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Management of Urban Security and New Technologies

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Abstract:

Purpose: *The main aim of the article is to discuss how and in what areas modern technologies can influence the process of ensuring safety in the city.*
Design/Methodology/Approach: *During the initial research stage, the main research problem was formulated as a question: How do modern technologies improve city safety? The research utilized both quantitative and qualitative methods. Data for the analysis was obtained using the diagnostic survey method. The case study method presented examples of solutions involving implementing new technologies to ensure city safety. Theoretical research methods, such as critical analysis of the literature on the subject and generalization, were also used to answer the research problem. In order to examine the extent to which projects shaping the intelligent and creative space of medium and large cities in Poland concerned security and what benefits were achieved, empirical research was conducted among representatives of 177 large and medium-sized cities in Poland. A CAWI and CATI survey was used.*
Findings: *In Polish middle-sized and large cities, issues related to ensuring safety are considered in projects that create smart urban spaces. However, the percentage of implemented projects aimed at ensuring safety is low. Although the implemented creative and intelligent solutions in Polish cities are not very relevant to the issue of security, respondents see benefits in this area like better organization of response to threats, supporting decision-makers in selecting appropriate actions to the existing threat, better protection of critical infrastructure, reducing the risk of threats.*
Practical Implications: *Practical implications mainly refer to drawing attention to the benefits of using new technologies for managing city security. As a result, this may lead to an increase in the number of projects creating smart city spaces aimed at improving security.*
Originality/Value: *It was found that new technologies can improve safety in cities, but the percentage of projects creating smart city spaces in this area is still insufficient.*

Keywords: *Urban security, smart city, information and communication technologies, challenges for security, management of security.*

JEL codes: *R00, O18, H12.*

Paper type: *Research article.*

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1. Introduction

At present, more than half of the human population lives in urban areas, leading to the expansion and multiplication of cities. Projections indicate that urbanization will persist in the coming years, with the urban population expected to reach 70% by 2050 (The World Bank, 2023). The ongoing urbanization process poses heightened challenges and potential threats to various aspects of city functioning (Tatham and Houghton, 2011). Their sources can be located both in the city and its surroundings. This means that the problem of ensuring the safety of cities, especially their residents and other people staying in them, will continue to be a critical concern in the future.

The city is characterized by complexity, uncertainty and dynamism. Its complexity arises from the many elements and relationships within it. As a specific social system, it is also dynamic – due to the intensity of changes occurring in it. This dynamism creates uncertainty. The city is affected by processes in specific periods (intervals) and phenomena in moments.

Both processes and phenomena are a source of security challenges for the city. Like the city, the processes and phenomena that affect them are also dynamic and complex. These processes and phenomena are also complex and dynamic, accumulating various positive and negative occurrences. As the city develops, the connections between these elements become more intricate, and new processes and phenomena emerge, further increasing uncertainty and the security challenges the city faces.

The city, as a security entity striving to ensure safety, not only takes action to eliminate threats but also adopts an active attitude, taking up emerging challenges, and, thanks to this, tries to shape its security (Zięba, 2016). In order to ensure the security of the city and its residents, it is necessary to use various methods and measures.

Over the centuries, these methods have taken different forms - depending on the development of civilization, technology, and opportunities. Modern information and

communication technologies are used on a large scale in cities. Their integration into city management processes is expected to have a positive impact on improving the quality of life of residents and their safety. Investments in smart city technologies are estimated to reach 327 billion dollars by 2025, compared to 96 billion dollars in 2019 (Trapenberg Frick, Mendonça Abreu, Malkin, Pan, Post, 2021). Many of the implemented projects are aimed at improving security in cities.

Considering the above remarks, the aim of the article is to discuss how and in what areas modern technologies can influence the process of ensuring safety in the city. The article will present theoretical aspects of the smart city concept, focusing on safety, and provide practical examples of how modern technologies are used in selected cities based on desk research, diagnostic survey methods, and case studies.

