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Analysis of the Social Aspect of Smart Cities Development for the Example of Smart Sustainable Buildings

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Abstract: The concept of a smart city is assumed to use resources more efficiently and in an innovative, creative, and intelligent manner. Initial experience with implementing this concept relates primarily to investments in technology and infrastructure using smart solutions, particularly technical urban infrastructure. An important social aspect of a smart city—people—cannot not go unnoticed. The inhabitants of a smart city are not only beneficiaries; they participate in its co-creation, initiate activities and are creative. This paper focuses on one of the smart city's technical infrastructure components, which are intelligent sustainable buildings. This article aims to analyze the factors characterizing smart sustainable buildings (SSB) and the possibilities for their development. For this purpose, a SWOT matrix was developed. The factors of this matrix were subjected to a cause-effect analysis using the DEMATEL method to establish relationships between them. The results of the analysis allowed us to examine the social aspect, i.e., the impact of creators and users of sustainable, intelligent buildings on their development and possibilities for their creative and innovative use in an urban space.

Keywords: smart cities; smart sustainable buildings (SSB); green buildings; society; cause-and-effect relationships

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1. Introduction

The implementation of the socio-economic concept of sustainable development combines three areas: social, economic, and environmental. Developing so-called high technologies for implementation in various areas of economic activity allow us to apply the principles of sustainable development in an intelligent manner, referred to as smart growth in Agenda 21 [1]. The principles of sustainable development are further defined in the United Nations document, *The Global Movement for Our Children's Future- World Top 20 Project* [2]. Goal 11 pays attention to "sustainable cities and communities". All development processes should be based on knowledge, innovation, investments, and skillful financial management. One of the effects of implementing the achievements of science and technology is the transformation of cities into so-called smart cities. In a simplified description, they are considered the implementation of technological achievements based on modern information technologies. As a result, the so-called intelligent technical infrastructure of a city is created. One of the city's elements is intelligent buildings. Literature on the subject emphasizes the significant participation of human capital in the process of sustainable development, both as creators of technical and economic progress and as beneficiaries of development effects, namely intelligent, sustainable development. The knowledge, skills, abilities, and experience of each citizen individually are increasingly important as a competition factor in all areas of economic activity [3].

The subject of the paper is smart sustainable buildings (SSB), a component of the technical infrastructure of a smart city. The purpose of our research was to identify factors supporting or limiting SSB development and indicate social aspects of intelligent construction. Based on our analysis of the smart city concept and development of SSB, mutual relationships between participants of construction projects (investors, creators, and users) were discovered. Factors causing an increase in awareness, competence, and creativity of SSB inhabitants, consequently affecting the development of smart cities, were also indicated.

This article contains a description of the research method (Section 2), brief characteristics of the smart city and its social dimension (Section 3), and smart buildings as an element of the infrastructure in a smart city (Section 4). Section 5 presents results from a survey of factors characterizing SSB organized in a SWOT matrix. The chapter also includes research results on cause-effect relationships between factors using the DEMATEL method. This article contains a discussion of the results and summary of the research.

2. Research Methodology

Research indicating social aspects in the development of smart sustainable buildings (SSBs) and thus smart cities was conducted in the following order:

1. Indication of the role of society in the development of smart cities based on critical analysis of the literature;
2. Characterization of smart buildings, basic components of smart cities' technical infrastructure, and their development trends. Based on literature about the research subject and analyzed survey results published in domestic and foreign literature;
3. Development of the SWOT matrix to assess the potential of smart sustainable buildings;
4. Analysis of factors contained in the SWOT matrix in the social context of smart sustainable buildings;
5. Causal analysis of the relationships between the SWOT matrix factors through the DEMATEL method [4–6]. This analysis aims to assess the interaction of factors in social and techno-economic contexts and their influence on the development of smart sustainable buildings and smart cities;

Discussion and conclusions on the role of creators and users of SSBs in the development and implementation of strategies conducive to their success in creating smart cities. This research was based on a critical analysis of literature in the field of smart cities and buildings, including smart, passive, and green (among others [7–11]). Research was also conducted as part of a Master's thesis for [12,13]. The commonly known and frequently used method of SWOT analysis, also used in construction (e.g., [14]), was used to assess the development of smart sustainable buildings and its social context. It considers previous experience with smart and sustainable buildings from practice and economic conditions.

