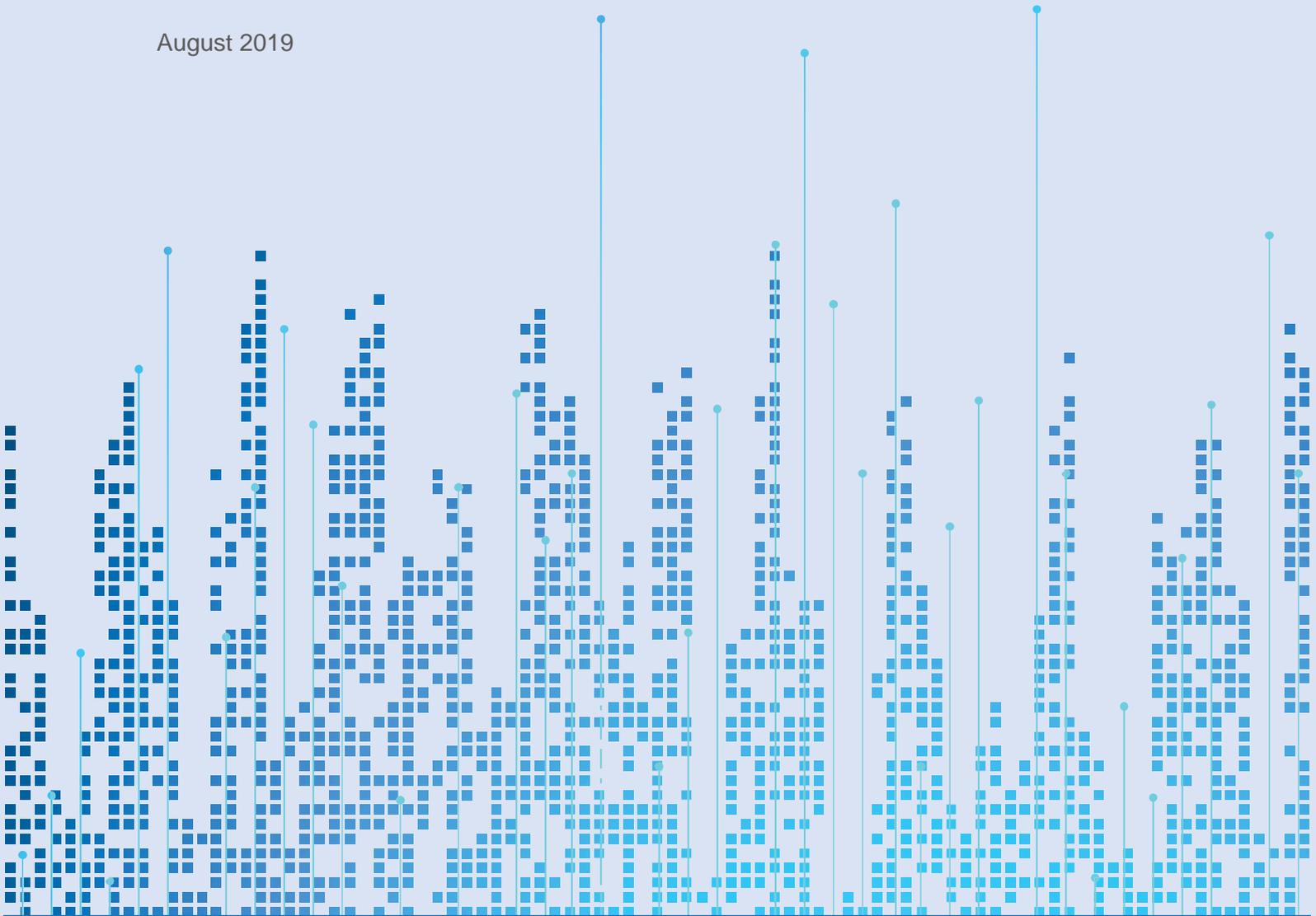


National Development Strategy Croatia 2030 Policy Note:

Croatia's Cities: Boosting the Sustainable Urban Development Through Smart Solutions

August 2019



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1 Smart Cities – challenges and opportunities at European and global level

An increasingly urbanized world presents both challenges and opportunities. By 2050, the proportion of people living in cities and towns is expected to increase to 68 percent, from 55 percent today.¹ 90% of this urban growth is taking place in developing countries who face a growing number of challenges, including: congestion, the strain on housing, water, waste management, transport, healthcare and education, as well as pollution, increasingly severe weather events, and climate change. In Europe, 74% of inhabitants are already living in urban areas but European cities are also not immune to these challenges.

Cities need to deliver better quality services to citizens with increasingly constrained resources. Citizens around the whole world are demanding better services while city governments are increasingly constrained by low human and budgetary resources. As well as being limited, city resources are unequally distributed, and increasingly so. In Europe, there is a mixed story of growth and decline; many countries have experienced people and economic growth concentrating around capital regions and/or a hierarchy of cities, while secondary cities have been shrinking. According to the World Bank, *a smart city is a city that leverages the latest technology and connectivity to make better decisions and achieve the urban aspirations of its residents* (World Development Report 2016).

Simultaneously, there is growing recognition that being a smart city is less about technology and more about governments, stakeholders, and citizens being able to ‘co-create’ innovative solutions. Being a smart city is also becoming synonymous with being green, sustainable, energy efficient, and climate resilient. There is an increasing need to develop strategies that both harness new technologies and simultaneously encourage innovation and the inclusivity of various stakeholders.² The goal of any smart city approach needs to be about providing people with the tools and data they can use to make decisions in a better way. Citizen engagement therefore is central to any smart city strategy.

The key elements of any smart city approach are efficiency, innovation and inclusion: Whereby a smart city aims to promote: (a) **Efficiency in city operations:** using large amounts of data to make service provision faster and more responsive to citizens’ needs, whilst still correcting it along the course; (b) **A platform for innovation on a city-wide scale:** to promote collaboration amongst all city-dwellers to build a city that optimally serves everyone’s needs; (c) **Social Inclusion:** ensuring benefits for everyone through transparency, citizen empowerment, and smarter decision-making. Regardless of the number and variety of Smart City definitions, all of them include elements of six major areas - smart governance, smart people, smart mobility, smart living, smart economy and smart environment.³ Table 1 shows the main characteristics and factors of smart cities in more detail.

¹ World Urbanization Prospects: The 2018 Revision, United Nations, 2018.

² Smart Cities as Innovation Ecosystems Sustained by the Future Internet – White paper on Smart Cities as Innovation Ecosystems, Ed. Schaffers, H., Komminos, N., Pallot, M., 2012.

³ Ghosal, A., Halder, S., 2018: Building Intelligent Systems for Smart Cities: Issues, Challenges and Approaches, in: Smart Cities: Development and Governance Frameworks (ed. Mahmood, Z.), Springer, Derby, UK

Table 1. Characteristics and factors of a smart city⁴

| Smart economy (competitiveness) | Smart people (social and human capital) | Smart governance (participation) |
|--|--|---|
| <ul style="list-style-type: none"> - innovative spirit - entrepreneurship - economic image & trademarks - productivity - flexibility of labour market - international embeddedness - ability to transform | <ul style="list-style-type: none"> - level of qualification - affinity to life long learning - social and ethnic plurality - flexibility - creativity - cosmopolitanism/ open-mindedness - participation in public life | <ul style="list-style-type: none"> - participation in decision-making - public and social services - transparent governance - political strategies & perspective |
| Smart mobility (transport and ICT) | Smart environment (natural resources) | Smart living (quality of life) |
| <ul style="list-style-type: none"> - local accessibility - (inter-)national accessibility - availability of ICT infrastructure - sustainable, innovative and safe transport systems | <ul style="list-style-type: none"> - attractivity of natural conditions - pollution - environmental protection - sustainable resource management | <ul style="list-style-type: none"> - cultural facilities - health conditions - individual safety - housing quality - education facilities - touristic attractivity - social cohesion |

1.1 Challenges

In general, one of the biggest challenges related to the implementation of smart solutions in cities is that leaders struggle to understand how to best invest in intelligent infrastructure and connectivity to deliver long-term value.⁵ This can arise as a result of short-term mindsets or a lack of the visionary leadership necessary for the success of Smart Cities.⁶ Additionally, specific technological challenges include machine-to-machine communications, security, spectrum utilization⁷, intelligent information networks, and the interconnection of a set of standards to achieve system interoperability.⁸ Data cannot be shared – and smart cities cannot fulfill their potential – if systems cannot work with other systems.

Other challenges include implementation costs, high energy consumption, privacy and security, integration, and the upgrading of technologies.⁹ In particular, data security and privacy represent a major challenge for city leaders. They need to tackle privacy more directly now, because today data is being managed, shared and collected in a more publicly visible way than ever before. Regarding the EU context, it is worth taking into consideration the EU General Data Protection Regulation (GDPR), which represents a challenge to, and specific requirement for smart cities/smart solutions that use personal data to offer intelligent services.

⁴ Riva Sanseverino, E., Riva Sanseverino, R., Vaccaro, V., Zizzo, G., 2014: Smart Rules for Smart Cities – managing Efficient Cities in Euro-Mediterranean Countries, Springer

⁵ World Development Report 2016: Digital Dividends, World Bank Group, 2016

⁶ Smart cities: understanding the challenge and opportunities, Smart Cities World, 2017

⁷ Spectrum utilization refers to efficient use of radio frequencies in order to promote social benefit via the increase quality and speed of wireless communication – Cave, M. et al, 2007: Modern Spectrum Management, Cambridge University Press

⁸ Smart Sustainable Cities: Reconnaissance Study, United Nations University, International Development Research Center, 2016

⁹ Ghosal, A., Halder, S., 2018: Building Intelligent Systems for Smart Cities: Issues, Challenges and Approaches, in: Smart Cities: Development and Governance Frameworks (ed. Mahmood, Z.), Springer, Derby, UK

Engaging citizens as well as a broad spectrum of stakeholders is crucial for the success of smart solutions implemented in cities. The potential solutions will be irrelevant to most inhabitants unless they can learn how to use the new technology.¹⁰ There is also the challenge of ensuring equity and fairness regarding access to technology of various socio-economic or disadvantaged groups in society.

Institutional and administrative capacity enhancement is needed to develop and adopt smart city solutions. At the EU level, the key difficulties identified regarding Smart Cities are: (a) inappropriate level of local competences, (b) insufficient level of administrative capacity, (c) high administrative burdens, (d) limited stakeholder involvement, and (e) lack of access to capital and public-private partnerships.¹¹ A potential solution for some of the challenges is the establishment of a dedicated and multi-disciplinary smart city task force charged with developing and implementing smart solutions and working across institutional boundaries. Simultaneously, there has been a shift in the smart city mindset from traditional top-down investment in infrastructure towards an innovative, collaborative and often inexpensive model centered around building partnerships with citizens, firms and academia supported by technology.

1.2 Opportunities

New opportunities to better manage increasingly complex challenges in cities are available in the form of information and communication technology, as well as various other technological solutions. A growing number of cities are developing new approaches to harness these opportunities. Incorporating new technologies and digitally enabled solutions, such as Internet of Things (IoT), Information and Communication Technology (ICT), open data, cloud computing etc. have the potential, if well designed and deployed, to significantly contribute to solving various challenges and difficulties cities face today. This has led nations and cities to develop strategies to advance their smart agendas. For instance, Barcelona developed a *Smart City Strategy* which contains five main components: *smart districts, a living labs initiative, infrastructure, new services for citizens, and open data.*¹² As part of this, Barcelona has identified an innovation zone (22nd District) to implement the city's smart solutions through a GrowSmarter Project.

In the EU, the European Commission (EC) has a coordinated approach to its smart city agenda. Various parts of the EC are collectively and independently involved in supporting it at international and national levels. The Directorate-General for Communications Networks, Content and Technology (DG CONNECT) has funded Smart City projects through 7th Framework Programme (FP7) projects and the ICT-Policy Support Programme (PSP), which is part of Competitiveness and Innovation Programme (CIP). It has also worked together with the Directorate-General for Research & Innovation (DG RTD) and the Directorate-General for Energy (DG ENER) on cross-cutting PPPs, including the European Green Cars Initiative and the Efficient Buildings Programme. The EC has provided policy

¹⁰ Smart cities: understanding the challenge and opportunities, Smart Cities World, 2017

¹¹ The making of a smart city: policy recommendations, EU Smart Cities Information System, 2017

¹² Smart Cities as Innovation Ecosystems Sustained by the Future Internet – White paper on Smart Cities as Innovation Ecosystems, Ed. Schaffers, H., Komninos, N., Pallot, M., 2012

support through policies of the Directorate-General for Mobility and Transport (DG MOVE) and via several communications that specifically refer to the role of Smart Cities.¹³

There are a number of opportunities for cities to develop and implement smart solutions. Smart infrastructure can improve city's environmental sustainability, affordability, business climate and general livability. For instance, smart infrastructure such as smart water meters and electricity grids can reduce usage and costs by raising awareness among individuals about how much they are using, but also by automatically reducing consumption at times of limited demand. By collecting large amounts of data and then translating these data into insights, cities are able to greatly boost the efficiency and responsiveness of their operations.¹⁴

1.3 Best practices

On a global scale, there are good examples of smart cities worth learning from. Singapore and London stand out on a global scale as cities which are using new technologies in ways that ensure greater quality of life for residents and visitors alike¹⁵, while numerous other cities implanted (or are implementing) smart solutions in order to optimize their services and increase the quality of life.

For example, the City of Florence in Italy, which has implemented an integrated smart city plan for the first smart district in Florence - the Novoli urban park. The Novoli area represents a mixed-use area with residential and tertiary settlements with mobility infrastructure consisting of a highway, an airport, and the main station. The actions to be implemented through the REPLICATE project include energy efficiency and district heating with an innovative seasonal solar thermal storage for social housing, smart grid and energy-demand management with smart metering and mobile application for final users, public multivendor e-mobility infrastructures, advanced mobility services for citizens, data management and a smart city control room, smart lighting based on LED technology integrated with other services like traffic control, video surveillance and environmental sensors, as well as intelligent systems (internet of things (IoT) pilot test on smart benches, smart waste and smart watering).

Another example is Manchester in the United Kingdom, which participates in the TRIANGULUM project, with the focus of the project being on the integration of energy, mobility and ICT systems around three core infrastructure assets within the innovation district 'Corridor Manchester': Civic Quarter Heat Network, University of Manchester's (UoM) Electricity Grid and Manchester Metropolitan University's (MMU) Electricity Grid. The aim of the project is to improve energy efficiency, reduce carbon emissions and provide a greater ability to meet demand in a more cost-effective way.

