

GLOBAL URBANIZATION AND THE NEED OF SMART CITIES DEVELOPMENT

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Abstract. *Nowadays, more than half of the world's population is living in cities, and by 2050 this percentage will rise up to 66%, according to the World Bank. These dynamics will bring important changes in the size and role of cities. The fast-growing urbanization will lead to an increased level of water, energy and fuel consumption with a significant impact on biodiversity. Cities are also important contributors to climate change but in the same time they are also vulnerable to it – the newspapers are often presenting articles regarding strong storms, heavy rains, extreme temperatures that affected life in cities around the Globe. This is an effect of urban development. However, the increased level of human concentration brings benefits too: an increased demand for cultural activities, education, and mobility, which can lead to an increased access to jobs, longer life expectation and so on. Cities – no matter how small or big are they, are very dynamic. They rely on people and resources. The article intends to present the cities needs to meet the economic and social aspirations of their inhabitants by presenting both the literature perspectives as well as few case studies we have found in Romania and in the world.*

Keywords: *smart city; IoT; technology.*

Introduction

According to the United Nation and the World Bank global statistics, more than half of the urban population lives in cities with less than 500.000 inhabitants, and just one eight lives in cities bigger than ten million inhabitants (London, Tokyo, Mumbai, Shanghai etc.). However, the highest growth rate is to be seen at cities with a population between 500.000 and 1.000.000 inhabitants – especially in Asia and Africa (United Nations, 2017; World Bank, 2018).

The fast-growing rate of urbanization and the unplanned expansion of cities today bring huge changes for the economies – at all levels: city, country or even region. If we are to speak only about the water consumption, fuel, and electrical power, we can imagine the high growing level of pollution – a phenomenon that strongly impacts the lives of citizens, climate, and environment. Even if only two percent from the Earth surface is covered by cities, they consume about 80% of the energy that is produced by the whole world and, even more, they produce 75% of carbon dioxide emissions (United Nations, 2017).

By that, we can easily say that even if cities are the most vulnerable entities to the climate changes for example, they are the most responsible for that too. Some of them are affected by the increased winds power, big storms etc. while others might be affected by extreme temperatures – above or below zero. All those elements do have the power to alter the quality of life of their citizens. In addition, many cities do face issues like

poverty, lack of housing – things that are easily associated with crimes. The pressure on the public safety system or on the health system is huge (World Bank, 2018).

Cities from the developing countries are facing the strongest challenges. Here, the statistics show a very fast growth rate of the urban population – 95% till 2050. Although those cities are poor, with insufficient resources and a low level of administrative capacities, their citizens will face very strong challenges. Almost one billion people live in slums – at the limit of subsistence, slums that are located inside the borders of big cities (UN-HABITAT, 2012).

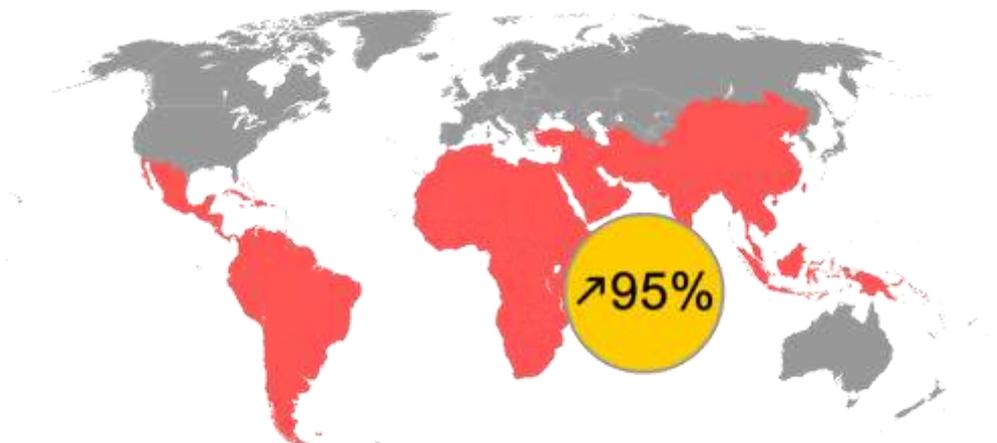


Figure 1. Most affected areas by the increased number of the inhabitants by 2050
(Source: The author after UN-HABITAT reports for 2012)

Although big cities are facing issues like those we already mentioned; there are few benefits as well. The pressure on the social services will force them to get improved, the number of hires will start to grow, and there will be an increased number of cultural and social activities. The same will be recorded regarding educational activities, mobility, public health and so on. In other words, we can speak about an increased life expectancy and a poverty reduction.

