5 System of indicators for measuring performance development of cities

Nothing focuses the mind better than the constant sight of a competitor who wants to wipe you off the map. (Wayne Calloway)

Recommended additional reading:

- Annoni, P., & Dijkstra, L. (2013). *EU Regional Competitiveness Index 2013*. JRC Policy and scientific reports. Retrieved from Portal European Commission. https://ec.europa.eu/jrc/sites/default/files/lbna26060enn.pdf
- Archibugi, F. (2000). *City Effect and Urban Overloas as Program Indicators of the Regional Policy.* The 40th Congress of European Regional Science Association. Barcelona: University of Barcelona. Retrieved from http://www.francoarchibugi.it/pdf/2000_barcelona%5Be%5D.pdf.
- Belton, V., & Stewart, T.J. (2002). *Multiple Criteria Decision Analysis: An Integrated Approach.* Boston: Kluwer Academic Publishers.

5.1 Chapter Overview

Recognizing that cities are becoming generators of economic development and a source of growth for the national economy, there is an increasing urge to identify the stages of development and positioning of cities upon which the adequate preparation of strategic and development guidelines is dependent. Comparison upon the level of their development efficiency calls for indicators, which measure the performance of cities, are representative and comparable between countries. In the case of medium-sized cities we consequently have to question the applicability of the methodology and indicators used mostly in cases of large, global cities by internationally recognized institutions. With the established set of qualitative indicators and assistance of computer program for multi-parameter decision-making processes (DEXi) this chapter also seeks to compare the performance development of selected European cities.

Learning outcomes

By the end of this chapter successful students will be able to:

1. Understand the theoretical background and applied practice for measuring performance of cities
2. Understand selection criteria for cities and indicators
3. Understand the multi-attribute decision – making
4. Interpret results of comparison.

5.2 Introduction

Existing methodologies of comparison in the field of city performance and quality of urban city structure affect more or less a wider field of urban and regional disparities, wherein specific approaches cover only limited areas. Hence, Nijkamp (1986, p. 1–21) focuses exclusively on infrastructure impacts, Callois and Aubert (2007, p. 809–821), however, empirically analyze the impact of social capital on regional development. An overview of sustainable development indicators give Singh et al. (2009, p. 189–212) as well as Slottje (1991, p. 684–693), Somarriba and Pena (2009, p. 115–133), but the interpretation of the quality of life indicators is missing. In the field of competitiveness Winter (2010, p. 52–53) presents synopsis of indicators measuring urban competitiveness on a European scale, while Parris and Kates (2003, p. 559–586) indicate the multilayered nature of sustainable development and consequently incompleteness of a measuring indicator's clear definition. Missing thematic indicators can also be found in the context of measuring regional disparities at the broader level of the European countries (Tausch et al. 2007; Oliveira Soares et al. 2003, p. 121–135). Comparing cities by the use of indicators, representing diverse aspects of urban life, is only possible with the meaningful formation of structured system; simply adding many of indicators to obtain a single index may result in criticism of uncertainty. Similar effects can also be reached by using a larger set of non-aggregated indicators; therefore identification of appropriate, small number of relevant indicators is crucial. In the process of system formation, inclusion of indicators with higher impact on the general differences between selected cities in different countries is necessary, at an additional assumption of environmental, human and social capital as well as the demographic point of view's integration.

In this paper we want to present the concept of measuring the urban development, based on different theoretical background and applied practices, through which the most appropriate, tailored concept (European Common Indicators or ECI) is introduced as the baseline for the study, considering the specific criteria, followed by selection of the qualitative, descriptive performance development indicators. Based on the structure and categorization of gathered data (by survey, taken in 5 EU cities), the applied DEXi method is introduced as the option in the multi-criteria decision making process (city management). The method's case applicability is further discussed by the results and their interpretation.

5.3 Theoretical background and applied practice

In accordance with the Charter on European Sustainable Cities and Towns Voula (1996, p. 133–154) lists six key areas of sustainable development and urban transformation: the active city/town, beautiful town, green city/town, town with a better environment, cooperation for a better city, and the town catalogue. The strategy of urban sustainability consequently includes urban performance indicators such as: 1) local involvement (citizen's participation), 2) employment, 3) city deficit, 4) economic growth, 5) urban mobility, 6) urban metabolism, resources, consumption, 7) environment and social expenditure, 8) urban safety, 9) public health, 10) social justice, and 11) global change.

Indicators of sustainable development show the complex and dynamic structure of the urban surroundings. After adoption of Agenda 21 (1992) this type of indicators developed many institutions (e.g. United Nations – Urban Indicators Program, World Health Organization (2009)) as the analytical tools for studying the quality of life in the urban environment. The wider set represent also SUD-LAB European Commission project's indicators with an extended database of European cities, where indicators are divided into the following categories: a) air quality, b) composed environment, c) cultural endowments, d) social disparities, e) transportation quality, f) urban administration, and g) waste management (Bănica 2010, p. 340).

