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Perception of the Quality of Smart City Solutions as a Sense of Residents' Safety

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Abstract: Personalization, mobility, artificial intelligence, corporate life transferred to the online world—all these elements will shape all intelligent solutions, including those for cities in the future also in the field of energy management. A necessary condition is to determine which specific repetitive behaviors and features smart cities will have to meet in order to build an image among residents and adapt to their preferences and requirements and energy requirements. Smart cities were created to support residents in using various services, to give them the possibility of easy communication without time and local barriers. Therefore, high-quality smart solutions in cities significantly affect trust in the city and can affect its reputation. Given that the purpose of the article is to examine the perception of intelligent solutions also in the field of energy and their impact on the sense of privacy and security, different exchanges of perceptions of quality, the risks they pose to residents and their perception of what gives a picture, have been studied. The results of empirical research clearly showed that the safety and level of satisfaction with the activities carried out by the city have a significant impact on the perceived quality, which in turn has a positive impact on reputation. The authors proposed a methodology based on the Kano model for examining residents' satisfaction in order to investigate undefined desires and identified and confirmed needs and to study the analysis of risk and potential threats. The study was in the form of a proprietary questionnaire that can be used in similar surveys on the satisfaction of residents; 2685 correctly completed questionnaires were analyzed and the results obtained after submission were included in management action plans. The city government has expressed an interest that the measures taken will be reviewed after one to two years.

Keywords: smart city; safety; security threats; safety of residents; energy management

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1. Introduction

Currently, as much as 53% of the population lives in the city [1]. Cities as a place of energy management play a huge role in the social and economic life of each country [2]. According to estimates, the percentage of people who will live in cities will also increase to 60% in 2030 [2] (including two-thirds in cities with more than half a million inhabitants) [2]. In countries of Europe or America, as well as Asia (which are highly developed), over 80% of the population lives in urban areas [3]. Countries in Eastern Europe, South America and North and South Africa, where income is average, are home to 50–80% of the urban population [4], while in underdeveloped and poor countries the vast majority of people still live outside the city [5]. Changes taking place in cities, including urbanization, are not always a phenomenon [6–8]. Progressive urbanization leads to changes. Development of suburban zones leads to a reduction in the level of efficiency in areas related to energy consumption, waste management and sustainable development. Also, prosperity in various dimensions of society will translate into a change and improvement in the quality of life of city dwellers as well as energy management processes in cities and also in individual

households [9]. Cities are therefore becoming organisms that are more complex, elaborate, complex and multi-faceted structures [10–12]. More and more often, due to the requirements of cities and their inhabitants, cities will use modern technologies and intelligent solutions in occupations of economic or social sectors [13,14]. As a result, the idea of a smart city is implemented quite successively at various stages. The concept of a smart city first appeared in 1992, describing the development of the city towards technology, innovation and globalization [12]. Currently, smart cities and smart city communities can be defined as systems of people that interact and use the flows of energy, materials, services and financing to catalyze a sustainable economy, development, resilience and high quality of life [15].

In order to achieve the effect of energy management and data security of residents, in addition to the city authorities, it is necessary to involve residents, owners of local companies and non-profit organizations operating in the city in the process of creating, helping in the development of a smart city. The term of smart city assumes that the characteristic features are the high competitiveness of enterprises, intelligent urban and suburban transport, sustainable and economic use of resources, a developed society, a sufficiently high quality of life and public management based on intelligent solutions [16].

The challenge facing a smart city is to ensure an appropriate level of safety and security, which is a necessary condition met by the city authorities. City managers often take into account not only security in the city and the safety of residents (in the physical sense), it is also worth taking into account other emerging threats, which include hacking, privacy and security. Often, these are data that cities have not dealt with so far. The aim of the article is to present to what extent smart space solutions initiated by cities in terms of security.

Tripathi [17] assumes that most of the smart city initiatives are described as safe, which positively influences, among other things, security, protection of property and people and privacy of city dwellers. Smart strategies include changing the pattern of behavior, a pattern of thinking for smart cities, where different urban elements are linked together using information and communication technologies and a variety of advanced technologies, such as Big Data [18–23], the Internet of Things (IoT) [10,18,19], artificial intelligence (AI) [20,21], or Blockchain technology [4]. Solutions for smart cities are praised for the emphasis on sensors, smart devices, and cameras used in various areas of life, which help to collect and process data, which can be of great importance for the safety of both people and the security of property in cities. Intelligent devices allow the collection and analysis of data in real time, which allows for quick action.

Smart city projects involve the implementation of a number of data-generating components, which is crucial for increasing safety and security of city energy management. It also presents challenges such as the residents' fear of violating their privacy.

While safety is paramount and the above-mentioned strategies have helped to improve and strengthen city safety, the concept of a safe city has not been widely adopted. However, the question of effectiveness and the possibility of risking personal privacy at risk is raised many times [24,25].

