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TRENDS OF DIGITAL INNOVATION FOR SMALL AND MEDIUM-SIZED CITIES

Setting-up of SMART COMMUNITIES

SUMMARY

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INTRODUCTION

Introduction of digital information & communication technologies (ICT) into the management of cities is a pressing issue in Europe and globally since new technologies are being developed at high pace, accompanied by new services for citizens, public infrastructure operators, private businesses and authorities. Concept of introduction of digital technologies to cities is known as **SMART CITY** model which aims at providing better quality of life in cities through introduction of new technologies, services, business models etc. supported by new ICT technologies.

There are several fields where new ICT technologies and services can be applied, like:

- **e-governance** (electronic governance or e-governance is the application of information and communication technology (ICT) for delivering government or local administration services)
- **crowdsourcing** (mining ideas, suggestions, complaints etc. through ICT channels)
- **mobility management** (ICT services for public transport management and information for citizens through mobile apps, support to car-sharing etc.)
- **energy management** (managing smart grids, energy monitoring etc.)
- **public infrastructure management** (smart metering support and data management, smart systems of waste management, public lightning, smart water and heating distribution etc.)
- **environmental management** (real-time on-line monitoring of environmental data etc.)
- **tourism and event management** (support to tourist, culture and entertainment sector through advanced ICT services)

To develop such a comprehensive system a lot of harmonization and joint development is needed among key stakeholders:

- Local administration
- Public service providers (utilities, waste management, public transport, water supply, district heating etc.)
- Researchers (ICT)
- Enterprises (ICT system providers and developers)
- Tourism and event management sector
- NGO's and citizens.

It is of vital importance that a **QUADRUPLE-HELIX NETWORK** is established consisted of above defined stakeholders before entering the process of Smart City (Community) development. The network should provide a comprehensive solution for:

- the technological requirements to set-up Smart City infrastructure on the level of the city
- data exchange/management
- new services to be introduced/integrated
- organizational system
- management of the system

The study offers an insight into the Smart City concept, guidance on how to start and implement such a process in your city/community and overview of existing best practices.

ABOUT SMART CITIES AND SMART COMMUNITIES

Definition

Smart Cities and Communities are defined by their intelligent use of integrated energy, transport and IC technologies to reduce their environmental impact and offer citizens better lives.

Diffusion and availability of new technologies has influenced evolution and organization of cities. New technologies and services, in particular in the areas of transport, energy and ICT, are requirements to transform a city in a **smart city** contributing to reach high level of urban sustainable development. The European Union is investing in research and innovation and developing policies about smart cities to achieve a triple bottom line gain for Europe: better quality of life for citizens, more competitive industry and SMEs, and more sustainable energy, transport and ICT systems and infrastructures.
The conference paper "The process of smart city definition at an EU level" [1] reports the following principal definitions.
The first use of term smart city has been in 2007:
The idea of smart cities is rooted in the creation and connection of human capital, social capital and Information and Communication Technology (ICT) infrastructure in order to generate greater and more sustainable economic development and a better quality of life.
In 2008 a little advanced definition could be found. *Smart City uses the network infrastructure to improve economic and political efficiency, and to allow the social, cultural and urban development.*
In 2011 an extension is proposed: *A city may be called 'smart' when investments in human and social capital and traditional and modern communication infrastructure fuel sustainable economic growth*

and a high quality of life, with a wise management of natural resources, through participatory governance.

In a Smart City, networks are linked together, supporting and positively feeding off each other, so that the technology and data gathering should: be able to constantly gather, analyse and distribute data about the city to optimize efficiency and effectiveness in the pursuit of competitiveness and sustainability; be able to communicate and share such data and information around the city using common definitions and standards so it can be easily re-used; be able to act multifunctional, which means they should provide solutions to multiple problems from a holistic city perspective.

A first complete definition in terms of system is given in 2013: *Smart Cities should be seen as systems of systems, and that there are emerging opportunities to introduce digital nervous systems, intelligent responsiveness, and optimization at every level of system integration*.

A smart city uses information and communications technology (ICT) to enhance its livability, workability and sustainability. In simplest terms, there are three parts to that job: collecting, communicating and "crunching." First, a smart city collects information about itself through sensors, other devices and existing systems. Next, it communicates that data using wired or wireless networks. Third, it "crunches" (analyzes) data to understand what's happening now and what's likely to happen next.

Smart City projects make cities work better. They apply information and communications technology to accurately monitor, measure and control city processes, from transportation to water supplies, the location of city vehicles to the performance of electric grids. Smart Cities are about saving money, becoming more efficient and delivering better service to the taxpayer.

