JOURNAL OF MODERN SCIENCE

2/62/2025

www.jomswsge.com

DOI: 10.13166/jms/207567

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THE SMART CITY CONCEPT AS A METHOD OF BUILDING URBAN RESILIENCE TO THREATS: EVIDENCE FROM POLAND

Abstract

For several decades, the world's urban population has been overgrowing. The functioning of cities is strongly influenced by local phenomena and global processes related to the urban natural environment, the functioning of the economy and social phenomena. Regardless of the reasons, progressing urbanization leads not only to an increase in the demand for energy, water or gas, transport services, housing or the reduction of urban space but also to uncontrolled development outside the city, the formation of slums, dispersed jobs, as well as the ageing of urban infrastructure. As a result, this process leads to decreased efficiency, especially in energy consumption, traffic, waste management and pollution. Therefore, it is necessary to implement solutions in cities that will enable sustainable economic development and social prosperity, which will improve the quality of life of city residents and increase the city's resistance to threats. In order to meet the emerging challenges, as well as to build urban resilience to threats, modern information and communication technologies are increasingly used. In this way, the idea of a smart city is gradually being implemented in cities. The research aimed to determine the impact of the smart city concept on building the city's resistance to threats. The main research problem was formulated as the following question: How does implementing the smart city concept affect building the resilience of cities? The research used quantitative and qualitative research methods. Data for analysis was obtained using a diagnostic survey (CAWI and CATI methods) using the survey technique. In order to answer the research problem, theoretical research methods were also used, such as analysis and synthesis methods, which were mainly used during the critical analysis of the literature on the subject.

Keywords: *smart city; urban resilience; security, Poland, city management.*

1. Introduction

One of the current major megatrends of the modern world is urbanization. Around 2005, the number of people living in urbanized areas exceeded 50% (World Cities Report, 2022). On November 15, 2022, the population on Earth exceeded 8 billion (Day of Eight Billion, United Nations, 2022). It is estimated that 56% of the world's population currently lives in cities, and this trend will continue. By 2050 the urban population will increase to approx. 70% (The World Bank, 2023). There are already countries where the level of urbanization is much higher than the world average. In the developed countries of Western

Europe, the Americas, Australia, Japan and the Middle East, over 80% of the population lives in urban areas. In middle-income countries in Eastern Europe, South America, and North and South Africa, 50-80% of the population lives in cities (Moch & Wereda, 2020). The growing trend of urbanization will continue, albeit slowly. The urban population is expected to increase by an average of 0.46% per year in 2020-2025 and by 0.40% in 2030-2035 (World Cities Report, 2022).

The future of humanity undoubtedly belongs to cities. It should be noted, however, that the consequence of civilization development is an increase in the risk of many challenges that may take the form of threats (Tatham & Houghton, 2011). Progressive urbanization, regardless of the reasons, leads not only to an increase in the demand for energy, water or gas, transport services, housing or the reduction of urban space but also to uncontrolled development outside the city, the formation of slums, dispersed jobs, as well as ageing urban infrastructure. The challenges for modern cities also include the following:

- overcrowding in cities – in 2020, there were 1,934 metropolises with more than 300,000 inhabitants, representing approximately 60% of the world's urban population. At least 2.59 billion people lived in metropolises, equivalent to one-third of the world's population. Thirty-four metropolises exceeded the number of 10 mil-lion inhabitants; 51 had a population of 5 to 10 million; 494 from 1 to 5 million; and 1,355 from 300,000 to 1 million. It is expected that by the end of 2035 there will be 2,363 metropolises. Of these, 14 new metropolises with over 10 million in-habitants and 22 new metropolises with a population of 5 to 10 million will be created (Global state of metropolies, 2020);
- greater susceptibility to the effects of natural disasters (natural catastrophe and technical failures) – if only due to the violation of environmental balance and, at the same time – due to population density, a high degree of dependence on the functioning of various types of infrastructure. It makes the consequences of dis-asters more severe. It is worth noting that out of 1,146 cities with a population of at least 500,000 in 2018, 679 (59%) were at high risk of exposure to one or more of the six types of natural disasters (cyclones, floods, droughts, earthquakes, land-slides, volcanic eruptions) (The World's Cities, 2018);

