

**Czech University of Life Sciences Prague**

**Faculty of Economics and Management**

**System Engineering and Informatics**



**Master's Thesis**

**Smart City Concept Implementation Strategy in Tbilisi**

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# **DIPLOMA THESIS ASSIGNMENT**

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Systems Engineering and Informatics  
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Thesis title

**Smart City Concept Implementation Strategy in Tbilisi**

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## **Objectives of thesis**

The main goal of the thesis is to create a strategy for the implementation of the Smart City concept for the capital of Georgia – Tbilisi. The existing elements of a smart city in various sectors of Georgia's environment will be analyzed, and then, based on successful examples of the concept implementation around the world, a strategy will be created that corresponds to the specifics of the country.

## **Methodology**

In the theoretical part will be used comprehensive research of professional literature, various articles, statistics, case studies, and professional reports from various governmental and non-governmental inter-national organizations. The theoretical part will also include a comparison and analysis of individual cities in Europe, Asia, and America, which have successfully implemented elements of the Smart City concept in various sectors, thus improving the quality of life of citizens.

In the practical part will be used empirical research methods – analogy, analysis, and synthesis. As part of the quantitative research, a questionnaire survey will be conducted and the results of the survey will help find answers to research questions and create a concept proposal for the city of Tbilisi.

## The proposed extent of the thesis

50-60

## Keywords

Smart City, digitalisation, green city, smart mobility, smart economy, smart governance, smart people, smart environment, smart living, innovation, security.

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## Recommended information sources

ALBINO, Vito, Umberto BERARDI a Rosa DANGELICO, 2015. Smart Cities: Definitions, Dimensions, Performance, and Initiatives. ISSN 10630732

AMERI, Renata Paola. Smart city implementation: creating economic and public value in innovative urban systems. ISBN 978-3-319-45765-9.

MONTGOMERY, Charles. Happy city: transforming our lives through urban design. First edition. New York: Farrar, Straus and Giroux. ISBN 978-1-4299-6953-6

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## **Declaration**

I declare that I have worked on my master's thesis titled "Smart City Concept Implementation Strategy in Tbilisi" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the master's thesis, I declare that the thesis does not break any copyrights.

In Prague on 2022

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I would like to thank Ing. Jana Pitrová, Ph.D and my mother, for their advice and support during my work on this thesis.

# Smart City Concept Implementation Strategy in Tbilisi

## Abstract

The idea of the "Smart City" has gained popularity recently and is now influencing both major and small cities' urban planning efforts significantly. With the use of various technologies, the potential for improving living circumstances, and the ability to create a protected environment, local authorities, businesses, non-profit organizations, and citizens themselves have embraced the Smart City notion to solve the mounting difficulties of metropolitan areas. The need to deal with more difficult and complicated issues brought on by cities getting bigger and the desire to get more out of city life are powerful forces that they support more active study into the Smart City concept. Local governments are attempting to establish smart prototype cities or at least intelligent programs, while academic scholars are still striving to comprehend exactly what makes up a smart city..

It seems that creating Smart Cities is an integral part of the future. Some technical solutions are very useful and their implementation in everyday life has, of course, undeniable advantages. However, smart technologies also have major disadvantages. This negative should be eliminated or at least minimized before the massive construction of smart cities. Since this idea is still so novel, the effects of technology on people have not yet been thoroughly examined. We won't begin to notice other effects of this process for some time.

**Keywords:** Smart people, a smart environment, smart living, innovation, and security, digitalization, green cities, smart mobility, and smart economies.

# Strategie implementace konceptu Smart City v Tbilisi

## Abstrakt

V posledních letech si myšlenka „chytrého města“ získala popularitu po celém světě a měla velký dopad na urbanistické plány ve velkých i malých městech. Obce, podniky, neziskové organizace a dokonce i jednotliví lidé přijali koncept „chytrého města“, který využívá různé technologie ke zlepšení životních podmínek a ochraně životního prostředí, aby se vypořádal s narůstajícími problémy v metropolitních oblastech. Nutnost řešit náročnější a složitější problémy, které rozšiřující se města představují, stejně jako touha vytěžit z městského života maximum jsou silnými motivy pro aktivnější výzkum myšlenky Smart City. Zatímco akademičtí odborníci se stále snaží definovat, co přesně dělá chytré město, místní samosprávy se pokoušejí vytvořit inteligentní prototypová města nebo alespoň chytré iniciativy.

Zdá se, že zakládání Smart Cities je nedílnou součástí budoucnosti. Některá technická řešení jsou velmi užitečná a jejich implementace do běžného života má samozřejmě nepopiratelné výhody. Chytré technologie však mají i velké nevýhody. Toto negativum by mělo být eliminováno nebo alespoň minimalizováno před masivní výstavbou chytrých měst. Tento koncept je stále tak novou záležitostí, že vliv technologií na lidstvo ještě nebyl plně prozkoumán. Ještě nějakou dobu potrvá, než uvidíme další důsledky tohoto procesu.

**Klíčová slova:** Smart City, digitalizace, zelené město, chytrá mobilita, chytrá ekonomika, chytrá správa, chytrí lidé, chytré prostředí, chytré bydlení, inovace, bezpečnost.

# Table of content

<b>1. Introduction .....</b>	<b>7</b>
<b>2. Objectives and Methodology .....</b>	<b>8</b>
2.1 Objectives.....	8
2.2 Methodology .....	8
<b>3. Literature Review .....</b>	<b>9</b>
3.1. Overview of Smart City Concept.....	9
3.1.1 Different definitions of the Smart City concept.....	10
3.1.2 Basic characteristics of a Smart City concept.....	11
3.1.3. Reasons for the importance of the Smart City concept .....	12
3.2. Comparative studies of the successful implementation of the concept.....	13
<b>3.2.1</b> Successful examples from North America.....	<b>13</b>
3.2.2 Successful examples from Asia.....	16
3.2.3. Successful examples from Europe .....	19
3.2.3. Challenges and opportunities in creating Smart Cities .....	22
<b>4. Practical Part .....</b>	<b>25</b>
4.1 Implementation of intelligent solutions in the Georgian environment .....	25
4.1.1 Analysis of the current situation in Georgia (in regards to Smart Cit).....	25
4.1.2 Citizen questionnaire survey .....	29
4.1.3 Interview with an analyst from the I.T.D at TBC Bank .....	38
<b>5. Results and Discussion.....</b>	<b>41</b>
5.1 Proposal of Smart City concept for the city of Tbilisi.....	41
5.2 Summary and analysis of work results .....	47
<b>6. Conclusion .....</b>	<b>50</b>
<b>7. References .....</b>	<b>52</b>
<b>8. List of pictures, tables, graphs and abbreviations .....</b>	<b>54</b>
8.1 List of graphs .....	54
<b>Appendix .....</b>	<b>55</b>



# 1. Introduction

The idea of the "Smart City" has gained popularity recently and is now influencing both major and small cities' urban planning efforts significantly. With the use of various technologies, the potential for improving living circumstances, and the ability to create a protected environment, local authorities, businesses, non-profit organizations, and citizens themselves have embraced the Smart City notion to solve the mounting difficulties of metropolitan areas. The need to deal with more difficult and complicated issues brought on by cities getting bigger and the desire to get more out of city life are powerful forces that they support more active study into the Smart City concept. Local governments are attempting to construct smart prototype cities or at least intelligent projects while academic experts are still striving to comprehend exactly what makes up a smart city.

Understanding what constitutes a smart city and what initiatives fall under that category is crucial. Determining the accepted definition is moreover the first step for any city in developing its own vision for the smart city plan and a thorough framework for the smart city that can connect all projects and efforts. A system of objectives for smart cities must be built on the concept and complete framework of smart cities.

The multidisciplinary nature of the smart cities initiative necessitates the establishment of a set of objectives. The most crucial role in establishing the objectives of smart cities and developing the best plan belongs to the citizens. Both the planning stage and the processes leading up to the concept introduction should involve them. This makes ongoing communication between government officials and residents, as well as raising public knowledge of the benefits of smart cities, essential.

This work provides a general overview of the Smart City concept and will focus on its most important aspects that should have a positive impact on city management and at the same time help reduce costs, streamline processes in the city and improve the living conditions of the city's citizens.

## **2. Objectives and Methodology**

### **2.1. Objectives**

The existing element of a smart city in various sectors of Georgia's environment will be analysed, and then, based on successful examples of the concept implementation around the world, a strategy for the implementation of the Smart City concept for the capital of Georgia – Tbilisi will be created that corresponds to the specifics of the country. This thesis will mainly be an overview and the proposal for the city and will mainly contain a description of individual measures, suitable activities, and services within the Smart City concept.

### **2.2. Methodology**

The work is divided into four basic chapters, of which the first two are theoretical and the other two are practical. In the theoretical part will be used comprehensive research of professional literature, various articles, statistics, case studies, and professional reports from various governmental and non-governmental international organizations. The theoretical part will also include a comparison and analysis of individual cities in Europe, Asia, and America, which have successfully implemented elements of the Smart City concept in various sectors, thus improving the quality of life of citizens. The practical part of the thesis is divided into two chapters.

The first chapter of the practical part is devoted to the analysis of the current situation in Georgia - what is the level of implementation of intelligent solutions in the Georgian environment in various sectors? Therefore in the practical part will be used empirical research methods – analogy, analysis, and synthesis. As part of the quantitative research, a questionnaire survey will be conducted, and based on a questionnaire survey, will be evaluated how the residents of Tbilisi are aware of the mentioned concept, how satisfied they are with individual services in the city, and what would change in the city administration. The information obtained will be analyzed and subsequently, a series of recommendations will be made for the city in which direction to develop infrastructure, protect the environment and how achieve socio-economic benefits and savings, support the sustainable development of the entire city and improve living conditions for city dwellers..

### **3. Literature Review**

#### **3.1. Review of Smart City Concept**

The Smart City concept has become a new trend in the global development of cities in the 21st century. The first academic work on Smart City was published in 1992, and the CEO of IBM introduced this concept in 2008. Then in 2010, IBM launched the Smart Cities Challenge. Smart City's concept is currently being developed around the world by academics, governments, and the private sector.<sup>1</sup> However, technologies have been helping in the daily lives of people in cities for a long time. In Los Angeles, for example, already in 1950, every piece of property in the city was monitored and analyzed using computer data, and in the 1960s, has begun the process of collecting data, creating reporting on neighboring demographic indicators, and on the quality of housing.

However, Smart City was not the initial term of the concept. In the literature, the term Web or Virtual City was first introduced in 1997, when the potential of the Internet was used to support local democracy, new types of electronic communal services, the local interconnection between companies and communities, and development within cities.<sup>2</sup>

The term Digital City mentions other work, presented a year later. The first implementation of the Digital City concept was carried out in Amsterdam in 1994. The penetration of the Internet in the city was successful and the citizens gradually adapted to it. Virtual, Digital, and Intelligent cities all have focused on creating communities using information and communication technologies in an effort to socialize people and democratize local governments. The concept of the Digital City has become synonymous with the Information city. It was seen as a metropolitan environment where ICT is a key driver in providing innovative online services.

The term Digital or Information City was later replaced by the term Intelligent city and it focuses on the city's performance in the production of innovation in the following three dimensions:

- (1) intelligence, ingenuity, and creativity;
- (2) collective intelligence and
- (3) artificial intelligence.

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<sup>1</sup> What exactly is a smart city? Blog de Bismart, Información sobre Big Data, Artificial Intelligence, BI. (n.d.). Retrieved December 7, 2022, from <https://blog.bismart.com/en/what-is-a-smart-city>

<sup>2</sup> Haleboua, G. R. (2020). Smart cities. MIT Press.

Furthermore, the term Smart City is already being used, which combines all the previous concepts.<sup>3</sup>

### **3.1.1. Different definitions of the Smart City concept**

There is still no uniform definition of a Smart City. The presentation of this concept varies from case to case, but all definitions have two elements in common: the human aspect - people as key players - and information and communication technology (ICT), which plays a key role in the Smart City concept.

- Definition according to the document of the Ministry for Urban Development of the Czech Republic.

"Smart Cities can be seen as the application of information and telecommunications technologies in the energy sector and in the transport sector, on the basis of which progress will be reduced energy and resource consumption, upgrading and interconnection of transport systems and mobility, and all this on the assumption of the use of modern information and communication systems.

- Definition according to the EU Digital Agenda

‘Smart Cities’ integrate various technologies to lessen harmful environmental effects and improve the quality of life for residents. There is no one special notion for a solution, but organizational change in local management and even in society as a whole is required. Making the city smart is a multidisciplinary solution that involves city managers, cutting-edge vendors, strategists from the national and EU levels, the academic community, and civic society’.<sup>4</sup>

- European Innovation Partnership on Smart Cities and Communities' defines Smart city as

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<sup>3</sup> Smart cities. European Commission - European Commission. (2022, October 3). Retrieved December 7, 2022, from [https://ec.europa.eu/info/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives/smart-cities\\_en#:~:text=A%20smart%20city%20is%20a,resource%20use%20and%20less%20emissions](https://ec.europa.eu/info/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives/smart-cities_en#:~:text=A%20smart%20city%20is%20a,resource%20use%20and%20less%20emissions).