Bănica (2010) defines the *index of local development* as an integrated indicator, including the importance of individual elements (weights), namely, category of infrastructure (4), followed by the economy (3), local community (2) and public administration (1):

$$I_{di} = \frac{4 I_i + 3 I_e + 2 I_{HL} + 1 I_{PA}}{10} \quad (1)$$

meaning:

I_{di} – *local development index,*

I_i – *infrastructure index:* utilities, transport and health infrastructure, natural resources,

I_e – *local economy index:* financial services and insurance, labour and public budget,

I_{mc} – *local community index* (community spirit): safety of citizens, tourist attractions, cultural / sports facilities, and cultural / historical heritage.

I_{ap} – *public administration index:* services and support to small and medium-sized enterprises, urban planning, communication and information dissemination.

5.4 Selection of cities

Methodology for the comparison of medium-sized cities includes selection of an appropriate sample, defined by*: location (*criterion 1: European cities), *inclusion in the databases* (criterion 2: city's inclusion in Urban Audit database), *definition in terms of a smart city* (criterion 3: city is placed in the Smart Cities base), *comparability in terms of the urban size* (criterion 4: population size: from 100,000 to 200,000 inhabitants) and *regional significance* (criterion 5: capital of the region or an important regional centre). The cities that have fulfilled the above stated criteria and were included in our research are Maribor (Slovenia), Pleven (Bulgaria), Linz (Austria), Erfurt (Germany), Trieste (Italy), and Brugge (Belgium).

5.5 Selection of indicators

The selection of qualitative indicators results from conceptual understanding of *urban sustainability* indicators, based on the ECI – European Common Indicators, first established in the period 1999–2003 under the guidance of the research institute Ambiente Italia. Among more than 1,000 indicators, reflecting trends in urban development in accordance with the principles of the social inclusion, local governance and democracy, local/global city integration, local economy, environment, cultural heritage, and quality of the institutional environment, in the context of ECI 10 key indicators, pointers of sustainable development of European cities were selected (Ambiente Italia 2003; Riga City Council 2005):

area 1: citizens' satisfaction with the local community – *indicator 1: average satisfaction with the local community,*

area 2: local contribution to global climate changes – *indicator 2: CO_2 emissions per capita,*

area 3: local mobility and transportation – *indicator 3: percentage of trips by private motorized transport,*

area 4: availability of local public open areas and services – *indicator 4: percentage of people, living within 300 meters of a public open area > 5000 m^2,*

area 5: quality of the local ambient air – *indicator 5: emissions of particulate matter (PM_{10}),*

area 6: children's journeys' to and from school – *indicator 6: percentage of children going to school by car,*

area 7: sustainable management through the local authorities and local enterprises – *indicator 7: percentage of environmental certificates with reference to the total of enterprises,*

area 8: pollution (noise) – *indicator 8: percentage of the population exposed at night to noise levels >55 dB,*

area 9: sustainable land use – *indicator 9: percentage of protected areas,*

area 10: products promoting sustainability – *indicator 10: percentage of population favouring "sustainable products".*

The quoted methodology that we found suitable for the study's baseline, was developed according to a bottom up approach, involving local authorities as the main actors in the process and improving synergies with the existing indicators set. This showed, on the one hand, to what extent the ethos (fundamental values peculiar to a specific person, people, culture, or movement) was actually based upon understanding the real needs of municipalities, and on the other, the possibilities of achievement of policy objectives for actions that shall bridge more than one level of governance. Indicators initiative was focused on monitoring urban sustainability at the local level, with the aim to help a local authority, interested in beginning to monitor the progress in the field of quality of its urban environment. Towns and cities can adapt the proposed set of 10 indicators to suit local circumstances. Respondents' distribution (from 14 EU countries) covered all classes of urban dimension (cities or aggregations of cities): 13 large (population > 350,000), 18 medium-sized (100,000 < population < 350,000) and 11 small (population < 100,000).

For countries and their cities (especially on a European scale, in transition countries and consequently, Slovenian cities) with a smaller population settlement, measurement concepts, formerly presented in the introductory part of this chapter may be partially or wholly inadequate. The selection of meaningful indicators, tailored to a specific city sample (e.g. medium-sized, European), situation and decision-making problem (city management), depends on the defined focused areas of city development. Selection of appropriate indicators in terms of narrow, specific measurement for future development's effectiveness from this perspective proves to be relevant.

The ECI concept was used in the study due to its successful implementation and effective city policy development's purpose. Based on its principles (the measurement method, definitions and scale values, which will be presented in sub-chapter 5.7, by introducing the specific areas from 1 to 5, qualitative performance indicators of urban development were selected in the study (Table 4).