Numerous other cities in Europe, such as Lyon, Nottingham, Stockholm, and many others, are implementing various smart solutions related to a large number of sectors (traffic, e-services, optimization of services related to water supply and waste collection, energy savings, etc.). Further examples of best practice in Smart Cities can be found in **Annex | Smart Cities: Best practices – detailed overview**.

¹³ Mapping Smart Cities in the EU, Directorate-General for Internal Policies – Policy Department A: Economic and Scientific Policy, 2014

¹⁴ World Development Report 2016: Digital Dividends, World Bank Group, 2016

¹⁵ Smart cities: understanding the challenge and opportunities, Smart Cities World, 2017

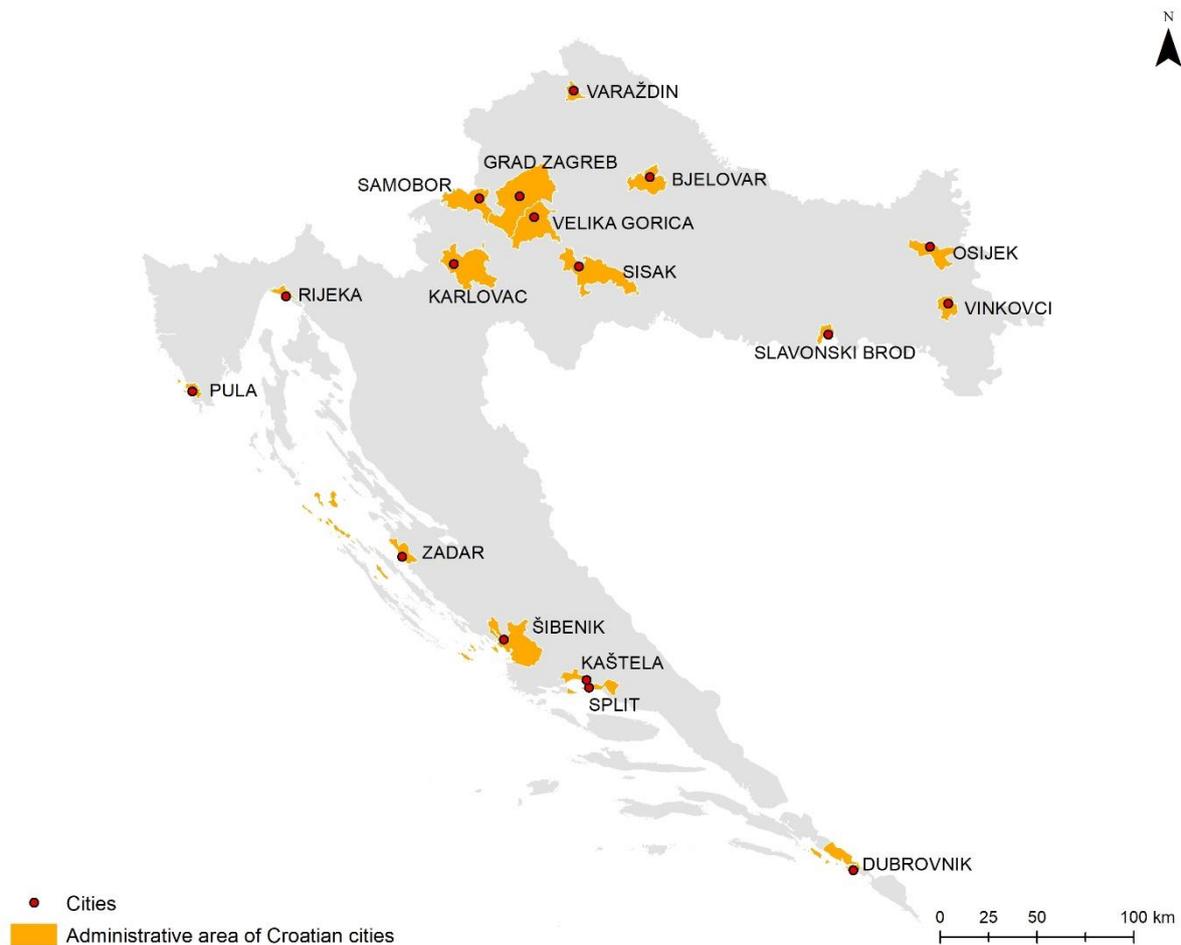
2 Development challenges and opportunities of Croatian cities based on their territorial capital

The analysis of territorial capital in Croatian cities is carried out for cities that are defined as the centers of urban agglomerations and larger urban areas¹⁶ in accordance with the Regional Development Act of the Republic of Croatia (NN 147/14, 123/17, 118/18). According to the above mentioned act, the territorial capital was analyzed for 17 cities: Bjelovar, Dubrovnik, Karlovac, Kaštela, Osijek, Pula, Rijeka, Samobor, Sisak, Slavonski Brod, Split, Šibenik, Varaždin, Velika Gorica, Vinkovci, Zadar and Zagreb¹⁷. Of these cities, ten are located in the NUTS2 region of Continental Croatia, while the other seven are in the Adriatic region of Croatia (Figure 1).

¹⁶ According to the Regional Development Act of the Republic of Croatia, urban agglomerations are Zagreb, Split, Rijeka and Osijek, while in the category of larger urban areas are administrative cities which according to the last population census (2011) have more than 35,000 inhabitants and are not included in urban agglomerations. In addition, considering their population of more than 35.000, cities of Velika Gorica, Samobor and Kaštela are also included in the analysis.

¹⁷ The term "cities" in this analysis refers exclusively to the aforementioned 17 cities.

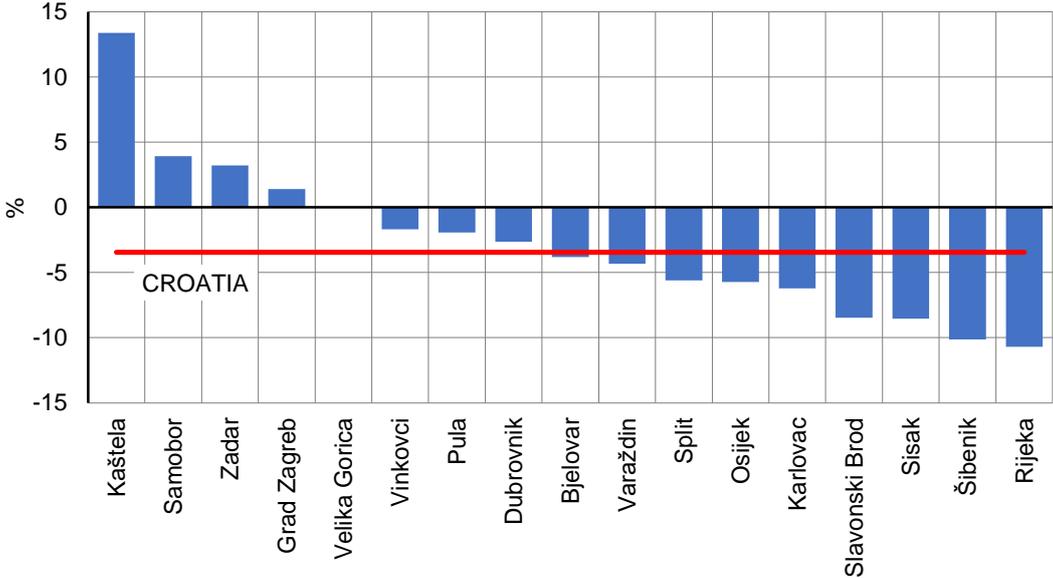
Figure 1. Spatial distribution of analyzed cities



A total of 1.85 million inhabitants lived in these cities as of 2011, which accounts for 43.2% of the total Croatian population. This data suggests that slightly less than half the human potential of Croatia is present in these cities, indicating their importance as engines of the state's economic development. **The differences in the number of inhabitants of individual cities are large; so, Zagreb –with 790,017 inhabitants– is 4.4 times more populated than Split,** the second most populous city, which indicates a high index of urban primality and the monocentricity of the Croatian urban system. A monocentric urban system is often associated with uneven regional development, which is evident in Croatia where a significant number of counties are significantly below the national average of development, according to the basic economic indicators.

In the period between the last two population censuses (2001-2011), the number of inhabitants in cities decreased by -2.05%. Despite the decline in the number of inhabitants, the trend in cities is above the national average, with the number of inhabitants in Croatia falling by -3.43%. Out of the total number of cities, eight had a decrease in the number of inhabitants lower than the national average, but in only four cities (23.52%) there was an increase in population, while in Velika Gorica the number of inhabitants stagnated. The largest increase in population happened in satellite towns that are part of larger urban agglomerations - Kaštela (13.38%) and Samobor (3.92%), while the third largest city in Croatia - Rijeka - lost -10.70% of its population (Figure 2).

Figure 2. Population change in cities between 2001 and 2011

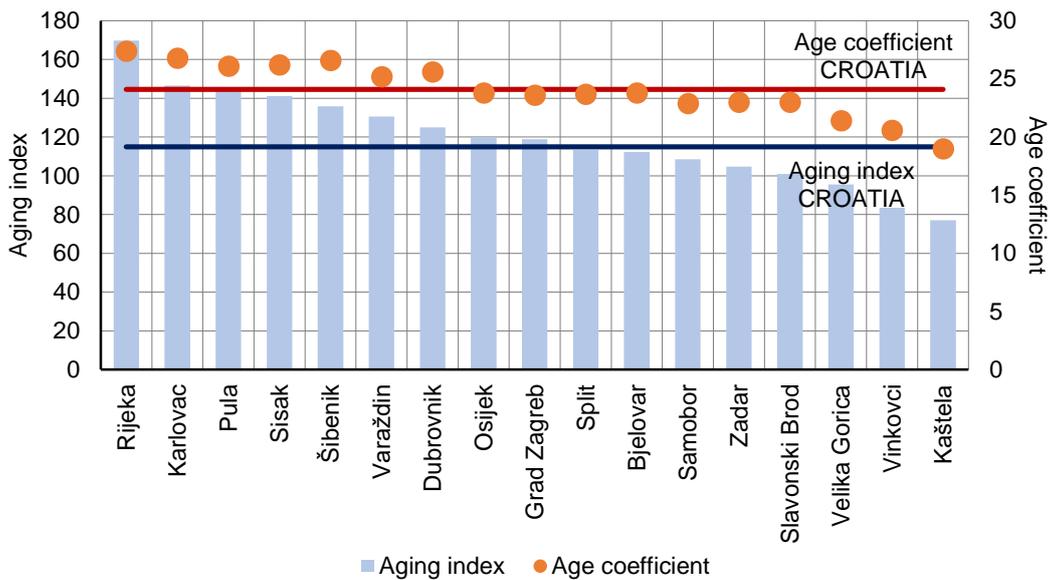


Source: Croatian Bureau of Statistics, 2012

More than half of the cities (52.94%) have an aging index¹⁸ higher than Croatia's average (115.0). Rijeka is the city with the highest aging index of 169.8, while the lowest aging index was recorded in Kaštela (at 77.1) (Figure 3). Given that this indicator shows the ratio between the number of old and young people, it is obvious that Croatian cities are characterized by an unfavorable age structure with a very high proportion of elderly people. The share of elderly people in the total population (age coefficient) shows that seven out of seventeen cities (41.17%) have a higher share of the elderly population compared to the national average of 24.1%. Resultingly, the basic challenge is to retain the existing and attract the new population, that is, to improve the age structure that is directly related to the overall development of a certain area. In terms of the implementation of smart solutions, an age structure with significant share of elderly means that more intensive education of residents on the aspects of use and benefits of smart solutions is needed.

¹⁸ Aging index shows the ratio of the number of elderly persons (60+ years) to 100 young people (0-20 years).

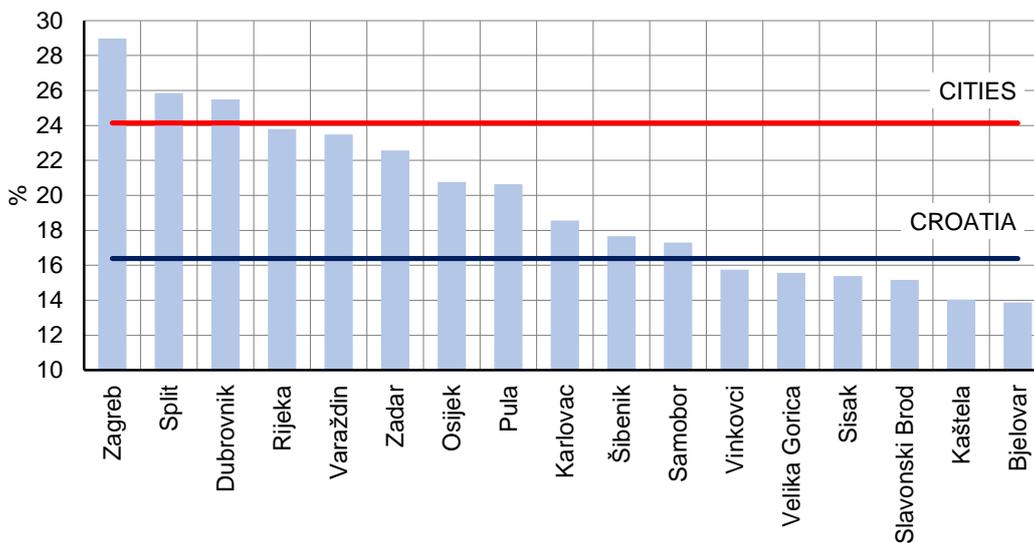
Figure 3. Aging index and age coefficient in cities in 2011



Source: Croatian Bureau of Statistics, 2012

The proportion of highly educated residents in cities was 24.14%, which is significantly higher than the national average (16.39%), as of 2011. It is also important to note that 64.08% of the highly educated people in Croatia live in cities, which indicates an increased concentration of highly educated people in urban areas and also highlights the significant potentials that could result from this, if capitalized on. From the aspect of individual cities, highly educated residents make up the largest share in Zagreb, where almost a third of the population is highly educated (29.0%); beside Zagreb there are another additional ten cities with a share of highly educated populations above the national average.

