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Smart City 4.0: Sustainable Urban Development in the Metropolis GZM

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Abstract: This article presents the development of the Metropolis GZM cities within the scope of the concept of a Smart City and 4T capitals. The subject matter discussed herein is also related to the search for municipal authorities' new models and tools to shape sustainable development in order to improve citizens' access to municipal services and facilities, as well as to increase citizens' impact on the future of their cities. The main objective of the research was to identify the way in which authorities of the selected cities consider the subject matter related to the Smart City and 4T capitals when formulating local policies. The aim of this article is to analyse the innovative potential in selected cities of the Metropolis GZM, in the light of academic entrepreneurship, the innovativeness of citizens, entities supporting innovativeness, and soliciting talent. The research was based on a systematic literature review and the analysis of local documents, supplemented by direct interviews with local managers and participant observation.

Keywords: Smart City; public administration management; metropolis; project management

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1. Introduction

The concept of the Smart City emerged as an effect of the research into smart urban environments [1]. The term 'smart city' is understood as a city having a certain intellectual ability, which refers to innovative sociotechnical and socioeconomic aspects of growth [2]. It has six dimensions [3]: a smart economy, smart mobility, smart environment, smart people, smart living, and smart governance.

N. Kaminionos proposed three phases of the development of smart cities defined as Smart City 1.0, Smart City 2.0, and Smart City 3.0. [4]. The proposed phases are of an open-ended nature, as there is currently the shaping of another phase—Smart City 4.0, inspired by economics [5].

Smart City 1.0 refers to intelligent cities in the earliest phase of creation. The use of modern technologies is initiated by ICT companies. They implement various solutions irrespective of whether they are necessary for the cities or not. A good example is the city of Songdo in South Korea. This, currently in construction, modern ubiquitous city is the largest private development investment in the world. It should become a business centre comparable to Shanghai, Hong Kong, or Singapore [6,7].

Smart City 2.0 is a phase in the development of smart cities with a predominant role for public administration. The use of modern technologies is initiated by local authorities, and the introduction of new solutions is aimed at improving the citizens' quality of life. According to the Smart City researcher, Boyd Cohen, today, the majority of cities implementing Smart City projects belong to the 2.0 generation.

Since 2015, a new approach to the creation of smart cities has been observed—the Smart City 3.0 model. Many influential contemporary cities are encouraging the active approach of their citizens to creating further development. The role of local authorities is focused on creating the space for and opportunities to use the various potential of their citizens. This concerns both encouraging citizens to use modern technologies (e.g., by educational projects for digitally-excluded persons) and allowing them to create their own technological solutions (e.g., through open data).

Although Smart City 3.0 still refers to the use of modern technologies to improve the quality of life in cities, the area of its interest has expanded and, apart from projects that were characteristic of the second generation, it includes social, equity, educational, and ecological issues. Smart City 3.0 fits the increasingly popular sharing economy. It often requires courage from municipal authorities to accept the increasingly influential participation of citizens. However, there must be not only a mental shift (authorities–citizens) but also a communication shift. Dialogue, mediation, and deliberation begin to play a dominant role.

With reference to local government practice, an interesting evolution of the approach to a Smart City is presented by authors of the guidebook for local governments on the scope of the Human Smart City, who, citing B. Cohen, distinguish three levels of development of smart cities. This conception has been presented in Figure 1 below, which has been extended with the fourth level discussed herein, the conception of a Smart City 4.0.

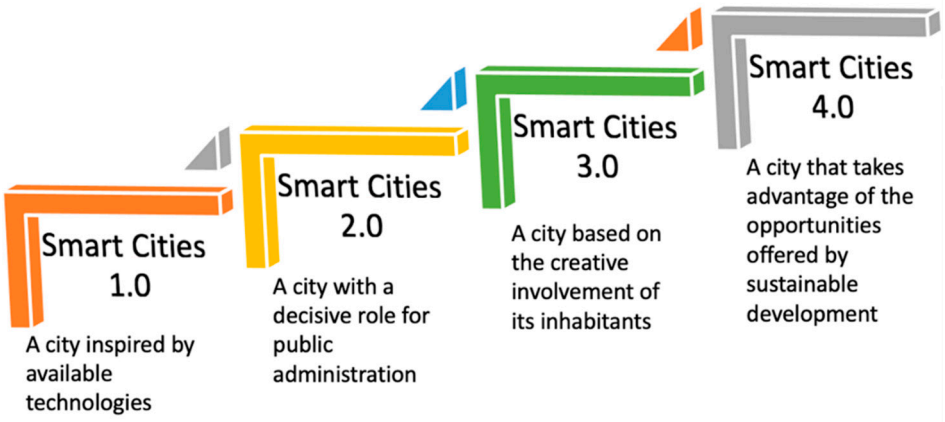

Figure 1. Levels of development of smart cities. Source: Own study on the basis of [8].

A challenge currently faced by local governments consists of basing the city's development on the creative engagement of citizens. In the third generation of Smart Cities, citizens start co-creating their cities, and a significant role is played by projects of a social character: equality, social inclusion, inexpensive housing, etc., [8].

Each modern city is a complex ecosystem [9] comprising many elements including all that connects people, the environment, and technology. What constitutes a distinguishing factor of dynamically developing cities is certainly the smart municipal infrastructure that serves both citizens and administration. When creating a Smart City 4.0, we need to take into account the complex network of interconnections that generate actual benefits [10]. We may use blockchain technology to encrypt and distribute data. Some of the systems used in smart cities already use such technologies.

