Article

The Impact of a Special Economic Zone Management on the Development of Modern Sectors and Technologies in a Polish Metropolis: The Smart City Context

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Abstract: The development of the high-tech sector has so far been studied within the cities, leaving their functioning within the special economic zones in the context of metropolitan belonging unexplored. The main purpose of the article is to determine whether the economic zone has a positive impact on the economic development of cities, which in the context of this research, has been operationalized with the use of computer-aided systems. The authors purposefully choose a Metropolis GZM, Poland (GZM), and Katowice Special Economic Zone (KSEZ). The importance of the high-tech sector in the GZM depends on the development of business in the region. Innovative specializations of cities located in the KSEZ were examined from the point of view of their perception by users of these new technologies, i.e., city residents. The research was conducted among over 1000 inhabitants of 16 cities in the GZM Metropolis. The results show correlations between the existence of modern businesses in metropolitan cities and their development of useful technologies, perceived from the perspective of residents.

Keywords: special economic zone; special economic zone management; smart city; decarbonisation; metropolitan regions

1. Introduction

Special economic zones are areas designated by the governments of countries where entrepreneurs can conduct business on preferential terms. Such zones are designed to attract investors who, thanks to the favorable conditions for operating in the zone, can increase their profits and employment. Therefore, special economic zones can contribute to the development of the high-tech sector in cities, attracting investments, stimulating the transfer of knowledge and technology, developing infrastructure, increasing employment, and attracting specialists. However, in order for these benefits to be achieved, it is important to effectively manage the zone, city, or organizations in this region.

The high-tech sector is a field that deals with the development and application of the latest achievements in science and technology in various fields, such as information technology, telecommunications, biotechnology, robotics, artificial intelligence, and many others. In cities with special economic zones, the high-tech sector may play a key role in economic and social development.

The first and most important aspect of the importance of the high-tech sector in cities associated with special economic zones is attracting investments. Technology companies

are often innovative and dynamic, and their development depends on access to the latest technologies and a skilled workforce. Special economic zones offer preferential investment conditions, such as tax breaks, access to infrastructure, and assistance in completing formalities. As a result, cities with special zones become attractive to investors in the high-tech sector, which contributes to the development of local economies. The second aspect of the importance of the high-tech sector in cities associated with special economic zones is the creation of new jobs and attracting specialists. The high-tech sector is characterized by high productivity and requires a skilled workforce, which contributes to the creation of new jobs for specialists in science and technology. Thanks to this, cities with special zones can attract and employ specialists, which in turn contributes to the further development of the high-tech sector. The third aspect of the importance of the high technology sector in cities associated with special economic zones is the development of innovation and technology transfer. Technology companies are often innovative and have access to the latest advances in science and technology. Thanks to this, they can contribute to the development of innovation in the region and stimulate technology transfer. In cities with special zones, these companies can conduct research and development activities, invest in innovations and cooperate with local universities and research centers, which contributes to the growth of the region's importance. The high-tech sector plays an important role in cities with special economic zones.

The development of the high-tech sector in cities and metropolises is extremely important in the holistic development of regions and entire countries. The importance of the high-tech sector in cities may depend on the development of business in the region. Innovative specializations of cities located in special economic zones can also be considered from the point of view of their perception by users of these new technologies, i.e., city dwellers. The study covered issues of broadly understood economic development, which is why a study was planned to draw attention to the impact of the existence of the economic zone on it. Metropolis GZM, as the largest metropolitan area in Poland, is a platform for implementing new management tools and methods, which can then be applied to other regions of the country. The perceived cognitive gap was the dominant way of generating research questions based on the collected literature. Bearing in mind the analysis of the collected texts, in particular the identified research gap, the main purpose of the article is to determine whether the economic zone has a positive impact on the economic development of cities, which in the context of this research has been operationalized with the use of computer-aided systems.

Searching for a solution to the research problem, based on the conducted detailed literature research and research results available in secondary sources, a research hypothesis was formulated: the functioning of the economic zone in a given city/metropolis affects its development. Solving the research problem, achieving the goal, as well as testing the research hypothesis required not only the literature research but also empirical research. Bearing in mind the cognitive gap in the researched area and the specificity of the formulated research problem and the hypothesis, we adopted both qualitative and quantitative data analysis techniques in the article.

By juxtaposing the empirical achievements and the identified research gap, scientific exploration in this area confirms its validity and legitimacy, particularly in the context of the impact of special economic zones on the development of cities and metropolises. This article contributes to filling the knowledge gap in terms of the benefits of the functioning of SEZs affecting the broadly understood development of cities/metropolises. The choice of the research field was not accidental. The subject of this article is the Katowice Special Economic Zone and the cities of the Metropolis (GZM) [1,2] within which the zone operates.

2. Literature Review

In the article, the critical review of the literature covers the following areas: special economic zones, competencies in shaping coherent elements of sustainable development-economic growth, social inclusion, environmental protection, and Smart City Technologies.