Figure 4. Share of highly educated inhabitants in cities in 2011



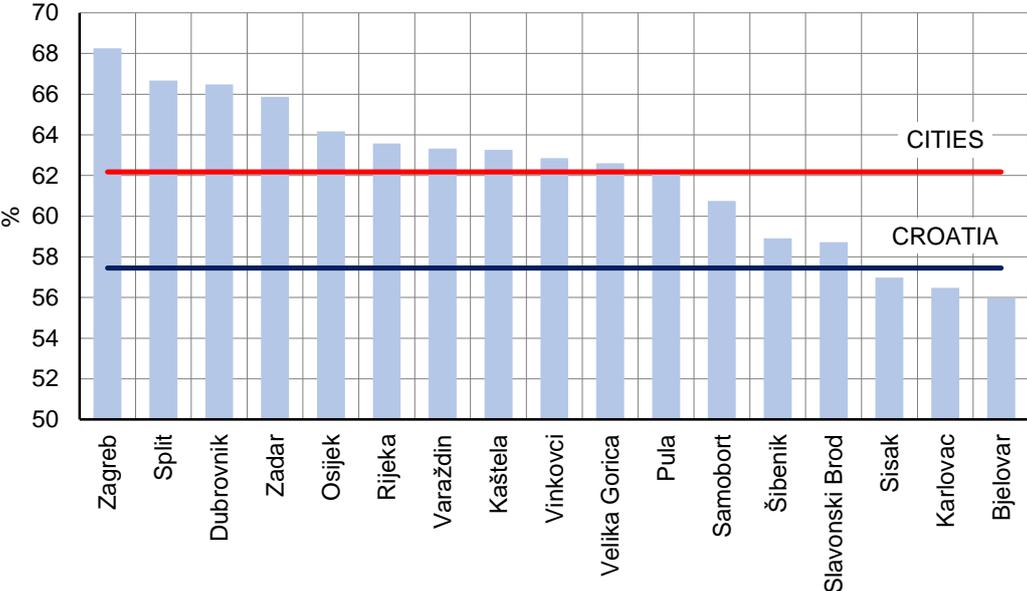
Source: Croatian Bureau of Statistics, 2012

More than half of the students enrolled in university and professional studies in Croatia lived in cities (51.95%) as of 2017. In cities there were 76,632 students enrolled in total; however, this figure was -1.48% lower than in 2011. When studying the ratio of the number of enrolled students and the

number of inhabitants in various cities in 2017, data found that 41.4 students per 1,000 inhabitants were enrolled in cities, while the national average was 34.3; this indicates that younger citizens in towns tend to opt for higher education more, which can be partially due to the age structure of the population (which is often more unfavorable in rural areas or where the share of young people is considerably lower than in the cities). Students, as well as highly educated people in general, represent a significant source of potential for the development and implementation of innovative solutions in different sectors of society and the economy.

An important aspect in the implementation of smart solutions is the Internet and, with it, related ICT and Information literacy. Informational literacy plays an important role in the quality of implementation and use of smart solutions. In 2011, on average 62.18% of the population in the cities used the internet, while the national average was 57.45%. Values vary considerably between individual cities, so the lowest share of inhabitants using the internet was recorded in Bjelovar (55.98%) while the highest was recorded in Zagreb (68.26%). It is important to point out that 49.05% of all people in Croatia who use the internet are living in cities. Given that the majority of cities have a share of inhabitants using the internet that is significantly above the national average, it is clear that cities have a great potential for the smooth implementation of smart solutions from the point of view of their use by the local population (eg e-services). Alongside the share of people using the internet, it is important to point out that in cities, on average, 62.54% of households have a personal computer, while the share at the national level is 55.28%. Out of the total number of households in Croatia who own a computer, 51.57% of them are in cities.

Figure 5. Share of inhabitants in cities who use the internet in 2011



Source: Croatian Bureau of Statistics, 2012

In the context of quality city management, it is worth mentioning research done by the Institute of Public Finance, which looks at the transparency of the work of local/county authorities in Croatia. The research is based on the number of publicly-published documents relating to the budget and the work of local bodies. Measured by the number of published documents, the average transparency of the budgets of local self-government units in Croatia is improving from year to year; in the last four cycles it almost doubled from an average of 1.8 to 3.52 published documents (ranging values from 0-5).

With an average level of transparency of 4.53, cities are considerably above the national average, indicating that public documents and documents of major importance for the development of cities are relatively widely publicized. Out of a total of 17 cities, 11 (64.70%) scored 5 in 2018, while five (29.41%) scored 4. Only the city of Vinkovci scored 2.

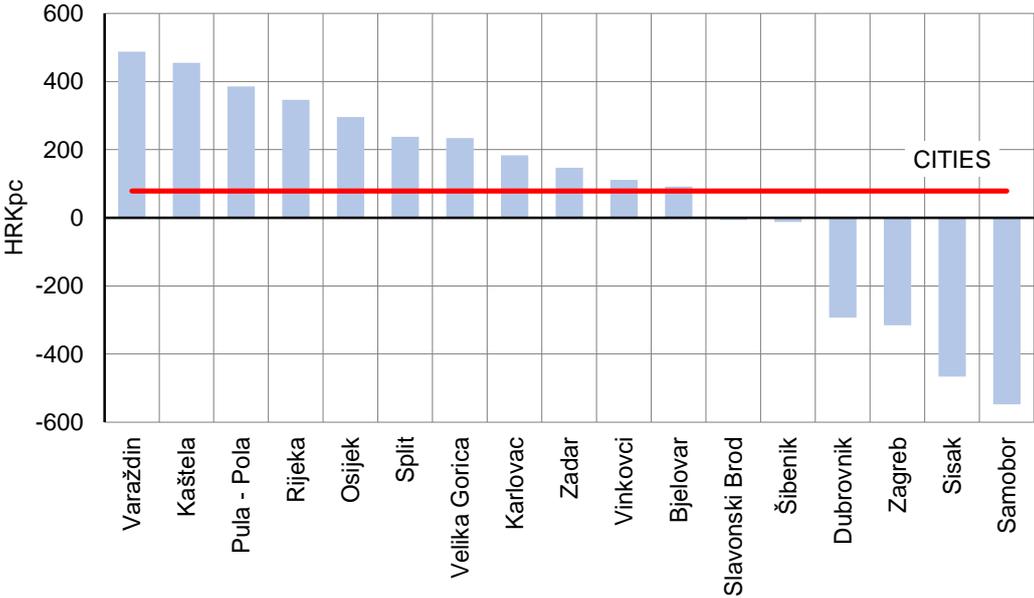
Table 2. Budget transparency of cities in 2018

| Score | Cities | |
|---------|---|------|
| 5 | Dubrovnik, Zagreb, Karlovac, Kaštela, Osijek, Pula, Rijeka, Sisak, Slavonski Brod, Split, Zadar | |
| 4 | Bjelovar, Samobor, Šibenik, Varaždin, Velika Gorica | |
| 2 | Vinkovci | |
| Average | Cities | 4,53 |
| | Croatia | 3,52 |

Source: Institute of Public Finance, 2019

From the aspect of budget realization, in 2016 the average budget surplus in cities was 78.51 kunas per capita. It is clear from the above that on average in that year the cities achieved a positive budget execution, i.e. a surplus. There are significant differences between cities; for example, while in Varaždin there was a surplus of 487.37 knpc, while in Samobor there was a budget deficit of -547,83 knpc.

Figure 6. Budget deficit/surplus in cities in 2016



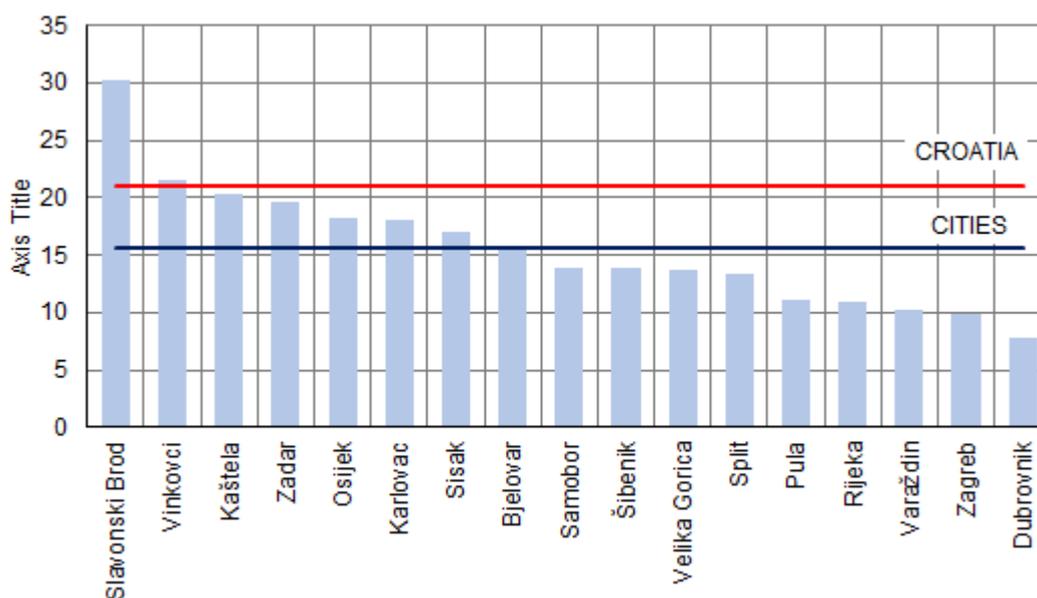
Source: Institute of Public Finance, 2019

Croatian cities are facing various challenges that need to be solved in order to better design and implement smart solutions. Two key challenges are: (a) a lack of local regulations and guidelines for implementing smart solutions; and (b) a lack of coordination in implementing planned ICT projects. This is further compounded by a lack of engineers, programmers, designers, artists and creators to design and implement such plans and approaches. Local authorities often lack the agile, open and inclusive forms of governance that would allow innovation to happen. That there are limited tools and approaches to involve local communities, non-government entities, and the private sector is another challenge that needs to be addressed and solved in order to fully implement smart city concepts that improve citizens'

quality of life.¹⁹ The lack of financial resources is a challenge in implementing not only "smart" projects in Croatian cities, but in general. Therefore, the aim of any smart city concept has to be based on the principle of how to effectively and efficiently use all available resources and demonstrate value-for-money interventions.

One of the indicators of quality of life is the rate of poverty risk, which in Croatia in 2011 was 21.10%, as defined by the income method. The average city in that year had a poverty risk rate of 15.63%, indicating that urban residents are less exposed to the risk of poverty; that is, they find jobs (source of income) and access to social services more easily. When analyzing individual cities, the poverty risk rate is lowest in Dubrovnik, with 7.83%, while it is highest in Slavonski Brod, with a rate of 30.30% (Figure 7). It is worthy to note that the two cities with the highest rate of poverty risk (which is above the national average) are in eastern Croatia.

Figure 7. Poverty risk rate in cities in 2011



Source: Croatian Bureau of Statistics, 2019

Another indicator of quality of life in some areas is the availability of various services (educational, cultural, health and other). In Croatia there were 1,715 kindergartens in 2017, of which almost half (46.41%) were in cities. At the same time, in cities, the number of children per kindergarten was 98.0, while the overall Croatian average was 81.2. There has been a noticeable increase in the number of kindergartens in the cities, which is to be expected considering the above-average concentration of the population within them. A data comparison with 2011 shows that the number of children per kindergarten decreased in the cities by -2.73%, while for Croatia in general, this decrease amounted to -3.30%. Nevertheless, it is important to point out that in the observed period the number of kindergartens in Croatia increased by 13.35%, while the increase in cities was somewhat lower, at 11.64%.

From the aspect of elementary schools, 19.51% of their total number in Croatia in 2017 was concentrated in the cities, while at the same time primary schools in cities were attended by 44.00% of the total number of pupils in Croatia. Primary schools are mostly concentrated in cities, with 51.34% in the 17 cities analyzed, and in 2017 they were attended by a total of 65.26% of all secondary school pupils

¹⁹ The smart city sector in Croatia, Flanders investment & trade market survey, 2017

in Croatia. From the data in Table 3, it is noticeable that the number of all analyzed educational institutions increased in cities in the recent period.

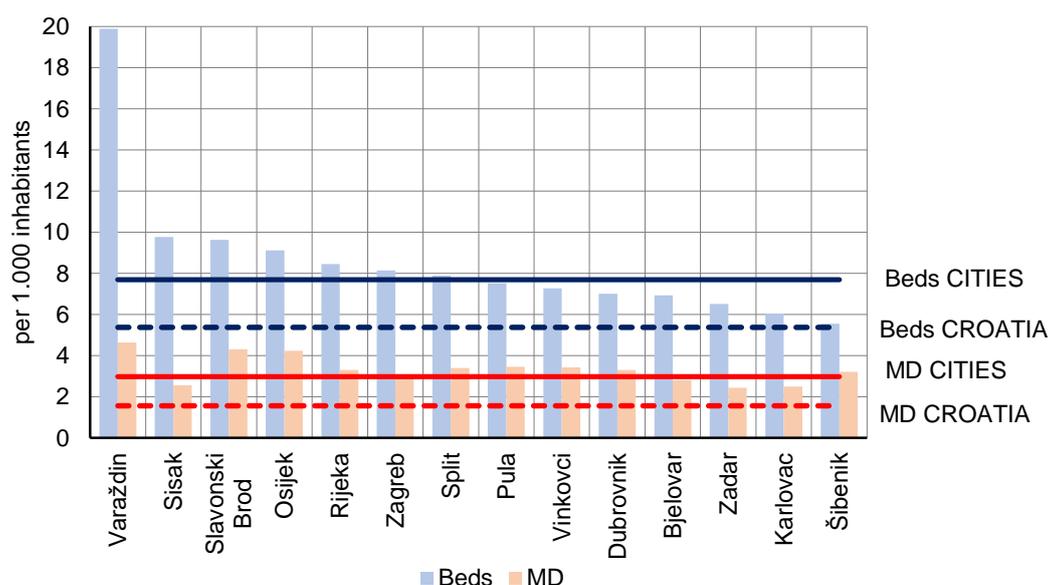
Table 3. Indicators of availability of kindergartens, primary and secondary schools in cities 2011 and 2017

| | 2011 | 2017 | Change (%) | 2011 | 2017 | Change (%) |
|--------------------------------|--------------|-------|------------|---------|----------|------------|
| Kindergartens | Institutions | | | | Children | |
| Cities | 713 | 796 | 11,64 | 71.815 | 77.980 | 8,58 |
| Croatia | 1.513 | 1.715 | 13,35 | 127.028 | 139.228 | 9,60 |
| % cities | 47,12 | 46,41 | -1,51 | 56,53 | 56,01 | -0,93 |
| Elementary schools | Schools | | | Pupils | | |
| Cities | 393 | 396 | 0,76 | 140.456 | 139.005 | -1,03 |
| Croatia | 2.073 | 2.030 | -2,07 | 340.116 | 315.942 | -7,11 |
| % cities | 18,96 | 19,51 | 2,90 | 41,30 | 44,00 | 6,54 |
| Upper secondary schools | Schools | | | Pupils | | |
| Cities | 367 | 382 | 4,09 | 117.198 | 101.569 | -13,34 |
| Croatia | 715 | 744 | 4,06 | 183.807 | 155.642 | -15,32 |
| % cities | 51,33 | 51,34 | 0,03 | 63,76 | 65,26 | 2,35 |

Source: Croatian Bureau of Statistics, 2019

There were a total of 5,508 medical doctors (MD) in the cities in 2017, representing 82.93% of the total number of doctors in Croatia. At the same time, the total number of hospital beds in cities amounted to 14,236, or 61.76% of the total number of hospital beds in Croatia. Health care facilities, primarily hospitals and clinic hospital centers, are located in the largest cities, which is to be expected considering the high concentration of population and the significance of these cities in the wider area. The concentration of health facilities in cities is also manifested through the relationship between the number of doctors and hospital beds per thousand inhabitants. In 2017 there were 3 doctors per thousand inhabitants in cities, while the Croatian average was twice as low (1.6). At the same time, there were 7.7 hospital beds per one thousand inhabitants in cities, while the Croatian average was 5.4 beds.

