Opportunities for Adaptation of the Smart City Concept – A Regional Approach

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SUMMARY

Smart City applications are becoming more prevalent in the world's major cities. In this study we briefly introduce the essence of this concept and attempt to examine the basis for introduction of the concept subsystems in Northern Hungary. We found that the region under investigation significantly lags behind the national average in the case of indicators for quantifying Smart City applications. We identify areas with a particularly low score on the newly developed SMART index and propose a possible area for future intervention.
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INTRODUCTION

In the 2014-2020 programming period of the European Union one basic issue is to make cities smart, and to initiate smart applications to make the cities' processes more effective. Although there is no agreed-on definition for a smart city in the literature, based on the newest European viewpoint (European Parliament, 2014) a smart city improves its competitiveness through the application of smart technologies, and secures a sustainable future for its inhabitants throughout the following factors: people, business sphere, technology, infrastructure, consumption, energy and spaces.

In the last decade several publications have appeared in connection with concept and sub-dimensions of smart cities, such as Hall, 2000; Giffinger et. al., 2007; Harrison et. al. 2010; Toppeta, 2010; Washburn et. al. 2010; Anthopoulos, L., Fitsilis, P. 2010; Schaffers 2011; Lados, 2011; Bizjan, 2014; European Parliament, 2014. However, the monitoring and evaluation of results has received less attention. At the same time the measurement of smart city development effects is a relevant and timely topic. In empirical works the appearance of city rankings is relatively frequent, measuring the values of cities by certain aspects (for example: Mercer Quality of Living Survey, Siemens Green City index, Liveability Index of Economist Intelligence Unit, UN City Prosperity index, Global Urban Competitiveness Report).

The aim of this research is to examine the introduction of the smart city concept in the Northern Hungarian sample area and to analyse the "smartness" of the region's settlements. In the article we try to create a SMART indicator to measure the situation (rating settlements in connection with smartness), and to identify opportunities for adapting smart technologies.

THEORETICAL BACKGROUND

The concept of the smart city appeared in the literature in the 1980s and '90s due to the wide-spread development of information and communication technologies (ICT). In the 2000s the increasingly intensive usage of the Internet has provided an opportunity to cities to offer more electronic services (like e-government, e-learning) to their inhabitants. Nowadays the revolution of wireless sensors can be observed among the smart applications (Bizjan 2014).

Although the expression "smart city" is becoming more widely known, there is no commonly agreed upon definition or concept of its content. The characteristics of smart cities can differ significantly depending on space and resources. There are often individual solutions to the adaptation of the concept.

One group of smart city definitions focuses on the role of ICT. In the opinion of Anthopoulos & Fitsilis, "in a smart city the ICT strengthens the freedom of speech, improves the availability of public information and services" (2010, p. 302).

According to Schaffers (2011), a city is smart when the investments in human and social infrastructure, in traditional and modern infrastructure foster the sustainable economic growth and contribute to the growth of the life quality, "with a wise management of natural resources and participatory governance" (2011, p. 432).

In the opinion of other authors, a smart city is a kind of city:

- which integrates every critical infrastructure (roads, bridges, tunnels, railways, subways, airports, harbours, communications, water, energy and main buildings), optimizes its resources, plans the activities based on security norms, and of course maximizes the services offered to its inhabitants (Hall 2000),
- which raises the city's collective intelligence with the integration of physical, ICT, social and business infrastructure (Harrison et. al. 2010),
- which combines ICT with other organizational and planning solutions to accelerate bureaucratic processes, and to create new, innovative solutions for the city management, and to increase sustainability and liveability (Toppeta 2010),
- which adapts ICT to make the city's critical infrastructure and services (administration, education, healthcare, public safety, wealth management, transport) more intelligent, effective and integrated (Washburn et al. 2010),
- whose aim is to become smarter (more effective, sustainable, fair and liveable) (National Resources Defence Council 2012),
- which performs outstandingly in the following six areas: economy, people, government, mobility, environment and living conditions (Giffinger et al. 2007).

In the last years a number of similar expressions have appeared in the literature in connection with cities, including intelligent city, knowledge city, sustainable city, talented city, wired city, digital city or eco-city, but the term smart city is the best known.

The number of smart city projects is constantly growing in the countries of the world, but their quality and complexity differs according to the opportunities and resources of the cities. The Fast Company made an analysis in 2013 to collect the most developed smart cities; the results are the following:

- Europe: Copenhagen, Amsterdam, Vienna, Barcelona, Paris, Stockholm, London, Hamburg, Berlin, Helsinki and Lyon;
- North America: Seattle, Boston, San Francisco, Washington, New York, Toronto, Vancouver, Portland, Chicago and Montreal;
- Latin America: Santiago, Mexico City, Bogota, Buenos Aires, Rio de Janeiro, Curitiba, Medellin and Montevideo;
- Asia and the Pacific: Seoul, Singapore, Tokyo, Hong Kong, Auckland, Sydney, Melbourne, Osaka, Kobe and Perth are the most developed smart cities (Cohen 2013).