Smart Communities are different. They seek to make better cities: places large and small, urban and rural, where citizens and employers thrive and prosper in the broadband economy. Smart Communities adopt technology but do not make it their focus. Instead, they find vision-driven, community-based, technology smart solutions to their most urgent problems. They make sure they have the broadband and IT infrastructure they need to be competitive. But they know it is only a means to an end. More of their energy goes into developing a workforce able to do knowledge work. More effort goes into crafting an innovation ecosystem where business, government and institutional partners create high-quality employment and meet social needs. More emphasis is placed on expanding access to digital skills and technology for those otherwise left out. More work goes into engaging citizens as advocates for progress.

Today the concept of Smart Community is widely used. The Smart Communities phenomenon is global in the sense that it exists all over the world as well as local since it is often based on local initiatives. The term Smart Community is generic and gives direct associations towards optimal, positive and sustainable development of a town, city or region.

There are several ways to define what the Smart Community concept means [8]:

In Smart Communities Guidebook, developed by California Institute for Smart Communities (1997) at San Diego State University the concept of Smart Community is presented as:

A "smart community" is simply that: a community in which government, business, and residents understand the potential of information technology, and make a conscious decision to use that technology to transform life and work in their region in significant and positive ways.

And in the Implementation Guide (1997), developed by the same Institute is stated:

A "smart community" is a community in which members of local government, business, education, healthcare institutions and the general public understand the potential of information technology, and form successful alliances to work together to use technology to transform their community in significant and positive ways.

Because of these unified efforts, the community is able to leverage resources and projects to develop and benefit from telecommunications infrastructure and services much earlier than it otherwise would. Instead of incremental change, a transformation occurs increasing choice, convenience and control for people in the community as they live, work, travel, govern, shop, educate and entertain themselves. Smart communities or regions are also economically competitive in the new global economy, and attract and promote commerce as a result of an advanced telecommunications infrastructure.

The Panel on Smart Communities, Industry Canada (1998), suggested the following definitions:

A "community" should be defined as a group of people sharing a similar interest, which includes some or all of the common elements: geography, history, interests, goals, culture, economic and social fabric. A "Smart Community" should be defined as a community ranging from a neighborhood to a nation-wide community of common or shared interest, whose members, organizations and governing institutions are working in partnership to use information and communication technologies to transform their circumstances in significant ways.

Smart Community International Network (SCIN)'s (2003) definition is:

A Smart Community is a community with a vision of the future that involves the application of information and communication technologies in a new and innovative way to empower its residents, institutions and regions as a whole. As such, they make the most of the opportunities that new

applications afford and broadband-based services can deliver – such as better health care delivery, better education and training, and new business opportunities.

In a similar way Australian Smart Community is defined as:
Smart Communities are communities with a vision of the future that involve harnessing the power of the Internet and other ICT technologies in new and innovative ways to empower their residents, institutions, community groups and businesses.

In summary the Smart Community concept has a holistic view and tries to incorporate all the possible aspects and parts involved outgoing from a geographically limited area such as a town, city or region and their citizens. This concept sets the community and citizens' needs in focus.

It is not enough for a community to offer jobs, space for enterprises or beautiful surroundings in order to be attractive and sustainable for the citizens and enterprises. A Smart Community also has the understanding of all the parties involved and combines the efforts to achieve the best results. The Smart Community concept stresses the importance of collaboration, cooperation and partnership between all parties involved including public institutions, private sector, voluntary organizations, schools and citizens.

ICT is used as a tool. A well-functioning infrastructure such as optical fiber broadband and Internet is absolutely necessary but not enough to become a Smart Community. In addition it is necessary to concentrate on ICT applications such as e-voting, e-learning or e-commerce for all the important aspects of the community's activities.

ICT infrastructure and applications are prerequisites but without real engagement and willingness to collaborate and cooperate between public institutions, private sector, voluntary organizations, schools and citizens there is no smart community.

