



Integrating Sustainability: Unveiling the Quadruple Helix – A Study on Pre-development of Smart City Strategy

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Abstract

Urban centers, irrespective of their size, grapple with critical issues concerning urban transport, parking, and environmental preservation. Finding solutions to these challenges requires proactive measures, such as research initiatives yielding practical applications. Sustainable innovation flourishes through collaborative efforts across diverse sectors, encouraging mutual learning and optimal solution generation. Embracing the principles of sustainability, one promising approach lies in the Smart City concept adoption. This article delves into the significance of the Smart City paradigm, emphasizing the integration of the Quadruple Helix model, with a specific focus on the involvement of the fourth helix – society. The article highlights the societal engagement in shaping Smart City strategies on a pre-development phase questionnaire survey, emphasizing the pivotal role of societal involvement in formulating sustainable urban strategies.

Keywords

Smart city, quadruple helix model, sustainability

1. Introduction

The “Smart City” is becoming a common term in the media and among the general public. In practice, the individual cities, which call themselves intelligent, differ significantly. This is mainly due to the fact that the concept itself is still evolving. As each city is unique and the implementation of the Smart City concept depends on the city’s policies, goals and financial capabilities, the outcomes show a versatile picture. The strategy dedicated to the Smart City concept is gaining popularity mainly due to the growing population of cities and the related effort to ensure sustainable urban development. There are large economic differences between the countries of the European Union, including unemployment and inflation rates and the amount of public debt. The growing population, relatively low birth rate and aging population are considerable problems not only in Europe, but all over the world.

In order to highlight the main trends regarding population changes, some urbanization facts are presented here from Ritchie and Roser’s article (2019):

- More than 4 billion people live in urban areas globally.
- The UN estimates 2007 was the year when, for the first time, more people in the world lived in urban than in rural areas.
- Estimates on urban populations vary – mainly as a result of disagreements on the exact definition of an “urban area” and what this includes.
- For most of human history, populations lived in very low-density rural settings. Urbanization is a trend unique to the past few centuries.
- By 2050 it’s projected that more than two-thirds of the world population will live in urban areas.
- It is projected that close to 7 billion people will live in urban areas in 2050.
- People tend to migrate from rural to urban areas as they become richer.
- Living standards tend to be higher in urban areas.



The world's cities are growing in both size and number. At the turn of the century in 2000, there were 371 cities with 1 million inhabitants or more worldwide. By 2018, the number of cities with at least 1 million inhabitants grew to 548, and by 2030, 706 cities are expected to have at least 1 million residents. Cities with more than 10 million inhabitants are often termed "megacities". Globally, the number of megacities is expected to rise from 33 in 2018 to 43 in 2030. In 2018, 48 cities had populations between 5 and 10 million. By 2030, 10 of these are believed to become megacities. Projections also indicate that 28 additional cities will cross the 5 million mark between 2018 and 2030, of which 13 are located in Asia and 10 in Africa. In 2030, 66 cities are expected to have between 5 and 10 million inhabitants (UN, 2018).

In the light of these data, it is clear that the city administration will have to face significant problems in the future related to waste management, natural resources, environmental pollution, traffic jams, deterioration of transport infrastructure and human health. The Smart City concept has the potential to address many of the challenges.

This article deals with the adoption of the concept of Smart city in the Slovak city, in its pre-development phase and it highlights the society engagement, because the successful implementation of the Smart city concept requires collaboration among various stakeholders, including government, private enterprises, and the local community (Peters, 2017).

1.1. Smart city definition

The concept of Smart City, as we see it, connects citizens, the city administration and the private sector through technology into one unit that works together to improve urban life experience, create solutions in challenging areas as ecology, transport, sustainability and wellbeing in general.

An overview of the definitions of the term Smart City was provided by the authors Gil-Garcia et al. (2015). They stated that definitions of a Smart City and many related phrases and terms refer to the same or very similar phenomena. However, each highlight different aspects or components, seemingly according to the focus of the proposing author's research, disciplinary backgrounds, and/or what different authors see as more important or prevalent. We have chose the ones that we think best capture the meaning of Smart City in line with our view.