2.1. Review of the Literature Regarding Special Economic Zones

Special economic zones (SEZs) are designated areas within a country that have been created to promote economic development and international trade. SEZs are typically characterized by relaxed regulations, tax incentives, and other benefits that are designed to attract foreign investment and encourage the growth of export-oriented industries. There is a growing body of the literature on the management of SEZs, and the research in this area has focused on a variety of topics, including the economic impacts of SEZs, the role of SEZs in regional development, and the challenges and opportunities of SEZ management. One of the key findings of this research is that SEZs can have significant economic impacts, both at the local and national levels. For example, several studies have found that SEZs can lead to increased economic growth, employment, and exports [3–6]. However, these benefits are not always evenly distributed, and there is evidence that SEZs can also lead to economic inequality and social unrest if they are not managed carefully [3,7]. Another important theme in the literature on SEZ management is the role of SEZs in regional development. Many researchers have argued that SEZs can serve as engines of regional growth, helping to drive economic development in less developed areas [8–10]. However, others have pointed out that SEZs can also have negative impacts on regional development if they are not integrated effectively into the local economy and if they do not contribute to the overall development of the region [11–14].

Finally, there is a growing recognition of the challenges and opportunities of SEZ management. These challenges include the need to balance economic development with social and environmental concerns [15,16], the need to address issues of governance and transparency, and the need to ensure that SEZs are integrated into the broader economy [17–20]. At the same time, there are also many opportunities for SEZs to contribute to economic development, trade, and innovation, particularly if they are managed effectively and in a way that is responsive to the needs of local communities and stakeholders [4,5,21]. In conclusion, the literature on SEZ management highlights the potential for SEZs to contribute to economic development, trade, and innovation [22–28], but it also underscores the need for careful and effective management to ensure that these benefits are realized in a way that is inclusive and sustainable.

2.2. Review of the Literature Regarding SEZ Competences in Shaping Coherent Elements of Sustainable Development-Economic Growth, Social Inclusion, and Environmental Protection

Special economic zones in Poland are an effective instrument for attracting foreign investors to selected regions. SEZs are a macroeconomic instrument of interregional policy. The role of the zones is noticeable at the macroeconomic, regional, and local levels [29]. It can be added here that real social feelings link the existence of the zone with the phenomena of socio-economic development, including structural transformations taking place mainly on a local scale, e.g., changes in the functional structure of the city [25,26,30]. The main objective of incorporating new areas into special economic zones is to support new investments implementing the policy of sustainable development, understood as socio-economic development, in which activities are integrated to increase the competitiveness of the Polish economy and create new jobs [20,31–35].

Sustainable development is an attempt to formulate a program integrating various levels of human activity—often previously considered separate—based on moral reflection regarding man's responsibility for nature (expressed in the principle "sustainable development is such development that guarantees the satisfaction of the needs of the present generations, without limiting the possibility of satisfying needs of future generations [36–39]. This integration means achieving order on many levels. These include the moral plane (the issue of human responsibility for nature), the ecological plane (nature and landscape protection), the technical plane (new technologies, saving raw materials), the economic plane (taxes, subsidies, and other economic instruments), the legal plane (environmental protection law), the social plane (interpersonal relations, and in Polish conditions

the extremely important problem of unemployment), the political plane (formulation of sustainable development strategies, their implementation, and control).

From the point of view of SEZ competencies, technical, ecological, economic, and social conditions are of particular importance. This is due to the objectives of the SEZ-accelerating the development of regions through, among others, attracting new investments, developing exports, and creating new jobs. Competences are an important instrument to support the innovation and competitiveness of entrepreneurs due to the form of support and the scale of public aid granted to them. The technical conditions of sustainable development relate to the functioning of the industry. The concept of "industrial ecology" developed in recent years should be mentioned here [40]. Robert A. Frosch points out that "it is based on an analogy with natural ecosystems. In nature, an ecosystem functions thanks to a network of connections through which "organisms live and eat each other." The classic approach to production processes is linear; raw materials are used to produce products, which results in the generation of waste. In industrial ecology, creating a closed system where waste is used as a source of energy or substrates for another product is proposed. An important challenge is that it is impossible to use the environment and obtain natural resources in such a way that these activities do not entail any negative changes. They can be direct or indirect and reversible or irreversible. Their scale will vary from relatively minor consequences of a local event to global problems. However, this negative aspect will always be present. Environmental damage can be minimized, which is a task for technical sciences, in particular for the currently developing environmental engineering [41].

Awareness of the threats resulted in specific actions covering several levels: strict emission standards, the introduction of new generations of purification devices (so-called "end-of-pipe solutions"), as well as in the longer term-changes interfering with the technological process itself, including other promotions of the recently fashionable concept of cleaner production, which is a direct reference to industrial ecology.

The technical plane of sustainable development refers to all the above-mentioned aspects; however, it is particularly important to emphasize the enormous possibilities associated with interference in the very essence of the technological process used. Four basic groups of strategies can be distinguished here: 1. Limiting the flow of raw materials, 2. Slowing down the flow of raw materials, 3. Closing the flow of raw materials, 4. Replacing the flow. The integration of these strategies takes place through the introduction of the so-called "cleaner production". The overall goal of cleaner production is to improve quality and yield, reduce human risk, and save money.