Cities are very dynamic entities that work mostly on the continuous flow of people, ideas, resources and, generally, their links with other entities from the surrounding environment. To prosper, cities should answer to the economic and social demands of their inhabitants. Cities should manage their impact on the environment to ensure a sustainable growth from which everybody to benefit.

Rio de Janeiro – an example of adapting technology to the needs of the inhabitants

Rio de Janeiro, the second city in size from Brazil, with a population bigger than seven million inhabitants, is a city full of life, but, as most of the world metropolis, it is facing major challenges in its development such as high number of criminal acts, old infrastructure, poor social services and so on. On top of that, being located on the Atlantic coast, quite often it is facing floods and landslides due to the high mountains of the surroundings. All those issues have the tendency to get even worse due to the climate changes. The slums from the suburbs are built on the mountain hills from the

surroundings and, by that, they are the most affected by those natural disasters (UNICEF, 2012) – heavy rains destroyed many times those highly populated areas making a lot of victims and demolishing a high number of houses.

To fight with those issues, and taking into consideration the fact that Rio was hosting two major sports events in the world - The 2014 World Football Championship and the 2016 Summer Olympics, the mayor of the city, Eduardo Paes, established a City Operations Center. It was built by IBM, and it started to run from 2010 – long before 2014 because such projects need time to produce effects. The Center is coordinating activities of over 300 agencies and city departments, plus those of the private companies – for transport, health, sanitation etc. integrating them into one single command and control system.

Surveillance cameras placed all over the city send info in video or photo format to the command center, images that are played back on hundreds of screens – from here the whole activity of the city might be seen. For analyzing traffic and avoid risks as traffic congestion or road incidents the center uses software applications designed especially for this purposes (the statistics made by it – with the support of big data collected over time, is the key of a fast and correct decision). Another software application, this time designed to analyze the climate changes and the sea level, is able to anticipate two days in advance the risks of flooding and areas where those risks might appear. This info helps the municipality to route police forces, ambulances and intervention teams, and by that being more close to the citizens and their needs. Of course, being known that prevention is more efficient then intervention, the authorities make use of technology to alert citizens in danger – closing the streets that are under risk or even by sending phone messages to citizens who, by the way, they have free access to the surveillance cameras in order to see and analyze by themselves the evolution of the variables that might put them in danger.

Those technologies are not the only one used by the city of Rio de Janeiro. In contrast with the huge investment made for the City Operations Center, young citizens are using the mobile technology in a very creative way. They attach smartphones to kites and then fly them over the slums and waste dumps in order to collect photos that are used to map those areas. By that, they manage to find out the areas that might be affected by landslides or electric poles that are at risk of collapsing and so on (UNICEF, 2014).

The characteristics of a smart city

The challenges that cities today are facing the future are completely new. This also provides a framework for collaboration and development among citizens and organizations to find solutions over the new technological opportunities. In smart cities, creativity, innovation, and entrepreneurship, together with smart technologies, are the ingredients for developing new solutions for their citizens.

As we saw already, there are two different important approaches to meet the smart cities concept: top-down and bottom-up. The top-down projects are usually big projects that imply huge investments - the City Operations Center in Rio de Janeiro for example. Bottom-up approaches, such as Rio's young people's initiative to use mobile phones attached to kites, are cheap solutions, at the citizen's fingertips that puts them both in the middle of the problem and the solution found.

Nevertheless, there are also situations in which smart solutions are not sustainable - when the development of technological solutions has been made for the sake of the technology itself. The city officials usually accept the technical challenges without really understanding what kind of problem they are addressing, having a rather superficial image about the concrete needs of the citizens. These solutions are, in most cases, the result of research by major IT companies that obviously want to sell their products. Due to the fierce competition on the market, it is quite difficult to find the relevance of a product in real life. There is often not enough time for the population or administrative environment to assimilate the solution found when it is tested during the pilot phase.