To better illustrate the level of security offered and the capabilities of this technology, it is worth giving an example. Blockchain, as a technology, is the technological foundation in cryptocurrency systems. In order for someone to be able to make a transaction with the selected cryptocurrency, the transaction must be sent to the blockchain community [11]. Transaction data contain public passwords, which strictly correspond to private passwords. The transaction concluded via the blockchain is both anonymous and encrypted. When transaction data become public, community members can collect and verify data and try to solve a very difficult computational puzzle that allows them to add transactions to the

public ledger [12,13]. The first member (or group of members) in the network to correctly solve the puzzle appends that transaction block to the end of the current blockchain. At this point, all transactions in the new block become permanently part of the public register. It is an extremely secure tool, and due to the fact that individual parts are stored in an extensive network, it cannot be faked. In other words, blockchain is where all transaction data are stored, such as data to confirm ownership of a given cryptocurrency and how new coins are created in that cryptocurrency [14,15].

Thanks to this level of security, blockchain can be used in concepts such as the Internet of Things (IoT) or a Smart City. The implementation and use of a network of IoT devices in smart city environments has resulted in a very large amount of data. In cities and metropolises, these data are held by many sources that use independent systems for collecting, storing, and using data. Such dispersion makes it difficult to take full advantage of their value. Blockchains, as distributed registers, can be used, for example, to develop a universal system for collecting and distributing data. Smart contracts can be used to automate all processes of such a network.

Shaping a Smart City 4.0 is strongly related to other industrial revolutions dominated by robots, artificial intelligence, nanotechnology, the Internet of Things (IoT), and autonomous vehicles. Profound technological changes [16] of significant social and economic consequences for cities and the natural environment are embedded in the process of sustainable development [17], which sets high standards for citizens [18].

One of many foundations of the idea of a Smart City is the well thought out and properly implemented smart municipal infrastructure. Put simply, it aims to use the integrated infrastructure of the Internet of Things [19] to increase the effectiveness of operations conducted by municipal services and companies and, finally, to improve the lives of citizens [20,21]. Properly introduced solutions comprising the holistic conception of a Smart City also have an impact on increasing the effectiveness of municipal investment and greater sustainable development of the city [6,22]. This results in changes noticeable by all [23,24].

One joint system of Smart IoT that is being implemented in an increasing number of Polish cities covers many basic services available to each citizen. It controls water supply and consumption measurement, energy saving LED lighting with a management system, city bike systems, smart monitoring and management of parking places, waste collection and recycling, and/or electricity supply. The above list can be extended to air and water quality sensors and so-called smart benches, which are located in the urban space in order to provide access to the Internet and to charge mobile devices, smartphones, and tablets, which draw energy generated by solar panels.

For all of the above to be possible, the consistent activities of municipal authorities and their cooperation with the suppliers of Smart systems who have the relevant knowledge, experience, and technologies, are necessary [25–27].

In the ESI ThoughtLab research conducted in 2019, S. Wray [28] named twenty global cities 'Cities 4.0'. These are cities that are advanced both in terms of progress in the implementation of the UN Sustainable Development Goals and in the effective implementation of digital technologies and data. These cities are: Aarhus, Athens, Baltimore, Barcelona, Berlin, Birmingham, Boston, Copenhagen, Helsinki, London, Los Angeles, Madrid, Moscow, New York, Orlando, Paris, Philadelphia, Singapore, Tallinn, and Vienna.

The comparative research on Smart City Solutions for a Riskier World conducted by the ESI ThoughtLab was based on a survey conducted in 167 leading cities from 82 countries across the world, in combination with data concerning municipal services and the quality of life from the World Bank, Numbeo, IESE, and other sources [29]. The report stated that Cities 4.0 usually implement 14 smart city projects on average, in comparison to about seven in other cities, and have better infrastructure, public transport, roads, parks, healthcare, and digital communication.

Furthermore, Cities 4.0 made the most progress toward the achievement of the Sustainable Development Goals generating 86% progress toward all 17 goals. The share of

funds for technological investment in all urban areas, especially in digital infrastructure, mobility and transport, public security, health, education, sustainable development, as well as energy and water, has grown.

The researchers believe that the first phase of Smart Cities 1.0 was driven by technology. Smart Cities 2.0 brought the belief that technology has to serve people, and Smart Cities 3.0 strived for 'hyper-connection', on which the ESI ThoughtLab focused in its research, in 2019. This hyper-connectedness concerned not only technology but also the engagement of citizens and partnerships.

Smart Cities 4.0 remain hyper-connected, as they use technology, data and engagement of citizens, but they use it to achieve the objectives of sustainable development [30]. We believe that this is where cities are headed. It does not suffice to be smart; you have to be sustainable [31].

The goals of sustainable development constitute the priority of the future. ESI ThoughtLab researchers found that presidents/mayors of cities were using the conclusions drawn during the pandemic to set a path toward achieving the Sustainable Development Goals. They have reported that they achieved the most with the Sustainable Development Goals related to people, including a lack of poverty (91% of cities), good health and wellbeing (89%), decent work (86%), and good education (86%). Moreover, survey respondents identified obstacles to the achievement of sustainable development objectives in the nearest three years, including complex policies and regulations (52% of cities), finding an appropriate partner or supplier (50%), as well as managing data security and privacy (44%) [12].

Going further, leaders of cities can use the research conducted by the ESI ThoughtLab as a roadmap to become Cities 4.0. They can also take four steps, which have been taken by Cities 4.0 in order to develop their SDG programme: (1) regularly monitor and assess SDG efforts, (2) ensure broad support for SDG programmes across the whole government, (3) appoint a department, which will lead the efforts toward the SDGs and (4) conduct a voluntary local review of progress in the implementation of the SDGs.

Furthermore, the research indicated that these cities invested in a series of smart technologies. The largest investments are currently made in the cloud (87% of cities), mobile telephony (85%), IoT (81%), biometry (72%), and AI (66%). In the next three years, technologies generating the highest increase in investment will be digital twins (+164%), 3D printing (+125%), and augmented reality/virtual reality (+63%), as well as data warehousing (+50%) [32].

Cities are becoming increasingly more complex and multidimensional urban systems, which are of key significance for human life on our planet. The significance thereof is proven by the global belief that we are living in an era of planetary urbanisation [33].

