

Implementation of Smart City Technologies in Odessa

Larysa Ivashko*, Mariia Filatova, Nataliia Shkurateniuk, Kateryna Petrenko, Emiliia Tashchy, Anastasiia Bogachova
Department of Management and Innovation, Odessa National I.I. Mechnikov University, Dvoryanska street, 2, Odessa, 65000 Ukraine

* Corresponding author, email: ivashkolm@ukr.net

Received: 05 November 2022

Accepted: 21 November 2022

Online: 30 December 2022

Abstract. The article deals with the practical application of the *Smart City* concept in the city of Odessa. It has been established that the main directions of development of the *Smart City* in Odessa are "smart" road infrastructure and mobile applications for convenient use of city transport, use of the latest housing management systems, electronic governance and online platforms for socially active citizens, "smart" lighting technologies *Jooby Smart City Lighting*, application of the Internet of Things (IoT) within the framework of the Odessa *Smart City* program. The article also describes the application of a system of efficient collection and sorting of garbage in the form of autonomous platforms, some of which work on solar energy. An element of the *Smart City* system in Odessa is the *Precious Plastic Odessa* organization, which has "rethought" plastic exits and partially solves the problem of their recycling. The considered online platforms solve the problems of establishing feedback and interaction of citizens with local authorities. Important questions and tasks are carried out on the platforms *Socially active citizen*, *Smart City*, *Electronic city*. All these technologies ensure a high quality of life for citizens, safe, ecological and economic functioning of all branches of the city's activities. It was established that the concept of *Smart City* combines the introduction of innovative technologies into the municipal and transport infrastructure of the city, thereby significantly increasing their efficiency, and also creates transparent relations between the city government, business structures and the public.

Keywords: Smart City; automation; video surveillance; IoT; modernization; lighting.

Citation: Larysa Ivashko, Mariia Filatova, Nataliia Shkurateniuk, Kateryna Petrenko, Emiliia Tashchy, Anastasiia Bogachova (2022) Implementation of Smart City Technologies in Odessa. – *Applied Business: Issues & Solutions* 2(2022)18–24 – ISSN 2783-6967. <https://doi.org/10.57005/ab.2022.2.3>

JEL: O31, Q42, R22, R49.

Introduction

Cities in modern realities are the dominant form of socio-economic organization and the so-called engines of the country's economic growth. The world's population is actively growing, especially the number of city dwellers. The consequences of this can already be seen not only abroad, but also in Ukraine: regional centers are growing, the number of cars on the roads is increasing, and the number of people on city streets is increasing. Therefore, such complex mechanisms as modern cities must be managed with the help of modern smart technologies, and in all directions: from the introduction of smart traffic lights and road signs to the construction of a global system of "smart" technologies in education, medicine, etc. This should really be one of the priority directions for the development of any *Smart City*, since the streets of this type of city should be comfortable, both due to the large number of technologies that make life easier, and due to absolute confidence of citizens and tourists in their safety. And despite Ukraine's population decline, urbanization continues. This determines the relevance of research and implementation of the "smart-city" concept in Ukrainian cities, especially in Odessa.

The concept of the smart city has attracted world interest, including governments, companies, universities, and institutes. Different stakeholders have tried to understand and explain the smart city from their different viewpoints [1]. The generally accepted definition of the concept of *Smart City* has not been established yet. Based on an integrated approach, *Smart City* is defined as an integrated and multifactorial municipal ecosystem that includes attracting human capital and full use of information and communication technologies by integrating physical, digital and human subsystems

in an artificial environment to solve current problems of the city balanced development in the economic, institutional, and environmental spheres to ensure the safety, comfort and quality of life of citizens in the future [2]. Smart cities have attracted great attention since 2008, with the launch of IBM's Smarter Planet project [3].

Today is the time of an active digital globalization, considerable technical progress, and the development of the Internet. The transformation of the entire infrastructure of each region of Ukraine with a focus on its existing potential is an important aspect that determines the attractiveness of Ukraine in the global space.

The most progressive regions of Ukraine are the Black Sea region and the Slobozhansky region. The attractiveness of an export activity in the Black Sea region was due to the development of industry and to the length of the maritime border, which makes it possible to receive and ship cargo from all the countries. Therefore, the city of Odessa in Ukraine is flexible enough to make changes and introduce innovations, which, as a result, contributes to Odessa residents' well-being and improve the quality of recreation and comfort of tourists in the city.