However, the availability of many intelligent IoT-enabled devices that can be controlled remotely is worrying. These are the voices of critics pointing to the legal loopholes enabling the intrusion into the privacy of citizens [5,24,26,27]. Citizens' fear of protecting their privacy also arise for other reasons. The main concern is that collecting a lot of data from different devices and used by different individuals or groups can be shared, for example, by government agencies, individuals or third parties [28–30]. The reason of collecting such data is unknown, but it can be dangerous because it may concern sensitive data. Actions are taken to secure the collected data and the devices collecting it through such activities as encryption, anonymity and the use of biometrics and the heterogeneity of protocols used by each device, which makes them more vulnerable [31–33].

As a result of the smart city concept, and thus ensuring energy management and security of cities and their inhabitants, this article is about understanding the emerging challenges associated with this concept.

2. Materials and Methods

The thematic scope concerned research on activities shaping a creative and intelligent city area and the space around it, especially in terms of energy security, user safety and data privacy for smart energy solutions. A study was carried out on large and medium-sized cities in Poland, Italy and Portugal. According to the state indicated in the statistical journal as of 30 December 2020, there were about 250 medium and large cities in the studied countries, where 47.1% of the population lives. People living in cities aged 20 to 60 participated in the study. The questionnaire was made available online in connection with the COVID-19 pandemic. Some data comes from city managers.

Earlier empirical results show that the satisfaction of residents increases when they perceive the city, intelligent solutions, and its image as positive, good and correct [34,35]. The security of smart solutions in as a possibility to counteract access by unauthorized persons or companies to information and resources, to conduct activities in a professional and continuous manner, while enabling residents to act reliably, continuously, professionally, and in a stable manner, maintaining all their functionalities and exact timing [36–38]. Concerns about the perceived risk and safety as well as the image of the city itself seem to be one of the basic challenges of smart cities [39,40]. Greater risk perception and fear of losses may induce people to avoid smart city applications [41] and question their quality, professionalism, preparation and functioning of their data collection [20,42]. It has been proven that security is one of the most important determinants of the implementation of smart cities among the Y generation [43,44]. Residents can easily use contact channels to provide intelligent services or applications if they have concerns about the safety of activities [29,45]. As previous research shows, safety can be treated as an important dimension of quality and a positive image of the city [29]. To test the effects of safety research in smart cities, we put forward the first hypothesis:

Hypothesis 1 (H1). *The security of energy management applications offered by smart cities has a positive impact on the perception of the city's image.*

The simplicity with which an intelligent application can be used means that today everyone has a profile that can be translated as ease of use and simplicity of functioning in the online world [46]. Earlier research, e.g., [47], implies that cities need to consider how to design intelligent applications and solutions to be informed and easy to use. Locals say that simple solutions have a positive effect on the perceived value [48] as well as on its actual use [22]. For testing the possible ease of use of applications and solutions for residents, we propose the hypothesis:

Hypothesis 2 (H2). *Ease of use and transparency of the offered applications improve the quality of smart cities.*

In the case of intelligent solutions, a wide range of services, products and services offered to residents is becoming more and more important. Applications in their simplest form may provide easy operation, but also more complex services may not be a problem for the user [7,22,49]. Service variability within smart cities includes the availability of various ancillary services [50] with the extension of the highest level of service variability in those systems, which give the opportunity to use of services, personalized services and marketing messages targeted at specific individuals [13,49,51,52]. Earlier research shows that the features of intelligent solutions and their wide variety can be treated as quality indicators, and their content and availability of services is important for mobile services [53,54]. Based on the research available so far, a hypothesis was developed:

Hypothesis 3 (H3). *The various energy management services offered by smart cities have a positive impact on quality as a safety* component.

Although security is a multidimensional construct that varies between stakeholders [55], the quality of the smart solutions offered has been identified as a determinant of the image of a smart city [56]. The quality of the offered services of the application services has its credibility and built "trust" among the residents [57], which builds residents' satisfaction and leads to a high level of involvement in urban development and loyalty [58]. The relationship between perceived quality and reputation is important because residents rely on image to assess perceived risk [11,55,59,60], when there are no objective and measurable attributes, to test this relationship, we propose the hypothesis:

Hypothesis 4 (H4). *The perceived quality of the smart solutions offered has a positive impact on the residents' sense of security.*

In order to test the hypotheses used to verify the conducted research, a questionnaire survey was conducted to collect responses from city residents who use products and services offered by smart cities. The research questionnaire consists of two parts. The first part of the survey measured the characteristics of smart cities, it consisted of 23 statements about safety energy management applications, ease of use, diversity and threats that an intelligent element can bring to the sense of safety of residents.