- environmental pollution – is caused, among others, by a high density of means of transport (air pollution, noise, traffic jams), economic activity, chimney fumes from residential houses and other sources. These pollutants affect both man and the surrounding nature and city infrastructure. Residents of polluted cities are more likely to suffer from respiratory and cardiovascular diseases; the average life expectancy is shortened;
- greater risk of crime or terrorism than in non-urban areas – a unique feature of the city is the presence of public spaces, i.e. places for public (social) use, attracting users, and thus conducive to the formation of clusters of people that may become the object of criminal activity or terrorist attacks. The latter in cities cause in-creased losses compared to the same methods and tools used in non-urbanized areas. In this way, the probability of achieving a *media* effect by terrorist organizations is more significant (Stelmach & Moch, 2022).

As a result of emerging challenges, urbanization processes lead to a decrease in efficiency, especially in areas related to energy consumption, traffic, waste management and pollution. Dealing with crises and their consequences requires finding tools that will allow for better preparation for their occurrence to mitigate threats and risks and protect the population, resources, infrastructure and the environment. In other words, it is necessary to take action to ensure the safety of the city and its inhabitants, which should be an essential task for the city authorities.

Emerging challenges related to urbanization processes change the approach to the security management issue in the city. One of the approaches to this issue is the concept of urban resilience, referring to local opportunities to prevent threats and respond in the event of their occurrence. It should be noted, however, that the security issue is not the key reason for the emergence of the so-called resilient city, but it is undoubtedly one of its pillars.

Considering the above, the research aimed to determine the impact of the smart city concept on building the city's resistance to threats.

2. Literature Review

2.1. Urban resilience and smart city

The term *resilience* interests many scientific disciplines (Coaffee, 2008; Walker & Cooper, 2011). For example, in psychology, resilience means *the process of adapting well in the face of adversity, trauma, tragedy, threats or even significant sources of stress […]* (American Psychological Association, 2014) or *the ability to adapt in the face of trauma, adversity, tragedy or even significant ongoing stressors* (Newman, 2012). In ecology, in turn, immunity is interpreted as *a measure of the ability of a system to withstand stresses and shocks—its ability to persist in an uncertain world* (Perrings, 1998) or *the rate at which a system variable returns to its reference condition following a perturbation* (Pimm, 1984).

The concept of resilience in scientific research appeared in 1973 thanks to C.S. Holling, who, referring to ecological systems, pointed out that *resilience determines the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist. […] resilience is the property of the system and persistence, or probability of extinction is the result* (Holling, 1973). In the following years, the concept of resilience spread to other scientific disciplines. In a general sense, today, it can be defined as *the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a shock or stress in a timely and efficient manner* (Mitchell & Harris, 2012) or *capacity to adapt or transform in the face of change in social-ecological systems, particularly unexpected change, in ways that continue to support human well-being* (Folke et al., 2016).

The concept of resilience was often used in 1990 with socio-ecological systems and then developed in the context of solving urban problems (Shao & Xu, 2017). At the beginning of the 21st century, an increased interest in the scientific debate on the issue of urban resilience can be observed. At that time, natural disasters such as tsunamis in Asia or hurricanes in North America constituted the context of considerations (Czachor, 2019). Therefore, resilience was still defined as the system's ability to restore its original properties after natural disturbances (Simme & Martin, 2009). Over time, the concept has been extended over time, e.g., about economic, or social issues.

