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THE CONCEPT OF A SMART CITY IN URBAN MANAGEMENT

Sławomira HAJDUK

Faculty of Management, Bialystok University of Technology, Bialystok, Poland
E-mail: s.hajduk@pb.edu.pl

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Abstract. Analyzing the literature covering public management, the author noticed that the urban planning is a crucial fac-tor in urban development. Cities which have an adequate intellectual resources and proper institutions as well as developed infrastructure are called smart cities. According to the author, proper local spatial development plans should be applied in those cities. Crucial parts of the city, places of the highest investors interest such as technology parks, R&D companies, business incubators, technology transfer centers and industrial complexes should definitely be incorporated in these plans. The ISO 37120 Standard is the most practical method to measure a city's perfor-mance. The factor which decides about special management is the level of investment pressure. If this indicator is decreasing then the area does not have to be covered by local spatial development plans.

This elaboration aims to examine the role of the smart city in urban management. The research shows the relationships between coverage planning, investment pressure and green areas. The main result is the author's classification of selected 34 Medium-Size Cities in Poland. The test procedure exploited taxonomic methods as Ward's hierarchical analysis.

Keywords: smart cities, ISO 37120, urban development, spatial management, urban sprawl, taxonomic methods, classification.

JEL Classification: R10, O18.

1. Introduction

The number of people inhabiting urban areas is constantly increasing. It is predicted that until 2050 the proportion of people living in cities will change from 53% to 70% (Lierow 2014; UN 2015). 70% of the global Gross Domestic Product is obtain by cities which are social and economic centers. Many governments may find investing in those areas profitable, however it should be done in an effective and balanced way. In addition cities have to face major changes and challenges resulting from global environmental shifts, abrupt urbanization as well as older and older infrastructure. Thus an appropriate and coherent methodology must be taken. The ISO 37120:2014 standard: Sustainable Development of Communities – Indicators for City Services and Quality of Life is the first standard of the International Organization for Standardization concerned with city metrics and can be helpful. City services and quality of life are crucial indicators which give information about cities efficiency. All necessary factors are determined and found thanks to special methodology. Neither location nor position and size matter in applying ISO 37120:2014 Standard.

Unequivocal and transparent urban planning should be the foundation of smart cities functioning in Poland. While initiating this work the author placed some research questions, for which response have been searched in the elaboration: How important is urban planning in the concept of smart cities? What factors influence urban planning? In the context of spatial management what are the differences between cities of Poland? How can local governments reduce urban sprawl?

This collection of doubts was exploited to establish the aims of the elaboration. The significant purpose of the elaboration is to examine the connection between coverage planning, investment pressure and green areas in term of urban management. The research included 34 medium-sized cities of Poland. The author exploited statistical data from the Local Data Bank of the Central Statistical Office and reports prepared by the Institute of Geography and Spatial Organization of the Polish Academy of Sciences, the International Organization for Standardization and the European Union. The test procedure covered the following methods such as: Pearson's linear correlation, Ward's analysis and k-means analysis.

2. Background literature

According to territorial management, smart cities is presently one of the most common and popular ideas. Miscellaneous efforts have been made to academically identify and conceptually delineate a smart city. This also has been showed in emerging modern theories of development management, especially within the concepts of the industrial district, the network model, knowledge organization, intellectual capital, e-governance, new public management, intelligent specialization, regional foresight, the cluster, learning region and city, value-based management, reengineering, innovative organization, lean management (Allwinkle, Cruickshank 2011; Arribas-Bel *et al*. 2013; Deakin, Waer 2011; Eleander 2002; Flynn 2012; Mateson 2008; Wiatrak 2011; Roberge 2013; Pors, Johannsen 2003; Foray *et al.* 2009; Andrews, Van de Walle 2013; Dias *et al*. 2014; Dunleavy, Hood 1994; Paskaleva 2009; Schiuma, Lerro 2008; Ricciardi, Za 2014).