The second part consists of statements measuring the perceived quality and safety of residents, trust and the image, visions and perceptions of a smart city. The last part of the instrument concerned respondent data, including, inter alia, the frequency of using the application, the way of using intelligent solutions. All measures that have been used are multi-point based on a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree) and are summarized in more detail in Table 1.

Table 1. The use of intelligent solutions among the analyzed city cities.

Nr	Attributes (Positive Attributes)
1	A city with a clean image should have a well-organized and transparent website and applications.
2	Access to the application should be universal
3	Information about smart solutions should be up-to-date and complete.
4	Regulations should be accessible and understandable.
5	All data provided through the application should be safe and private.
6	The resident should be able to easily contact the order service in order to clarify any doubts.
7	The resident should be able to cancel the transaction before the end of the action.
8	Profiles and applications present content in several languages
9	Profile, the application allows logged in users to use the discount code offered.
10	The profile, applications and smart solutions are provided by free webinars
11	Regular app maintenance gives residents confidence that their actions are in place reliable.
12	Keeping your profiles safe prevents attacks on residents.
13	Loyalty programs should be introduced in applications for the ties of the local community
14	The applications make it possible to involve residents in the development of the city
15	The ability to hack the application—no sense of security
16	Electronic tickets—convenience of use
17	Consumption monitoring—saves money
18	Location monitoring—saves time
19	The sense of privacy in smart cities is essential for residents
20	Using the application should be easy to use
21	Smart solutions are widely available on pages in applications
22	The use of smart solutions brings benefits for users
23	The use of smart solutions poses security and privacy risks for users

The criterion for selecting respondents for the study was the activity and use of intelligent solutions in cities, which allowed us to distinguish the so-called application

and intelligent solutions leaders [61,62]. The selection of respondents was well thought out, adjusted to age, with the ability to use smart city solutions [51]. The survey was sent by e-mail to selected respondents from a sample of 3000 city dwellers using smart solutions in Poland, Italy and Portugal. The selection of cities for the study among their inhabitants was deliberate. City authorities made it possible to perform the analysis by categorizing cities in terms of demographics and culture, but it facilitated the analysis of being a smart city. In all analyzed cities, the same categories were taken into account, i.e., standard of living, access to information, dealing with official matters, care for the environment, transport/communication, safety, energy efficiency, enterprises/buildings, infrastructure. Figure 1 contains information on the level of a given category in a given country and information on the average value of the level of being a smart city.

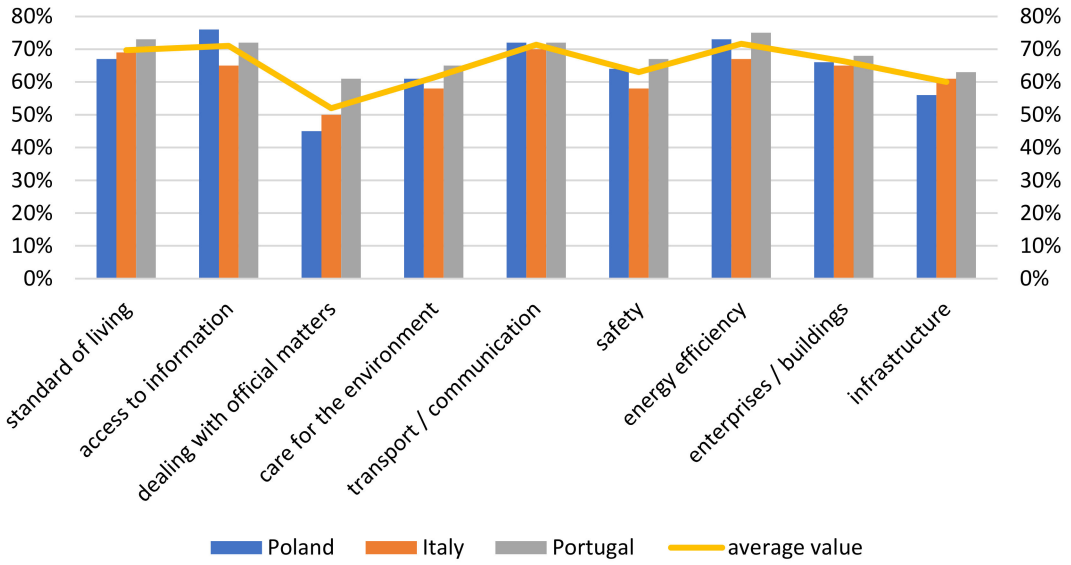

Figure 1. The level of being smart in individual countries in the categories assessed. [own study].