3. Characteristics of the Smart City and Its Social Dimension

The smart city concept assumes to use its resources more efficiently, i.e., in an innovative, creative or intelligent manner. The idea of a smart city, in simple terms, is the involvement of the city's inhabitants in its co-creation, i.e., inhabitants are not only the beneficiaries of the actions but also their initiators and creators. Most definitions of a smart city emphasize the use of technologies and their multidimensional functionality. According to [15], a smart city is a new dimension of the city that comes from the combination of increasingly effective digital telecommunications networks (compared to nerves), ubiquitous intelligence (compared to brains), sensors and markers (compared to sensory organs), and software (compared to knowledge, and cognitive competence). An important feature of the smart city is that this new dimension does not exist in isolation from other functioning urban systems; as it builds up, it provides them the so-called "intelligent dimension".

The dynamic development of technology in the initial development period of the smart city concept has shifted the city's citizens, the beneficiary of the solutions, to the background. However, it is the so-called "urban intelligence" that are concerned with using the skills, creativity, and knowledge of people, the inhabitants of cities. The level of their readiness for changes offered by modern technologies largely depends on the effectiveness of their use. Therefore, it seems that one of the factors conditioning the implementation of the smart city concept is to emphasize the development of digital and cognitive competencies of individual residents and the development of the residents' collective, i.e., a broadly understood social capital.

According to [16], a smart city is an area (municipality, district, cluster, city, city-region) consisting of four key elements:

1. An active population implementing knowledge-intensive activities or a cluster of such activities;
2. Effectively operating entities, institutions, and procedures in the field of knowledge creation, enabling its acquisition, adaptation and development;
3. Developed broadband infrastructure, digital spaces, e-services and online knowledge management tools;
4. Innovative potential.

It should be noted that the concept of smart cities, while being developed, considers sustainable development, which is expressed in the nomenclature as smart sustainable cities. It contributes to meeting the needs of inhabitants of modern cities without diminishing development opportunities for future generations [17].

Smart sustainable cities could not exist or develop without their greatest asset, the inhabitants. Angelidou [18] brings attention to this point, stressing the social dimension of the smart city and defining its four main objectives as:

- Development of human capital: strengthening the position of the inhabitant (conscious, educated, and participatory), strengthening intellectual capital and generating knowledge;
- Development of social capital: sustainable social development and digital inclusion;
- Behavioral change: a sense of causality and meaning, i.e., the feeling that all inhabitants are co-owners and responsible for their city;
- Social dimension: implementing technology that responds to the needs, skills, and interests of users, respecting their diversity and individuality.

Boyd Cohen [19] defined three generations of smart cities, indicating that the third generation is characterized by the fact that their citizens take over the key role in urban development. It is the citizens who design the way cities function owing to to their active attitude. On the other hand, local authorities have the task of creating space and opportunities to use the diverse potential of citizens. The new approach to activities concerns encouraging inhabitants to use modern technologies (e.g., e-government) and enabling them to create new technological and social solutions (e.g., economy of sharing with the use of technology). Third-generation smart cities put emphasis on social, equality, educational, and ecological issues. This emphasis results in the growing position of citizens not only through social participation expressed in the civic budget but through their increase in self-awareness.

Cohen's concept of Smart City 3.0 points to these entities and their dependencies, which are important in the Smart Sustainable City (SSC) concept. The creative involvement of residents in smart civic cities also mobilizes authorities to prepare space for these activities. Social capital plays an important role in developing SSCs, which, unlike human capital, is collective in nature because it defines a community that includes human relations and not the sum of individuals. Social capital is the basis of civil society, which is characterized by the self-awareness of its members for the community's needs and the desire to meet those needs as a result of their interest and personal responsibility. In the social dimension, the high level of social capital results in undertaking joint actions to improve the living conditions of the community. In the economic dimension, a high level of social capital translates into easier negotiations, lower transaction costs, reduction of corruption, the spread of knowledge, the development of civic institutions (the third sector) in the context of the control of public authorities, as well as favoring long-term investments [20,21].

In a broad sense, the smart city refers to the need to bind environmental and social issues [22]. It can be considered a contemporary version of a sustainable city [23]. Understanding such sustainable social development is an important task in a city that requires an understanding of social sustainability and discovering the potential of smart technologies in improving social quality of life in a population and approaching sustainability goals [24]. According to [25], the optimal model for city management and the creation of a smart city and smart sustainable city is based on synergy between four stakeholder groups: administration, business, science, and citizens. The overriding aim of this synergy should be to improve the quality of life for inhabitants in various dimensions of their individual and socio-occupational functioning. Research and management of such a complex organism as SSC requires the use of advanced research methods and tools [26–28].

Smart buildings, being an element of smart cities, are examples of a technical combination of these issues and constitute a source and base for innovative use by individual citizens and the whole community in an urban space [29].

4. Smart Building—An Element of Infrastructure of the Smart City

The concept of an intelligent building is constantly being modified with the development of technology, IT, building technology, and the implementation of socio-economic concepts such as sustainable development and circular economy.