Strategic Implementation Plan and Operational Implementation plan

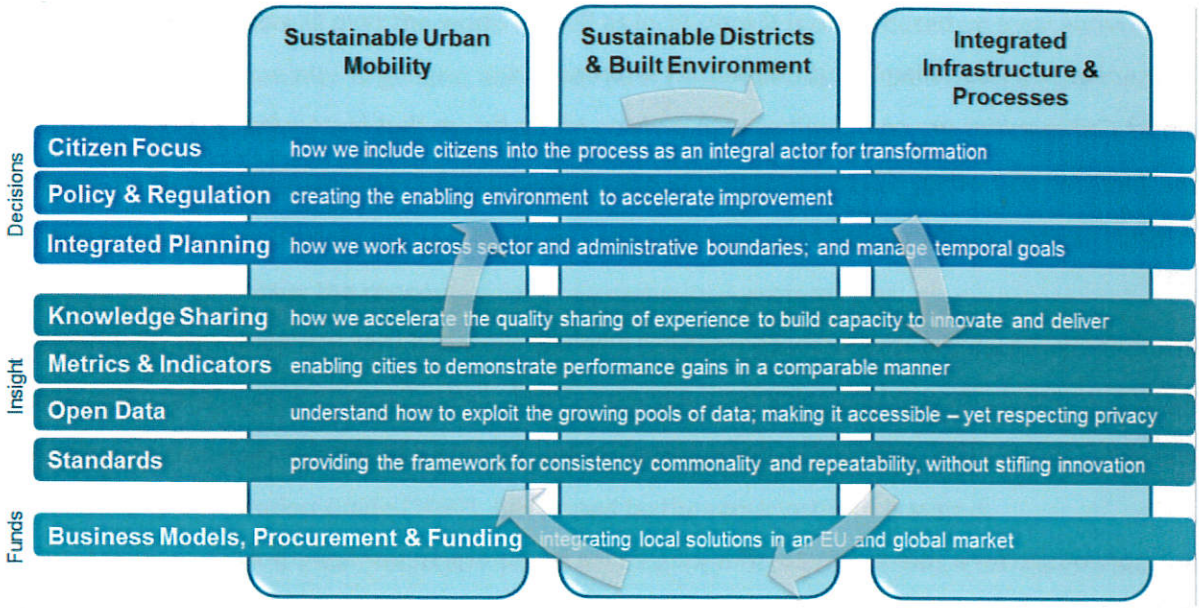

Figure 1: SIP framework

Purpose of introducing the smart community concept

Cities and urban areas are expanding all around the world due to urban growth and migration. The increase in population increases the demand on the base infrastructure of each city. For instance demand for water and energy increase due to the increased consumption. There is also an increased need for higher public transport capacities, as well as increased demand on heath institutions and service established for protection (police, firefighters, paramedics). Forward-thinking cites are trying to take advantage of new technologies, skills and knowledge originating mainly from ICT, such as cloud technologies, the Internet of Things and migration to big open data. Namely, forward thinking authorities recognize that in spite budget cuts and scarcity of cities resources and potential (including infrastructure) the new technologies offer not only challenges but also several opportunities. By migrating to big open data and development of feature analytical tools stakeholders may gain a deeper insight into internal workings of different city's potentials. The IoT phenomena allows them acquire and combine data from various existing and new sensors and data sources in order to obtain even more information about cities potential. The Cloud technology then allows them not only to share information but to develop composite applications ensuring join participation and facilitate the creation of joint activities benefiting both public and private stakeholders.

The purpose of introducing the smart community concept is therefore to develop a technological framework for smart cities (e.g. platform), which will exploit new technologies (ICT and social) in

order to increase the potential and attractiveness of a city in an environmentally friendly way, and thereby create new business opportunities for public and private stakeholders as well as benefits for final users (citizens, tourists and visitors). In order to achieve the specified goals and challenges of urban information model the consortium foresees research & development activities being carried in on cloud solutions supported with big open data in the following areas: smart energy, smart infrastructure, smart buildings, smart mobility, smart health, smart education and government and smart security.

A Smart City is a city well performing in 6 characteristics, built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens.

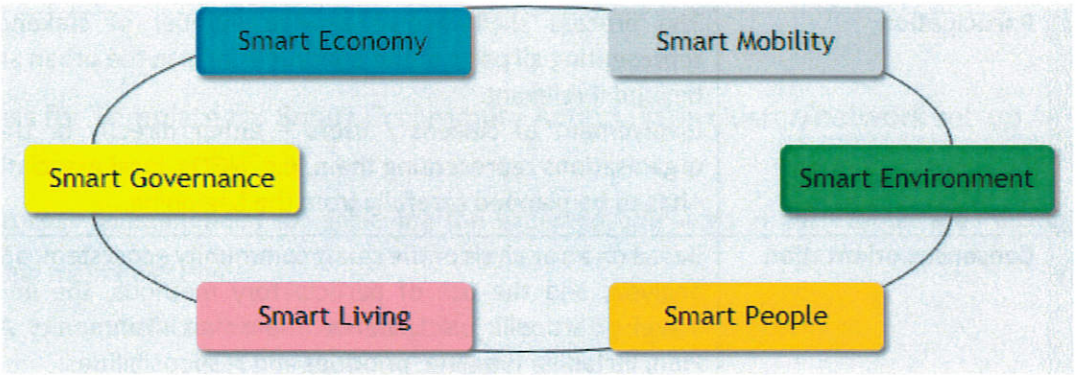

Figure 3: The smart city model [14]

SETTING-UP A SMART COMMUNITY AS A BACKBONE OF DIGITAL INNOVATION

Methodological approach

The challenges have been recognised and are being addressed in different ways in the overall broader context of the development and implementation of initiatives – some with a technological focus, others with a broader approach including societal aspects – which can be regrouped under the heading "smart city strategies".