The authors and the authorities of the cities assessed that the compared cities in individual countries are as close to each other as possible and that the assumptions and analyzes will be presented together. In Poland, the analysis covers: Warsaw, Wrocław, Kraków, Poznań, Łódź, Katowice, Gdańsk and Bydgoszcz. In Italy, the analysis covered: Milan, Genoa, Rimini, Padna, Turin, Bolonga, Bergamo, Modena, while the study in Portulagia: Lisbon, Bragance, Porto, Oeiris, Fundo, Penela, Gueda, Palmela.

The selection of the study sample was deliberate, so people of similar age were selected by the city administrators (the maximum difference between the age limits is 10 years), with higher education, living in cities of similar size. Before the questionnaire was sent to the respondents, city managers completed the demographic and economic declarations in order to be able to compare data from selected countries. On the other hand, the respondents themselves declared similar cultural, social and economic features. The study participants first received an e-mail inviting them to complete the questionnaire, and the e-mail also contained a brief explanation of the purpose of the study and objectives. The anonymity of the respondents was preserved. During data collection, it was checked that the data was in line with the planned design of sample amounts. In total, 2685 responses were received. The sample consisted of 72% of men and 83% of respondents with higher education. Among the respondents, 33.8% use applications and intelligent solutions several times a week, 50.87% of respondents use it every day, and 0.46% less than once a month. The distribution of the use of intelligent solutions is presented in Table 1.

Several statistical analyses were carried out to ensure the credibility of the research and to check the correctness of the hypotheses. First of all, the accuracy of the research tool was checked. As the items of the questionnaire were adjusted based on the existing literature

and the correctness of the content was ensured. It was decided that the application of the Kano model will illustrate customer satisfaction with the company's image in social media. The Kano model allows to examine the dependence on the development of a product or its service [8], characteristics and the level of customer satisfaction [8,63]. When using the Kano model as a satisfaction testing solution, it should be remembered that not all product elements are equally important from the customers' point of view and this should be demonstrated [3,64]. Noriaki Kano divided the attributes into six groups [64]:

- "must-be" or "must-have" attributes that must be included in the product and service as standard. Lack of these functions can lead to client loss [57]. In the case of intelligent solutions, access to complete information is a mandatory feature [63].
- The "one-dimensional" attributes are the most important from the point of view of customer satisfaction with the product or service. For example, sorting options or the number of filters a customer can select are a "one-dimensional" feature. The more filters, the easier and faster the customer can make a choice.
- "Attractors" aim to attract a customer to a product or service because they exceed their requirements. Over time, they can turn into one-dimensional features and become mandatory or completely disappear, the trend will change. Poorly designed decoy features may go unnoticed by the customer. However, when they do appear, they bring joy to customers. They are extremely difficult to define, it is impossible to define them unequivocally, their popularity is very short-lived. When it comes to intelligent solutions, maybe all kinds of codes, applications, promotions that will convince residents to use intelligent solutions.

Indifferent features or errors are imperceptible, which means completely unnecessary. They do not affect the satisfaction of the inhabitants [65]. They do not reduce or increase customer satisfaction.

Reverse features are features that the client does not want. Inverted attributes occur when the client prefers the lack of the attribute, and does not do it like his presence [57]. The presence of more such attributes in a service or product leads to greater customer dissatisfaction.

The Kano method was used in the form of a specially developed questionnaire [64]. Based on the statements regarding the quality of the profiles, a questionnaire was prepared with positive or negative versions of the statements related to features and smart relationships in cities. In the survey, the residents indicated which features should be taken into account, which will have an impact on the level of satisfaction, and thus on the perception of residents' safety.

3. Results

Many previous studies presented in research and scientific works emphasize the factors that occurred as the most frequent, often also referred to as recurring [66–68], i.e. factors that are often mentioned by scientists, and probably also local residents [24]. By collecting information on the features, quality level of activities, and how they are perceived in terms of safety in smart cities [69], we analyzed the rich literature on this subject. By analyzing this article, as well as other works [6,13,70,71], it was possible to distinguish a group of factors that have the greatest impact on the satisfaction of residents [8], which includes intelligent solutions, their applications, operation and content, relations with residents, reliability and the possibility of using codes and coupons [72].

This stage of research is primarily a questionnaire part describing the potential attributes of intelligent solutions and the sense of security of residents, intelligent solutions and those that carry threats [73–75]. The participants of the study were obliged to express their opinion and give positive and negative features. On the basis of the answers, it was possible to indicate the features that must be taken into account, but also those that affect the overall customer satisfaction (one-dimensional). The list of positive features of the Kano questionnaire is presented in Table 1. The assessment of these features (answers to

these questions) was based on the following scale: (a) "I like it", (b) "It must be like this", (c) "I don't mind this", (d) "I can take it", (e) "I don't like it" [11].

The analysis of the results was performed on the basis of the answers given to the individual types of attributes included in the survey. Then it was analyzed which type is most often chosen.

