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## Urban Resilience and ICT Solutions in Management of Polish Cities

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### **Abstract:**

**Purpose:** The aim of the article is to introduce the integration the urban resilience and ICT solutions in management of Polish cities.

**Design/Methodology/Approach:** In order to investigate the extent of the impact of ICT solutions on urban resilience in large and medium-sized Polish cities and the resulting benefits, an empirical study was conducted with representatives of 177 large and medium-sized Polish cities. CAWI and CATI surveys were used.

**Findings:** The considerations contained in the article are the part of a broader research on the integration of urban resilience and ICT solutions in management of Polish cities.

**Practical Implications:** Cities in Poland use ICT solutions to cooperate with various stakeholder groups. Thanks to ICT, public managers can use modern digital solutions to increase the satisfaction of residents and partners and improve the work of officials.

**Originality/value:** In contemporary cities, one of the most important elements are ICT solutions to meet the needs of Society 4.0. The dominant part of the research is showing the effects of implementing the ICT solutions in management of large and medium-sized cities in Poland.

**Keywords:** Urban resilience, ICT solutions, security management, Polish cities.

**JEL classification:** M31, M21, L22, R00, O18, H12.

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## 1. Introduction

The urbanization process leads to a decrease in efficiency due to emerging challenges, especially in areas related to energy consumption, transportation, waste management and pollution. Dealing with crises and their consequences requires the development of tools to better prepare for their occurrence, reduce threats and risks, and protect the population, resources, infrastructure and environment. In other words, it is necessary to take measures to ensure the safety of cities and their inhabitants, which should be an important task of urban authorities.

The new challenges associated with the urbanization process are changing the approaches to urban security management. One of the approaches to this topic is the concept of urban resilience, which refers to local opportunities to prevent threats and respond to them when they occur. But it is worth noting that security issues are not the main reason for the emergence of so-called resilient cities. It is important to integrate the urban resilience and ICT solutions in security management, on the example of Polish cities.

## 2. Literature Review and Applied Research Methodology

### 2.1 The Characteristics of Urban Resilience and ICT Solutions in Cities

The concept of urban resilience is currently gaining importance. However, it is impossible to find a main definition of this concept. One of the reasons for this is the specificity of the city itself as a complex system, in which various processes take place and which also have to adapt to changing conditions. Among them, multiple threats can be identified (e.g. natural, economic, social, terrorist, criminal), which the city has to manage but also try to prevent if possible. This makes urban resilience dynamic and flexible, and its full understanding requires an interdisciplinary approach.

In the literature on this topic, there are many attempts to explain what urban resilience is. International organizations and associations have also proposed their own interpretations of this concept. Table 1 shows selected definitions of the concept of urban resilience.

**Table 1.** *Selected definitions of urban resilience*

| Author(s) and date                            | Definition                                                                                                                                                        |
|-----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| D. Mileti (1999)                              | A resilient city mainly responds to climate change and resist disaster through the construction and improvement of urban physical environment and infrastructure. |
| C.S. Holling (2001)                           | Resilience in cities – the degree to which cities tolerate alteration before reorganizing around a new set of structures and processes.                           |
| H. Ernston, S.E. van der Leeuw, Ch.L. Redman, | To sustain a certain dynamic regime, urban governance also needs to build transformative capacity to face uncertainty and change.                                 |

|                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| D.J. Meffert, G. Davis, Ch. Alfsen and T. Elmqvist (2010)                                                         |                                                                                                                                                                                                                                                                                                                                                          |
| K.C. Desuoza and T.H. Flanery (2013)                                                                              | Resilience in terms of cities generally refers to the ability to absorb, adapt and respond to changes in an urban system.                                                                                                                                                                                                                                |
| I.Wagner and P. Breil (2013)                                                                                      | A more comprehensive definition of a resilient city emphasizes a community's overall ability and ability to withstand stress, survive, adapt, and recover from a crisis or disaster, and move forward quickly.                                                                                                                                           |
| F. Collier, J. Hambling, S. Kernaghan, B. Kovacevic, R. Miller, A.P. Pérez, E. Richardson and S. Macmillan (2014) | The degree to which a system can continue to function effectively in changing environment.                                                                                                                                                                                                                                                               |
| The Rockefeller Foundation and Arup (2014)                                                                        | City resilience describes the capacity of cities to function, so that the people living and working in cities – particularly the poor and vulnerable – survive and thrive no matter what stresses or shocks they encounter.                                                                                                                              |
| A.Drobniak (2015)                                                                                                 | The degree to which cities can tolerate environmental variability before reorganizing a new set of structures and processes.                                                                                                                                                                                                                             |
| S. Meerow, J.P. Newell and M. Stults (2016)                                                                       | Urban resilience refers to the ability of an urban system-and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales-to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity. |
| A.Mehmood (2016)                                                                                                  | Urban resilience can be defined in evolutionary terms as a proactive vision for planning, policy formulation, and strategic direction in which communities play a vital role in resilient place modeling through their active learning ability, robustness, capacity for innovation, and adaptability.                                                   |
| <i>City Resilience Profiling Tool. Guide</i> (2018)                                                               | Resilient city is one that is able to absorb, adapt, and recover from the shocks and stresses that are likely to happen, transforming itself in a positive way toward sustainability.                                                                                                                                                                    |
| L. Figueiredo, T. Honiden and A. Schumann (2018)                                                                  | Urban resilience can be understood as the ongoing capacity of cities to absorb, adapt, transform and prepare for shocks and stresses along the economic, social, institutional and environmental dimensions, with the aim of maintaining the functions of a city and improving response to future shocks.                                                |
| ICLEI (2019)                                                                                                      | The ability of cities to anticipate, prevent, absorb and recover from shocks and stresses, and to improve essential basic response structures and functions, while integrating the different aspects of urbanization, sustainability, development, and climate change.                                                                                   |
| P. Ribeiro and L. Gonçalves (2019)                                                                                | Urban resilience is 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.                                                                                                                                                                                                                                                                            |
| UN-HABITAT<br>DiMSUR (2020)                    | and | The ability of any urban system, with its inhabitants, to maintain continuity through all shocks and stresses, while positively adapting and transforming toward sustainability.                                                                                                                                                          |
| UN-HABITAT<br>Prefeitura de Teresina<br>(2022) | and | Ability of any urban system, with its inhabitants, in a changing environment, to anticipate, prepare, respond to, and absorb shocks, positively adapt and transform in the face of stresses and challenges, while facilitating inclusive and sustainable development.                                                                     |
| World Health<br>Organization (2022)            |     | Resilience is the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management. |

