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Concept of "Smart City" and its Practice in Poland. Case Study of Łódź City

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1 ABSTRACT

Paper's objective is to present the concept of "smart city" as an approach to urban development and, on this ground, to analyze urban practice in Polish city of Lodz.

First part of the paper, therefore, will be dedicated to definitional aspects of the "smart city" approach, with focus on determinants and factors included in this concept of multidisciplinary growth. Some aspects of measurement of the concept will also be included. Having the conceptual base settled, concept of "smart city" will be confronted with urban practice of Lodz. The city was chosen based on its recent development: inclusion of multidisciplinary aspects in its growth strategy and good results of implementation of verified urban development programs. Analysis conducted in the practical part of the paper will use both qualitative and quantitative methods and both secondary and primary sources of data and information. Official strategic and program documents of the city will be researched and analyzed, as well as confronted with in-depth interview with policy-makers. Statistical data (regional, national and community) will be used for quantitative methods.

Research will allow for conclusions regarding implementation of "smart city" concept in general, but also for verification of question whether this particular approach to urban development is suitable for countries and areas in different stages of economic development, as analysis will concentrate on a Polish city. In this light – the European Union's single solutions for all Member States approach will be evaluated.

2 INTRODUCTION – GROUNDS FOR THE SMART CITY CONCEPT

Role of cities in modern economy is well described and has become obvious – not only are urban areas places of living for more than a half of population but also (in case of European Union) generate ca. 80% of GDP. The UN estimates (United Nations 2012) that urbanization will get intensified and urban areas will increase their economic impact, as well as will become increasingly important for culture and social relations. At the beginning of urban studies and economic research of urban areas, cities were mostly seen as a 'by-product' of industrialization; currently however, are rather treated as a catalyst of economic change – with intensive correlation of urbanization and economic growth as well as increasing importance of high value added industries, mostly localized in cities. Relation of urbanization and wealth (measured by GDP per head) is illustrated by model elaborated by the World Bank, presented in fig. 1. The model explains 55 per cent of variation of urbanization; however, as a regression model, it does not explains causality.

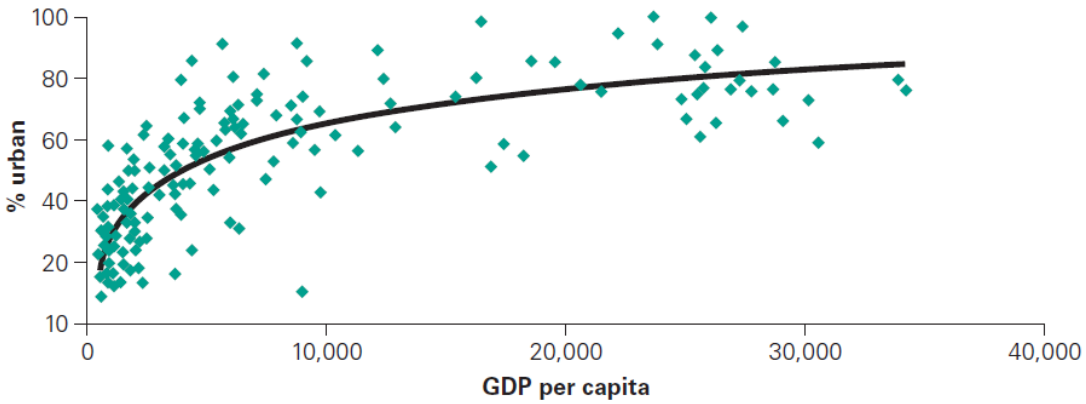

Fig. 1: Urbanization (percentage of urban population) and wealth (GDP per head) in chosen countries, 2000 (in 1996 USD). Source: The World Bank (2006), p. 3.

Increasing economic importance of cities is reflected in urban studies which focus transfers from social science (social relations in urban areas, segregation, social inclusion) increasingly towards economics (management, entrepreneurship, competitiveness). In context of economic research, cities are treated not

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only as a location for entrepreneurial activity, with institutional environment analysis, but also as an economic entity itself, capable of competing with other entities.

Urban development research point to two pillars of urban growth, i.e. entrepreneurial environment and quality of life. Those two elements (represented by companies and people) are significant and necessary for a competitive city to develop (Szczech-Pietkiewicz 2013). Well elaborated in literature and implemented in urban practice concept of urban competitiveness gave grounds for the introduction of the idea of “smart city”. Goal of the following paper is to present this concept by its definition, comparison with other urban development notions, as well as elaboration of a synthetic index providing tool for assessment of “smartness” of a city. In this respect, concept of smart city is an extension of urban competitiveness research, by identification and introduction of new dimensions to urban growth analysis, followed by its quantification.

Smart city concept, in its current understanding, combines and gives ground for synergies between competitiveness and sustainable development in urban areas. Urban growth, as observed in last couple decades, came with negative externalities such as inequality and competition among cities, therefore there seems to be a need for policies that emphasize balance, social inclusion and competitiveness at the same time. Goals of sustainable development and competitiveness, however contradictory at first glimpse, can be successfully combined in concept of smart city.