The assessment made in the Kano method can be used for customer satisfaction and dissatisfaction. it means calculation of indicators in the range (0, 1). When the value of the index is 1, customer satisfaction was very high. If the value was close to 0, customer dissatisfaction was very high. These indicators can also be interpreted graphically using a two-dimensional matrix where the X axis was an index of dissatisfaction with individual attributes to the absolute, and the Y axis was an index of satisfaction. The interpretation is presented on the basis of Table 2.

Table 2. Interpretation method [64].

Distribution of Response	XY Pair	Location of the Point on the Graph
All attractive	0 1	Top left corner
All one-dimensional	1 1	Top right corner
Evenly split between attractive and one-dimensional	0.5 1	Middle of the top, halfway between attractive and one-dimensional
All must-have	1 0	Bottom right corner
Evenly split between one-dimensional and must-have	1 0.5	Middle of right edge, halfway between one-dimensional and must-have
All indifferent	0 0	Bottom left corner
Evenly split between must-have and indifferent	0.5 0	Middle of bottom edge, halfway between must-have and indifferent
Evenly split between indifferent and attractive	0 0.5	Middle of left edge, halfway between indifferent and attractive
Evenly split among attractive, one-dimensional, must-have, and indifferent	0.5 0.5	Exact middle of graph
Evenly split between attractive and must-have	0.5 0.5	Exact middle of graph, halfway between attractive and must-have, without an influence of one-dimensional or indifferent
Evenly split among attractive, one-dimensional, and must-have	0.67 0.67	Equally spaced between attractive and must- have, but influenced by one-dimensional

The respondents' answers are presented in pairs (positive and negative attributes) in accordance with the adopted Kano method. The most common traits and indicators of satisfaction and dissatisfaction were calculated. The comparison of the obtained results is presented in Table 3.

When analyzing the results presented in Table 4, it can be seen that the responses of the respondents were very diverse. The development of social media in Europe and the widespread access to them have resulted in companies increasingly turning to this solution in order to communicate effectively with customers and to offer them products and services in this way. Clients are becoming very picky and demanding [74], which was badly reflected in the results. Most of the attributes of corporate social media are, according to customers, essential functions. In Table 4 there are functions that an enterprise must have, they are marked with the letter M. The lack of such features means that customers go somewhere to the competition [75].

Table 3. Kano questionnaire results [own study].

Attribute-Number	Assessment of the Attribute	Satisfaction Index Dissatisfaction Index	Dissatisfaction Index
1	M	0.75	−0.25
2	M	0.82	−0.31
3	O	0.65	−0.75
4	A	0.25	−0.85
5	O	0.57	−0.89
6	M	0.67	−0.24
7	M	0.89	−0.18
8	M	0.66	−0.40
9	O	0.68	−0.59
10	A	0.34	−0.84
11	A	0.40	−0.80
12	A	0.31	−0.93
13	A	0.20	−0.92
14	M	0.82	−0.33
15	O	0.89	−0.68
16	A	0.46	−0.65
17	O	0.55	−0.96
18	O	0.69	−0.93
19	O	0.66	−0.55
20	M	0.73	−0.30
21	I	0.22	−0.20
22	R	0.46	−0.65
23	M	0.70	−0.48

Table 4. Identified threats.

Nr	Smart City Elements	Threats	The Level of Threat
1	Intelligent transport	Ecological city transport	4
2		Delays in urban transport	5
3		Transport information	3
4		Location and route information	4
5		The ability to hack the application	1
6		Electronic tickets	4
7	intelligent energy/intelligent life	Scanning license plates	1
8		Face scanning	1
9		Current monitoring	5
10		Monitoring of consumption	1
11		Privacy	2
12	intelligent technology	Collecting large amounts of data	2
13		Processing large amounts of data	4
14		Behavior Monitoring	2
15		Location monitoring	1
16		Vehicle registration systems	2
17		Public transport management systems	3
18		Supply networks and logistics in the city	4
19	Smart citizens and education	City parking services	3
20		Population registration systems	4
21		Registration systems for companies and other organizations	1
22		Systems for registration and planning of municipal investments (integrated with the city geoportal)	1

Table 4. *Cont.*

Nr	Smart City Elements	Threats	The Level of Threat
23	intelligent environment, smart economy	Regional spatial business community	1
24		Stationary exhaust gas analyzers	1
25		Air monitoring systems	1
26		Noise registration systems	1
27		Tax calculation systems (especially ad valorem property taxes)	1
28	smart government and safe city	Traffic monitoring systems (including traffic violation recording devices	1
28		City Geoportals	1

It can be concluded that the respondents understand the need for sustainable development [76], and the so-called the related features were treated by them mainly as indispensable features, i.e., they must be among the attributes of corporate social media [77,78]. Comparing the results of these studies with previous studies available in the literature, it was possible. It can be noted that the respondents pointed to certain features of company media in terms of sustainable development, which were repeated in other studies, e.g., customer involvement in activities for local society, as shown in Figure 2.