Apart from advanced technologies, the significance of soft potentials, including technology, talent, tolerance, and trust, is growing. From the point of view of the Smart City Conception, it is crucial to base it on these four pillars—4T potentials: Technology, Talent, Tolerance, and Trust; the advancement of these in a city defines its smartness, entrepreneurship, and innovativeness [34]. An advanced share of 4T in smart city management determines the quality of life of its citizens and its competitive position in the metropolis.

Cities treat their urban innovative systems as a priority moving from the traditional urban character to an innovative 'green', 'smart', and 'open' city, striving for sustainable environmental and social development [35].

The idea of an innovative city, as well as an entrepreneurial, attractive, and competitive city, refers to the stream of research that ascertains that the largest potential resource conditioning economic development is knowledge, whereas innovativeness (that constitutes emanation of knowledge) is the main driving force of economic growth and development [36–38]. Implementation of innovation results in modernisation, an increase in effectiveness and competitiveness and, in consequence, the amount of generated income [39]. Nevertheless, the analysis of the conditions and benefits of a pro-innovative strategy of city development primarily requires defining the scope of the substantive concept of innovativeness that exceeds the context of urban research.

2. Research Methodology

The analysis began with an accurate systematisation of the literature, determination of clear objectives of the research, and a properly defined methodological process [40,41]. The following sources for publications containing full text sources were used in the systematic literature review: ProQuest, Emerald, and SCOPUS. We collected publications in accordance with the rules in [42,43] and narrowed down to the list of publications containing full reviewed texts in the indicated databases. The material was supplemented with publications from recognized Polish publishing houses. Adopting this order of activities led to the creation of significant work [44]. A systematic review of the literature identifies, assesses, and synthesises existing research evidence providing source material for designing empirical research [45]; in addition, as indicated by Tranfield et al., (2003), the use of the systematic review of literature, despite explicit epistemological differences, allows establishing a methodology adjusted to the researchers' needs and based on evidence, which may provide a valid and effective means to create practical knowledge [46]. On the grounds of the collected source materials, a cognitive loophole was identified: a lack of sufficiently described and diagnosed subject matter on the concept of a Smart City, not only as a whole for Poland but also in regional terms. Therefore, the Metropolis GZM was adopted as the subject of consideration. The Metropolis GZM comprises 41 participant cities and municipalities, which constitutes an excellent area of exploration due to its polycentric and evolving nature. The research covered the broadly understood area of a Smart City; thus, research aimed at drawing attention to the diversified potential of cities/communities was planned. The Metropolis GZM, as the largest urban area in Poland, also constitutes a platform for implementation of new management tools and methods, which can then be applied in other regions of the country. The noticed cognitive loophole was the prominent means of generating research questions based on the collected literature. Nonetheless, it should be noticed that the detected loophole is an effect of complex, constructive, and creative processes [47].

Then, based on the methodology of scientific research conducted by J. Creswell [48], the following research problems were determined:

- The development policy of the studied cities and municipalities with regard to the concept of a Smart City,
- The local policy referring to records characterising 4T capitals in two contexts—diagnostic records and contents shaping the desirable future of the city, and
- The identification of the implementation of methodologies of managing projects in offices.

Thus, the indicated research problems will allow obtaining not only interesting research results but will probably be used in practice by staff managing cities and municipalities, and will generate further research [49–51]. Ainley et al. (2002) suggest that such designed research can have a larger positive impact, which may result in a greater effort made by recipients in order to use the new knowledge [52,53]. Much scientific research also includes unexpected or contrary to intuition discoveries that direct, or sometimes redirect, new research [54].

The main research tools were surveys and IDIs (Individual In-Depth Interviews) conducted among representatives of the Metropolitan Office of the Metropolis GZM (the entity connecting all member municipalities), as well as among representatives of municipalities with diverse potential:

- Gliwice (leader of one out of five sub-regions of GZM),
- Dąbrowa Górnicza and Siemianowice Śląskie (urban municipalities located in 'the core of the Metropolis'),
- Mikołów (urban municipality outside of 'the core of the Metropolis'),
- Pyskowice and Wojkowice (smaller urban municipalities outside of 'the core of the Metropolis').

Interviews were conducted with the Presidents/Vice-Presidents of cities or persons appointed by them, who have competencies and professional responsibility related to the management of a given municipality or area thereof.

Designing questionnaires and interview questions began with establishing the procedure for obtaining results. Using the suggestions of Salant and Dillman [55] as a starting point, the response rate and the preferred level of accuracy for the study were determined. The choice made was the so-called theoretical sample (see the research by, inter alia, Attewell and Rule [56]), as it allowed the identification of entities with the desired characteristics, on which the research was focused. Although the theoretical sample was not randomly selected as a whole, individual respondents from this sample were selected at random for an approximate result. An important determinant of the above decisions was also the ability to gain access to the desired areas of research.

The survey used closed questions with preliminarily coded options for answers [57]. It was motivated by previously conducted analyses of the subject matter. While preparing in-depth interviews, researchers based their work on the approach proposed by M. Hennink, I. Hutter, and A. Bailey [58] and K. Charmaz [59]. The questions for the survey and the in-depth interviews were constructed on the grounds of the information collected in the systematic review of the literature and research texts to provide the possibility of making a contribution, where the existing literature was either incomplete or omitted an important perspective to fill in these gaps [60]. The preliminary set of questions was verified in terms of the significance of research and in order to narrow the focus [48,61].

Surveys and in-depth interviews were supplemented by the analysis of source materials in the form of subject strategic and programme documents of particular municipalities. In particular, the development strategies of cities were the main documents subject to analysis as well as local/municipal programmes of revitalisation and programmes of cooperation with non-governmental organisations were taken into account as supplementary analytical documents [62]. The enumerated documents were selected due to their complex character, long-term perspective, and primarily their central position in local planning systems. Each of the considered types of documents was based on the activation of local entities, in particular, using and reinforcing values present in the Smart City conception [63].