The smart city is a global trend of urban strategies aimed at recovering the quality of inhabitants living in urban areas and at leveraging innovation and high technologies to solve the difficult problems generated by high-population density (Marinova, Philimore 2003; Dameri 2013; Hancke, Silva 2013). It helps to solve issues of urbanization, especially pollution of environmental, land consumption, urban sprawl, transport congestion, energy needs, difficulties in accessing public services and contains a diversified set of public initiatives: form building better transportation systems to endorsements creative innovation, knowledge for designing energy-saving policies (Florida 2008; Eger 2009; Hollands 2008; O'Grady, O'Hare 2012).

The concept of smart city was first used in 1994 (Porter 2003; Lombardi *et al.* 2012; Dameri, Cocchia 2013). Since 2011 the amont of publications referring to this subject has distinctly grew. This is associated with the emergence of smart city projects and endorsement by the European Union. The concept of smart city is most frequently mentioned in literature. Nam and Pardo presented a smart city model having Three Dimensions: technology, people and institutions. In all analyzed smart city models the authors stated repeating social elements related with technologies aimed at transforming the economy, the environment and the community (Nam, Pardo 2011).

Caragliu and Nijkamp determined a city to be smart when investments in human and social asset as well as traditional and modern communication infrastructure fueled balanced economic development and a high quality of life, coupled with reasonable management of natural resource, through taking part operation and commitment (Caragliu *et al*. 2011). Giffinger constructed a smart city ranking list based on some urban characteristics (Giffinger *et al*. 2007). They identified 6 categories: governance, economy, mobility, people, environment and living. The authors ranked 70 cities within the European Union based on a amount of ratios and indicators. Leydesdorff and Deakin considered a Triple-Helix model of smart cites underpinned by local government, academic leadership and industry wealth (Leydesdorff, Deakin 2011). Lombardi also describes smart cities using the Triple-Helix model and the role of universities and research centers in generating innovation and patents (Lombardi *et al*. 2012). Whereas Sainz Pena defined a smart city as something that exploits information and communication technologies to make its critical infrastructure, its elements and public services more interactive, efficient and noticeable to inhabitants (Sainz Pena 2011). Mandelson and Bradshaw, in turn, identify ten main areas possessed by a smart city: health, effective use of resources, ICT literacy, public administration, regional economics, education, innovative services, culture and recreation, public safety (Mandelson, Bradshaw 2009). Several authors determine a smart city as a inteligance transport, comprehensive urban strategy based on some important components such as technology, sustainable economy and environment, digitalization of daily life, a good style of governance and ICT (Simmie, Strambach 2006; Briggs 2009; Lazaroiu, Roscia 2012; Tachizawa *et al*. 2015).

The smart city phenomenon developed due to some important challenges such as technological progress, innovative devices, knowledge economy, environmental pressures and the political support of global institutions, including the United Nations, the European Union and the OECD (EU 2011, 2014; Thite 2011; Winters 2011; Zygiaris 2013; Cocchia 2014). Analysis of international literature concerned with the smart city suggests that the present concept is the result of three trends of urban research, that of the digital city, the green city and the knowledge city (Chourabi *et al*. 2012; Vanolo 2014; Neirott *et al.* 2014). ICT, knowledge and the environment are seen as inextricably linked with the implementation of more innovative cities (Table 1).

The smart city is an integrated and comprehensive vision of all aspects of urban life including: the economy, government, transport, green areas, health care and culture.

Table 1. Trend of smart cities and definitions (source: own elaboration on the based Ishida 2002; Schuler 2002; Giffinger *et al.* 2007; Batagan 2011; Gartner 2011; Ergazakis *et al.* 2004; Komninos 2006)

