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Daria-Petruta Bratu, PhD Student, Simion Mehedinţi Doctoral School "Nature and Sustainable Development". Bucharest, Romania.

Smart city ideas for a medieval fortress – Sighisoara

Abstract: A smart city represents a caring urban area that uses different types of sensors to collect an electronic data in order to provide information that is used to efficiently manage its resources. The smart city concept comprises six major areas: smart environment, smart mobility, smart government, smart people, smart living and smart economy. This paper aims to present aspects of the urban development of Sighisoara that can be classified in the smart city category. Although it is a small municipality, with a population of 24,447 inhabitants, according to INSEE on January 1, 2020, and has its hearth located on one of the oldest historical localities in Romania, being at the same time a UNESCO site, it has been experiencing in recent years an application of smart projects in the field of urbanism. Without going into contradiction with the medieval vestiges of the municipality, in Sighisoara we try to intertwine the historical environment with the new technologies of the 21th century based on digitalization. The Internet of Things (IoT) is already present in the city by implementing programs in transport, infrastructure and parking. Projects are underway on the construction of smart residential complexes and the transition of digitalization to industry and agriculture. The new global challenge of SARS-COV-2 virus requires a more alert development of smart systems that help to comply with the rules imposed by the authorities without creating discomfort to citizens. The smart citizen is the most important tool in the fight against the pandemic. A citizen who learns to communicate with public authorities and institutions with the help of the internet, who pays his taxes and taxes online is one of the answers of technology to the problems raised by the COVID-19 pandemic. At present, more than 7 billion euros of European funds are available at EU level for the smart development of communities. Sighisoara is among the cities that have seen this development opportunity.

Keywords: digitalization, economy, innovation, smart city, Sighisoara, Romania.

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Idei de smart-city pentru o cetate medievală – Sighişoara

Abstract: Un oraş inteligent -*smart city*-, reprezintă o zonă urbană care utilizează diferite tipuri de senzori de colectare a datelor electronice pentru a furniza informaţii care sunt utilizate pentru a gestiona eficient resursele acestuia. Conceptul de smart city cuprinde şase mari domenii: smart environment, smart mobility, smart

government, smart people, smart living şi smart economy. Lucrarea de faţă îşi propune să prezinte aspecte ale dezvoltării urbane a municipiului Sighişoara ce pot fi încadrate în categoria *smart city*. Deşi este un municipiu mic, cu o populaţie de 24.447 locuitori, conform INSEE la data de 1 ianuarie 2020, şi are vatra aşezată pe una dintre cele mai vechi localităţi istorice din România, fiind în acelaşi timp un sit UNESCO, acesta cunoaşte în ultimii ani o aplicare a proiectelor de tip *smart* în domeniul urbanismului. Fără a intra în contradicţie cu vestigiile medievale ale municipiului, în Sighişoara se încearcă împletirea ambientului de tip istoric cu noile tehnologii ale secolului XXl bazate pe digitalizare. *Internetul Lucrurilor (IoT)* este deja prezent în oraş prin implementarea programelor în transporturi, infrastructură şi parking. Sunt în curs proiecte privind construcţia de ansambluri rezidenţiale *smart* şi trecerea digitalizării în industrie şi agricultură. Noua provocare apărută la nivel global dată virusul SARS-COV-2 impune o dezvoltare mai alertă a sistemelor de tip smart care ajută la respectarea normelor impuse de autorităţi fără a crea un disconfort cetăţenilor. Cetăţeanul inteligent este cel mai important instrument în lupta împotriva pandemiei. Un cetăţean care învaţă să comunice cu autorităţile şi instituţiile publice cu ajutorul internetului, care îşi plăteşte taxele şi impozitele online este unul dintre răspunsurile tehnologiei la problemele ridicate de pandemia COVID-19. La ora actuală, la nivelul UE sunt disponibile peste 7 miliarde de euro, fonduri europene pentru dezvoltarea smart a comunităţilor. Sighişoara se află în topul oraşelor care au văzut această oportunitate de dezvoltare.

Cuvinte cheie: digitalizare, economie, inovaţie, oraş inteligent, Sighişoara, România.