In Europe most of the smart cities can be found in the United Kingdom, Spain and Italy. But if we examine occurrence per capita then Italy, Austria, Denmark, the Netherlands, Norway, Sweden, Estonia and Slovenia are the richest countries in smart cities.

The expression smart city appears also in the documents of the European Union more and more frequently, but it has been given several concepts. In 2011 the European Smart Cities Initiative defined three main character axes which are necessary to a smart city. These factors are environmental friendly technologies, ICT technologies like management tools, and sustainable development.

The definition of the European Commission (2011) contains also some economic aspects. The European city of the future has well-developed social and environmental processes, which can sustain their economic attraction and economic growth through integrated approaches (every dimension of sustainable development).

In 2013 there was an analysis titled "Smart Cities and Communities" which also defined the European concept of smart city. According to its statement, smart cities use the available technology widely to reduce the environmental pressures and to secure a better quality of life for their inhabitants. It is a multi-disciplinary issue to make a city smart, which should be realised based on the cooperation among city management, innovative enterprises, politicians, researchers and the civil society (Smart Cities and Communities 2013).

The newest European commitment to this topic comes from the European Parliament (2014) in its "Mapping Smart Cities in the EU" analysis. This defines a smart city as a place which improves its competitiveness through the adaptation of ICT, and which secures a sustainable future through a network of the following dimensions: people, business sphere, technology, infrastructure, consumption, energy and places (European Parliament 2014).

In Hungary the most comprehensive analysis was made by the IBM Smart City Initiative (Lados et al. 2011), which was created with the help of the Hungarian Academy of Sciences. According to the results a smart city is a settlement that uses the available technology in an innovative way to create a better, more diversified and sustainable city environment. A city is smart when the investments in human resource, conventional (transport) and modern information and communication infrastructure foster sustainable economic development and increase the quality of life, while it handles natural resources wisely (Lados et al. 2011; IBM Institute for Business Value 2010).

DATA AND ANALYSIS

Secondary Analysis: Settlement Level Results

In this recent study we have examined the prerequisites for introducing Smart technologies into the settlements of the Northern Hungary region. As is observable from the above, the concept of smart city is adaptable primarily in cities, and the smart activities can improve mostly the quality of life in these cities. In spite of this, our aim was to examine the basic requirements of the concept in the case of the Northern Hungary region's settlements. In our analysis we applied the data of the Hungarian Central Statistical Office to secure the consistency of the analysis. Of course there are some dimensions in the smart city concept, that it is almost impossible to measure (such as a creative workforce or creative enterprises), so these dimensions were dropped from our examination. One basic goal of the analysis was to represent the strengths and weaknesses of the region according to the concept of smart city.

Based on the earlier Hungarian empirical analysis (Lados et al. 2011) we made a settlement-level examination of introducing Smart technologies based on seven sub-systems:

- people, which contains public safety, healthcare and education,
- business,
- city services,
- transport,
- communication,
- water management,
- energy management.

In the given sub-systems we have compared the analysed indicators to the national average. In some cases there was a need for modification because of the different scale of the indicators. In that situation, if the scale of indicator was not adequate, for example with the death indicator (where a smaller value indicates a better quality of life in the settlement), we used the inverse of the indicator in the calculations. The value of the sub-systems was calculated by the meaning of the indicators, which were compared to the national average. The end result (the SMART indicator) was created as a means of the sub-systems (pillars). Although in the literature (Lados et al. 2011) a weighting method was also used, we chose not to deal with it, because we believed it would make our results as more criticisable. Of course we know that this approach can result in a high degree of generalisation, hence in the given sub-indices the importance of the territories can be different. With this approach (avoiding weights), we can place attention on general tendencies, instead of highlighting some particular territories. Let us see the given sub-system values.

People Sub-System

We hope to describe with the indicators of this sub-system the living conditions of the settlements' inhabitants. We wanted to examine employment (including its content and structure) and age structure. Beside this we wanted to analyse also the demographic situation, living conditions, health and educational situation, and the public safety of the settlements.

The applied indicators of the analysis:

- number of unemployed people per hundred employees, 2011,
- dependents per hundred employees, 2011,
- number of employed in the industry and construction per hundred employees, 2011,
- number of employed in the services per hundred employees, 2011,
- number of employed as manager or intellectual per hundred employees, 2011,
- number of employed as other white collar employee per hundred employees, 2011,
- number of elderly (60 or over) per hundred in the working age, 2011,
- live births per thousand inhabitants, 2014,
- deaths per thousand inhabitants, 2014,
- inhabitants per hundred homes, 2014,
- average selling price of homes, 2014,
- newly built homes per ten thousand inhabitants, 2014,
- family doctors and paediatricians per ten thousand inhabitants, 2014,
- hospital beds per ten thousand inhabitants, 2014,
- share of elementary school students with computer usage, 2014,
- average completed years of education, 2014,
- crimes per ten thousand inhabitants, 2014.