The purpose of this article is to determine the available elements of Smart City technology in Odessa and analyse the prerequisites for their implementation. The specified goal involves the following tasks:

- 1) determine the prerequisites for the introduction of Smart City technologies in Odessa;
- 2) consider the aspect of the development of the transport system on the way to the modernization of the city;
- 3) specify the available technologies that ensure the safety of city residents and guests;
- 4) consider the principle of operation of the *My City* platform

- and the advantages of its use;
- 5) analysis the "Socially Active Citizen" platform in terms of the Smart City concept in Odessa;
 - 6) reveal the problem of street lighting and the use of new technologies in this area;
 - 7) analyse the role of the *Smart City* program in ensuring the development of the city;
 - 8) consider examples of the use of IoT technologies;
 - 9) determine the possibility of electronic management of the city;
 - 10) consider technologies of the Smart City concept in the field of ecology.

1. Concept of the *Smart City*

Considering the importance of the role of forming a high-quality integrated system to meet the interests and needs of the municipal city residents, a number of scientists, including foreign ones, paid attention to the problems of defining the concept of *Smart City* and *Smart City Management*. Thus, the many domestic and foreign authors dedicated their works to this topic. D. Gibson, G. Kozmet-sky, R. Smilor [1] reveal the conceptual framework of a technopolis wheel from studying the dynamics of high-technology development and economic growth. The papers point to new institutional relationships among the segments of the technopolis wheel. E. Muraev [2] devoted his work to solving an important scientific problem formation of organizational and information support for strategy development smart cities of Ukraine in the conditions of the digital economy. S. Palmisano [3] considered the aspect of the global development of the world, including the role of smart cities in the development of the planet. V. Soto, E. Frias-Martinez [4] investigated the role of mobile devices in sensing the urban environment and described a method to automatically identify land uses from call detail record databases. I. Zhukovych [5] studied the interpretation of the concept of *Smart City*, also systematized all definitions according to the criterion of participation of certain interested parties. Chukut S., Dmytrenko V. [6] studied modern approaches to understanding the essence of the concepts *Smart City* and electronic city in the context of the development of electronic governance at the local level. Besides, the main problems that inhibit the development of e-government at the local level in Ukraine are identified, and the possibilities for overcoming them are indicated.

These scientists studied the theoretical part of the *Smart City* concept, systematized the existing concepts, and considered the conceptual foundations of the implementation of this strategy at various levels.

2. Modernization of the transport system

The transport system has a significant impact on the overall modernization of the city and this aspect must be considered in the Smart city concept. At his presentation on March 9, 2021, the director of the Department of Transport, Communications and Traffic Management of the Odessa City Council, Serhiy Tetyukhin spoke about the plans for the development of the road and transport infrastructure of the city of Odessa. The main areas of work were the development of pedestrian and bicycle traffic, fight against traffic jams and overloading of parking lots, as well as modernization of electric transport. Today in Odessa there are tools and technologies to solve these problems.

At the end of 2019, a free app "Public Transport — Odessa" appeared in application services [7]. It locates each tram and trolley-

bus in real time. Thanks to the application, you can find out the waiting time for a certain tram or trolleybus. Also, you can track the change in the electric transport route after the streets are closed, view all its stops and the inventory number of a vehicle and the number of seats.

This program was developed by employees of the *Provectus IT* company. Data on the location of transport is downloaded from the municipal website *Odessa Transport* [7]. But the site is not adapted and not suitable for use on a smartphone, so Provectus decided to create a mobile application. Today, the application is used by more than 3 600 Odessa residents and guests of the city, and its biggest advantage is the ability to work in offline mode.

In the future, the developers of *Public Transport — Odessa* are going to add the function of tracking minibuses. However, the main problem on the way to solving this issue is that the owners of route transport in most cases are private entrepreneurs. Therefore, there is a need to coordinate with each of them and install sensors in buses that will be maintained and constantly updated.

Regarding the development of electric transport in Odessa, the possibility of cashless payment in transport is important according to the Smart city concept. Since October 2020, this opportunity has appeared in Odessa trams and trolleybuses thanks to the joint actions of ME *Odesmiskelektrotrans*, *Transpod* and *EasyPay* companies. To do this, it was necessary to connect a payment card to the *Transpod* application and purchase a ticket by selecting the option "payment for travel".

The cashless payment system developed further and at the beginning of October 2021, PrivatBank launched cashless payment for travel in city transport. Payment can be made via the Privat24 application, where you can scan a QR code. In Odessa, for public transport passengers who buy tickets using a QR code, the price of a ticket is UAH 7 instead of the standard tariff of UAH 8, which is active from November 1, 2021.

In modern developed countries, traffic lights do not just play the role of an element within the transport system, they are equipped with a camera, Wi-Fi, a car, and license plate recognition system and the like. In 2018, a smart traffic light also appeared in Odessa at the intersection of Nebesnaya Avenue and Levitan St. It is equipped with video sensors and can adapt to the intensity of traffic flows. The traffic light decides automatically when to turn on the red or green light, according to the number of cars.