It is therefore essential to keep in mind this broader context and ensure the coherence between the project and its outcomes and the local broader "smart city" developments.

The methodological approach builds on the following milestones for each target area:

1. Mapping of the smart community ecosystem and its stakeholders,
2. Establishments of a core team of stakeholders, which will be primarily in charge of the development of the cluster / network,

3. Development of a basic smart community roadmap, setting the thematic priorities and overall objectives of the cluster / network and providing the basis for a strategy,

4. Formal set-up of a clusters or networks, ensuring sufficient commitment of multiple partners,

5. Development and commitment to a common strategy – the Smart Community Action Plan (SCAP).

Considering this, the setting-up of quadruple-helix urban innovation clusters/networks in target regions shall build on the following guiding principles:

Table 3: Guiding principles for setting-up of quadruple-helix urban innovation clusters/networks in target regions.

For	**Participation**	The process shall involve a wide number of stakeholders representing all parts of the quadruple helix in the urban area or beyond if relevant. Involvement of citizens / users – either directly or through organisations representing them, e.g. NGOs, local associations... - has to be planned carefully from the beginning.
	Consensus orientation	Based on an analysis of the smart community ecosystem, a SWOT analysis, and the use of participatory methods, the involved stakeholders will jointly define the Smart Community Action Plan, including timeline, priorities and responsibilities.
	Integration	The process shall take into account the major existing or upcoming policy / strategic developments relevant to the target area: • European and national framework • Regional smart specialisation strategy (S3) • Etc. This does not mean a full subordination to those developments, but looking for synergies, filling gaps, etc.
	Durability, sustainability	The newly created clusters/networks will be sustainable and implement the action plans beyond the project end. The established core teams as well as the leaders of the new clusters/networks will be trained and established to guarantee • a broad involvement of stakeholders, • relevance of the strategy, • a strong commitment by the involved stakeholders, • regional innovation and financial sustainability (i.e. gaining external resources for further development). Each action plan is owned by the respective network/cluster and has an initial timeframe of five years.

Table 4: Major outcomes of the process.

	Smart community (SCCNs) established	In each region, a new **quadruple helix cluster/network** dedicated to smart community shall be established, involving the most relevant stakeholders. The formal establishment of each new cluster/network shall be made public at a **launch event** and materialised by the **signature of a memorandum of understanding** by the founding partners. Aims is to implement durable clusters/networks with a clear mandate to develop urban innovation processes.
	Urban Innovation Action Plan (SCAP)	SCAPs shall be developed within each target region. **The SCAP set objectives and priorities, including actions, responsibilities, timeframes, indicators, sources of funding and budget allocations.** The **time horizon for the SCAPs is 5 years**, contributing to stable efforts for urban innovation in each region.

Process for Template for Smart Community Action Plans cluster/network set-up

The process recommended for achieving the expected outcomes in each target area includes the following main milestones:

- Establishment of new SCCNs, validated by a formal agreement,
- Development and approval of SCAP.

The newly established SCCNs will elaborate SCAPs for future implementation.

The main steps are described below and build on positive experiences in using participatory approaches involving the quadruple helix stakeholders in the development of SCCNs and SCAPs, as well as regional innovation and development strategies.

Set-up of smart community clusters / networks

Table 7: Mapping of urban ecosystems in the target regions including an inventory of key innovation stakeholders

	Aim	The main aim of this task is to provide an overview of the current status of the urban innovation ecosystem and its stakeholders, supporting the identification of possible drivers (people and topics) for the development of the SCCNs. The mapping reports on the urban ecosystem will address the following main topics: • Description of the urban / regional context • Socioeconomic analysis • Overview of urban ecosystem stakeholders - Businesses (industry / service providers)