According to the European Commission: „European cities of tomorrow are places of advanced social and environmental progress, while maintaining economic attractiveness and economic growth achieved by integrated approach including all aspects of sustainable development” (European Commission 2011). This definition of future urban development takes into consideration all elements of smart city concept, while at the same time emphasizing that this is the model of growth that EU will be supporting and promoting.

Implementation of the smart city concept at the community level has been started by Commission’s initiative „Smart Cities and Communities – European Innovation Partnership” (C(2010) 4701 fin). The goal of this initiative is promotion of sustainable urban development while concentrating on issues of transport, mobility, energy and information and communication technologies (ICT). The project will be supported by the cohesion policy and financed with European funds (mostly with Horizon 2020 means). First step in the initiative’s implementation is establishment of SCC Platform (Smart Cities and Communities Stakeholder Platform), as a tool for best practice and information exchange among engaged cities and communities. Further, the European Commission recommends data collection for the purposes of progress monitoring in the area of smart city in the European Union.

3 DEFINITION OF SMART CITY AS AN APPROACH TO URBAN DEVELOPMENT

Current discussion over multi-dimensional urban growth and development quite often uses notions like: intelligent cities, knowledge-based cities, smart cities, learning cities. Large number of these notions and their understanding calls for a common definition of the concept of smart city which is a subject of this paper. First and the most important, differentiation will be made between smart city and intelligent city.

Intelligent city is most commonly defined as an area which uses and enables access to (ICT), using them in management, governance, administration and communication with inhabitants. Such a city will therefore be equipped with intelligent systems of transport management, monitoring of security and public wireless Internet access points. Moreover, intelligent cities are often characterized by intensive concentration of highly qualified work force and representatives of the creative class (R. Florida 1996), capable of creating the knowledge spill-overs. Intelligent city therefore is one that uses available technology in all aspects of management and development: creating intelligent systems of communication with inhabitants (e.g. e-government), creating public transport management and traffic management systems, guaranteeing security and managing urban services (Lombardi et al. 2009). Technology is used mostly with the goal of resources efficiency increase, on the other hand also – to increase quality of life in the city.

One of the most often cited definition of intelligent city is that created by the IBM (IBM 2010). Their definition emphasizes advanced technology use in urban development and planning, it also focuses mostly on urban infrastructure. According to the IBM: „Technological advances allow cities to be ‘instrumented’, facilitating the collection of more data points than even before, which enables cities to measure and influence more aspects of their operations. Cities are increasingly ‘interconnected’, allowing the free flow of

information from one discrete system to another, which increases the efficiency of the overall infrastructure. To [meet] these challenges and provide sustainable prosperity for citizens and business, cities must become 'smarter' and use new technologies to transform their systems to optimize the use of finite resources."

Criticism of the concept of intelligent cities focuses on the fact that it is questionable to attribute whole complex system of urban areas development to just one factor – in this case technology (Hollands 2008). Despite the fact that impact of modern technologies on shaping urban areas is well documented in literature (Graham and Marvin, 1996), it is unjustifiable to give this one determinant a superior role. Other criticism of intelligent cities concentrates on the social aspect of intelligent systems. One of the risks of excessive use of advanced ICT systems and tools is increasing technological exclusion (digital divide), as some groups of city's inhabitants may not be able, capable or willing to use them. Therefore, intelligent city is created for an intelligent inhabitant, however intelligence is understood very narrowly, as capacity of cooperating with technology. Graham and Marvin (2001) call this phenomena a splintering urbanism, as development concerns only chosen groups of inhabitants, while increasing fragmentation and polarization in the area. Intensive use of intelligent urban systems (in transport, social security, social capital activation, resources management), even though biased with technological exclusion, may also increase efficiency growths to the extend impossible to obtain by "traditional" methods. For example, automated public transport system can generate more frequent circulation of buses or trains than by using only human knowledge, talent and abilities. Quite similarly, progress in automotive industry and use of modern technologies in vehicles' production may increase efficiency of urban traffic. Technology can also increase social inclusion by increasing the lengths of senior citizens activity (e.g. 'self-driving' cars).

Concept of smart city goes beyond this narrow understanding of development (limited to ICT). Even though there is no one commonly used definition of smart cities, literature of subject proposes two threads of approach to the concept. One approach is to define it as a city where ICT delivers infrastructure for social and economic initiatives concerning economic growth, social capital and higher resources efficiency (Hollands 2008, Komninos 2006, Van Der Meer and Van Winden 2003). Other thread is to assume wider approach, where smart cities are treated as a new urban development paradigm (Giffinger et al. 2007, Caragliu et al. 2011, Neirotti et al. 2014, Lazariou and Roscia 2012). In the latter approach, focus is therefore put on phenomena such as human and social capitals, education and natural environment (Lombardi et al. 2012). Such models of urban development point to smart cities as areas which, on one hand, are a supporting factor for intellectual capital development and well-being growth by institutional system; at the other hand providing a knowledge transfer mechanism for system of innovation. These models however, despite including city management issue, does not concern natural environment and sustainable development issues. It also does not provide tools to research causality (Lombardi et al. 2012, s. 138).