Introduction

The concept of Smart City can be defined as a more efficient usage of digital and telecommunications technologies based on traditional internet services for the benefit of the inhabitants of an urban settlement and the economic activities that take place in that area. Another feature of smart cities is the use of communication technologies and IT programs for the best use of resources and the reduction of emissions. It can be applied for urban transport network, improving the water management arrangements, and making the power sources and heat systems for buildings more efficient. The European Union has also introduced in the Smart City concept the digitization of urban area management, increasing safety in public space and improving living conditions for the elderly.

In Romania, the implementation of the Smart City concept has been attempted since 2010. The first project, unfinished however, was in Târgu Mureş, by trying to implement a visa card for citizens to pay for all facilities. But the first cities that benefited from the strategy of implementing the Smart City concept were Alba Iulia, Timişoara, Cluj-Napoca and Oradea since 2016.

A city can be defined as smart when investments in human and social capital and traditional (transport) and modern (ICT) infrastructure foster sustainable economic development and a high quality of life, with wise management of natural resources, through participatory actions and commitment. (*Caragliu et al., 2009*)

Another definition states that a Smart City is an urban area that creates sustainable economic development and a high quality of life par excellence in many key areas such as economy, mobility, environment, people, life and government. Excellence in these key areas can be achieved through

strong human capital, social capital and / or ICT infrastructure (*Business Dictionary for Entrepreneurs, 2020*).

A Smart City represents a caring urban area that uses different types of sensors to collect an electronic data to provide information that is used to efficiently manage its resources. The concept of Smart City encompasses six major areas: smart environment, smart mobility, smart government, smart people, smart living, smart economy (*Giffinger & Suitner, 2015*).

The aim of the paper is to bring an image on the development of the Smart City concept in Romania by presenting cases of use of information technology for this purpose in a medium-sized urban locality. For this, the municipality of Sighişoara was chosen, an urban locality with a population of 24,447 inhabitants (INSEE data, January 1, 2020).

The methods section describes how the information regarding the implementation stage of the Smart City concept in Sighişoara was obtained, as well as the expectations of the citizens of the municipality and tourists who visited the area recently. In the section III, Results, we present the analysis of the material obtained from the on-site research and surveys on people's complaints. The section dedicated to the conclusions centralizes the results and draws lines for future research of the development of the Smart City idea in Sighişoara.

Methods

The concept of Smart City came to the attention of researchers from various fields such as Economics, Territorial Planning and Environment in 1995, in the U.S., with the start of the program San Diego: City for the New Millenium (*Kotkin, 2017*).

Smart City initiatives have been unified in a model that wants cities to become a more pleasant place to live in them. Proceeding from this idea, three conceptual levels were highlighted (Lom, Pribyl, Svitek, 2016). First of all, smart services appear, which means user-friendliness in the relationship between residents and authorities, providers of hospitals and public institutions. Secondly, the concept of Smart City is related to the directions strategically eluted by the urban planning service, and thirdly, in the context of technological development, Smart City is related to A. I., I.O.T and machine learning.

In the case studied, since 2013, in the municipality of Sighişoara, a locality that has as a pivot at present the tourist activity related to the former medieval fortress, programs belonging to the concept of Smart City have been implemented.

Applying the observation method, a number of elements belonging to this concept have been identified at the 2020 level. These relate to the fields:

- smart mobility, in which we can highlight the traffic light system, the T-PARK application for car payments, the Railway Bridge Târnava-Sighişoara;
- smart living, where we have the video surveillance system, smart street lighting and the redevelopment of SIGMA market-lower City Center;
- smart people, in which we can discuss the WIFI4EU program;

- smart environment, where it is discussed about tourist routes for bicycles around the city for visiting other sights in the area of influence of the municipality.
- smart economy for tourism where there is the program Sm@rt Expo, a program to valorize the cultural heritage of the locality in the virtual environment.

In addition to those identified on the ground, in order to create an overview of the degree of implementation of the Smart City concept in Sighişoara, we also carried out a quantitative analysis using the questionnaire method. The questionnaire was addressed to both residents and tourists who visited the municipality in the last period of time (1-2 years).