Trends	Authors	Definitions
Digital city	Ishida 2002	An arena where people can interact and share knowledge and information in a digital format
	Schuler 2002	As a result of a physical or virtual ICT infrastructure
	Giffinger *et al.* 2007	A digital platform on which a complex ecosystem of multiple agents (includuding administration, companies and citizens) is developmened, equipped with sensors and capable of offering, through the processing of all the information acquired by the sensor network, the best services possible at every moment
Green city	Batagan 2011	A city pursuing economic development while reducing greenhouse gas emissions and polution
	Gartner 2011	The city will act on this information flow to make its wider ecosystem more resource efficient and sustainable. The information exchange is based on a smart governance operating framework designed to make cities sustainable
Knowledge city	Ergazakis *et al.* 2004	A city that aims at a knowledge-based development, by encouraging the continuous creation, sharing, evaluation, renewal and update of knowledge
	Komninos 2006	A cities are territories with high capacity for learning and innovation, which is built in the creativity of thei population, their institutions of knowledge creation

The specific character of a smart city consists of creating and consolidating knowledge and innovation (Rogerson 1999; Baqir, Kathawala 2004; Edvinsson 2006; Yigicanlar *et al.* 2008; Navarro *et al.* 2012; Kourtit, Nijkamp 2012; Labra, Sanchez 2013). This is the reason implementation of smart initiatives increases social and economic attractiveness and competitiveness a city supported by its technological infrastructure (Qi, Shaofu 2001; Rosvall *et al*. 2005; Dameri, Cocchia 2013; Kitchin 2014). In particular a smart city exploits ICT to optimize the performance and effectiveness of serviceable and needful city processes, activities and services typically by joining up diverse components and actors into a more or less seamlessly interactive intelligent system (Yovanof, Hazapis 2009; Woods 2013; Townsend 2013; Manville *et al*. 2014). All these aspects are combined with wider concepts including environmental protection and energy production (Cozens 2008; Brondizio *et al*. 2009; Fiksel 2006; Levin *et al*. 1998; Oliver 1997; Roseland 1997; Albino, Dangelico 2012; Mori, Christodoulou 2012).

Nowadays every city needs indices to measure its performance. Current indices are generally not standardized, compatible or comparable over time. The smart city

ISO 37120 standard is a collection of standardized indices which ensure a uniform approach to what is measured and how that measurement is made (Steele 2014). On the whole, ISO 37120 determines 100 city performance indices that are required or recommended (Tillie 2014; Lynch 2015) as well as includes 46 core and 54 supporting report indices (Fig. 1). These indicators can be used to track and monitor progress of a city's sustainable development. Planning for future needs must take into consideration current effectiveness of resource use. According to ISO 37120 cities can receive various levels of certification based on the number of reported and verified indicators (Table 2). The indicators have been developed in order to help cities learn from one another by allowing comparisons across a wide range of performance measures and sharing best practices. This standard can be exploited in combination with the ISO 37101 Sustainable development in communities: Management systems – General principles and requirements.

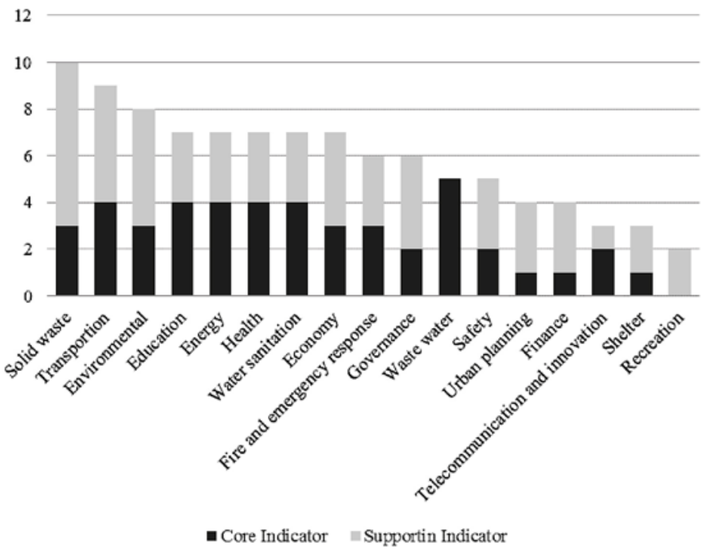

Fig. 1. Themes and the number of indicators in ISO 37120
(source: own elaboration on the based Standard ISO 37120:2014 Sustainable Development of Communities: Indicators for City Services and Quality of Live)