<sup>4</sup> Handbook of Research on developing Smart Cities based on Digital Twins. (2021). Advances in Civil and Industrial Engineering. <https://doi.org/10.4018/978-1-7998-7091-3>

“A system of people interacting, utilizing, and funding sustainable economic development, resilience, and high quality of life should be included when defining smart cities. When information and communication infrastructure and services are strategically used in open processes of spatial planning and management that address the social and economic needs of society, these flows and interactions become intelligent”

- Smart Cities Council defines smart city as

" A city is considered smart if digital technology are interwoven into every aspect of city life."<sup>5</sup>

### **3.1.2. Basic characteristics of a Smart City concept**

What makes a city smart? How is it possible to define the city's intelligence and measure it? Many cities around the world claim to be more or less intelligent. In an effort to overcome the sometimes-incorrect classification of the Smart City category, experts have developed various models and criteria of the city to identify the Smart City and to measure the progress made in this area. Scientists agree that cities can be classified as smart if they have the following characteristics: a smart economy, smart transportation system, a smart environment, a smart population, a smart way of life, and a smart government, despite the fact that there is no universal agreement on the definition.<sup>6</sup>

1. Smart economy-the goal of the "smart economy" is to alter and enhance the local economy while also enhancing the city's business climate and attracting start-ups, investors, and new (highly qualified) personnel. An intelligent economy will experience sustainable and inventive growth. Increasing competition is the main objective. Economic development is a result of utilizing digital technologies and clever strategies, and this wealth in turn produces stable and beneficial conditions for all parties involved. According to the government, "intelligent economic development" is a crucial tool for aggressively seizing opportunities and creating environments that are favorable to new business startup and growth as well as job creation.

2. Smart transport - in order to promote the use and adoption of innovative mobility solutions and boost people's mobility through efficient mobility management and targeted infrastructure

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<sup>5</sup> E-book: Smart cities. Home Page. (n.d.). Retrieved December 7, 2022, from <https://www.norton.com/books/smart-cities/>

<sup>6</sup> E-book: Building a future Ready City. Smart Cities World. (n.d.). Retrieved December 7, 2022, from <https://www.smartcitiesworld.net/ebooks/e-book-building-a-future-ready-city>

investments, smart transport focuses on improving the efficiency and quality of urban transportation services. The most crucial objective is to achieve more integrated, faster, more affordable, and environmentally friendly mobility in the city. An important component of the strategic approach to intelligent mobility is encouraging the combination of various public and private transportation modes as well as the adoption of new forms of transportation (such as electric and hydrogen vehicles, autonomous vehicles, bicycle sharing, and carpooling/carsharing).

3. Smart environment - is one that provides residents and tourists with comfortable living conditions. Utilizing new technologies and creative methods, cutting product waste, monitoring and regulating pollutants, lowering emissions, managing water resources, attaining energy efficiency, and limiting environmental harm are all important objectives in creating a smart environment.

4. Intelligent people - can develop their talents, pursue intelligent types of education, engage in lifelong learning opportunities for all ages, record demographic information, and use intelligent technologies in a variety of contexts.

5. Smart living - the major goal of smart living is to improve people's quality of life, taking into account the requirements of all age and demographic groups. The two key elements for maximizing the advantages for the city administration and all city residents are facilitating and improving living circumstances and optimizing environmental management. The improvement of social and digital inclusion (such as the use of electronic services, connection, and social platforms), the improvement of the standard of elder care, security, housing, and smart buildings are all key components of smart living.

6. Smart government - focuses on improving the connections and interactions between the government and all stakeholders, including the general public, corporations, and other civil society organizations. Using a new approach, implementing cutting-edge technologies and innovations, and enhancing efficiency and transparency in service delivery are all examples of smart governance.<sup>7</sup>

### **3.1.3. Reasons for the importance of the Smart City concept for individual cities and for the whole world**

The Smart City concept is and will be one of the most important challenges in the next few decades. Today, 55% of the world's population lives in urban areas, and this figure is expected to increase to 68% by 2050. The gradual shift of population from rural to urban areas, together with the overall growth of the world population, could bring an additional 2.5 billion people to urban

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<sup>7</sup> Measuring smart cities' performance - OECD. (n.d.). Retrieved December 7, 2022, from <https://www.oecd.org/cfe/cities/Smart-cities-measurement-framework-scoping.pdf>

areas. The mass concentration of individuals in cities creates many opportunities, but also brings with it a large number of problems related to pollution, poverty, security, cost of living, mobility, etc. Therefore, it is important today to promote sustainable urban development and transform cities in such a way that they do not harm the environment and life in them was pleasant and easy.

Another reason why cities should be transformed into smart ones is the global trend – the aging of the population. Globally, the number of people over 60 should double by 2050 and by 2100 more than triple. And therefore cities should be prepared for this change and should be able to offer services and products according to the needs of all segments of the population.

In addition, the implementation of the Smart City concept brings many opportunities, such as:

- cost savings,
- impacts on the environment,
- increase in efficiency,
- connection,
- quality of life,
- economic well-being.<sup>8</sup>

## **3.2. Comparative studies of the successful implementation of the Smart City concept in the world**

The following chapter introduces and analyzes the individual cities in which the Smart City concept is implemented. Each city has its own focus and approach to the concept of a Smart City, which is usually related to geographical, economic, and demographic characteristics as well physical and social capital

### **3.2.1. Successful examples from North America**

According to research by the Eden Strategy Institute, 12 of the top 20 smartest cities in the world were located in the US. I chose Seattle, New York City, and San Francisco from a list of the best smart cities in North America. I'll go over a few of the clever projects that these cities have to offer down below. These cities were selected on the basis of population (less than 1 million and more than 5 million). On the basis of these illustrations, I hoped to demonstrate that cities of any size may successfully execute the idea of a smart city.

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<sup>8</sup> Smart Cities—Opportunities and challenges. (2020). Lecture Notes in Civil Engineering.<https://doi.org/10.1007/978-981-15-2545-2>

## *Seattle*

Seattle, the largest city in Washington, is a hub for the technology sector. Here are located several of the top corporations in the globe, including Amazon and Microsoft. The city is bordered by lakes, mountains, evergreen forests, and parks, nevertheless. 725,000 people call it home. According to the idea of a "Smart City," the city places a strong emphasis on data-driven innovation and efficiency, as well as on citizen security and privacy.

A few initiatives centered on the Smart City idea:

- MetroLab: White Huse program launched in 2015 as part of Smart City, fosters collaborations between universities and cities to establish "living labs" for testing technological solutions across the nation.
- Comprehensive Municipal Privacy Program: A framework that outlines the obligations and demands of municipal authorities with regard to the management and use of data, based on a fundamental set of privacy principles.
- Start-up Center: Seattle is one of the most significant North American startup hubs, in part due to the fact that it is the only city in the continent to have more than 1,000 open data files. Transparency is unquestionably one of the most crucial factors in the process of fostering the expansion of start-ups, particularly those that develop technology and applications that enhance urban mobility and quality of life.<sup>9</sup>

## *New York City*

On the east coast of the United States, near the southernmost point of the state of New York, is one of the most prominent intelligent cities in North America as well as the entire world. The city is well-known for its stunning buildings, popular tourist destinations, and expansive Central Park. 8,622,698 people call it home. The city prioritizes tight data standards and cutting-edge smart sustainability as part of the Smart City concept.

A few initiatives centered on the Smart City idea:

- A strong overarching vision: Sustainability is a goal of Mayor Michael Bloomberg's PlaNYC 2030 plan. The strategy addresses many of the issues brought on by a growing population

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<sup>9</sup> Smart cities in the United States: Which ones are making it to the top and their peculiarities. Tomorrow.City - The biggest platform about urban innovation. (n.d.). Retrieved December 7, 2022, from <https://tomorrow.city/a/smart-cities-united-states>



and deteriorating infrastructure, as well as providing solutions for the growth of transportation systems using smart technologies.

- **Citizens 'Data:** The City of New York has put in place a variety of programs that encourage the ethical handling and use of citizen data. For instance, the city of New York (NYC) has created a set of Internet of Things (IoT) regulations that establish privacy requirements for the installation of IoT devices in public areas. A working group must be established by the city to oversee the use of algorithmic decision-making systems in the public sector, according to legislation that was just introduced.<sup>10</sup>
- **Wi-Fi City:** Users of New York's public transportation must have access to cell networks in addition to the city's free public Wi-Fi (at four major wireless operators in the United States: AT&T, Sprint, T-Mobile, and Verizon). Additionally, there is free WiFi available in every metro stop. On the city's streets, there is a network of public Wi-Fi kiosks with charging ports and information portals.
- **Open Data:** More than 2,400 databases are accessible to the public in New York.
- **Indoor lighting innovation:** To improve the sustainability of building lighting, the New York City administration introduced the Accelerated Conservation and Efficiency (ACE) initiative in 2013. More than 650 buildings operated by 16 local organizations had their LED lighting upgraded thanks to a program that provided \$350 million in funding. This scheme is anticipated to save more than \$ 800,000 a year and cut greenhouse gas emissions by about 900 tons.
- **Air Quality Monitoring:** Since 2008, the NYC Department of Health and Mental Hygiene has begun measuring air quality. 75 temporary monitoring stations were used in the survey, which collected vital information that will help the NYC government implement effective air quality improvement initiatives. For instance, the program discovered that the use of low-quality heating oil by a number of buildings pollutes the air more than all the automobiles in the city put together. The use of several different types of oils was prohibited after this fact was discovered.<sup>11</sup>

## ***San Francisco***

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<sup>10</sup> Smart America: Smart Cities USA. Smart America RSS2. (n.d.). Retrieved December 7, 2022, from <https://smartamerica.org/teams/smart-cities-usa/>

<sup>11</sup> Top 10 smart cities in America for 2022: Which should you move to? - . smartcity tech. (2022, April 13). Retrieved December 7, 2022, from <https://www.smartcitytech.eu/home/top-10-smart-cities-in-america-for-2022-which-should-you-move-to>

Silicon Valley is well-known in San Francisco. On the American west coast, it can be found in northern California. It is both one of the most significant smart cities in the area and the city with the second greatest population density in North America. It is home to 870,887 people. The city places a great emphasis on start-up enterprises, the Internet of Things, and citizen involvement as part of the Smart City idea.

Some projects within the Smart City concept:

- **Startup Support:** Many of the most well-known technological startups in the world, including Airbnb, Craigslist, Uber, Lyft, Dropbox, and Twitter, are based in San Francisco. The Mayor's Office for Civic Innovation supports startups with a lot of potential..
- **Smart Urban Development:** San Francisco is a pioneer in smart urban development and is consistently placed well in the US Green Cities index (in 2019 it ranked second). The San Francisco Planning Department started a program in 2012 that focuses on four distinct urban "eco-districts" with the intention of lowering greenhouse gas emissions, trash, water use, and energy use. This program has led to the construction of 302 LEED-certified buildings in San Francisco. The city was the first in America to outlaw plastic bags. There are bins for sorted waste at every city store, eatery, campus, and apartment complex. One of the biggest food waste and composting systems in the country has been implemented in San Francisco since 2009. Compared to 2018, greenhouse gas emissions have reduced by 12% since 1990. San Francisco has been attempting to cut its water consumption for many years, and as a result, the city's average daily water consumption has dropped to just 49 gallons. The national average is 80 to 100 gallons of water each day, for comparison. Such positive outcomes have been made possible not just by the residents' individual commitment to water conservation, but also by the free water-saving amenities that the city provides to citizens and businesses.
- **Creating a safer, more efficient, and environmentally friendly transportation system** is the goal of a project being worked on by the San Francisco City Transportation Agency (SFMTA).<sup>12</sup>

### **3.2.2. Successful examples from Asia**

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<sup>12</sup> US smart city industry 2022-2026. ReportLinker. (n.d.). Retrieved December 7, 2022, from <https://www.reportlinker.com/report-summary/Smart-City/163491/US-Smart-City-Industry.html>

Currently, urbanization is a major issue throughout Asia. Over the next 20 years, 1.1 billion people are anticipated to relocate to Asian cities. Additionally, a large number of Asian nations are situated in regions with harsh environmental conditions that are getting worse due to climate change. Cities across the continent must get ready for rapid population increase as well as the threats that come with it. Because of this, most Asian cities have made becoming more sustainable and intelligent a top priority on their legislative agendas.

Currently, urbanization is a major issue throughout Asia. Over the next 20 years, 1.1 billion people are anticipated to relocate to Asian cities. Additionally, a large number of Asian nations are situated in regions with harsh environmental conditions that are getting worse due to climate change. Cities across the continent must get ready for rapid population increase as well as the threats that come with it. Because of this, most Asian cities have made becoming more sustainable and intelligent a top priority on their legislative agendas.

### ***Osaka, Japan***

On the Japanese island of Honshu, Osaka is a commercial hub with a sizable port. It is renowned for its cutting-edge architecture, vibrant nightlife, and filling street fare. 2,691 million people call it home. The city places a strong emphasis on smart homes and recycling as part of the "Smart City" concept.