A comprehensive definition of smart city is provided by Vienna University of Technology (VUT) in „Smart cities – ranking of European medium-sized cities". Basing on literature review, Authors conclude that by the time the report was published (2007), the term "smart city" was used to describe such verified actions in urban areas as: development of ICT in cities; increase of inhabitants education achievements; creation of attractive conditions for business locations, mostly in IT sector; providing modes of communication with inhabitants (e-administration); modern modes of transport; urban development respecting sustainability. VUT therefore, assumes that a smart city is: „well performing in a forward-looking way in these six characteristics, built on a 'smart' combination of endowments and activities of self-decisive, independent and aware citizens". The six characteristics of a smart city are: economy, people, governance, environment and quality of life. With such assumptions, this approach, unlike intelligent city concept, gives grounds to extending analyses of urban progress further than technology, while also reaching beyond urban competitiveness from the point of view of business sector. Therefore, it avoids risk of dedicating urban development strategy to a sole goal of competitiveness growth (by limiting goals to increasing business location attractiveness).

Other definition of smart city present Bakici, Almirall and Wareham (Bakici et al. 2013, p. 135) in their case study of Barcelona, where they state that such cities: „base their strategy on the use of information and communication technologies in several fields such as economy, environment, mobility and governance to transform the city infrastructure and services". This definition therefore puts ICT in the position of urban development tool and this role is in this case significant, which may prove that Authors lean more toward

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understanding smart city more as an intelligent city. The goal of using ICT in urban management is here obtaining efficiency gains in resources management, job creation, quality of life increase and innovation.

A current and comprehensive definition of smart city is brought by A. Caragliu, Ch. Del Bo and P. Nijkamp (A. Caragliu et al. 2012), in a statement that: „investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance". This definition combines areas almost identical to TUV's approach (human and social capital, transport, ICT, environment, quality of life and democratic institutions), however adds a dynamic analysis by pointing to mechanism and causality between these notions. Significant is also differentiation among goals (sustainable development, quality of life), tools (human and social capital investment, transport and ICT) and mechanisms (effective resource management and social participation), while VUT's approach gave all those aspects the same role.

Current literature also stresses that core concept for smart city is the ability to combine intelligent solutions with particular city's conditions (Deakin 2013). M. Komninos (2008) points to following conditions of smart city development:

- broad spectrum of electronic devices and technology use in cities and communities;
- use of information technologies for quality of life and work increase in the region;
- ICT embeddedness in the city;
- territorialization of the above practice in order to bring people and technology closer together, while encouraging innovation, learning, knowledge and problem solving that technology provides.

Generally, Komninos proposes to defines smart cities as (2008, p. 1): „…territories with high capacity for learning and innovation, which is built-in the creativity of their population, their institutions of knowledge creation, and their digital infrastructure for communication and knowledge management".

Summing up, smart city as a concept of urban development assumes it should include six spheres of growth: economy, people, urban governance, geographic mobility, natural environment and quality of life. These areas should be further supported by information technology systems, provided they are a tool not a goal of development strategy. Smart strategy should also include not only multi-dimensional approach but also city's stakeholders, i.e. enterprise sector, inhabitants and local government.

4 METHOD

Issue of urban development determinants is well embedded in literature, which of course does not mean this list is constant and complete. Researchers still discuss the role of particular factors, their impact on urban growth, their hierarchy and timing. Most commonly analyzed determinants include: innovation (R. Capello, P Nijkamp), creativity (Ch. Landry, R. Florida), entrepreneurship (OECD), quality of life (R. Rogerson) and human and social capital (E. Glaeser). All of these factors are to some extend included in the concept of smart city and extended, by addition of mechanisms, instruments and governance.

Interesting approach to urban development determinants of a smart city is presented in P. Lombardi's paper (Lombardi et al. 2012). Using Analytic Network Process (ANP) method, over 60 indices of urban development is analyzed. Indices are first grouped according to triple helix model, however helix is in this case extended to four dimensions, fourth dimension being civil society. ANP analysis, including relations between priorities (dimensions of the helix) and alternative solutions, gave grounds to grant following weights to particular determinants: (1) entrepreneurial city – 48 per cent, (2) innovative city – 20 per cent, (3) people friendly city – 17 per cent, (4) networked city – 13 per cent.

According to the smart city approach, it is assumed that urban development is analyzed in line with the previously listed six characteristics. All six areas have their justification for urban development in traditional and neoclassical urban growth and development theories, including: competitiveness theory, transport and ICT economics, human and social capital, quality of life theories. Each determinant's impact on urban development can be also verified by correlation analysis with urban wealth, measured by GDP per head. Table 1 presents correlation and p-value results for chosen measurements from each of the six areas with GDP per head PPS. Calculation concerns over 40 European cities, which also serve as sample for the whole analysis presented in this paper.