Figure 8. Indicators of availability of health services in cities in 2017



Source: Croatian Bureau of Statistics, 2018

The lack of digitally available services affects quality of life in cities. City authorities are characterized by a low level of provision and use of public e-services and their poor adaptation to the needs of individual users, as well as by the insufficient efficiency, efficacy, transparency and accountability of urban authorities in the implementation of public policies related to the provision of public services.²⁰ In cities there is a relatively small number of existing digital services related to communication between citizens and city authorities on social services such as health, education, culture, etc. It is also important to emphasize the lack of monitoring and prevention system related to the natural disasters that many cities are exposed to, especially due to climatological changes and seismological conditions. Wildfires in recent years are an example of such impacts which have posed a specific threat to communities and tourism.

47,09% of the total number of employed persons in Croatia are living in cities (Population Census 2011). In the cities, the largest number of employed persons worked in trade (17.71%), followed by manufacturing (13.31%) and public administration (8.42%). In contrast, at the national level, the largest share of the employed worked in the manufacturing (16.90%) while the trade sector was in second place (15.71%). It is obvious that the dominant trade in the cities is a typical representative of a tertiary (service) sector of activity prevalent in developed societies. In the fields of information and communication, as well as professional, scientific and technical activities, the cities employed a larger proportion of employees compared to the national average, pointing to the potential for the development and implementation of smart solutions, as they can be directly related to the mentioned activities.

Table 4. Employed by activities in cities in 2011

| Activity | Croatia | Cities | % of cities in totally employed |
|-------------------------------------|---------|--------|---------------------------------|
| A Agriculture, forestry and fishing | 5,31 | 1,11 | 9,83 |

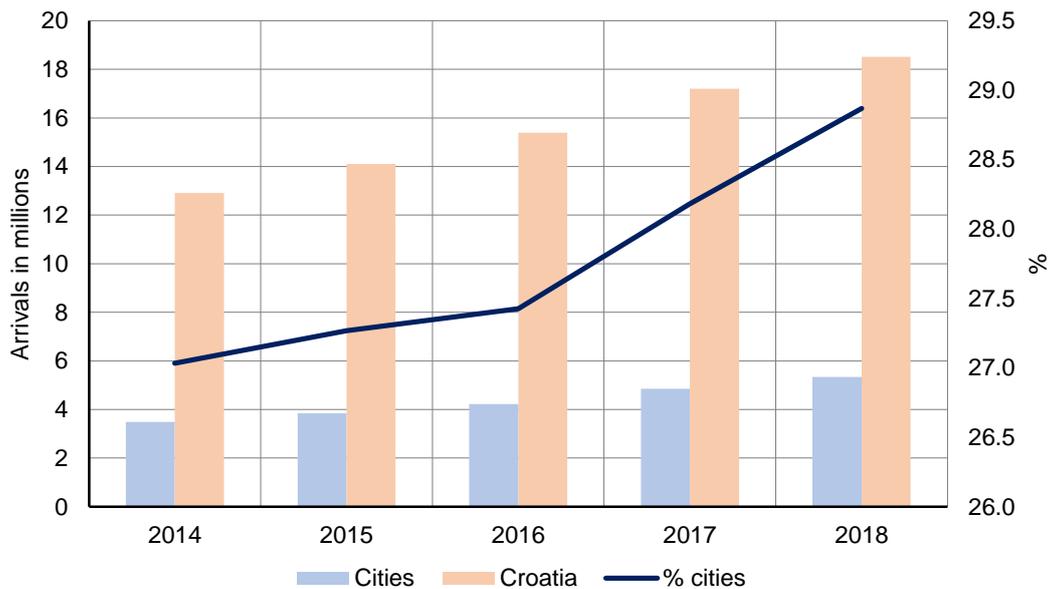
²⁰ e-Croatia strategy 2020, Ministry of Public Administration of the Republic of Croatia, 2017

| | | | |
|---|-------|-------|-------|
| B Mining and quarrying | 0,52 | 0,38 | 34,43 |
| C Manufacturing | 16,90 | 13,31 | 37,10 |
| D Electricity, gas, steam and air conditioning supply | 1,10 | 1,09 | 46,76 |
| E Water supply, sewage disposal, waste management and environmental remediation activities | 1,51 | 1,12 | 35,11 |
| F Construction | 7,64 | 6,09 | 37,54 |
| G Wholesale and retail trade | 15,71 | 17,71 | 53,10 |
| H Transportation and storage | 6,01 | 6,15 | 48,22 |
| I Accommodation and food service activities | 6,10 | 5,11 | 39,44 |
| J Information and communication | 2,80 | 4,57 | 76,79 |
| K Financial and insurance activities | 3,03 | 4,33 | 67,20 |
| L Real estate activities | 0,35 | 0,50 | 67,68 |
| M Professional, scientific and technical activities | 4,26 | 6,13 | 67,79 |
| N Administrative and support service activities | 2,61 | 2,88 | 52,01 |
| O Public administration and defense | 8,18 | 8,42 | 48,49 |
| P Education | 7,04 | 8,23 | 55,05 |
| Q Human health and social work activities | 6,75 | 7,73 | 53,90 |
| R Art, entertainment and recreation | 1,79 | 2,43 | 64,18 |
| S Other service activities | 1,97 | 2,27 | 54,25 |
| T Activities of households as employers, household activities that produce different goods and perform various services for their own needs | 0,11 | 0,09 | 38,33 |
| U Activities of extraterritorial organizations and bodies | 0,04 | 0,08 | 85,30 |
| Unknown | 0,27 | 0,25 | 43,74 |

Source: Croatian Bureau of Statistics, 2012

5.3 million tourists visited cities, which is only 28.87% of the total number of tourist arrivals in Croatia in 2018; however, the number of tourists visiting cities is steadily rising. In the period 2014-2018 the number of tourists visiting cities grew by 53.13%, which is higher than the national average (43.39%). Compared to the number of inhabitants, in cities there were 2886.8 tourists per thousand inhabitants in 2018, while the national average was 4320.5 tourists per thousand inhabitants. It is noteworthy that cities, despite their increasing attractiveness, are still not as attractive as less populated areas of Croatia, primarily coastal areas and islands, which are extremely attractive to tourists. In 2018, only 17.9% of all tourist nights occurred in cities, indicating that tourists are spending less time in cities than in other tourist destinations. This is confirmed by the fact that the duration of the stay in cities is 3 days, while the national average is 4.8 days. This data shows that tourists in cities are staying for a shorter time, visiting primarily cultural attractions. Due to coastal cities being under extreme pressure during the tourist season (summer months), Croatia's aim of striving for the development of sustainable tourism and ensuring the standard quality of life of the local population during the tourist season arises. For example, in Dubrovnik, there are 29,689.9 tourists per thousand inhabitants, and more than seven thousand tourists to one thousand inhabitants in Zadar and Šibenik. The above mentioned ratios create huge seasonal burdens on local infrastructure and systems (traffic, water supply, etc.).

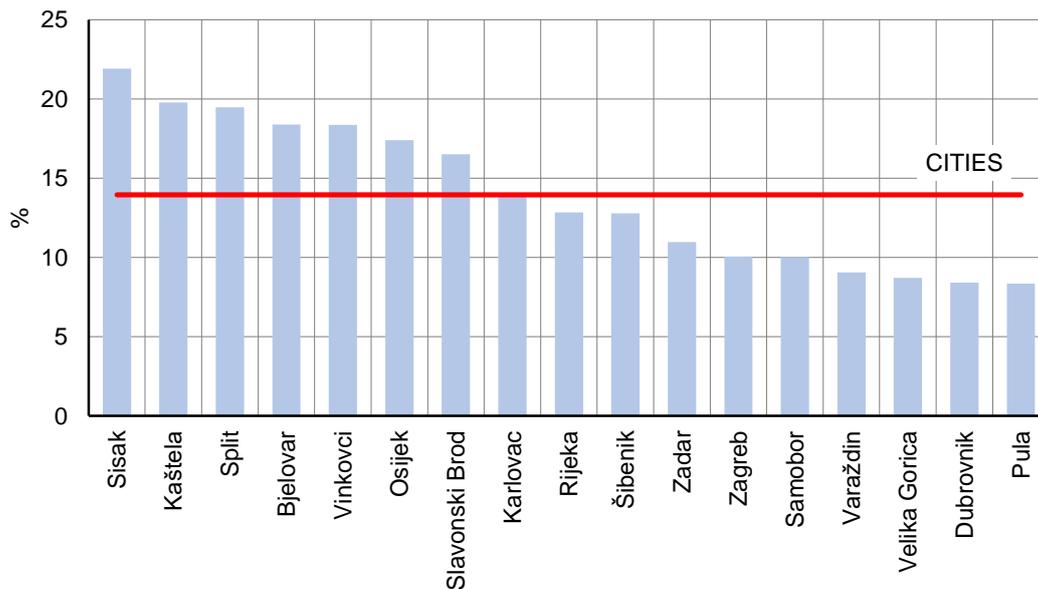
Figure 9. Number of tourist arrivals in cities in the period 2014-2018



Source: Croatian Bureau of Statistics, 2019

The average unemployment rate of local administrative units in Croatia was 17.83% between 2014-2016. At the same time, in the cities, the unemployment rate was considerably lower than the average, at 13.95%; this is because there are greater opportunities for finding employment in urban areas. At the level of individual cities, the unemployment rate varies considerably; Pula is the city with the lowest unemployment rate of 8.36%, while the highest is recorded in Sisak with a value of 21.93%. It is important to point out that as many as eight out of 17 analyzed cities had an unemployment rate higher than the average in Croatia, which indicates the need for further economic development with an emphasis on sustainable and smart businesses and the diversification of economic activities in order to increase resistance to adverse external factors.

Figure 10. The average unemployment rate in cities between 2014 and 2016.



Source: MRDEUF, 2018

The lack of e-services in business is also a challenge that prevents more intensive and faster economic growth nation-wide. Coastal cities also face the consequences of unplanned tourism development, for which supporting infrastructure has not been appropriately planned. Moreover, there is a conflict of interest between certain categories of users and a lack of an integrated development approach.²¹ The problem of the seasonal nature of tourism not only manifests itself by placing an overwhelming burden on local infrastructure, but also by intensifying the vulnerability of the coastal environment to anthropogenic impacts.

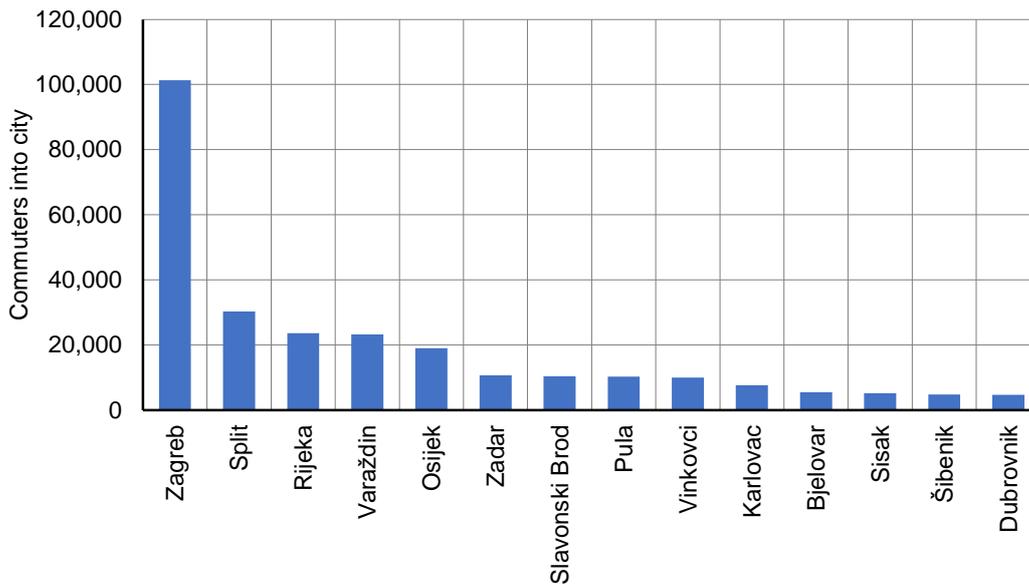
The largest cities encounter specific challenges relating to their size, such as inadequate public transport. The central cities in most regions have up to 95 percent of all workplaces.²² This leads to traffic congestion in the central cities resulting from the extremely large number of daily commuters travelling into the city. In 2011, 46.29% of the total number of employed commuters in Croatia and 56.12% of the total number of pupils and student commuters was travelling each day in cities. According to the number of commuters, Zagreb is the largest city with 101,355 commuters, followed by Split with 30,276. A large number of commuters require a high-quality transport system and infrastructure that can cater to commuters' needs. It is important to point out that cities often do not have an adequately developed transport system, especially in terms of public transport that could dislodge road traffic by reducing the number of passenger cars. Public city transport is present in most cities in the form of bus transportation, but the poor connections between the central urban settlement and the surrounding local administrative units pose a challenge, forcing commuters to use the car as the main means of transport. Public transport in the largest cities is often not adequately organized nor well-integrated; for example, there are no harmonized rides or systems for selling single tickets for various modes of transport. Intermodal terminals, which would allow passengers to switch to other modes of transport, do not exist or are exceptionally rare.²³ Generally speaking, cities lack intermodal infrastructure and innovative solutions that make it easier to use public transport services.