		- Higher education and research (HER) - Government and public administration - Clusters / networks in the urban area / region - Other intermediaries - Civil society, citizens, users • Local, regional and national policy context for Smart Community Cluster / Network development • Success stories / good practice cases The mapping reports will be complemented by an **inventory of stakeholders**, including representatives from: • **BUSINESS** (manufacturing and services, primary sectors, creative industries, social sector, large firms, SMEs, young entrepreneurs, students with business ideas, etc.), • **HIGHER EDUCATION AND RESEARCH** (public and private research bodies, universities, education and training, etc.), • **GOVERNMENT AND PUBLIC ADMINISTRATION** (if relevant at different government levels, agencies e.g. for regional development, business advice, public procurement offices, incubators, etc.), • **CLUSTERS / NETWORKS IN THE URBAN AREA / REGION** (clusters with different thematic focus, broader member bases, etc.), • **OTHER INTERMEDIARIES** (incubators, accelerators, science and technology parks, financial institutions, chambers of commerce, professional organisations, technology transfer offices, etc.), • **CIVIL SOCIETY, CITIZENS, USERS** (NGOs and citizens' initiatives related to societal challenges for which innovative solutions would be helpful, consumers' associations, talents, etc.). The most relevant stakeholders for the development of the SCCNs will be highlighted and build the basis for the set-up of the core teams. At least for these stakeholders additional information on their expectations regarding the SCCNs and their possible contributions will be provided.
	Methodology	Desk research analysis, informal face-to-face meetings, interviews.
	Result	There are 2 main results: • **mapping report of the smart community ecosystem** (will be included in the basic smart community roadmaps and build the basis for further analysis), • **inventories of key innovation stakeholders**
	RESOURCE	*Template for mapping urban ecosystems* *Template for documenting personal meetings with stakeholders* *Template for contact database*

Setting-up core teams and roadmaps in the target areas

Table 8: Set-up of core teams (cluster development leader)

	Aim	The core teams will ensure long term engagement of stakeholders and collaborative leadership. They should consist of quadruple helix representatives including especially public authorities, entrepreneurs, universities and other ready-to-work representatives of the local stakeholders. Ideally, they are formed by 6-8 people who can work together smoothly. One group of actors (e.g. policy representatives) should not dominate this group.
	Methodology	Meetings, interviews
	Result	The main result will be the set-up of one core team per region. The intention to establish an SCCN and the commitment of the representatives of the smart community ecosystems to actively support the SCCN development will be demonstrated in • **core teams' agreement**
	RESOURCE	*Template for core team agreement*

Table 9: Training of core teams

	Aim	In order to guarantee high quality and high innovative networks/clusters, each core team will take part in 2 trainings delivered under the responsibility of the mentoring partner. The trainings, provided by the mentoring partners (if needed with external support), will support the collaboration within each core team and prepare the teams to take the lead in the development of SCCNs and SCAPs. The topics for the workshops / training will be defined based on the needs of the mentored partner; the format will be suggested by the mentoring partner. Topics that might be covered include e.g.: • Guidance on the development of Smart Community Roadmaps, • Definition and identification of common obstacles and benefits of a quadruple-helix cluster, • Cluster management, • Communication process within the network, • Trust building, • Specific innovation topics (e.g. open data, ...), • Participatory methods and tools, • ... Workshops (trainings) for core teams will provide them with long-term commitment to the ongoing process of formation and functioning of the cluster.
	Methodology	Workshops, trainings
	Result	The main result will be • **2 trainings for each core team**
	RESOURCE	*Workshop methodology for training of core team*

Table 10: Development of basic smart community roadmaps

Aim	Basic smart community roadmap will highlight the short-term (about 1 year) steps to take towards the establishment of smart community networks/clusters. Thereby, a common understanding of future priorities shall be gained in a participatory approach targeting all potential stakeholders including citizens in collaboration with the mentoring partners. Three main activities will be performed by the core team, which are strongly interlinked and feed into each other: **1. Analysis and diagnosis of the urban ecosystem** Based on the mapping report and the inventory of key stakeholders a more in depth analysis, including a SWOT analysis, will be performed. The analysis will cover topics such as: • identification of priorities for the local economy, significant from the point of view of the economy and future cluster, • identification of development trends of regional / urban economy, • identification of the cluster place in the economic development of regional / urban economy, • identification of possible level of activity of potential participants in the cluster as part of its future operation. **2. Participatory workshops to concretise the basic smart community roadmaps** The experiences in setting up Smart City initiatives and urban quadruple helix clusters show that an early integration of a broad stakeholder basis, including citizens / users, is crucial for the acceptance and successful implementation by committed partners. Topics that could be covered during the participatory workshops include: • situation in the city, major problems to solve, • identification of priority areas and main objectives (region/city vs. cluster), • identification of opportunities and threats / strengths and weaknesses of urban ecosystem in terms of the subject matter, • identification (choice) of first main topics that the cluster/network should focus on (e.g. efficient energy, education, tourism, ICT etc.), • the geographical area of the cluster/network activities (e.g. whole urban area, specific quarters), • identification the vulnerability of the business sector, science sector, business support units, government on the possibility of implementing the cluster concept. **3. Preparation of basic smart community roadmaps** The results of the performed analysis and of the participatory workshops will be included in basic smart community roadmaps. The roadmaps will highlight the joint understanding on the set-up of SCCNs and the major topics to be addressed. Thereby, they build the basis for the formal establishment of the SCCNs. The basic smart community roadmaps will include information on: • outcomes of the mapping report of the smart community ecosystem,