	Numer of enterprises	Population age median	Administration found helpful (in inhabitants' opinion)	Air pollution is a big problem (in inhabitants' opinion)	City is a safe place to live (in inhabitants opinion)	Multi-modal accessibilty of the city
Correlation	0,435173	-0,20992	0,306024	0,003477	0,356538	0,690771949

Table 1: Chosen indices correlation with GDP per head in urban areas in the European Union. Source: own elaboration based on Eurostat data.

Calculating correlation of chosen smart city measurements with GDP per capita (regarded as a synthetic index for wealth in the urban area) proves that it is the multimodal accessibility that has the strongest relation to urban development. Such result supports the importance of hard infrastructure for cities. Nonetheless, other indices included in the calculation, except for city's inhabitants opinion on air pollution, were also to lesser or greater extend correlated with growth in urban areas which supports the choice of the six characteristic areas for further research of smart cities and choice measurements of measurements in these six areas as proxies for smart city development.

Similar indices for city smartness evaluation were used in A. Caragliu, Ch. Del Bo and P. Nijkamp's research (A. Caragliu, Ch. Del Bo, P. Nijkamp 2011). Their evaluation was based on the correlation of six proxies: employment in entertainment industry, multimodal accessibility, length of public communication system, e-administration (no. of forms accessible on-line) and proportion of population with 3-4 ISCED level education with GDP PPS per head. Analysis presented in their paper, despite moderate levels of correlation between indices allowed for conclusion that the most significant determinants of smart city's development are: existence of the creative class (in line with R. Florida's theories) and multimodal accessibility (in line with New Economic Geography's assumptions).

According to OECD's „Better Understanding our Cities" (1997, p. 23), criteria chosen for a analysis should: be significant for policy-making and application value; have good degree of analytical soundness and be quantifiable. Ever since the report was published, i.e. for over two decades, the state of urban research has changes significantly. The statement that: „it is still not common to study economic processes and products at the scale of cities" (OECD 1997, p. 11) is inadequate, however urban economics may not be considered leading concern of economists. Still, some challenges and recommendations presented by OECD remain current, e.g. still quantitative research in urban studies are rather fragmented and concern chosen spheres of economy (innovation or energy market), they are also territorially limited (regard few Western European cities or are a case study). Moreover, still quantitative analysis is biased by heterogeneity of statistical systems for local level. Therefore, OECD proposed best practices separately for different spheres of urban economy: natural environment protection, energy, economics, sustainable development. Unfortunately, suggested by OECD "mission information" i.e. the need for data collection in urban areas in international dimension, is still valid. Lack of comparative (including international comparisons) and updated data is one of the challenges urban researchers and researchers have to overcome (Goldstein and Sly 1974, Short et al. 1996, Taylor 1999, Florida 2008, Taylor et al. 2011).

Presented in this paper analysis is based on secondary data from Eurostat's Urban Audit which collects data from over 300 EU cities every three years. Collected data concern mostly social and economic development based on over 300 proxies. The database is however updated with considerable delay, and accessibility of data is dependent on local governments or municipality's input, therefore some data is non-available or outdated. Despite this bias, Urban Audit's data allows for international quite detailed comparisons in the territory of the European Union.

Smart city index presented in this paper was elaborated with the goal of simplification of this notion, its quantification and creating a tool for communication in this policy area. Index can be used for international comparisons and ratings and enables drawing conclusions and recommendations for urban development. As every index or model however, it is just a simplification of reality and particular case-studies (cities) require more thorough analysis for a more precise identification of their urban growth pattern.

Proxies for the smart city index elaboration were chosen for the sample of 45 European cities, which may be considered a representative group given their geographic location, size and stage of social and economic development. Proxies represent all six smart city characteristics presented in this paper.

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Economy	GDP PPS per capita (EUR) Number of entreprises / 1000 inhabitants Activity rate (%) Unemployment rate (%)
People / Human capital	Median population age Employment rate (%) Number of students (5-6 ISEAD level) / 1000 inhabitants
Governance	Administration found helpful by citizens (0-100 index) Resources are used efficiently in citizens opinion (0-100 index) Inhabitants satisfied with public spaces (0-100 index)
Mobility	Multimodal accessibility (UE-27=100) Number of registered cars / 1000 inhabitants Inhabitants satisfied with public transport system (0-100 index)
Environment	Population density (people/km2) Number of days in a year when ozone concentration exceeds 120 µg/m³ Air pollution is a big problem in inhabitants opinion (0-100 index)
Quality of life	Number of households living in social housing / 1000 inhabitants City is a safe place to live in citizens opinion (0-100 index) Easy to find affordable housing (0 – 100 index)

Table 2: Proxies for the smart city index. Source: own elaboration

Presented in the paper smart city index is not the first attempt of this concept's quantification. Lazaroiu and Roscia's (2012) elaborated a model which may serve as a tool for smart city rating based on 18 proxies. Their model however is based on a more narrow understanding of city smartness (quality of life and human capital issues were not included and model was calculated based on proxies concerning economy, energy, environment, mobility and administration). Moreover, the model was tested on a group of six Italian cities and its application value may be limited by the requirement of consultation with experts in each analyzed area. According to authors' conclusions (G.C. Lazariou, M. Roscia 2012, p. 332): „The example reported in this paper is on a hypothetical smart city and the evaluation of weights, criteria and indicator have not been carried out by experts of the specific fields. In case of a real city, the establishment of correct values requires the experts contribution in the various chosen fields."