2. Literature Review

The city is a unique type of local community, and as a result, it is an area of unique research regarding the security of this community. Marian Cieślarczyk emphasizes that "the perspective of thinking about security in relation to such an entity as the modern city seems very interesting, both from a cognitive and practical point of view. It can be assumed with great probability that cities may be particularly exposed to various types of threats and crisis situations in the coming decades.

The term 'city security' did not appear by accident. Both in theoretical analysis and empirical research on 'public security in urban space', it is worth taking into account not only the security of citizens in the city but also the security of the city understood as a social and organizational system" (Cieślarczyk, 2010).

When examining the relationship between security and the city, attention should be paid to two fundamental dimensions of this security—structural and personal. In the first case, the city becomes a specific subject of security, while in the second, it becomes its guarantor. In the first case, we are dealing with the security of the city, and in the second, security in the city.

Security in the personal dimension assumes the creation of such conditions for a person that would enable their survival and development. In turn, structural security is organizational (institutional) security, the essence of which is to provide a person - as an individual, but also as a member of a more or less numerous social group - with conditions for existence and development, and thus a sense of security (Cieślarczyk, 2010).

The security of a city as a social and organizational system directly impacts personal security. Both dimensions of security encompass three primary living conditions: duration, survival, and development. Duration is related to physical existence, while survival refers to the ability to overcome emerging difficulties and threats. Development opportunities involve improving possibilities and potential.

Currently, issues related to the city and its development planning and work related to security have become closely interconnected (Moch, 2019; Moch and Wereda, 2020; Sjöberg and Nygren, 2021). It is, therefore, not surprising that the concept of a safe city can be encountered in the literature. This is not an entirely new issue, but no single, commonly used definition has been developed. Some authors refer to the concept of a safe city only to issues related to ensuring safety in public places, e.g., reducing the number of murders or rapes (Borker, 2017; Nazrin, Anuar, Noorbaizura, and Aziz, 2012).

However, defining this concept only as physical protection is also narrow because it mainly assumes reactive actions after an adverse event has occurred. Meanwhile, urban security is the result of many complex factors today. As emphasized by Gaspar Viega, *"If you think about safety only in terms of reducing crime, that doesn't necessarily mean that the city will be kept safe. For example, you can look at casualties from poor traffic management and auto accidents. It's also about the level of pollution in a city. This is how a safe city should be analyzed"* (Davies, 2023).

The safety of a city is a result of many different factors. Cities are often the "first front line" in the face of emerging social, economic, ecological or political challenges. Some researchers of the city phenomenon even point out that currently, the city is associated with danger because there are many different types of threats in its area (Ellin, 1997).

In light of this, a safe city can be understood as a city that is protected from physical, social and psychological threats but also from all factors that may in any way threaten the well-being of society and the creation of a prosperous, safe and comfortable environment for living, working and playing (Ali, Tarmidi, Malmun, Noor, Hassan, Sidek, Nasir, and Ramly, 2022).

Maroš Finka, Vladimír Ondrejicka and L'ubomír Jamečný understand city security as any security related to humans in any area of the city (urbanized area) to which society has more or less unrestricted access without restrictions (i.e., in public space, with particular emphasis on outdoor space) or any security related to humans, related to phenomena and activities in public spaces (Finka, Ondrejicka, and Jamečný, 2016).

Thus, this concept covers many factors and activities related to public spaces, including crime prevention, environmental protection and institutional and organizational issues.

Some authors treat the concept of a safe city as one of the smart city systems (ex., Perboli and Rosano, 2020; Lacinák and Ristvej, 2017). The subject of interest of a smart city is the issue of using modern technologies to improve the quality of life of its residents, increase the efficiency of city management, improve the quality of city services provided and increase the competitiveness of the city (The Committee of

Digital and Knowledge-based Cities of UCLG, 2012; Caragliu and Nijkamp, 2009; Schaffers, Komninos, Palloot, Trousse, Nilsson, and Oliveira, 2011; Moch and Wereda, 2020). In their opinion, the concept of a safe city includes issues related to protecting people, property, the environment and infrastructure.