Other cities regard smart technologies as a universal panacea. They believe that the location of sensors all over the locality, electric cars, smart grids or the existence of an operations center will solve all the problems. Although they have not configured clearly the purpose of the smart technology, they choose to implement this type of solution simply because they are functional elsewhere. Prioritizing the actions of the public is a very important element in the sustainable approach to the development of a smart city. First of all, the problems of the community must be identified, and then it will be decided whether the solution really resides in smart technologies.

In developing smart city strategies, there is a need for vision - both in terms of planning and management - for smart cities to evolve sustainably and harmoniously. The Rockefeller Foundation, through its 100 Resilient Cities (100RC) program, devotes its efforts to help the world's cities become more resilient to the 21st century social and economic challenges. 100RC Experts describe resilience through its four dimensions (100 Resilient Cities, 2013):

- **Health and well-being** - this dimension takes into account all those who live and work in a city and not just its citizens;
- **Economy and society** - social and financial systems must allow the urban population to live peacefully and to act collectively;
- **Leadership and strategy** - these are the processes that promote effective leadership and inclusive decision-making for integrated planning with the involvement of all actors in the social, political and business environment;
- **Infrastructure and the environment** - this dimension concerns the resilience of a city through artificial and natural systems that provide critical services, enabling the flow of goods, services, and knowledge while protecting city assets.

If smart cities want to address the challenges they face, the most important step is to involve all actors (public administrations, private companies, universities, public service providers, non-governmental organizations and members of the local community) for discussions. Together, they need to explore the complexity of their problems and get involved in the decision-making and strategic planning process of the city they operate in. Only after these discussions, the councils will understand the problems of the city, allowing them to explore through the variety of solutions in the idea of identifying the best of them - which, indeed, could have an important technological component.

The city as a system of systems

In 1960, American mathematician Edward Norton Lorenz introduced, in the theory of chaos, a new theory called The Butterfly Effect. According to this theory, a small change in a system can cause great changes in its later state (Elaydi, 2007). For example, a town can reduce the number of polyclinics in an attempt to concentrate resources on hospitals, increasing their capacity. However, this decision may lead to an increase in the number of cars driving to and from the medical centers now placed at a bigger distance. The effect might be an increase in the number of traffic jams on the city's boulevards, which would lead to pollution that would eventually affect the health of the population in the city. Here is how a decision to raise citizens' quality standards and standards of living could, in fact, lead to long-term adverse effects.

Cities are very complex entities - they are often presented in literature, metaphorically, as living organisms (Magnaghi, 2000). They involve the existence of many interconnected systems, including energy supply system, drinking water, and sanitation, health, food, economic, transport, educational, cultural and much more. This network of systems, products, services, and people flows can be described as a system of systems.

Departments within the local government institutions often collaborate, in private, with service providers (whether private or public) when trying to solve the city's problems - local public transport service providers only collaborate with the transport management departments within the mayoralties, energy providers only with the specialized departments of the public administrations. In the same way, the drinking water distribution system is only connected to a similar department within a particular public institution and so on. In reality, however, the problems faced by these sectors are interconnected, interdependent and, as such, strategies need to be integrated. Only by that, it will be a certain benefit both for the systems themselves and for the recipients of the services they provide (e.g. citizens).

The systemic approach - an instrument in the management of complexity - is the one that can provide students with information on how to address new and complex situations usually placed in uncertain environments - situations that are difficult to understand and manage, being, obviously, difficult to solve with simple solutions (Checkland & Scholes, 1999; Checkland, 2000).

How does the systemic approach work? As we have already figured out, a system can be defined as a set of interconnected components, all serving a common purpose - in a more familiar approach, their efforts must be concentric.

Here is an example: Supposedly, a team of transport experts wants to remodel the transport system in a city - a system that developed unplanned and has been amorphous over the last hundred years. Inherited infrastructure is based on the traditional model of transporting people as being the primary objective of the transport system - which we all know today as being a wrong approach. In a smart city, the objective is citizen mobility - the ability to connect them, in an efficient and elegant manner, with their points of interest.

One way to explore the components and attributes in a system is to plot diagrams to symbolize their interaction or, for very complex systems, to make three-dimensional

models with mobile components (similar to a Lego game). This method helps to understand the complexity of a system, managing to portray it either symbolically - in the first case, or on a small scale - in the case of a 3D layout. More and more often, three-dimensional layouts are also made digital (eventually 3D printed), so it is possible to analyze each element and not just its major components. In making such diagrams or layouts it is advisable to involve all the actors involved by delegating experts to the respective research and development areas. Only in this way can the system be fully understood.