Indicator	Scale value			
Perception of local community				
The overall level of satisfaction with the local community	very satisfied	moderately satisfied	unsatisfied	
Public transport	easy accessible	difficult to access	inaccessible	
Social and health services	Appropriate	acceptable	unacceptable	
Quality of the institutional environment	High	solid	unsatisfactory	
Education (number of educational facilities in your city)	1	1–5	more than 5	
Accommodation options and accessibility	high	medium	low	
Employment opportunities	frequent	occasional	rare	
Local mobility				
Systematic displacements (home – school and home – work)	private transport	public transport	non-motorized	
Number of daily trips (per capita), unsystematic	1–5	to 10	more than 10	
Access to basic services (bakeries, public transport, health facilities)	in the range of 300 m	in the range of 2 km	more than 2 km	
Accessibility to educational institutions (schoolchildren, students)	by foot, bicycle	public transport	private transport	
Enterprises				
Enterprises (sectoral)	mainly service sector	balanced industrial and service sector	mainly industrial sector	
Enterprises R&D	1–5	6–9	≥ 10	
SMEs and large enterprises	mainly SMEs	balanced SMEs and large enterprises	mainly large enterprises	
Environment				
Noise exposure	55–64 dB	65–74 dB	≥75 dB	
Environmental protection (opinion)	good	average	satisfactory	
Preference for eco-products	my preferen	high costs	occasionally available, diverse habits	I don't trust them
QOL				
Subjective perception of poverty (local environment)	high	moderate	low	
Subjective perception of safety (local environment)	completely safe environment	stable environment	lower safety	

Table 4: City performance indicators – qualitative; descriptive
Source: KWIK Surveys Questionnaire (2011).

5.6 Data structure and categorization

In the cities Maribor, Pleven, Linz, Erfurt, Trieste, and Brugge, a survey (By planning the survey, the recommendations of the sample survey approach were followed (see Tominc 2006, p. 10)), based on a questionnaire implementing method CAWI (Computer Assisted Web Interviewing employing application KWIK Surveys (SOZ 2011)) was carried out. The size of a representative sample was calculated by using standard deviation of the observed variable for statistical population, which can be determined from previous studies and on predicted confidence interval base (Bastič 2006). Standard deviation's (σ) value for the studied variable in the statistical population is 3.607, error probability is 0.5; value of the variable t at $t_{0,05}$ is 1.96.

Calculation of the sample size n was the following:

$\sqrt{}_n = 1.96*3.607/0,5$; $n = 199.92$, $n = 200$, respectively. Sampling was conducted according to the principle of non-random quota sampling, judgement sampling and partly also at random using a social network.

In $n = 200$, we obtained 184 correctly completed questionnaires, representing the sampling fraction:

$$p = (184/200 = 0.92);\ \text{SE (standard error of estimate)} = (\sqrt{0.92\ (1\text{-}0.92)\ /200})*100 = 1.9. \quad (2)$$

Considering the error probability, *z*-value (standard score *z* at the selected error probability) was calculated:

$$\alpha = 1\text{-}0.95 = 0.05;\ \alpha/2 = 0.025;\ z_{\alpha/2} = z_{0,975} = 1.96. \quad (3)$$

At the standard error of estimate SE (without correction factor) of 1.9 percent, lower confidence limit was determined:

$$8\% - 1.96*1.9\% = 2.4. \quad (4)$$

The questionnaire consisted of 20 closed questions, to which respondents (aged 20 to over 60 years, wherein this range didn't predefine the target group) replied with a choice between anticipated, mutually exclusive answers. In a single case dichotomous question (of two completely opposite directions type, i.e. male, female) had been used, a selection of multiple answers was not admissible. By using the Likert scale, respondents expressed their level of agreement/disagreement with a rank of viewpoints, semantic differential was not included.

Interpretation of the survey results

On the survey sample (n = 200) it was measured that at the indicator *the perception of poverty, 66.7* percent of respondents assigned most votes to the *alternative b) moderate*. If the results are induced to the population, in accordance to the sample size, we will be able to predict with 95 percent probability that between 60.1 and 73.3 percent of population believe in the existence of moderate perception of poverty. The aim of the survey does not represent a projection of the results to the entire population in particular cities, but a creation of the database for setting up a DEXi decision model (a "case study" of qualitative database's processing possibilities using artificial intelligence decision-making methods). In the qualitative research it is necessary to consider the limitations of subjectivity and perception; the results are yield of the respondents' answers (subjective, reflecting their self-image, which is not inevitably consistent with objective indicators), attention must be drawn also to the social desirability of responses (overvalued shares).

5.7 Multi-attribute decision – making using program DEXi

With an established system of descriptive city performance development indicators the study wants to enable qualitative decision-making in a systematic way by using a multi-attribute model in complex situations with a large number of factors and variables. By Grünig and Kühn (2005, p. 7), problem solving can be done in several ways: intuitively, routinely – by adopting formerly employed procedures or by random selection and systematic rational thinking, supported by relevant information. The general approach of the decision analysis originates from the axioms of the game theory by John von Neumann and Oskar Morgenstern (1953). Its main steps represent: problem structuring, estimating the likelihood of possible outcomes, determining their utility and evaluating alternatives as well as selecting strategies (Belton & Stewart 2002, p. 6; Čančer & Mulej 2005; Čančer 2007).