Currently, the concept of urban resilience is gaining in importance. However, it is impossible to identify one leading definition of this concept. One of the reasons for this state of affairs is the specificity of the city itself as a complex system in which various processes take place and which also has to adapt to changing conditions (The Rockefeller Foundation and Arup, 2014). Among them, several threats can be identified (e.g., natural, economic, social, terrorism, crime), the effects of which the city must deal with but also try to prevent – if possible. It makes urban resilience dynamic and flexible, and its complete understanding re-quires an interdisciplinary approach (Deb & Sultana, 2024).

In the literature on the subject, there are many attempts to explain what urban resilience is. International organizations and associations also propose their interpretations of this concept. In many cases, urban resilience is defined as the ability of a city to function in times of emerging shocks or threats. For example, the definition proposed by P. Ribeiro and L. Gonçalves can be quoted as a capacity of a city and its urban systems (social, economic, natural, human, technical, physical) to absorb the first damage, to reduce the impacts (changes, tensions, destruction, or uncertainty) from a disturbance (shock, natural disaster, changing weather, disasters, crises, or disruptive events), to adapt to change, and to systems that limit current or future adaptive capacity (Ribeiro & Gonçalves, 2019). Many other authors have proposed similar interpretations of urban resilience (The Rockefeller Foundation and Arup, 2014). Another group of definitions indicates that a resilient city is a city that reacts to emerging threats but also takes various types of actions to prevent negative events (Mileti, 1999). Some definitions understand urban resilience as the degree to which cities tolerate change before reorganizing around a new set of structures and processes (Holling, 2001) or as a particular mode of operation (Collier et al., 2014).

Analysing the definitions, several conclusions regarding urban resilience can be drawn. Firstly, it is considered a positive and desirable feature of cities (Singh & Sharifi, 2022). Secondly, urban resilience is a specific ability of the city to absorb, adapt and respond to changes. This ability can be shaped and strengthened, but it is necessary to take action in all areas of the city's activity for this purpose. Urban resilience can be described as a specific process consisting in anticipating, preventing, absorbing, and rebuilding the city after crises and disturbances so that it is possible to restore the ability to perform its functions.

The basic attributes of urban resilience include: 1) robustness (degree of strength); 2) efficiency (rapidity of effective responses); 3) diversity (degree of functionally different components); 4) redundancy (degree of functionally similar components); 5) physical/social connectivity (degree of physical and social linkage); 6) capital building (capacity of shaping social cohesion and fostering future development); 7) flexibility (capacity of modification and adaptation); 9) innovation (capacity of creating new mechanism) (Shao & Xu, 2017).

A resilient city is expected to improve urban safety and resilience during urban crises and extreme conditions, protecting people from direct economic losses and deaths, and quickly recovering urban systems to normal (Xiong & Sharifi, 2022). Solving emerging problems will be possible, e.g., thanks to information and communication technologies that are part of the smart city concept.

The opportunities created by implementing the smart city concept are increasingly used to build urban resilience (Sienkiewicz-Małyjurek, 2020). Smart city is a city that is characterized by a competitive economy (smart economy), smart transport networks (smart mobility), sustainable use of resources (smart environment), high-quality social capital (smart people), high quality of life (smart living), and intelligent public management (smart governance) (Florida, 2010). Therefore, a smart city is characterized by a comprehensive approach to the issues of city management, including improving the quality of life of its residents and ensuring safety (Chodyński, 2019; Smart Cities Study, 2012).

Every day, cities must deal with many challenges, including threats. Solving them will be possible thanks to innovative solutions and translating them into concrete actions. The smart city concept assumes using modern technologies and solutions to create cities as friendly to their inhabitants as possible. A smart city is also safe, supporting the authorities in managing its infrastructure and bringing savings. It is indicated that a smart city should have such features as efficiency, adaptation, innovation, and resistance to emerging crises of different natures, e.g., social, economic, environmental and others (Wójcicka, 2020).