- Kourtit et al. (2012: 234): "Advanced business and socio-cultural attractiveness [...], presence of a broad (public and private) labor force and public facilities [...], and presence and use of sophisticated e-services."
- Komninos (2009: 338): "Territories with high capacity for learning and innovation, which is built-in the creativity of their population, their institutions of knowledge creation, and their digital infrastructure for communication and knowledge management."
- Kourtit and Nijkamp (2012:93): "A promising mix of human capital (e.g. skilled labor force), infrastructural capital (e.g. high-tech communication facilities), social capital (e.g. intense and open network linkages) and entrepreneurial capital (e.g. creative and risk-taking business activities)."
- Woods and Citron (2014:1) "The integration of technology into a strategic approach to sustainability, citizen well-being, and economic development."
- Rios (2008:4): "A city that gives inspiration, shares culture, knowledge, and life, a city that motivates its inhabitants to create and flourish in their own lives."
- Giffinger et al. (2007:11): "A city well performing in a forward-looking way in [economy, people, governance, mobility, environment, and living] built on the smart combination of endowments and activities of self-decisive, independent and aware citizens."

1.2. Benefits of the Smart cities

The introduction of the concept of a Smart City brings many benefits. The positive reasons for the spread of this concept include, in particular, the rapid progress in technological development and the reduction of costs for data collection, sharing and analysis. With the right planning and investment, cities can improve their functionality, long-term sustainability and raise the living standards of their citizens (Smartcity.gov):

- Increased level of functionality of the city: means a functional economy of the city, the possibility of employment, access to basic aspects of prosperity – to infrastructure services such as interconnection and connectivity; reliable, sustainable and low-cost energy sources; adequate training opportunities; affordable forms of housing and efficient transport.
- Sustainability: means giving citizens access to the resources they need with regard to security for future generations. Sustainability is a method by which resources are not depleted or permanently destroyed. Sustainability is not only about the environment, but also about the economy. Smart cities make efficient use of natural resources, economic resources and human capital in order to create their urban infrastructure that delivers the highest possible outputs and costs as few inputs as possible.



- Raising citizens' living standards: In a Smart City, citizens have access to a comfortable, healthy, clean, safe and active lifestyle, which includes several aspects such as cheap energy, convenient public transport, quality education, faster public services, clean water and air, low crime rates and access to various entertainment and cultural opportunities.

These activities help to increase the standard of living of the population, to improve the overall management of the city and to regulate the negative impacts on the environment (Jaculjaková et al., 2019).

2. Data and methods

Huong Thu Nguyen from Universitat Autònoma de Barcelona is currently conducting research on the project “From triple to quadruple helix, The role of society/citizens/customers in innovation.” The triple helix model was the core concept of innovation developed since the mid 1990s where the collaborations among three helices of university, industry and government were encouraged. It aimed to enhance knowledge transfer, product and service development; and therefore, it aimed to lead to positive impacts on innovation and regional development. Having such top-down approach, the effectiveness of the triple helix model has recently been questioned. It is argued by some authors that the model does not ensure a long-term sustainable growth due to the lack of society's involvement (Cai and Lattu, 2022), (Pique et al., 2018).

Based on the concern above, the purpose of developing the Quadruple helix model is adding to the Triple helix model a fourth helix that represents societal needs. Thus the new model explicitly includes society in the process of knowledge creation. The advantage of this model is the combination of both top-down and bottom-up approaches. Bottom-up initiatives strengthened by top-down programs are believed to lead to the most successful results (Nguyen, 2018).

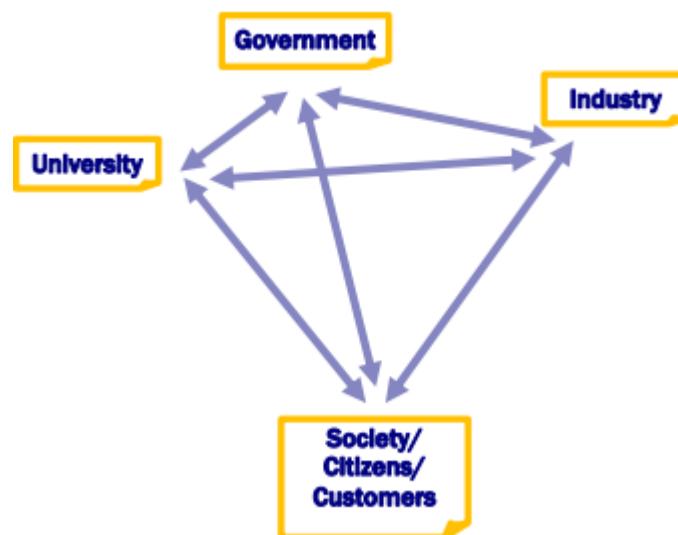


Figure 1 Quadruple helix model

Today, involving the public in research, development, and innovation is the dominant paradigm both in international STI-policy and in innovation research. The concept forms the backbone of several national innovation policies, strengthening regional innovation systems and enabling better evaluation of research organizations and research proposals (Cavallini et al., 2016). Collaborating with societal actors not only meets an established standard – cooperation and collaboration is the duty of every actor in an innovation system (Schütz et al., 2019).