The development of automation and its use in controlling the operation of mechanical devices in buildings has been the reason for the development of buildings called "intelligent buildings", reacting "intelligently" to all external and internal conditions of buildings [30].

The idea of intelligent buildings is believed to have originated in the USA during the 1970s from the needs of industry. The first applications were for large production halls, not only in connection with the production taking place but also for managing their functioning (equipment control). It was then transferred to office buildings, residential and public buildings.

Adaptation of factory and office design premises to the dynamically changing production required much effort and resources. The starting point was to equip them with control systems such as IBS (Intelligent Building System) for building control (automation of heating, air-conditioning, lighting, fire, burglary, etc.), BMS (Building Management System), and a coherent, integrated BMCS (Building Management and Control System), which manages, and monitors, all technical and corresponding safety subsystems in the building. These systems are still being improved; they use the achievements of technology and computer science, including IoT (Internet of Things) technology [31–33]. Some developers have separated a new category of this technology, the so-called Building Internet of Things (BIoT), due to its large spectrum of use in buildings [34].

The development of these systems required interdisciplinary knowledge and achievements. An intelligent building results from the integration of the achievements of architects, building constructors, and contractors, and automation, electronics, IT, electrical engineering, etc.

The main tasks of smart solutions include knowing the habits of household members and controlling without their direct involvement. The needs of users/inhabitants change, working methods change, innovations are introduced, and new technologies are introduced, which entails the transformation of buildings. There is a growing awareness of the need to care for the environment; this aspect continues to contribute to the development of smart buildings. This factor introduces an increase in care for the implementation of sustainable development principles in smart building technologies. According to a study conducted in Poland by Smart Home Systems [35], the most popular smart products were devices improving the comfort of use, ensuring safety, and guaranteeing additional savings during building operation. The largest savings in buildings' operating costs are associated with heating and air conditioning. Hence the development of passive or ecological building, also called green building, is widely described in the literature (e.g., [36–38]. Its structural and material solutions and equipment are supported by intelligent building systems and form a coherent whole [7]. The current priority is the full cooperation of these systems, which results in a constant reduction of operating costs; it has become important to strive for a complete lack of environmental impact. However, the main priority is primarily about ensuring maximum environmental friendliness of the building and self-management. The building itself adjusts the use of electricity itself (e.g., switching off the light in unused rooms or corridors), heating energy (analogy reducing or increasing the temperature), monitoring and managing the camera system inside and outside.

Research and application works are being conducted on the control and management of energy use relating to the thermal comfort of the inhabitants of individual buildings [39] as well as the whole city [40]. Complex system solutions are offered on the market for equipping buildings with intelligent devices, covering various levels of building automation [41].

The definition of a smart building formulated by the European Intelligent Building Group and Intelligent Building Institute [42]:

"A smart building is an infrastructure facility that integrates different systems to efficiently, in a coordinated manner, manage resources, services and their interrelationships to best meet the changing needs of its users, maximize savings in investment and operating costs and enable full flexibility of operation with constant respect for the environment", is still valid.

Therefore, it can be assumed that the above definition of intelligent building is consistent with current trends in the concept of sustainable development.

A combination of building features that meets the principles of ecological buildings (green, passive, etc.) and smart (intelligent) buildings can be acceptably called "smart sustainable buildings". However, it should be noted that the perceptions of building smart and sustainable may differ depending on the occupation or industry of building user groups [43].

Smart building is an important trend in the construction market worldwide and in Poland [12,13]. Cyclical surveys by Dodge Data & Analytics (2012, 2015, 2018) [8], conducted in many countries globally, show that intelligent buildings, more often referred to as green buildings, currently account for about 1/4 of the total construction market share worldwide, and the trend is increasing. Green building is expected to develop in every country, beginning with the fastest-growing global trend of commercial buildings (offices, shopping centers, hotels) with a global average of 46%, public buildings (hospitals, schools, courts) at 38%, modernization of existing buildings at 37%, new residential buildings of a higher standard at 35%, new low-rise residential buildings at 30% and also green interiors (Poland is leading).

Trends observed in studies by Dodge Data & Analytics and other professional studies in different countries indicate an increase in customer needs, an increase in demand for healthier air (fight against smog), an increase in regulation, and thus in government intervention. It is also influenced by the activities of international organizations, the setting of goals for socio-economic development in a comprehensive manner (17 GOLS) and individual areas (goals for construction).

Although interest in creating healthier buildings is growing worldwide, the specific objectives and priorities for these buildings vary according to local circumstances and needs. In recent years, one can generally characterize the development of construction in many countries from energy-efficient, passive, and ecological to intelligent construction. Of course, this trend is observed to a different extent in different countries [8,44].