3. METHODOLOGY

Implementing the smart city concept, including building resistance to threats, is possible in all cities – from small to large agglomerations. In order to assess the impact of implementing this concept on building the resilience of cities, a study was conducted among representatives of large and medium-sized cities in Poland. As of 31 December 2020, Poland contained 217 medium and large cities (GUS, 2021). The study was conducted in 177 cities. The research sample was determined based on the following parameters: the confidence level – 95%, – fractional size, – 0.5, – maximum error – 5% – specifying these values separately for each city class. The target group of respondents were people per-forming specific functions in municipal offices: executive body (mayor, city president and deputies), treasurer, secretary[1], or manager or functional manager responsible for security issues in the city (Table 1). Persons performing the indicated functions in cities are responsible (by law or by the tasks performed) for implementing tasks related to ensuring safety.

Table 1. *The research sample and respondents*

Population	City class	Number of cities	Research sample	Respondents	
				Category	Size
20 000 – 49 999	IV	134	99	executive body treasurer secretary manager	2 19 49 29
50 000 – 99 999	V	46	43	executive body treasurer secretary manager	0 11 17 4
100 000 – 199 999	VI	23	23	executive body treasurer secretary manager	3 3 10 7
200 000 and more	VII	14	14	executive body treasurer secretary manager	0 3 7 4

Source: own work.

One hundred-three of the analysed cities have a service function. Thirty-two cities have an industrial function, and 23 cities have a commercial function. Eleven cities fulfil the recreational and tourist functions, while six cities perform the industrial and service functions. One city is a religious object. One city performs a mixed function (Table 2).

Table 2. *City function: dominant type of activity*

City function (dominant)	Medium cities		Large cities		Total
	IV	V	VI	VII	
Industrial	8	12	10	2	32
Commercial	0	3	10	10	23
Service	75	24	3	1	103
Recreational and tourist	10	1	0	0	11
Industrial and service	5	1	0	0	6
Religious object	0	0	0	1	1
Other	1	0	0	0	1

Source: own work.

At the preliminary stage of the research, the main research problem was formulated in the form of the following question: How does implementing the smart city concept affect building the resilience of cities? In order to answer the above question, several detailed problems were addressed: 1) what are the primary benefits of building the city's resilience resulting from the implementation of the smart city concept?; 2) how can it assess the impact of the implementation of the smart city concept on building resilience in the indicated subsystems of the city; 3) to what extent can the implementation of the smart city concept positively impact strengthening urban resilience in the indicated areas?

At the preliminary stage of the research, a working hypothesis was formulated in the form of a supposition that implementing the smart city concept affects the building of cities' resistance to threats.

Quantitative research methods were used in the research process. The data for the analysis were obtained using a diagnostic survey (CAWI and CATI methods) using the questionnaire survey technique. The research was conducted in April 2023. Statistica (StatSoft. Elektroniczny podręcznik Statystyki, 2020) and Microsoft Excel software were used to analyse the obtained data.

In order to answer the research problem, theoretical research methods were also used. Methods of analysis and synthesis were mainly used during the critical analysis of the literature on the subject. Their application defined urban resilience, and the relationships between the smart city concept and urban resilience were determined. The generalisation method made it possible to reveal the characteristics and effects of a repetitive and general feature and formulate conclusions.

The study provided only general knowledge on how implementing the smart city concept affects building the resilience of cities. Although respondents had the opportunity to provide their answer, most of them limited themselves to choosing only from the proposed answers.

4. Empirical results and discussion

The respondents were asked about the essential benefits of building the city's resilience by implementing the smart city concept. In this case, as in the previous question, the respondents could indicate a maximum of six answers from among the indicated proposals (Table 3). Most often, the respondents indicated that the technologies implemented in the smart city concept would increase the city's resilience in protecting critical infrastructure. This answer was given by 43% of the respondents. 36% of respondents indicated an improvement in ensuring the continuity of operation of this infrastructure. The fewest respondents pointed to the possibility of reducing the risk of threats and faster response to the threat – 27% of respondents each. 4% of respondents could not indicate in which areas the implementation of the smart city concept would bring benefits for building city resilience.