Another type of "smart" traffic light, which allows trams to pass, was installed in Odessa at the intersection of General Petrov and Yitzhak Rabin streets in 2019. The new traffic light object is equipped with LED lamps, a countdown timer, and its controller has a system that spots the approach of a tram: if the car approaches crossroads, the traffic light turns on a green signal for it and the tram does not stop at the crossroads. Today about 370 ordinary traffic lights are operating in Odessa, half of them do not comply with the legislation at all, and the effectiveness of smart traffic lights is still being monitored and new ones are not being installed [8].

The development of modern technologies in the transport system has led to the fact that many residents of Odessa, switch from cars and public transport to bicycles, segways, unicycles - their own or rented ones, whenever it is possible. And in 2020, an automated rental of electric scooters appeared in Odessa. Scooter rental was created to combat inefficient city transport, traffic jams, and the problem of air pollution in the city.

KIWI was the first company to launch scooter rental in Odessa in 2020. The price of using this company's electric scooter is UAH 10. Each minute of use will cost UAH 3.

The next company that introduced automated scooter rental in

Odessa was Bolt company. The first scooters appeared on the city streets in April 2021. The price of the service includes the price for unlocking the vehicle and the time of its use. Unlocking an electric scooter in Odessa will cost UAH 9, a minute of travel from Monday to Thursday — UAH 1.9, and from Friday to Sunday — UAH 2.5.

Another company that provided Odessa residents and guests with electric scooters was the JET company in September 2021. Unlike its competitors, Jet does not require an unlocking fee. You need to pay only for the time of the trip, the price is UAH 2.50 per minute.

To use the rental car, you only need to download the application of the relevant company to your phone, in which you can see where the scooters are parked. To set the scooter in motion, you need to link your bank card and scan the QR code. The maximum speed of the scooter is 25 km/h. The battery charge lasts for 2-4 hour of active use. In Odessa, scooters are located throughout the city, but mostly in the central part of the city. These are popular locations, such as Mysksad, Primorskyi Boulevard, Deribasivska st., Soborna Ploshcha, Oleksandrivskyi Prospekt and others.

Speaking about electric vehicles, we should mention electric cars. They are gaining increased popularity in Odessa because most of the electric cars supplied to Ukraine were imported through the port of Odessa. Therefore, the creation of charging stations, which are now represented in Odessa by network complexes of popular gas stations, recharging stations in parking lots and parking lots of hotels, restaurants, cafes, shopping, and dealership centres, has become an urgent issue.

In 2019, the first location where you can charge an electric car at a fast electric gas station appeared in Odessa. It contains 3 stations, which are installed near the Odessa CLEAN UP dry cleaner at Rozkidailivska st. 3. The first station charges cars with a 50-kW direct current and has a CHAdeMO connector, which allows you to charge the popular Nissan Leaf car in 30 minutes. The second station (EFS AC-32MSB), AC 22 kW, has a Type2 connector (Mennekes) and charges a Renault ZOE in 50 minutes. The third AC station (EFS AC-32J2M1SB) has two Type1 ports (J1772) and one Type2 port (Mennekes), and can simultaneously charge three cars with a capacity of up to 7 kW, for example, the same Nissan Leaf will be charged in 3 hours [9].

Today, the city of Odessa has about 30 charging stations for cars running on electricity. Most of them are in the central part of the city, three devices are in Tairov borough, two near the industrial market "7th kilometre", four of them are located in Kotovsky and Fontanka boroughs.

3. The role of the video surveillance system

Another important component of a modern city developing according to the "smart city" concept is smart technologies that provide the safety of residents and visitors of the city on its streets [5]. Odessa does not stand aside of this direction of development.

In 2017, the city authorities initiated the launch of the *Safe City* automated video surveillance system [10]. Due to this technology, it became possible to confront various offences, to read registration plates and identify faces, to measure the speed of traffic on the roads and to look for criminals, missing people, stolen cars and other vehicles, suspected people. The system works round the clock in real time, therefore, all the information is accurate and operational.

Odessa is the cultural capital of the southern region of Ukraine. Nowadays it is one of the biggest cities in Ukraine, with over a million inhabitants, the fourth after Kiev, Kharkov and Dnipro in terms of population. And for this city several dozens of cameras of the National Police of Ukraine and municipal enterprises are crucially

insufficient. But that was the reality before 2017. However, the city authorities have decided to change it, first of all, by creating a new department – the Centre of integrated video surveillance system and video analytics of Odessa (*Center-077*) [10].

According to Boris Magazinnik, head of the organizational and analytical support of the Department of Municipal Security, Odessa became one of the first Ukrainian cities which implemented a similar video surveillance system, that can automatically monitor the maintenance of order in the city and carry out necessary analysis.

"We were inspired by the experience of the city of Kyiv. It was their video surveillance that we liked most because of its excellent results of work. Our hardware specialists recorded the necessary data, and then worked on the development of this project," said Boris Magazinnik [10].