The social plane is sensitive to degradation processes. The process of degradation can affect the natural environment, and so can the social environment. This type of environment consists of many factors, including customs, culture, spirituality, as well as interpersonal relationships and living conditions. Even the relationship between man and nature has its social dimension because all human activity towards the environment always takes place through the mediation of existing socio-cultural patterns. The social environment should secure the foundations of an individual's existence, both in the material and spiritual dimensions. This is also how it is understood in the WHO Concept of Healthy Cities, where the issue of a clean environment and adequate urban infrastructure is put on a par with social issues [42–44]. There is a lot of truth to that. After all, what is the benefit of a clean environment when the people living in it are a threat to each other? We are already seeing an increase in hostility and aggression. The consequence of disrespect for other people is also disrespect for the environment. It should be emphasized that in the global dimension, the possible self-destruction of humanity will also be the destruction of the biosphere as such.

Interpenetration and integration of sustainable development planes, within the concept of sustainable development, the idea of the so-called "ecological footprint". It is an area that is necessary to provide raw materials and resources necessary for the life of an individual, society, or any population surveyed. It is estimated that even in the case of a medium-sized city, the ecological area can be from 500 to even 1000 times larger than the

area occupied by the city itself. On a global scale, however, the situation is very diverse. According to available estimates, taking into account the available land resources, there should be about 1.7 ha of "area" per one inhabitant of the Earth. There are areas (symbolic south) where people consume much less, but there are also areas (north) where the situation is extremely different.

2.3. Review of the Literature Regarding Smart City Technologies

Smart cities are urban areas that use technology to improve the quality of life for their citizens, increase efficiency and sustainability, and enhance economic development. There are many different technologies that can be used to create smart cities, and these technologies can be grouped into various categories, such as transportation, energy, water, and waste management, public safety, and governance [45–49]. One of the key technologies for smart cities is the smart urban monitoring system, which uses sensors, cameras, and other technologies to monitor various aspects of a city or urban area in real-time. These systems can be used to track and analyze a wide range of data, including traffic patterns, environmental conditions, and public safety incidents, and they can help cities to become more efficient and livable by providing city planners and policymakers with valuable data that can be used to optimize city services, infrastructure, and policies [50,51].

Another important technology for smart cities is the city Wi-Fi network system, which provides wireless Internet access to citizens and visitors in public spaces such as parks, squares, and libraries [52–54]. These systems can be used to support a wide range of applications, including social networking, e-government, e-commerce, and entertainment, and they can help to promote economic development and social interaction [21,55–57].

Internet platforms for servicing residents are another key technology for smart cities, as they provide a convenient and efficient way for citizens to access city services and information online [58–60]. These platforms can be used to support a wide range of services, including payment of bills, request for services, and participation in city planning and decision-making processes [61–63]. Intelligent urban lighting control systems are another important technology for smart cities, as they use sensors and other technologies to optimize the use of streetlights and other forms of public lighting [64–67]. These systems can be used to reduce energy consumption and costs, improve public safety, and enhance the aesthetic appeal of cities [35,68–71].

City information systems that provide information about the city's activities through various channels such as press, radio, television, and public transport stops are also important technologies for smart cities, as they help to keep citizens informed and engaged [49,72]. These systems can be used to support a wide range of applications, including emergency notification, public transportation schedules, and community events [73–76].

Smart cities can also use YouTube channels, fan pages, and other social media platforms to promote the city and its activities and engage with citizens [70,77–79]. These platforms can be used to support a wide range of applications, including marketing [80–83], tourism [84–86], and citizen engagement [87–89]. Systems for measuring and informing residents about air quality are another important technology for smart cities, as they help to improve public health and environmental sustainability [90–92]. These systems can be used to monitor air quality in real-time and to provide citizens with information about air quality levels and potential health impacts [93,94].

Systems for measuring and saving water, energy, and heat for the use of the city are also important technologies for smart cities, as they help to improve resource efficiency and environmental sustainability [95,96]. These systems can be used to monitor resource consumption in real-time and to optimize the use of resources through techniques such as demand-side management and real-time pricing [97–99].

3. Materials and Methods

The conducted diagnoses began with a systematic literature review, clearly defining the research goals and a properly defined methodological process [100,101]. Adoption of this

sequence of actions leads to the creation of an important work [102]. A systematic review of the literature identifies, evaluates, and synthesizes existing research evidence, providing the source material for designing empirical studies [103] as well as indicated by [104] the use of a systematic review of the literature, despite clear epistemological differences, allows the development of an evidence-based methodology tailored to the needs of researchers, which can provide an important and effective means of creating practical knowledge [105]. Based on the collected source materials, a cognitive gap was identified: the lack of sufficiently described and diagnosed issues of the impact of special economic zones on the development of metropolitan cities. Therefore, the Katowice Special Economic Zone (KSEZ) and the Metropolis GZM were adopted as the subject of consideration.

The Metropolis GZM consists of 41 member cities and communes, of which 16 communes are located within the area of operation of the KSEZ and are Dąbrowa Górnicza, Bieruń, Bytom, Zabrze, Katowice, Sosnowiec, Rudziniec, Piekary Śląskie, Świętochłowice, Siemianowice Śląskie, Siewierz, Gliwice, Sławków, Knurów, Tychy, Lędziny. Twelve communes responded to the survey, while the last four mentioned did not participate in the survey. The survey was conducted using the CATI technique (computer-assisted telephone interviewing), and the tool used to conduct it was a questionnaire. The deadline for the survey was July 2022, and the respondents were mayors of cities or their deputies or substantive persons indicated by them.