SSB development not only includes building construction and equipment [44] but is technologically linked to other components of smart cities (energy infrastructure, telecommunication infrastructure, as well as social infrastructure). Ongoing research, for e.g., [45–47], shows the possibility of technological innovation (patented) spreading beyond smart cities and their components.

Finally, it should be emphasized that new buildings are being designed and constructed to SSB standards, and existing buildings are being retrofitted to achieve energy savings and increase occupant comfort [48].

5. Assessment of the Relevance of Determinants for Smart Sustainable Building Development

5.1. Identification of Factors for Assessing Smart Sustainable Buildings

Based on the results of the conducted research literature [8,12,13], and questionnaire surveys, a SWOT matrix was developed (Table 1). It contains identified and ordered factors constituting strengths and weaknesses of sustainable and intelligent buildings as well as threats and opportunities (influence of the environment) for its development. All factors of the SWOT matrix were assigned weights based on the assessment of selected experts. The assessment was made on a scale of 1–5 points. An online questionnaire was provided to 57 specialists in the fields of construction (designers and contractors), property management, and IT. This matrix was the basis for determining trends in the development of the analyzed phenomena, and in particular, for adopting strategy types from economic and social organization activities etc. In this case, the authors focused on SWOT matrix factors related to the social aspect. The aim of this analysis was to explore the relationship between social and other factors.

Table 1. SWOT matrix of smart sustainable buildings.

STRENGTHS	Weight	WEAKNESSES	Weight
1.1. Smart building creates a sense of community (applies to public buildings) [1]	1.87	2.1. Higher costs of building and equipping the building	4.23
1.2. Increases worker productivity of those who work inside them [1]	2.83	2.2. Higher costs of renting office space	4.06
1.3. Intelligent construction activates the national economy [1]	2.94	2.3. Management of more complex supply chain	3.4
1.4. Encourages sustainable business practice [1]	2.98	2.4 Increased project complexity	3.57
1.5. Improves the company's attractiveness in terms of attracting and retaining employees—improving competitiveness [1]	3.09	2.5. Capacity of the local industry to carry out such works	3.02
1.6. Protection of natural resources: reduction of energy consumption during the operation of buildings, reduction of water consumption, reduction of greenhouse gas emissions	4.14	2.6. Increased project risks of numerous kinds (financial, regulatory, safety, design issues, . . .)	3.19
1.7. Lower operating costs in use and long-term operation	4.18		
1.8. Increasing indoor air quality and improving the wellbeing of residents [1]	4.04		
1.9. Possibility to equip smart sustainable buildings (BSS) with technologies and systems to integrate BSS with infrastructure (e.g., technical, social) of smart cities.	3.62		
OPPORTUNITIES	**Weight**	**THREATS**	**Weight**
3.1. Increased interest of green/smart buildings	3.73	4.1. Financial possibilities of poorer countries with a weaker economy	3.4
3.2. Increased demand for healthy air [1]	4.08	4.2. Belief that intelligent buildings apply only to buildings with large cubature [1]	2.34
3.3. Increased demand for remote working and other smart city facilities [1]	3.42	4.3. The lack of legal, fiscal incentives taxations, no support from politicians	3.64
3.4. Increase in legal regulations, norms, recommendations, guidelines encouraging smart buildings	3.19	4.4. Low demand for green/smart buildings	3.02
3.5. Right thing to do [1]	3.15	4.5. Lack of specialists in green building [1]	3.36
3.6. Development of automation and building technologies and IT achievements	3.86	4.6. No easily accessible offer	3.51
3.7. Improving the competitiveness of a company located in an intelligent building	2.94	4.7. Lack of knowledge and awareness of current and potential benefits [1]	3.53
3.8 Development of technologies and systems integrating smart building complexes and smart city infrastructures	3.34		

[1] Designation SOCIAL—factors directly related to society.

Comparing the results of the authors' research presented in Table 1 with for e.g., Dodge Data & Analytics company's cyclic research in a similar scope [8], one may notice a certain convergence. Their research reports state that the number of intelligent buildings constructed depend on certain factors, including: "customer requirements (34%), environmental regulations (33%), healthier buildings (27%), market demands (25%), right thing to do (25%), lower operations cost (22%)". Similar features of SSB construction can also be seen in the study [44]. Here, attention was focused on equipping buildings with building automation for savings and comfort.

The analysis of the SWOT matrix results indicates a clear advantage of the strengths of green/smart buildings over weaknesses. On the side of external factors, there is a small advantage of opportunities in the environment, i.e., factors that enable and support the development of smart sustainable buildings. An important factor regarding threats is the lack of potential beneficiaries of smart sustainable buildings. Public awareness, especially regarding environmental pollution, is low.

In the SWOT matrix, almost 50% of the strengths relate to social aspects.