Table 3. *Benefits for building city resilience from the implementation of the smart city concept in % (n=177)*

Benefits	Total	Medium cities		Large cities	
		IV	V	VI	VII
Reducing the risk of hazards	27	28	26	35	7
Better organization of response to the existing threat	32	35	32	26	29
Better protection of critical infrastructure	42	43	39	48	36
Ensuring the continuity of operation of critical infrastructure in the city	36	36	45	13	50
Increasing the involvement of citizens in building the city's resilience to threats	31	29	34	35	29
Supporting the activity of decision-makers in the selection of adequate actions to the existing threat	31	32	32	30	21
Reduction of economic losses due to the occurrence of a threat	34	32	21	43	64
Increasing the ability to warn the population about threats	33	21	42	17	36
Faster response to a threat	27	35	26	35	36
Other	0	0	0	0	0
Hard to say	4	5	7	0	0

Source: own work.

The next question concerned determining the impact of the implementation of the smart city concept on building resilience in the indicated subsystems of the city. Respondents were asked to evaluate on a scale of 0-5, where 0 meant no impact, and 5 – very high impact (Table 4). Analysing the answers provided, it can be concluded that, according to representatives of medium and large cities in Poland, implementing the smart city concept has a more than-average impact on building city resilience. It is worth emphasizing, however, that in the case of some subsystems, this impact was de-fined as high or close to high (3.6 and more). In Class IV cities, these are: environmental protection – 3,70, food supply – 3,68, local business environment and finance and economy – in both cases 3,61. In class VI cities, areas on which the implementation of the smart city concept may have an impact close to large were indicated finance and economy – 3,83, participation and social awareness and employment – in both cases 3,65, education – 3,61. In class VII cities, such an assessment was made in relation to such subsystems as energy and water supply – in both cases 4,0, sanitary conditions and waste management – 3,84, education and transport – in both cases 3,71, budget, local business environment and food supply – in all cases 3,64. The lowest impact of implementing the smart city concept on building the resilience of cities in the indicated subsystems of the city is assessed by representatives of medium-sized class V cities.

Table 4. *Impact of the implementation of the smart city concept on building resilience in city sub-systems (n=177)*

City subsystem	Total	Medium cities		Large cities	
		IV	V	VI	VII
Budget	3,38	3,38	3,10	3,39	3,64
Local business environment	3,46	3,61	3,12	3,48	3,64
Finance and economy	3,53	3,61	3,32	3,83	3,36
Participation and social awareness	3,45	3,48	3,12	3,65	3,57
City data	3,43	3,57	3,19	3,48	3,50
Fighting crime and policing	3,29	3,42	3,02	3,22	3,50
Culture	3,40	3,56	3,19	3,30	3,57
Crisis management	3,44	3,44	3,49	3,35	3,50
Sanitary conditions, waste management	3,47	3,50	3,22	3,30	3,86
Education	3,49	3,51	3,12	3,61	3,71
Employment	3,36	3,40	3,02	3,65	3,36
Energy supply	3,55	3,57	3,32	3,30	4,00
Environmental Protection	3,39	3,70	3,15	3,35	3,36
Food supply	3,50	3,68	3,29	3,39	3,64
Management	3,22	3,08	3,17	3,43	3,21
Healthcare	3,35	3,45	3,12	3,26	3,57
Housing	3,37	3,38	3,24	3,17	3,71
Communication and information technologies	3,44	3,57	3,46	3,52	3,21
Law and justice	3,14	3,33	2,85	3,26	3,14
Infrastructure protection	3,20	3,41	2,97	3,30	3,14
Social assistance	3,33	3,41	3,00	3,48	3,43
Transport	3,42	3,49	3,22	3,26	3,71
Spatial planning and development	3,26	3,52	3,07	3,17	3,28
Ensuring the continuity of operation of key city services	3,31	3,28	3,29	3,09	3,57
Water supply	3,57	3,50	3,22	3,56	4,00

Source: own work.