The study covered issues of broadly understood economic development, which is why a study was planned to draw attention to the impact of the existence of the economic zone on it. Metropolis GZM, as the largest metropolitan area in Poland, is a platform for implementing new management tools and methods, which can then be applied to other regions of the country. The perceived cognitive gap was the dominant way of generating research questions based on the collected literature. Bearing in mind the analysis of the collected texts, in particular the identified research gap, the main purpose of the article is to determine whether the economic zone has a positive impact on the economic development of cities, which in the context of this research has been operationalized with the use of computer-aided systems. Searching for a solution to the research problem, based on the conducted detailed literature research and research results available in secondary sources, a research hypothesis was formulated; the functioning of the economic zone in a given city/metropolis affects its development.

Solving the research problem posed in the work, achieving the goal, as well as testing the research hypothesis required not only literature research but also empirical research. Bearing in mind the cognitive gap in the researched area and the specificity of the formulated research problem and the hypothesis, both qualitative and quantitative data analysis techniques were adopted in the article.

By juxtaposing the empirical achievements and the identified research gap, scientific exploration in this area confirms its validity and legitimacy, in particular in the context of the impact of special economic zones on the development of cities and metropolises. This article contributes to filling the knowledge gap in terms of the benefits of the functioning of SEZs affecting the broadly understood development of cities/metropolises. The choice of the research field was not accidental. The subject of this article is the Katowice Special Economic Zone and the cities of the Metropolis (GZM) [1,2] within which the zone operates.

The aim of the study was to find out the respondents' opinions on issues related to the SMART CITY concept. One thousand four hundred thirty-six respondents took part in the study, and one thousand respondents reflecting the demographic structure were selected for evaluation. The research was conducted online. Respondents were also reached in the traditional way, i.e., through direct interviews (by phone and website). Comparative analysis of response parameters of online and face-to-face respondents showed no significant difference. One thousand questionnaires were analyzed. The study was conducted in the period from June to July 2022 in the 16th city of GZM Metropolis. The selection of respondents was random. Respondents reflect the structure of the population in the study

area. Hence, the obtained results can be generalized to the entire population of the region's inhabitants. The plan of the research is shown in Figure 1.
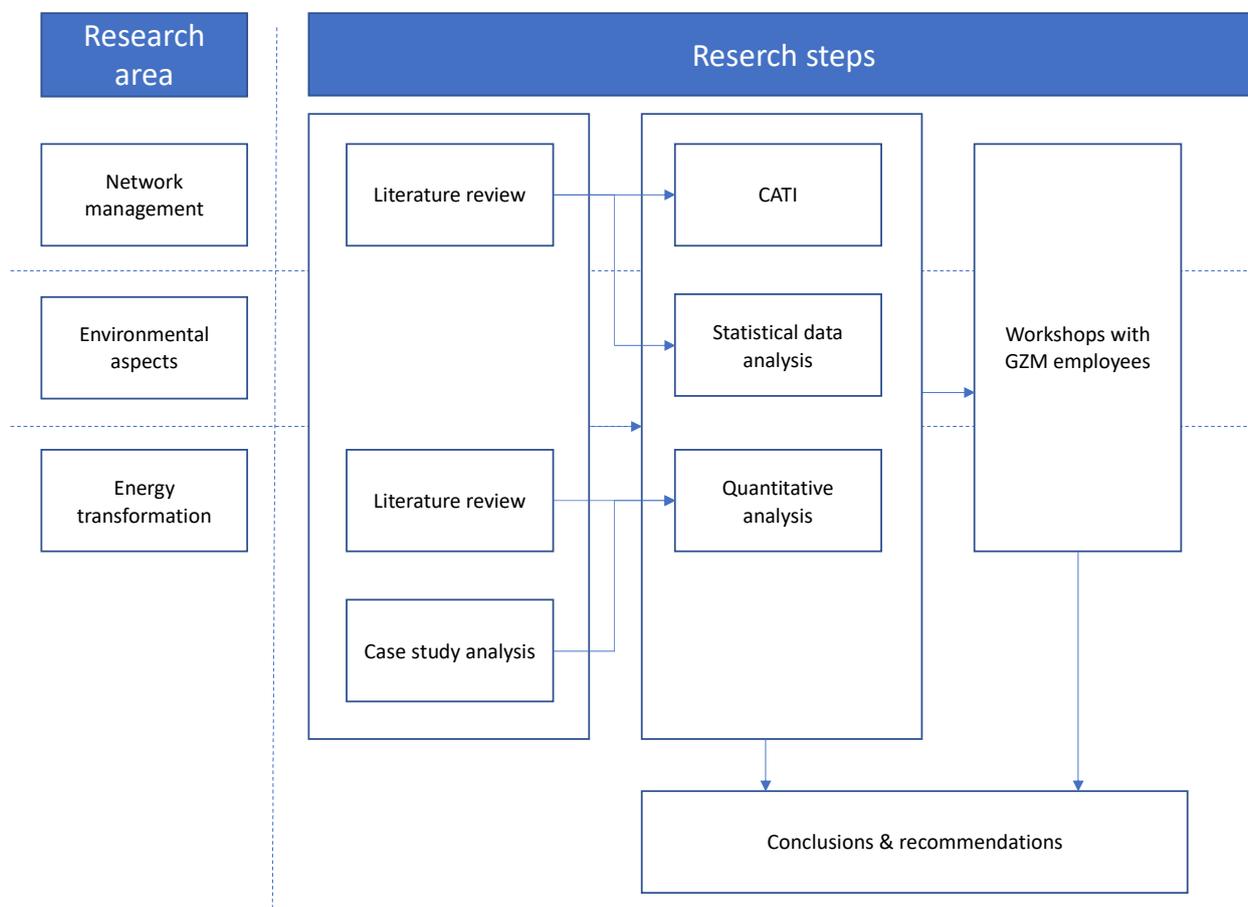
Figure 1. Research plan. Source: own elaboration.