In this study, we conclude to use DEXi (Decision Expert) multi-attribute decision method, developed at the Jožef Stefan Institute (on the methodology DECKMAK or DECisionMAKing), which includes a result analysis of the evaluated variants (Bohanec & Rajkovič 1990, p. 145–157, Bohanec & Rajkovič 1995, p. 427–438, Špendl, Rajkovič & Bohanec 1996, p. 3). DEXi uses discrete and qualitative criteria, whose values are in general words, such as: good, excellent, unacceptable, unlike AHP – analytic hierarchy process as a numerical method, which for determining the importance of the criteria uses weights (e.g. the **Saaty Rating** Scale (1990)). Like AHP, the DEXi method is based on the decomposition of the decision problem to the hierarchical structure of criteria, where instead of words, intervals of numerical values can be used. The difference is noticeable also at the lower – level criteria aggregation functions into the final assessment, where the program instead of weights uses decision rules of "if-then" type. DEXi allows evaluation of variants also in the case of their incomplete and inaccurate information (Bohanec 2011).

In the first phase of the study, we identified the criteria, hierarchically reordered in a tree of attributes for building the decision model. Following this purpose, for each attribute (basic and aggregate) description and scale values were determined. Basic criteria represent the perception of the local community, local mobility, enterprises, environment, and QOL ("Quality of Life").

Area 1: Indicator: *satisfaction with the local community*. An important component of a sustainable society characterizes general welfare of its members or living in conditions, which include safe and affordable housing, the availability of basic services (schools, health, etc.), interesting and satisfying work, as well as opportunities to participate in local planning and decision-making. For this indicator there aren't any validated goals, only a general recognition that the welfare of citizens and their satisfaction with the local community are important elements of sustainability (European Commision 2002, p. 1–3).

Indicator *public transport (accessibility),* adopted from the models of sustainable urban development, is related to accessibility, availability of transport/transportation, social connectivity, access to motor vehicles and travel perceptions. Integrated accessibility is defined as the spatial distribution of potential destinations, as well as the quality and characteristics of the involved activities (Zahavi et al. 1981; Handy & Niemeier 1997). According to Wegener et al. (2000) accessibility is defined as a construct of two functions, one representing the activities and opportunities, respectively, and the other representing effort, time, distance or the costs of achieving them:

$$\$_L = \sum_M J(:_M). I(F_{LM}), \tag{5}$$

where A_i represents the accessibility of the area *i*, W_j activity *W* on the area *j* and c_{ij} the cost of reaching the area *j* from the area *i*. Functions $g(W_j)$ and $f(c_{ij})$ are defined as activity functions.

Among the indicators of area 1 the study also included: *social and health services*, *accommodation options and accessibility, as well as employment opportunities*. Their selection was based on the Eurobarometer Survey "Perception survey on quality of life in European cities 2009" (Eurobarometer 2009), which indicated significant variations in the level of satisfaction with health services between EU cities; 80 percent majority at the possibility "moderate" or "very satisfied" was noticed for residents of western European cities, while the level of satisfaction in many southern and eastern European cities was significantly lower (Eurobarometer 2009, p. 4). Considering the methodologies of Eurobarometer survey and the Urban Audit Perception Survey (Urban Audit 2004, p. 4–5) indicators *accommodation options and accessibility,* as well as *employment opportunities* were selected for our study. The results of the stated surveys show a pessimistic view on the labor market, with the expected inverse relationship between the availability of jobs and the availability of accommodation options.

Area 2: *local mobility* indicators include: 1) *systematic displacements* (home – school and home – work), 2) *the number of daily trips (per capita), unsystematic,* 3) *access to basic services* (bakeries, schools, public transport, health facilities), and 4) *the accessibility to educational institutions*. The set of indicators derives from theoretical principles of European Common Indicators (ECI), where the indicators of local mobility and transport include the percentage of trips by private motorized transport. Systematic trips (per capita) represent daily displacements to work/school and back, while unsystematic trips are made for other reasons, e.g. shopping, recreation and others. Model of citizens local mobility in the urban context is important in terms of quality of life (promoting alternative modes of transport; public transport, cycling). *Access to basic services* (bakeries, schools, public transport, health facilities) in sustainable community is vital for the quality of life and performance of the local economy.

The selection of the indicator is based on the headline indicator *availability of public open areas and services (see ECI).* Accessibility is defined as a percentage of people living within 300 meters of a public open area or other basic services and collective transport routes that, at least for part of a normal business day, have a minimum frequency (half-hourly service); public school (compulsory education); bakery, greengrocery, and primary public health services. European Environment Agency, Directorate-General for Regional Policy and ISTAT **(Istituto nazionale di statistica** – Italian National Bureau of Statistics) apply the concept "within 15 minutes by foot" for determining the accessibility. Absence of stores, selling fresh fruits and vegetables is an indicator of social exclusion and health risk (European Commission 2002, p. 15–18). Methodological principles of the indicator *accessibility to educational institutions* are also found in the context of ECI indicators, where the headline indicator of the area "children's journeys to and from school" represents the percentage of children going to school by car. The value of the attribute in the study refers to the modes of transport, used for children's journey to and from school (public and private transport), including also the possibility "walk, bike" (European Commission 2002, p. 25). A sustainable society is namely the one, which in terms of the traffic safety and crime seems safe enough to parents to allow the children street walking, cycling and using public transport.