The questionnaire had a set of 16 questions regarding the way and frequency of use of Smart City systems installed in the municipality as well as the degree of satisfaction of the beneficiaries. Out of the 16 questions, 15 were closed questions related to the above matter at hand and at the end of the questionnaire we introduced an open question on the respondents' desires for the urban development and other systems that fall into the Smart City category.

The online questionnaire was opened from 20 May to 1 June and was accessed by 103 people with a Google account.

Through the responses sent, the study participants provided a relevant picture of how the concept of Smart City is understood and viewed and the possibilities of its expansion in other areas compared to the current ones.

Results

The field observation was carried out for several years, through successive visits, starting from 2017 and consisted in the pursuit of the introduction of smart systems in the area of Sighişoara municipality. It was followed what type of systems developed in these years, as well as the effects of those installed before this period (2017-2020).

The first smart system was from the sphere of smart mobility and consisted of the T-PARK System, the smart application for car payments.

Parking payment by SMS is the fastest, easiest and most convenient way to pay the parking fee. Drivers need to send an SMS to a short number according to the city with the text code no. License plate. The short number and parking payment code can be found on the city's parking Billboards. The T-PARK System was adopted in Sighişoara to facilitate access to parking for tourists who want to visit the fortress, starting from November 1, 2013.

Through the T-PARK app, in addition to paying parking in the areas rounded up by the city hall, you can also find the payment of rovinieta, the payment of parking fines and other car taxes.

In the same sphere, in September 2019, a traffic light system with synchronous operation was implemented in the radius of Sighişoara municipality, on the DN13 E60 road, to provide the green light for cars crossing the city. Thus, an intelligent traffic light system appeared for 13 pedestrian crossings and intersections in the city starting from the entrance to the city (CESIRO factory) to the exit from the city (Cornești Church). Following an analysis in September 2020 it was shown that the green light system is beneficial justifying the efficiency of the investment since during this period

there were no road accidents with victims causing non-priority to pedestrians when crossing the public road (*Sighişoara City Hall, 2020*).

According to the data of the Sighişoara City Hall from the report on the green light traffic light system, from august 2020, "since the implementation and so far there have been no road accidents with victims on pedestrian crossings in the municipality".

Another smart mobility project related to the municipality of Sighişoara that has been implemented is the one related to the construction of the new railway bridge over Târnava. At the SMART CITY Industry AWARDS 2019, in the SMART MOBILITY category, the SMART INFRASCTRUCTURE subcategory winner was declared the Târnava Sighişoara Bridge Project-railway arch bridge, pan-European Corridor 4.

The technical data of the bridge are: opening – 125 m, length – 134.6 m. The bridge is located on the 300 railway bus Arad – Brasov – Bucharest, the pan-European corridor lV.

In the smart living category, the public lighting system stands out. In 2014, through the Regional Operational Program Priority axis 3-Supporting the Transition to a Low-Carbon Economy, the project on the modernization and expansion of the lighting system in Sighişoara municipality was approved. The project is ongoing and has completion date 28.02.2023. It provides for the modernization of 111 streets and the expansion of the public lighting system on 3 others. At the end of the project there will be 2453 light points equipped with lighting apparatus with led sources. Each led lighting device will have a remote control module and all will be managed from a workstation (Regio-ADRCENTRE). They are designed in such a way as to fit into the architecture of the municipality.

In the same category falls the video surveillance system. The purpose of the system is to ensure the security of people on the public domain in Sighişoara. In September 2020, the work on the investment objective rehabilitation and expansion of Sighişoara video surveillance system was completed. It comprises 55 high-quality surveillance cameras, monitors the entrances and exits of the city with special cameras, intersections, parks, tourist areas inside the fortress, being a monitoring system comprising a data transmission network of an image capture system and a dispatching system for processing and storing information.

Also, in the field of smart living stands out a project for the modernization of the city center submitted by the Sighişoara City Hall for European funding. It is about the urban regeneration project of the historic center of Sighişoara, UNESCO World Heritage site that provides for the rehabilitation and redevelopment of the SIGMA area in the lower City in order to transform it into a pedestrian area, a green space for socializing and organizing outdoor events (Sighişoara City Hall, 2020).