Primary data has been collected and analyzed, starting with a preliminary understanding of research areas related to network management, environmental aspects, and energy transformation stemming from a literature review and case studies of smart cities and management systems in the economy. Databases enabling access to current and important journals and publications in full-text versions were used, such as Mendeley, Emis, ProQuest, Emerald, Scopus, and Google Scholar. Then, a selection was made based on defined keywords and the criterion of the nature of the publication (narrowing down to the list of publications containing fully reviewed texts). The adopted methodology allowed for the collection of source materials relevant to further analyses. In the next step of the literature review, the prepared literature material was extended to include Polish scientific publications, monographs, and reviewed articles in leading Polish journals. A systematic review of the literature identifies, evaluates, and synthesizes existing research evidence, providing source material for designing empirical studies. Adopting a systematic review of the literature allows for the development of evidence-based methodology tailored to the needs of researchers, which can provide an important and effective means of creating practical knowledge [99].

The next step was to find the gap. Based on the collected source materials, a cognitive gap was identified; the lack of a sufficiently described and diagnosed issue of the role of special economic zones as a tool for sustainable development of metropolitan cities, not only in Poland as a whole but also in regional terms. It is very important to listen to citizens and incorporate their opinions into the management decisions of policymakers.

Implementation method:

- METHOD: quantitative research;
- TECHNIQUE: CAWI (computer-assisted web interviewing);
- Average interview duration—19 min;
- SAMPLE: n = 1000;
- DATE of the study: June–July 2022.

In order to obtain the reliability of the study, ensuring high certainty of the results obtained, the following assumptions were made:

- Confidence Level: 95%;
- Estimation error: 3%.

With these indicators, the assumed size of the research sample is n = 1000.

In identifying the opinions of residents, a five-point Likert scale was used, which is typical for the study of views and attitudes. In some questions, a nominal scale was used-especially in a situation where there was a suspicion that the respondents may not have sufficient knowledge to answer.

The scales that were used were adopted on the basis of the literature on the subject (footnote).

The following issues were addressed in the survey, divided into segments:

Segment 1. Assessment of the level of development of 4T Capitals in the Smart City concept (Creative City), including:

1. Introduction/deployment of smart technologies (knowledge and assessment);
2. Facilitating the development of talents and creativity;
3. Building trust between the authorities and each other among the inhabitants;
4. Evaluation of the attitude of the city on issues important to the residents.

Segment 2. Assessment of the development level of the six main dimensions of the Smart City concept (Smart City-European Smart Cities), including:

1. Assessment of the effectiveness of implementing modern/innovative solutions;
2. Modern mobility, transport, and communication;
3. The use of pro-environmental and climate-protecting solutions by the city.

Segment 3. Assessment of the level of use of social media to activate residents (Communicative city)

Segment 4. Assessment of the level of understanding of the sustainable development goals (sustainable city)

Segment 5. Assessment of the level of implementation of climate protection measures (Ecological city)

Within each of the segments, detailed questions were asked. The list of opinions included in the thematic blocks of a given segment was created as a result of consultations with experts and on the basis of a literature review.

The first part of this document contains a description of the sample-using demographic variables. In the second part, an analysis of the structure and descriptive statistics was carried out, divided into thematic blocks. In the next part, a correlation analysis was carried out for this purpose; the values of the indexes were estimated as the arithmetic mean value for the respondent based on the opinions constituting a given thematic block. High values of correlation coefficients were obtained, which indicated statistically significant relationships.

A factor analysis was carried out to ensure consistency that a given block allows studying a given area. The values of Cronbach's alpha coefficient indicated the possibility of such an analysis. Furthermore, the values of the KMO coefficient obtained values indicating the validity of the factor analysis. Varimax rotation was used.

The next part contains the results of the regression analysis, the purpose of which was to identify the cause-and-effect relationship.

Detailed information on the characteristics of the sample is included in Table 1. It shows that the survey was dominated by men in terms of age. The largest group was constituted of respondents aged 35–44, although the group aged 25–34 is almost as numerous. On the other hand, in terms of education, people with secondary education are the most numerous.

Table 1. Sample characteristics.