The idea of a smart city developed in the late 20th century as a new paradigm of urban development and socioeconomic growth (Kourtit, Nijkamp, Arribas, 2012). The term itself was first used in 1992 to describe urban development moving towards technology, innovation, and globalization.

Since then, the concept has evolved, but there is no single, universally accepted explanation. For example, the ISO 37122 standard indicates that "a smart city increases the rate at which it delivers sustainable social, economic, and environmental development outcomes.

Smart cities respond to challenges such as climate change, rapid population growth and political and economic instability by fundamentally improving how people are engaged, applying collaborative leadership methods, working across disciplines and urban systems, and using data information and modern technologies to deliver better services and quality of life to people in the city (residents, businesses, visitors), now and in the foreseeable future, without unfairly disadvantaged others or degrading the natural environment" (ISO 37122, 2019).

In turn, the European Innovation Partnership on Smart Cities and Communities (EIP-SCC) defines smart cities as systems of people interacting and using flows of energy, materials, services and finance to advance sustainable economic development, resilience and high quality of life, these flows and interactions are made "smart" through the strategic use of ICT infrastructure and services within a transparent urban planning and management process that responds to the social and economic needs of society" (Smart Cities Study, 2017).

The European Commission has assumed that a smart city uses digital technologies to increase efficiency, improve living conditions, reduce costs and resource consumption, and engage citizens more effectively and actively. Such a city should also be able to respond more quickly to urban and global challenges (Ferrara, 2015).

Literature also does not indicate one universally recognized definition of a smart city. This means that one can encounter many attempts to explain it (Moch, 2019). However, it is most often indicated that a smart city is characterized by a competitive smart economy, smart mobility, smart environment, smart people, smart living and smart governance.

In the past, the development of the smart city concept was based on the assumption to provide the widest possible access to information about the city and its development plans, but also on creating the most favourable conditions for

investments, care for the natural environment, developing communication between stakeholders in the city and creating opportunities for attractive leisure activities.

One of the elements of the concept was and still is also ensuring the safety of the city and its residents. The development of technology, including geospatial information systems, artificial intelligence or augmented reality, allows for increasingly precise identification, analysis and evaluation of the specific place and area in which action is necessary, and thanks to this, better planning of the city's development is possible. Cities, changing their model of functioning from traditional to intelligent, must take care to improve the quality of life of residents and the services provided, increase the efficiency of management and increase the competitiveness of the city.

3. Research Methodology

Solutions involving modern technologies are being implemented in cities of all sizes worldwide. In order to examine the extent to which projects shaping the intelligent and creative space of medium and large cities in Poland concerned security and what benefits were achieved, empirical research was conducted among representatives of 177 large and medium-sized cities in Poland.

As of December 31, 2020, Poland had 217 medium and large cities (GUS, 2021). The research sample was determined based on the following parameters: a confidence level of 95%, a fractional size of 0.5, and a maximum error of 5%, with values specified separately for each class of cities. The target group of respondents included individuals holding specific positions in municipal offices: members of the executive body, treasurer, secretary, or manager responsible for security issues in the city (Table 1).

Table 1. *Research sample*

City class		**Population**	**Number of cities**	**Research sample**
Medium sized	IV	20 000 – 49 999	134	99
	V	50 000 – 99 999	46	43
Large sized	VI	100 000 – 199 999	23	23
	VII	200 000 and more	14	14

Source: *Own work.*

During the initial research stage, the main research problem was formulated as a question: How do modern technologies improve city safety? In order to answer this question, specific problems were formulated:

1) to what extent do the projects implemented in cities shape the smart space of the city?
2) what benefits for the city's safety result from the use of new technological solutions?;

3) what new technologies were used in selected cities to improve safety?