A few initiatives centered on the Smart City idea:

- **Public transport:** The extensive, high-quality, and modern metro system encourages city dwellers to actively use the service.
- **Basic environmental strategy:** By developing a low-carbon society, a recycling business, and a more sustainable urban environment, the city administration hopes to put into practice a sustainable metropolitan model. To do this, the government works to increase public awareness of global warming, put new CO2 emission-reduction policies into place, create low-carbon urban environments, etc. To actively track air pollution, Osaka utilizes a method. The government wants to promote the involvement of all community stakeholders in initiatives to put smart city solutions into practice.
- **Smart Home Technology:** The City Council has been putting the Smart Home project into action since 2011, working with Osaka Gas to combine clean energy solutions with an

internal energy management system. Electric vehicles and a solar heating system will be integrated as part of this project.<sup>13</sup>

### ***Seoul, South Korea***

South Korea's national capital The vast city of Seoul combines traditional Buddhist temples, palaces, and street markets with contemporary skyscrapers, cutting-edge public transportation, and a variety of fashion styles. 9,861 million people call it home. The goal of the Smart City concept is to use modern technology to make city life as precise and efficient as possible.

Some projects within the Smart City concept:

- **Conducting research:** Due in large part to its role as a "living laboratory" for experimentation in other cities, Seoul is regarded as a pioneer and leader in the creation of smart cities. The emphasis on technology permeates almost every facet of public life in Seoul, from an online government emergency warning system to a comprehensive public transportation network. The city administration started providing inhabitants with various information in March 2013 using the GPS capabilities of cellphones, such as information about the whereabouts of free Wi-Fi zones, accessible amenities, and much more.
- **Smart Devices and Digital Inclusion:** The city administration started giving out used smart devices to low-income families and other people in need in 2012. Additionally, the government grants a tax benefit of between \$50 and \$100 for old donated devices as part of an incentive program that encourages individuals to contribute old equipment when purchasing new equipment. The government has been providing training programs for anyone who want to learn how to use smart technology since 2009. Most frequently, immigrants, low-income individuals, and elderly individuals who are not tech-savvy enroll in these courses. More than 47,000 people took these courses between 2009 and 2011. The city administration is currently putting together more challenging courses that will let individuals take part in enhancing the city's intellectual services..
- **Rechargeable roads:** Online Electric Vehicle Technology is used on Seoul's roads (OLEV). As a result, automobiles can wirelessly recharge from the road surface while being driven.
- **Safety for the general public:** The Seoul Security Service, which was established in April 2008, covered handicapped individuals, young children, the elderly, and those suffering

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<sup>13</sup> Asian smart city industry 2022-2026. ReportLinker. (n.d.). Retrieved December 7, 2022, from <https://www.reportlinker.com/report-summary/Smart-City/163495/Asian-Smart-City-Industry.html>

from Alzheimer's disease. It is easier to provide aid to such people when authorities and family members are both aware of their location in the event of an emergency.<sup>14</sup>

## *Singapore*

Singapore is a sovereign city-state situated on the Southeast Asian island of the same name. It is a major financial hub recognized for its cutting-edge structures, first-rate public transit, immaculate streets, tropical climate, diverse population, and dedication to sustainable development. 5.6 million people call it home. The Internet of Things and technological innovation are the city's main priorities as part of the Smart City idea.

a few initiatives centered on the Smart City idea:

- Using IoT to enhance public services: In order to become a pioneer in the creation of Internet of Things standards, the government created the Singapore-Smart Nation initiative in 2014. Singapore has implemented numerous IoT projects across a number of city functions. One such is the sensors put in every Singaporean bus that have assisted in easing the city's congestion issue. The city also intends to launch driverless minibuses..
- Innovation in the water system: Singapore has always relied on Malaysia for its needs in terms of clean drinking water. Singapore today has more than 100 businesses that sell its water collecting and recycling technologies globally for \$ 370 million in yearly sales as a result of encouraging innovation in the water sector.
- Digital governance and civic participation: Singapore has a dedicated digital government agency that collaborates closely with numerous organizations in the fields of housing, security, health care, and the environment. These agencies' expertise can be used to construct a variety of pilot applications successfully. These include the OneService portal, which enables citizens to communicate with city authorities about local issues.<sup>15</sup>

### **3.2.2. Successful examples from Europe**

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<sup>14</sup> Discover how accessible ICT Benefits Smart Cities. Smartcities4all. (n.d.). Retrieved December 7, 2022, from <https://smartcities4all.org/>

<sup>15</sup> Smart city projects flourish in Asia-Pacific amid uptick in public interest. GovInsider. (2022, August 16). Retrieved December 7, 2022, from <https://govinsider.asia/connected-gov/smart-city-projects-flourish-in-asia-pacific-amid-uptick-in-public-interest/>

Most people familiar with the term Smart City remember typical examples, such as Amsterdam, Barcelona, Toronto, and Vienna. In my opinion, however, it is important to highlight innovative projects and smart solutions implemented in lesser-known cities around the world, and not just in the world's major cities, which are leaders in this field. Below I will briefly describe some large and small smart cities, which, regardless of their size and location, are trying to become "smarter" for the benefit of their citizens. <sup>16</sup>

### ***Groningen, Netherlands***

The eighth largest city in the Netherlands, located in the north of the country, was originally known for its Gothic church and historic architecture. Now it also appears on the map as the center of the smart cities of the Netherlands. The population is approximately 9 million. As part of the Smart City concept, the city focuses on healthy population aging and intelligent energy systems. Groningen is sometimes referred to as the city of "smart users" or "city of talents". <sup>17</sup>

Some projects implemented within the Smart City concept:

- Intelligent streetlights: These new street lights dim and brighten as someone passes/walks by.
- Intelligent traffic lights: The intelligent vehicle traffic control system combines traditional traffic lights with a range of sensors and artificial intelligence for efficient vehicle and pedestrian routing.
- Smart grids: Energy-intensive appliances such as washing machines can only be switched on / used if there is enough solar energy available.
- Open data portal of the city: Citizens have access to data on everything essential for the city: from energy and transport to waste capacity. This information can be used to create useful smart city applications.
- Development of customer service centers: With their help, citizens can get better and more uniform answers to questions, regardless of the channel they communicate with the city (for example, face-to-face meetings, telephone, e-mail, chat, or letter).

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<sup>16</sup> Alavi, A., & Buttler, W. G. (2019). Data Analytics for smart cities. CRC Press, Taylor & Francis Group.

<sup>17</sup> Global smart city industry 2022-2026. ReportLinker. (n.d.). Retrieved December 7, 2022, from <https://www.reportlinker.com/report-summary/Smart-City/163490/Global-Smart-City-Industry.html>

- Public Transport Scheduler: A mobile phone application that provides real-time public transport information, such as bus timetables, movements, etc.
- Improving services for entrepreneurs: creating Groningen business centers, it improves the way services are provided to entrepreneurs.<sup>18</sup>

### ***Hamburg, Germany***

Hamburg is the main port city and the second-largest German city in the north of the country. The population is 1.8 million. As part of the Smart City concept, the city focuses on the aggregation and analysis of data collected by sensors and the use of this information for the benefit of the population.

Some projects within the Smart City concept:

- Smart Port: Thanks to various sensors and cameras, Hamburg is trying to optimize the infrastructure and port traffic management systems, and improve security and environmental conditions.
- HAFEN City: The newest city block in Hamburg is already the largest European urban development project in Europe and continues to evolve. Pilot projects are focused on the reduction

and optimizing operations and creating intelligent property management solutions.

- Stadtrad Hamburg: a bicycle-sharing project that Hamburg officials say is the most successful in Germany. As part of this project, it is available in most areas of the city bicycle for 30 minutes free.
- eGovernment: The Hamburg Road Licensing Division is one of the first to introduce eGovernment. Since 2014, visitors can book their appointments online, saving a lot of time.

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### ***Riga, Latvia***

Riga is the capital of Latvia. Located on the Baltic Sea, at the mouth of the Daugava River, it has long been known to be a cultural center and also home to many museums and concert halls.

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<sup>18</sup> Big Data Analytics for smart and connected cities. (2019). Advances in Civil and Industrial Engineering. <https://doi.org/10.4018/978-1-5225-6207-8>

<sup>19</sup> Deakin, M., & Waer, H. A. (2014). From intelligent to Smart Cities. Routledge.

The population is 650,000. As part of the Smart City concept, the city focuses on optimizing energy consumption and production.

Some projects within the Smart City concept:

- Remote voltage control, programmable LED street lighting with the ability to set different lighting settings for different times of the day.
- Smart meters, which include a connection link for remote data reading, are one way that energy management in public and apartment buildings is being improved. A database based on Q was made for Riga residential structures. The city's central district heating system then receives these heat usage data automatically..
- Biogas generated locally.
- Flye gas and cooling stream heat recovery in power plants.
- Water heat recovery, which enables you to conserve heat in residential structures with multiple apartments.<sup>20</sup>
- City buildings with solar batteries on the roofs.
- Electric vehicles for the delivery of technical municipal services.
- In Europe, Riga boasts the most free Wi-Fi spots per square kilometer..
- Riga offers its citizens and visitors electronic public transport tickets. Electronic tickets are a cashless payment solution, providing a modern and easier payment system. The electronic ticketing system works on all means of Riga's public transport.<sup>21</sup>

### **3.2.4. Challenges and opportunities in creating smart cities**

As we see today, creating smart cities is an integral part of the future. Some technical solutions are very useful and their implementation in everyday life has, of course, its undeniable advantages. However, smart technologies also have major disadvantages. This negative should be eliminated or at least minimized before the massive construction of smart cities.

It is obvious that there will be no mass construction of smart cities in the near future, due to financial needs, this concept will be primarily intended for large cities with a high population concentration. At the same time, it is important to understand that this concept is still such a new

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<sup>20</sup> Seeing cities through Big Data. (2017). Springer Geography. <https://doi.org/10.1007/978-3-319-40902-3>

<sup>21</sup> The OECD programme on Smart Cities and Inclusive Growth. OECD. (n.d.). Retrieved December 7, 2022, from <https://www.oecd.org/cfe/cities/smart-cities.htm>



issue that the impact of technology on humanity has not yet been fully explored. It will be some time before we see further consequences of this process.<sup>22</sup>

In this chapter, I present selected challenges and opportunities that may arise in a smart city. However, there are, of course, problems and contradictions that still remain hidden, manifested over time, along with changes and the introduction of new technologies. Of course, it would be appropriate to develop some case studies to find out whether a citizen is not losing minimal social contact in a smart city. For example, instead of asking someone at the bus stop when the next bus leaves, the bus station will tell them and show them the way. Instead of communicating with the citizen about interesting events in the city, the tourist uses the QR code mobile application. However, it is positive that there are already cities that are they become living laboratories where various solutions can be tried. Other cities that follow them do not have to repeat the mistakes of previous cities.

As another problem of smart cities, I would emphasize security. This is a really important and scary thing to think about, and seriously. What happens when in every big way or in a smaller city, will mass-installed sensors and cameras collect our personal data, urban mobility information, etc.? The probability that we will have to give up certain freedoms and parts of privacy is very high. It is not difficult to predict what threats this process may bring. Therefore, it is important to find a line between what is monitoring to ensure safety and improve the lives of the population, and what is already useless. It is also important to understand that a city cannot be controlled solely by computer software and decision-making. It always is necessary to involve people in the decision-making process, because it is precisely the people who live in the city, who spend their time there. The city should be there, especially for them.

However, creating smart cities opens up many opportunities in addition to threats. The whole concept of a smart city was developed primarily to improve the lives of its inhabitants, ensure the sustainable development of the city and protect the environment. The results of efforts to improve the environment in which we live are already visible: more efficient use of alternative sources, reduction of pollution, and saving money. The problem may be that most of the positive aspects of building a smart city are more visible in the long run. Examples are the above-mentioned savings on heating (at least six months) or environmental improvements.

Another positive aspect is new jobs and opportunities. Cities that have decided to become smart can work very well with private companies on various technological solutions. Of course,

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<sup>22</sup> Discover how accessible ICT Benefits Smart Cities. Smartcities4all. (n.d.). Retrieved December 7, 2022, from <https://smartcities4all.org/>

there is also the potential for cooperation between different cities around the world, where the exchange of experience is very important, thus reducing the likelihood of repeating the same mistake in technological and other processes.

Cities are investing heavily in integrating new technologies with their own infrastructure. If something goes wrong, repairs can cost a lot of money and it is not clear whether the investment pays off at all. Even services that are beyond the control of sensors (such as banking, water, or electricity) are vulnerable to many hacker attacks. If there will be sensors monitored and attacked by a computer that can be accessed by people with bad intentions, it is not difficult to imagine how much risk we take.

On the other hand, sensors and data are very suitable for efficient city management. Sensors that monitor the operation and condition of roads, buildings, or bridges allow you to effectively manage investments to repair them. From the data available via the sensors, it is possible to determine which places are heavily congested or in need of repair. New cities built in accordance with the Smart concept can attract technology lovers and tourists. The city will get additional funding, usable to improve existing or introduce new technologies.

Thanks to the sensors, it is possible to detect and monitor air quality, control an intelligent parking system and at the same time eliminate the number of harmful substances emitted by cars into the air. Such a parking system makes it possible to monitor vacancies in the car park through the application, which is a great opportunity for drivers, but especially for people with disabilities. Clever Cars that the driver can control through the app are another opportunity for the disabled.