An assessment of the interaction of factors in a social and techno-economic context and their influence on the development of smart sustainable buildings and smart cities can be made using the DEMATEL method [4,49,50]. This method allows for a cause-and-effect relationship between the factors of the SWOT matrix.

5.2. Cause-and-Effect Analysis of Smart Sustainable Buildings and Smart Cities

5.2.1. Research Methodology

To identify cause-effect relationships, the authors proposed the DEMATEL method [6]. The DEMATEL method enables identifying the form of the impact structure using a cause-and-effect diagram. The graphical interpretation allows us to present a map of influential relations between the examined factors in a clear manner. In addition, the arcs of the total flow (T) are accompanied by numerical values indicating the intensity of the total net effect. The graphical interpretation (Figure 1) and later transformations and calculations with the use of the DEMATEL method allows us to determine the values of indicators, describing the role and importance of the considered factors in the context of direct, indirect and total impact. These indicators are referred to as position s^+ and relation s^-. The item s^+ is used to determine the role of a given factor in the process of determining the structure of relations between objects. On the other hand, the relation indicator s^- determines the total influence of a given object on all other objects.

The computational flow is as follows [51]:

1. Determining a set of influence factors in the proposed study based on the SWOT matrix (Figure 1);
2. Development of a direct influence graph. A scale with a parameter value of N = 3 (where: 0—no influence, 1—weak influence, 2—influence, 3—strong influence) was used to assess the "strength" of influence for each factor. The values of the direct influence relations within each pair of factors were determined based on the evaluations of the expert group (Figure 1);
3. Based on the relationships determined within the graph, a matrix of direct mutual influence of factors on each other A_D was created;
4. Determination of the normalized direct influence matrix A'_D. The normalizing number (n) is taken as the largest of the sum of the rows or columns of the matrix A_D:

$$A'_D = \frac{A_D}{n}, \tag{1}$$

$$n = \max\{\sum_{i=1}^{n} a_{ij}; \sum_{j=1}^{n} a_{ij};\}, \tag{2}$$

5. It is also possible to develop an indirect impact matrix ΔT:

$$\Delta T = A'^2_D \cdot (I - A'_D), \tag{3}$$

6. Determination of the total influence matrix T:

$$T = A'_D \cdot (I - A'_D), \quad (4)$$

7. Based on the above matrices, the determination of the indices of position and relationship, respectively, express in turn:
s^+—tells about the role of a given factor in the process of determining the structure of links between objects, while
s^-—expresses the total influence of a given factor on the others.
These values are determined according to the formulas (Table 2):

$$s^+ = \sum_{j=1}^{n} t_{ij} + \sum_{j=1}^{n} t_{ji} = R_{T_i} + C_{T_i}, \quad (5)$$

$$s^- = \sum_{j=1}^{n} t_{ij} - \sum_{j=1}^{n} t_{ji} = R_{T_i} - C_{T_i}, \quad (6)$$

When these values are plotted on a graphical representation, observation is clear as to which factors have the greatest influence on the others. It is also possible to determine the causes and effects of the actions taken (Figure 2)
8. Finally, the net impact value is also determined, which tells the factor with the greatest impact on the others considering both the cause-and-effect nature (Table 2):

$$netto = s^+ + s^- \quad (7)$$

Table 2. Summary of DEMATEL analysis results.

Criterion	R_{T_i}	C_{T_i}	s^+	s^-	Netto
1.1	0.3556	0.1067	0.4622	0.2489	0.7111
1.2	0.2000	0.3511	0.5511	−0.1511	0.4000
1.3	0.3200	0.0000	0.3200	0.3200	0.6400
1.4	0.4089	0.6444	1.0533	−0.2356	0.8178
1.5	0.0622	0.5822	0.6444	−0.5200	0.1244
1.6	0.3911	0.3156	0.7067	0.0756	0.7822
1.7	0.2533	0.3422	0.5956	−0.0889	0.5067
1.8	0.4222	0.4578	0.8800	−0.0356	0.8444
1.9	0.4000	0.1200	0.5200	0.2800	0.8000
2.1	0.5822	0.3111	0.8933	0.2711	1.1644
2.2	0.0933	0.2444	0.3378	−0.1511	0.1867
2.3	0.1156	0.2133	0.3289	−0.0978	0.2311
2.4	0.1867	0.4311	0.6178	−0.2444	0.3733
2.5	0.0533	0.1511	0.2044	−0.0978	0.1067
2.6	0.0533	0.6356	0.6889	−0.5822	0.1067
3.1	0.1644	0.0000	0.1644	0.1644	0.3289
3.2	0.0178	0.0000	0.0178	0.0178	0.0356
3.3	0.1067	0.0000	0.1067	0.1067	0.2133
3.4	0.0889	0.0000	0.0889	0.0889	0.1778
3.5	0.0533	−0.0089	0.0444	0.0622	0.1067
3.6	0.2089	0.0578	0.2667	0.1511	0.4178
3.7	0.1511	0.0844	0.2356	0.0667	0.3022
3.8	0.0356	0.1244	0.1600	−0.0889	0.0711
4.1	0.0622	0.0356	0.0978	0.0267	0.1244
4.2	0.0533	0.0356	0.0889	0.0178	0.1067
4.3	0.0622	0.0000	0.0622	0.0622	0.1244
4.4	0.0000	0.0356	0.0356	−0.0356	0.0000
4.5	0.1244	0.0000	0.1244	0.1244	0.2489
4.6	0.1200	0.0000	0.1200	0.1200	0.2400
4.7	0.1244	0.0000	0.1244	0.1244	0.2489