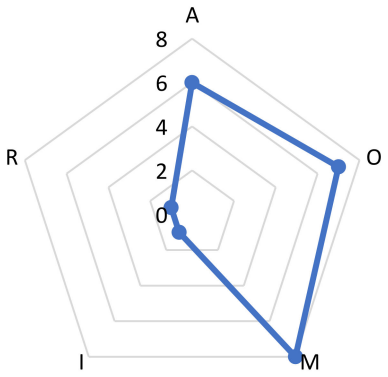

Figure 2. List of attribute types, where: A—attractive; O—one-dimensional; M—must-have; I—indierent; and R—reverse [own study].

Analyzing the results presented in Table 4, it can be seen that the respondents' answers were very diverse. The development of smart cities in Europe and the widespread access to intelligent solutions meant that residents increasingly used this solution to communicate effectively in the field of these solutions, and thus offer them products and services tailored to their needs.

City dwellers are becoming very picky and demanding [8,71], which can be seen in the results presented. The attributes of smart solutions, according to residents, are the basic functions. Table 5 lists the functions that must be fulfilled by a smart city, marked with the letter M. Lack of such attributes means that customers will choose a different solution or its lack [52.53). It can be assumed that the respondents understand the need for sustainable development [58] and the residents' sense of security [26,29]. They treated related features mainly as indispensable features, i.e., they must be one of the attributes of smart cities [56,65]. Comparing the results of these studies with previous studies available in the literature, it can be noticed that the respondents pointed to certain features of cities in terms of development and the sense of security of residents, which were repeated in other studies, e.g., involvement of residents in activities for the local community.

Table 5. The level of threat and the sense of security among residents.

	Threat	Vulnerability (1–5)	Risk Level (Threat × Vulnerability)	Security Level
1	Intelligent transport	4	16	3
2		5	25	
3		3	9	
4		2	8	
5		2	2	
6		1	4	
7	intelligent energy/intelligent life	2	2	2
8		2	2	
9		3	15	
10		2	2	
11		2	4	
12	Intelligent technology	1	2	4
13		1	2	
14		5	10	
15		2	2	
16		1	2	
17		3	9	
18	Smart citizens and education	3	12	2
19		5	15	
20		5	20	
21		1	1	
22		3	3	
23	intelligent environment, smart economy	2	2	4
24		3	3	
25		2	2	
26		2	2	
27	smart government and safe city	2	2	3
28		2	2	

Notes: Low–Hight, 1–5.

The next was to determine, thanks to the respondents, the level of their sense of security, which was assessed thanks to the risk analysis. Risk is a danger, often unavoidable by humans, which is also noticeable in the business activities of everyone who makes any decisions. This word is used to describe the combination of frequency or likelihood of a particular hazardous event occurring and the consequences associated with it [34,76,77]. Smart cities are characterized by a large variety of elements and a wide range of threats. Therefore, the article takes into account the risk factors of a smart city in terms of the safety of its inhabitants [48]. In order for a smart city to be safe in the eyes of its inhabitants, it is necessary to prevent risk before it occurs and a strategy to minimize the impact of risk when risk occurs [72].

Lac-inak and Ristvej [29] presented nine elements of the system that make up a smart city. The scope of risk management and its reporting should be carefully controlled, but in such a way as not to disrupt the company's work, but to support it. Risk analysis is a significant support for all processes in a smart city; therefore, individual areas should be examined in a thorough and comprehensive manner, also taking into account feedback. In the process of identifying and defining risk, attention should be paid to the impact of risk on the objectives pursued, so that the goals set as priority serve to eliminate or minimize the effects of risk. Scientists have refined the list of threats in various aspects of a smart city, but there is no joint research in different areas. The most significant threats created a group of issues determining the level of the sense of security, for which potential effects that could have a negative impact on the inhabitants were defined (scale 1—negligible ÷ 5—high) (Table 4).

The threats contained in Table 4 affect the residents' sense of security to a different extent, and thus the image of a smart city. It should be emphasized, however, that these are preliminary studies and therefore may turn out to be only part of the smart city's problems. In addition to identifying threats and their level, it is also necessary to identify their causes and the possibility of eliminating or minimizing their effects when building a risk management system.

As part of the analysis, it is assumed that risk identification cards are mainly used to collect information on the types of risks according to a specific classification and to measure them. The next step in examining the level of threats should be the assessment with the use of the risk identification card. The smart city card is presented in the form of a form to be completed by the respondents (Table 5).

The estimated level of threats and the estimated vulnerability of resources are the basis for determining the level of risk. They negatively affect the proper operation and functioning of smart city residents and the residents' sense of security.