Table 2. Levels of certification cities and the number of indicators
(source: own elaboration on the based WCCD 2014)

Levels of certification cities	The number of indicators
Aspirational	30–45 core indicators
Bronze	46 core + 0–13 supporting
Silver	46 core + 14–29 supporting
Gold	46 core + 30–44 supporting
Platinum	46 core + 45–54 supporting

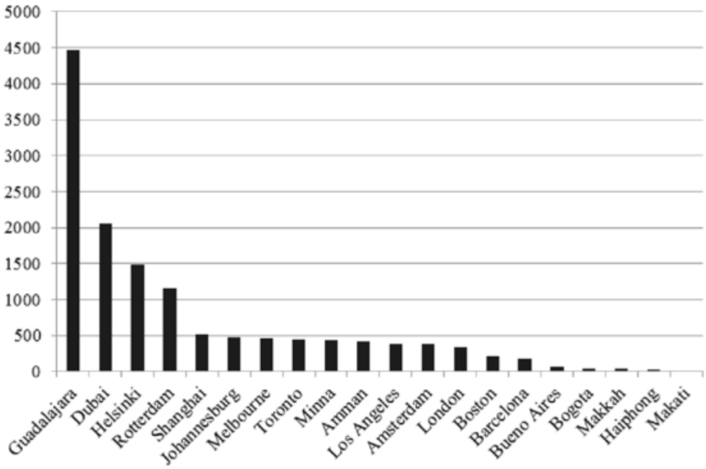

Fig. 2. Green space in cities [hectars/100000 person]
(source: own elaboration on the based WCCD 2014)

One of the 17 themes defined by the ISO 37120 Standard is urban planning. Urban planning indicator's role is to report about green area and trees planted per person, the areal size of informal settlements as well as the jobs/housing ratio (McCarney 2014). A green area is broader than a recreational space and it is publicly accessible. According to World Health Organization it is advised to all cities to have at least 9 m^2 of green area per person. It is suggested that 10 and 15 m^2 per inhabitant is the most reasonable number. The cities with the highest number of green areas worldwide is Guadalajara in Mexico having 446 m^2 per capita. On the following positions Dubai and Helsinki can be mentioned. An extremely difficult task, succeeded by Rotterdam and Shanghai, is the ability of incorporating large green areas in populations with high density. The least green cities are Haiphong with 2 m^2 and Makati – 0.6 m^2 of green space per person (Fig. 2). The indicator of trees planted ensures a helpful measure of the city's involvement to urban and environmental sustainability, and municipal adornment. Informal settlements contribute to urban sprawl and as plenty of people displaced into cities attracting new businesses will help ensure greater jobs and economic growth. In 2003 the American Planning Association released a planning instrument for local governments that overrun that problem. The often cited Jobs-Housing Balance report suggests permissible compartments of jobs-to-housing indicators should fall between 1.3:1 and 1.7:1.

3. Research methodology

This research involves 34 facilities with populations between 100 thousand and 500 which were chosen from 305 Polish cities. Eleven of these cities are situated in the Silesia Province (Table 3). Indices for the study have been computed on the basic of statistical data from the Local Data Bank of the Central Statistical Office from 2014 and are linked to three dimensions: coverage planning, investment pressure and green space. The first determines the surface area covered by local spatial development plans. It consists of following indicators: X_1, X_2, X_3, X_4. The second results from decisions on building conditions and land development. It obtains following indicators: X_5, X_6, X_7, X_8. And the last considers the size of green area. It consists of following indicators: X_9, X_{10}, X_{11}. According to the assessment of literature above-mentioned, the author assumed the following indices as eleven diagnostic variables:

X_1 – the share of the area covered by local plans in the total city area [%];

X_2 – the share of the area covered by proposed local plans within the total city area [%];

X_3 – the average area covered by the local plan [hectares];