Once the project was approved, 30 million UAH were allocated by the local authorities for its realization. With this money, monitor rooms with large screens were equipped, and video surveillance cameras were also installed throughout the city. In these modern monitor rooms, 81 images can be displayed on the screen at the same time. This greatly facilitates the work of guards and increases performance.

If we talk about the modern scales of the video surveillance system, in today's Odessa we have already had more than 1000 such cameras installed. There are such kinds of the cameras: overview cameras, with license plate recognition, cameras with face recognition function, controlled cameras, panoramic cameras. There are also more than 200 cameras of the Specialized Installation and Maintenance Department and the Main Department of the National Police in Odessa region that work in the system [10].

The largest number of such cameras is inserted in the most popular district of residents and tourists of Odessa – in the Primorskyi district. It was here where many incidents involving theft, criminal offences, and so on were recorded.

Most of the offenses were recorded on the *Health Route* – a pedestrian zone 6 km long. It was before the introduction of an automated video surveillance system.

Maintenance of one camera with a communication service costs the city budget about 650 UAH per month. Kyiv spends more than 1200 UAH for the same purposes, Dnipro - about 1000 UAH [10]. Today, the results of the authorities' activities in this direction can already be felt. According to the *Center-077*, with the advent of cameras, the crime rate in areas where large crowds gather has dropped significantly.

During the Centre's work reported cars and motorcycles theft cases decreased by more than 72%. Moreover, with a video surveillance system, it was possible to catch lots of groups of car thieves, to find about 250 missing cars and more than 20 missing children. However, there are certain nuances in the system operation. Consequently, it is important to understand them.

These have been described by Boris Magazinnik: "It is important to understand that our database has not got contacts with any other database. We can't identify each person by an image. The system does it only for those people who were put on a wanted list officially, and information about them is open." [10].

This video surveillance system also works for the development of transportation logistics in Odessa, as well as the control and managing the individual city's objects.

For example, at the request of the Tourist Centre, a huge amount of visual information about those who visited a certain type of beaches in the summer is collected by cameras. In addition, *Center-077* evaluated a program to identify violations of parking in the city, however, the results of this work have not been made public yet.

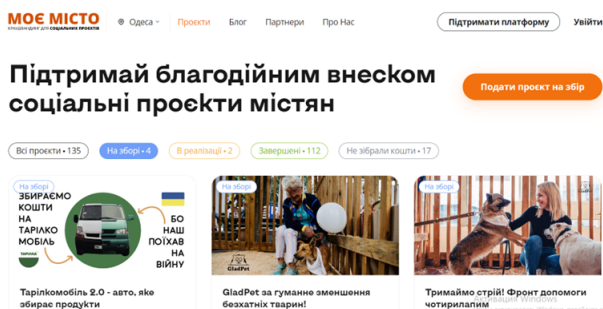


Fig. 1. Online platform *My City* [11].

About 50 people with access to the system currently work in *Center-077*. They monitor everything that happens on the screen and look for information at the request of citizens and organizations. Access to the municipal video surveillance system is also granted to the following subjects: the National Police Headquarters in Odessa region, the Office of the patrol police in Odessa, the Ukrainian Security Service, the Specialized Installation and Maintenance Department, the State Emergency Service of Odessa region [10]. Footage can also be purchased by those who have special permission at the appropriate rates.

4. Online platform *My City* and *Socially Active Citizen*

It should also be said that in the modern world the townspeople very often independently initiate the introduction of certain innovations for full development of their city [6]. Odessans are no exception. Thus, *My City* online platform was created by a few active citizens - see Fig. 1. With its help, everyone can collect the necessary resources for the implementation of their project. Only non-political, non-religious projects that can be of substantial public benefit and to resolve or mitigate some specific problem in the city can be submitted to the platform [11].

On the site, you can review the city's existing projects, as well as post your project for public consideration. You can also support any project and spread the experience of implementing some projects.

The main way to attract resources on this platform is crowdfunding, that is, collective financing. As described on their website, it deals with the collaboration of people who bring together money and other resources to support the efforts of other people or organizations to implement their ideas [11].

For maximum efficiency in promoting your project or idea, you should follow a certain algorithm of actions, that are clearly indicated on the website of the *My City* platform. Once the author has had an idea of his project, they should submit an application to the platform, choose the most appropriate title, describe their project, and also choose the duration of the fundraising and the required amount.

Philanthropists who like the purpose of the project support it financially. Thanks to this, the author raises the necessary amount for the implementation of the project and brings it to life. If the project does not raise the required amount, after checking with the author, *My City* team will transfer the received funds to another project [11].

The interface on the platform's website is very convenient, and all projects are classified into the following groups: roads and transport, ecology, improvement, sports and health, charity, tourism, economy, education and assistance to the military. Thanks to this platform,

more than 110 projects have already been implemented and more than 6 million UAH have been collected.