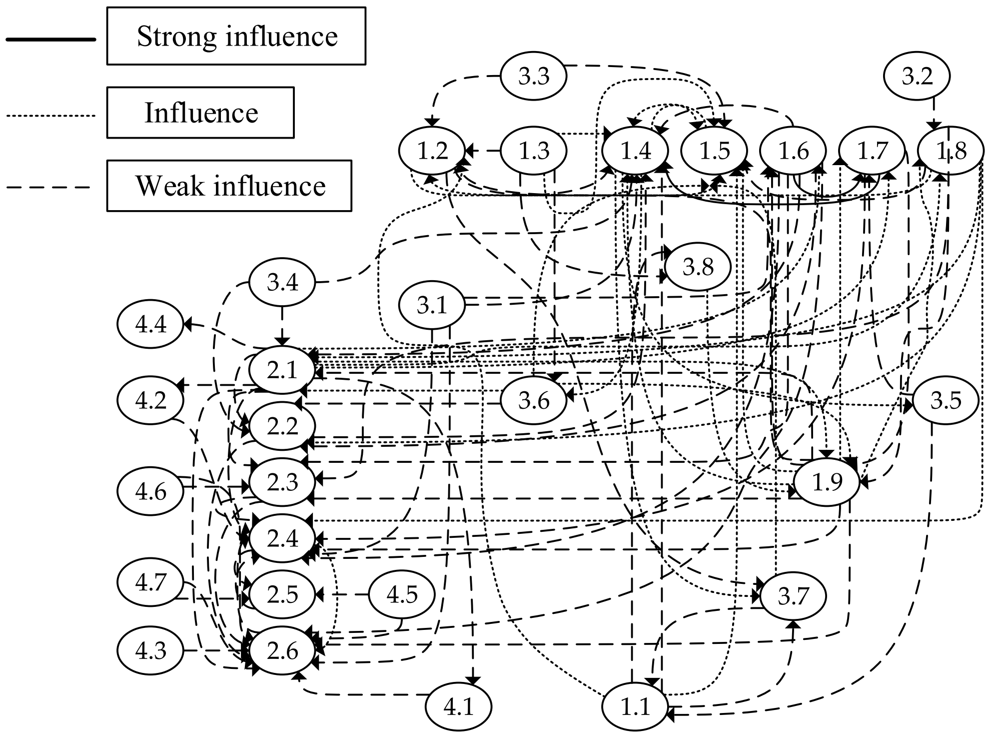

Figure 1. Direct influence graph with expert evaluation results.