Confrontation with various tools can lead to new conceptualisations and allow a leap from the multidisciplinary approach to the truly interdisciplinary approach [64,65]. In the latter, the contribution of various tools is integrated in new conceptualisations and not only combined. Thus, the collected broad and multithreaded data can constitute grounds for using and possibly synthesising many theories into a new conceptual development [66].

The collected research results were introduced and subjected to inductive analysis, to then apply descriptive characteristics that described the common basic characteristics of the data in an orderly manner.

Scientific rigour was applied in the conducted research, since reliable research has to be something more than simply opinions or speculations (see more in: [50,67]). The assumptions of this research, the process of understanding thereof (epistemology), and used research tools were up-to-date and were understood by others during analyses. This is of great importance for the development of good theories and practices as the effect of conducted research [68]. The assumed criteria of methodological rigour [69] were the following:

- Assessment and interpretation of data was performed in a logical and impartial manner, and the integrity of findings was ensured by the objective determination of correlations between the data and findings;
- The truth about the conclusions originated from cause and effect or causal relations (in order to allow for an accurate explanation of research problems);
- Conducted surveys were verified by in-depth interviews and analysis of collected source documents;
- Understanding of the obtained results in one part of the research can be transferred in order to explain phenomena observed in other contexts by analytical generalisation.

Complex understanding of one context justifies useful interpretation of similarities and differences in other contexts.

- Reliability was achieved in all phases of the research process—including collecting data, coding, and all other processes of preparing and analysing data—these have been described as accurately as possible in order to achieve a high level of transparency.

3. Results

Smart management in cities and communities comprises implementation of projects that are based on available tools, often IT and also tried and tested management projects. It means that there have been used certain tools that allow diagnosing problems and achieving certain goals faster and better.

The first dimension of development policies' analyses consisted in the assessment of provisions thereof in terms of the presence of direct references to the Smart City conception. The research covered the contents of strategic documents with a separation of provisions referring to diagnosis and separately to fragments determining desirable future states usually formulated in the form of development visions, goals, directions, or undertakings. It should also be indicated that despite the fact that the whole research covered six cities of the Metropolis GZM, one of them, Wojkowice, did not have an up-to-date available strategy of development. Detailed references to the remaining five units are presented in Table 1 below.

With reference to the diagnostic part of the analysed documents, the above contents only in two cases directly indicated the Smart City conception—in the case of Siemianowice Śląskie—it was additionally unambiguously positive, understood as internal processes and distinctive features of the city and has been marked in green. The provisions of Mikołów's strategy also indicate reference to a Smart City (marked in yellow); however, first of all, these are factors of a tertiary significance in the document, and additionally they have been indicated as the town's weaknesses or external factors—opportunities. In the case of the other cities, the analysed documents did not include direct diagnostic references to a Smart City (marked in pink). The analysis of strategic provisions of cities referring to Smart City in the future aspect presents itself differently: through development vision, goals, directions or projects, e.g., in the aspect of climate protection or efficient energy use [70–75]. All of the analysed strategic documents include subject references, in the majority as an element of visions or goals (marked in green), while, in the case of Dąbrowa Górnicza these provisions refer only to smart specialisations, and not directly to a Smart City (marked in yellow).

Another stream of research is the analysis of local policies referring to provisions characterising 4T capitals also presented in two contexts—diagnostic provisions and contents shaping the desired future of the city. It allows creating a synthetic image jointly, taking into consideration the diagnostic parts and elements shaping the planned future of the city (usually included in the implementation vision, goals, or undertakings/projects). The subject indicator has been presented in Table 2.

Table 1. Five cities detailed references from policies.

Gliwice	Dąbrowa Górnicza	Siemianowice-Śląskie	Mikołów	Pyskowice
		Diagnosis		
A lack of direct provisions concerning Smart City.	A lack of direct provisions concerning Smart City.	Internal process—implementation of solutions creating a Smart City both by using modern technologies, as well as including citizens in decision-making processes. A distinguishing factor—awareness and implementation of solutions in the scope of a Smart City in city management, among others, on the basis of a project creating an integrated partnership system of information about the city supporting local socio-economic development.	Weaknesses—third degree problems (other)—insufficient level of local government employees' knowledge concerning modern technologies related to the management of development of small cities as smart cities. Opportunities—third level (other)—universities looking for local government partners to implement innovative Smart City projects and their conceptions in this scope.	A lack of direct provisions concerning Smart City.
		vision—goals—directions—projects		
Goal—increasing the use of IT and communication techniques with the full cross-section of citizens, including readiness to implement other projects in the scope of smart transport, monitoring, and mobile applications related to specific public services.	The phase of formulating visions and missions—embedding the city strategy in the conception of Smart Specialisation that is indicating the most important directions of the city's development—updating the Strategy.	Vision—city specialisation—competences, activities, conditions, and relations developed by the City in the scope of implementation of Human Smart City solutions. Goal—Smart solutions supporting business and administration.	Vision—community using modern public space solutions and technologies, including the Smart City. Operating goal/strategic task—organisation of contents for innovative conceptions of digitalization of the Town Hall of Mikołów and municipality units and companies, implementation of Smart City technology. Providing modern, far-reaching, integrated in terms of functions, multidisciplinary, and advanced educational services—education for future needs of the labour market: among others in the scope of a smart city.	Operating goal—high quality of public services reinforced by the use of modern technologies and social innovations in everyday life—reinforcing the potential of the city through the implementation of the idea of a Smart City. Suggested areas crucial for the development of the city–Innovations–the Smart City Conception is not only the support for urban infrastructure, mobility, security, or environmental management but also increasing the share of citizens in the city's decision making process. Implementation of the idea of a smart city can contribute to generating savings, improvement of public and environmental security, improvement of the quality of citizens' lives, and facilitating the communication between the office and citizens.