Once again, it was found that both the government and even citizens of Odessa are interested in funding such projects. Thus, with the joint efforts, the full implementation of the *Smart City* concept in Odessa will be much more efficient and faster.

Since April 19, 2017, there has been an online platform *Socially Active Citizen* - see Fig. 2. This is a unified electronic system that combines three areas: submission of projects, registration of petitions and participation of Odessa citizens in public discussions.

On the website, you can submit collective petitions, provide your idea regarding the use of budget articles, and also consider the discussions of citizens that are relevant and important.

Every Odessa resident can register on the platform using a bank ID (bank card), electronic digital signature, social networks with a copy of the passport and identification code.

The first direction of this system is *Public Budget*. It gives every Odessa citizen the opportunity to submit his idea in an electronic version, having previously issued it in the form of a project. By means of electronic voting, the citizens of Odessa vote for the projects, and the city government pays for the implementation of the chosen ideas from the city budget.

The second direction is the electronic petition submission service. This is an opportunity to submit collective appeals to executive authorities on any occasion.

The third direction called *Public discussion* is working according to the principle of conducting public hearings, but only in electronic form. This allows to cover a greater number of opinions of Odessa citizens [12].

On December 7, 2021, the Odessa Public Budget Commission completed consideration of projects submitted by Odessa residents for implementation in 2022. 97 projects submitted to the online platform [13] of the Odessa City Council *Socially Active Citizen* were considered. According to the results of the meetings, the Commission supported 70 projects that were submitted for online voting, including 23 small projects. The total amount of expenditures for 2022, which was planned to be directed to the implementation of the winning projects, was UAH 50 million [14].

5. Operation of smart meters

Next on the list of smart city technologies are smart meters and Jooby RDC radio modules for remote reading. They take the readings automatically and send them independently to the relevant companies. Jooby sensors are created to measure water, gas, heat and electricity meter readings. Such Jooby RDC systems are used in several cities of Ukraine, and in general their users are more than 15 thousand subscribers.

The second smart technology is *Jooby Smart Lighting* systems. Depending on the time of day, the lamps automatically adjust the brightness of the light. Also, the operation of the lighting system can be adjusted to the presence of a person [15]. For example, if

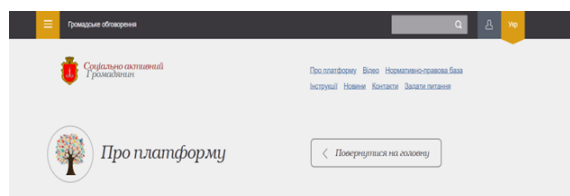


Fig. 2. Online platform *Socially Active Citizen* [12].

there is no movement on the street, then the lighting is reduced to the minimum level. This significantly reduces the level of electricity consumption. Accordingly, when the motion sensor is triggered, the brightness increases. *Jooby Smart Lighting* systems are used in Ukraine and other countries, and also meet the highest environmental standards.

Another application of the *Jooby Smart Street Lighting* technology in Odessa is street lighting system which is managed by the *Jooby CMS* cloud service, developed in Switzerland. This solution is easily applied both to one object and to the entire network of the city. The lamps can be adjusted for time and brightness, they turn on and turn off accordingly to the astronomical calendar. The process of controlling the lighting intensity according to the schedule allows you to set up to 8 points of daily brightness change [15]. And the *Jooby CMS* cloud system reads and visualizes data on consumed energy, current energy capacity, brightness level of lamps and the number of activations of motion sensors — reports are available for 26 parameters of the system.

And, of course, there is an example of the use of this technology in Odessa. It is the lighting of the entrance to the "City Centre" shopping centre. These devices can be managed both by list and by map. It is easy to group objects and choose different management programs.

Also, there is the third technology — *Jooby RDC Dashboard*. It is a service for collecting and processing data on the consumption of all types of resources and the status of devices [16]. This allows the resource company, developer, etc to receive accurate readings just in time. Using the service, consumers have access to data on the status of devices and the network, as well as receive graphic reports on resource consumption.

6. State program *Smart City*

We can also highlight the *Smart City* program in the Odessa Regional State Administration, which was presented by IoT Ukraine. A *Smart City* is a developed urban area that generates sustainable economic development and high quality of life, focusing on improvements in the economy, mobility, environment, as well as improving the living conditions of people and the government. Success in these areas can be achieved through strong human and social capital.

According to the developers, the main problems of cities today are as follows:

- a) up to 30% of cars on central roads look for a parking space;
- b) up to 40% of all public spending is spent on street lighting;
- c) urban waste is expected to increase by 100% in the period 2010-2025;
- d) occupying 2% of the total area of the Earth, cities emit 80% of carbon dioxide [17].