Finally, representatives of medium and large cities in Poland were asked to assess the extent to which the smart city concept can positively impact urban resilience in the indicated areas. The City Resilience Index methodology, presented by The Rockefeller Foundation and Arup (2014), was used to identify the areas. As part of the methodology, four key dimensions were distinguished – Health and Well-being, Economy and Society, Infrastructure and Environment, and Leadership and Strategy. Each key dimension is additionally divided into 3 goals that each city should strive towards to achieve resilience. As part of the goals, 52 indicators were identified that further define 12 goals and identify critical factors contributing to urban systems' resilience (Table 5).

Table 5. *City Resilience Index: key dimensions, goals, and indicators*

Key dimensions	Goals	Indicators
Health and Well-being (HW)	Minimal human vulnerability	Safe and affordable housing
		Adequate affordable energy supply
		Inclusive access to safe drinking water
		Effective sanitation
		Sufficient affordable food supply
	Diverse livelihoods and employment	Inclusive labour policies
		Relevant skills and training
		Local business development and innovation
		Supportive financing mechanisms
		Diverse protection of livelihoods following a shock
	Effective safeguards to human health and life	Robust public health systems
		Adequate access to quality healthcare
		Emergency medical care
		Effective emergency response services
Economy and Society (ES)	Collective identify and mutual support	Local community support
		Cohesive communities
		Strong city-wide identity and culture
		Actively engaged citizens
	Comprehensive security and rule of law	Effective systems to deter crime
		Proactive corruption prevention
		Competent policing
		Accessible criminal and civil justice
	Sustainable economy	Well-managed public finances
		Comprehensive business continuity planning
		Diverse economic base
		Attractive business environment
		Strong integration with regional and global economies
Infrastructure and Environment (IE)	Reduced exposure and fragility	Comprehensive hazard and exposure mapping
		Appropriate codes, standards and enforcement
		Effectively managed protective ecosystems
		Robust protective infrastructure
	Effective provision of critical services	Effective stewardship of ecosystems
		Flexible infrastructure
		Retained spare capacity
		Diligent maintenance and continuity
		Adequate continuity for critical assets and services
	Reliable mobility and communications	Diverse and affordable transport networks
		Effective transport operation and maintenance
		Reliable communications technology
		Secure technology networks
Leadership and Strategy (LS)	Effective leadership and management	Appropriate government decision-making
		Effective co-ordination with other government bodies
		Proactive multi-stakeholder collaboration
		Comprehensive hazard monitoring and risk assessment
		Comprehensive government emergency management
	Empowered stakeholders	Adequate education for all
		Widespread community awareness and preparedness
		Effective mechanisms for communities to engage with government
	Integrated development planning	Comprehensive city monitoring and data management
		Consultative planning process
		Appropriate land use and zoning
		Robust planning approval process

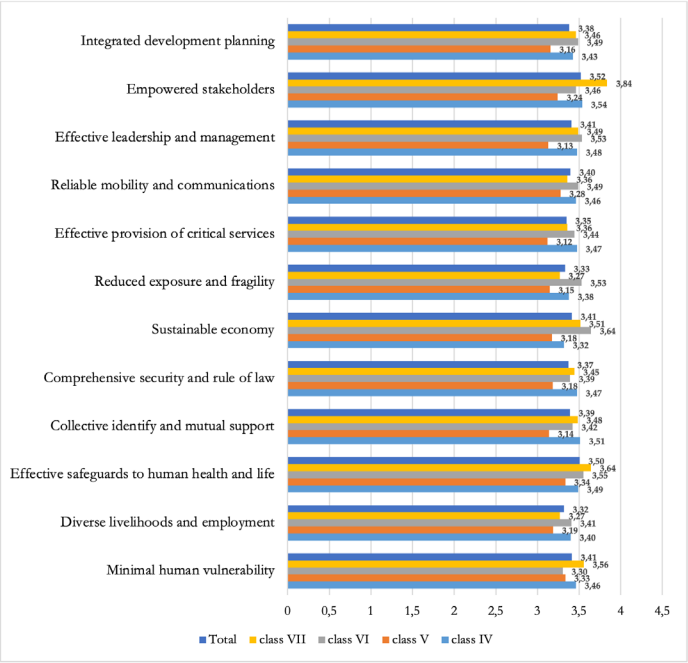
Source: own work based on: The Rockefeller Foundation and Arup (2014).