		• results of the SWOT-analysis, • mission and vision, • main goals and priorities, • determination of the timing and functional stages of the cluster development, • determination of the directions of the cluster development and short-period strategy, • first suggestions on pilot projects / activities, • information on potential members that expressed interest.
	Methodology	Participatory workshops (e.g. using design thinking), presentations of good practices, personal meetings, consultations, interviews, desk research.
	Result	The main result will be a concrete suggestion for the set-up of SCCNs and its main characteristics that is based on a broad analysis and a participatory process, resulting in • **basic smart community roadmaps**
	RESOURCE	*Methodology for participatory workshops* *Template for basic smart community roadmaps*

Establishing smart community clusters / networks

Table 11: Preparation of Memorandum of Understanding

	Aim	During this phase the final preparation for the establishment of the SCCNs will be done. A draft of an official, formal agreement / memorandum will be prepared as foundation for the establishment of the SCCNs. The specific form will depend on the institutional framework selected for the SCCNs (association, foundation, informal network, partnership agreement etc.). This draft will be agreed upon by the potential founding partners of the SCCNs.
	Methodology	Meetings, document exchange.
	Result	The main result will be • **SCCN memorandum drafts**
	RESOURCE	*Draft Memorandum of Understanding*

Development of Smart Community Action Plans

Table 12: Initiation of Smart Community Action Plan development

	Aim	SCAPs will be developed within each target region. In order to develop SCAPs that will build the basis for a measurable increase the urban innovation level, an effective process will be set-up addressing the following main issues: • establishment of the management system of the implementation of the strategy, • identification of core activities,

		• clear division of tasks and responsibilities, • timeline with milestones. The SCAP development will involve the official members of the SCCNs, additional interested local stakeholders with a deep and up-to-date knowledge about regional needs (e.g. companies that will implement pilot projects).
	Methodology	Meetings
	Result	The main result will be an agreement on • **Activities, responsibilities, priorities, timing of tasks**

Table 13: Smart Community Action Plan

	Aim	As already outlined, the SCAPs will address three main levels: vision, strategic and operational objectives and define concrete projects and initiatives, which shall contribute to the implementation of the SCAPs and consequently to the achievement of the objectives. Thereby, the SCAPs serve also as a quality standard for innovation development planning. The proposed time horizon for the SCAPs is 5 years, contributing to sustainable efforts for urban innovation in each target region and the realisation of pilot actions focusing on crucial topics that are to a large extent identified in the basic smart community roadmaps. The main contents of the SCAPs regarding concrete projects and testbeds for industrial partners to be implemented include: • development of activities / projects undertaken by cluster members, either alone or in partnership, to achieve common development strategy goals, • identification of needed resources (e.g. partners, technology, financial resources), • identification of funding sources for the implementation of innovation actions (smart private investments, public funding, structural funds & financial instruments), • determination of a timeline for the implementation of the planned projects, • allocation of responsibilities, resources and budget. Moreover, the UIAPs will address cross-cutting issues such as • vision, • strategic and operational objectives, • establishment of the know-how management within the cluster, • development of the monitoring and periodic evaluation system of the effects of actions (adoption of appropriate indicators), • periodic evaluation / assessment of the implemented action plan and results achieved by the cluster as a whole and its individual members.
	Methodology	Workshops, meetings, study visits, desk research
	Result	The main result is • **Smart Community Action Plan**
	RESOURCE	*Template for Smart Community Action Plan*

Overview of ICT systems and tools

Participatory methods

Participatory methods include a range of activities enabling ordinary people (citizens, consumers) to play an active role in decision-making processes, thus strengthening citizen engagement.
Since the participatory processes are performed in almost every aspect of modern life, the participatory methods can support the innovation process in smart communities' ecosystems by involving end-users (citizens, consumers).