The examined settlements have relatively good values in this dimension; hence the weighted average of the sub-system is 94%. The value of 527 settlements from the 610 of the Northern Hungary region does not reach the national average, and 169 of these do not reach 75% of the national average. The relatively satisfactory values are the result of the relatively young age structure, high live birth ratio, relative low density standard (floor space), and good crime statistics.

Business Sub-System

In the business dimension we tried to find indicators that represent the density of enterprises, the average number of small and medium-sized enterprises and also the average number of enterprises active in the economic sectors with significant SMART technologies.

The applied indicators are the following:

- active enterprises per thousand inhabitants, 2013,
- share of active enterprises with more than 50 employees, 2013,
- active enterprises per thousand inhabitants in the information and communication sector, 2013,
- active enterprises per thousand inhabitants in the professional, scientific and engineering sector, 2013.

The lag of the region's settlements compared to the national average is greatest in this dimension. The weighted average value of the sub-system reaches only 67% of the national average! There are seven settlements in the region which do not have a single active enterprise. In the business dimension there are 410 settlements, whose average sub-system value does not reach 50% of the national average, 138 settlements have values between 50 and 100% of the national average, and only the situation of 62 settlements is better than this. The significantly negative situation is caused by several factors, for example the low share of active enterprises with more than 50 employees and the lack of active enterprises in the information and communication sector.

City Services Sub-System

In the dimension of city/settlement services we tried to analyse the income of local governments focusing on their budget opportunities to promote SMART technologies. We applied two indicators to measure this:

- self-income of the local governments per thousand inhabitants, thousand HUF, 2011,
- local tax incomes of the local governments per thousand inhabitants, thousand HUF, 2011.

There is a significant lag also in this sub-system compared to the national average. The weighted average sub-system value of the examined settlements is only 75%. There are 504 settlements with values below 50% of the national average, 69 settlements between 50 and 100%, and 37 settlements above the national mean. The situation of the examined territory is the worst compared to the Hungarian mean in the indicator of local tax income.

Transport Sub-System

We intended to analyse the situation of local roads and the capacity of given vehicles in the transport dimension. Naturally our opportunities were in this case somewhat limited, as we could not calculate with the big cities' transport systems which are based on SMART technologies. The examined factors of our Northern Hungarian analysis were the following:

- deployment of local roads, %, 2014,
- number of passenger cars per thousand inhabitants, 2014,
- number of motorcycles per thousand inhabitants, 2014,
- number of buses per thousand inhabitants, 2014.

In this sub-system the weighted average value of the settlements is favourable compared to the national average, at 104%. There are only 141 settlements whose value does not reach 50% of the national mean, a further 330 settlements are between 50 and 100%, and in 139 settlements the value of transport dimension is higher than the national average. The good situation is mostly the result of the relatively favourable deployment of local roads.

Communication Sub-System

In the communication dimension our main goal was to examine the infrastructural situation of the territories. We selected indicators that represent the infrastructural situation in terms of installing SMART technologies. The applied indicators in the communication dimension were:

- number of ISDN lines per thousand inhabitants, 2014,
- number of Internet subscriptions per thousand inhabitants, 2014,
- number of Internet subscriptions in xDSL network per thousand inhabitants, 2014,
- number of Internet subscriptions in wireless network per thousand inhabitants (without mobile internet), 2014,
- homes with cable TV in the share of housing stock, 2014.

Analysing the sub-system as a whole, we can observe a great lag compared to the national values. The weighted average of the examined settlements' sub-system indicators is only 84%. Lamentably, there are 6 settlements in the region where none of the examined services are available. There are 194 settlements where the value of the sub-system does not reach 50% of the national average, and a further 292 settlements with values between 50 and 100%. The situation of 121 settlements from the region is more favourable than the Hungarian average. In the examined sub-system the number of ISDN lines per thousand inhabitants showed the worst values, and mostly because of this factor the situation of the region is negative in the communication dimension.

Water Management Sub-System

In the sixth sector our aim was to point out the opportunities of SMART technologies applied in water management through the analysis of communal infrastructure and water consumption. The indicators of our analysis:

- share of waste water cleaned by high cleaning degree of the whole public cleaned waste water quantity, 2014,
- share of homes connected to the public plumbing network, 2014,

- share of homes connected to the public sewer system, 2014,
- quantity of provided water to households per 10,000 inhabitants (1000 m3), 2014.