**Source:** Own work based on the literature.

Several conclusions can be drawn from the analysis of the definitions in Table 1. First, it is seen as a positive and desirable characteristic of cities. Second, urban resilience is the specific ability of cities to absorb, adapt and respond to changes. Urban resilience can be described as a specific process that includes anticipating, preventing, absorbing and rebuilding crises and turmoil. The basic characteristics of urban resilience are:

- 1) robustness (degree of strength);
- 2) efficiency (speed of effective response);
- 3) diversity (degree of functionally different components);
- 4) redundancy (degree of functionally similar components);
- 5) physical/social connections (degree of physical and social connections);
- 6) capital building (ability to shape social cohesion and promote future development);
- 7) flexibility (ability to change and adapt); 9) innovation (ability to create new mechanisms).

Regarding the impact of the transformation of the digital age on urban management, it can be said that there are four trends brought about by the digital transformation on a global scale. The first trend is attributed to the aggregation around emerging markets. Industrial and urban planning are constantly undergoing transformations.

The second trend is the power of technology to accelerate the phenomena occurring in the market, its scope and its consequences. The rapid development of technology therefore requires organizations to adapt to prevailing trends. Currently, organizations face challenges such as time constraints, constant updating of resources and the proper management of big data, cloud computing and electronic management procedures.

Another thing that is happening is that more people are elderly. In the present day, our society is aging, with two consequences. First, the new technological solutions

introduced could be met with disapproval and passivity from the older generation. Second, it can be associated with an increase in the prices of training courses for preparing older generation employees for the changes in the mode of operation of the city. The latter trend is the impetus of international markets' development and information, people, and financial resources exchange.

Digital transformation can increase the efficiency of cities' tasks and reduce their costs and improve functioning, as well as improve the availability of data and services and transparency processes. Digitization, and especially the ability to provide services remotely, has become particularly important in the context of pandemic experiences. For example, service delivery and resident communication. Remote communication with the office is currently one of the key elements of building the resilience of cities for crisis situations (Miazga *et al.*, 2022, p. 5).

ICT tools managing resources and the costs of maintaining these resources. The use of ICT investments is not cheap, but in a period that provides immeasurable benefits for cities and their inhabitants. Recent ICT solutions in cities include the IoT option (Wereda, 2023, p. 420):

- e-administration applications;
- social media and website;
- cloud computing;
- cybersecurity solutions;
- Internet of things;
- etc.

Modern technologies that influence the life of cities and fall within the concept of Smart City are also referred to as digital media technologies, including smart cards, video monitoring, E-government applications, social media, websites and wireless networks (De Lange and de Waal, 2013, p. 11).

The concept of Smart City covers a concept broader than just ICT or, more broadly, modern technologies - the participation of all city stakeholders is crucial for creating safe and functional urban spaces and building a sense of community between generations (Tota, 2017, p. 9).

## 2.2 Characteristics of Respondents

In order to evaluate the role of ICT in developing city resilience, a study was conducted among medium and large city representatives in Poland. As of 31 December 2022, Poland had a total of 217 medium and large cities (GUS, 2023). The study was carried out in 177 cities. The size of the research sample was determined based on the following parameters: the level of confidence equal to 95%, -fractional size, -0.5, -maximum allowable error equal to 5%, these values were

specified separately for each class of cities selected.

The respondents are important officials working in municipal offices: people within the executive body (mayor, president and vice-presidents), the treasurer, the secretary and/or the or acting functional secretary in charge of security matters in the city as shown in Table 2.