3. Case study

For the purposes of this paper, we chose the city of Žilina, Slovakia. The city of Žilina is the capital of the Žilina Region, which covers an area of 6809 km and has a population of 691 613, including 82 656 inhabitants living in the city itself, while the district of Žilina has 161 377 inhabitants (SODB, 2021).

The reasons why Žilina is an eligible city for Smart city concept are as follows.

- population over 100 000 citizens (in the whole district),
- university,
- headquarters of several multinational companies.



The Smart City concept in Žilina should correspond with Strategic Implementation Plan created by European Innovation Partnership on Smart Cities and Communities (Strategic Implementation Plan, 2013):

- Sustainable Urban Mobility – Alternative energies, public transport, efficient logistics, planning.
- Sustainable Districts and Built Environment – improving the energy efficiency of buildings and districts, increasing the share of renewable energy sources used and the livability of our communities.
- Integrated Infrastructures and processes across Energy, ICT and Transport – connecting infrastructure assets to improve the efficiency and sustainability of cities.

3.1. Creation of the Smart City strategy

Mora and Bolici (2016) published a case study about developing a Smart City strategy in Barcelona, which started in 2010. The good practice of creating the Smart City strategy in the cities around the world should become the source of knowledge and inspirations for cities of any size. The development process for creation of Smart City strategy consists of these steps:

1. Starting – Based on the motivation to make a decision to create a strategy and find the right people to create it.
2. Planning – analysis, vision formulation, action plan, team building.
3. Development of the projects – start of the implementation process, support of financing.
4. Monitoring and evaluation – supervision and possible adjustments.
5. Communication – getting the Smart city concept into the consciousness of the population, arousing enthusiasm.

To implement such a fundamental and complex strategy, the positive engagement of the citizens is needed. According to case study by Mora et al. (2018), the collaboration of the public and the private sector is the core engine behind the Smart City development strategies in chosen European cities under investigation and the program of activities that they have implemented. These programs mainly result from a Triple helix model of collaboration based on the interaction between Research, Industry and Government. Civil society organizations are the less represented organization type, along with citizens. But the data in the study also show that the four chosen cities have made an effort to connect urban innovation and civil society by stimulating citizens' active involvement in the development of Smart City projects and initiatives, thus acting according to Quadruple helix model. Involvement of the citizens should be important in the developing the Smart City strategy in Žilina and in subsequent expansion of the concept. As Žilina with its 82 656 citizens does not belong to the large European cities, the sense of community is important to build on.

For the involvement of citizens in the Smart City strategy in the pre-developing phase, a questionnaire survey could be the first step. Citizens can feel positive that they are thus directly involved in improving their city, and the planned change will also be based on their views.

In further phases of development, locals can be involved in the project in the following ways.

1. Involvement in workshops, discussions, forums with other stakeholders.
2. Making citizens beta testers for purposed smart solutions.
3. Encourage citizens to participate in the developing of the new digital ideas – hackathon and other creative events.

3.2. Proposal for a questionnaire survey for Smart City strategy in Žilina

Research characteristics:

- Object of the investigation: Residents of Žilina city.
- Type of the research: Primary research, quantitative research.
- Data collection method: Electronic inquiry, personal inquiry.
- Collection technique: Inquiry via electronic questionnaire Google Docs, inquiry via paper questionnaire.
- Time period: It will be specified based on current situation, but the collection must take place for at least a month.
- Method of the research testing: Pre-test on a small sample of respondents.



Through a survey, the city of Žilina could bring the concept of Smart city to the attention of residents and start promoting its benefits. The city could create a campaign through which this survey would also be carried out. Campaign name suggestions: “Be a smart citizen,” “Creating a Smart City together,” “Smart change together.”

Questionnaires should be collected electronically, through the campaign website, which would be advertised on the largest electronic media in Žilina: Žilina.sk, myzilina.sme.sk. Questionnaires in paper form could be available on the premises of the client center, where it could be filled in by the center’s clients while waiting for the services. The questionnaires would be anonymous. The design of the Smart City concept strategy for the Žilina should also take into account the needs of the citizens who live in the city on the basis of the results of the questionnaire survey. The questionnaire should focus on satisfaction in the areas that are the most important for the citizen. Topics of the questionnaire should be based on citizens’ suggestions from the “Odkaz pre starostu” (odkazprestarostu.sk) platform, including:

- city management,
- cleanliness,
- urban transport
- communication with citizens.