²¹ Spatial development strategy of the Republic of Croatia, NN 106/2017

²² Spatial development strategy of the Republic of Croatia, NN 106/2017

²³ Transport development strategy of the Republic of Croatia 2017.-2030., Ministry of Maritime Affairs, Transport and Infrastructure of the Republic of Croatia, 2017

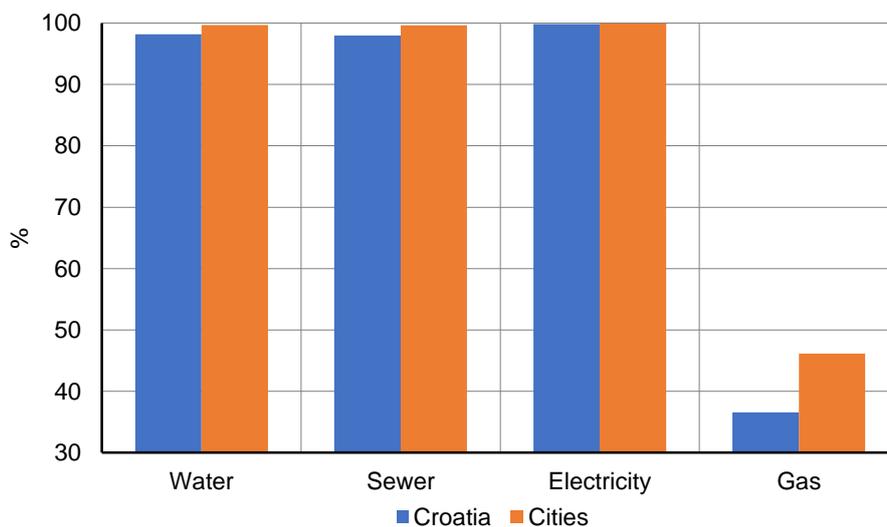
Figure 11. Number of commuters in cities in 2011



Source: Croatian Bureau of Statistics, 2019

The availability of various infrastructure services is an important aspect of quality of life. On average, cities have a very high rate of access to basic installations - water supply, sewerage, electricity and gas. In the cities 99.69 % of apartments are connected to the water supply system, which is above the Croatian average (98.19%). The connection of apartments to the sewerage system is also high (99.66%), as well as the connection to the electricity supply network (99.95%). In both of these aspects, cities are above the national average. Gas supply infrastructure is available in 46.15% of apartments in cities, while the Croatian average is significantly lower, at 36.55%.

Figure 12. Availability of basic infrastructure in apartments in 2011

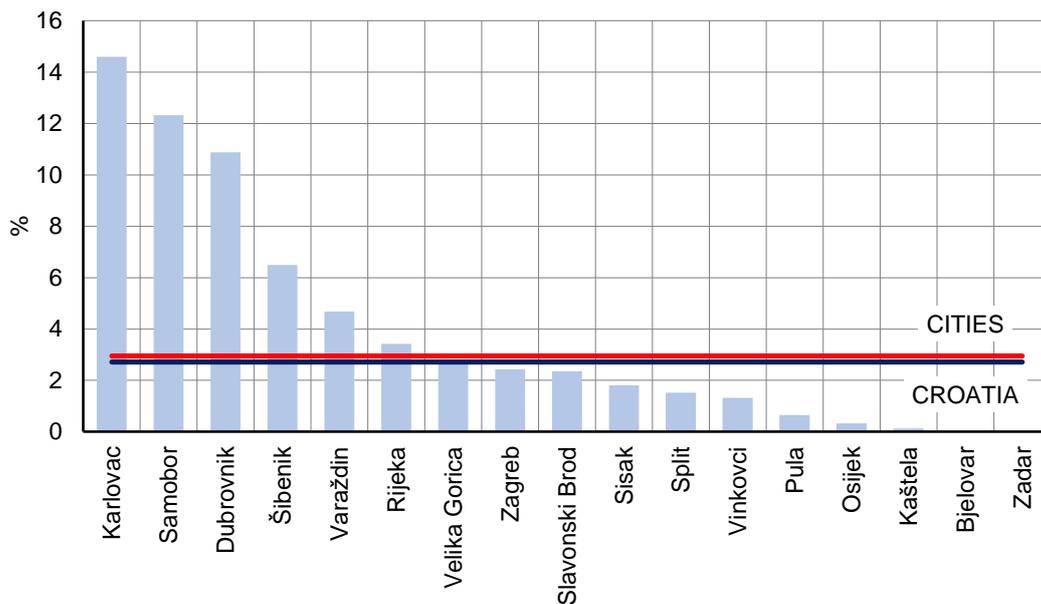


Source: Croatian Bureau of Statistics, 2012

A total of 631,283.5 tons of waste was collected in cities in 2017, which is 45.19% of the total waste collected in Croatia. Of the total waste produced in cities, only 2.95% was collected from separate waste collection tanks in public areas. Although very low, this share is above the national average

of 2.71%. An analysis of the amount of collected waste compared to the number of residents shows that 0.34 tons of waste per capita is collected annually in cities, which is slightly above the national average of 0.33 tons per capita. There are significant differences between the cities – 0.58 tons per capita were collected in Dubrovnik, 0.51 tons in Zadar, and 0.24 tons of waste per capita was collected in Sisak. Coastal cities generally produce more waste per capita, which is the result of the large number of tourists present during the summer months. From the aspect of the share of waste collected from separate waste collection tanks, only seven cities are above the national average, with 14.61% of the waste collected separately in Karlovac. At the same time, in some cities the amount of separately collected waste in 2017 did not exceed 1.0%.

Figure 13. Share of separately collected waste in cities in 2017



Source: Environmental Pollution Register, 2019

Seawater quality in the coastal cities (seven of the 17 analyzed) was estimated at an average rating of 2.84 in 2015, while the average rating of seawater on all analyzed beaches in Croatia was 2.94.²⁴ This data suggests that because of the concentration of population and industry and the increased release of harmful substances into the sea, the quality of seawater is somewhat weaker in urban areas, when compared to the average. The above indicates the need for smart solutions to reduce sea pollution in the cities.

Significant resources in Croatian cities are being irrationally spent as a result of obsolete infrastructure and lack of mechanisms for monitoring and real-time management. Water, wastewater and energy infrastructure in some urban areas is declining as infrastructure is degrading and inadequately maintained.²⁵ In some coastal cities there is a shortage of drinking water during the tourist season due to the considerable increase in demand. The issues of smart water distribution and management, as well

²⁴ According to the Institute of Oceanography and Fisheries (2019). Qualitative assessments by Institute of Oceanography and Fisheries have been assigned with quantitative ratings for the purpose of calculating the average quality of the sea: unsatisfactory - 0, satisfactory - 1, good - 2, excellent - 3. The minimum possible rating is 0 and maximum is 3.

²⁵ Spatial development strategy of the Republic of Croatia, NN 106/2017

as those of waste management, drainage and energy efficiency, are challenges that all Croatian cities are increasingly facing, but especially coastal cities.

There is a need for the integrated management and development of various forms of territorial capital through smart solutions. Many Croatian cities are developing the concept of smart cities and aiming to apply "smart" solutions that enable a better quality of life for their citizens. Most cities participate in some individual smart city projects, e-governance or similar, and plan to allocate certain funds to implement smart city concepts. Opportunities in the development of smart city concepts are reflected in the ability to translate examples of good practice that have already been implemented in certain cities and adapt them to specific local needs. Some Croatian cities represent learning opportunities. For example, Pula began its e-government business back in 2008 while Dubrovnik is trying to optimize waste management, especially during the tourist season, using "smart tanks" with GPS technology and special computer programs, where emails tracking of the remaining capacity of the tank are being sent automatically and directly to the mobile phones of utility company employees.²⁶

The sustainable and smart development of cities in Croatia requires an innovative approach based on local specificities. For small towns, new innovative urban models are needed that must find a balance between the preservation of Croatia's natural and historic heritage and ensuring its sustainable socioeconomic development so as to strengthen their attractiveness and competitiveness while preserving the authenticity of fragile local communities. The fast and intense development of technologically innovative solutions generates a variety of possibilities for interaction and action. Today, from the energy efficiency point of view, a range of materials and technological solutions are available that can contribute to significant savings.²⁷ This is the result of cheaper and more accessible technology that represents a good potential for further use in the development of smart cities in Croatia. Also, "bottom-up" innovation and collaborative models for developing systems must be enabled. The notion of the 'smart citizen' as a co-creator of these solutions draws on a rich intellectual backdrop in technology design, urban design, and people-center design.

There is a need to better use the limited public financial resources and find models for financing new 'smarter' infrastructure. This requires the funding model to shift from "traditional" tools such as public resources to contractual models of public-private partnership able to attract private capital.²⁸ Other than private entrepreneurship projects and national and local subsidies, there are European Structural and Cohesion Funds that can be accessed through which the EU is encouraging Member States to implement smart solutions. Also, the EU has introduced new financial instruments to support the environment and climate action projects for which cities can apply, including: The Financial Instrument for the Environment and Climate Action (LIFE) Programme, Horizon 2020 and Intelligent Energy Europe (IEE).²⁹

The more intensive and innovative application of new technological solutions is a prerequisite for the development of smart cities in Croatia. Smart city growth and development is based on smart decision-making supported by the collection and analysis of good quality data. Such data collection needs to be targeted and systematically sourced to link it to important services such as public transport, traffic, infrastructure services, etc. Smart data can enable faster and more rational decision-making and can prevent resource dispersion in areas where the concept of a smart city would not be as successful.³⁰

²⁶ Paliaga, M., Oliva, E., 2018: Trends in applying the concept of smart cities, *Ekonomska misao i praksa* 2, 565-583

²⁷ Paliaga, M., Oliva, E., 2018: Trends in applying the concept of smart cities, *Ekonomska misao i praksa* 2, 565-583

²⁸ The smart city sector in Croatia, Flanders investment & trade market survey, 2017

²⁹ The smart city sector in Croatia, Flanders investment & trade market survey, 2017

³⁰ Paliaga, M., Oliva, E., 2018: Trends in applying the concept of smart cities, *Ekonomska misao i praksa* 2, 565-583

Given the degree of development and availability of technological solutions, there are great opportunities for applying them to develop smart solutions in the areas of city management, economic development and mobility, environmental preservation and increasing the availability of public services to citizens.

Based on the analysis conducted, it is clear that Croatian cities face a number of development challenges. These challenges need to be taken into account when developing any smart city strategies in order to address them in a timely manner, as well as to define a quality strategy based on real needs and potentials. Croatian cities must continually work on increasing the quality of governance, especially through increased transparency and through the development of communication with citizens. From the analysis it is clear that on the one hand, there is a strong development potential in the form of a high share of the population being highly educated; however, on the other hand one of the main factors to take into account is the decline and aging of the population. Seasonal impacts that are manifested through tourism have a major impact on local economies, as well as the environment and the amount of waste produced. Data shows that tourists stay for shorter periods in cities than the national average, but is on the upward trend, so it is necessary to attract tourists through the application of smart solutions and the development of sustainable forms of tourism. From the aspect of urban mobility, the need for significant improvements in the quality of public transport and digitalization of the transport system, especially in larger cities or cities that are transport hubs, should be a priority.

3 Key areas of intervention and performance indicators

3.1 Key areas of intervention (KAI)

The results of a previously conducted analysis of territorial capital in Croatian cities show that cities generally have more developed human resources (as indicated by a higher proportion of highly educated and internet using population) as well as a more developed economy. Nevertheless, Croatian cities do not adequately take advantage of these development potentials, and only a small number of them has started developing smart development strategies or preparing and implementing projects that can be characterized as "smart projects". In line with the existing features of Croatian cities and the global and EU trends in the development of "smart cities", the following key areas of intervention (KAI) and the thematic areas within which emphasis should be placed on applying the concept of "smart cities" in Croatia are defined:

1. Smart governance
 - a) e-public administration
 - b) ICT infrastructure
 - c) communication platforms for dialogue with citizens, civil and private sector
 - d) smart planning of urban development
2. Smart economy
 - a) ecosystem for entrepreneurs
 - b) development of smart clusters and new funding sources
 - c) sustainable tourism development
 - d) industry 4.0.
 - e) supporting the development of emerging industries and the IT sector
 - f) development of the creative and cultural industry
 - g) e-commerce
 - h) e-business and businesses networking
3. Smart mobility
 - a) the infrastructure of clean urban transport
 - b) alternative fuels infrastructure
 - c) cycling infrastructure
 - d) digitalization of city transport system
 - e) clean urban transport vehicles
 - f) intermodal transport and smart urban logistics
4. Smart environment
 - a) renewable energy sources

- b) smart energy and water distribution systems and smart drainage
 - c) smart public infrastructure
 - d) smart buildings, homes and districts
 - e) smart waste management
 - f) control and monitoring of air, soil and water quality, noise reduction
 - g) smart management of industrial sites and polluted land
 - h) smart measures for adapting to climate change
5. Smart people
- a) development of digital skills
 - b) lifelong learning in line with the need of the labour market
 - c) e-citizens
6. Smart living
- a) high capacity broadband network
 - b) e-health services
 - c) digitalization in the field of health care (smart healthcare infrastructure)
 - d) smart educational infrastructure and development of educational platforms
 - e) social cohesion and social infrastructure
 - f) protection, valorization and promotion of cultural heritage and cultural services
 - g) security of public spaces, including cyber security

3.2 Key performance indicators (KPI)

In order to monitor the intensity of the use of smart solutions in cities and the impact of their application on the socioeconomic development of those same cities, through a review of the available indicators at the local level in Croatia indicators that have the potential to contribute to monitoring the degree of "smart cities" development have been identified. These indicators can be used to define a unique composite indicator for monitoring the development of smart cities, and when defining it, it is necessary to carry out extensive research which will identify an adequate composite indicator and to define it through a special study. It is important to note that in Croatia numerous statistical data are not collected at the local level, but exclusively at the regional and/or national level, therefore the number and quality of the available individual indicators at the city level are affected by the above-mentioned limitation.