Aggregated index presented here provided a tool for comparative studies, rankings elaboration and observation of progress in urban development without broad consultations with experts and policy-makers in every particular area.

Presented index is based on six sub-indices corresponding to six smart city characteristics (economy, people, mobility, governance, environment, quality of life). Proxies for the calculation are presented in tab. 3 together with weight given to each sub-index and proxy. So far, in this first version of the index, each sub-index is given the same weight (1/6) and weights for proxies divided equally within each sub-index. It may turn out necessary, however, that in course of research and consultations, those weights will be altered. The model elaborated for smart city index gives such possibility and it may be used, if further research will justify it.

Value of each proxy was given evaluation on a 1 – 5 scale based on quintiles of order systematization of cities. Therefore, 20 per cent of cities best performing in a sphere estimated by a proxy were evaluated with a 5, while 20 per cent of worst cities was granted a 1. Such parameterization of measurements allowed for full comparability of development of urban areas. Weighted average of points granted for each proxy within sub-index to a city gave value of a sub-index (yet, since proxies are given the same weights it is in fact an arithmetic average).

Aggregated smart city index is a weighted average of sub-indices values. In the presented version of the index each of sub-indices has however the same weight, hence average value is actually equal to arithmetic average.

Alternative approach may be to order cities according to the value of a particular proxy followed by granting them „grades" according to their relative position. In such model, for the sample of 45 cities, a city with third

highest value in GDP per capita would be granted 0.93 points. Sum of such grades would then give a synthetic position. This method however limits analysis to the sample group without the possibility of enlarging it with other cities or entities.

Sub-index	Proxy	Weight in sub-index	Weight of the sub-index
Economy	GDP PPS per capita (EUR) Number of entreprises / 1000 inhabitants Activity rate (%) Unemployment rate (%)	25% 25% 25% 25%	1/6
People / Human capital	Median population age Employment rate (%) Number of students (5-6 ISEAD level) / 1000 inhabitants	33% 33% 33%	1/6
Governance	Administration found helpful by citizens (0-100 index) Resources are used efficiently in citizens opinion (0-100 index) Inhabitants satisfied with public spaces (0-100 index)	33% 33% 33%	1/6
Mobility	Multimodal accessibility (UE-27=100) Number of registered cars / 1000 inhabitants Inhabitants satisfied with public transport system (0-100 index)	33% 33% 33%	1/6
Environment	Population density (people/km2) Number of days in a year when ozone concentration exceeds 120 µg/m³ Air pollution is a big problem in inhabitants opinion (0-100 index)	33% 33% 33%	1/6
Quality of life	Number of households living in social housing / 1000 inhabitants City is a safe place to live in citizens opinion (0-100 index) Easy to find affordable housing (0 – 100 index)	33% 33% 33%	1/6

Table 3: Proxies for smart city development and their weights in smart city index.

Other alternation to the method (also considered) is also ranking according to average intervals (instead of percentiles). This operation, given homogeneity of European cities, proved to be inadequate. Since normalization does not regard the distribution of values, in case of extreme values or concentration of values in a small range (as in the case of European cites), normalization brings values in a very tight scale. Normalization (i.e. use of average for proxies) can therefore cause over-representation of proxies in chosen ranges. Overall, use of average values was in this model inadequate and percentile order was used instead.

Values of measurements in presented analysis were ordered in ascending order, i.e. the higher the value the better the grade. Following proxies, due to the fact that lower values are desired in urban development, were ordered in descending order: unemployment rate, median population age, dependency ratio, population density and air pollution as a big problem.

5 FINDINGS

Values of smart city index for the analyzed sample are presented in tab. 4. Finally, out of the group of 45 cities, full data set was obtained for 27 cities but sub-indices values for particular sub-indices have been calculated for larger groups of urban areas.

City	SMART INDEX	Smart Economy	Smart People	Smart Management	Smart Mobility	Smart Environment	Smart Quality of life
Bordeaux	3,97	2,50	4,33	5,00	4,33	3,67	4,00
Groningen	3,96	3,75	3,33	5,00	3,00	3,67	5,00
Rotterdam	3,61	3,00	3,00	4,67	4,00	2,67	4,33
Lille	3,49	2,25	4,00	5,00	3,67	2,67	3,33
Bologna	3,47	4,50	3,67	3,67	4,00	3,33	1,67