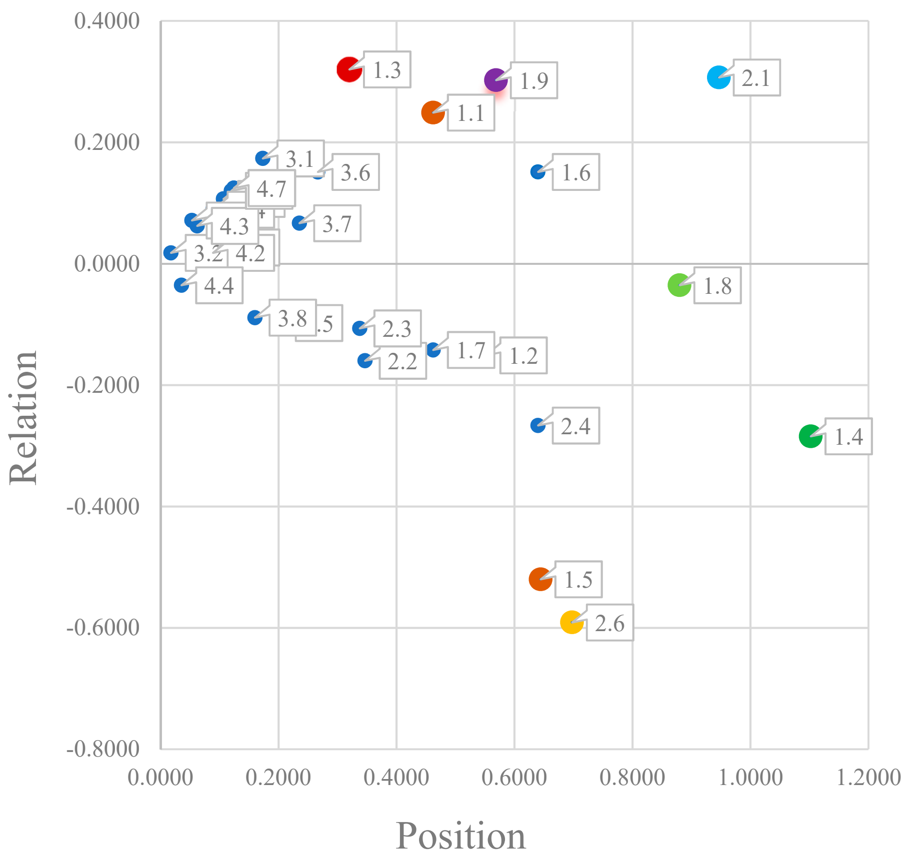

Figure 2. Graphical illustration of results in the relation—position coordinates.

5.2.2. Study Results and Its Analysis

The factors identified during the SWOT analysis are subjected to assessing the strength of their impact on each other. For the analyzed issue, the role of factors, in particular social factors, on the development of smart cities in the form of a direct influence graph is presented in Figure 1. The intensity of relations was coded using different hatchings of arc lines.

Then, according to the algorithm described in Section 5.2.1, calculations were performed. The results are presented in Table 2.

The analysis was performed using summative, linear aggregation of the values of the position and relationship indicators (s^+ and s^-). The calculations, in general, are expressed in the graph shown in Figure 2, which shows the values of the position and relation indicators.

The analyses conducted (Figure 2) shows that criterion 1.3 (Intelligent buildings activate the national economy) is the most causal character, followed closely by 1.9 (Possibility to equip smart sustainable buildings (BSS) with technologies and systems to integrate BSS with the infrastructure of smart cities), 2.1 (Higher costs of building construction and equipment), and 1.1 (Smart building creates a sense of community). Most of the causal factors belong to advantages in the SWOT matrix. Moreover, half of these factors describe the social aspect, which confirms the importance of these factors for the development of SSB.

The negative values of the relation index corresponding to factors 2.6 (Increased project risk) and 1.5 (Increases the attractiveness of the company in terms of attracting and retaining employees—improved competitiveness) indicate their greatest effect. As can be seen, the effects are associated with an increase in the attractiveness of companies (also the social aspect) with a simultaneous increase in project risk.

On the other hand, the leading criteria on the position axis are 1.4 (Encourages sustainable business practices), 2.1 (Higher building construction and equipment costs), and 1.8 (Increases indoor air quality and improves occupants' self-perception), which indicates that they have the largest role in determining the causal (positive) and effectual (negative) nature of the particular criteria. It is worth noting that criterion 2.1, related to increased project risk, has a strong impact and simultaneously a strong causal character, while criterion 1.4, despite its greatest role, has more of an effect character. The last criterion with a significant role is 1.8, the nature of which can be classified as mixed factors. The other objects have a mixed character (values close to zero) or show a much smaller influence on the other criteria.

The cause-and-effect analysis shows that the criteria belonging to the social aspect represent one of the key roles in the development of smart cities.

6. Discussion

In the case of intelligent buildings, two groups can be distinguished: creators (builders) and users.

The creators include all participants of the investment and construction process, including developers, architects, and constructors of various specialties, while the second group consists of users.

The investor plays a leading and dual role as a product provider and financer of the smart building project. They know the market and customer requirements, and work closely with designers who are familiar with developing technologies (benefiting from scientific and technological developments). On the other hand, the investor can be both the owner and user (tenant). In both cases, their priorities are mostly of a business nature.

From the above-mentioned research, the most important benefits of smart sustainable building, including business benefits, are: lower operating costs, improved occupant health, documentation and certification providing quality assurance, higher value at the point of sale, education of occupants about sustainability, future proofing, increased productivity for tenants, higher rental rates, higher occupancy rates, and design flexibility. For the ordinary investor/resident, the disadvantage is the higher cost of constructing such buildings.

These factors are, of course, of different importance for different participants in green buildings. For example, owners also place more importance on higher occupancy rates than architects, engineers, or contractors.

The activities of these two groups may be subject to legal regulations and the requirements of socio-economic concepts. These include, in a nutshell, safe building and use and require an effort on the part of society to use smart building rationally and creatively in smart cities.