This was a brief description of the challenges and opportunities in creating smart cities, of course, there are many more. However, the number of advantages outweighing the number of disadvantages does not mean that the implementation of the Smart City concept really pays off. It is not the number that matters, but the effect that Smart City brings. For example, the question arises as to whether the possibility of potential stock surveillance and the threat of a possible attack is worth better air quality or investment management. These questions each city should judge independently, based on the requirements of its inhabitants.<sup>23</sup>

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<sup>23</sup> Resource 10

## **4. Practical Part**

### **4.1. Implementation of intelligent solutions in the Georgian**

It is important to note that the process of implementing smart solutions in the Georgian reality began several years ago and is already showing good results in various important areas. Mostly well-known cities in Georgia - Tbilisi, Kutaisi, and Batumi - are involved in this process. Tbilisi is the capital of Georgia, Kutaisi is the third most populous city in Georgia and the second most important city after Tbilisi. Batumi is a Black Sea resort and port city that plays a strategic role in the economic growth of the country. In my dissertation, I focus on Tbilisi and analyze the current situation in terms of the possibility of using the concept of a Smart City in various industries.

#### **4.1.1. Analysis of the current situation in terms of the use of the Smart City concept in various industries in Georgia**

Georgia is a state on the border of Southeast Europe and Southwest Asia. It borders Armenia, Azerbaijan, Russia, Turkey, and the Black Sea. An area of fewer than 70,000 km<sup>2</sup> (which is about 90% of the territory of the Czech Republic) has a total population of 3.718 million, of which 2.128 million people live in cities and 1.590 million people in the countryside. Georgians make up 86.6% of the population. The largest part of national minorities are Azerbaijanis (5.3%) and Armenians (4.5%), others are Ukrainians, Russians, Greeks, Ossetians, Kurds, Abkhazians, etc.

Georgia's economy has been showing high GDP growth over the last period. In 2018, GDP growth was 4.1%, compared to 2016, when it was 2.8%. According to the forecast, it is still expected stable economic development and economic development. GDP per capita in 2018 was \$ 4,529 compared to \$ 3,762 in 2015. The inflation rate in 2018 reached 3% compared to 2017 when this indicator was 6%. The unemployment rate has remained around 12% in recent years.<sup>24</sup>

One of the most important days in Georgia's new history is July 1, 2016, when the Association Agreement (AA) with the EU on the Deep and Comprehensive Zone (DCFTA) entered into force on the basis of which import duties between Georgia and the EU have been eliminated. However, under the Association Agreement, Georgia is also committed to implementing a reform agenda in various areas and sectors. This agreement is very important for the development of the Georgian

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<sup>24</sup> Making Cities Smarter. Smart Cities Asia 2022. (n.d.). Retrieved December 7, 2022, from <https://smartcitiesasia.com/>

economy.<sup>44</sup> According to the competitiveness indicators calculated by the World Economic Forum (WEF) in 2017, Georgia was ranked 67th out of 137 ranked economics.

Tbilisi is the capital of Georgia and at the same time its political, cultural, economic, and educational center. The area of the city is 720 km<sup>2</sup>, located on both banks of the river Mtkvari and is surrounded by mountains. In the northeastern part of the city is the Tbilisi Sea, a popular holiday resort the area of the city that is also used to supply the city with water. The city has a well-preserved historic center, although a significant part of the local architecture still dates back to the Soviet era and many buildings were built to low standards of construction quality. Tbilisi has a population of 1.1 million.

Tbilisi has already achieved some success in the Smart City concept. On May 31, 2018, the World Urban Data Council (WCCD) awarded Tbilisi the ISO 37120 certificate, which is one of the most important certificates in the world. It determines the level of their intelligence.<sup>25</sup>

Despite the fact that Tbilisi has obtained this certification, the situation is relatively serious. According to a 2014 Mercer study, Tbilisi ranks 191st in terms of quality of life. In the survey, the cities were evaluated according to 39 indicators, including political, social, and economic status, health, education, recreation, and environmental protection. There have been many changes in the country since 2014, but the quality of life has not improved significantly. According to studies published by the World Health Organization, Tbilisi is one of the most polluted cities in the world. In terms of the number of victims of air pollution, Georgia is in third place overall in Europe. Tbilisi has a green coefficient per capita of 4 to 5 m<sup>2</sup>, but according to the recommendations of the World Health Organization, it should not fall below 9 m<sup>2</sup>. The complexity of the situation is particularly evident when comparing Tbilisi with other European cities. For example, in Stockholm there is 87.5 m<sup>2</sup> of green planting per capita, in Amsterdam 45.5 m<sup>2</sup> in Vienna 120 m<sup>2</sup>.

Given the current reality, it can be said that Tbilisi is still in the early stages of development of the Smart City concept, but it should be mentioned that the city already has several elements of modern technology and intelligent systems. At the moment, they are working and providing people with better living conditions. And that, of course, is a good precondition for further success. Below we will describe some of the other possible intelligent solutions.<sup>26</sup>

### *Public transport route planners*

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<sup>25</sup> EBRD green cities. EBRD. (n.d.). Retrieved December 7, 2022, from [https://www.ebrdgreencities.com/assets/Uploads/PDF/8d40619e4d/GCAP\\_Tbilisi.pdf](https://www.ebrdgreencities.com/assets/Uploads/PDF/8d40619e4d/GCAP_Tbilisi.pdf)

<sup>26</sup> Sustainable smart cities and smart villages research. (2020). <https://doi.org/10.3390/books978-3-03928-219-7>

Online public transport route planners are available in all modern cities around the world - on the website or in the mobile application. Online trip planner facilitates urban mobility for locals and tourists and allows you to operate your transport system more efficiently and smoothly.

There are 3 types of public transport in Tbilisi (metro, buses, and cable cars). They serve around 600,000 passengers a day. A web portal <http://transit.ttc.com.ge> has been set up to make it easier to find information on public transport services and to plan points from point A to point B. Transit TTC mobile application. Thanks to the transmission of information in real-time, passengers can find out where the vehicle is and when its next arrival is expected.

#### *Electronic boards at the bus stop*

Electronic boards located at bus stops identify bus numbers, directions, and arrival times. The same information is available on the web portal <http://transferen.ttc.com.ge/?setLng=en> and in the mobile application Transit TTC

#### *Intelligent payment system*

The "Metromoney" plastic card is used as a means of payment in the Tbilisi transport system. This is a plastic electronic payment card that passengers can buy for 0.61 euros and charge it with a certain amount of money (one ride on public transport costs 0.15 euros). This is especially convenient for those who use the "Metromoney" card often, but uncomfortable for those who rarely use public transport, as well as for tourists who have just arrived and have not yet received the card did not buy. To address this, in the spring of 2017, the city administration announced the launch of a project to improve the provision of public transport services. The project will modernize the public transport payment system. The new system will allow local citizens and tourists to pay in meters, buses, and cable cars using Georgian and foreign bank cards (VISA and MasterCard).

#### *Smart traffic light*

Intelligent traffic lights are an important innovation in urban management. They reduce CO2 emissions because vehicles do not have to wait long in line. It is a unique means of managing traffic flow. Tbilisi City Hall has been implementing a project to implement intelligent traffic lights for several years and is increasing the number of streets each year where old traffic lights have been replaced by modern ones, which are connected to a single management system and can be interconnected at the same time. In the event of heavy traffic congestion, the control center can

change the timing of traffic lights (color change) and allow more vehicles to pass. By the end of 2017, the city had 189 such traffic lights, which is 73% of the total number (258 traffic lights).

#### *Smart map*

Tbilisi has a unified online map (<http://maps.tbilisi.gov.ge>) based on a geographic GIS information system, which is used by citizens and departments of architecture and property management.

#### *Electronic portal for privatization of municipal property*

An electronic portal [www.iauction.ge](http://www.iauction.ge) has been created for the privatization and lease of municipal property. The web portal is linked to an online map showing all asset procedures/actions (privatization, leasing, change of ownership, encumbrance of property rights, etc.) carried out by the portal and the public register. Below is a list of services provided to citizens and companies through this electronic system:

- request for public information
- disposition of property
- refunding payments made to the wrong account or transferring to another account
- agreements on the terms of contractual obligations
- overlapping of the property of the self-governing unit
- issuing various authorizations for linear structures
- submission and return of a bank guarantee and many more.

#### *Electronic portal for building permits*

In the last few years, obtaining a building permit is only available online, via the web portal [www.tas.ge](http://www.tas.ge). Before obtaining a building permit, the conditions of land use, modification of functional land use planning, presentation of the development of regulatory plans and other architectural services are determined using this portal. Physical and legal people can find answers to their questions and requests in an online environment (prepared by the ministry). Stakeholders can get online consultations or calculate the number of fees they will pay in a particular case. This service simplifies the submission of documents to the relevant department and the processing of documents and ensures that the application processes his application in a timely manner. In addition, the system is transparent and minimizes the risk of corruption.

### *Tbilisi mobile application*

The mobile application "Tbilisi Loves you" is an online guide that provides various useful information about tourist attractions, restaurants, hotels, shopping, and more. It's acting is a free app for iOS and Android mobile phone users.

### *Free Wi-Fi*

There are many places in the city where free internet is possible.

### *Emergency Center*

Tbilisi Emergency Center provides unified fire, rescue, medical and patrol services. Emergency services are available 24 hours a day, via telephone number 112 (from any mobile or fixed telecommunications network).

### *Tbilisi Public Service Hall*

Key services such as public access to public records, issuing passports and identity cards, business registration and much more are provided in one place.

### *QR library*

Banners with QR codes are located in various public areas. Everyone who uses a smartphone or tablet has the opportunity to download books for free.

### *City Forum*

Using online applications and printed applications, the public can share problems and ideas about the city. The best projects and ideas then have a great chance of implementation.<sup>27</sup>

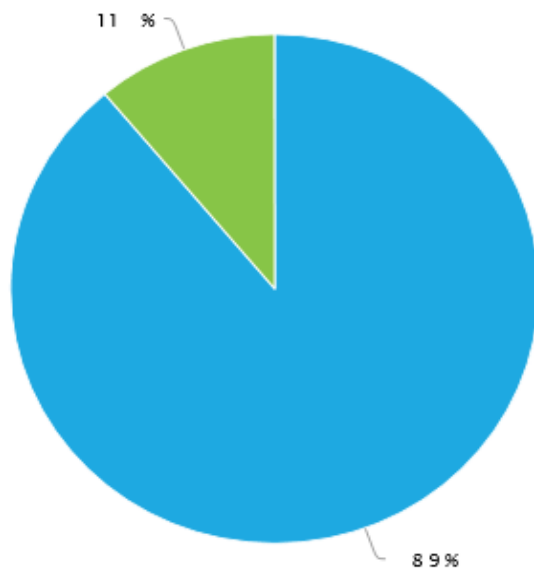
#### **4.1.2. Citizen questionnaire survey**

In order to identify the city's current problems and needs, a questionnaire survey was conducted among permanent residents (89%) and visitors (11%) of Tbilisi. The survey was conducted in the period from November 2021 to January 2022. Respondents were contacted mainly through various social groups on Facebook. In these groups, citizens and visitors usually share their reviews on various topics related to the city.

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<sup>27</sup> TBILISI SMART CITY. Tbilisi City Hall. (n.d.). Retrieved December 7, 2022, from [http://msdp.undp.org.ua/data/publications/success\\_stories\\_english.pdf](http://msdp.undp.org.ua/data/publications/success_stories_english.pdf)

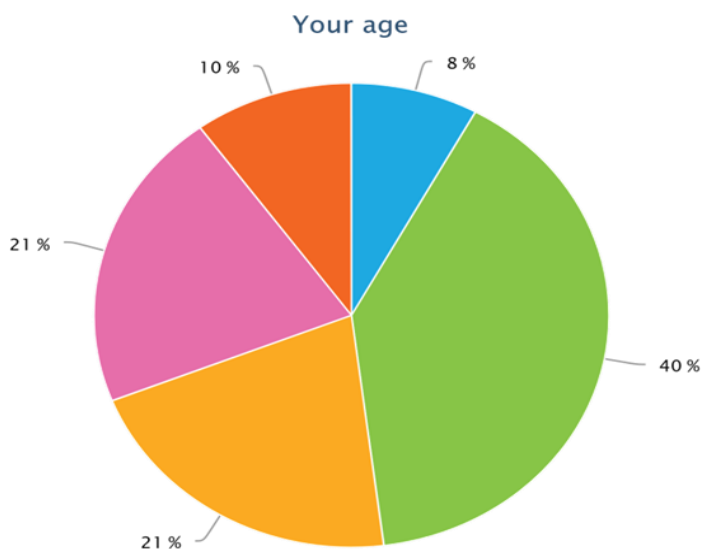
Please select the option that fits you best



● I am a permanent resident of Tbilisi ● I have visited Tbilisi in the last 6 months

Graph 1: Structure of respondents according to whether they are permanent residents of Tbilisi or have visited in the last 6 months city(source: own elaboration).

The online questionnaire consisted of a total of 22 questions, of which 16 were closed and 6 open. A total of 100 respondents took part in the survey. The age structure of the respondents is shown in Graph 2.