Table 2. Synthesis of direct reference to 4T capitals in development strategies of selected cities of the Metropolis GZM.

City	Talent	Tolerance	Technology	Trust
Mikołów	High Level	Medium Level	High Level	High Level
Siemianowice-Śląskie	Medium Level	Low Level	High Level	Low Level
Pyskowice	Medium Level	Low Level	High Level	Low Level
Dąbrowa Górnicza	Medium Level	Low Level	Medium Level	Low Level
Gliwice	Low Level	Low Level	High Level	Low Level

In order to increase the clarity of analyses in the above compilation, the following scale of assessment with the use of three colours has been used:

1. Green—a very high level of direct reference to 4T capitals;
2. Yellow—a medium level of direct reference to 4T capitals;
3. Red—a low level or a lack of direct reference to 4T capitals.

The conclusions drawn from the above compilation can be considered in subjective and objective terms. Taking into account the subjective approach, a ranking of analysed cities could be presented, in which the first place was taken by Mikołów, then, Siemianowice Śląskie and Pyskowice were classified at the same level, the following place was taken by Dąbrowa Górnicza, and the ranking ended with Gliwice. The above assessment concerned strategy documents, and since they were not created with uniform guidelines, differences in assessments were also related to the diverse procedure of drawing up a document and adopting a detailed methodology. In consequence, the diversification also concerns the level of details and the length of a document, e.g., Mikołów's strategic document was very thorough and contained 238 pages, whereas strategic documents from Siemianowice Śląskie or Gliwice contained only approximately 50 pages and included a synthetic diagnosis or conclusions from the diagnosis instead of detailed descriptions.

In objective terms it was also possible to determine the ranking of the 4T capitals' presence in strategic documents, which put the capitals in the following order: technology, talent, trust, and tolerance. Thus, it can be unambiguously indicated that technological capital was the primary dimension present in all strategic documents. However, it should be noticed that in the diagnostic dimension, the reference to technology was diverse, and, additionally, the presence of capital can be treated in two ways—as a stimulant and an inhibitor. In almost all cases (apart from the document from Gliwice) the strategic part also included a direct reference to 'talent'; additionally, in the case of Mikołów the subject reference was also included in the diagnostic part. With regard to the direct presence of the capitals 'trust' and 'tolerance', reference to these capital occurred only in the town of Mikołów—in case of trust in each part of the document and in case of tolerance only in the strategic part.

The conducted research explicitly indicated that the studied municipalities/cities, as well as the metropolitan office used project management to implement their goals. All respondents stated that within the functioning of the office they work for, tasks of a project character are implemented that do not constitute an operating recurrent activity. In total, 100% of respondents gave a positive answer to the question of whether the municipality/city uses project management to implement tasks. Furthermore, all respondents unanimously indicated that to this end they use developed templates of documents and IT tools. However, not all respondents answered that a complex project management system had been introduced (Figure 2), understood as:

1. Project management model;
2. Defined roles;
3. Defined processes of the project life cycle;
4. Templates of documents and IT tools.

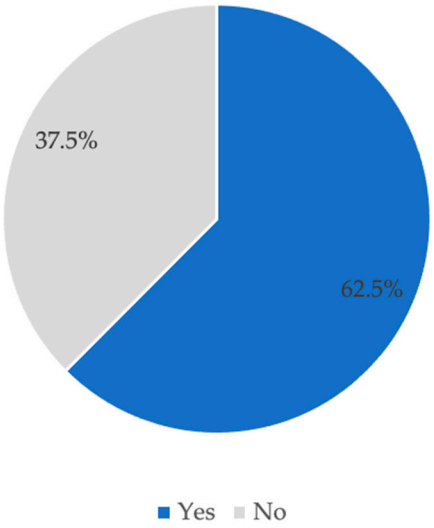

Figure 2. Implementation of project management system in the Metropolis GZM.

An additional issue that authors wanted to draw attention to was the identification of the implementation of methodologies of managing projects in offices (Figure 3).

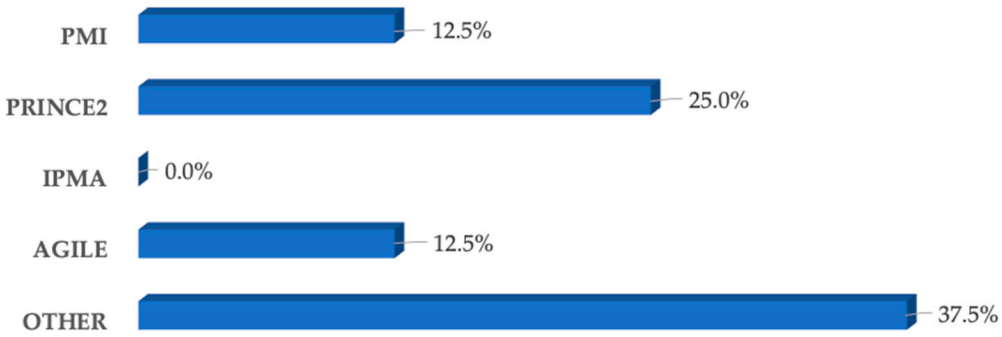

Figure 3. Project management methodologies used in the Metropolis GZM.

According to the respondents, one of the main methodologies is PRINCE2 (25%), followed by PMI and AGILE (12.50%). The answer that was not indicated at all is IPMA (0%). Nevertheless, the largest group of persons (37.5%) indicated completely different methods:

1. Balanced Scorecard;
2. Methods defined in provisions, instructions, and rules and regulations;
3. Own methodologies constituting a mixture of various methodologies, adjusted to the needs of a given office.