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Hamburg	3,40	3,75	2,00	3,33	4,00	3,67	3,67
Praha	3,35	4,75	2,33	3,00	4,33	3,67	2,00
Kraków	3,33	3,00	3,67	4,33	3,67	2,33	3,00
Bialystok	3,28	2,00	3,33	4,00	2,67	3,67	4,00
Amsterdam	3,26	4,25	2,67	3,33	3,33	2,33	3,67
Warszawa	3,21	4,25	3,00	2,33	3,67	3,00	3,00
Paris	3,18	3,75	3,67	3,33	3,33	2,00	3,00
Manchester	3,15	2,25	3,33	4,33	2,33	2,33	4,33
Leipzig	3,06	2,00	2,33	3,00	3,33	4,00	3,67
Ljubljana	3,06	4,00	1,33	3,33	3,00	4,33	2,33
Liège	2,92	1,50	2,67	3,00	3,67	3,67	3,00
London (greater city)	2,89	3,00	3,00	3,67	3,00	2,00	2,67
Brussel	2,85	2,75	3,67	2,67	3,67	2,33	2,00
Bratislava	2,81	3,50	3,00	2,00	2,00	4,67	1,67
Berlin	2,64	2,50	1,67	1,67	2,67	3,33	4,00
Kosice	2,64	1,50	3,00	3,67	1,00	4,67	2,00
Vilnius	2,58	2,50	3,67	1,33	2,67	3,00	2,33
Madrid	2,56	2,00	2,33	2,67	3,33	2,33	2,67
Tallinn	2,56	3,00	3,33	2,00	1,67	2,67	2,67
Barcelona	2,51	2,75	2,67	2,00	3,33	1,67	2,67
Riga	2,38	2,25	3,33	1,00	2,00	2,67	3,00
Sofia	2,29	2,75	2,33	1,00	2,67	3,00	2,00

Table 4: Values of smart city index and sub-indices for chosen European cites. Source: own calculation

Out of the analyze sample group, the best performing cities in the smart city development seem to be medium-sized cities, which rather do not play a dominant role in their countries economy and rather serve as regional centres. Highest value for large cities, large and significant enough to be included in global cities network, achieved Paris. Surprising may also be the position of Barcelona – city dedicated to the idea of smart city and location of numerous smart city initiatives (Bakici et al. 2013). Eastern European cities rank rather low in smart city index but worth noticing is the fact that their position is not lowered due to the indices in the smart economy index but rather quality of life and urban governance factors.

6 FURTHER LINES OF RESEARCH

Smart city index presented in this paper is its first version and requires further research, alternationas and improvements. Potential areas of areas for improvements include mentioned differentiations of weight or enlargement the group of chosen proxies. Changes in weighing system may be introduce with the use of fuzzy-logic method (Lazaroiu, Roscia 2012), building on experts’ consultations. This line of changes to the model may also give grounds to building recommendations and policy-making based on the index as change in weight of particular proxy or sub-index may show a potential gain achieved by new urban development activity.

Other line of improvements may include alternations in the range of points granted to cities for their values. So far, calculations were based on 1 – 5 scale, however may be proper to limit the range if extreme values for a chosen proxy are not observed. Then, a range of 2-5 or 1-3 may prove more informative (e.g. when analyzed group of cities rank relatively low in a particular issue globally). This change however requires experts’ evaluation and decision.

7 CASE STUDY OF ŁÓDŹ (LODZ)

Lodz is an average-sized city located in central Poland. The choice of this particular case-study is based on an industrial history of the city, as well as its development after economic transformation in Poland. Historically, development of city of Lodz has been strongly related to the textile industry and stated in the industrial revolution period, when industrialization was inevitably followed by urbanization. Typically for urban growth in that era, Lodz grew around large textile production sites, with urban plans being elaborated and implemented by and for large industry owners. Also typically for the Enlightenment philosophical thought, some ideas concerning social development were introduced – with dwellings, schools and hospitals built for industrial workers. Post World War II, Lodz continued path of development relying on hard industries, mostly textiles. With centrally planned economy, city's industrial production grew, yet this growth did not turn into development, especially when it comes to negative agglomeration externalities. These tendencies came especially vivid after the economic transformation and introduction of free-market economy in Poland, leaving Lodz with social challenges non-existent middle class, brain drain towards Warsaw, high rates of crime, low rated of education attainment and employment. Yet, Lodz still remained an attractive location for industrial production, due to the infrastructure heritage, large pools of labor force and central (both Polish and European) location.

Post-transformation development of the whole region of Eastern Europe is characterized with deindustrialization forces, necessary to adjust economies to the free-market service-oriented globalized world. These tendencies did not by-passed Lodz and meant close down of many inner-city plants and large losses of manual jobs, followed by wide range of social problems (crime, unemployment, premature mortality, neighborhood abandonment to name just few). Pattern of deindustrialization, analyzed in urban development literature (Turok and Edge, 1999), has been followed with difficulties to replace lost opportunities or retain work force. Literature of the subject brings different explanations of the process of deindustrialization. In some papers, lower skills intensive production is being moved outside of cities while urban areas remain locations higher level functions (Massey, 1984). Cities are then centers of strategic control, and smaller regional centers lose their significance in economic development. There is also theories bringing similar patterns to the international level, with Sassen's global cities network, as the main example (Sassen, 1994). The same division of labor is here described in international perspective, with offshore, emerging economies acting as regional centers. The network analysis of urbanization is followed by works of Castells who puts emphasis largely on technological advances in economic growth and emergence of informational phase of economic development. In these theories, "economic relationship within cities have become less important than the position of cities within wider international network" (Turok, 2005, p. 39).