**Table 2.** *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<br>treasurer<br>secretary<br>manager | 2<br>19<br>49<br>29 |
| 50 000 – 99 999   | V          | 46               | 43              | executive body<br>treasurer<br>secretary<br>manager | 0<br>11<br>17<br>4  |
| 100 000 – 199 999 | VI         | 23               | 23              | executive body<br>treasurer<br>secretary<br>manager | 3<br>3<br>10<br>7   |
| 200 000 and more  | VII        | 14               | 14              | executive body<br>treasurer<br>secretary<br>manager | 0<br>3<br>7<br>4    |

**Source:** *Own work.*

### 3. Results

The concept is of a smart city has to do, for example, with the application of modern ICT technologies in cities. Thus, the respondents were asked which areas of activity had most often been affected, in the last five years, by ICT technologies that had been implemented in their cities. Each respondent could mark a maximum of 6 responses (Table 3).

The research findings affirm that, over the last five years, the most common concerns of IT technologies implemented in medium and large cities were in the construction and development of urban infrastructure (38%), planning, forecasting, and scheduling processes (35%), and promoting the city's image and its brand (32%).

There was relatively low implementation of ICT technologies for functions related directly to issues of security. As an example: in customer service and safety, only 20% of projects; in supporting administrative processes and building public safety, only 9% of projects.

**Table 3.** The areas of activity most often related to ICT technologies in the city introduced in the last 5 years (n=177)

| Areas of activity                                                                                                     | Implemented Projects [%] |               |    |              |     |
|-----------------------------------------------------------------------------------------------------------------------|--------------------------|---------------|----|--------------|-----|
|                                                                                                                       | Total                    | Medium cities |    | Large cities |     |
|                                                                                                                       |                          | IV            | V  | VI           | VII |
| Obtaining key data from institutions                                                                                  | 23                       | 28            | 15 | 17           | 14  |
| Data storage and processing for the city                                                                              | 26                       | 22            | 30 | 30           | 36  |
| Managing and sharing key knowledge with employees and customers                                                       | 30                       | 32            | 30 | 22           | 36  |
| Planning, forecasting, and scheduling of processes                                                                    | 35                       | 33            | 38 | 39           | 36  |
| Ongoing communication inside the office                                                                               | 31                       | 35            | 23 | 26           | 43  |
| Promoting the city's own image and brand                                                                              | 32                       | 31            | 45 | 26           | 14  |
| Implementation of intelligent solutions in urban space                                                                | 28                       | 27            | 23 | 26           | 57  |
| Construction and development of urban infrastructure                                                                  | 38                       | 42            | 43 | 9            | 50  |
| Construction and dissemination of ICT infrastructure for the community (wi-fi access, hot spot, optical fibers, etc.) | 24                       | 22            | 28 | 22           | 36  |
| Customer service and safety                                                                                           | 20                       | 19            | 15 | 30           | 21  |
| Establishing contacts with investors                                                                                  | 19                       | 20            | 18 | 17           | 21  |
| Reporting and analysis and evaluation of activities                                                                   | 14                       | 13            | 18 | 13           | 14  |
| Supporting administrative processes and building public safety                                                        | 9                        | 7             | 15 | 4            | 7   |
| Construction of IT technical infrastructure (server rooms, computer equipment, etc.)                                  | 17                       | 17            | 15 | 22           | 21  |
| Other                                                                                                                 | 1                        | 0             | 3  | 0            | 0   |
| Hard to say                                                                                                           | 3                        | 4             | 2  | 0            | 0   |

**Source:** Own work.

Based on the research conducted, it can be assumed that the administration of the future will increasingly use ICT technologies in its activities. Polish cities are changing and gradually increasing their competences and operational capabilities, but they are still only at the beginning of the road to full digital transformation.

The increased popularity of various digital solutions in cities was undoubtedly influenced by the COVID-19 pandemic, which encouraged local governments to introduce new solutions for employees, e.g. related to increasing remote access to city resources, and to implement further e-services for residents (Moch, Wereda, 2020).

#### 4. Conclusions and Recommendations

To summarize the assumptions of the article and the conducted research, it should be noted that representatives of medium-sized and large cities in Poland recognize the

importance of ICT in the functioning and building the resilience of cities. They believe that ICT solutions have a major impact on: construction and development of urban infrastructure, managing and sharing key knowledge with employees and customers, planning, forecasting, and scheduling of processes, ongoing communication inside the office, promoting the city's own image and brand.

ICT is widely used in the implementation of technical, social and administrative services in the city. The digital transformation and technological development create 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 each ICT solutions activities to the specificity of the city and its inhabitants.

The main barriers hindering the digital transformation of cities still include, above all, insufficient financial resources, as well as employees' reluctance to change and low competences of officials and applicable law. Despite various difficulties, cities are introducing more and more e-services for residents. Unfortunately, many of them are scattered on various websites and rarely allow the entire matter to be handled online. In the case of e-services, residents still have to go to the office in person at some stage (e.g., delivery of the decision).

Improving the availability of e-services and ICT solutions requires, first of all, looking at them from the user's perspective and ensuring that various solutions are easier to find and understandably described. It is also worth putting emphasis on the gradual expansion of functionalities and the creation of increasingly comprehensive e-services, as well as on providing residents with support in using these solutions.

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