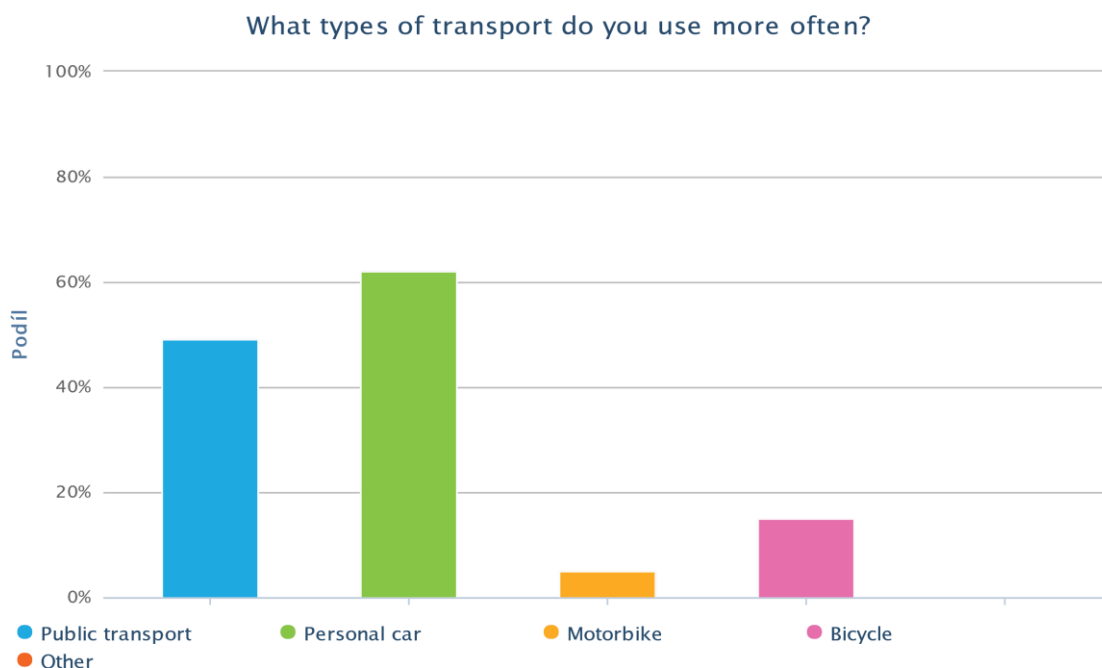


● less than 21 ● 21-30 years old ● 31-40 years old ● 41-50 years old ● 50 years and older



Graph 2: Structure of respondents by age (source: own elaboration)

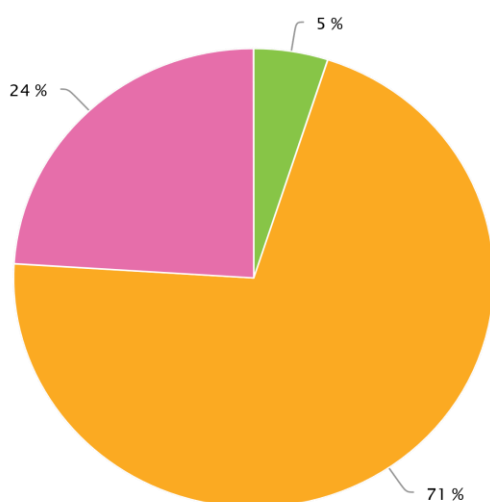
According to the questionnaire survey, the city's most pressing problem seems to be the area of mobility. 49% of respondents usually use public transport, while the others travel in person by car (62%), by bike (15%) or by motorcycle (4%).



Graph 3: Structure of respondents by use of means of transport (source: own processing)

Respondents are most faced with problems related to congested traffic in the city center, parking, and public transport. Respondents' satisfaction with the flow of car traffic is shown in Graph 4.

Are you satisfied with the flow of cars in Tbilisi?

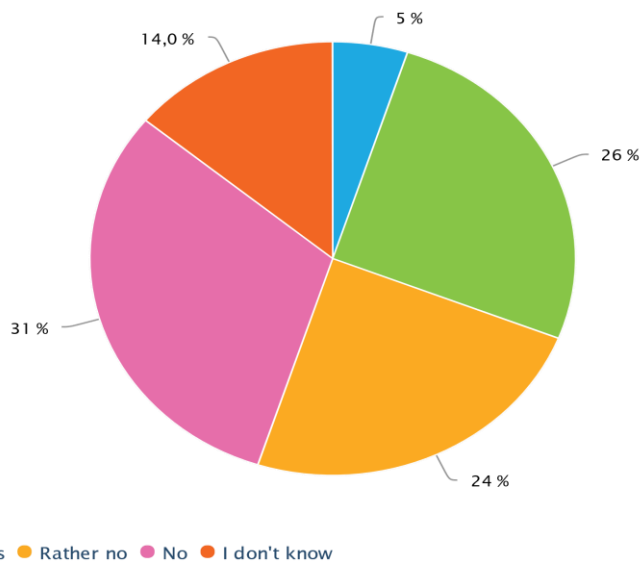


● Yes ● Rather yes ● Rather no ● No

Graph 4: Respondents' satisfaction with the flow of car traffic in Tbilisi (source: own processing)

Of the total number, none of the respondents is completely satisfied with the flow of car traffic in the city. When asked whether citizens think there is a sufficient number of parking spaces in the city center, 55% of respondents answered in the negative. The result is shown in Graph No. 5

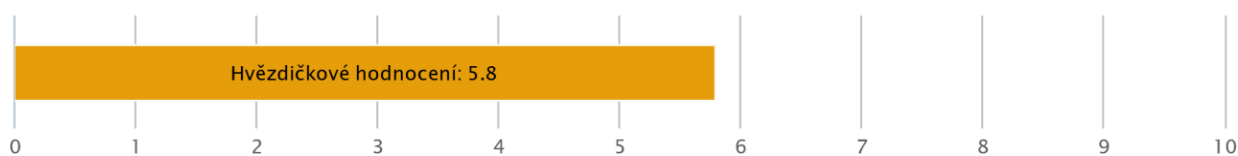
Do you think there is enough parking in the city center?



Graph 5: Satisfaction with the number of parking spaces in Tbilisi (source: own processing)

Another question related to satisfaction with the operation of public transport. Graph No. 6 shows that respondents' satisfaction with the operation of public transport is very low.

If you regularly use public transport, please indicate the level of your satisfaction with it

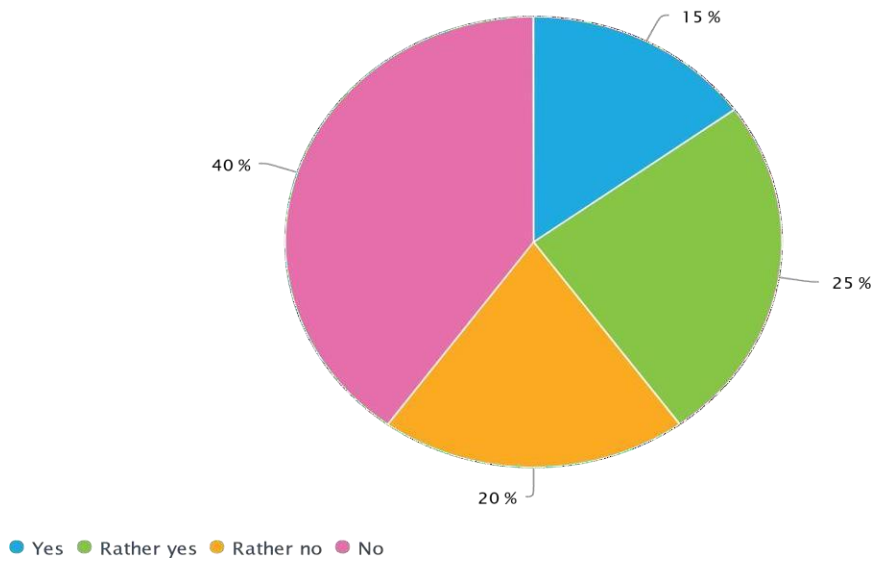


Graph 6: Satisfaction with the operation of public transport (source: own processing)

Most respondents cited inconvenience, insufficient connection frequencies, inappropriately distributed stops, frequent traffic delays, and congested means of transport due to their insufficient capacity.

Other problems that concern the inhabitants and visitors of the city are those associated with air pollution, lack of green and recreational areas, as well as a limited number of bike paths or pedestrian zones in the city. The questionnaire confirmed that the Smart City concept is known to 40% of respondents.

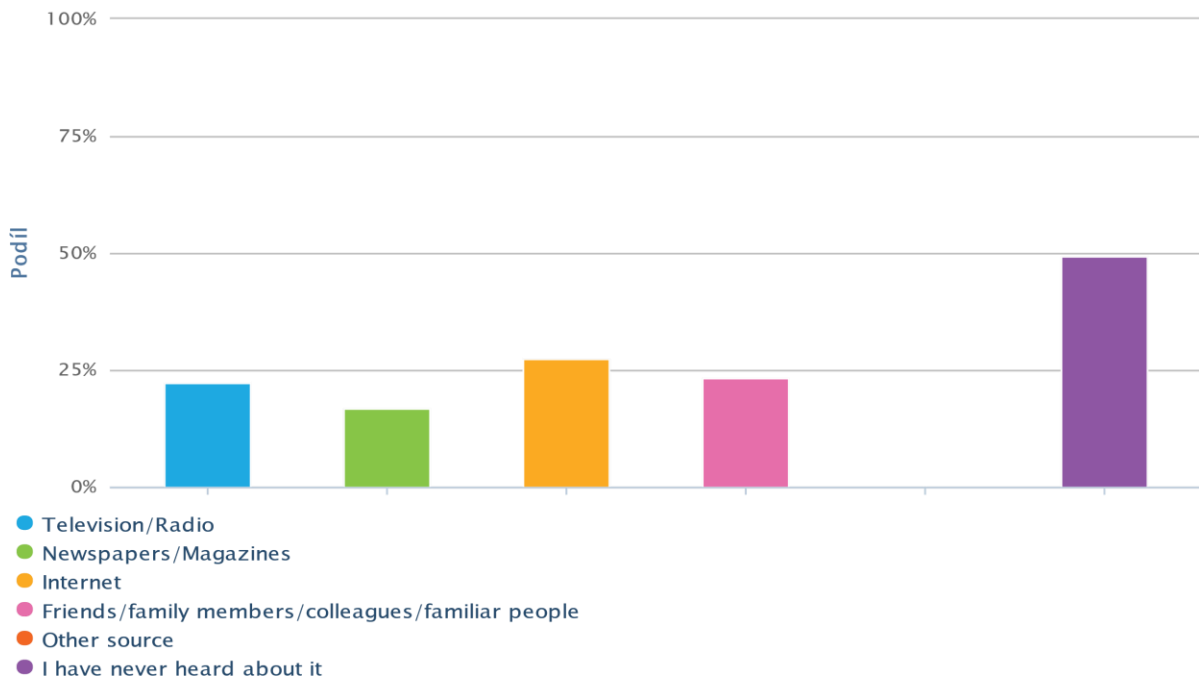
Are you familiar with the concept of "Smart City"?



Graph 7: Structure of responders based on knowledge of the idea of smart cities

The majority of respondents said they learned about the concept from the internet, newspapers, periodicals, friends, family, coworkers, and acquaintances.

From which source have you heard about Smart City concept?



Graph 8: Source of information on the Smart City concept (source: own elaboration)

It should be emphasized here that each interpreted this concept in a different way, but they all mentioned that it is the use of modern technologies that serve to improve life in the city. To illustrate, below are examples of what the Smart City concept represents for individual respondents.

"A city that makes meaningful use of modern technology to improve the lives of its inhabitants and visitors."

"A city that cleverly and sparingly uses modern approaches to more efficient city management, conservation of natural resources and energy sustainability."

"A city that uses modern technology is energy sustainable and environmentally friendly."

"A city that makes the most of modern technology."

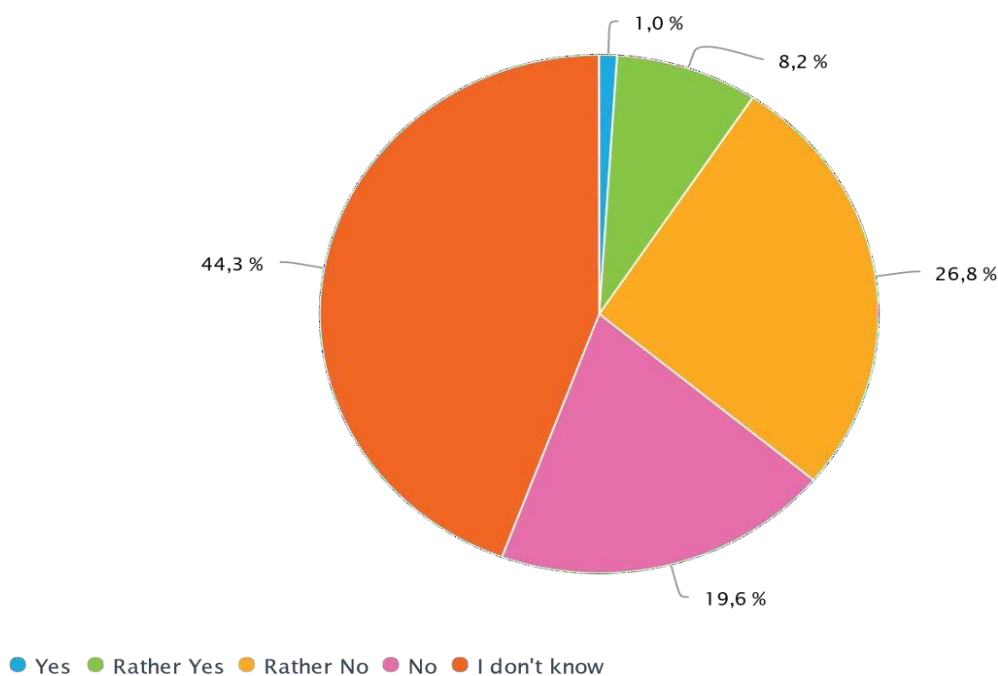
"A city that uses modern technology to make life easier for its citizens."