Sex	Number of Indications	Percentage
Man	433	43.3
Woman	567	56.7
Total	1000	100.0
Age	**Number of Indications**	**Percentage**
18–24 years	117	11.7
25–34 years old	291	29.1
35–44 years	293	29.3
45–54 years	147	14.7
55–64 years	102	10.2
65 and over	50	5.0
Total	1000	100.0
Education	**Number of Indications**	**Percentage**
Primary and lower secondary	48	4.8
Basic vocational	139	13.9
Higher secondary	459	45.9
University	354	35.4
Total	1000	100.0
Place of Residence	**Number of Indications**	**Percentage**
Bieruń	13	1.3
Bytom	101	10,1
Dąbrowa Górnicza	78	7.8
Gliwice	116	11.6
Katowice	213	21.3
Knurów	24	2.4
Lędziny	11	1.1
Piekary Śląskie	36	3.6
Rudziniec	7	0.7
Siemianowice Śląskie	42	4.2
Siewierz	11	1.1
Sławków	6	0.6
Sosnowiec	147	14.7
Świętochłowice	32	3.2
Tychy	65	6.5
Zabrze	98	9.8
Total	1000	100.0

Table 1. *Cont*.

Family Status	Number of Indications	Percentage
I run a one-person household	200	20.0
I run a household only together with my partner	351	35.1
I run a household with children	449	44.9
I run a one-person household	200	20.0
Total	1000	100.0
I live in	**Number of Indications**	**Percentage**
apartment	789	78.9
single-family house/terraced house/semi-detached house	211	21.1
Total	1000	100.0

Source: own elaboration.

The assumptions of this research, the process of understanding them (epistemology), and the research tools used are up-to-date and were understood by others during the analysis. This is important for the development of good theories and practices as a result of conducted research. The adopted criteria of methodological rigor are as follows:

- The evaluation and interpretation of the data were performed in a logical and impartial manner, and the integrity of the findings was ensured by objectively establishing the relationship between the data and the findings.
- The truth about the conclusions came from cause-and-effect or causal relationships (so as to allow accurate explanation of research problems).
- The conducted survey research was verified by in-depth interviews and analysis of the collected source documents.
- Understanding of the results obtained in one study could be transferred to explain phenomena observed in other contexts through analytical generalization. A comprehensive understanding of one context warrants useful interpretations of similarities and differences in other contexts.
- Reliability, all stages of the research process, including data collection, coding, and all other data preparation and analysis processes, are described as accurately as possible to achieve a high degree of transparency.

4. Results and Discussion

The results are divided into blocks and discussed separately. Conclusions are separate, but recommendations are common for both blocks.

Block 1. Knowledge of inhabitants about the introduction or implementation of smart technologies by the city

A significant part of the respondents has knowledge about smart technologies that operate in the city. First of all, those related to safety, information about the city's activities, recruitment system for educational institutions, city Wi-Fi, as well as an internet platform for residents and registration systems for the city's health service are noticed. The systems of measuring and saving water, energy, and heat, as well as the system of virtual sightseeing of the city and its facilities, were mentioned least often (Table 2).

Table 2. Knowledge of residents about the existence/implementation of smart technologies.

Type of Solution	Knowledge of Residents about the Existence/Implementation of Smart Technologies			Dominant Share in the Category		
	Yes	**No**	**I Do Not Know**			
Smart urban smart monitoring system	72	13.4	14.6	Men	35–44 yo	Higher secondary
City Wi-Fi network system	69.5	14.7	15.8	Women	35–44 yo (also 45–54 yo)	Primary and lower secondary
Internet platform for servicing residents	66.8	11.6	21.6	Men (almost equally women)	45–54 yo	University
Intelligent urban lighting control system (dimming, dimming, etc.)	65.1	14.9	20	Men (almost equally women)	55–64 yo (also 45–54 yo)	Higher secondary (also University)
City information system about the city's activities (press, radio, television, public transport stops)	63.2	20.8	16	Women	18–24 yo (also 65 and older)	Basic vocational (also Higher secondary)
YouTube channel about the city and its activities, fan page and/or other social media about the city	62.6	15.2	22.2	Equally	65 yo and older (also 25–34 yo)	Basic vocational
A system for measuring air quality and informing residents about it	60.8	20.9	18.3	Women	65 yo and older (also 25–34 yo)	Basic vocational and University
A system for measuring and saving water, energy, and heat for the use of the city	57	18.7	24.3	Men	18–24 yo (also 25–45 yo)	University
Electronic service system and schedule with notifications for collecting segregated municipal waste	51.6	17.8	30.6	Women (almost equally men)	45–54 yo (also 65 yo and more)	Primary and lower secondary
Electronic recruitment system for schools, kindergartens, and nurseries	44.8	23.8	31.4	Women	25–34 yo (also 18–24 yo)	University (also basic vocational)
Electronic registration system for the municipal health service	41.2	23.8	35	Women (almost equally men)	65 yo and older (also 18–24 yo)	Basic vocational
A system of virtual sightseeing of the city and its objects, museums, and exhibitions	39.1	23.1	37.8	Women (almost equally men)	18–24 yo	Basic vocational and University

Source: own elaboration.