The research utilized both quantitative and qualitative methods. Data for the analysis was obtained using the diagnostic survey method (CATI and CATI method) and the questionnaire study technique. The research was conducted in April 2023, and Statistica and Microsoft Excel software were used to process the data.

Additionally, the case study method presented examples of solutions involving implementing new technologies to ensure city safety. In this case, the analysis subjects were Polish cities and cities located in other countries.
Theoretical research methods, such as critical analysis of the literature on the subject and generalization, were also used to answer the research problems. This approach allowed to formulate conclusions.

4. Research Results and Discussion

Every day, cities face numerous and diverse security challenges. Undoubtedly, urban planning processes and security are closely linked (Sjöberg and Nygren, 2021). Cities, on the other hand, are not only places where problems arise but also places where their solutions can be found, which is why urban space is fertile ground for the development of science and technology, culture and innovation, or the development of individual and collective creativity (European Commission – Directorate General for Regional Policy, 2011).

The analysis of available studies and reports justifies the statement that although cities implement projects that shape creative and intelligent space to improve broadly understood security, they are not prioritised (Mikulik, 2017; Perboli and Rosano, 2020). In the ranking of safe cities developed by The Economist Intelligence Unit, it was indicated that out of 60 cities analysed, only one – Caracas – does not have a plan to implement the smart city concept or the intention to invest in the city's digital transformation in the next five years. It is also indicated that developing smart cities could be a boon for urban security.

Also, in Polish cities, issues related to ensuring safety are considered in projects that create smart urban spaces. However, the percentage of implemented projects aimed at ensuring safety is low. In the case of projects concerning fire protection and crisis management, the overall result is only 21% of implemented projects, and in the case of projects concerning public safety – 27%, with the values differing depending on the size of the city (Table 2).

Although the implemented creative and intelligent solutions in Polish cities are not very relevant to the issue of security, respondents see benefits in this area (see Table 3). Respondents often indicated that the implemented modern technologies contribute to better organization of response to threats – 42%.

Table 2. *The scope of projects shaping the smart space of the city, implemented in medium and large cities in Poland*

Scope of projects	Percentage of cities implementing projects in each scope (in %)				
	total	medium cities		large cities	
		IV	V	VI	VII
economy	28	28	12	43	50
natural environment	49	45	46	61	64
poverty minimization	19	18	10	22	50
healthcare	34	33	29	39	50
sewage	29	27	27	35	36
education	42	38	44	43	57
recreation	42	35	54	39	64
solid waste	26	25	15	39	43
fire protection and crisis management	21	24	15	13	29
transport	33	31	34	26	50
water supply	33	33	27	43	29
energy	33	32	29	30	50
public safety	27	24	27	30	43
management	16	19	7	13	21
IT technologies	26	29	19	22	29
customer service	20	22	12	26	21

Source: *Own work.*

However, in class VII cities, as many as 64% of respondents considered supporting decision-makers in selecting appropriate actions to the existing threat as the most significant benefit. 36% of respondents indicated better protection of critical infrastructure, while as many as half of the representatives of the largest cities indicated this answer.

The fewest respondents indicated the possibility of reducing the risk of threats and faster response to threats – 27% of respondents each. In the most significant cities, respondents see the most minor benefits from implementing modern technologies in reducing the risk of threats.

Table 3. *Benefits for city security resulting from the implementation of the smart city concept (in %)*

Benefits	Total	Medium cities		Large cities	
		IV	V	VI	VII
Reducing the risk of threats	27	28	26	35	7
Better preparation for natural disasters and technical failures	32	35	32	26	29
Better organization of response to threats	42	42	39	48	36

Better protection of critical infrastructure	36	36	45	13	50
Ensuring continuity of critical infrastructure in the city	31	29	34	35	29
Increasing citizen involvement in building the city's resilience to threats	31	32	32	30	21
Supporting decision-makers in selecting appropriate actions to the threat	34	32	21	43	64
Reducing economic losses as a result of the threat	27	21	42	17	36
Increasing the ability to warn the population about threats	33	35	26	35	38
Faster response to the threat	27	27	29	17	36
Hard to say	4	5	7	0	0

Source: *Own work.*

In practice, it is possible to indicate many solutions that cities, not only in Poland but all over the world, have implemented as part of the smart city concept and which have positively impacted the safety of both the city and its residents.