It is also worth noticing that all respondents pointed out that to the largest extent a project's success depends on: Project's goals that fit in the strategic objectives of the City and Risk management. A significant influence was also attributed to the fact that Projects are monitored on an ongoing basis or The project is led by a qualified Project Manager. A slightly smaller influence was attributed to the Activated Project Management Office or Key stakeholders management.

The sequence of the diagnostic–analytical process based on the research results also led to the recognition of the significance of the Smart City concept through smart management perceived both in terms of its significance and its practical aspects, as well as good practices and projects together with expectations in the scope of counselling and implementation thereof. The entirety of this process was analysed in the context of project management in the Metropolis GZM. This approach is synthetically presented in Figure 4 below.

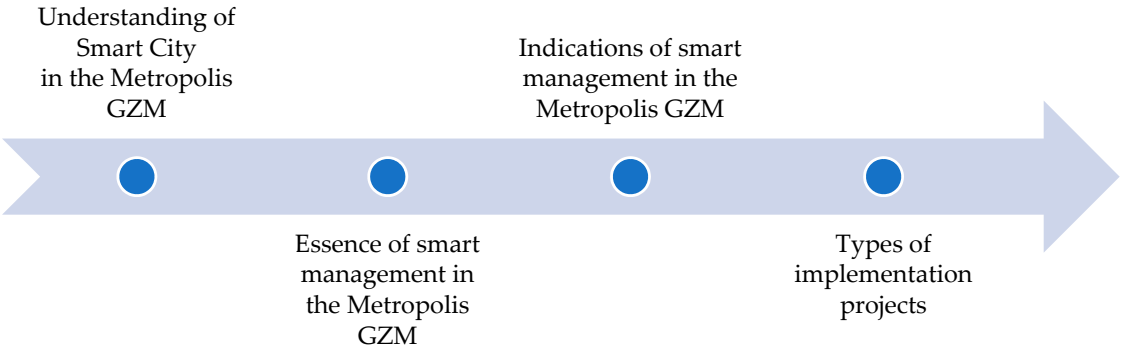

Figure 4. Sequence of the diagnostic–analytical process.

The main approaches to a practical definition of the Smart City concept can be specified as follows:

4. The result of measures undertaken to benefit citizens should be the high level of comfort, satisfaction, and pleasure derived from functions performed in the municipality and the provided public services, improving the quality of life and comfortable, easy and unproblematic functioning; in broader terms this concept should refer not only to citizens, but also to other users—municipality stakeholders [76,77];
5. Development of professional qualified staff thinking in a modern way, willing to learn, which allows using the maximum substantive knowledge of employees, while providing them with the available working tools and flexibility; in broader terms, the municipality uses its both human and economic resources and capabilities in full [78,79];
6. A municipality that is not only smart but has also introduced and implemented procedures in the scope of smart activities and willingly uses smart solutions in selected areas of functioning, e.g., communication and mobility and renewables [80];
7. Introduction of smart solutions understood as innovative solutions or the best solutions in conjunction with information exchange in order to search for these solutions;
8. Efficient use of technology including the use of proper IT tools to manage projects for the benefit of citizens and entities who are implementing these projects. It is important that a given project is supported with a relevant IT tool;
9. Multi-dimensionally sustainable development referring to, on the one hand, particular functional areas and intertwining socioeconomic and environmental-spatial dimensions and, on the other hand, indicating sustainability of the management process leading to smart management.

All of the above approaches should be treated as complementary, and particular attention should be paid to embedding the Smart City in the context of sustainable development and a transfer from a Smart City to smart management, which is also treated multi-dimensionally. Its essence, based on the practical understanding of the concept in local government reality, indicates the following factors:

1. The measurability of development processes is understood as, among others:
    10. Management by effects and indicators;
    11. Effective feasibility and a good ending of a project;
    12. Maximum use of available resources and reduction in costs and losses to a minimum;
    13. Ensuring very high quality of life, as well as maintaining and developing high standards;
    14. Verification of citizens' ideas in conjunction with acting with a sense of perceiving citizens as 'employers' for employees of municipal units, in broader terms—public units;

15. Adopting and implementing specific priorities, objectives, and directions constituting an indicator for development projects in conjunction with a good compromise between ambition and the reality of projects' implementation.

2. Teal management, a responsible and learning organisation, that is, in particular:
    16. Smart management that is multidisciplinary and multicriteria;
    17. Benchmarking-based management, which should mean that new solutions are implemented in a correct manner by eliminating mistakes made by predecessors;
    18. A modern approach to management without stereotypes and administrative modes;
    19. Environmental responsibility and health- and ecology-oriented approaches.
3. Communication, openness, and transparency of activity concerns primarily:
    20. The use of the 'open doors' method consisting in, among others, providing the team/project team with a possibility of meeting and discussing or calling and consulting about any problems;
    21. Implementation of managerial processes with transparency and striving for the truth;
    22. Priority for effective communication and real consultations with citizens with the use of effective channels of communications, including new ones, among others, through the agency of social media and IT tools.
4. IT tools and management projects mean, among other things:
    23. That new technology is used in conjunction with the permanent development of human resources as well as the technology itself;
    24. The use of technological tools, including the Internet, in internal and external communication;
    25. Implementation of projects, including management projects, based on available tools, often IT tools;
    26. The use of tools which result in faster and better implementation of diagnostic and management processes.

The analysis of the essence of smart management in GZM municipalities is inseparably connected to the indications of smart management in particular units. Therefore, with reference to the aforementioned ways of understanding this concept, Figure 5 below presents practical indications of smart management in municipalities of the Metropolis GZM.