"The city, which collects various data thanks to modern technology, analyzes it to provide information to citizens and visitors in order to improve living conditions."

"When smart solutions are actively used in different areas and industries of the city."

The most often cited examples of cities that adopted the idea, according to the respondents, were Vienna, London, Chicago, Barcelona, Stockholm, and Amsterdam, as well as Reykjavik, Boston, Dubai, Austin, Tokyo, and New York. 46% of all respondents do not think Tbilisi is clever, while 46% are unsure of Tbilisi's status as a smart city.

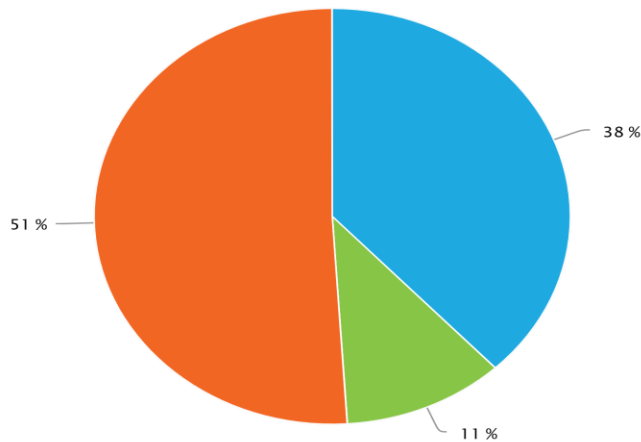
Would you determine the city of Tbilisi as a "Smart city"?



Graph 9: Assessment of Tbilisi as a Smart City (source: own elaboration)

Therefore, 48% of respondents think that the implementation of the smart city concept can improve the lives of city residents, but the remaining respondents are unsure.

Do you think that the implementation of the Smart City concept in Tbilisi can have a positive impact on citizens' lives?

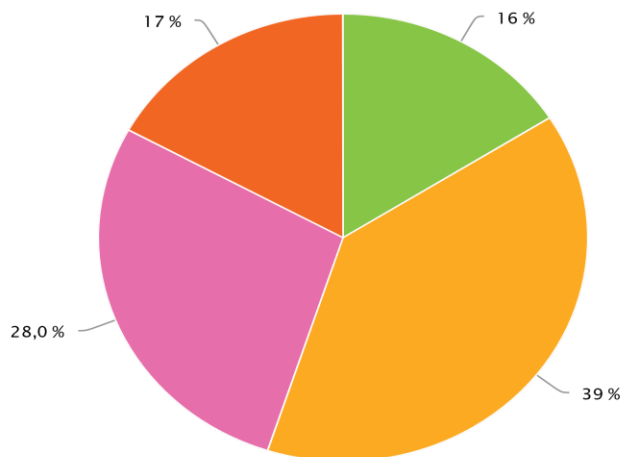


● Yes ● Rather Yes ● Rather No ● No ● I don't know

Graph 10: Evaluation of the Smart City concept's implementation's effects in Tbilisi (source: own elaboration)

According to graph 11, 67% of respondents think it's challenging to access certain Tbilisi statistics that the government publishes.

Do you think that various data published by the authorities about Tbilisi are easily accessible to the public?

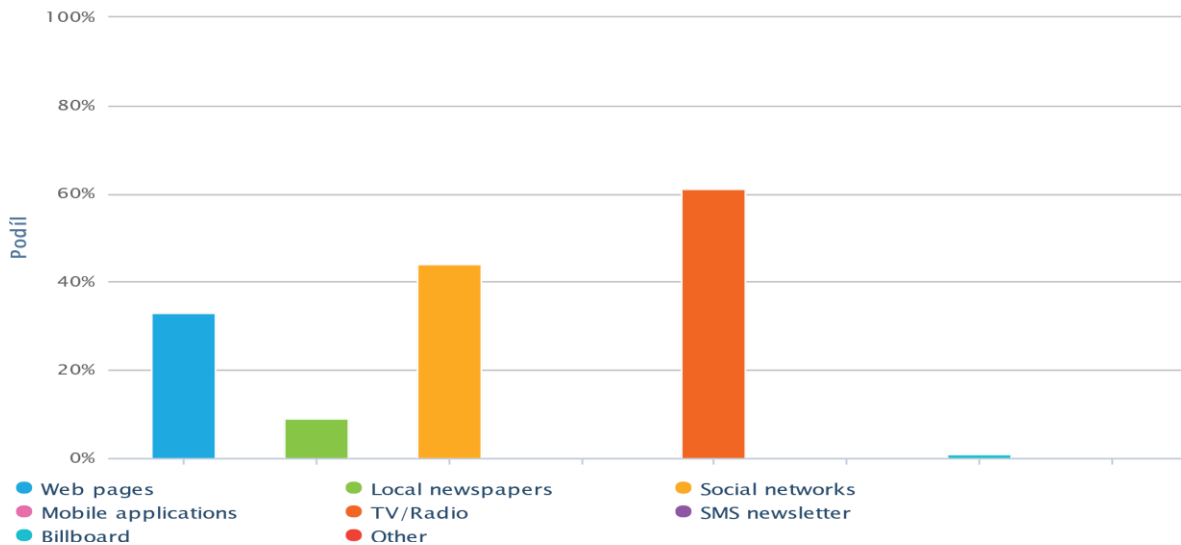


● Yes ● Rather yes ● Rather no ● No ● I don't know

Graph 11: Accessibility of information made public by authorities (source: own processing)

Usually accessible sources of crucial information regarding Tbilisi, these media are (news, information about various events, traffic information, public transport information, etc.) The city hall website, social networks, and local media were mentioned by 33%, 44%, and 9% of respondents, respectively. The result is shown in Graph No. 12.

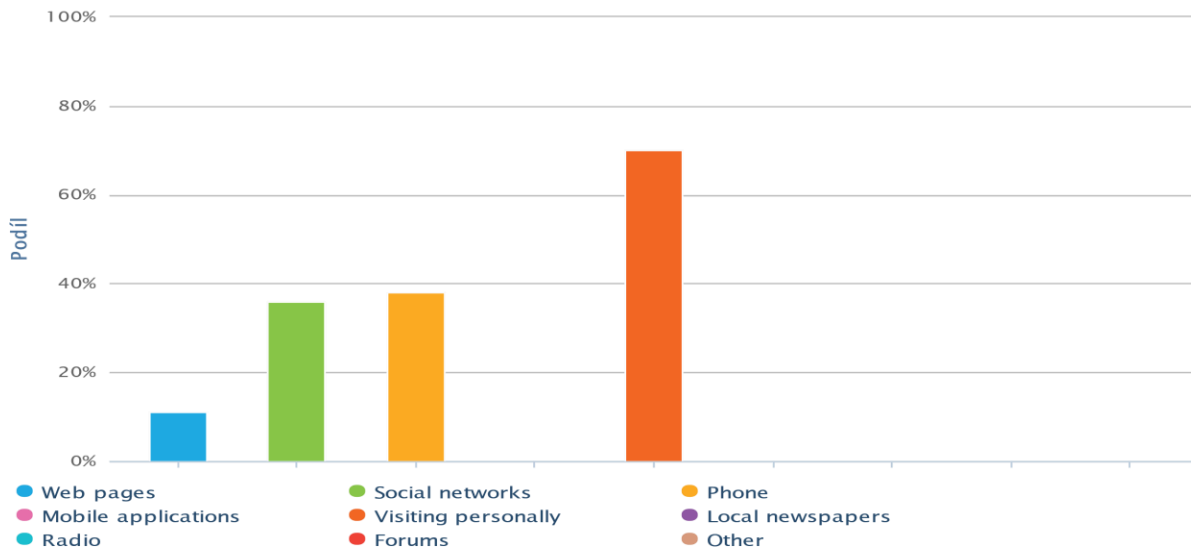
Where can you usually find important information about Tbilisi (news, information about various events, traffic information, information about public transport, etc.)?



Graph 12: Information channels providing important data on Tbilisi (source: own processing)

Another question focused on the communication of the city authorities with the citizens. Graph 13 shows that in most cases communication with the authorities takes place through personal visits to municipal authorities (70%), by telephone (38%), via social networks (36%) or websites (11%).

If necessary, through which channels do you usually communicate with city authorities?



Graph 13: Information channels for communication with city authorities (source: own elaboration)

Respondents' satisfaction with Tbilisi's sports, cultural and recreational facilities was very negative.

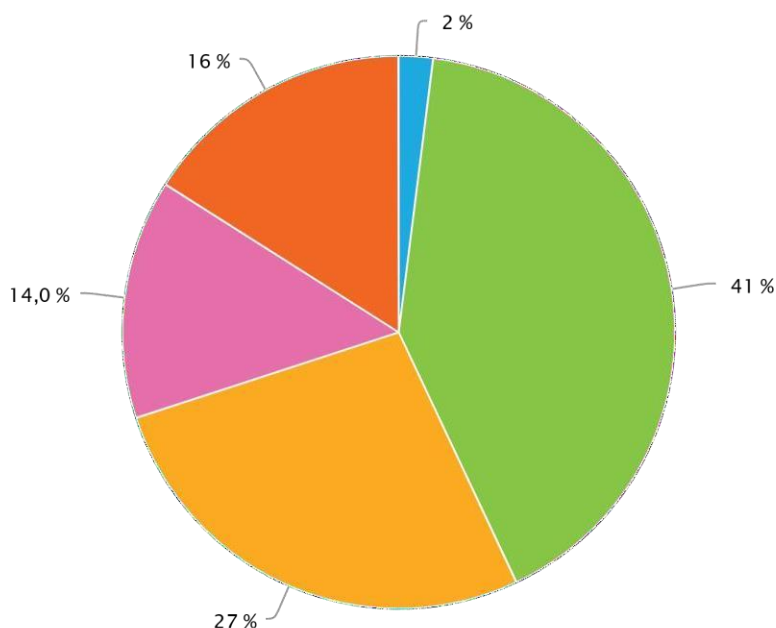
Please indicate the level of your satisfaction with the facilities of Tbilisi with sport, cultural and recreational zones?



Graph 14: Respondents' satisfaction with Tbilisi's sports, cultural and recreational areas (source: own elaboration)

41% of respondents said that there are not enough places in Tbilisi to connect to a free Wi-Fi network.

In your opinion, is there enough space in Tbilisi to connect to a free Wi-Fi network?



● Yes ● Rather Yes ● Rather No ● No ● I don't know

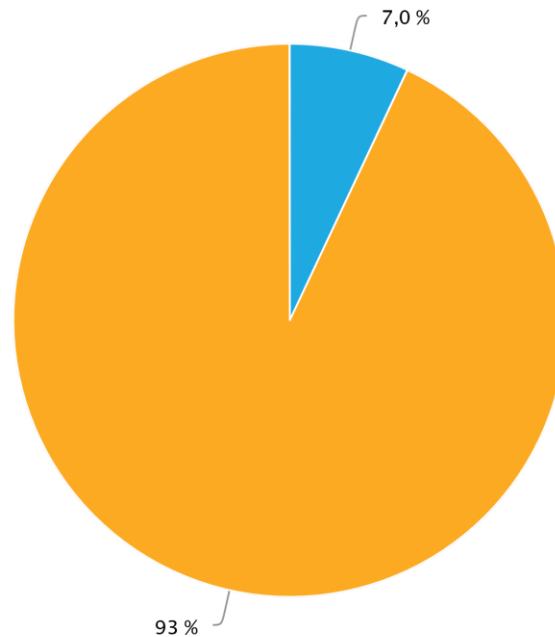
Graph 15: Satisfaction of respondents with the number of places of possibilities of possibilities to connect to a free Wi-Fi network (source: own processing)

When asked "What would you like to add to the infrastructure or services in the city", respondents said that they would use the concept of car or bicycle sharing for city transport, they also wanted to be able to report various defects in the city not only by phone and personal visits to the City hall or ministries but also through websites or through mobile applications. To reduce waiting times in long queues in the City hall or ministries, respondents said they would like to be able to use electronic booking through a mobile application or website.

Most respondents said that air pollution is the most significant problem in Tbilisi and that there are not enough recreational and pedestrian zones in the city. They would also like to see the establishment of new playgrounds and an increase in the number of places with free Wi-Fi.

One of the questions also concerned waste sorting. Only 7% of respondents sort waste.

Do you sort waste?