A monitoring system is the most commonly used solution in cities to improve their safety. In smart cities, city monitoring systems are supported by video detection. Thanks to their unique algorithms, it is possible to detect specific events (e.g., a suspicious package or backpack at a metro station or train station) and then inform the dispatcher about the situation, who will take the necessary actions to eliminate the threat.

Data from city monitoring systems usually flows to monitoring centres or operational centres, where they are processed. An example of advanced "intelligent" city monitoring is the Katowice Intelligent Monitoring and Analysis System (KISMIA) (Poland), which has operated since 2017. It consists of 361 cameras (in 2023) that record several events, such as road incidents (e.g., collisions, parking in unauthorized places, driving "against traffic"), attempted theft or burglary, or a person lying on the sidewalk. Licence Plate Recognition camera points can be helpful in the process of finding stolen vehicles.

Additionally, placing them on city entrance gates allows for monitoring traffic intensity on the city's main roads. Equipping the system with air quality sensors allows for the assessment of the level of pollution. The effectiveness of the KISMIA system is confirmed by the decrease in car thefts, which fell from 337 in 2016 to 79 in 2020, while the detection of these crimes increased from 16.4% to 76%, respectively (Katowice Official Page, 2024).

In Katowice, an intelligent transport system has been implemented to support traffic control in the city. The system includes automatic control of traffic lights, real-time

information about traffic jams, priority for public transport (especially trams), and an intelligent parking system.

Additionally, 17 variable message signs (VMS) in the form of gantries and booms and 12 TIP boards have been installed as part of the system. The dedicated SPRINT/SCATS application allows real-time traffic management by controlling traffic lights. Although the system is fully automated, the operators of the Traffic Control Center can use manual control at any time (Terech, 2022; Jurkiewicz, 2023). Similar solutions operate in Opole, Tarnów, Bielsko-Biała, and Wałbrzych (Poland). Other commonly used solutions are intelligent traffic signal systems. Their use allows for monitoring road traffic, reducing traffic jams, improving traffic management, minimizing its negative impact on the natural environment, and increasing pedestrian safety.

Many cities use systems combining cameras and traffic lights. Such solutions have been used, among others, in Boston (USA). This city is a global Vision Zero initiative leader, aiming to reduce severe and fatal road accidents (www.boston.gov , 2020). The system collects data necessary to determine people's behaviour on the roads. The information obtained in this way is used in designing streets, contributing to improving safety.

An intelligent traffic light system has also been installed in Bucharest (Hungary) at 176 intersections as part of the Bucharest Traffic Management System (Bucharest's Traffic Management System, 2020). The system allows vehicle traffic control, combining traditional traffic lights with sensors and artificial intelligence to direct vehicle and pedestrian traffic. They help improve traffic flow, increase road safety and reduce air pollution. The indicated solution also reduces the risk of overlooking certain events, consequently increasing threat detection and neutralization effectiveness.

One area where "intelligent" solutions can support city authorities is the management of crisis situations caused by natural forces and those resulting from human activity. The use of sensors enables monitoring the situation in critical locations. The information obtained in this way and its analysis and assessment in real time contribute to a faster and more targeted response and improvement of the decision-making process.

Lessons drawn from the experience of delays in making decisions on the activation of crisis response measures during the Great Hanshin Earthquake in 1995 and difficulties in assessing damage after the Great East Japan Earthquake in 2011 have shown how important immediate identification of the threat is at the initial response stages for the needs of comprehensive and immediate decision-making and action.

