art systems implemented, among others City Dashboard and wide range of open data distributed by city municipality [29]. These citied cities and examples will be further elaborated in the following sections of this report.

3.3.4. Prague

Prague is the Capital and largest city in the Czech Republic which has the strategic document the **Smart Prague 2030 concept** for accomplish Smart City projects. This document is based on six following areas, which are preferred in the Smart Prague:

- *Mobility of the Future*,
- *Smart Energy and Buildings*,
- *Waste free-City*,
- *Attractive Tourism*,
- *People and the Urban Environment*,
- *Data Area*.

From these six areas Data Area comes as very important, because it ensures connectivity in all areas. Accomplishment of Smart Cities is mainly ensured by **Operator ICT**, which cooperates in Smart City projects with other subjects. For instance, Technical Road Management of the Capital City of Prague, Prague Institute of Planning and Development and Prague Public Transport Company. From academic institutions we can mention the Charles University or the Czech Technical University in Prague. Concept also allows communication with professional or unprofessional public components. Authority of the city decides about implementation of Smart City projects [30].

I. Solving problems with Smart City - Prague

In accordance with the strategic document, the city is aiming at six important areas of Smart City. But three areas occur as dominant. First area is the Mobility of the Future which contains many challenges: air and noise

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pollution, traffic congestion, problems with parking etc. Currently, there are 22 projects. Second area with 17 projects is the area of the People and the Urban Environment. This area deals with obsolete street furniture, non-intelligent surveillance camera systems etc. Last area with 14 projects is the area of Smart Building and Energy. This area deals with obsolete street lightning, insufficient current electric power distribution for charging electric vehicles, dependency on fossil fuels and others[31].

II. Project financing in Prague

Within investment action **ICT Smart City Projects** it is possible to gain financing from sources of finance. However, a project must be in the conception of Smart Prague and fit in any of the six areas.

III. Current and ongoing projects in Prague - examples

- Contactless fare payments

This project is from the area of Mobility of the Future. With special validators which are installed on trams we can select appropriate fare and pay for it by our debit/credit cards. System has been installed in 22 trams and the Prague Public Transport Company is now preparing tender to expand the system to entire tram network. Average usage of validators is about 5000 transactions in a calendar month. Payments for fares will be easier, faster and more comfortable for passengers [32].

- Energy savings utilizing the EPC method

This project is related to the area Smart Buildings and Energy. EPC method can save an energy especial in buildings which have obsolete heating system. It was the case of the institute for the Care of Mother and Child which was modernized by this method (EPC). Their heating system was changed from steam to hot-water, which has better energy consumption. It leads to greater building operation efficiency [33].

3.3.5. Pisek

Pisek is the small and beautiful city of the South Bohemia and it is popular tourist destination. It is an important mention in light of the Smart Cities at it declared a will to become first Smart City (city driven by the information technologies) in the Czech Republic. Shortly after the city was able to establish professional department for development of Smart City projects which is called Smart Office and organize cooperation with The CTU in Prague, Schneider Electric and IBM Companies to achieve that goal. The

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Smart Office is responsible for development Smart City projects in appropriate areas. These areas are defined in strategic document **Blue and Yellow book of Smart Pisek**. The document defines three following significant areas of Smart City:

- *Intelligent mobility*,
- *Intelligent energy and services*,
- *Information and communication technology*.

I. Solving problems with Smart City - Pisek

There are several problems in the city of Pisek. The main traffic problems in the city are resident parking, visitor parking and employee parking. Traffic also produces many negative environment effects. We can mention emissions, vibrations, dust etc. The area Intelligent mobility of the Smart Pisek deals with the mentioned problems. The second area is focused on power engineering, which contains smart measuring and controlling energy consumption etc. The scope of third area is Information and Communication Technologies. Nowadays these technologies are only focused on administration of the city. Thus, there is effort to implement principle of open data.

II. Project financing in Pisek

Project financing is the key component of Smart City projects. The strategic document of the city mentioned several ways to finance Smart City projects. **Subsidy programs** contain **European Structural and Investment Funds** for the Czech Republic (ESIF), **Cross Border** operational programs financing from ESIF, **National Programs to Support**, **Community Programs** in the management of the European Union, credits from the **European Central Bank** and other banks are advantageous to the city.

A second way how to finance Smart City projects is from **Bank Tools**. This is the standard way to financing projects (credits, bills and bonds) and alternative business model (leasing, **Energy Performance Contracting** (EPC), **Public – Private Partnership** (PPP) etc.). PPP is public service, which is financing and operating due to partnership among public organization and several private companies and there is also **Full-Service Partnership**. **City Budget** is the last model of the project financing, when the previous financing models are not available [34].