X_4 – the share of the number of developing local plans whose preparation has taken longer than 3 years in the total number of developed local plans [%];

X_5 – the share of the area covered by local plans which will use agricultural lands and forests for non-agricultural and non-forest purposes [%];

X_6 – the number of decisions issued on building conditions and land development per 1,000 hectares of area not covered by the local plan;

X_7 – the area of land excluded from agricultural and forestry production per 1000 population;

X_8 – the number of decisions for building conditions issued per 1,000 population;

X_9 – the share of the green area in the total city area [%];

X_{10} – green area per 100000 population in hectares;

X_{11} – the yearly number of trees planted per 100,000 inhabitants.

Table 3. Medium-size cities of Poland vs. nomenclature of territorial units (source: own elaboration)

NUTS 1	NUTS 2	Medium-size cities of Poland
Central Region	Lodz Province Mazovia Province	– Płock, Radom
South Region	Lesser Poland Province Silesia Province	Tarnów Bielsko-Biała, Bytom, Częstochowa, Gliwice, Zabrze, Chorzów, Tychy, Katowice, Ruda Śląska, Rybnik, Dąbrowa Górnicza, Sosnowiec
Earth Region	Lublin Province Subcarpathia Province Swietokrzyskie Province Podlasie Province	Lublin Rzeszów Kielce Białystok
North-West Region	Greater Poland Province West Pomerania Province Lubusz Province	Kalisz Szczecin, Koszalin Gorzów Wielkopolski, Zielona Góra
South-West Region	Lower Silesia Province Opole Province	Legnica, Wałbrzych Opole
North Region	Kuyavia-Pomerania Province Warmia-Masuria Province Pomerania Province	Bydgoszcz, Toruń, Włocławek Olsztyn, Elbląg Gdańsk, Gdynia

Polish municipalities are characterized by low planning coverage averaging 29.2% (Śleszyński *et al*. 2015). There are provinces with above-average coverage of local plans and these, include the following: Silesia, Lower Silesia, Lublin and Lesser Poland. Low planning coverage applies in particular to urban agglomerations and transport corridors. Polish cities are covered in 49.6% by local plans. Analyzed cities are characterized by 42.1% coverage planning which is higher than the national average, but lower than coverage in all cities (Table 4). Three cities have full coverage planning as: Chorzów, Ruda Śląska, Rybnik.

Table 4. Profil of the medium-size cities (source: own elaboration)

Characteristic of cities	Frequency	Percentage
Area covered by local plans [%]		
Under 20	7	20.6
20–40	13	38.2
40–60	9	26.5
Greater than 60	5	14.7
Land excluded from agricultural and forestry production [hectar/1000population]		
Under 2	25	47.1
2–4	4	11.8
Greater than 6	5	13.6
Green area [%]		
Under 5	29	85.3
5–10	4	11.8
Greater than 10	1	2.9

The scope of my research included three stages of the test procedure (Carrillo 2004):

- reducing of the variables set by means of the Hellwig parametric method with Pearson's correlation coefficient matrix (appendix 1);
- classification of cities using Ward's hierarchical analysis (Figs 3, 4);
- determining the characteristics of individual clusters through the use of a deglomerating k-means analysis (Fig. 5).

The author computed indicators by applying STATISTICA12.0 computer package and a Microsoft Office Excel 2010 spreadsheet. Variables X_7, X_8 and X_{10} were not taken into consideration in further analysis as a result of author's assumptions using the Hellwig parametric method with Pearson's correlation coefficient matrix. Other eight variables (X_1, X_2, X_3, X_4, X_5, X_6, X_9 and X_{11}) were included in the further part of the study. Ward's hierarchical analysis encompassed Euklidean distance (Panek 2009; Olszewska 2014).

4. Results and discussion

The author presented the connections between coverage planning, investment pressure and green space by analysing the outcomes of the taxonomic analysis. It was prepared within the urban management in chosen 34 Polish cities. The researched entities had the same characteristics which enabled the division of medium-sized cities into three individual groups (Fig. 3). Applying comparing binding distance chart to binding levels facilitated to establish the limiting distance at the level of 10.0 (Fig. 4).