In the smart government category, the WIFI4EU project-promoting internet connectivity in local communities stands out. In May 2020, the WIFI4EU project-promoting internet connectivity in local communities was launched. According to a press release from Sighişoara City Hall, the contract provides for the installation of a wireless network with free access in 26 points in Sighişoara municipality, but the costs will be borne from the voucher accessed from the European Commission platform.

Through the 26 wireless access routers of which 14 located in the fortress area and 12 located inside the administrative and state institutions, thousands of people will have free internet access in public spaces.

The representatives of the City Hall of the Municipality of Sighişoara sent on Monday, September 18, by means of a press release to the media, and the fact that as of this week, it has become a functional system that is implemented in the framework of the project, WiFi4EU the Promotion of internet connectivity in local communities", which provided for the installation of a wireless network to access, free of charge, in 26 points in the city of Sighişoara, the costs of the funds made available to the City of Sighişoara, on the platform of the European Commission.

In the field of smart environment there is the initiative cycling in Transylvania, a program that promotes an environmentally friendly alternative for visiting the surroundings of the municipality.

In the plateau of Târnavelor and Hârtibaciului there is a large territory of Saxon villages, fortified monasteries, traditional dishesand a patriarchal lifestyle that is difficult to find in the world.

For this purpose more than 200 km were arranged. of marked roads connecting the villages of săşesti.

A route that leaves from Sighişoara is to Malancrav which crosses the Breite plateau (31 km). Another route is Sighişoara-Aurel Vlaicu-Viscri (47 km) For both routes you can rent bikes in Sighişoara.

And last but not least, at the smart-economy cateoria for the promotion of tourist attractions in Sighişoara fortress, on July 31, 2013, at the Sighişoara History Museum, the collection of medieval weapons was launched the SM@RT EXPO project. This is a program to valorize the national cultural heritage in the virtual environment. This implies that visitors will access much faster the information for the tourist objective to visit (virtual tour of the exhibition). Also, the museum added additions to the permanent exhibition of images and texts that can be accessed by visitors through smart phones by placing Quick Response Codes.

Establishment of a National Tourist Information and Promotion Centre co-financed by the European Fund for regional development through the Regional Operational Programme 2007-2013 inaugurated in 2014. By establishing this center, Romanian and foreign tourists can discover the historical elements of the architecture of the fortress, hiking trails, bike paths for the surroundings of the municipality.

The center offers tourists who cross its threshold detailed maps of the fortress, tourist and advertising leaflets as well as the info app for smartphone Sighişoara City APP for free download and use.

All the materials that they offer to tourists are free of charge, the financing is from the local budget.

Quantitative analysis on the implementation of the Smart City concept took the form of a questionnaire. The questionnaire was addressed to both the resident population of the municipality and the tourists who visited Sighişoara in the last two years. The questions in the questionnaire were grouped into three categories. In the first category there were questions about the degree of satisfaction of the interviewees for the Smart City measures already implemented. The second type

of questions referred to the perception of the interviewees about future Smart City projects. A third category was given by the open question addressed to the interviewees on suggestions of feasible projects for the studied area in the immediate temporal proximity.

The interview was online, on the Google Forms platform and was conducted between May 20 and June 1 and was accessed by 103 people. According to their statements, 45.6% is resident population and the difference, 54.4%, belongs to tourists who have visited Sighişoara in the last two years.

Of the total respondents, 58 were men and 45 were women.

The structure of respondents by age is shown in the graph above. It is noted that there is a balance between age categories. The least represented age group is over 60 years, which is 7.8%, a phenomenon explained by the lack of access to modern means of communication for older people.

Regarding the degree of education, according to the graph below on the last school graduated, 31 of the respondents declared high school, 5 post-secondary studies, 36 university studies (Bachelor's degree), 14 university studies (Master's degree) and 11 doctoral and post-doctoral studies. Six people said they had completed less than 12 classes.

The questions were about the already implemented Smart City systems (such as the T-PARK app, the traffic light system with synchronous operation to ensure the green light on the portion of the National Road E60 that crosses the municipality, WIFI4EU program, the QR codes and the bicycle rental system for visiting) and about the systems under implementation or the ones who are in need of being completed in the immediate period (such as the expansion of intelligent public lighting and the video surveillance system of public places, as well as the rehabilitation and redevelopment of the SIGMA area in the lower City). Also, there were questions regarding new Smart City systems such as the installation of the air quality monitoring system in real time, the use of VR technology in events related to the medieval fortress. The last question was an open one, about what other Smart City elements could be introduced in the municipality of Sighişoara. The replies received are centralized in a short version in Table 1.