Indicators of the area 3 (enterprises) are represented by: enterprises (sectoral), enterprises R&D, followed by SMEs (small and medium-sized enterprises) and large enterprises. The selection of indicators is based on the study "The Economic Map of Urban Europe" (Laakso & Kostiainen, 2007, p. 12–15), which in the context of the city's economic structure emphasizes the importance of service and manufacturing sector. The results of the study show specialization of the service sector (concentration of administrative functions), which in some capitals (e.g. Vienna) includes the dominant share of employment. In other capitals (e.g. Barcelona) markedly closer balance between service and manufacturing sector was noticed (Laakso & Kostiainen, 2007, p. 12). Production in the European Union on average employs 25 percent of the workforce, despite the de-industrialization plays an important role in the economy of many European urban regions. Industrialized European cities are seldom cities in economic decline, on the contrary, some of them are among the most dynamic and economically robust ones in Europe (Laakso & Kostiainen, 2007, p. 14). Considering the importance of both, the service and manufacturing sector, in the formation of decision rules for cities the equilibrium principle (balanced service sector and industry) is preferred in our study.

The selection of *indicators SMEs and large enterprises,* as well as *enterprises R&D* is argumented on the basis of the ECORYS (2012) research and the Eurostat database (2013). The results of the research show that despite the crisis in the euro area and the strained economic situation, small and medium-sized enterprises (SMEs) in the EU represent an important role in the Union's economy. According to the 2012 data, 20.7 million of SMEs contributed to 67 percent of total employment and 58 percent of total gross value added (ECORYS 2012). "Small Business Act – SBA" for Europe (newer version from 2011) recognizes the importance of the SMEs' role in the EU economy with the aim of striving to strengthen it in terms of reducing the administrative barriers, accessing new markets, ensuring free competition, promoting R&D, and supporting SMEs in regional and environmental context of the Europe 2020 key objectives – smart, sustainable and inclusive growth. Many SMEs are faced with so-called "non-recruitment growth" (or "jobless growth"), but the dynamic, despite the delicate economic environment, demonstrates increased enterprise (EU) activity in the "high-tech and knowledge-based industries and services". According to the EU-27 area's Eurostat data almost balanced contribution of micro and SMEs as well as large enterprises to the added value can be seen in average. Considering the above starting-points regarding the role of SMEs and large companies and their added value, the decision rules (*indicator SMEs and large companies*) in our study are related to their balanced distribution in the urban environment of medium-sized cities. The importance of high technology sector and knowledge based services leads to a preference for a higher number of R&D enterprises in selected urban areas.

Area 4 relates to the environment and includes indicators: 1) exposure to noise, 2) environmental protection (opinion) and 3) preference for eco products. Selection results from the set of European common indicators, which cover the area of noise pollution (European Commission 2002, p. 33–36; Ambiente Italia 2003, p. 113–114), where the headline indicator represents the percentage of the population exposed to noise Lnight (at night) > 55 dB(A) (Abbreviation for DeciBels Adjusted, dB(A) is the noise power, calculated in dB.). On the quoted basis the indicator of noise exposure with scale values of 55–64 dB, 65–74 dB and ≥ 75 dB (noise level), which do not relate to a specific time of day (e.g. by day, by night) was used in the study. A sustainable society should combine urban functions such as housing, work and mobility without exposing residents to excessive noise. Selection of the indicator environmental protection (opinion) refers to the Urban Audit Perception Survey (Urban Audit 2004, 5), which in the context of the local perception of quality of life measurement (QOL) in 31 European cities uses indicator of a "clean city". Interestingly, between cities, where most of the population believes that the city is clean, the majority of the population feels also completely safe. The baseline of the indicator preference for eco products represent the European common indicators (Ambiente Italia 2003, p. 127–128) in the field of sustainability promoting products (the headline indicator "percentage of people buying sustainable products", respectively). The indicator includes eco-labeled products, organic products, energy-efficient products, FLO fair trade products (Fairtrade Labelling Organizations), and eco products (e.g. Blauer Engel/Germany, the Nordic Swan/Scandinavian countries and the EU-Ecolabel /European Union).

Indicators of area 5 – QOL ("Quality of Life") are represented by: a) *subjective perception of poverty (the local environment)* and b) *subjective perception of safety (the local environment)*. Indicator subjective perception of poverty is based on the Eurostat database (2011) indicator "population at risk of poverty or exclusion; NUTS2". Selection of the indicator *subjective perception of safety* refers to the Urban Audit Perception Survey (Urban Audit 2004, p. 5) about the local perception of quality of life (QOL) in European cities.