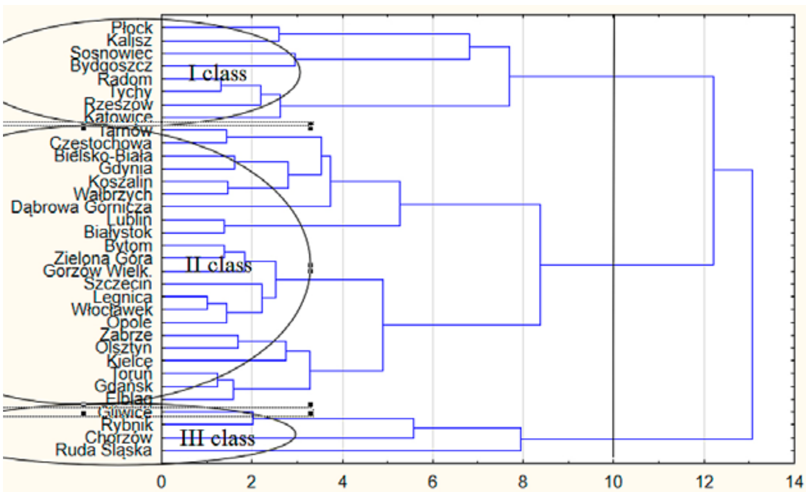

Fig. 3. The dendrogram grouping Polish medium-sized cities by Ward's analysis (source: own calculation using STATISTICA12.0)

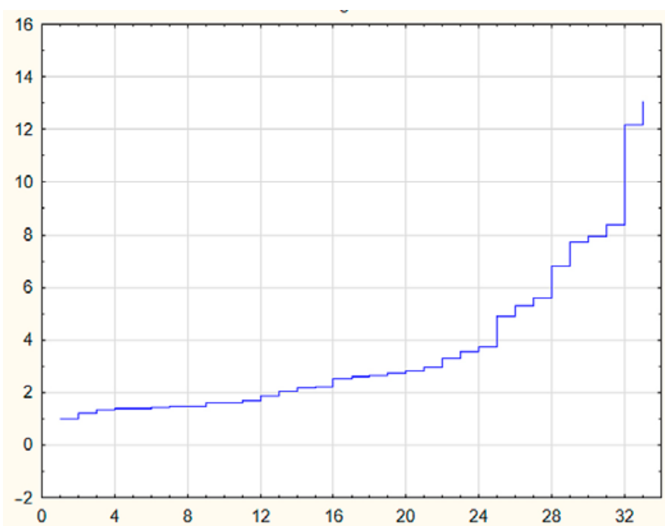

Fig. 4. The chart comparing distance to binding levels (source: own calculation using STATISTICA12.0)

The first class includes eight elements such as: Kalisz, Płock, Sosonowiec, Bydgoszcz, Radom, Tychy, Rzeszów and Katowice. These cities are showing the lowest levels of coverage planning.

Moreover, the second class consists of twenty two cities such as: Tarnów, Częstochowa, Bielsko-Biała, Gdynia, Koszalin, Wałbrzych, Dąbrowa Górnicza, Lublin, Białystok, Bytom, Zielona Góra, Gorzów Wielkopolski, Szczecin, Legnica, Włocławek, Opole, Zabrze, Olsztyn, Kielce, Toruń, Gdańsk and Elbląg. These objects are characterized by an medium level of coverage planning.

Therefore, the third class consisted of four-elements such as: Gliwice, Rybnik, Chorzów and Ruda Śląska. These cities are characterized by very high levels of coverage planning adapted to investment pressures (local plans cover areas which are the most attractive to investors).