Is seems like development of Lodz post-transformation first followed the pattern analyzed in Massey's work. Large pools of low- and medium-qualified labor force made the city attractive location for production of lower ranges of value-added chains. Analyzing the city development in industrial clusters terms, Lodz may have followed the model of product cycle (Vernon 1960, 1966), according to which firms separate stages in life cycle of their products spatially. For example, information- and qualification-intensive activities will be located in urban location which give access to highly skilled work force, as well as allow for face-to-face contacts necessary for information creation and circulation. However, with the further stages of product's life cycle, once the product has been designed, tested and developed, the firm will no longer need sources of non-standardized innovative production. Once the information about the product is standardized and available, the production technique become not only easier to implement but also does not require highly skilled labor. The location of production can be then moved to lower-cost (and lower-skills) areas.

Therefore, city and its region became location of various household equipment production sites, as well as business support centers (mostly call-centers, accounting and computing). As expected, this process did not bring any advances of economic development of the city, nor did it solve growing social problems. A new development strategy of Lodz tried to face these challenges and lead the city to new pattern of growth, which seems particularly interesting.

The strategy ("Integrated Development Strategy for Lodz 2020+") envisages three sources of competitive advantage for the area, namely: industrialization, innovation and creative sectors. Building on the industrial history of the city and its legacy (infrastructure, labor ethos), the city's policy-makers are trying to introduce activities from higher level of value-added chain, more technologically advanced. So far, Lodz has succeeded in attracting R&D centers, which may prevent further loss of qualified labor to Warsaw. The

city’s industry is still mainly concentrated in textiles (using the still existing infrastructure), yet leaning towards technological advancements (e.g. production of innovative fabrics). On the other hand, great emphasis is put on creating conditions for growth of the creative sectors, based also on factors endowment as the city is home to various artistic schools and universities (film, fine arts, music). In this respect, the city is strongly supporting creative cluster creation, mostly by satisfying demand for locations of artistic activities through means of revitalization. The actions resulted in emergence of two large creative clusters in the city, bringing together large number of small firms of artistic character (Off-Piotrkowska and Księży Mlyn).

The development strategy of Lodz, even though not related per se to the concept of smart city, may be analyzed as such. It stresses a multidisciplinary development of city (with industry as important as art) while not neglecting the hard infrastructural size of urban development. The three priorities of the development strategy are as follows: (1) economy and infrastructure, (2) society and culture, and (3) space and environment. With an overarching goals of efficiency and citizen-friendliness, they all together constitute all fundaments of the smart city concept of urban development, therefore Lodz may be analyzed in these terms.

Main strengths of the city, according to its decision-makers, include (The City of Lodz Office, 2012, p. 20):

- central position in Poland, Europe and in the agglomeration with a population of over a million;
- infrastructural investments carried out in Lodz and the agglomeration, including those in transport with network of national highways and fast trains to/from Warsaw;
- diverse, substantial investment areas that are available in the city;
- competitive costs of carrying out business activities;
- numerous higher education institutions, both public and private, as well as research institutes generating efficient and experienced staff;
- post-industrial heritage – tradition, identity, unique architecture and urban arrangement;
- experience in regeneration of post-industrial structures for education, trade and entertainment purposes;

In the light of strategic documents, survey data and information from the entrepreneurship sector, location of economic activity in Lodz is still mostly chosen for the characteristics of its labor force. As characteristic as it is for the emerging economies, it still bears all weaknesses and risks of low-cost locations. Lodz is not going to turn into an agglomeration include in the international network of cities, nor will it benefit from the new ‘informational’ phase of capitalism by becoming one of the nodes of international network of information processing and control. Yet, Lodz may still benefit from international labor and capital division, as well as may serve as regional cluster of small firms capable of delivering Saxenian’s ‘milieux’ for innovation. Analysis of the city’s development also proves that it is becoming even so often a pool of qualified, yet still cost-competitive, labor – over the last decade number of companies in creative and innovative sectors is increasing. Worth mentioning is also a fact that innovation in Lodz is to some extend driven by revival of textile industry, yet in its current, technology intensive stage. Building on infrastructure, know-how and tradition of the industry in the region, investors are starting to produce and research textile products in Lodz and, moreover, many of the investors are small and medium sized companies.

Attachment of the city of Lodz to the smart city initiatives is also supported by its bid in IBM’s “Smarter Cities Challenge”, which Lodz finally won (together with other 30 cities around the world). Under this program, Lodz will be consulted by IBM’s leading experts as far Was development challenges are concerned. The whole project is valued at 50 million USD and included three-weeks-consultation period, analysis of city’s growth, interviews with city’s policy makers, academia and business representatives, concluded with recommendations. So far, IBM experts are analysis the area of social transfers in the urban area, which may seem unorthodox for an urban development primary research but as the project is still undergoing, it is hard to evaluate its outcomes yet.