Taking into account demographic variables, people who answered positively to the statement that the city in which they live introduced or is introducing smart technologies were more often women and people aged 35–44 or 25–34. However, taking into account the distribution of answers within a given group (by gender, age, and education), it can be seen that the percentages confirming the knowledge of solutions were different for individual technologies.

Conclusions of block 1.

1. The structure of respondents who answered affirmatively to the question about knowledge of smart technological solutions in their cities is different, most often indicating the intelligent city monitoring system, the city information system on city activities (press, radio, television, transport stops), and an electronic recruitment system for schools, kindergartens, and nurseries.
2. The electronic service system and schedule with notifications for the collection of segregated municipal waste, the system of virtual sightseeing of the city and its facilities, museums, and exhibitions, and the system for measuring and saving water, energy, and heat for the use of the city were the least frequently indicated, less than 50% of positive answers.
3. Women are more familiar with smart technological solutions than men.
4. People aged 25–34 and 35–44 answered yes to the question about smart technological solutions, yet there are no regularities when it comes to knowledge of IRT taking into account the level of education.

Block 2. Assessment of the level of improvement of city services as a result of the implementation of smart technologies

Respondents who had knowledge about the implemented solutions spoke quite neutrally about the quality of the implemented solutions. The average value oscillated in the range of 3.58–3.89. The recruitment system for educational institutions received the highest rating, which is a positive assessment, although it does not exceed 4. However, the dominant answer is 5 (completely works), which means that many residents are satisfied to the highest degree (36%). The value of 4 was indicated by 30% of those with sufficient knowledge to assess. In most questions, the standard deviation from the mean takes the value of 1 or slightly above, which means that there were differences in opinions (the higher the value of the deviation, the greater the diversity of attitudes) (Table 3).

Table 3. Evaluation of the level of improvement of city services as a result of the implementation of smart technologies depending on the age of the respondent.

	Age											
	18–24 yo		**25–34 yo**		**35–44 yo**		**45–54 yo**		**55–64 yo**		**65 yo and More**	
	Average	**SD**	**Average**	**SD**	**Average**	**SD**	**Average**	**SD**	**Average**	**SD**	**Average**	**SD**
Smart urban smart monitoring system	3.46	1.15	3.38 *	0.99	3.55	1.1	3.89 *	0.93	3.8	1.01	3.81	0.95
City WiFi network system	3.51	1.02	3.37 *	0.99	3.53	1.09	3.73	0.93	3.89 *	0.91	3.81	0.83
Internet platform for servicing residents	3.57	1.09	3.45	0.96	3.64	1.08	3.69	0.9	3.81	0.9	3.87	0.86
Intelligent urban lighting control system (dimming, dimming, etc.)	3.71	1.16	3.40 *	1.03	3.64	1.12	3.87 *	0.91	3.91 *	1	4.00 *	0.69
City information system about the city's activities (press, radio, television, public transport stops)	3.58	1.14	3.61	0.99	3.83	1	3.89	0.91	3.81	0.88	3.78	0.72
YouTube channel about the city and its activities, fanpage and/or other social media about the city	3.69	1.11	3.59	1.07	3.73	1.06	3.77	0.9	3.53	1.01	3.81	0.87
A system for measuring air quality and informing residents about it	3.62	1.08	3.6	0.91	3.87	1	3.73	0.98	3.82	0.94	3.68	1.12
A system for measuring and saving water, energy and heat for the use of the city	3.27 *	1.21	3.41	0.94	3.77 *	1.06	3.77	0.96	3.84	0.9	3.58	1.02
Electronic service system and schedule with notifications for collecting segregated municipal waste	3.58	1.14	3.52 *	1.09	3.95 *	1.02	3.82	0.95	3.93	1.1	4	0.78
Electronic recruitment system for schools, kindergartens and nurseries	3.91	1.21	3.89	1.01	3.89	1.08	3.79	1.06	3.92	1.14	4.07	0.98
Electronic registration system for the municipal health service	3.69	1.21	3.64	1.06	3.77	1.07	3.84	1.06	3.87	1.02	3.89	0.95
A system of virtual sightseeing of the city and its objects - museums and exhibitions	3.51	1.03	3.52	1.03	3.67	1.06	3.9	0.98	3.73	1.01	4.1	0.77

* statistically significant differences, $p < 0.05$; Source: own elaboration.

Conclusions for blocks 1 and 2.

1. Most of the respondents know about the introduction or introduction of selected smart technologies. The most frequently mentioned were the intelligent city monitoring system, SIM, and the recruitment system for educational institutions.
2. The least frequent respondents had knowledge about the system for measuring and saving water, energy, and heat for the city, as well as the system of virtual sightseeing of the city and the service and schedule for collecting segregated municipal waste.
3. Taking into account the demographic criteria, women, people with secondary education, and aged 35–44 and 25–34 answered affirmatively to the questions about the implemented innovative solutions.
4. There is a significant difference in knowledge about implemented/implemented solutions, taking into account the share of respondents in a given group distinguished in terms of age, gender, or education.
5. Respondents' opinions on the improvement of city services are moderately positive. They all oscillate around a neutral value. The recruitment system for educational institutions, the electronic service system, and the schedule with notifications about the collection of municipal waste, as well as the electronic registration system for the municipal health service, received the highest positive ratings. The system of the municipal WIFI network, the intelligent city monitoring system, and the system for measuring and saving water, energy, and heat received the lowest scores.
6. Taking into account demographic variables, statistically significant differences were observed only in the case of some innovative solutions. In general, the opinions of the respondents, taking into account the level of education, do not differ; differences occur in the case of age groups and gender.