Respondents were asked to rate each of the indicators on a scale of 0-5, where 0 means no impact of the implementation of the smart city concept on strengthening the city's resilience and 5 – a very high impact in this regard (Figure 1).

The analysis of the research results allows us to conclude that representatives of medium and large cities in Poland determine the impact of the smart city concept's implementation on building the city's resilience between medium and large. Representatives of class V cities are the most skeptical in this regard. It is worth emphasizing, however, that there are indicators whose impact is described as high or close to high (3.6 and more). Among class IV medium-sized cities, the following areas were indicated as areas where the implementation of the smart city concept will positively affect building resilience: inclusive access to safe drinking water (HW) – 3,62; adequate education for all (LS) – 3,61; secure technology networks (IE) – 3,60. Respondents from large cities in class VI indicated: well-managed public finances (ES) – 3,91; comprehensive hazard monitoring and risk assessment (LS) – 3,87; strong integration with regional and global economies (ES) – 3,78; comprehensive government emergency management (LS) – 3,70; adequate access to quality healthcare (HW), strong city-wide identity and culture (ES) and effectively managed protective ecosystems (IE) – in both cases 3,69; comprehensive business continuity planning (ES) and consultative planning process (LS) – in both cases 3,65; effective transport operation and maintenance (IE) – 3,61. Representatives of large Class VII cities as the areas where the implementation of the smart city concept has the most positive impact in terms of building resilience: ad-equate education for all (LS) – 4,36; effective emergency response services (HW) – 4,14; comprehensive government emergency management (LS), effective mechanisms for communities to engage with government (LS) and effective sanitation (HW) – in all cases 3,86; reliable communications technology (IE) – 3,79; consultative planning process (LS), appropriate land use and zoning (LS) and effective systems to deter crime (ES) – in all cases 3,71; proactive multi-stakeholder collaboration (LS), diverse economic base (ES), sufficient affordable food supply (HW) and supportive financing mechanisms (HW) – in all cases 3,64. It is worth noting that respondents from class V medium-sized cities did not indicate any indicator that has a high or close to high impact on building resilience thanks to the implementation of the smart

city concept. Comparing this data with the answers to the previous question, it can be concluded that these respondents are the least optimistic about the positive impact of the actions taken as part of implementing the smart city concept on building city resilience. The representatives of large cities, the VI and VII Class, are most optimistic about these activities.

Figure 1. *The impact of the implementation of the smart city concept on strengthening urban resilience using indicators from the City Resilience Indexw*



Source: own work.

Summing up the research, it should be stated that representatives of medium-sized and large cities in Poland see the potential of implementing the smart city concept for building city resilience. They believe it is primarily a medium or close to high positive impact. However, not everyone is equally optimistic. Slightly less potential in implementing the smart city concept for building city resilience is seen by representatives of class V medium-sized cities. They think it is rather average.

The smart city concept has an extensive application in implementing technical, social or administrative services in the city. Its potential is also noticeable in the implementation of tasks to ensure the city's and its inhabitants' safety (Sienkiewicz-Małyjurek, 2020). Technological development creates many opportunities, including increasing the efficiency of city management. However, it should be remembered that each city is different, has different potential, but also has different needs. Therefore, it is necessary to adapt the actions taken to the specificity of the city each time.