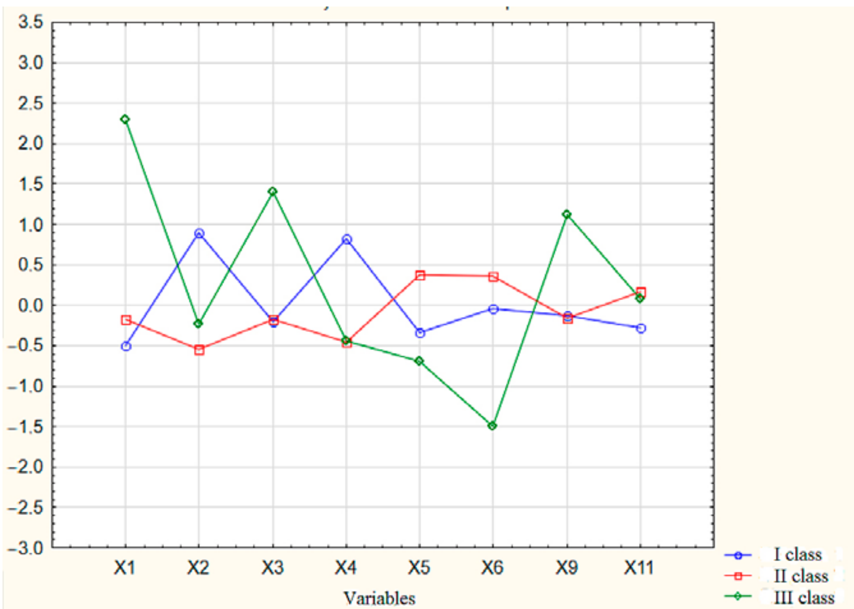

Fig. 5. The characteristics of classes by a deglomerating k-means analysis
(source: own calculation using STATISTICA12.0)

Figure 5 presents the characteristics each classes of cities. First class stands out the lowest share of green areas. Objects of second group are distinguished by having the highest investment pressure and the lowest values of coverage planning. Elements of third class can boast of having the highest share of green areas and coverage planning but the lowest investment pressure.

5. Conclusions

Analyzing the literature covering public management, the author noticed that the urban planning is a crucial factor in urban development. Cities which have an adequate intellectual resources and proper institutions as well as developed infrastructure are called smart cities. According to the author, proper local spatial development plans should be applied in those cities. Crucial parts of the city, places of the highest investors interest such as technology parks, R&D companies, business incubators, technology transfer centers and industrial complexes should definitely be incorporated in these plans. The ISO 37120 Standard is the most practical method to measure a city's performance. The factor which decides about special management is the level of investment pressure. If this indicator is decreasing then the area does not have to be covered by local spatial development plans.

A close connection of coverage planning, investment pressure and green space was observed thanks to applying taxonomic methods on 34 medium-sized urban centers in Poland. Analysed cities have been included into three individual classes. The first class of urban centers contained cities which need an improvement in coverage planning. It will certainly positively affect the innovation levels of these cities. The methods suggested and recommended by the author might serve an important role in supervising planning coverage in different territorial units. This kind of monitoring can have a beneficial effects for local governments, public institutions and organizations connected with those entities.