The *Smart City* project will help to correct this situation in such areas as industry, logistics, agriculture, environment, transport and traffic, parking, waste management, smart lighting, protection and safety of residents. This platform is driven by useful and resource-saving applications to improve cities and keep citizens informed. The project describes functions such as air quality checks, assessment of café sanitary conditions, inspection of current buildings and legislation to be implemented should be easily accessible.

One of the key elements that connects all the components of a smart city is sensor IoT devices [6]. By extracting information from the sensors and integrating it, social networks help members of society to be closer to each other, leaving the city government to deal with more serious security issues. In Singapore, thanks to the Inter-

net of Things technologies, just one computer warns of traffic jams, directs additional public transport to congested routes, and monitors the state of utility networks in real time. Meanwhile, in most Ukrainian cities, people still pay cash for travel in buses, and utilities learn about accidents from calls from outraged users. Today, the window of opportunity for Ukrainian cities is open: innovative ideas are waiting to be finally accepted and applied.

There is a vivid example of the use of IoT technologies, which gives an advantage to utilities when there are constant accidents in the place. After all, IoT technologies allow real-time automatic monitoring of all systems [5]. For example, a water utility can equip metering devices in homes and even infrastructure facilities with such sensors. Through a SIM card in each sensor, the utility will automatically, without collecting data manually, receive up-to-date information about the state of the networks, in particular: how much resources a house or entrance consumes, where an accident occurred, and prevent disasters by responding to events in a timely manner. The mobile operator will provide not only SIM cards for continuous monitoring, but also a special online platform for management and control - the IoT Control Centre.

Thus, in the *Smart City* it will be easier to obtain information directly from specially installed sensors or "indirectly" - thanks to sensors installed for another purpose, but which have useful information. The *Smart City* contains intelligent sensors in every corner, facilitating the management of urban economy through a system of intelligent video analytics. Video data is integrated through wired and wireless networks, creating an urban public safety platform [17].

7. Electronic (Open) City platform

Another element of the *Smart City* program in Odessa is the Electronic (Open) City platform. It is defined as a system of electronic city management on the one hand and a service for receiving applications from citizens on the other. This program was first presented in Odessa in 2015. Its main task is the maximum openness of the authorities, control of city services and demonstration of the work of officials. Within the framework of the program, a single centre for citizens' appeals has already been created, thanks to which Odessa residents can report any city problem and get a result without leaving their homes.

The main element of the program is the system of processing citizens' appeals. For the first time, all appeals are consolidated into a single database with control over their implementation. Electronic document management allows to connect all departments, municipal institutions and make them fully function. The current system of citizens' appeals is not so effective. And within the framework of the project, the following scheme works: a person publishes an appeal on the site (it is equivalent to a written one), and in a few minutes this message is already with the executor. It becomes possible to speed up the processing of appeals, as well as to avoid paperwork. By the way, in the future, the mayor will also have his own office, where he will be able to see at any time how this or that service works, at what stage of execution the work is, etc.

Operators collect applications from all possible city channels (citizens' appeals department, hotlines, district and city receptions, reception departments at district administrations, social networks) and include them in the Unified Electronic Register. Appeals come to the relevant deputy mayors or to him and are redistributed to the direct executors. Thus, appeals are under bilateral control - by Odessa citizens and the city leadership. In general, the priority directions of the city management system are housing and communal services,

social direction, medicine, education, tourism, transport, administrative direction and urban planning [18].

In addition, other portals are being created. Thus, on the investment portal Odessa residents will be able to place their proposals for investment, on the tourist portal - it will be possible to view a directory of all attractions and the mobile application *Guide to Odessa*. Separately, it is planned to create an electronic directory on housing and communal services with passports of all houses, as well as a map for GPS tracking of public and technical transport (for example, snow removal equipment) [19].

It is impossible not to pay attention to the addition to the city program *Electronic City*, where Odessa residents can use the service *Open City Budget*. According to the authors, the purpose of the project is to launch a unified information infrastructure of the executive bodies of the municipality. Thus, Odessa residents will see how a transaction is included in a particular department or, conversely, how part of the money goes to certain needs. That is, all financial flows can be tracked and analysed.

According to the Director of the Department of Information and Public Relations Andriy Syvash, the key changes that will be made to the project include:

- a) creation of a comprehensive city information protection system;
- b) introduction of an information system for property management of the territorial community;
- c) development of an electronic archive of technical inventory and evaluation of real estate objects [20].

Creation of a *Personal Account of Odessa Citizen* is another change to the program. According to the project, it should be a unified system of identification and authentication, which will provide authorized access of participants of information interaction - citizens-applicants and officials of the authorities to the information contained in local information systems. As well as integration into the main portal of the city and providing unified access to numerous services, portals and systems of the city council.

This program also involves the creation of a system of informing Odessa citizens. Residents of the city will be able to receive up-to-date information about the events of the city, the work of public utilities. The service of sending electronic and free SMS messages for the city residents regarding emergencies, changes in traffic, road closures, urgent search for blood donors, scheduled power outages, water cut-offs, etc.