Potential indicators that can be used to track progress in the development of smart cities:

| Indicator | Indicator description | Data source |
|-------------------------|---|-----------------------------|
| Smart Governance | | |
| Budget transparency | Budget transparency in 2017 measured by the number of key budget documents published on the official city websites. | Institute of Public Finance |

| | | |
|--|---|---|
| Share of children in nurseries and kindergartens in the total number of children aged 0 to 6 in the city | The share of children in nurseries and kindergartens in the total number of children aged 0 to 6 in the city. | Croatian Bureau of Statistics |
| The proportion of women council members to the total number of city council members | The proportion of women council members to the total number of city council members. | State Election Commission |
| Smart Economy | | |
| R&D expenditure | The share of book value of R&D and patents in the total value of the assets of all companies with headquarters in the city. | Financial Agency (FINA) |
| Self-employment rate and flexibility of labor market | The share of self-employed in the total number of employees in the city. | Croatian Pension Insurance Institute |
| Newly established enterprises | The share of newly registered enterprises in the total number of companies in the city. | Ministry of Justice Court Register |
| Export intensity | The share of revenue from exports in the total revenues of all companies with headquarters the city. | Financial Agency (FINA) |
| Employment in Knowledge-intensive industries | The share of employees in knowledge-intensive industries in the total number of employees in all companies with headquarters in the city. | Financial Agency (FINA) |
| Patent applications | The number of registered patents whose inventors listed the city as their place of residence in the patent application. | The State Intellectual Property Office of the Republic of Croatia |
| Labor productivity | The ratio between value added and the number of employees in all companies with headquarters in the city. | Financial Agency (FINA) |
| Unemployment rate | The share of unemployed persons in the city in the total population | Croatian Employment Service |
| Smart Mobility | | |
| Share of daily commuters into the city | The share of daily commuters commuting into the city in relation to the total city population | Croatian Bureau of Statistics |
| Electric vehicles charging stations | Number of electric vehicles charging stations in the city | Google Maps, HEP |
| Public transport lines per area | Number of public transport lines (bus, tram, train) per km ² of city area | LAU |
| Public transport lines per inhabitant | Number of public transport lines (bus, tram, train) per 1.000 citizens | LAU |
| Smart Environment | | |
| Mixed municipal waste | Produced mixed municipal waste per inhabitant. Quantity of waste (tons) in relation to the population of the city. | Croatian Environment Agency |
| Amount of municipal waste collected separately | Amount (tons) of total municipal waste collected separately | Croatian Environment Agency |
| Use of electricity | Electricity delivered to households (MWh per capita) | HEP Distribution System Operator |
| Smart People | | |

| | | |
|---|--|-------------------------------------|
| Share of highly educated citizens | The share of population with tertiary education (university and more) in the city in relation to the total population of the city. | Croatian Bureau of Statistics |
| Share of citizens using internet | The share of population using internet in the city in relation to the total population of the city | Croatian Bureau of Statistics |
| Students enrolled in university studies | The number of students enrolled in university studies located in the city. | Croatian Bureau of Statistics |
| Number of institutions of higher education | The number of institutions of higher education located in the city. | Croatian Bureau of Statistics |
| Share of employees in cultural industries | The share of employees in cultural industries located in the city in relation to the total population of the city. | Financial Agency (FINA) |
| Smart Living | | |
| Doctors of medicine per 1,000 inhabitants | The number of medical doctors in the city in comparison to the number of inhabitants in the city. | Croatian Health Statistics Yearbook |
| Hospital beds per 1,000 inhabitants | The number of hospital beds in the city in comparison to the number of inhabitants in the city. | Croatian Health Statistics Yearbook |
| At-risk-of-poverty rate in 2011 | The estimated risk-of-poverty rate. | Croatian Bureau of Statistics |
| Theatre attendance per inhabitant | The number of theatre visitors in the city in comparison to the number of inhabitants in the city. | Croatian Bureau of Statistics |
| Museum visitors per inhabitant | The number of museum visitors in the city in comparison to the number of inhabitants in the city. | Croatian Bureau of Statistics |
| Residential area per capita in m ² | The size of residential area per capita in m ² in the city. | Croatian Bureau of Statistics |

4 Policy mix recommendations

The thematic coverage of smart cities encompasses a wide range of development sectors, which is evident from the thematic areas outlined in the previous chapter:

- smart governance
- smart economy
- smart mobility
- smart environment
- smart people
- smart living.

Given that almost all of these sectors are the subject of a number of sector-oriented policies, within the policy mix for the development of smart cities recommendations have been defined which aim to create generally incentive conditions for the development and implementation of integrated smart solutions from different sectors to facilitate their application in cities.

4.1 Short-term policy recommendations (1-3 years)

Recommendation

Improve knowledge and strengthen the capacities of city authorities

Problem

Research shows that most cities in Croatia do not have the sufficient staff or financial capacity to support the public affairs which are in their jurisdiction and are regulated by law. Following this, there is a challenge of preparing and implementing smart solutions and smart projects in cities, which is extremely difficult to realize if the knowledge required is lacking and there is insufficient familiarity with the concept and importance of smart cities for their overall development. The results of the Economic Institute of Zagreb (2018) show that only a few cities in Croatia have developed smart development strategies, while only thirty of them are preparing or developing smart projects. As such, smart solutions are at the very start of their implementation in Croatian cities, where there is still not enough awareness of the importance of, and possibilities for, their application. Croatian cities typically do not have long-term strategic plans, and existing development plans neglect to address key development challenges, while the goals and development measures are determined without relying on key implementation indicators. This leads to the inadequate quality of public goods and services, as well as an unnecessary waste of public funds.

Approach

The scope and quality of smart city solutions that should be a priority during implementation largely depend on the competencies, knowledge, and skills of local authorities. Given that there are indications

that the city authorities in Croatia are not sufficiently familiar with the themes of smart solutions, their potential, and their importance for the overall development of the local community, it is necessary to strengthen the competencies and capacities of the city authorities, but also to define a clear vision of development along with the application of smart solutions in the short, medium, and long-term. This will contribute to securing the clearer and more directed actions of city authorities and will facilitate the process of preparing and implementing smart projects.

Required actions

1. Strengthen the capacities and competencies of city authorities
 - a) Carry out research on the knowledge of the city authorities of the concept, thematic coverage, and possibilities for the implementation and financing of smart solutions in the cities.
 - b) Based on the results obtained, assess the educational needs of the city authorities towards specific segments of the development, implementation, and financing of smart solutions.
 - c) Provide education to city authorities (unified for all city representatives or regionally at the county level).
2. Define a clear direction for the development of smart cities based on real needs and potentials
 - a) Develop strategies for the development of smart cities.
 - b) Develop a Smart Investment Directory (catalogue) containing a list of identified needs with the potential to apply smart solutions in order to attract investors.

Risk management

| Potential risks | Mitigation measures |
|---|---|
| The lack of interest of city authorities on the topic due to insufficient familiarity with them | Information/media campaigns showing the necessity for, and benefits of, smart solutions |
| Insufficient human and/or financial capacity of city authorities to develop smart strategies | Provide financial support from state bodies |

Recommendation

Encourage a stronger link between stakeholders from the public, private and civil sector at the local level

Problem

At the local level, the lack of co-operation between different local-level stakeholders is often a factor that prevents more intense, sustainable and inclusive development solutions being developed. This primarily is due to a lack of cooperation between the three main stakeholders; city authorities, the private sector (entrepreneurs) and the population, and civil society organizations. Developing mutual cooperation between these stakeholders is a prerequisite to clearly identify development challenges in the local community (i.e. in each city individually), but also to operate and integrate the resources possessed by these stakeholders. In cities, or more generally at the local level, it is not uncommon to have a situation in which the population requires a certain change (such as the improvement of some services), the local

government alone has no knowledge and/or financial capacity to solve this challenge, and simultaneously private sector stakeholders have a finished product/service or idea that would cater to those needs and the knowledge and skills to turn it into a final product.

Approach

It is necessary to develop a platform at the local level that will bring together stakeholders from all three development sectors and stimulate a more intense level of interaction between them in order to unify the existing development resources.

Required action

Implement a grant scheme for the "Development of Smart City Labs"

Short description

Smart City Labs could be developed with the purpose of creating a platform that enables the integration of entrepreneurs, the public sector, the scientific community and citizens at the local level. Smart City Labs are a combination of small-scale incubators and information centres, which are presenting themselves to the public through smart solutions developed to overcome local development challenges. Smart City Labs are not involved in co-financing smart solutions but have the exclusive function of integrating and connecting different stakeholders and promoting (by enhancing the visibility of) smart solutions. Smart City Labs work with the aim of raising awareness of the importance and capabilities of smart solutions, encouraging start-ups, and featuring showrooms where the methods of developing, implementing and using smart solutions are being presented to public.

Bodies responsible for the implementation

Cities (LAU)

Implementation model

It is implemented in the form of a grant scheme, where cities of different sizes can apply with project ideas.

Risk management

| Potential risks | Mitigation measures |
|--|---|
| The lack of interest of local stakeholders from the private and civil sector | Information/media campaigns showing the necessity for, and benefits of, smart solutions and cooperation |
| Slow mobilization of stakeholders and institutions at the local level responsible for implementation | Set up a national coordination body for the mobilization of institutions and stakeholders |

4.2 Medium-term policy recommendations (4-7 years)

Recommendation

Developing strong links between scientific, research and higher education centers, the private sector and city authorities on a wider regional scale

Problem

A total of 178 entrepreneurial support institutions operate in Croatia, which are defined by the Entrepreneurship Infrastructure Enhancement Act (NN 93/13, 114/13, 41/14, 57/18) as subjects aimed at creating a quality, user-oriented entrepreneurial environment in the Republic of Croatia. They do this by implementing programs aimed at developing entrepreneurship. It is noteworthy that these institutions are primarily oriented towards the development of entrepreneurship, and despite the relatively large number of entrepreneurial support institutions in Croatia, the cooperation between scientific and research institutions and private and public sectors is not yet sufficient. The importance of higher education institutions (primarily universities), which are often simultaneously scientific and research centers, is extremely large in the context of the development and application of smart solutions. Universities have by now evolved, from their initial basic functions of teaching and conducting research, to a third function; commercialization. Within such, having a partnership with the industry is a key element. University business cooperation includes many elements of human resources (academic staff, students, company employees), intellectual property rights, legal aspects of contracts, funding start-ups and spin-offs and the promotional activities. Likewise, there is an exceptional need for intensifying public-private partnerships, particularly from the point of view of developing and implementing smart solutions that directly contribute to the local community or that can address local-specific challenges. Whether it is the traditional public-private partnership in infrastructure, or health, or education, it is more and more a world where both financially and from a skills perspective, there is a need to combine.

Approach

It is extremely important to create the preconditions for a more intensive link between scientific research, higher education centers, the public sector (city authorities) and entrepreneurs. Only in this way it is possible to combine the knowledge, skills, experience, financial resources and competences of different development actors in an appropriate way with the purpose of developing smart solutions that address specific problems in the city. Since almost no entrepreneurial support institution is involved in co-financing smart solutions developed for urban use, it is necessary to develop a certain type of ecosystem, i.e. to develop supporting elements that will, together with the unification of different development stakeholders, simultaneously act as an investor in the development of smart solutions and be aimed at solving specific challenges.

Required actions

Implementation of the strategic project "Smart City HUBs"

Short description

Smart City HUBs are realized as a strategic project of importance for the development of smart and innovative solutions that have direct application. Smart city HUBs are a "soft" approach to the development of smart cities in Croatia, where they have the role of linking (integrating) entrepreneurs with educational and research institutions. Smart City HUBs, based on defined criteria and the importance of smart solutions for solving relevant local needs, co-finance their development (which differentiates them from the classic entrepreneurial support institutions). Smart City HUBs cooperate with local authorities, where on the one hand they act as a link between local authorities and entrepreneurs, as well as educational and research centers, and on the other hand as stakeholders who co-finance the development of the smart solutions needed to address specific development challenges in the local community or on a wider (regional or national) level. Smart City HUBs can potentially act as centers for solving specific local development challenges through, in the first stage, cooperating with local self-government units (cities) that present and describe an existing problem, then disseminating this information among entrepreneurs and the scientific research community, and finally, based on the project ideas of smart solutions, co-financing the development and implementation of these projects (co-financing by the HUB and the local self-government unit). In this way, the HUB directly contributes to solving social challenges at the local level by applying smart solutions.

Regional HUBs proposal

Given the anticipated significance and scope of HUBs (including project development co-financing), this policy note proposes the establishment of at least four regional HUBs in cities that are profiled as macro-regional centers and are most easily accessible from all other parts of Croatia:

- Zagreb
- Split
- Rijeka
- Osijek

Bodies responsible for implementation

Competent body at the national level – a Ministry (Ministry of Economy, Entrepreneurship and Crafts, Ministry of Regional Development and EU Funds), with the involvement of the Ministry of Science and Education.

Implementation model

In the process of implementation, a decommitment system is implemented, whereby the main project stakeholder is defined before the start of the realization of the project, and depending on the capabilities and competencies of other possible stakeholders, several secondary stakeholders are defined. At the same time, the deadlines for the implementation of certain activities within the project (phases) are defined, and if the primary stakeholder does not reach the set goals within certain deadlines, the financial resources and the project implementation authority are transferred to another (secondary) stakeholder.

Risk management

| Potential risks | Mitigation measures |
|-----------------|---------------------|
|-----------------|---------------------|

| | |
|--|---|
| Unclear how the decommitment system works within project implementation | Conduct Informative and Educational Campaigns at the Regional Level |
| Slow implementation of projects in cases in which the decommitment system is used | Develop in detail the entire decommitment implementation process for the purpose of implementing it and define the bodies responsible for implementing it |
| Slow mobilization of stakeholders and institutions at the regional and local level that are responsible for implementation | Set up a national coordination body for the mobilization of institutions and stakeholders |

Recommendation

Intensify the process of developing digitally available services for citizens

Problem

According to the Digital Economy and Society Index (DESI) survey of the European Union, in 2018 Croatia was 22nd out of 28 EU members, rising by only one place as compared to its 2017 position. Accordingly, Croatia belongs to the group of countries that were less successful in digitalization. It is important to point out that the overall rating of the Croatian digital index is distorted, with poor technical connectivity and a very bad result in e-government, where Croatia is ranked 25th. And while the results compared to the number of users are favorable, it is precisely the offer of services that would respond to the implicit interest of the user that is missing. Considering the importance of cities as drivers of the nation's overall development and as the demographic centers within which most of the Croatian population resides, they are the key to e-service development at the local level. Smart management and widely available digital services (e-services) are an essential element and key driver of the wider process of the digital transformation of urban space. The study of the digital readiness of Croatian cities (2019), conducted in 20 of the largest cities in Croatia, showed that cities are characterized by insufficient levels of services' digitalization, the lack of use of nationally available identification and authentication models, the abundant multiplication of channels and platforms for the same or similar services, acquisition of IT solutions that are not used or maintained, a lack of user experience in the presentation of information, a lack of awareness of the importance of data in management, a lack of transparency through passive publishing of raw information, and the inadequate application of social networks for the governments interaction. The development of e-services at the local level needs to be coordinated to largest extent possible with the development of e-services envisaged within the e-Croatia 2020 Strategy.