Urban centres, regardless of their size, face challenges of various nature, intensity, duration and effects daily. Effective city management policy and practice can provide solutions to address emerging challenges and contribute to mitigating their potential impacts (Sharifi, 2022). However, the conventional approach to action may prove insufficient, which is why more and more emphasis is placed on innovative solutions that can accelerate the processes of building resilient and sustainable cities. Urban resilience has become a prerequisite for designing and operating any city model, including the smart city (Gazzola et al., 2019). As Godschalk wrote, *Resilient cities are constructed to be strong and flexible rather than brittle and fragile . . . their lifeline systems of roads, utilities and other support facilities are designed to continue functioning in the face of rising water, high winds, shaking ground and terrorist attacks* (Godschalk, 2003).

Many studies indicate that smart city concepts and urban resilience are created and developed based on similar foundations. They also have similar goals and ways of achieving them for similar problems (De Jong et al., 2015). It is even indicated that since the spread of the smart city concept in the 1990s, it began to be used to meet the needs of cities, especially in terms of their sustainable development – along with resilience, inclusive-ness, citizen engagement, and participation (U4SSC, 2021). A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services and competitiveness (referring to the policies, institutions, strategies and processes that deter-mine the sustainable productivity of the city), while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental, as well as cultural aspects (ITU-T, 2016; Kapucu, Ge, Rott & Isgandar, 2024). One of the needs is also the need for security and the

related building of urban resilience, which is part of the implementation of the Sustainable Development Goals (especially Goal 11, *Make cities inclusive, safe, resilient and sustainable*), set out in the 2030 Agenda (UN, 2015).

In the above context, attention should be paid to the mutual influence of both concepts. On the one hand, the use of modern solutions, such as information and communication technologies or the Internet of Things, positively affects the optimization of many processes in cities, which in turn leads to better resilience of urban infrastructure, and also has a positive impact on social and economic development. Monitoring the situation in the city supports quick reactions. From the point of view of developing a resilient city, this is crucial, as the use of traditional methods of operation alone may prove insufficient many times. Meanwhile, information of the right quality, received at the right time, supports making the right decisions and thus accelerates overcoming emerging crisis situations.

On the other hand, to ensure the security (integrity, availability, confidentiality) of data collected in a smart city, it is necessary to have systems resistant to threats and interference in which these data are processed. Urban resilience aims to ensure the safety of city residents, the environment, resources and processes taking place in the city. It, in turn, is important from the point of view of better effectiveness and efficiency of the city, and thus the achievement of the goals that guide the implementation of the smart city concept (Ateş, 2024).

Considering the above, it is worth considering their integration of the smart city concept and urban resilience at the stage of city development planning. Doing so will bring benefits in the form of innovative, resilient and sustainable urban centres. As previously indicated, resilience is one of the basic features of a smart city, which is why the smart city concept can become an effective way to build basic capabilities in the context of urban resilience.

5. Conclusions

Sustainability and resilience are among the most critical challenges in ensuring city security. Actions taken to build them are aimed, among others, at minimizing the negative impact of development on the environment while focusing on development and building better living conditions for future generations. Modern information and communication technologies support the implementation of these goals. The research showed that representatives of medium-sized and large cities in Poland see the potential in implementing the smart city concept in the context of building cities' resilience to threats. Thus, the goal of the study was achieved, which was to determine the impact of the smart city concept on building city resilience to threats. Thanks to modern solutions, cities are seeing improved security, e.g. crisis management, transport, health, etc. Thanks to modern solutions, cities note safety improvements, e.g., crisis management, transport, health, etc.

Smart technological solutions are conducive to better convergence and urban development. The concepts of smart city and urban resilience can complement each other. For example, the information collected by sensors and other elements of the smart city used to collect data can then be used to support or improve systems to strengthen urban resilience, e.g., warn city residents of an impending threat.

Considering the above, it is reasonable to conclude that the integration of the concepts of smart city and urban resilience is conducive to their development and, at the same time, strengthens the process of building sustainable and safe cities and communities.

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Endnotes

[1] The city secretary is primarily responsible for the efficient functioning of the office and supervision of its administrative activities. The treasurer is responsible for planning, implementing and controlling the city's financial management.