Crowdsourcing – Participative Governance

Crowdsourcing is an online citizen engagement which enables their involvement in decision co-creation process. It is a two-way collaboration between government and citizens.

Participatory budget

Participatory budgeting is a process of democratic deliberation and decision-making, and a type of participatory democracy, in which ordinary people decide, how to allocate part of a municipal or public budget. It enables taxpayers to work with government to make the budget decisions that affect their lives. [

5.1.2 Technology areas

The smart city technological ecosystem is a complex one comprising many technology areas [16]. Major players operate in several areas, providing solutions that complement (and sometimes overlap) other players. To visualize the technology ecosystem, five key technology groupings can be identified:

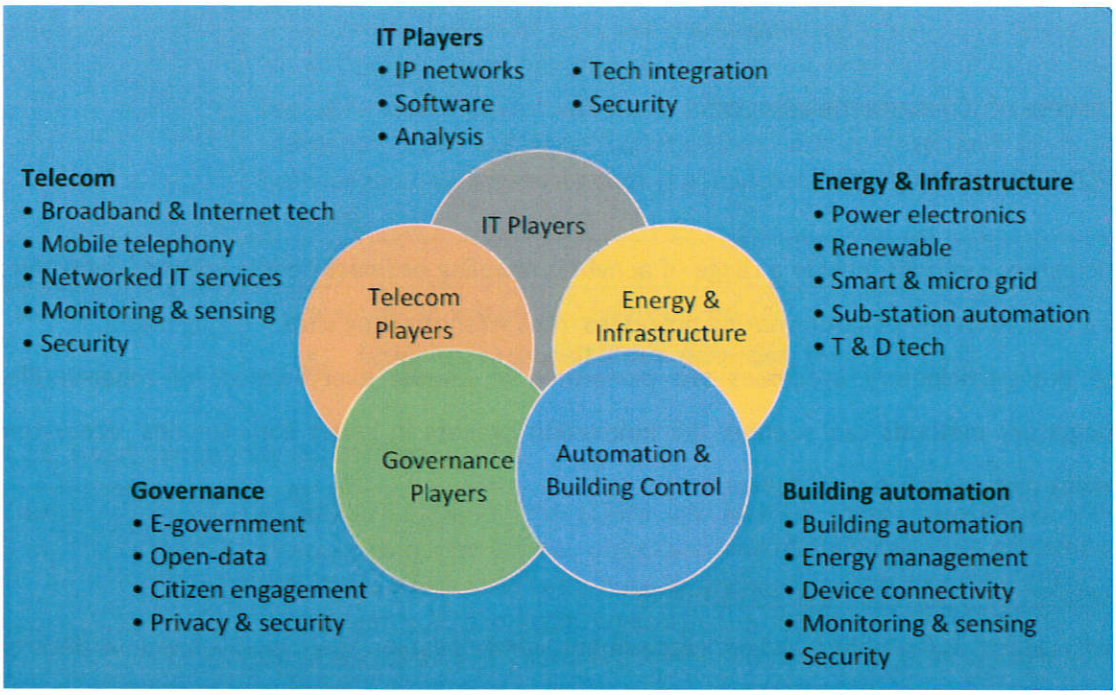

Figure 61: The technological ecosystem in smart cities [16].

Networking and communications

The complexity of smart city technological and service ecosystems requires a holistic approach to networking and communications that offers support for a range of needs, from infrastructure monitoring to backbones for digital media enterprises and from household security to citywide transportation monitoring. These diverse needs dictate that any smart city will encompass a range of technologies.

Low-Power WAN technologies

Fitting a niche in the technological landscape between personal/local area networking technologies such as Bluetooth LE, ZigBee and WiFi; licensed cellular networking such as existing 3/4G, and the evolution to 5G; sit technologies such as LoRaWAN and the evolving 802.11ah [16]. These technologies use unlicensed spectrum and focus on low power and cost. While some argue they are a stopgap measure before the deployment of 5G networks, they are the subject of much interest and a number of trials including those by NTT in Japan, SigFox in France and Australia, and Comcast in the United States. One major appeal driving city adoption is the ability to offer a citywide service, for free, at a relatively low capital cost (see showcase 5.2.5).

3/4G evolution

The 3GPP consortium is working on several activities including work on CAT-1 (and Cat-0) as well as the upcoming CAT-M1 and the narrow-band long-term evolution (NB-LTE). These standards focus on IoT scenarios and include better energy efficiencies, cost reductions, and better penetration/density, all critical for IoT situations in smart cities.