● Yes ● Sometimes ● No

Graph 16: Structure of respondents who sort waste (source: own processing)

Most do not see the importance of recycling, or think that the recycling containers are located too far from their home, or they do not know at all that waste recycling containers exist in the city.

#### 4.1.3. Interview with an analyst from the Innovation Testing and Development Department at TBC Bank

As an example of the implementation of intelligent solutions in the Georgian environment, I decided to introduce the reader to TBC Bank - a leading Georgian company based in Tbilisi, which implements a large number of smart projects. The company's mission is to support innovative ideas and businesses. Its vision is to be the best provider of digital financial services in the region.

In order to find information on various innovative and intelligent projects driven by TBC Bank, a semi-structured interview method was used. The interview was conducted in the Georgian language with Mr. Giorgi Nadareishvili. He is an analyst in the Innovation Testing and Development Department at TBC Bank and has been working there for 10 years. He has seen first-hand how the



company has developed year on year its services and products and how it tries to follow the trends of the modern world. As part of the interview, Giorgi Nadareishvili gave more details about various innovative inventions and smart projects of TBC Bank. When asked what sets TBC Bank apart from other companies, I got a very detailed answer.

The largest banking organization in Georgia is TBC Bank. About 83% of the nation's population is served by it. In order to provide its customers with top-notch digital channels and the most cutting-edge solutions, the bank, which operates in a digital environment, continually enhances its operations and makes technology investments.

TBC's Internet and mobile banking programs have already won numerous accolades for being the finest in the world. The first Georgian-speaking chatbot, Ti-Bot, was created by TBC Bank, along with a biometric speech recognition system for its call center. The first chatbot in Georgia is Ti-Bot, which is accessible via the Messenger app. It is a cutting-edge and engaging channel that enables users to carry out straightforward financial operations and offers helpful details on TBC Bank's offerings, entertainment, and weather forecasts.

The first entirely digital bank in Georgia was introduced by TBC Bank in May 2018 as "Space." The newest mobile app for handling daily finances is this one. This software offers straightforward operations and products, clear pricing, and immediate fund transfers. With just a few clicks, the "Space" app offers all of its goods and services. Nothing needs to be done in person; everything can be done online. The software is incredibly user-friendly and intuitive. Simply use the "+" or "-" buttons, for instance, to request a loan or to transfer money. The "Space" software currently allows users to open accounts remotely, apply for consumer loans, send money, pay for various fees, use debit cards, and make online purchases. The mobile application "Space" operates as a fully digital bank that only provides all of its goods and services online.

The bank hosts numerous training sessions, conferences, one-on-one consultations, and regional Agro-Forums as a part of TBC's Business Education Program. These services are all provided without cost. The goal is to assist business owners in developing their management, marketing, financial, and taxes skills so they may grow their own companies.

The bank introduced a cutting-edge B2B business platform as part of the creation of the business support program ([www.businessstool.ge](http://www.businessstool.ge)). This platform helps develop new software that is appropriate for Georgian companies while also creating a marketplace that links enterprises and information technology service providers.

The "Challenge of Applications" initiative from TBC Bank is the first IT contest that encourages young IT companies to develop ground-breaking solutions while promoting Georgian

applications. Due to the fact that software systems created by Georgian IT specialists are more affordable and customized to local needs than their foreign counterparts, this situation is advantageous for both IT companies and businesses.

One of the competition's winners, the start-up company System Jet, developed software that enables beauty salons, cosmetic clinics, and organizations like these to carry out all of their everyday operations online. This is the first app in Georgia that allows a variety of companies to manage their internal business processes, front-line operations, and statistical analysis.

The Bank continually makes investments in the professional growth of its staff members. In order to offer training and seminars in numerous disciplines and give employees the chance to learn from the top and middle management Bank, TBC Academy, a local training platform, was established in 2011. Technical topics like financial institutions, capital markets, ethics, and financial fraud management are included in training courses, along with communication skills like leadership, management, and human resources.

The Bank helps talented young people start new businesses and initiatives and advance their careers. In the Leonardo da Vinci competition for young researchers and inventors, TBC Bank has played a prominent role as a partner since 2016. This annual event attempts to boost the interest of young people in STEM fields (science, technology, engineering, mashinary)

Since its founding, TBC Bank has consistently promoted Georgian culture and worked on several initiatives to develop Georgian heritage. In 2003, the TBC Bank established Saba, Georgia's top literary award. Since then, more than 150 awards in various categories have been given out by the Saba Prize. The primary online store for electronic books and audiobooks in Georgia is Saba's website, [www.saba.com.ge](http://www.saba.com.ge), which launched in 2017. The website features 300 authors and publishers who have contributed, and it has 170,000 readers worldwide.

TBC Bank has consistently supported Georgian culture since its founding and has carried out numerous initiatives to do so. The first web channel in Georgia devoted to art and culture is called "Art area," and it is a significant endeavor. Viewers can access a variety of cultural programs, online lectures, exhibitions, concerts, and amusement through "Art area." The bank launched the "Write in Georgian" project in 2016 to promote the Georgian language and incorporate the Georgian script into the digital sphere. The Bank and Microsoft collaborated to establish the first Georgian language platform, [www.kartulad.ge](http://www.kartulad.ge), as part of this project. Its purpose was to include Georgian into Microsoft products as well as other programs like Skype and Office.

These were only a few of the efforts and projects that TBC Bank worked on to better the lives of people and give them chances to grow. As can be seen, the business is actively involved in putting

the key components of the Smart City concept into practice in the Georgian setting. It is well acknowledged that including several sectors in the process of putting the concept into practice is necessary for success.<sup>28</sup>

## **5. Results and Discussion**

### **5.1. Proposal of Smart City concept for the city of Tbilisi**

The last part of the thesis describes the draft of the Smart City concept for the city of Tbilisi. Based on the results of the questionnaire survey, the development vision of the city was determined, and 4 priority areas were addressed by the concept design. They are:

- Smart Transport
- Smart People
- Smart Environment,
- Smart government

Below is formalized the city's development vision which defines the state in which the city should be in the medium and long-run period time and towards which it should be constantly moving:

"Tbilisi uses modern technology in its everyday life, is environmentally friendly, and energy efficient has a smooth transportation system and functioning social and educational services. The city creates a healthy and attractive environment for its citizens."

Based on successful examples of the implementation of the Smart City concept in cities around the world, several recommendations will be made for each area. This is essentially an overview of appropriate activities and services that the city should use. The proposal will not specify the exact costs and benefits, individual measures, and nor will they be described technologically.

First of all, it should be mentioned that for the successful implementation of the Smart City concept, the city administration should create a strategic document that will include a long-term plan for the implementation of smart solutions, setting out the goals, priorities, and pathways for achieving these goals. On the other hand, it is important to establish a working group of experts who

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<sup>28</sup> TBC Bank invests in smart, digital solutions. TBC Bank. (n.d.). Retrieved December 7, 2022, from <https://www.tbcbank.ge/web/internet-banking>

will deal with the process of implementing the concept and evaluate the measures taken and their results.

A special fund to support the Smart City concept is another important step in this process. The government sector can contribute a certain amount to the fund from its budget, as well as the private sector. Academia and the commercial sector should also help in the development process and implementation of the concept. Providing information to the population on the importance of the concept, on the projects related to this, and increasing their involvement is an integral part of success. It would be possible to gather public input through various channels, to launch competitions for the best idea, which would then be implemented.

Another prerequisite for the successful implementation of the Smart City concept is the creation of innovative products. Therefore, it is important to create an incubator (laboratory) that will actively support the development of innovative projects and products.

## **PRIORITY 1 - INTELLIGENT TRANSPORT**

Strategic objectives:

- Increase traffic flow
- reduce traffic congestion
- increase the attractiveness of public transport
- increase parking availability
- promoting sustainable modes of transport

Description of measures:

- Monitoring, evaluation, and regulation of traffic flow - using Bluetooth technology, which could be placed in the lanes, it would be possible to monitor the flow and occupancy of individual roads, monitor the average number and speed of vehicles, monitor the time interval between vehicles, etc. This technology will also allow the detection of potential traffic problems and recommend alternative routes to passengers. In particular, the system can be used on major routes used by urban traffic. The information provided by these technologies will improve the quality of the existing transport portal.

- Attractive public transport - there are currently five types of public transport in the city: metro, bus, cable car, minibus, and taxi. The metro operates until midnight and the other modes of public transport are very limited after midnight. Therefore, people usually use taxi services at night. As public transport cannot meet the needs of the large capacity of passengers, citizens are pushed to buy private cars. This situation causes traffic jams and air pollution. To increase the attractiveness of public transport the frequency of services, and the capacity of modern means of transport should be increased where will be air-conditioners, internet access, possibility to charge phones. Means of transport should have accessibility for the disabled, there must be developed modern and easier payment methods (uniform tariffs, contactless payment).
- Smart parking – the creation of a mobile application for easier parking, where the data collected by monitoring mobile devices, it would be possible to see occupancy parking spaces. Sensors or cameras can also be installed to refine occupancy information individual car parks. Information on prices and capacities of local car parks or their occupancy, together with a mobile app, could also be checked at the traffic portal. The construction of underground parking could also help to solve parking problems.
- Sustainable modes of transport - are one of the elements of smart mobility. Developing cycling or walking areas would help reduce pollution. In addition to appropriate infrastructure, it would be effective to develop a mobile app to support cycling, where it would be possible to find the nearest bike and unlock it. Using the app, it would be possible to measure the length of the route and the number of calories burned during the ride. The app could become a game in which citizens could compete with each other, helping to reduce emissions and improve their health condition at the same time. In addition to encouraging bike-sharing services, another effective way to address mobility issues would be promoting car-sharing services, especially encouraging the use of electric cars. The launch of a project promoting electric car sharing would have great economic benefits, as well as environmental. Citizens would be able to rent a car using a mobile app by having the option to choose a preferable size available close to their location. To motivate residents to use the electric car rental service, the City Council could provide users with free parking in all specially designated zones, or free charging. However, in order to start and develop this project, it is necessary to initiate the construction and expansion of charging stations.

## **PRIORITY 2 - SMART PEOPLE**

Strategic objectives:

- Increase the awareness and involvement of the population
- Educate residents

Description of measures:

- Information channel - active and continuous informing of residents about important news concerning the city, communicating with them, and collecting their suggestions and ideas is one of the most important aspects of the Smart City implementation process. From the questionnaire survey showed that the most frequent communication between citizens and the authorities is by phone or in a personal meeting. To make this process more efficient, it would be advisable to develop a social web page, but also a mobile application that is user-friendly and where citizens can easily report defects they encounter in the city, for example. On the other hand, the mobile app should also serve as a guide for citizens and visitors the city, to inform about major news, news related to the city, planned cultural events, etc. The user could receive this information in the form of notifications. The app could also help to find playgrounds, toilets, health centres, etc. The office section of the app could include opening times, important contacts, advice on how to deal with certain problems, and through this section it would also be possible to make a reservation at the local authority. The mobile app could be linked to the transport portal, to inform the public about traffic flow or planned repairs, the number of available parking spaces in the area.
- Support for educational programs in the field of innovation and smart technologies - i.e. support for the use of new technologies in education, support for the development of creative skills (virtual reality, 3D modeling, design), creation of a cultural environment for the public, etc.

### **PRIORITY 3 – INTELLIGENT ENVIRONMENT**

### Strategic goals:

- increasing the city's sports and cultural facilities and recreational zones
- air quality measurement
- smart waste management and efficient energy management
- environmental education

### Description of measures:

- Equipment with sports, cultural and recreational zones - a questionnaire survey showed that respondents' satisfaction with Tbilisi's equipment with sports, cultural and recreational zones is meager. Renovation of the city center to make it "greener" will be recommended to solve this problem. This means revitalizing the existing parks, and playgrounds and building new ones, planting specially selected types of trees, creating green infrastructure on the streets, such as facades, sidewalks, and pedestrian zones, street lighting from solar batteries, installation of devices for measuring the level of air pollution, etc. Embankments that can become popular places for residents to meet and relax in the future and tourists, should also be restored and reconstructed. Renting boats could become a popular recreational activity for both the city's citizens and its visitors.
- Measuring air quality - it is important to realize that a city is not only about the unity and interaction of infrastructure and tools, but above all about the people who live in it. Cities can use their full potential only when they create a healthy and pleasant living environment for their citizens and visitors. As already mentioned, Tbilisi is one of the most polluted cities in the world. This problem is one of the most significant, and it should be solved without delay. Today, a number of new technologies and innovative methodologies are available to cities that help to recover. They help reduce product waste, monitor, and manage environmental pollution, reduce emissions, effectively use natural resources, achieve energy efficiency, and minimize environmental impacts.
- Environmental education – on the basis of various beneficial and entertaining lectures and competitions, especially the young generation should be informed about important aspects in the field of environmental protection.
- Effective energy management – reducing the city's energy demand is important not only from an environmental point of view but also from an economic point of view. City administration should restore at least part of the public lighting and replace it with lighting

that can be dimmed if no movement is detected on the streets. As a result, the light smog of the city will be reduced, as well as its energy consumption.