*Figure 2. Model layout for a smart city
(Source: Designed after <http://iotforum.advantech.com>, 2017)*

Brasov – one of the best Romanian examples of Smart City

The city of Brasov, placed in the center of the country, is surrounded by mountains, is a very attractive touristic destination both for Romanians and foreigners. The metropolitan area of the city has, according to Romanian National Statistical Council (NSC) is about 400.000 inhabitants making Brasov the 7th most populous city in Romania.

In order to manage the touristic flow as well as its own population and industry, the municipality invested in different management systems that generally might be seen as a City Operations Center. Bellow, we will describe few of the subsystems that are integrated within:

“Integrated Technical Dispatch for the Municipality of Brasov – Geospatial Electronic Services” is built to help the citizens of Brasov to signal any urban problem that they may encounter:

- On one hand, there is a unique phone number. by which the citizens might get in contact with human operators in order to describe the problem that they might have encountered on the public domain (i.e. an infrastructure failure);
- On the other hand, citizens could place a pin on a map on the municipality Web portal, by themselves, to signal the problem that they might have been encounter.

Another component was developing an infrastructure platform for exchanging data among public utility companies. Implementing this had the following stages: Problem analyzing, Design, Developing, Configuration, Software integration, System testing, Implementation, Users training.

The Technical Dispatch is functioning as an informational and decisional hub made to collect information coming from different systems managed by Brasov city hall (e.g. video monitoring system, public lighting system, semaphore management system, GIS, e-documents management, ERP systems) and from those belonging to the public utilities companies, as well as to provide information to private and public institutions expected to deal with security issues (e.g. Police).

The Call Center component is actually an automatized phone system build for citizens unable to use the Web platform, to provide them with the information they need.

The Geoportal subsystem consists in an interactive map – made with an accuracy of ten centimeters, for citizens, to pin the urban problem they face as well as for displaying the problem status. It allows a proper information of citizens regarding the urban problems, as well as, it is allowing them to report any malfunction or service delivery delay.

Another factor we should not ignore is that the software provides a transparent communication channel environment throughout the Brasov citizens by showing them short notices about the repair/replacement or any other working activity needed for resolving the issue.

The Geospatial Electronic Services Delivery subsystem is bridging successfully utility companies with other partner institution, by allowing a fast endorsement for problem troubleshooting and intervention on the public domain. The requests are filled in online, and sent to all the actors involved, together with all the information needed for a prompt intervention (e.g. specific geographical position).

The Business Intelligence Reporting subsystem was developed in order to bring together, under the same screen, all the data from every partner, contractor, and sub-contractor who report to the city hall. All this information flow is possible by an easy to use Graphical User Interface who allows all the actors to input data easily and with accuracy.

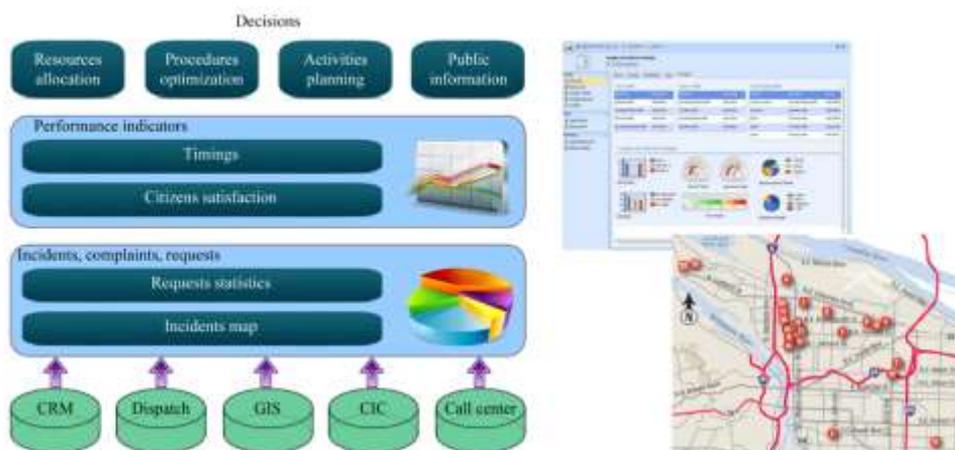


Figure 3. Business Intelligence Reporting subsystem
(Source: Brasov city hall)

Problems encountered by a smart city

Some cities have a pronounced touristic character, while others are just industrial cities. The first can attract tourists either because of the mountain landscapes, the beautiful seaside resorts or because of the historical importance they have. Industry can attract investors for easy-to-understand reasons. Each locality has its own specificity. Some are closer to become a smart city; while others have as priorities to meet the basic needs of their citizens. Copying a functional model elsewhere has been proven to have a great potential for turning into a failure (Winston, 2006; Haque, 2010).