In addition, the amendments provide for the creation of online registration for Odessa residents to make an appointment with deputies or officials.

8. Ecological aspect in the *Smart City* concept

One of the most critical issues that must be addressed with a sense of urgency is the environmental issue [4]. Among other things, the various pollution problems and the problems of secondary use of waste are also solved by the smart city concept. So, there are several notable examples of solving these issues in Odessa.

In the period from 2020 to 2021, 27 underground containers for collection and sorting of domestic solid waste were installed in Odessa. A total of 9 complexes with containers of waste disposal with a volume of 1.1 cubic meters, the special monitoring system that determines the degree of their fullness, the warning system and the remote control have been installed.

An aboveground part includes three garbage containers with LED lighting, with information stickers telling people what can be thrown in and what cannot, with 4 solar panels and with Wi-Fi system.

These containers are autonomous. When the container is full, the LED light changes from green to red and the lid is locked.

A garbage truck driver can empty the container simply by pressing one button on the remote control. Then, he needs to manage the system through the special program on his phone.

After receiving a signal, the platform with the container, located underground, will rise up and after unloading of containers, it will set in place, and will be lowered in the underground chamber by pressing a button. Such a system can help to reduce the time for emptying containers and, as a result, improve logistics of waste disposal organizations.

Another innovation is the solar panels that are located beside waste collection systems. Charge the batteries for at least 50 descents and ascents of the platform. Thanks to the installation works on cable laying into containers were removed [22].

This system helps to sort waste conveniently and send it for further processing. In addition to this, the implementation of the *Solar City* project was started in the beginning of 2020 with the assistance of the Odessa City Hall. The project calls for installation of solar panels on the roofs of apartment buildings. The project is implemented by funds of the companies that have the appropriate license. These solar panels are intended solely for the generation of electric current that will be directed to the power grid according to the "green tariff".

"As for the residents of apartment buildings, the benefit is obvious for them. They will have a repaired roof and they will subsequently receive 25% of the profits from the electricity produced. According to preliminary calculations, this profit will be about UAH 80000 per year for one house. Residents will be able to spend these funds on the improvement and repair of their own home," said Genady Trukhanov.

He also emphasized the benefits of this activity for Odessa. It consists of attraction of investments for the repair of housing stock and reducing the consumption of traditional energy sources. This innovation will contribute to lower annual CO2 emission levels and implementation of the Covenant of Mayors for a reduction of carbon dioxide emissions which Odessa joined in 2015 [23].

Also in Odessa, was developed «Precious Plastic Odessa» project. In short, this is a plastic waste collection point. The workers of this centre accept all sorts of plastic and create different household objects from it, for example, dishes, toys, jewellery, lamps, and many other things which we use in daily life.

The prices of these products are based on the cost of the plastic bottle caps per kilogram. Now it is about UAH 20 per kilogram. In addition, employees of the centre systematically carry out educational activities, talk about the peculiarities of plastic material, organize theoretical and practical events. The founders say the workers of the *Precious Plastic Odessa* project are always ready to cooperate with organizations and carry out even very urgent and large orders in exchange for receiving plastic raw materials for further work [24]. Examples of such projects include bicycle parking, tables, chairs and even the technology for creating paving slabs from recycled plastic has been developed.

Conclusions

The article reveals the nature of the existing elements of *Smart City* technology in Odessa and reflects the prerequisites for their implementation.

1. Prerequisites for the introduction of *Smart City* technologies in Odessa and the prospects of this region are described. The

aspect of the development of the transport system on the way to the modernization of the city is considered.

2. Existing technologies that ensure the safety of city residents and guests were considered and technologies were analysed in the future.
3. The principle of operation of the *My City* platform and the advantages of its use are described. The *Socially Active Citizen* platform was analysed from the point of view of the *Smart City* concept in Odessa. The role of the *Smart City* program in ensuring the development of the city was analysed.
4. The problem of street lighting and the use of new technologies in this area is revealed.
5. Examples of the use of IoT technologies are considered. The possibility of electronic management of the city is determined.
6. Technologies of the *Smart City* concept in the field of ecology are considered.

Every year Odessa gets closer to the concept of the *Smart City*, introducing the latest technologies for the infrastructure potential create good perspectives for the attractiveness of the Black Sea region of Ukraine in the world. The acceleration of the modernization of this region offers many new innovative solutions for the development of the city, including the development of the city's transport model, the creation of platforms for the development and implementation of projects that ensure people's comfort. In addition, the city of Odessa takes care of security by installing automated video surveillance systems and implementing smart lighting technology. And some resources, such as IoT technologies, even help to automate household tasks, facilitating the work and functioning of the city. In addition to the government, citizens also participate in im-

proving the city. They actively propose and finance projects, express their opinions in the form of petitions and public discussions, and create eco-initiatives to save the environment.