The purpose of the first question was to categorize the interviewees from the point of view of location. Following the centralization of responses, a balanced distribution was found between the number of residents and the number of tourists. Thus, 45.6% declared themselves residents of the municipality of Sighişoara, 43.7% said that they visited Sighişoara in the last year, and for 10.7% the response was more than one year.

The second question concerned the degree of satisfaction regarding how Sighişoara municipality is perceived as an intelligent city. Data centralization is shown in the Appendix section.

The graph shows a good perception of the interviewees on the Smart City concept and the degree of implementation of the systems in Sighişoara. Thus, it is observed that the majority of respondents (61%) have an average to slightly dissatisfied degree of satisfaction, while only 33% declare themselves satisfied or very satisfied. This indicates that the respondents are aware of the concept of Smart City and what it implies, they are aware of the progress made by the authorities in this regard, but they want a greater openness towards this concept and on other areas compared to those already addressed.

The following questions focused on finding out how respondents are satisfied with the degree of implementation of smart systems in the municipality of Sighişoara. The questions concerned T-PARK systems, smart traffic lights on the E60 section that crosses the municipality, the implementation of smart street lighting, QR codes for historical monuments and the WIFI4EU program. The data are presented in the table from the Appendix section.

This table shows the degree of understanding of the above smart systems on a scale from 1 to 5. After calculating the mean, dispersion and standard deviation it is observed that there is no large difference in perception between these systems, the standard deviations being less than 20% from the average of the responses.

The degree of satisfied or very satisfied, being on average 43% shows that these systems require improvements to thank those who use them or who benefit from them.

Next, in the questionnaire, the respondents' desire for the introduction of new Smart City systems was tested. For these there were three questions about the advisability of installing an air quality monitoring system, the expansion of the SIGMA Square pedestrian area as well as the use of VR technology in events related to the medieval fortress. All three proposals were well regarded by respondents, so for each question, 94.2% said they agreed.

Regarding the concept of smart environment, in the questionnaire there was a question about smart tourism involving the use of bicycles to visit the surroundings. 44.7% of respondents said they used rented bicycles, and 30% said they planned to use these means of transport instead of the classic (car).

When we addressed in the interview what measures could still be implemented on the Smart City line, 59 proposals were received, out of a total of 103 questionnaires sent. These responses have been summarized in the table from the Appendix section.

Conclusions

The concept of Smart City is a new paradigm in urban development. They require complex interaction between legislative authorities, administrative authorities, municipal utility and transport companies, and citizens.

Currently, there is support from the European Union, including through non-reimbursable funds that can be accessed by local governments for Smart City development.

Sighişoara is one of the municipalities where the implementation of these concepts has been experienced since 2013. This study was intended to be an image of the current state of implementation of Smart City concepts in Sighişoara and how it is perceived by both residents and those who visit the city.

In quantitative questions regarding the use of different Smart City systems by respondents, the percentage of their use was from 70% for the T-PARK application (in conditions where there were also minors who do not have the right to drive) to 88.3% for those who agree to the expansion of the video surveillance system for public places. Also, on the proposals for the installation of an air quality monitoring system, the redevelopment of the SIGMA area, or the use of VR technology at events in the fortress, the percentage of those who agree was over 94%. Also, to the open question

on proposals for other elements that can be installed in the municipality of Sighişoara, of the 59 responses recorded only three mentioned that Sighişoara is a medieval fortress and Smart City implementations do not fit into the profile of the municipality. Another answer that comes out of the acceptance patterns of the new Smart City technology is related to the question about the use of rented bicycles for the list of surroundings. The percentage of those who used the service is only 44%. Great is the fact that along with them 30% have expressed their intention to use this service provided by the City Hall of Sighişoara.

It should also be mentioned that the open question was answered with a high degree of understanding of Smart City systems such as Siri/Sam applications, interactive panels, iBeacons, which demonstrates that the public is interested in new trends in the development of the city.