Practical indicators of smart management are, finally, reflected in particular projects in the scope of the Smart City implemented in the municipalities of the Metropolis GZM. One of the classifications [81] of the thematic areas of projects allows enumerating nine various types, that is:

1. Social and technological housing innovations, among others: energy savings, senior policies, universal design, and green construction;
2. Sustainable housing complexes, in particular modelling sub-urbanisation processes and areas for the benefit of local structures ensuring necessary services and guaranteeing a high quality of citizens' lives;
3. Innovative solutions for the benefit of supporting social participation as the element necessary for a smart city co-created by citizens;
4. Smart solutions in the scope of sustainable mobility in the functional area of the city covering, among others, an electric vehicle network with a particular consideration for public, emission-free, collective city transport, management and monitoring systems for pedestrian and vehicular traffic, as well as parking information;
5. Smart networks for managing utilities; creating ICT solutions to manage power transmission grids, heating, gas and water supply networks, waste, and street lighting;

6. Internet of Things as a tool for better city management, in particular, monitoring air quality, security, pedestrian and vehicular traffic volume, waste management, transmission grids, etc.;
7. eco-technologies and eco-solutions—among others, a circular economy, innovative ecological solutions, an eco-city—integrated bioclimatic management, counteracting air pollution in cities;
8. Effective and innovative use of data concerning the city, its citizens, and users (among other things, the use of big 'urban' data, opening data, data security in smart systems, interoperability, and civil solutions based on open data);
9. Urban audits, in particular, creating integrated, open, permanent, and cyclically supplemented and user-friendly databases and ongoing monitoring systems.

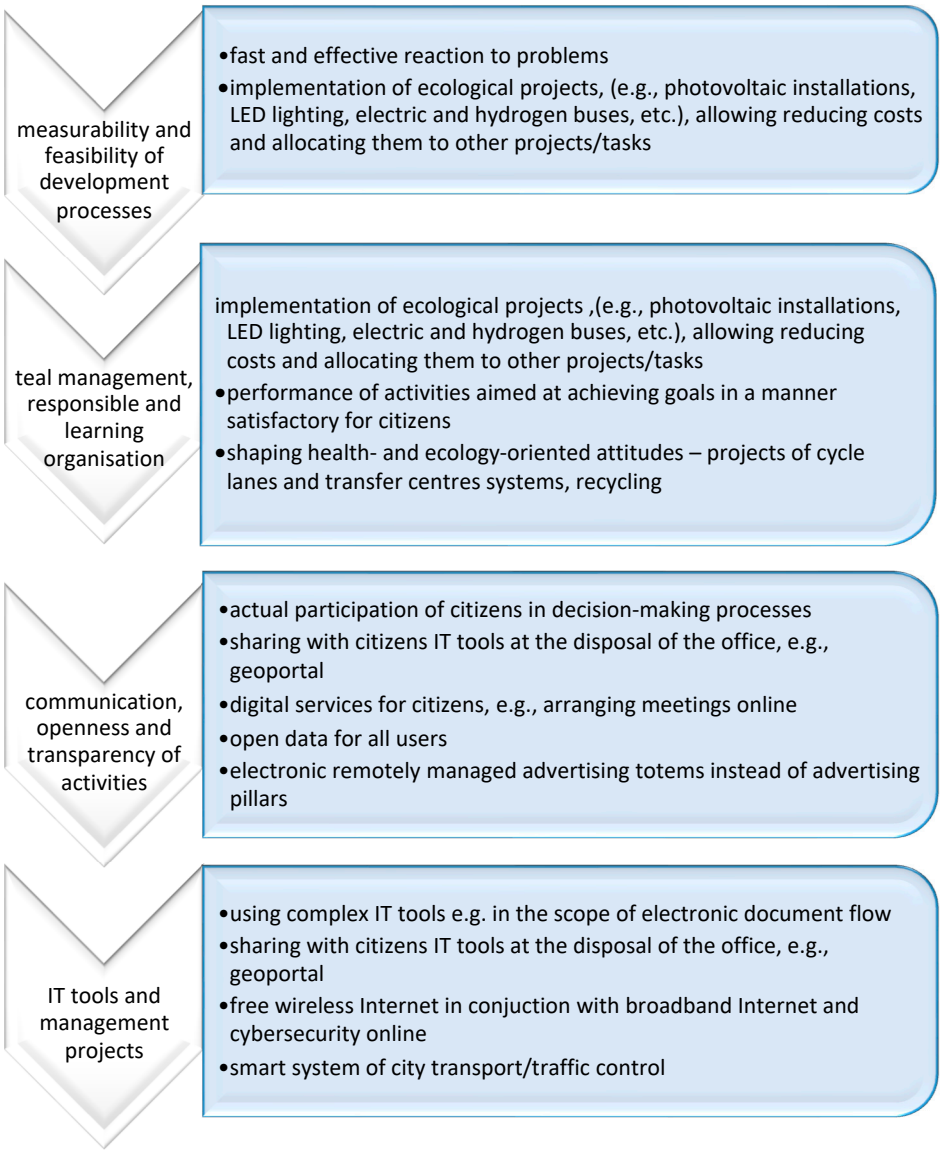

Figure 5. Indications of smart management in the GZM municipality in the context of its essence.

4. Conclusions

A tried and tested model to create a Smart City is a development model based on the innovative technical and economic infrastructure, learning organisations, and a strong university. This model works in metropoles that have a large population, are characterised with a high GDP and GDP per capita [82,83], and are seats of large corporations, where business centres and public sector institutions are located. In order to achieve this goal,

smart cities are organisations creating innovative economic sectors, improving the quality of life of citizens with an effective management centre.

In order to be called a Smart City, a city has to be a centre with the highest level of technological advancement. The basic features of its characterisation are as follows:

1. Technology (innovativeness),
2. Talent,
3. Tolerance,
4. Trust.

A Smart City requires a concentration of social and economic factors which are crucial for a permanent increase in the competitiveness of a smart city characterised by an innovative management culture and permanent absorption of this culture by citizens.

The research results have important implications for public sector organisations, decision makers, HR specialists, and organisational leaders. Public sector organisations will, in the future, face growing difficulties with attracting, developing, engaging, and retaining competent employees without a practical strategy of talent management. This, in turn, can limit the capability of these organisations to compete for talents with the private sector, which often manages them well. As indicated by the research, HR managers face the challenge of identifying talents [84].