Intelligent transport is associated with the highest level of risk. The lowest level of risk in the studied cities is quite often at level 2, which is associated with social awareness and great interest in intelligent solutions, because, according to research, the sense of safety of residents has not reached level 1 in any area.

4. Discussion

The levels of satisfaction and dissatisfaction indicators for individual attributes made it possible to create a map of attributes and indicate the type of attributes more precisely. This map helped identify the necessary and conditioning attributes and their other types of attributes. The map of the attributes of this research venture is shown in Figure 3.

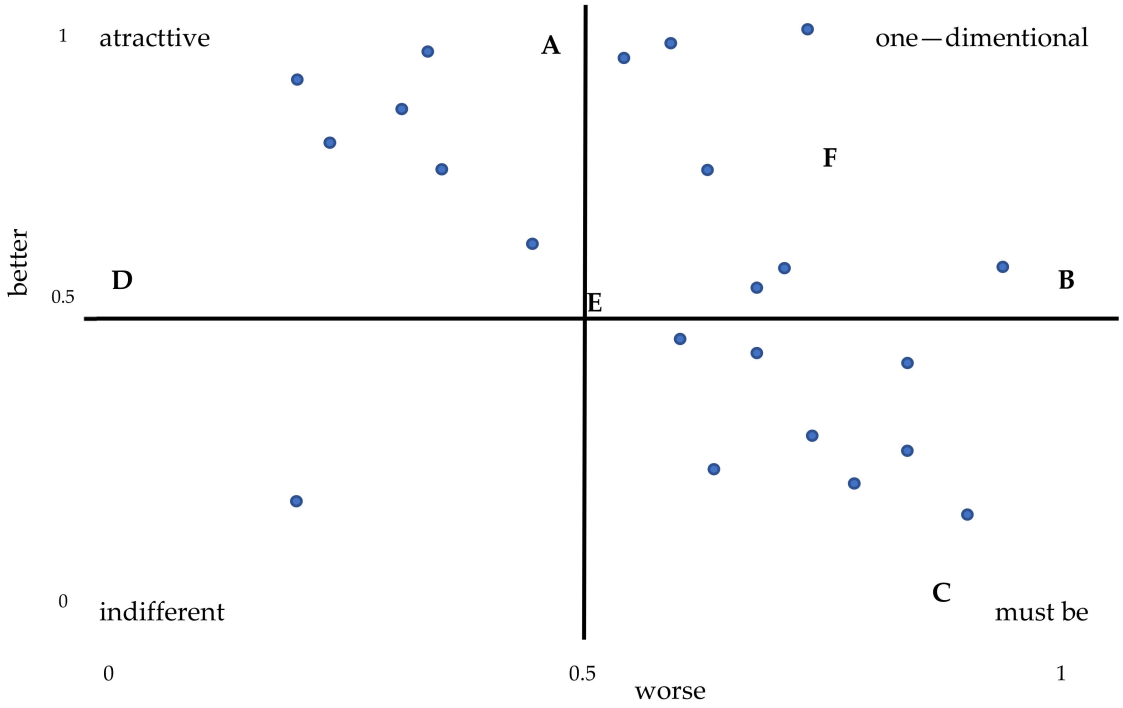

Figure 3. Map of attributes according to the Kano questionnaire [own study].

As shown in the map in Figure 3, many of the attributes were actually a mix of functions. A large part of the marked points are on the right side of the map (high level of dissatisfaction), and most of the points are in the center of the map (i.e., in the middle of the right edge, halfway between the one-dimensional and the basic ones listed in Table 3). There were many points near the "must-have" point. None of the points was placed in the lower left corner of the so-called "Neutral".

The conducted analyzes allowed for the preparation of the results of activities carried out in recent years. Individual cities do not have identical solutions, using applications to support smart solutions, in different categories of evaluation they have a similar level of being a smart city, but the individual solutions themselves are different. However, they have a common goal, also ensuring energy security for the residents of smart cities, and thus joint reduction of energy, reduction of energy consumption, the Figure 4 shows the results achieved.