Therefore, it is important to emphasize the necessity to develop a link between the benefits of smart/green buildings for an individual and the benefits of the communities living in and creating smart cities.

The factor analysis of the developed SWOT matrix using the DEMATEL method, allowed us to indicate the cause-effect relationship between these factors, also indicating their significance (a measure of influence). Knowledge of these relationships allows for a better understanding of the concept of smart sustainable buildings and their relationship with the environment. They also point to society's place in particular as a beneficiary of smart cities and their infrastructure. At the same time, the studies mentioned above also show what enables these benefits, which is the reason for the concrete measures—effects.

The SWOT matrix presented in this paper indicates the possibility of adopting an aggressive strategy for the development of green building as an element of smart cities. However, the analysis and association of external and internal factor pairs of SWOT matrixes also indicate directions and specific tasks/actions for decision makers and society.

7. Conclusions

This paper contains a brief description of the development of smart sustainable cities, the social aspect, and development of smart sustainable buildings as an element of smart cities' infrastructure.

The analysis of obtained information identifies social aspects of smart sustainable buildings. The analysis shows no significant contradictions between the participants of smart projects who take part in the design, construction, and subsequent exploitation of green building; this is because both creators and users share many common benefits (see Sections 4 and 5).

Many so-called strengths are not only beneficial to the individual participant of a "green building" but to the overall community of smart cities. A notable example is the basic feature of green buildings, namely the minimization of energy consumption. Saving energy and switching to ecologically sustainable sources has an impact on the elimination of smog and ensures healthy air in urban spaces.

Minimizing energy consumption is one of the main aspects of environmentalism. Energy consumption is examined in the current analyses and is an element of environmental care; it is also necessary to ensure that the materials used do not emit or deplete nonrenewable resources and can be easily recycled and reused. Such research is not common. This is where the creativity and intelligence of society are needed in the creation and use of technological achievements and technologies.

The commitment of the general public as a beneficiary and creator leads to complete success. The SWOT analysis also shows the basic barrier that high construction/purchase or rental costs for a large group of the city's population are incurred. A factor reducing costs would be the prevalence of green buildings in the city, which would bring about economies of scale. However, low awareness of opportunities and benefits of sustainable construction, which a large part of society brings, is an obstacle to widespread use.

Therefore, central and local government institutions, whose duty it is to engage in stimulating these activities, help create new social attitudes, increasing the competence of the role they play and contributing to the sustainable development of smart cities. The social dimension of smart cities should foster the deployment of technology that meets users' needs, skills, and interests while respecting their diversity and individuality.

The main directions that need development in the strategy of broad community participation in the smart building of smart cities are:

- Increasing legal provisions conducive to the development of smart building;
- Assistance to public institutions in financing and crediting green building;
- Educating and shaping public awareness;
- Facilitating and supporting society's creative and innovative activities;
- Support city authorities and urban infrastructure service companies in implementing strategies to optimize the simultaneous implementation of intelligent power supply systems, intelligent logistics, and transport systems, and intelligent systems for rationalizing the use of city and even regional resources.

The value of this article is to draw attention to:

1. The inseparable characteristics of green (sustainable) buildings and intelligent buildings. A building constructed and used in an environmentally friendly manner must be equipped with integrated control systems for its equipment, and is an intelligent sustainable building;
2. The social aspect of intelligent sustainable building and its conscious, active beneficiary.

The results obtained from the analysis of relationships between the SWOT matrix factors indicate directions for a possible development strategy smart sustainable buildings and the society's role as creator and beneficiary.

The inhabitants of a smart city cannot be its beneficiaries only but can also participate in its co-creation, initiate actions and be creative.

8. Directions for Further Research

Based on the first stage of research results presented in this article, further research on SSB in smart cities can be conducted in different directions. One of these thought processes is to define conditions and principles for the implementation of intelligent, sustainable construction in individual buildings, housing estates, and finally, agglomerations. Systematic, orderly actions supported by financial and nonfinancial incentives are needed. These should be guided not only by market mechanisms but also by legal regulations.

Based on the SWOT matrix obtained, the type of strategy applied can be adopted. However, in order to develop detailed strategies, the research should be extended. At the same time, specific conditions should be considered, for e.g., individual property managers covering complexes, housing estates, and city districts preparing strategic plans.

Using the results of the research presented in this article, the authors plan to develop strategic directions in the development and implementation of smart sustainable construction on a wider scale in urban settlements and cities, and principles for developing strategic plans implementing SSB in smart cities.

In this new research, special focus should be assigned to the connection and interaction of SSB with other smart city systems, i.e., administration, security, energy, ICT, transport, water supply, and sewage, etc.

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