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Appendix 1

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
	%	%	ha	%	%	units	ha	units	%	ha	units
Płock	36.6	18.61	62.0	45.45	**36.8**	30.48	**9.7**	1.39	193.32	2.7	**772**
Radom	11.2	32.84	19.6	57.78	10.2	50.97	0.6	2.33	234.74	4.6	630
Tarnów	35.8	5.54	60.3	0.00	0.6	71.06	0.1	**2.96**	122.97	1.9	356
Bielsko-Biała	38.3	6.27	43.0	25.00	19.9	54.18	5.5	2.40	97.36	1.4	179
Bytom	32.5	27.45	94.2	21.43	0.0	31.60	0.0	0.86	187.57	4.7	201
Częstochowa	17.5	9.06	65.0	0.00	0,3	50.85	0.0	**2.91**	211.77	3.1	296
Gliwice	91.4	14.45	**211.1**	27.27	0.0	2.62	0.0	0.02	231.49	3.2	670
Zabrze	31.4	22.18	120.4	45.45	0.2	39.37	0.0	1.22	186.36	4.1	749
Chorzów	**100.0**	9.12	86.2	55.56	0.0	0.00	0.0	0.00	**667.48**	**22.2**	191
Katowice	21.8	**36.29**	29.0	**75.00**	3.1	27.81	0.4	1.19	343.95	**6.3**	125
Ruda Śląska	**99.9**	1.43	**7768.0**	7.14	0.0	0.00	0.0	0.00	223.20	4.0	700
Rybnik	**99.8**	31.71	548.1	11.11	0.0	0.00	0.0	0.00	226.19	2.1	326
Dąbrowa Górnicza	40.4	8.67	131.6	0.00	11.6	10.77	7.2	0.98	**366.03**	2.4	658
Sosnowiec	32.7	16.34	124.2	40.00	2.5	67.76	0.4	1.98	224.65	5.2	**1811**
Tychy	16.9	24.58	20.3	70.97	17.4	50.01	1.9	2.64	301.22	4.7	658
Lublin	47.0	16.25	**256.9**	16.13	8.8	**84.74**	1.8	1.94	244.83	**5.7**	114
Rzeszów	15.5	**38.17**	9.2	**73.63**	0.0	65.36	0.0	**3.47**	168.40	2.7	567
Białystok	45.0	20.34	43.8	39.29	13.5	**87.22**	2.1	1.66	171.14	5.0	285
Kielce	17.3	7.20	34.5	68.75	1.4	42.79	0.1	1.95	165.58	3.0	124
Gorzów Wielkopolski	44.6	17.46	57.9	25.00	7.8	39.80	2.4	1.52	284.29	4.1	35
Zielona Góra	59.0	24.77	47.8	30.00	4.3	21.31	1.3	0.43	144.46	2.9	122
Kalisz	17.1	9.15	41.0	**72.73**	**51.1**	51.63	**5.9**	2.87	165.76	2.5	236
Koszalin	35.7	3.52	79.9	0.00	3.6	19.78	1.2	1.15	170.93	1.9	152
Szczecin	46.6	**35.73**	66.4	61.67	2.4	22.50	0.8	0.89	108.14	1.5	130
Legnica	39.0	21.37	18.8	41.67	5.8	18.93	1.3	0.64	195.36	3.5	134
Wałbrzych	17.5	4.03	29.6	22.22	12.6	19.74	1.6	1.18	144.35	2.0	59
Opole	38.3	15.35	67.2	54.55	0.0	23.16	0.0	1.15	253.17	3.1	249
Bydgoszcz	33.5	9.66	46.1	33.33	20.1	28.04	3.3	0.92	**415.66**	8.4	**1816**
Toruń	44.9	8.53	29.7	33.33	0.0	30.88	0.0	0.97	170.63	3.0	382
Włocławek	30.1	24.58	47.9	56.25	3.9	22.05	0.9	1.14	132.97	1.8	174
Gdańsk	64.8	4.81	29.6	20.27	0.0	33.76	0.0	0.67	167.99	3.0	650
Gdynia	27.4	11.38	39.0	3.85	28.7	34.26	4.3	1.36	99.27	1.8	48
Elbląg	45.5	10.77	46.0	30.77	8.0	13.33	2.4	0.47	125.27	1.9	748
Olsztyn	55.8	16.25	75.8	41.67	0.1	66.34	0.0	1.49	182.50	3.6	562

Grey color in the table means the highest value of variable.
Source: Own calculation using Microsoft Office Excel 2010.

Sławomira HAJDUK received the MSc Eng. degree in environmental protection from Bialystok University of Technology, Poland, in 1995, the M.S. degree in Math from University of Bialystok, Poland, in 2001 and the PhD degree in economy from Wroclaw University of Economy, Poland, in 2002. She is currently working in the Faculty of Management, Bialystok University of Technology, Poland. Her long-established research activities are in the fields of the territorial management, in particular urban and regional development.