The quality of life in Romanian cities generally does not stand at the level of Western European or North American cities. But not only there the cities are trying to become smart. Cities in medium or developing countries also look for solutions to grow smart. The results are not, of course, always what they want. They must analyze and evaluate past experiences to prevent failures and avoid mistakes already made. The experiences of India, Latin America or Africa, the problems encountered by them during the development process may sometimes be more useful to Romanian cities than the successes of Paris, London or New York.

Urban challenges such as poverty, sustainability, quality of life are typically framed in the SWAT analyzes, in the weaknesses chapter. In the case of a city, these weaknesses are social, cultural or diversity issues that, for various reasons, are very difficult to solve - if not impossible. As early as 1973, German Horst Rittel, a professor of urban planning at the University of California at Berkeley and the University of Stuttgart, said that the issues that cannot be even defined by the actors involved better should be left to solve by themselves (Rittel & Webber, 1973).

Let's take poverty for example. What would be the solution to this problem at the municipal level? It is closely related to other elements - education, food, economy and so on. In an attempt to eliminate a weak point, the solution to a particular problem often brings at the surface another, perhaps more complex, one - often there is no recipe for

removing a weak point. However, solutions can be found to help ease the suffering of the populations affected by the problem.

In addressing the challenges that a city encounters, it is often necessary to slowly change the structures of society, rather than implementing a momentary technological solution. Changing behavior (and/or mentality - as we often hear it being discussed), the way we live and work, are essential elements in the evolution of a city that wants to become smart. Technology can indeed play a particularly important role in facilitating these behavioral changes - for example, helping to reduce electricity consumption or changing inter and intra-urban transport methods, but it is not enough. As we have already said along this article, technology is not a universal panacea. It helps solve some problems but does not solve them all. For that reason, the society needs the involvement of its people!

We want to make it clear that cities can be associated with living scientific laboratories, with the participation of all citizens as specialists of the city's lifestyle. They are the only ones who have the ability to explore the problems they face and to find solutions - either with the use of smart technologies or new business models or even complete new public services. Often, following the collection of ideas from citizens, it is possible to develop completely new public policies; new solutions, that would have been impossible to identify from the council's level, can be found. According to the Stanford Summer Arts Institute, the Stanford Design Impact program, strategic thinking is a process that can help cities find viable solutions to solve their weaknesses with their own citizens (IRIS Design Lab, 2018).

Key elements for a smart city

As mentioned above, smart city projects involve the participation of experts from different backgrounds to work with residents in order to help them discover solutions to the issues that they, the inhabitants of that city, consider important.

There is no agreed definition of the smart city concept - although it is generally seen as a smart city a city that uses smart technologies along with data and information gathered/processed by digital equipment to address the challenges it faces.

The fact that cities often make the mistake of starting with technology investments rather than what is important to citizens is also already known (Cushman & Wakefield, 2015). To be successful, a smart project must start with a problem that is about to be solved. We need to focus on the following five elements considered most important in building a successful smart city project (Modi, 2014; Vrabie, 2017):

1. Citizens;
2. Technical infrastructure and data flow;
3. Entrepreneurship and innovation;
4. Strategy and leadership;
5. Education.

Each of the five elements listed above must take into account the following fundamental concepts of success:

1. Sustainability;

2. The use of open data applications - a factor that helps develop smart projects;
3. Protecting privacy and ethics - elements that citizens are increasingly concerned about.



Figure 4. Key elements for a smart city
 (Source: The author after Modi, 2014 and Vrabie, 2017)

Lessons learned

To be successful, Smart cities initiatives should consist in a partnership between the citizens – as the most important actor, business sector, and public authorities. Only by that, it will be possible to be built a solid environment in which information from the public side meets service delivery companies.

Each partner must be responsible for their role and by that to properly interact with the others. Education along with communication is the key ingredients.

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