The decision model consists of 22 attributes (Figure 10), hereof 16 basic and 6 aggregate. In the next phase of our study an adequate value, which in DEXi consists of words or numerical intervals (Jereb, Bohanec & Rajkovič 2003, p. 17), is assigned to each attribute. The rule "if-then" is used by DEXi in the table rows, which represent the utility function or decision rules. By setting the first (representing the worst options' combination) and the latest rule (best value) using Function Editor and by setting appropriate weights, the program automatically calculates other values, which, if found as unacceptable, can still be properly edited.

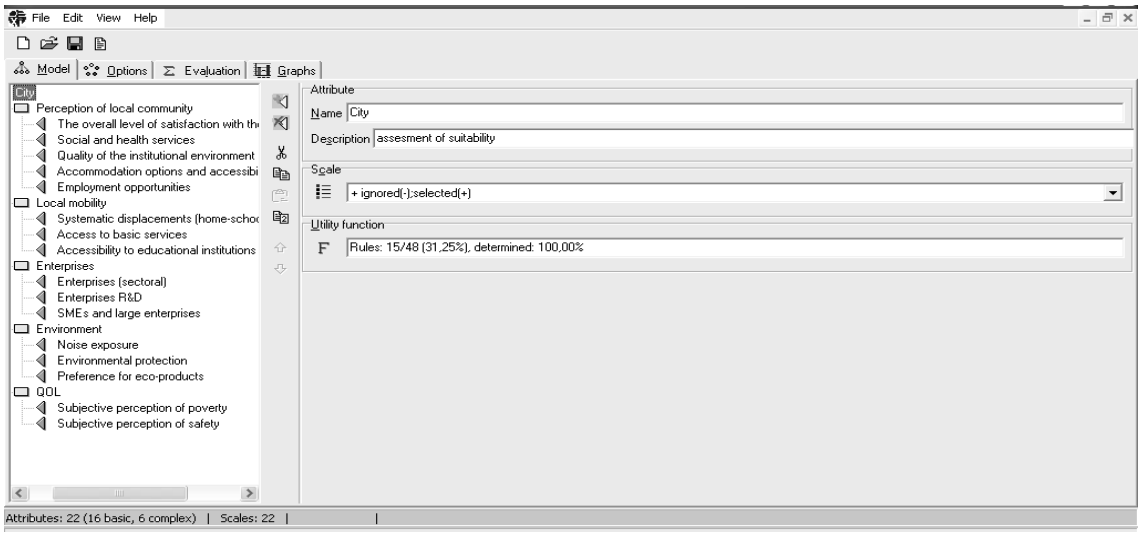

Figure 9: The model page of DEXi model window
Source: DEXi processing of collected data.

Interpretation of the decision rules for the attribute environment (Figure 11): in the case of noise exposure, greater than 75 dB, regardless of the scale value (represents any value) referring to the attributes environmental protection and preference for eco-products, the decision for the city selection is not taken. Decision rules are formed with reference to previously presented European Union environmental policy, wherein the headline indicator represents the percentage of the population exposed to night noise levels > 55 dB(A). Correspondingly still acceptable daily noise level up to 75 dB was considered in the study.

Decision rules	Noise exposure	Environmental protection	Preference for eco-products	Environment
	41%	36%	22%	
1	more than 75 dB	*	*	Ignored
2	<= 65-74 dB	satisfactorily	*	Ignored
3	<=65-74 dB	<=average	<=occasional available	Ignored
4	*	satisfactorily	<=high costs	Ignored
5	*	<=average	<=diverse habits	Ignored
6	*	*	<=I don't trust	Ignored
7	>=65-74 dB	>=average	>=high costs	***Selected***
8	>=65-74 dB	***Good***	>=diverse habits	***Selected***

Figure 10: Decision rules for attribute environment
Source: DEXi processing of collected data

Selection is confirmed in the case of the attribute scale value "65–74" (weight of 41 percent), environmental protection with a scale value "good" and preference for eco-products with a scale value "diverse habits". After entering attribute values (Figure 12) for *all options* (Maribor, Pleven, Linz, Erfurt, Trieste, Brugge), obtained by completed survey questionnaires (value selection is determined by the percentage majority), the study includes *evaluation of alternatives*. Option with the highest evaluation is generally the best, but the analysis based on the mutual comparison is essential because of reasonable, proven solutions given (Jereb, Bohanec & Rajkovič 2003, p. 14).