III. Current and ongoing projects in Pisek - examples

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- Smart Parking – mobile application eParkomat

The main goal of this project was to create mobile application which helps drivers with finding a free parking spaces. Drivers are guided on free parking spaces by mobile application, which can be downloaded to their smartphones. The application shows them on the display of their smartphones their actual position and possible streets in which driver has chance to park. The application also displays the successful parking probability by colorful indicators. It uses data of mobile network operators and tracks smartphones of each user. Ownership of smartphones tracking application creates a probability model which serves to estimate success rate of parking. Project also uses magnetic sensors to obtain information about occupancy of parking spaces. Application is mainly for home citizens, who parks in the city center every day. If user does not have a smartphone he can use website which gives him an information about occupancy of parking spaces. City is preparing to expand system to other parking places around the city. The project is very useful because we do not have to find a parking place for a long time so, drivers can save time [35][36].

- Smart Public Transport

The project Smart Public Transport is all about formal public transport services for passengers. Passengers will be better informed about their links (departures and arrivals to/from the links) and thus public transport will be more efficient and clearly. It will require information equipment in public transport vehicles and at bus stops which is necessary to transfer actual information to passengers [37].

3.3.6. Pilsen

Pilsen, the city located in the western Bohemia is recognized as an example of appropriate application of Smart City concept. The goal oriented projects, consultations with the citizens and many other factors grant Pilsen position which is pursued many other cities in the Czech Republic. The key actor of Smart City Pilsen is **Information and Communication Administrator of the city**. Strategic document for Smart City defines roles for the key actor which are connecting him to realization of the concept Smart City Pilsen. These roles are as following:

- *Enabler* – responses for joining parties (organizations) to create creative solutions which could not be possible without the joint,
- *Administrator* – creates and keeps the environment for making Smart City projects,

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- *Driver* - responses for realization of Smart City projects and he defines the goals (targets) of the projects,
- *Innovator* - responses for innovating processes in Smart City projects.

The **Information and Communication Administrator of the city** provides support in the area of realization of Smart City projects (traffic, environment etc.) and provides platform to collect and visualize data. He also secures Information and Communication Technology (ICT) for the city and its organizations. He prepares and realizes his own Smart City activities and projects. It covers presentations of best practices, preparing of new projects and activities and communication with other parties [38].

I. Solving problems with Smart City – Pilsen

The city is mainly aiming at three areas of Smart City. The first one is the **SMART GOVERNANCE**. The SMART GOVERNANCE covers projects which are targeted to improve and increase the efficiency of public administration. For instance, simplification rules and methods in the public administration, an effort to increase connection with ICT, periodical data collection and ensuring their evaluation. The second area is called being named as **SMART EDUCATION**. SMART EDUCATION covers projects which are connected with modernization and development of kindergarten and primary (elementary) schools, development of technical education and universities in Pilsen. The last area is **SMART BUSINESS SUPPORT**. The projects in the SMART BUSINESS SUPPORT are trying to improve business environment. It covers improvement of innovations, competitiveness for small and medium companies and start-up companies [38].

II. Project financing in Pilsen

Nowadays, Smart City projects are financing from city budget, but there is an effort to gain subsidy programs, the European Union founding, Horizon 2020 program projects and enrolment in PPP business model.

III. Current and ongoing projects in Pilsen - examples

- Intelligent trams stations

This project is aimed to give an actual information connected with public transport to passengers. The intelligent tram stations give a text and sound information about public transport especially for blind people. The benefits for passengers are actual information about public transport, passengers can see arrival of public transport vehicles and they have information about transfers [39].

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- Pilsen card

The main goal of this project was to create card which people could use to pay for the fare in the public transport and in the future add other useful functions to the card. Now people can use the card when they go to the library, when they want to pay for car-parking, when they are shopping, for students in the school as the identity card for canteen, libraries etc. With this card people can pay for the fare easily and more comfortable with many other benefits for them [40][41].

4.Summary

In this part of the study, authors described basic terms and definitions connected with the field of Smart Cities. First of all, an up-to-date literature review and thoughts of world experts are introduced, to better understand what Smart City concept covers. In following part, new possibilities, transformation approaches and complexity of the phenomenon is described. This part (Part I) is divided in 3 chapters. Firstly, multiple approaches and technologies from other brands that may and are successfully adopted in the management of the Smart Cities are introduced. More importantly, emerging viewpoint of shifting perception in the cities toward services rather than resources as main concern is described. Here we could learn about biggest benefits from introducing attribute "smart" to our cities.
Secondly, attitude towards SC concept around the world is described and mapped. Three different approaches are introduced and brightest examples of Smart City concept implementation are provided. Moreover political and government attitude in each region is described and briefly analysed.
Finally the third chapter introduced the best practices, policies and lessons learned in Smart City field from all around the world. Different approaches and focus areas were presented, as well as hopes seen in cities of tomorrow. Section is finalized with detailed introduction to situation in the Czech Republic involving description of policies, financing and couple of examples of the Czech Smart Cities.

Part II of the report, which will be delivered before the end of this year, will provide closer look to current situation in Danube Region. It will also verify common strategies and cooperation toward Smart Cities, and analyse and compare projects deployed and results achieved in countries in Danube basin. It will also include a policy paper providing recommendations and direction for future development of regions and cities in smart Danube Basin.

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