The questionnaire should not be time consuming for respondents to fill in. The main goal of the survey is to identify the most important areas that citizens consider fundamental to include in the Smart City strategy of Žilina. according to our proposal, the survey form should contain 16 closed questions with a choice of answers. A draft questionnaire is given in Appendix. We based the creation of the questionnaire on the strategy of the Czech city Písek and its “Blue and Yellow Book (Modrožlutá kniha Písek, 2015),” which contains the strategy of the Smart City concept in this city.

Every city with the motivation for implementing the Smart City concept should follow several steps. The main step should be to set up a working group composed of experts to deal with this agenda. As a matter of priority, the city should anchor the Smart City concept in a strategic document, which would define long-term goals and projects that the city should address. An appropriate way to set the priorities is to take into account the needs of the citizens who live in the city. The city should also set up a special fund to support the Smart City concept, to which it will contribute a certain amount from its budget and use all available resources from the government and European Union. The city should also be open to cooperation with the academia and commerce, and develop cooperation across cities. Citizens should be informed about the projects and the concepts, and they should ideally be involved in the development.

The introduction of the Smart City concept, with the right timing and implementation, can be a significant step forward for all city stakeholders. It is a concept without which cities are unlikely to function in the future.

4. Conclusion

The Quadruple Helix Model integrates industry with three other major actors: science, policy, and society, fostering innovation. Utilizing information and communication technologies, diverse tools, and knowledge management strategies in organizations can lead to innovations applicable to the Smart City concept. Following the Quadruple Helix model, governments increasingly prioritize greater public involvement in innovation processes, aligning with sustainability goals.

As urban centers grapple with multifaceted challenges related to transportation, environmental preservation, and overall quality of life, the Smart City paradigm emerges as a promising avenue for holistic solutions. The article advocates for a proactive approach that involves the active participation of the community in the formulation of Smart City strategies. By incorporating the insights and preferences of the residents through pre-development phase questionnaire surveys, the article underscores the importance of aligning technological advancements with the values and needs of the society it serves.

In essence, the success of the Smart City concept lies not only in the sophistication of its technological infrastructure, but also in the depth of its integration with the values and aspirations of the society it serves.

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Appendix

Dear Citizen, we would like to kindly ask you to express your opinion about life in our city, also on the basis of which we will begin to create a strategy for the concept of Smart City in the city of Žilina. With the Smart City concept, we want to create an environment that will bring the citizens of the city the opportunity to benefit from the introduction of sophisticated modern technologies that systematically complement each other and go beyond the perspective of one field (transport, energy, environment, etc.).

1. What is your age category?
a) >20 b) 20–30 c) 31–40 d) 41–50 e) 51–65 f) 65 >
2. Do you use public transport for transport around the city?
a) Yes, regularly (Skip Q nr.4) b) yes, sporadically c) No (go to Q nr.4)
3. Are you satisfied with the frequency of the lines you normally use?
a) Yes b) No
4. Why don't you regularly use public transport services for transport around the city?
a) insufficient frequency of the line b) uncomfortable type of transport c) unsatisfactory routes of the lines
d) use of other types of transport (car, train, bicycle...) e) other
5. Are you satisfied with the flow of car traffic in your city?
a) Yes b) Mostly yes c) Mostly no d) No e) I don't know
6. Do you think the parking situation has been getting worse over last years in the city?
a) Yes b) No c) I don't know
7. Would you use car sharing/rental services for city transport?
a) Yes b) Probably yes c) Probably no d) No e) I don't know
8. On a scale of 1–10, rate the cleanliness of your city center (1 – the city center is constantly dirty, 10 – the city center is constantly clean)
1 2 3 4 5 6 7 8 9 10
9. Are you satisfied with the frequency of waste collection at your place of residence?
a) Yes b) Mostly yes c) Mostly no d) No e) I don't know
10. Are you interested in the economy of the city?
a) Yes b) Mostly yes c) Mostly no d) No e) I don't know
11. Can you easily get information about the city's economy?
a) Yes b) Mostly yes c) Mostly no d) No e) I don't know
12. Are you sufficiently informed about what is happening in the city?
a) Yes b) Mostly yes c) Mostly no d) No e) I don't know
13. Which information channels between the city and the citizens do you use?
a) webpage of the city b) local news (paper, or electronic) c) social media
d) public debates e) information tables f) other g) none
14. Would you use a mobile application that would bring together the whole city agenda?
a) Yes b) Probably yes c) Probably no d) No e) I don't know
15. On a scale of 1–10, rate the importance of free WIFI and mobile chargers & charging stations in your city (1 – absolutely irrelevant, 10 – very important)
1 2 3 4 5 6 7 8 9 10
16. Is there enough sports and cultural activities in your city?
a) Yes b) Mostly yes c) Mostly no d) No e) I don't know

If you want to, please express your opinion on what other areas the city should focus on?

Thank you for your time.