According to our analysis, in this sub-system the region has a relatively favourable position compared to the national average. The weighted average value of the dimension is 102%. Only 9 settlements had a mean value that does not reach 50% of the average, and the position of 277 settlements is between 50 and 100%. In the remaining 324 settlements the situation is better than the national mean. Principally the lack of a public sewer system indicates the main problem among the region's settlements. In the territories that have a public sewer system, the share of waste water cleaned by high cleaning degree is higher than the average, which means higher quality, so the lag is not so significant in these areas.

Energy Management Sub-System

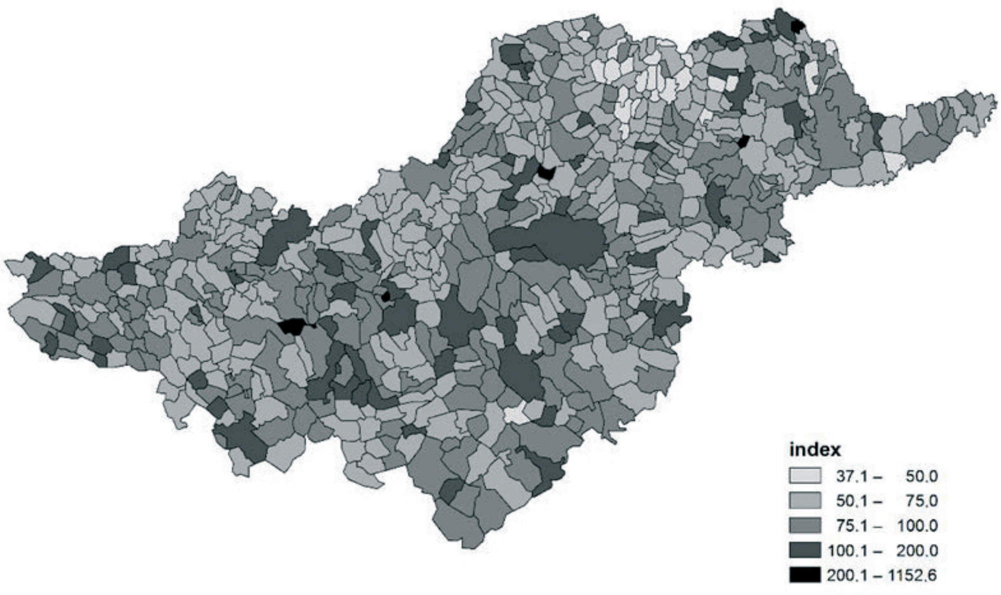
Among the indicators of the energy system we have intended to analyse in which quantity the region needs new technologies to reduce their energy costs. The factors used through the calculation are as follows:

- households using piped gas in the share (%) of housing stock, 2014,
- yearly gas consumption per one household, 2014,
- yearly electricity consumption per one household, 2014.

The average value of the sub-system is the highest among the 7 dimensions; its value is 107%. There are 42 settlements with values lower than 50% of the national average, 303 between 50 and 100%, and 265 with values higher than the average. The gas consumption per households is the closest to the average, so presumably there may be a big chance to install new technologies or solutions in this dimension.

Mean of the Sub-Systems – SMART Index

Although, as we earlier emphasised, the factors and indicators that are the basis of smart solutions are very different, and the sub-systems created from these factors are hardly comparable, we have tried to create a complex indicator based on the weighting and averaging of the sub-systems, which we have called the SMART indicator. Naturally it is adequate only to describe general tendencies, and we cannot draw further conclusions from the difference of the values.



Source: compiled by the authors

Figure 1. Values of the SMART indicator in the Northern Hungary region

The weighted average value of the SMART indicator is 91% compared to the national average. There are 28 settlements whose value does not reach 50% of the national average, the vast majority of settlements (516) have values between 50 and 100%, while the SMART indicator of 56 settlements is higher than the average. From the data, it appeares that primarily the city services and business sub-systems had the most negative effects on the values of the SMART index. The highest SMART values were mostly for small settlements (population below 1100 people) like Sima, Berente, Mátraszentimre, Terpes, and Pusztafalu. Tiszaújváros has the most favourable position among the significant economic centres; its value is 161%. The county centres of the region have on the average a good position; their index values are: Eger 118%, Miskolc 111%, and Salgótarján 101%.

CONCLUSION

After presenting the Smart city concept and framework we have tried to examine the installation requirements of the concept's sub-system in a sample area. According to the results from our self-designed SMART indicator, the Northern Hungary region has a small lag in the SMART indicator values (average of the sub-system values) compared to national average. The cause for this can be found mostly in the business dimension (which characterises the entrepreneurial environment) and the city services sub-system (which represents the settlements' income situation). Our results indicate that the energy management dimension has the most favourable position in the sample area, so the installation of Smart solutions can bring potentially the highest benefit in this area.

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