5G networking

Next-generation networking (5G) aims to address some of the key future needs of smart cities with higher bandwidth, delivery and performance guarantees, adaptability, energy efficiency, and real-time capabilities. 5G is still an evolving space, with considerable discussion on its long-term goals and technologies (see also chapter 5.3).

Cyber-physical systems, IoT and big data

Advances in wireless communication, in computing and in sensing devices, along with the cost reduction of these technologies, have prompted and accelerated the development of Cyber-Physical Systems that adopt the Internet of Things paradigm to provide several types of services, such as surveillance, weather monitoring, management of vehicular traffic, control of production activities, etc. The development and the adoption of these systems are still facing various challenges that the research community and the industry are actively trying to solve. On one hand, the development challenges are mainly related to security, robustness, availability, adequate performance and energy consumption optimization. On the other hand, the use of these systems produces large amounts of fine-grained data that need to be processed and interrelated, typically requiring big data analytics for the extraction of useful knowledge that can be used by the software services controlling these systems.

Cloud and edge computing

Cloud computing, defined generally as the delivery of computing as a service, has offered organizations such as cities ways to reduce costs and increase efficiency. A secondary factor driving the adoption of cloud solutions for smart cities is the massive increase in data being generated, captured, and analyzed by cities as they start to deploy and exploit IoT technologies. [16]

Scientists predict that IoT and Smart City projects will force the move of more computing to the networks edge. They say that moving processing power to the edge of networks would solve many of the toughest problems associated with robotics and computing Infrastructure. IoT, Smart City applications and data analytics mean connecting pools of data that never needed to be brought

together before. Traditionally, organisations have maintained data silos successfully, without sharing – but the advent of Smart City and IoT technologies is forcing the move away from silos to more open and mutual sharing of systems and data. In Smart City situations, the growing need by city leaders for more operational intelligence and a greater focus on the needs of the community will drive the need for edge computing power. [18]

Open data

Open data is not a technology trend in itself, but t leverages a number of the underlying technologies discussed discussed in this chapter such as cloud computing and the IoT, and is a source of big city data. Open data is driving the use of these technologies as cities develop open data portals and other city stakeholders begin to exploit access to this open data. Some of the challenges associated with big data including data security and in particular issues of privacy.

Open data in the context of smart cities refers to public policy that requires or encourages public agencies to release data sets and make them freely accessible. Typical examples are city service levels and infrastructure data. Many governments and leading cities now run open data portals, e.g., the UK and Canadian data portals, (data.gov.uk and open.canada.ca) and city portals such as San Francisco (dataSF.org) and London (data.london.gov.uk). [16]

CONCLUSIONS

As shown in this study, trends of digital innovation in cities are to be observed through the perspective of Smart City concept which was recognized globaly and in EU as an approach that should provide a model for introduction of complex digital systems into the cities. Smart cities will increase the quality of life for their citizens through improving public services, quality of environment, energy sustainability, safety etc. through innovative solutions enabled by digital services and technologies.

Smaller cities are usually lagging behind the urban centres, but the challenges of improving urban management are very similar. This paper offers an insight into developments in digital innovation in the context of Smart City and descrptions of exisiting smart city networks where also smaller cities can participate and use the experiences of more advanced actors. This should help smaller cities to get

involved in City Cooperation project to get the idea of what is possible and where to find partners and knowledge to implement the Smart city concept in their environments.

General insight is further supported by the practical guidelines how to start such a process in a city. This part represents tools for city adminsitrations and development partners (such as development agencies) to facilitate the smart city process in their communities. The guidelines are supported by templates to make the process easier. The short-term objective of such a process is to develop a digital innovation urban action plan where projects, partners and financial sources should be defined, while long term objective should be to develop a digtal backbone of the city where all public (also private) services are integrated and provided to citizens.

Finaly, a part of study is dedicated to showcases so the cities can see how the processes were implemented in some of cities in EU and (if interested) organize some study visits or staff exchange programmes to transfer the know-how. Relevant financial sources (national and EU) are also identified, which should help City Cooperation partners to upgrade initial efforts done by the project and to proceed with Smart City processes through international partnerships on a higher scale.

Introducing digital technologies and services into the life of cities is inevitable. Today, we can observe different approaches to this – some cities are aware of the global developments in this field and are actively facilitating the process, and other are simply "going with the flow" which causes confusion resulting in numbers of solutions, mobile apps etc. offered to citizens which are getting lost in the "digital forrest". This study was designed and prepared to help smaller cities to take an active role in community digitalization process and to provide their citizens with organized and transparent digital support at using public services (public transport, social and health services, public infrastructures etc.) and communicating with local community (crowdsourcing). However, it is up to involved communities to use it and follow the path set by this paper.