- Smart waste management – the implementation of the recycling strategy is now only in the initial stages in Tbilisi. The strategy was created in cooperation with the European Bank for recovery and development (EBRD), and shortly afterward containers for recycling glass, paper, and plastics began to appear in Tbilisi. There are only four recycling points in the city, which of course is not sufficient. At this point, it is necessary to emphasize that it is important to develop not only appropriate infrastructure but also awareness of this topic on the part of the city's inhabitants. As far as containers themselves, it would be advisable to invest in smart containers, and now at the very beginning. Containers should be equipped with the function of compressing the discarded waste and sensors that will inform about their filling. There will be garbage collection in the city planned based on this information. This will allow maximum use of baskets and along with it saves on waste collection costs.

#### **PRIORITY 4 – INTELLIGENT GOVERNMENT**

Strategic goals:

- improving the effectiveness of communication with citizens using modern tools
- electronic ordering systems
- availability of verified data

Description of measures:

- Using contemporary tools to increase the effectiveness of communication with residents - utilizing new technologies optimizes public services, enhances and streamlines administrative procedures, and makes them more accessible and efficient. It also raises the standard of living in society, making it more educated and open. Promoting and expanding electronic public administration services is crucial if individuals are to effectively and promptly address their concerns through communication. Current websites mostly only provide one-way communication between the city administration and citizens. However, two-way communication is necessary to increase efficiency.



- Electronic ordering systems – if it is possible to book an appointment with an office worker for a certain hour directly from home, it saves both parties a lot of time and becomes more efficient public administration services.
- Availability of verified data for the public – this requirement plays a key role in the successful implementation of the Smart City concept. To improve data collection, the government should designate a responsible authority to coordinate proper data collection and verification. It is also necessary to introduce a methodology for collecting, sorting, verifying, and storing the relevant economic, social, political, trade, regulatory and other data at national and sectoral levels. Examples of open data are state revenues, transport regulations, budgets, lists of social service providers, air quality measurement databases, etc. This data is interesting for citizens, but must be easily accessible through various applications and platforms.ext...

## **5.2. Summary and analysis of work results**

The main goal of the work was to propose a strategy for the implementation of the Smart City concept for the capital of Georgia - Tbilisi. The diploma thesis concerns and contains the most important aspects of the concept based on the information and results of the questionnaire survey, several were proposed recommendations that should have a positive impact on city administration and at the same time help reduce costs, reduce processes in the city and improve the living conditions of the city's citizens.

Following the analysis of the results of the questionnaire survey and the available information on successful examples of the implementation of the concept in the world, it can be confirmed that the transformation of cities into smart cities is effective both from an economic point of view, as well as from an ecological and social point of view.

In cities where this concept has been implemented, their openness has improved and credibility and the interaction of the authorities with the public have been strengthened, the city has become more energy and financially efficient, the quality of the environment has improved, and overall well-being has been created for residents and visitors to the city. Of course, in addition to opportunities, this process also brings a lot of threats that have not yet been fully explored, for example, the loss of minimal social contact between people, and the loss of the security of private data. If the city is controlled only by computer software and a decision-making system, cybercriminals can damage the whole system, which can cause great problems of a global nature. Therefore, it is important to realize that the most important elements in the implementation of the

Smart City concept are people. It is they who should play a major role in the decision-making process.

However, it should be mentioned that for the implementation of individual services and products within the Smart concept the City must be approached in a unified manner. The success of the implementation is not conditioned by the size of the city. Therefore, it is possible to say that cities with a population of more than 1 million, such as Seoul (9.86 million), Hamburg (1.8 million), and Singapore (5.6 million), can have economic and ecological benefits equal to cities with a population of less than 1 million (Seattle - 725,000 inhabitants, Latvia - 650,000 inhabitants, San Francisco - 870,000 inhabitants).

In the theoretical part of the thesis, it was described how different authors, companies, and organizations approach the mentioned concept. Current theories usually say that the term Smart City it is not just the use of modern technologies, but a comprehensive strategy for improving the lives of the city's inhabitants. Although it may seem that the Smart City concept is only a modern trend, it is important to understand that achieving greater sustainability in cities is only possible if they consider the concept from a long-term perspective. A questionnaire survey of permanent residents and visitors to the city of Tbilisi showed that the problems most worrying the respondents are connected with mobility, lack of recreational zones, and air pollution. As part of the thesis, several specific recommendations were proposed for the city of Tbilisi, which has economic and environmental benefits and social benefits.

The practical part of the thesis dealt with the analysis of the level of implementation of intelligent solutions in various sectors in the Georgian environment. Although Tbilisi has received ISO certification, it is important to assess the development stage of the Smart City concept. It can be said that the city is progressing slowly pace, but constantly implements intelligent solutions to simplify and improve the living conditions of the residents of the city of Tbilisi. Although the research and analysis of the available information showed that in the Georgian environment in various sectors companies are already dealing with the concept, there is not a single no established strategy or initiative group to focus on the concept. However, Tbilisi City Hall has already set the years 2020-2021 for the development of the strategic document Tbilisi Smart City.

Based on the information obtained during the preparation of the diploma thesis, it can be confirmed that the implementation of the Smart City concept in Tbilisi with 1.1 million inhabitants will have a positive effect on the lives of the residents, for the administration of the city, but also for the competitiveness of the entire state, because increasing the flow of traffic, reducing the traffic burden, increasing the convenience of public transport, expanding parking options, supporting

sustainable modes of transport, increasing the availability of verified data, greater awareness and involvement of residents, supporting the use of new technologies in education, increasing the city's equipment with sports, cultural and recreational zones, improving air quality, building smart waste management and efficient energy management, supporting environmental education, improving the effectiveness of communication between authorities and citizens, etc., all of this will guarantee the well-being of the city's residents and visitors, and of course, it will have a positive effect on the competitiveness of the entire state.

The work can become a suitable basis for the administration of the city of Tbilisi, especially the part analyzing the attitude of citizens towards certain aspects of the city. To improve the living conditions of the city a section containing proposals for individual services designed in accordance with the Smart City concept should also contribute. The work contains a basic overview of the Smart City concept, and therefore it can also be useful for those who want to learn more about the issue.

## **6. Conclusion**

The diploma thesis dealt with the Smart City concept. This topic is becoming more and more relevant nowadays due to global world challenges - population growth, population aging, urbanization, environmental problems, social security, poverty, etc. As already mentioned, today's lives 55% of the world's population lives in cities, and this share is expected to rise to 68% by 2050. A large number of people in cities creates many opportunities, but also brings with it many problems: traffic congestion, pollution, unemployment, poverty, high crime, costs etc.

Based on the opinions of experts in the field of theory and practice, various definitions of the Smart City concept were described. The subsequent analysis shows that there is currently no uniform definition or methodology for the implementation of this concept. Despite the lack of consensus on the definition of the concept, scientists agree in that cities can be defined as smart if they have the following elements: smart economy, smart transport, smart environment, smart people, smart housing, and smart government.

Various smart strategies and implementation tools are currently being developed for individual cities. More and more organizations are involved in the development and support of the Smart City concept. The most active of them are the European Innovation Partnership on Smart Cities and Communities (EIP-SCC), Smart Cities Council, The World's Smart Cities Organization (WSCO), City Protocol Society, etc. These organizations are constantly proposing various initiatives, models and projects within the concept. A vital role of the European Commission, which finances a large number of projects related to science, research, and innovation, also plays a role in the process of developing the Smart City concept in various European cities.

Successful examples of the use of the Smart City concept in the world show how a correctly chosen strategy, based primarily on knowledge of the needs of the city and its citizens, can create a pleasant environment for their lives in the city. The analysis of successful examples shows that the introduction of the concept does not depend on the size of the city and is beneficial for both large and small cities. However, it should be noted that every city is different, and therefore it is necessary to approach the implementation of the concept in a unified way. Of course, the size of the city determines how to approach the mentioned concept and what areas to focus on.

The practical part of the thesis was devoted to the analysis of the level of implementation of intelligent solutions in various sectors of the Georgian environment. The main goal of the work was to propose a strategy for the implementation of the Smart City concept for the capital of Georgia - Tbilisi. Although the study and analysis of available information showed that some elements of the

Smart City concept already exist in various sectors of the Georgian environment, the actual implementation of the concept is only at the beginning.

The questionnaire survey showed that the most important problems of the city are connected with mobility, lack of recreational and pedestrian zones, and air pollution. In addition, administrations should make more use of modern technologies, primarily to support public communication technologies between citizens and authorities. Another fact that should be emphasized is that the city does not sort waste. This is a very fundamental issue that the authorities should urgently address.

Based on the information obtained from the questionnaire survey, several concrete steps were proposed for Tbilisi that reflect the needs of citizens and visitors. Their implementation will be beneficial not only economically and environmentally, but also socially. As already mentioned, the Smart City concept is primarily based on a long-term strategy, which Tbilisi currently does not have, if it is absolutely necessary for the long-term development of the city. In order to create the right strategy, an active public and the collection of ideas are necessary, since the involvement - as already said - the Smart City concept should not only concern modern technologies but should primarily reflect the needs of the city and its citizens.

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## **8. List of pictures, tables, graphs and abbreviations**

### **8.1. List of graphs**

Graph 1: Structure of respondents according to whether they are permanent residents of Tbilisi or have visited in the last 6 months city

Graph 2: Structure of respondents by age

Graph 3: Structure of respondents by use of means of transport

Graph 4: Respondents' satisfaction with the flow of car traffic in Tbilisi

Graph 5: Satisfaction with the number of parking spaces in Tbilisi

Graph 6: Satisfaction with the operation of public transport

Graph 7: Structure of responders based on knowledge of the idea of smart cities

Graph 8: Source of information on the Smart City concept

Graph 9: Assessment of Tbilisi as a Smart City

Graph 10: Evaluation of the Smart City concept's implementation's effects in Tbilisi

Graph 11: Accessibility of information made public by authorities

Graph 12: Information channels providing important data on Tbilisi

Graph 13: Information channels for communication with city authorities

Graph 14: Respondents' satisfaction with Tbilisi's sports, cultural and recreational areas

Graph 15: Satisfaction of respondents with the number of places of possibilities to connect to a free Wi-Fi network

Graph 16: Structure of respondents who sort waste



## Appendix

Annex A - questionnaire: "Citizens' satisfaction with life in the city of Tbilisi"

Good day,

If you are a resident of Tbilisi or have visited Tbilisi in the last 6 months, please donate a few minutes of your time to fill out the following questionnaire.

1. Choose the option that suits you best.

- a) I am a permanent resident of Tbilisi
- b) I have visited Tbilisi in the last 6 months

2. Are you familiar with the idea of a "Smart city"?

- a) Of course
- b) More or less
- c) Not really
- d) Not at all

3. Where did you learn about the idea of "Smart Cities"?

- e) Television or Radio
- f) magazines or newspapers
- g) Internet
- h) Friends/ family/ coworkers / acquaintances
- i) Other
- j) I've never heard about it

4. If you are aware of any, please provide an example of a city that follows the "Smart city" concept.

5. Please explain what a "Smart city" is in your own words.

6. Do you think Tbilisi can be called a "Smart city"?

- a) Yes
- b) Rather yes
- c) Rather not
- d) No

7. What do you think are the most serious problems concerning Tbilisi?

8. Do you believe that the public can easily access the various Tbilisi statistics that the government has published?

- a) Absolutely
- b) More or less yes
- c) Rather not
- d) Not at all
- e) I'm not sure.

9. Where can you typically get crucial information about Tbilisi (news, details on different events, traffic data, information on public transportation, etc.)?

- a) Local newspapers
- b) Website
- c) Social networks
- d) Radio
- e) Mobile application
- f) Notice boards
- g) SMS newsletter

10. How do you typically get in touch with the local government when necessary?

- a) Website
- b) Social networks
- c) Telephone
- d) Mobile application
- e) Personal visit to the Met office
- f) Local newspapers
- g) Radio
- h) Forums
- i) Other

11. What would you like to change or add to the city's infrastructure or services?

12. What means of transport do you usually use?

- a) Town public transport
- b) Passenger car
- c) Motorbike
- d) Bicycle
- e) Other

13. Are you satisfied with the smoothness of car traffic in the city of Tbilisi?

- f) Yes
- g) Rather yes
- h) Rather not
- i) No

14. Do you believe there are enough parking places in the city's core?

- a) Absolutely
- b) More or less yes
- c) Rather not
- d) Not at all
- e) I'm not sure.

15. Please state your rate (from 1 to 10) if you frequently take public transportation .

16. If you are not satisfied with public transport in Tbilisi, please give reasons.

17. Please indicate your level of satisfaction with the facilities of Tbilisi with sports, cultural and recreation zones (from 1 to 10)

18. Do you sort waste?

- a) Yes
- b) Sometimes
- c) No

19. If you do not sort your waste, please state the reasons.

20. In your opinion, there are enough places to connect for free in Tbilisi Wi-Fi network?

- a) Yes
- b) Rather yes
- c) Rather not
- d) No
- e) I don't know

21. Do you think that the implementation of the Smart city concept in Tbilisi can have a positive impact on life residents?

- a) Yes
- b) Rather yes

- c) Rather not
- d) No
- e) I don't know

22. What age group do you belong to—?

- a) Under 21 years of age
- b) 21-30
- c) 31-40
- d) 41-50
- e) Over 50