Option City	Maribor	Pleven	Linz	Erfurt	Trieste	Brugge
Perception of the local community			*selected*			
The overall level of satisfaction with the local community			*selected*			*Selected*
Social and health services			*very satisfied*	*very satisfied*		*very satisfied*
Quality of institutional environment			*appropriate*	*appropriate*	*appropriate*	*appropriate*
Accommodation options and accessibility			*high*			*High*
Employment opportunities						
Local mobility		*frequent*	*frequent*			*frequent*
Systematic displacements (home-school and home work)	*Selected*	*selected*	*selected*	*selected*		*selected*
Access to basic services	*private transport*		*private transport*	*private transport*	*private transport*	
Accessibility to educational institutions	*in the range of 300 m by foot, bicycle*	*in the range of 300 m by foot, bicycle*	*in the range of 300 m by foot, bicycle*	*by foot, bicycle*		*in the range of 300 m by foot, bicycle*
Enterprises		*selected*	*selected*	*selected*	*selected*	
Enterprises (sectoral)		*balanced industrial and service sector*	*balanced industrial and service sector*		*balanced industrial and service sector*	*balanced industrial and service sector*
Enterprises R&D			*more than 10*	*more than 10*		
SMEs and large enterprises		*balanced SMEs and large enterprises*	*balanced SMEs and large enterprises*		*balanced SMEs and large enterprises*	
Environment		*Selected*	*selected*	*selected*	*selected*	
Noise exposure		*55-64 dB*		*55-64 dB*		*55-64 dB*
Environmental protection			*good*	*Good*		
Preference for eco-products			*my preference*			
QOL						
Subjective perception of poverty						
Subjective perception of safety						

Figure 11: Options' evaluation results

Source: DEXi processing of collected data.

5.8 Results and their interpretation

Comparison of options (cities) Maribor (unselected) and Linz (selected) shows parallel values of both cities, namely: values according to weights and decision rules for Maribor illustrate moderate satisfaction with the local community, the acceptability of health services, solid quality of the institutional environment, predominantly services and SMEs, 65–74 dB of noise exposure, average environmental protection, distrust of eco-products, moderate subjective perception of poverty, and stable environment (median values, positioned neither in the critical nor in the selection interval).

Comparison of options

Attribute	Maribor	Linz
City	ignored	***selected***
Perception of local community	ignored	***selected***
The overall level of satisfaction with the local community	moderately satisfied	***very satisfied***
Social and health services	acceptable	***appropriate***
Quality of the institutional environment	solid	***high***
Accommodation options and accessibility	medium	
Employment opportunities	rare	***frequent***
Local mobility		***selected***
Systematic displacements (home - school and home - work)		***private transport***
Access to basic services		***in the range of 300 m***
Accessibility to educational institutions		***by foot, bicycle***
Enterprises	ignored	***selected***
Enterprises (sectoral)	mainly services	***balanced industrial and service sector***
Enterprises R&D	1-5	**≥10**
SMEs and large enterprises	mainly SMEs	***balanced SMEs and large enterprises***
Environment	ignored	***selected***
Noise exposure	65 –74 dB	
Environmental protection	average	***good***
Preference for eco-products	I don't trust them	***my preference***
QOL	ignored	
Subjective perception of poverty	moderate	low
Subjective perception af safety	stable environment	

Figure 12*:* Comparison of options Maribor-Linz
Source: DEXi processing of collected data.

Determinant values for city's non-selection include rare employment opportunities and the extremely small number (up to 5) of R&D enterprises (the importance of this weight amounts 47 percent), as non-selected also common combination of aggregate criteria values is characterized. Values, favorably affecting the choice, represent private transport within the systematic mobility (the latter is independent from the use of public transport), rapid access to basic services and the availability of educational institutions (proximity to schools). For the city of Linz all listed values express maximal selection influence (Figure 14).