Approach

Digital services are one of the key steps for improving the quality of life of the local population, and for enabling considerable time savings in carrying out administrative and other obligations and procedures (education, health, culture, etc.). A clear strategy and digital city transformation plan are the basic prerequisite for a clearly focused development plan that is aligned with the existing needs (as well as potentials) of the country and its citizens. When defining the steps that need to be taken, it is essential to initiate an analysis of user experience to determine the needs of citizens, as well as to undertake a thorough analysis and optimization process for the cities' business processes. As a result, the need to define concrete action plans for the development of digital services in cities is emphasized, and it is necessary to define the institutional framework of implementation, but also to provide funding for the action plan to be fully implemented.

Required actions

1. Develop an Action plan for the development of digital services in cities.
2. Define the institutional framework for the implementation of the Action plan.
3. Secure funding for the implementation of the Action plan.
4. Implement the Action plan for the development of digital services in cities.
5. Monitor and evaluate the implementation of the Action plan.

Risk management

| Potential risks | Mitigation measures |
|---|--|
| Insufficient human capacity for the implementation of the plan at the local level | Educate the employees of the city administration on the development and implementation of digital services |
| Insufficient financial resources for the development of digital services | Provide financial support mechanism for cities in the development of digital services |

4.3 Long-term policy recommendations (8-10 years)

Recommendation

Accelerate the process of developing an infrastructure that encourages and facilitates the use of smart solutions in cities

Problem

The Broadband Development Strategy for the Republic of Croatia 2016-2020 defines the goals and measures for the development of broadband infrastructure, which is one of the basic prerequisites for the application of a number of smart solutions in cities, whereby the realization of defined goals needs to be significantly accelerated. After the implementation period of the strategy is completed, it will be necessary to define more concrete measures for the development of broadband infrastructure in urban areas, where the sources and the dynamics of financing them need to be defined in order to facilitate the smooth implementation of broadband expansion projects. In Croatian cities, almost no large-scale projects aimed at the optimization of all systems (networks) such as energy supply, water supply (etc.) are currently being implemented. The only exceptions are projects at city-level, with which existing lighting is replaced by energy-efficient lighting. It is extremely important to boost investment in projects that develop infrastructural and software solutions that stimulate and facilitate the application of smart solutions at the level of cities as a whole.

Approach

It is necessary to create a long-term funding program for developing and promoting smart infrastructure in cities that will define specific areas of action and define specific funding sources for project implementation. This process must occur at the national level, where cities will have the opportunity to prepare and submit projects that need co-financing from the program.

Required actions

1. Create a financing program for promoting the establishment of smart infrastructure in cities.
2. Secure funding for the implementation of smart infrastructure projects in cities.
3. Continually assessing the socio-economic contribution of program implementation and its contribution to intensifying the application of smart solutions in cities.

Short description

The public infrastructure financing program for the implementation of smart solutions is implemented at the national level for the purpose of developing infrastructure in cities that facilitates the application of smart solutions in the future (e.g. broadband access) or that is in itself a smart solution that contributes to achieving direct benefits on a city-wide scale or that extends to a wider urban area/agglomeration.

Smart infrastructure project examples

- **Development of Broadband Access Infrastructure:** The project improves and expands the existing infrastructure, enabling greater and better coverage of the city's broadband access through increased transmission speeds, with an emphasis on the implementation of optical infrastructure in the most populated parts of the city in order to obtain extremely high speeds and facilitate the ease of use and application of information-communication technologies and other smart solutions.
- **Implementation of a large scale smart grid system:** The project develops a smart grid system in a particular city that encompasses a large number of different components operating in synergy with the aim of reducing electricity consumption and simultaneously increasing the use of electricity from renewable energy sources (such as smart meters, smart home appliances which consume small amounts of energy, demand distribution system, the installation of solar photovoltaic panels, etc.).
- **Integrated sustainable mobility:** the development of a comprehensive urban (and suburban) transportation system through a comprehensive concept that combines all (or a large number) of transport components - infrastructure and organization of public transport, individual transportation (taxi transport), pedestrian traffic, the integration of various transport modes (e.g. park & ride, park & bike systems), digitalisation of traffic, development of unique integrated maps for various forms of transportation, procurement of environmentally friendly vehicles in public transport, and the encouragement of sustainable forms and modes of transport (public, cycling, pedestrian, car sharing, carpooling, on-call systems).
- **Development of ecosystems for entrepreneurs:** the establishment of a comprehensive ecosystem for entrepreneurs, including the development and/or arrangement of entrepreneurial zones and subsequently encouraging entrepreneurs to adopt them, as well as the development of business infrastructure (business centers, accelerators and incubators, industrial parks, digital innovation centers, etc.) and research infrastructure (science and technology parks, technological incubators, etc.).

Bodies responsible for the implementation

Cities, units of regional self-government, operators of systems (bodies managing the infrastructure of electricity supply, telecommunication infrastructure, public transport, etc.).

Implementation model

Financing large integrated smart projects through a call for project proposals.

Risk management

| Potential risks | Mitigation measures |
|--|---|
| Insufficient financial resources to implement large projects | Provide financial resources for project implementation from national and EU sources as well as international funds |
| Poor implementation of projects due to a large number of actors involved and competence issues | Set up a national coordination body for assisting local governing bodies and other stakeholders (providers of internet/optical, energy, transport, etc. infrastructure) |

4.4 Cross-cutting issues and their implications for policy

Smart cities cover different thematic areas such as traffic, the economy, public administration, social services and the environment (including water, energy, environmental protection, waste management, etc.). From the aforementioned thematic coverage (i.e. a broad spectrum of sectors within which smart solutions can be implemented in cities) it is clear that the application of smart solutions in cities almost always overlaps with some of the individual sectors (such as water supply, waste management, etc.). Within the National Development Strategy (NDS) of the Republic of Croatia, some of the key areas of intervention (KAI) overlapping with "smart cities" are: KPI digital technology integration into the economy, KAI digitalization of culture, KAI development and construction of electronic communications networks and infrastructure of very large capacity, KAI effective public administration, and a number of other KAIs that by their very nature are smart solutions.

For this reason, it is extremely important to understand that thematically „smart cities“ pervade throughout the NDS and that significant contributions to the development of smart cities will be made not only through the recommendations proposed in this report, but also through the implementation of recommendations and projects defined within a large number of other KAIs. It is important to point out that currently, very few cities in Croatia have developed smart development strategies that define thematic areas for development sectors within which a smart solution can be implemented in each individual city. At the same time, development documents at the regional and national level (sectoral development documents) have so far not put particular emphasis on the application of smart solutions specifically in urban areas. In the future, it is necessary to ensure a more intensive integration of sectoral development planning at the national level, with documents that guide smart city development at the local level to ensure that there is sectoral coherence between the required and anticipated development measures that have the character of smart solutions.

5 Overview of possible funding sources

Local budget funds represent the initial resources needed to implement a project that fosters the development, innovation, sustainable management, and growth of smart cities. A local budget is being developed in advance for the next two fiscal years, with a projection of revenue, receipts and expenditures, so it is the main framework for the future financing of all public projects in the local units. Regional unit budgets in Croatia have the same framework as the budgets of local units.

The Strategy Europa 2020 recognizes the problem of the structural weaknesses of the European economy, but also highlights ways to improve its productivity through smart and sustainable economic growth. In the Republic of Croatia, EU structural and investments funds (ESIF) that are used to finance the projects of environmental protection, research and innovation, education, strengthening of public administration capacities, and small and middle business development, represent the primary source of funding for the implementation of smart projects. Within the Operational Program Competitiveness and Cohesion 2014-2020 (OPKK) the Republic of Croatia has 6,8 billion euros available, out of which 4,3 billion euros are from the European Regional Development Fund (ERDF) and 2,5 billion euros are from the Cohesion Fund (CF).

- *The European Maritime and Fisheries Fund (EMFF)* is one of the five European structural funds which provides funds to the fisheries industry and coastal communities with a goal of adapting them to the changing conditions in the sector and achieving economic and environmental sustainability. The Republic of Croatia within the Operational Program for Maritime and Fisheries 2014-2020, has 252 million euros available.
- *The European Agricultural Fund for Rural Development (EAFRD)*, through the Common agriculture policy, has the goals of fostering competitiveness in agriculture, ensuring the sustainable management of natural resources and climate change, and achieving the balanced territorial development of rural areas. Through the grants, EAFRD targets all types of projects pursuant to one of the six priorities, including activities supporting the transition to a low-carbon economy and adaptation to climate change and risk prevention.
- *HORIZON 2020* is the main EU programme for research and innovation. In the HORIZON 2020 structure there is the special initiative "Smart Cities and Communities" which financially supports the demonstration of advanced information and communication solutions. After the end of the 2014-2020 EU financial period, EU plans to continue the work of HORIZON 2020 through Horizon Europe. Horizon Europe will incorporate policy missions to ensure the effectiveness of research and innovation funding by pursuing clearly defined targets.
- *The European Local Energy Development Assistance (ELENA)* is an instrument created to facilitate the mobilization of funds for investments in the development of sustainable energy at the local level. The European Commission (EC) and the European Investment Bank (EIB) have established the ELENA technical assistance facility, financed through the IEE Programme. ELENA support covers a share of the cost of technical support that is necessary to prepare, implement and finance investment programmes, such as in-depth feasibility and market studies, the structuring of programs, business plans, energy audits, the preparation for tendering (etc.). ELENA support can be provided for the development of investment programs or projects within the following areas: (i) Public and private buildings, including social housing and street and traffic lighting, to support increased energy efficiency, (ii) The integration of renewable energy sources (RES) into the built environment – e.g. solar photovoltaic (PV), solar thermal

collectors and biomass, investments in renovating, extending or building new district heating/cooling networks, including networks based on combined heat and power (CHP); decentralized CHP systems, transport to support increased energy efficiency and integration of renewable energy sources, e.g. high energy efficiency buses (including hybrid buses) etc.

- *CIVITAS Activity Fund* is a programme that supports the take-up of sustainable urban mobility measures in Europe by providing financial assistance for specific activities of the CIVNETS.
- *European Cross Border, Transnational and Interregional Cooperation Programs (INTERREG)* - one of the key instruments of the EU, which supports cross-border cooperation through project funding. Its aim is to jointly tackle common challenges and find shared solutions in fields such as health, environment, research, education, transport, sustainable energy and more. The fifth period of Interreg (2014-2020) is based on 11 investment priorities laid down in the ERDF Regulation which contribute to the delivery of the Europe 2020 strategy for smart, sustainable and inclusive growth.
- *COSME* – the programme targets actions meant to improve and strengthen the competitiveness and sustainability of EU enterprises in general, and in particular those of SMEs. This programme can be used to support the development of skills and innovative companies offering the services required in a smart city.
- *LIFE+* - the new 'climate change' component of the LIFE programme can be used to promote both mitigation and adaptation activities in urban areas. These can be related to seed capital, testing and pilot projects, exchanging good practices and improving governance.
- *URBACT III* is an interregional cooperation program funded by the European Regional Development Fund (ERDF) under the European Territorial Cooperation objective. The aim of the program is to exchange knowledge and build the capacities of European cities (and municipalities) that develop or implement integrated strategies and action plans for sustainable urban development.
- *Urban Innovative Actions (UIA)* are European Commission initiatives that provide resources to cities across Europe to test new solutions for sustainable urban development that are very relevant at the EU level.
- *The Urban Development Network* is a programme, financed by ERDF, that is responsible for implementing integrated actions based on Sustainable Urban Development strategies. It is a network of more than 500 cities with the mission of reviewing how European funds are implemented on the ground in Europe's cities, support information exchange between cities involved in integrated Sustainable Urban Development and in Urban Innovative Actions and promote direct dialogue between the Commission and cities on Sustainable Urban Development.
- *The European Urban Initiative* is a new instrument providing coherent support for cities that builds on all thematic priorities of the Urban Agenda for the EU (UAEU) and covers all urban areas in the next programming period (2021.-2027.). This initiative aims to strengthen integrated and participatory approaches to sustainable urban development and provide a stronger link to relevant EU policies. It will do so by facilitating and supporting cooperation between - and the capacity building of- urban actors, innovative actions, knowledge, policy development and communication in the area of sustainable urban development. The Instrument is planning on providing the information and results of experiences and expertise from the initiatives and programs from this programming period (URBACT, UDN, UIA, etc.).

In order to increase the role of ESI funds in the period up to 2020, additional financial instruments are needed in order to encourage and support the use of public and private sources for project financing.

- *European investment bank (EIB)* is the main EU financial institution which provides technical and financial advice as well as financing support for smart city projects. Transforming cities and making them smarter and more sustainable are important goals of the investment approach, informed by both the EU's 2020 Strategy and the EU Urban Agenda. EIB supports big and important infrastructural projects and, in cooperation with Croatian Bank for Reconstruction and Development, gives credits for smaller development projects.
- *Croatian Bank for Reconstruction and Development (CBRD)* is a specialized bank whose main goal is stimulating the development of Croatian economy. CBRD offers and supports a broad range of guarantees and credits for projects of primary importance like the development of small and medium entrepreneurship, infrastructural projects and energy efficiency projects.
- *European Bank for Reconstruction and Development* is the main international bank for financing countries undergoing an economic transition whose focus is to re-stimulate markets by lending to businesses and local financial institutions or by offering long-term credit to governments and utility companies.
- *The World Bank*, through - The International Bank for Reconstruction and Development (IBRD) and the International Financial Corporation (IFC)- provides public and private sector financing with and without sovereign guarantees for a range of sectoral investments and assistance related to smart solutions.
- *European Fund for Strategic Investments (EFSI)* - is an initiative launched jointly by the EIB Group, the European Investment Fund, and the European Commission to help overcome the current investment gap in the EU. EFSI is one of the three pillars of the Investment Plan for Europe that aims to revive investment in strategic projects to ensure that money reaches the real economy. EFSI is providing funding for economically viable projects, especially for projects with a higher risk profile
- *InnovFin* is a joint initiative launched by the European Investment Bank Group (EIB and EIF) in cooperation with the European Commission under Horizon 2020. One of the key factors constraining the implementation of R&I activities is the lack of financing available at acceptable terms to innovative businesses since these types of companies or projects deal with complex products and technologies, unproven markets and intangible asset. This is where InnovFin aims to facilitate and accelerate access to finance and capital for innovative businesses and other innovative entities.
- *Europe's Connecting Instrument (CEF)* - provides guarantees and financing through bonds for investment in the construction of new high performing, sustainable and efficient projects.
- *European Energy Efficiency Fund (EEEF)* - provides market-based financing for commercially viable public energy efficiency and renewable energy projects, and free technical assistance to investors within the EU. The projects that are financed through EEEF can be divided into three groups: Energy Saving and Energy Efficiency, Renewable Energy sources and Clean Urban Transport. The EEEF provides financing for projects on a municipal, local and regional level.
- *Private Energy Efficiency Facility (PF4EE)* is a joint agreement between the EIB and the European Commission which aims to address the limited access to adequate and affordable commercial financing for energy efficiency investments. It provides credit for investments in energy efficiency projects in line with the priorities included in the national energy efficiency action plans.