Classifying persons on the basis of their results and potential constitutes the talent management matrix. The talent management matrix allows determining standards upon the fulfilment of which employees are considered talents. These standards can be used as 'benchmarks' in employee assessment, employment, employee promotion, or making decisions on dismissals. Determining standards concerning persons considered talents facilitates identification of employees [85].

It seems that there are broader issues such as adjusting values, team development, and HR policy, which public sector organisations should work on as a prerequisite for future initiatives concerning talents. It should be noticed that a lack of funds and insufficient internal specialist knowledge in the scope of initiatives concerning talents are challenges that require solving with other measures. Talent identification should be treated as a priority and should be supported by the senior management of the organisation.

Technology is the most underlined factor in the goals and directions of development of the analysed cities of the Metropolis GZM. In a slightly smaller scope, human resource development is emphasised, i.e., the sphere of talent, whereas the issues of trust and tolerance are areas of a significant deficit.

Among the studied municipalities, no relations have been observed between the level of consideration of 4T aspects and the size, character, and potential of a given city. A lack of operationalisation of the goals and directions specified in the strategy as well as indicating the implementation of the Smart City conception in operating and individual documents of cities was observed.

5. Recommendations

The following are the main recommendations:

- Use in diagnostic processes analyses of qualitative character allowing better definition of existing potentials and stakeholders of development processes, which will increase the level of effectiveness of development policies' implementation;
- Reconstruct and readjust the compatibility of local planning systems so that operating documents are compliant with the goals and directions specified in the strategy and constitute actual tools of implementing local development policy in areas indicated in the strategy;
- Ensure compatibility of the development policy and sector policies' implementation and coordination systems and basing them on the principles of partnership and participation with the use of networked open ICT tools, in the perspective of the metropolitan IT system.

Smart Cities 4.0 are targeted at ensuring the co-existence and compatibility of functions influencing the quality of life of citizens and cooperation stakeholders. The following are of particular importance:

- Guaranteed mobility throughout a Smart City—solution to automation of traffic and public transport [86];
- Public protection—modern technologies more and more often support public administration in security management. The use of large sets of data and in-depth analysis thereof become the basis of making decisions. An increasing number of sensors allows for monitoring of threats in real time. Intuitive management is replaced by fact-based management [87].
- Clear water—smart water refers to a holistic approach to water management. Due to recognition of anomalies in consumption models of enterprises and individual households, cities can optimise and eliminate wasting water and reduce costs of the supply [88].
- Energy efficiency—a well prepared low-emission strategy embedded in the general policy conducted by a Smart City can constitute a strong development stimulus, which has a chance of generating changes leading to the improvement of the quality of citizens' lives. In order to make it real, it is necessary to properly diagnose the existing situation across the scope of energy and raw materials management and, then, to develop a vision of the city's development targeted at a low emission economy in the context of its functional relations and existing potential of possible changes [89].
- Recycling—there are ongoing debates on the economic efficiency of recycling. Municipalities often notice tax benefits from implementation of recycling programmes primarily related to the reduced costs of landfills. The research conducted by the Technical University of Denmark indicated that in 83% of cases recycling is the most effective method of getting rid of waste from households. Additionally, apart from tax benefits, justification for recycling lies in what economists call external effects, not estimated costs and benefits, which are generated for units not related to private transactions. Examples include: decreasing gas emissions (among others greenhouse) generated as a result of combustion, reducing leachates including hazardous substances leached from waste landfills, reducing energy consumption, and decreasing the consumption and quantity of generated waste that lead to limiting the mining activity detrimental to the environment [90].
- Smart tourism—tourism is a smart specialisation, in which smart specialisations in tourism, especially those which favour development of specific services, e.g., medical services, health resort tourism, eco-tourism, wellness, and others, are of great importance for the development of a Smart City [91].
- Industry 4.0—there are grounds to believe that new technical solutions, in particular robotization, nanotechnology, Internet of Things, autonomous vehicles, and artificial intelligence will drastically change the economy, including the economy of cities and the life of the society [92,93].

A Smart City cannot allow ill-considered management of the urban space and excessive energy consumption at a time when each element of our everyday life depends on it. A Smart City does not only consist in city monitoring but primarily in effective management with the full support of advanced technologies. In key decision making, optimisation of budget, effective public communication, and supervision of water and energy economy—smart cities create a coherent future free from chaos and will be safe.

Thanks to its maximum level of security, blockchain can be used in concepts such as the Internet of Things (IoT) or a Smart City. It is certain that the implementation and use of a network of IoT devices in the environments of smart cities and metropolises brings a vast amount of data [94]. For the Metropolis, these data are in the possession of many cities and systems that use independent systems for collecting, storing and using data. Blockchains, as distributed registers, can be used, for example, to develop a safe universal system for

collecting and distributing data. Smart contracts can be used to automate all processes of such a network.

The idea of a Smart City attracts many investors. However, is it possible to create Smart Cities in Poland? As in the case of other countries, it is indeed possible. However, in order to create a city fully corresponding to the character of a Smart City, one should first of all listen to the citizens. Their needs determine innovative solutions that will work best. Due to the opening to opinions from society, innovations can have a practical application in many places; however, for them to function properly, human resources prepared to implement innovations are necessary. Therefore, given the willingness to create a smart city, it is best to also invest in the development of clerks' digital competencies and start the learning process of offices.

This article has focused only on selected aspects of the Smart City concept and the use of the 4T Capital theory. The research team also conducted research on elements of Technology, Trust, and Tolerance. Further research results will also be published in subsequent articles. Further research also covers the impact of the Sustainable Development Goals on Smart City evolutions. In this area, researchers can also look for the best-suited indicators to estimate the remaining 3Ts in the concept discussed above.

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