In summary, it can be assumed that (it is rather an interpretation or hypothesis that can be put forward to explain the results potentially):

1. Low ratings result from the fact that respondents in the filtering question marked affirmative answers and then were redirected to the rating question, where they had more difficulty in assessing because they have no experience in using a given innovation, although they know that it is implemented.
2. A high share of affirmative answers in the group of respondents aged over 65 and high averages may result from greater acceptance of changes and a positive attitude towards them, as well as fear of admitting ignorance.

5. Conclusions and Recommendations

The study aimed at examining the functioning of the economic zone in Metropolis GZM in light of the effects on the development of the cities within Metropolis GZM. By focusing on the cities belonging to Metropolis GZM, we substantiate that functioning within the economic zone has positive effects. As Metropolis GZM is the first and the only metropolis in Poland functioning under the government act, our pioneering analyses are based on actual data and show substantial benefits to its participants.

Among the smart technologies implemented in cities, according to the respondents, the systems of the urban Wi-Fi network, city monitoring, and heat/energy/water saving systems are the worst. Improvements related to electronic recruitment for kindergartens, intelligent control of city lighting, and registration for city health services were rated the best. Interestingly, in a significant part of the areas, the level of improvement is assessed significantly better by people who are better versed in the number of electricity bills, living in single-family houses, and heating their houses with solid fuels. The highest number of positive opinions compared to other cities was recorded in Lędziny. Among other things, the following were rated higher than in other locations: Wi-Fi network, the Internet platform for service to residents, city information, and city health service registration.

Among the analyzed capitals, the cities that are part of the Metropolis GZM, in the opinion of the respondents, are the best at using the development of smart technologies for their own development, while they are slightly worst at building trust in the authorities and residents and mutual tolerance. It is worth noting, however, that the last two areas are assessed significantly better by the residents of Sosnowiec.

According to 74% of GZM residents, the arrival of investors is the main factor that would accelerate the transformation of their city into a modern "Smart City. Equally important is access to EU funds (71%), establishing cooperation with modern partner cities in Europe (69%), and improving the competence of officials in obtaining external sources of financing (68%).

The change of local authorities or the political situation may also be one of the factors stimulating the transformation of the city into a Smart City; however, in the opinion of the respondents, these are secondary factors.

Other factors included:

1. Cooperation with the inhabitants of the city;
2. Discontinuing the sale of land for the construction of private houses to ensure sustainable management of spatial planning in favor of green areas, which are disappearing from the city every year;
3. Use of biogas from sewage treatment plants to supply energy to urban centers;
4. Implementation of solutions that will allow for the simultaneous care of the environment and the use of the benefits of the acquired technologies because, in the respondent's opinion, the key to success is technology and not limitations.

Among the factors blocking the transformation of the city into a Smart City, the lack of investors and, thus, financial resources were most often indicated. In contrast to the stimulators here, according to the residents, political factors may be important in slowing down the process of creating a Smart City. Among the barriers indicated were the following:

1. The unwillingness of city officials and authorities to change the current style of city management (the city is treated as a "machine for earning money");
2. The president or major is a technocrat who doesn't care about nature and the environment";
3. "Those who now rule my city".

Quite often, the lack of cooperation with modern European cities (54%), the impact of the lack of competence of officials (50%), and the lack of will on the part of residents to change something (47%) were also pointed out.

1. The limitation of this study may be attributed to the selective case study presentation. This study does not have exhaustive ambitions, but, in turn, it might be biased by the omission of many theoretical and empirical works. Based on the conclusions of the study, here are some recommendations for future work:
2. Further analysis of the economic zone in Metropolis GZM: This study highlights the positive effects of functioning within the economic zone in Metropolis GZM. Further research could examine the specific mechanisms and policies that contribute to these positive effects and explore how they could be improved or replicated in other regions.
3. Investigation of smart technology implementation: The study also provides insights into the perceived effectiveness of smart technologies implemented in cities. Future research could delve deeper into the reasons behind these perceptions, explore the challenges of implementing smart technologies, and identify strategies for improving their adoption and effectiveness.
4. Comparative analysis of different cities: the study compares the cities in Metropolis GZM in terms of their use of smart technologies, trust in authorities and residents, and other factors related to becoming a "Smart City." Future research could expand this analysis to include other regions or countries, providing a broader perspective on the factors that contribute to successful Smart City transformations.

5. Exploration of factors blocking Smart City transformation: the study also identifies several barriers to becoming a Smart City, such as lack of financial resources and the unwillingness of officials to change the current style of city management. Future research could investigate these barriers more deeply and explore strategies for overcoming them.

Expansion of the scope of the study: The authors acknowledge that this study has limitations due to its selective case study presentation and the omission of many theoretical and empirical works. Future research could expand the scope of the study to include more cities and different regions and a more comprehensive review of the literature.

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