Various other financing and funding models and instruments are available:

- *Crowd funding* raises funding from individuals to support projects. The difficulty of such an approach is the need for the project to be of interest to a large constituency. Crowdfunding can take many forms such as donations, equity or loans.
- *Smart bond* - these bonds are paid off following the completion of projects (i.e. the achievement of a stated goal) and their return is based on the financial returns of the initiatives covered by the bond. The bond offers a fixed interest rate.
- *The spread shareholding mechanism* is a way of investing where investors buy shares in the ownership of the infrastructures and services they are financing. This involves a higher level of risk, but the potential for higher profit and a more active involvement as ‘owners’ of the project. Investors may finance projects for which they are partially beneficiaries. This can be particularly useful for projects such as district heating.
- *Challenge Fund* is a competitive financing facility used to disburse donor funding for international development projects, typically utilizing public sector or private foundation funds for market-based or incentive driven solutions. In practice, the objective of a Challenge Fund is to provide the smallest possible financial contribution to a socially worthwhile project consistent with making it less risky and more financially sustainable to the private promoter.
- *Matching grants* are an effective means of funding small projects, especially those with active community support. The concept of a matching grant is simple: state or local governments designate funds to go to particular types of projects. Various groups within the community can then develop project proposals and apply for the grant.
- *A public-private partnership (PPP, 3P or P3)* is a cooperative arrangement between two or more stakeholders from the public and private sectors, typically of a long-term nature. PPPs are best seen as a special kind of contract involved in the provision of infrastructure, such as the building and equipping of schools, hospitals, transport systems, water and sewerage systems.

From the aspect of quality project preparation, it is worth mentioning the technical support instrument *Joint Aid for Project Support in European Regions (JASPERS)*. It is the main technical support instrument of the European Commission, the European Investment Bank and the European Bank for Reconstruction and Development. JASPERS provides independent advice to beneficiary countries to help prepare high-quality major projects to be co-financed by two EU Structural and Investment Funds (European Regional Development Fund and Cohesion Fund). JASPERS' assistance may cover:

- I) Project preparation support, from the identification to the submission of the request for EU grant financing,
- II) Independent Quality Review of projects,
- III) Post-submission appraisal function for all major projects submitted directly to the EU Commission,
- IV) Horizontal assignments and strategic support,
- V) Capacity building, including a Competence Centre, Implementation support, Connecting Europe Facility projects, mainly in the rail and road sectors, European Investment Advisory Hub (EIAH) through the screening and handling of requests.

6 Annex | Smart Cities: Best practices – detailed overview

Best practice examples promote an integrated smart city approach, demonstrating effective solutions for the integration of sustainable homes and buildings, smart grid solutions (electricity, district heating, telecom, water, etc.), the clever use of energy storage, electric vehicles and innovative charging infrastructures, as well as the latest generation ICT platforms. These projects are accompanied by energy-efficiency measures and the use of very high shares of renewables. Their goal is to facilitate a successful transformation towards intelligent, user-driven and demand-oriented city infrastructures and services. Some of them are described in the following sections.

6.1 The REPLICATE project, Florence, Italy

By becoming one of the lead cities in the REPLICATE project, the City of Florence has implemented an integrated smart city plan for the first smart district in Florence - the Novoli urban park. The Novoli area represents a mixed-use area with residential and tertiary settlements with mobility infrastructure consisting of a highway, an airport, and the main station. The actions to be implemented through the REPLICATE project include energy efficiency and district heating with an innovative seasonal solar thermal storage for social housing, smart grid and energy-demand management with smart metering and mobile application for final users, public multivendor e-mobility infrastructures, advanced mobility services for citizens, data management and a smart city control rooms, smart lighting based on LED technology integrated with other services like traffic control, video surveillance and environmental sensors, as well as intelligent systems (internet of things (IoT) pilot test on smart benches, smart waste and smart watering).

This big project contributes to the effectiveness of the infrastructure and utilities that represent the demonstration area for the next smart growth projects



Source: Replicate Project EU, 2019

6.2 The GrowSmarter project, Barcelona, Spain

The city of Barcelona is one of the lighthouse cities for the GrowSmarter project. Through it, the 22nd District has been chosen to become the innovation zone that will encourage innovation in areas such as transport, shopping, street lighting and environmental monitoring. This multi-purpose area mixes residential, industrial and academic buildings in a lively, vibrant quarter. The smart solutions demonstrated in the 22nd District include retrofitting the building envelopes, the integration of efficient lighting and the integration of smart heat pumps for heat storage in heating systems and hot water systems. Also, the project includes energy systems integration aspects through smart electrical energy storage, smart street lighting, waste heat recovery and integrated district heating and cooling, as well as introducing electric vehicles and installing charging infrastructure.

According to Smart Cities Information System's (SCIS) calculations, based on energy design data and the respective emission factors available, the primary energy savings go up to 5.729 MWh/yr while the carbon dioxide (CO₂) emissions reduction amounts to 1.610 tons every year.



Source: EUGrowSmarter, 2019

6.3 The TRIANGULUM project, Manchester, United Kingdom

The TRIANGULUM project focuses on the integration of energy, mobility and ICT systems around three core infrastructure assets within the innovation district 'Corridor Manchester': Civic Quarter Heat Network, University of Manchester's (UoM) Electricity Grid and Manchester Metropolitan University's (MMU) Electricity Grid. These assets supply heat and power to the respective estates and buildings belonging to the Corridor partners. TRIANGULUM will build on the work already undertaken to establish a smarter, more independent infrastructure whereby energy generation, as well as its supply, storage and use, is managed in a much more demand-responsive manner. The primary focus of this project is on those buildings with heritage status value, a sector that until now has proved a major challenge in terms of carbon reduction. All the new investments around renewable energy generation, supply and demand management will be connected through a new ICT infrastructure called the MCR-i. This platform will consist of a number of discrete layers, which will create two new knowledge environments.

The first network of data and services that bridge the investments set out above will, in an integrated way, enable greater analysis and better-informed decision-making at both a strategic and operational level. This will improve energy efficiency, reduce carbon emissions and provide a greater ability to meet demand in a more cost-effective way. The second is the establishment of an open access marketplace from which innovative end-user and business applications can be developed and marketed independently. The implemented solutions should impact the following target aspects: energy use, energy costs, energy generated from renewable sources, as well as the increased air quality that the reduction of carbon emissions will bring about.

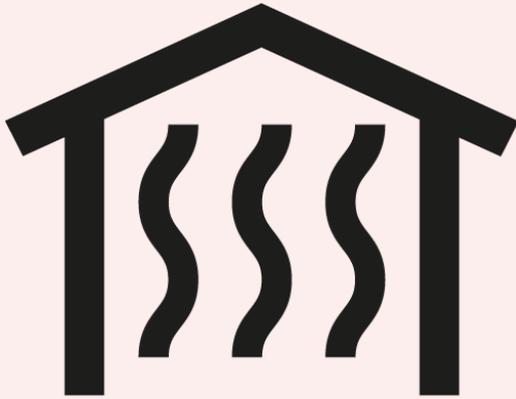


Source: Digital Futures, 2019

6.4 The SMARTER TOGETHER project, Lyon, France

Lyon is one of the lighthouse cities in the SMARTER TOGETHER project. The demonstration area in focus is Lyon-Confluence, one of the largest urban redevelopment projects in France (150 ha) and an area with many urban innovations. With SMARTER TOGETHER, Lyon-Confluence heads towards a zero-carbon objective, which means that after the implementation phase the annual greenhouse gases emissions of the buildings must not be superior to the level of emissions at the beginning of the project, despite an increase in built area (1 000 000 m² of new constructions), population and activities in the area. The goal will be reached by refurbishing 35.000 m² of existing buildings in order to reduce their energy consumption, but also through local renewable energy generation, and electric vehicle car-sharing system establishment.

LYON



DISTRICT HEATING

Wood - gas fired Cogeneration Heating Power system

Constructing 2MWe/4MWth heating system to power the local new district heating

10 smart substations equipped with smart heat meters

A call for tender is in progress to develop a software gathering all the data from the substations of the district heating, and able to communicate with the Lyon Metropolis data platform



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 691676

Source: Smarter Together, 2019

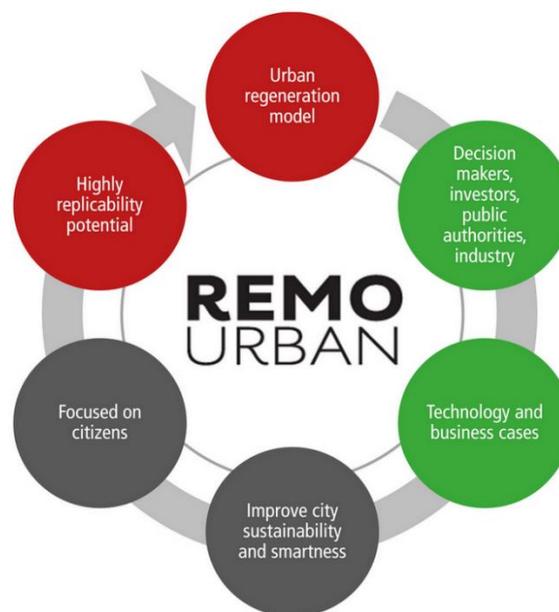
6.5 The REMOURBAN project, Nottingham, United Kingdom

REMOURBAN is a smart city project and its ultimate goal is to design and deliver a model to show how sustainability can be integrated into the regeneration of our towns and cities to develop 'Smart Cities'. The REMOURBAN model takes advantage of the crossover between energy, mobility and ICT to develop a new method for developing smart cities.

The model aims to:

- improve quality of life for people living in the area,
- improve environmental sustainability,
- speed up the amount of time it takes to deploy innovative solutions,
- develop new business and funding models for city regeneration, and
- ensure that the solution is welcomed by the local community and fit for how people want to live their lives.

The area around Sneinton Road in Nottingham is considered to be the most appropriate for the development of the REMOURBAN demo site in the United Kingdom. An intensive retrofitting programme will be developed in the Sneinton area in order to achieve a low-energy district. The district heating intervention will extend the existing district heating network (4.700 homes) by using the low-temperature return heating for the first time on this system, and maybe for the first time in the United Kingdom as a whole. With regards to mobility and transport, the actions foreseen are going to reinforce the city's sustainable transport strategy by improving the transportation infrastructure, extending the city's fleet of electric buses and developing a small local consolidation center for last-mile delivery by using small electric vehicles for the transportation of goods to the city center, thereby reducing the number of large vehicles used for domestic and business deliveries. All these measures are complemented by ICT technologies and social actions, including a citizen engagement strategy, a social media strategy, a real-time integrated city model, a strategy for the development of the integrated urban plan, funding models to help private owners of retrofitted properties, a smart energy map and a common sustainability and smartness evaluation procedure.



Source: BuildUp, 2019

6.6 The GrowSmarter project, Stockholm, Sweden

Stockholm is growing rapidly and sometimes faces the challenges of both keeping and developing its unique city character. A key priority is to ensure that it remains a sustainable city while offering an attractive and inspiring living and working environment.

The implementation and monitoring of all climate actions undertaken in the city is coordinated by a climate action group. Their long-term aim is to become completely fossil fuel free by 2040. In this context, within the GrowSmarter project Stockholm demonstrates smart solutions in the fields of low energy districts, as well as integrated infrastructure and sustainable waste solutions in Arsta, a fast-growing district in the south of the city. The final energy demand of the site is reduced by 3.333 MWh every year thanks to the refurbishment. According to SCIS calculations, based on energy design data

and the respective emission factors available, the primary energy savings go up to 4918 MWh/yr while the CO2 reduction amounts to 1.187 tones every year.



Source: EnvacGroup, 2019

6.7 The REPLICATE project, Bristol

As part of the REPLICATE project, Bristol will deploy a number of smart integrated mobility and ICT solutions in the neighborhoods of Ashley, Easton and Lawrence Hill. The pilot will explore how technology could help people be more active and have more choice on how to travel. The focus of the project will be the availability of electric, hybrid and clean vehicles such as electric bikes, cars and buses. Within the project, the electric car club will be established, as well as an on-demand electric mini-bus service. In order to allow the widespread use of the electric vehicles, charging points will be established in the district.

The project will contribute towards Bristol's ambition to be carbon neutral and run entirely on clean energy by 2050.



Source: Replicate Project, 2019

6.8 The TRIANGULUM project, Eindhoven, Netherlands

The former Philips industrial complex in the Strijp-S neighbourhood in Eindhoven, Netherlands will become a creative smart district. An innovative concept to clean up contaminated land will double as a means of producing energy. It is also planned to optimize the heat provision powered by renewable energies of the existing buildings. A district-wide ICT solution will allow residents to access different kinds of infrastructure, such as booking electric vehicles from a district car-sharing scheme or using smart parking concepts. In this way, the IT-based tool will help residents to develop sustainable patterns of energy and mobility behavior. In addition, electric buses will make city traffic eco-friendlier.

There have been and continue to be efforts to uptake smart solutions and redefine quality of life, especially in terms of the quality of mobility and transport, through the introduction of improved parking management and detailed assessments for parking spaces (real-time parking guide system) as well as smart charging of electric vehicles through the optimized use of charging station.