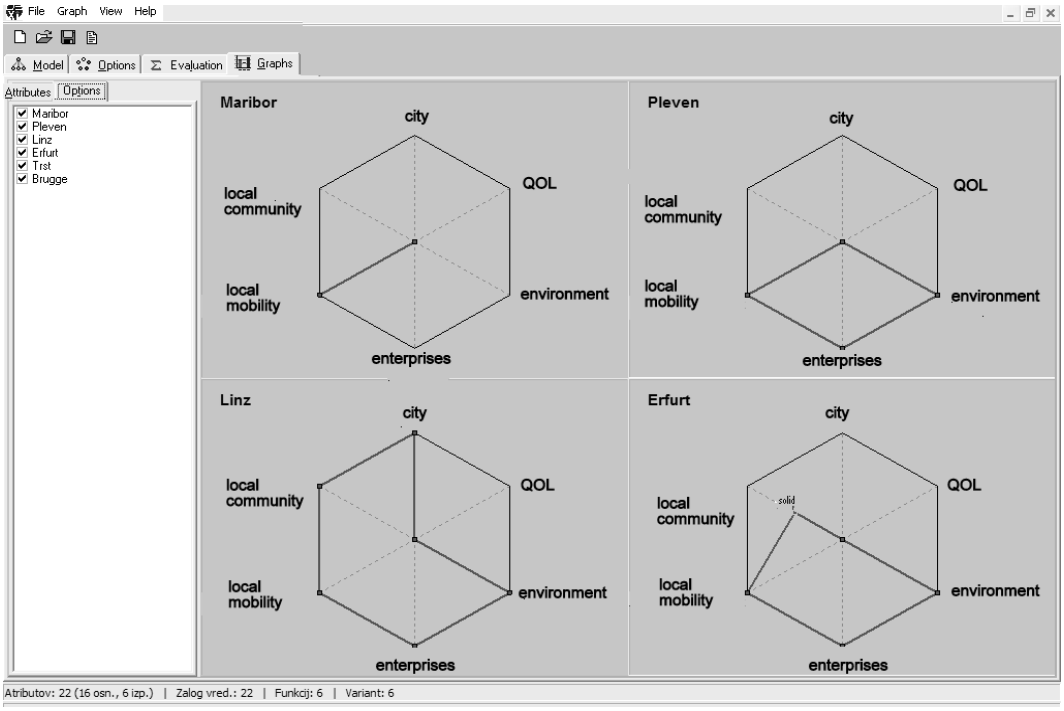

Figure 13*:* Radar chart (star plot) – comparison of options' (cities) attributes
Source: DEXi processing of collected data.

By the size of the star plot radarchart (Figure 14) and the pursuance of the weights, selection's decision criteria are met only by the city of Linz. Bottom option represents the city of Maribor with the best evaluation of the attribute local mobility. The evaluation results can be interpreted more clearly in a graphic form with a *star diagram*, taking into consideration the extent of the surface area (star) or criteria importance.

City of Erfurt is better than Pleven in the area of local community perception (solid), while the plot areas of Trieste and Brugge are identical (Figure 15), with the difference that Trieste is being better evaluated at the attributes enterprise and the environment and Brugge at the attributes local community perception and local mobility. Interesting is the area of QOL with the attributes subjective perception of poverty and safety under the assumption of strict selection's decision rules, namely; the option (city) is chosen only in the case of imperceptible poverty and stable environment or imperceptible poverty and completely safe environment (QOL expresses an important attribute of evaluation), whereby the decision rules of this attribute are not met by any city, included in our study.

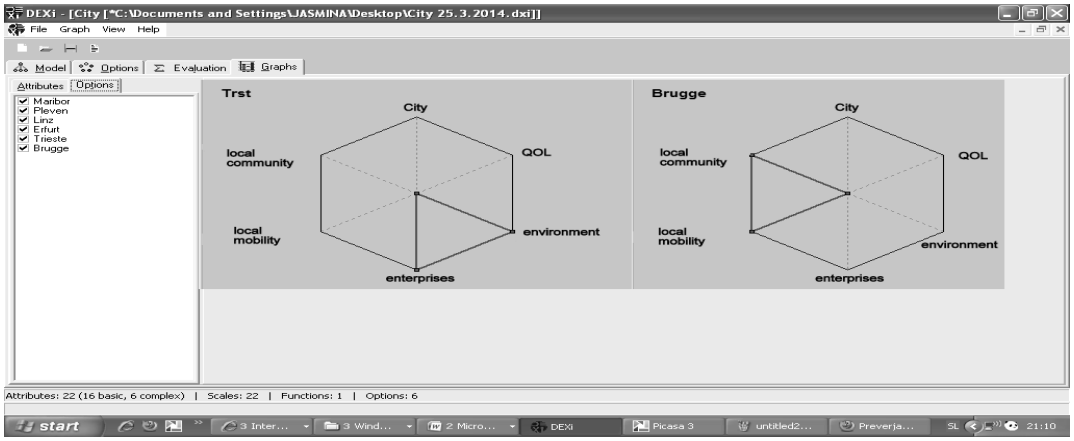

Figure 14*:* Radar chart (star plot) – comparison of options' (cities) attributes
Source: DEXi processing of collected data.

5.9 Conclusion

The purpose of our study is to compare the performance development of chosen European cities on the basis of the established set of qualitative indicators and the assistance of computer program for multiparameter decision-making processes, by using ECI methodology in national and international (European) comparable cities' sample, whose selection followed certain criteria. Determination of appropriate measurement indicators, closely related to the evaluation of well-known methodological concepts (ECI indicators, indicators of urban status and sustainability) and collected relevant databases (questionnaire, KWIK Survey) resulted in obtaining useful tool: an enlistment of selected descriptive indicators, reasonably divided into five areas and measurement categories, allowing selection of the most suitable option (city). By using multi-attribute decision-making and supporting software tool DEXi for qualitative data analysis, the decision model of the city selection consisted of 22 criteria, among them16 basic and 6 aggregate. Evaluation of options offered clarity in multi-criteria decision-making in accordance with the specified hierarchy and the importance of decision criteria (decision model, rules and option evaluation). Achieving the best possible decision often requires a trade-off between perfect modelling and usability of the model.

Meanwhile multi-criteria decision-making program DEXi allows verbal assessment (scale values: ignored, selected), it also offers a graphical user interface (the star diagrams – comparison of the options' attributes). It is reasonable to draw attention also to the trend of combining other methods. Namely, in addition to the use of DEXi, in the phase of decision making method's selection also programs as DEXiTree and Vredana can be employed. The latter uses mixed qualitative and quantitative evaluation, where to options beside qualitative also numerical assessment (numerical interval) is given, enabling them to differ even within a single qualitative value.

5.10 References

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