In connection with this, in 2014, the implementation and development of a system that allows for estimating and identifying damage in real-time in the event of an

earthquake or similar disaster began. The system estimates the spatial distribution of the ground based on information on seismic intensity transmitted at different times from observation stations, as well as the population's exposure to seismic intensity and damage to buildings, using data on estimated ground movement. The information obtained is sent to users via a web browser or e-mail using Web GIS. The system was used during the earthquake in Kumamoto, Japan, in April 2016.

Local emergency response teams were able to take action thanks to the damage estimates, including the exposure of the civilian population, provided by the system after only 10 minutes. The high usability of the system was also confirmed during the earthquake in Iburi Subprefecture on the island of Hokkaido, Japan (UN Office for Disaster Risk Reduction, 2021).

Applications also help improve security in smart cities. According to predictions, by 2025, the most important will be those related to: 1) predictive police actions; 2) real-time crime mapping; 3) detection of gunshots; 4) intelligent video surveillance; 5) optimization of response in crisis situations; 6) body-worn cameras; 7) early warning system for disasters; 8) warning via smartphones; 9) home intruder alarm systems; 10) data-based building inspections; 11) crowd management (Woetzel, Remes, Boland, Lv, Sinha, Strube, Means, Law, Cadena, and von der Tann, 2018).

An example of this type of solution is the 19115 application in the capital city of Warsaw. It allows, among other things, reporting problems that the city authorities and municipal services should address. Another example is the application based on Blockchain technology being developed in Kołobrzeg, which aims to minimize the time emergency services take to arrive at the scene. The solution, which will be made available to all emergency services operating in the city, is to enable the opening of all barriers in the form of barriers or gates (Żuber-Mamakis, 2023).

5. Conclusions, Proposals, Recommendations

Regardless of the uncertainty surrounding us, the future of cities will be increasingly digital. The rapid spread of modern technologies has raised new hopes and fears. The Safe Cities Index 2021 report, prepared by The Economist Intelligence Unit, found that cities' digital security is often insufficient to meet current needs. The lack of security will intensify as urban areas increasingly implement smart city concepts.

The current level of digital security is worrying. As indicated in the report, around a quarter of the surveyed city governments implement public-private partnerships in digital security. A similar percentage of cities thoroughly analyse network security in their smart city plans (Safe Cities Index, 2021). Although only 60 cities were analysed, practice shows that this situation reflects a general trend. In the ranking indicated above, out of 59 cities that have plans to implement smart cities, only 15 focus on the security of basic networks and data.

Meanwhile, smart cities, due to the technologies they use, are highly vulnerable to all forms of cybersecurity threats. 60% of smart city leaders believe that cybersecurity is their cities' most significant challenge (The role of cybersecurity in smart cities, 2023). Sensors and devices connected to the Internet can improve city services, but hackers and foreign states can also use them to disrupt city systems or spy on them.

Another concern is that the large amount of data collected about people can undermine privacy, allowing for even greater tracking of citizens. Criminals or hostile states can also steal data. Cyberattacks can also disrupt the continuity of crucial city services, such as electricity or water supply, affecting not only residential areas but also critical facilities such as hospitals and emergency services.

Ensuring cybersecurity in a smart city requires rethinking several key issues:

- cities must view cybersecurity as an investment or at least an "insurance policy" of sorts rather than as a wasteful expense;
- a holistic approach to implementing technology in the city is necessary;
- digital security, especially the protection of smart grids, must be at the level expected and demanded by residents and, more broadly, city stakeholders.

Cities need to be ready for the future to face emerging security challenges. To make this possible, city authorities should not focus only on implementing new technologies. A holistic approach is necessary for comprehensively considering a safe, smart city. We cannot think only about increasing the amount of data, which many believe is a solution to all problems. The focus should be on people and the city's safety and well-being.

Therefore, the security of a smart city should be treated as a public good, which is currently often lacking. To this end, it is necessary to create conditions in which the involvement of stakeholders, especially city residents, in implementing new projects will increase. Building smart city projects around city residents will make security a natural integration element.

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