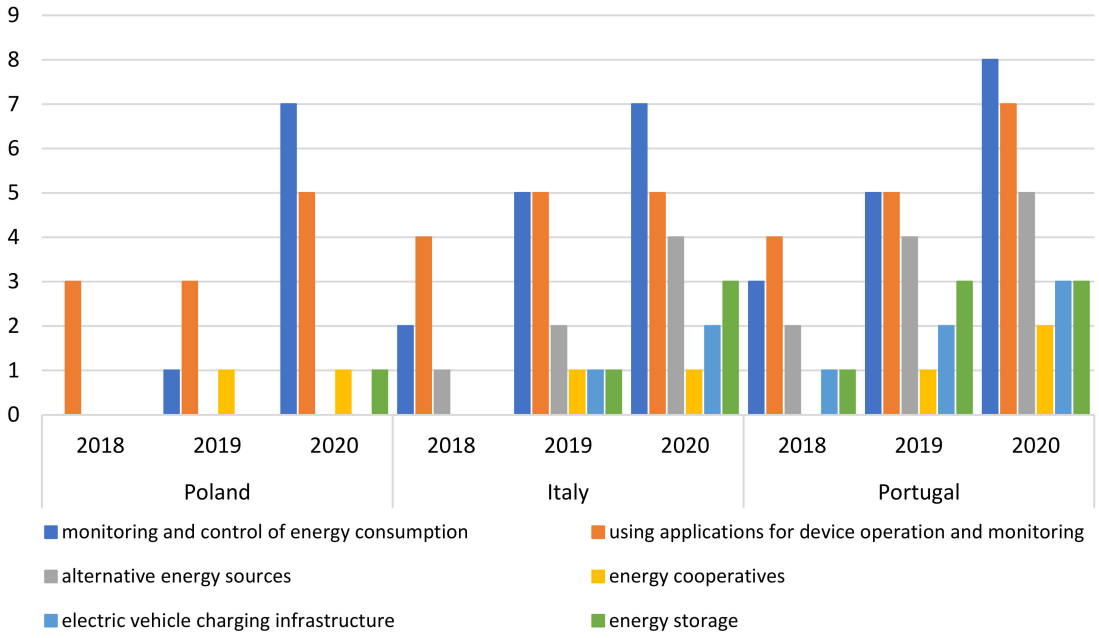

Figure 4. Energy saving activities (on a scale of 0–10) [own study].

On the basis of the conducted research and analyzes, the respondents selected 6 factors assessing energy savings, they will assess their level in individual years on a scale of 0–10, where 0 is the lack of this solution and 10 is a solution that does not need changes, ideally suited to the needs of residents. There are apparently changes, none of the solutions is rated worse from year to year. The assessments are confirmed in the attributes of the Kano model, where without these solutions, residents cannot imagine a smart city.

5. Conclusions

The turbulent environment, fierce competition and developing technology on the market force us to adapt to constantly changing requirements, and this development will, in a way, force the development of cities, and thus the residents' approach to intelligent solutions. One of the strongest drivers of change in cities is Revolution 4.0. Industry 4.0 tools deserve special attention, including internet applications and universal access to intelligent solutions. Currently, cities that are not online, do not care about the safety and development of their city, are less attractive to residents looking for solutions and information about the solutions provided. Another factor forcing changes in cities is the need to manage energy. Such transformation is aimed at more thoughtful and effective management of all resources. Doing so will allow for less pressure and less environmental impact.

In the case of smart city activities, individual dimensions of activities have specific advantages and disadvantages. Smart solutions provide long-term benefits, ensure a balance between the availability of modern intelligent solutions and the sense of security among residents, the sense of privacy and freedom cannot be disturbed [78–81].

The article uses a questionnaire for assessing activities based on research hypotheses and a model of assessing the satisfaction of the Kano resident in order to indicate the

features of visualization, the sense of security of the resident, taking into account selected assumptions of sustainable development. The next step was to analyze the risk related to security and the sense of privacy. Thanks to research in which city residents from Poland, Italy and Portugal have identified one-dimensional features that affect the image in a direct and immediate way. It should therefore be emphasized that the respondents are aware of the development of technology, but respect the need for security and privacy in line with the concept of smart growth [82–84]. Moreover, a satisfied and loyal city resident is a good source of publicity [40] for the city and an opportunity to build an image in the online world.

These results have been presented to the city authorities and discussed, and will also be taken into account when designing further actions for smart solutions. The city authorities expressed interest that after 1–2 years of operation after the changes in activity, the authors could conduct new research in order to check the functioning of the level of satisfaction and sense of security in the conditions described in the smart features questionnaire.

The methodology is very universal. Created for research purposes, the Kano questionnaire and questionnaire can be used by research authorities in other cities to design intelligent activities and assess the quality of their activities and image.

Through this research, this article aims to understand the importance of content quality, intelligent solutions and their relationship to the energy management of applications, whose privacy is maintained while using [85]. The aim of this article was also to contribute to the current literature by identifying the aspects of intelligent activity that are perhaps the most fueling an increase in the sense of security. The results show that all analyzed quality elements have a positive impact on the perceived quality of the service, thus confirming our first three hypotheses. Taking into account that the sense of security is the perception or public image of the city, it is not directly controlled and therefore difficult to manipulate [21,83,86].

Future research should include, for example, a group of respondents from a particular city or group of cities, and seek to include more objective ways to assess the quality of smart activities as well as the sense of safety of residents. Moreover, there are additional elements that may influence the perceived quality of activities and the sense of security [27,87].

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