Abbreviations

IBM	-	International Business Machines
IoT	-	Internet of Things
IT	-	Information Technology
LED	-	Light Emitting Diode
UAH	-	Ukrainian Hryvnia

Authors' contributions

Larysa Ivashko chose the topic of the article and the aspects that should be covered in it, developed the methodology of its writing.

Maria Filatova created the final version of article, designed it according to the requirements, reviewed the literature devoted to this topic and analysed the technologies in the transport system.

Nataliia Shkurateniuk considered the relevance of this topic and research perspectives, highlighted the problem of security in the modern city.

Kateryna Petrenko systematized the terminology of this article and considered the latest innovations in implementing the *Smart City* concept.

Emilia Tashchy conducted an analysis of online platforms that ensure the development of modern cities and determined their role in the general concept of a *Smart City*.

Anastasia Bogachova considered the ecological aspect of the *Smart City* and drew general conclusions.

All authors read and approved the final manuscript.

Conflicts of interest

There are no conflicts to declare.

References

1. Gibson, D.; Kozmetsky, G.; Smilor, R. (1992) *The Technopolis Phenomenon: Smart Cities, Fast Systems, Global Networks*. - Rowman & Littlefield Publishers, 1992.
2. Muraev, E. (2021) Organizational and information support for the development of the smart cities strategy of Ukraine in the conditions of the digital economy. - Kharkiv National University. 2021. - P.38-39.
3. Palmisano, S. J. (2008) A smarter planet: the next leadership agenda. - IBM, 2008.
4. Soto, V.; Frias-Martinez, E. (2011) Robust land use characterization of urban landscapes using cell phone data - *Proceedings of 1st Workshop on Pervasive Urban Applications* in conjunction with 9th International Conference on Pervasive Computing, San Francisco, 2011.
5. Zhukovych, I. (2014) Smart city as a new object of statistical research: some conceptual aspects - *Statistics of Ukraine* 2 (2014) 69-73.
6. Chukut, S.; Dmytrenko, V. (2016) Smart city or electronic city: modern approaches to understanding the implementation of e-government at the local level - *Investments: Practice and Experience* 13 (2016) 89-93.
7. Odessites have created an application that tracks the movement of public transport - <https://www.digest.pro/news/odessity-sozdali-prilozhenie-kotoroe-otslezhivaet-dvizhenie-obshhestvennogo-transporta>
8. A smart traffic light was installed for trams in Odessa - <http://www.golos.com.ua/article/324164>
9. The most powerful charging station for charging electric vehicles was opened in Odessa - <https://autogeek.com.ua/v-odesse-otkryli-samuju-moshnuju-lokaciju-dlja-zarjadki-jelektromobilej>
10. Safe city: who is watching us and why would Odessa do that? - <https://odessa-life.od.ua/article/bezopasnyj-gorod-kto-za-nami-sledit-i-zachem-jeto-odesse>
11. My City platform - <https://Odessa.mycity.one/about>
12. The platform Socially Active Citizen was presented by the mayor of Odessa Gennadiy Trukhanov - <https://ukranews.com/news/492807-mehr-odessy-gennadyi-trukhanov-prezentoval-onlayn-platformu-socyalno-aktyvnyy-grazhdanyin>
13. <http://citizen.omr.gov.ua>
14. Odessa's public budget for 2022: 14 small projects became winners - <https://omr.gov.ua/ua/news/226115>
15. Smart street-lighting systems - <https://jooby.eu/ua/cms-admin-panel>
16. Jooby RDC Dashboard - <https://jooby.eu/uk/rdc-software-ua>
17. The Odessa Regional State Administration presented Smart City - http://izmail.es/print_version/article/43878
18. How it works: the Electronic City system has launched in Odessa. - https://od.vgorode.ua/news/transport_y_nfrastruktura/252870-kak-eto-ustroeno-v-odesse-zarabotala-systema-elektronnyi-horod
19. The Electronic City: in a virtual city Odessa they will receive complaints, monitor transport and making the most detailed map - <https://dumskaya.net/news/elektronnyj-gorod-044123//?setua=1>
20. Odessa City Council will launch the Open Budget programme before 2018 - <http://bornyakov.com.ua/2016/09/08>
21. The Open Budget - http://probudget.org.ua/news/odesskiy-gorsoviet-planiruet-zapustit-sistemu-otkryityy-byudjet-do-2018-goda_200
22. In Odessa is being installed underground tanks for the collection of solid domestic waste - <https://omr.gov.ua/ua/news/222949>
23. The project to install solar panels on the roofs of a multi-storey buildings was launched in Odessa - <https://www.omr.gov.ua/ua/news/221342>
24. Precious Plastic Odessa - <https://Odessa.name/ru/articles/2209-studiya-plastika-v-odesse-precious-plastic-odessa>