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Appendix

Figure 1. The size of the Smart City concept. Illustration: Bratu, D.-P., Adobe InDesign

Figure 2. Smart lighting system. Photo: Bratu, D.-P, 2017, 2019, 2020

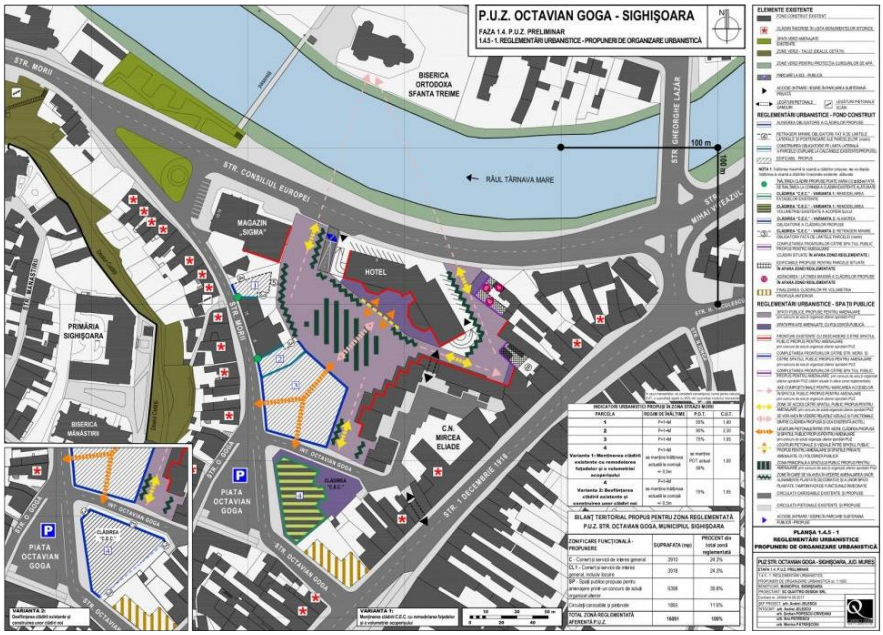

Figure 3. P.U.Z. Sighişoara City Hall

Figure 4. QR code, Sighişoara Fortress. Photo: Bratu D.-P. 2020

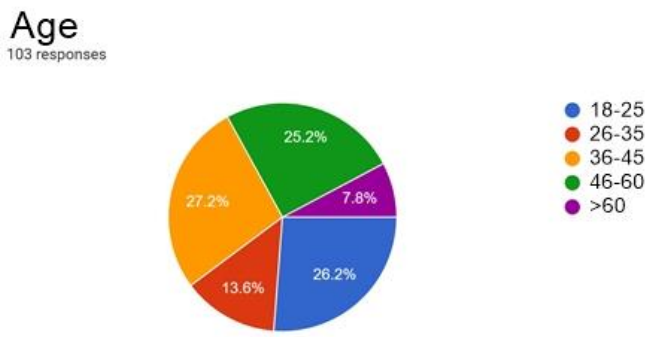

Figure 5. Age of interviewees, Google Forms

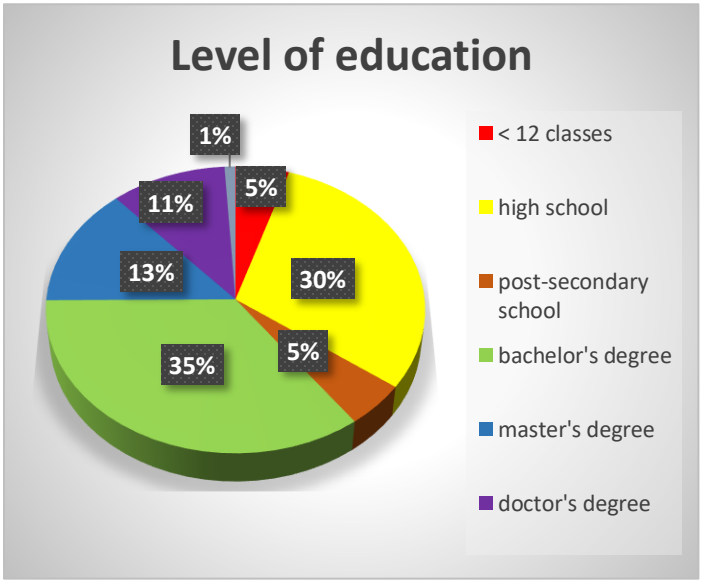

Figure 6. Level of Education. Diagramme: Bratu, D.-P., Microsoft Excel

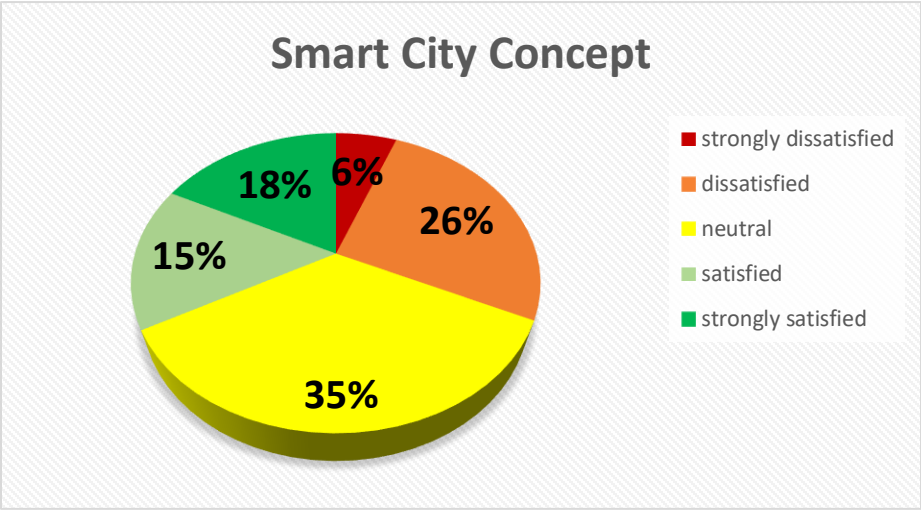

Figure 7. Degree of satisfaction regarding the implementation of Smart City concept in Sighisoare. Diagramme: Bratu, D.-P., Microsoft Excel

Table 1. Satisfaction degree. Bratu, D.-P.

	Satisfaction degree				
	1	2	3	4	5
T-PARK	6.7	30.6	24	18.7	20
TRAFFIC LIGHT SYSTEM	6.8	21.4	26.1	24.3	21.4
INTELLIGENT PUBLIC LIGHTING	6.8	22.3	28.2	18.4	24.3
WIFI4EU	5	18.8	31.2	25	20
QR CODES	7.1	24.7	25.8	21.2	21.2
ARITHMETIC MEAN	6.48	23.56	27.06	21.52	21.38
DISPERSION	0.6	16.0	6.1	7.5	2.5
STANDARD DEVIATION	0.75	3.99	2.46	2.74	1.57
STANDARD DEVIATION, %	12	17	9	13	7

Table 2. Smart City domains and proposals. Bratu, D.-P.

Smart City domain	Proposals
smart-living	digitization and transparency in local education
	expansion of the video monitoring system
	application to measure water flow in the main points of the city
	touch-screens around the city
smart-environment	initiatives on the introduction of mandatory weekend pedestrian zones for certain historic areas of the city
	campaign to restore and expand where possible the existing green structures in the municipality
	application that allows users to adopt certain elements of the city (trees, trash containers) for awareness of keeping cleanliness in the city
	installation of solar panels or gardens on the roofs of administrative institutions
smart-government	digitization in administration
	facilitating access to administrative documents by improving the Town Hall website
	interactive panels for citizens' opinion polls on official initiatives
	chat application to facilitate the connection with the City Hall
	application for reporting city infrastructure issues to local government
smart-mobility	application on the management of the bicycle park provided by the City Hall of Sighisoara for trips in the surroundings
	application for signaling traffic accidents or traffic jams within the radius of the municipality
smart-economy	extending QR codes for HORECA units
smart people	introduction of iBeacon technology for transmitting relevant information about locations, products and events
	updating the SighisoaraCityApp app
	Siri / Sam-like application that provides real-time information for tourists about their location and surroundings
NO Smart City	Sighisoara must remain medieval.