The issue of smart city growth in the context of various stages of economic development (i.e. in developed or low-income countries) has not been widely elaborated upon in literature, neither conceptual nor empirical. This approach is slightly touched upon in Neirotti et al. (2014), as structural factors, with economic development, constitute one of the groups of explanatory variables in their regression analysis.

It seems however, that the concept of smart city may be treated as a universal model for urban development given a wide definition is assumed. If we assume smart city a new paradigm of urban development, and include areas concerning social and human capital, mobility, governance, sustainability, the concept seems appropriate for both developed and emerging economies. Understanding of smart city to just city "intelligence" and its endowment with ICT distorts the picture as it favors both technology and population capable and willing of its use. Cities equipped with ICT are not necessary better cities or more livable cities or even cities more attractive for investors.

Studies and rankings show that the smart city initiatives are elaborated and implemented in cities throughout the world, yet priorities are chosen depending on city or region's needs. Empirical analysis of those initiatives (Neirotti et al. 2014) proves that the level of economic development (with GDP per capita as proxy) is not as important to implementation of smart city initiatives at all, as it is to the type of actions chosen. The study proves, contrary to conventional knowledge, that cities in developed countries tend to concentrate more on 'hard domain' (energy, natural resources, transport, built environment, healthcare and public security) whereas low-income cities are active in projects aimed at innovation capabilities and human capital.

The index elaborated in the presented study also shows that cities from various economies score similarly in the ranking. This analysis is, however biased by the fact that it is geographically limited to EU member countries, therefore the representation of low-income economies is inadequate to global comparative studies.

The case study, its potential and development in terms of smart city concept will be analyzed using the previously elaborated index. Data for the following calculations come from three sources: Urban Audit data base of Eurostat, Bank of Local Data of Polish National Statistical Office and quality of life and quality of public institutions service survey, carried on for the Lodz's Municipality in 2012.

Fig. 1 shows results in the previously prepared index for Lodz. As Lodz was not include in Eurostat's survey on quality of life in European cities, other proxies had to be used in this particular case. Number of households living in social housing, for the lack of data, was substituted with declarations on the use of any social assistance by city's inhabitants (based on the Municipality's own survey,). Efficiency of resources use, since not accessed by neither the Municipality nor Eurostat, was estimated based on Standard&Poor's rating. Other proxies remained unchanged compared with the original smart city index and the values come from either Urban Audit or Municipality's survey on quality of life in the city.

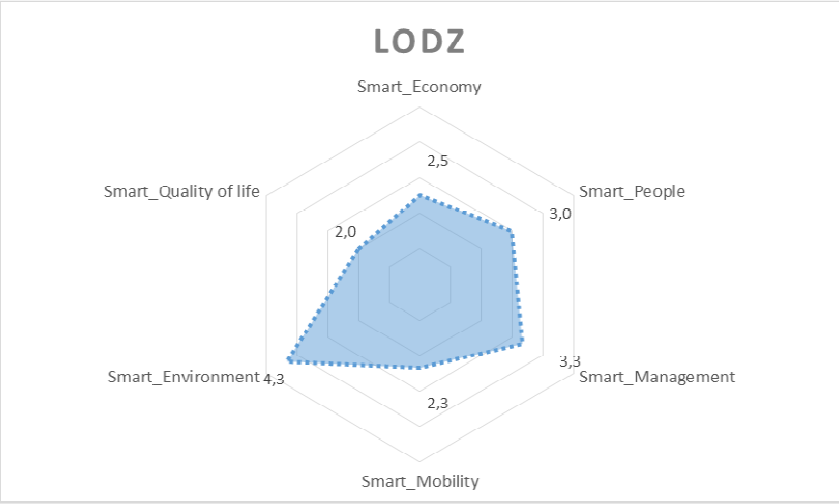

Fig. 2: Smart city index an sub-indices in Lodz. Source: own calculations based on Urban Audit and Lodz Municipality survey data.

The overall point value for Lodz in smart city index comes to 2.90 which ranks the city in the middle of the sample used for the evaluation. It is also a value that is similar to other Eastern European cities. Interestingly however, Lodz ranks relatively well in areas of environment and management, where other Eastern European cities had lower values. In case of Lodz, overall value of smart city index is lowered by quality of life and mobility sub-indices. The mobility issue may be covered in the near future by the extension of high-way and rail-track network around in within Lodz. Furthermore, Lodz has just lounged a large investment in inter-city train system. Overall accessibility of Lodz and mobility infrastructure within the city should increase in the near future and comparing the smart city index throughout next few years might bring interesting results.

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Other area of policy focus should concentrate on social development. High numbers of households living in social housing are to some extend an aftermath of industrial history of the city and its social consequences – unemployment, social exclusion, problems with adjustment to free-market reality.

The fact that Lodz is not following the pattern of smart city development typical for other Eastern European countries may support the hypothesis that smart city is a concept for multi-dimensional urban development suitable for both developed and emerging economies. This particular case study proves that smart city strategy is more dependent on actions and initiatives taken within this particular urban area or region than overall macroeconomic situation of national economy. The fact that analyzed concept covers six characteristics gives possibility to make up deficits in one area by excellent results in others.

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