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Urban Green Space Policies: A Comparative Study on Performance and Success Conditions in European Cities

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Abstract

Urban green spaces play a key role in improving the liveability of our towns and cities. The quality and viability of cities depend largely on the design, management and maintenance of urban green as well as on open and public spaces that make up an important social constellation and offer a visual representation of urban quality. Actually, urban green spaces may be seen as an important contribution to a sustainable development of cities. However, the full potential of green spaces is not always realized, so that current management practices are sometimes sub-optimal. From a *policy perspective***,** the results of several case studies have highlighted critical policy needs and priorities for the development and management of urban green spaces. It is, therefore, of strategic importance to compare and evaluate urban green space policies for identifying the *best practices* with a view to proper policy recommendations and guidance for urban society and planning authorities in order to improve the quality of life in modern cities.

Against this background, the present study investigates urban green spaces from a policy evaluation perspective and analyses in a comparative sense European cities in order to obtain strategic and policy relevant information on the key features of urban green. The study aims to compare and evaluate the current management practices in various European cities on the basis of the actual performance of urban green space policies. The data and information used for comparison and evaluation are based on extensive survey questionnaires filled out by relevant departments or experts of municipalities in European cities which aim to share their experience in innovative green space policies and strategies. As a rather novel methodological contribution, a recently developed artificial intelligence method, i.e. rough set analysis, is deployed to assess and identify the most important factors that are responsible for successes and failures of urban green space policies. Our approach is able to reveal the most critical policy variables.

1. Introduction

The concept of sustainability has in recent years become an important paradigm in urban planning, in particular since a high proportion of the world's production, consumption and waste generation is concentrated in cities. Therefore, a general concern about quality of life and sustainability, with a particular focus on the city, has emerged on a world-wide scale. Our urbanized societies have increasingly become concerned with the built or man-made environment and with protecting or shaping nature in urban areas, and this has led to both specific man-made landscape patterns in the countryside and the creation of parks and gardens in urban areas (see e.g. MacHarg, 1971, Roelofs, 1999, Turner et al., 1999).

Urban green spaces are a nice example of positive environmental externalities and play a key role in improving the liveability of our towns and cities. The quality and viability of cities largely depend on the design, management and maintenance of urban green as well as on open and public spaces with a view to their social, ecological and visual functions. The quality of green spaces helps to enhance the identity of towns and cities, which can improve their attractiveness for living, working, investment and tourism. Therefore, urban green can positively contribute to the competitiveness of cities.

Despite the great benefits that urban green spaces provide, there is a serious lack of information about the quantity and quality of urban green spaces. From a *policy perspective,* the results of several case studies showed critical policy needs and priorities for the development and management of urban green spaces. Among these needs for planning and management of urban green spaces the following five factors can be mentioned in particular.

First, to improve the quality of urban green spaces an up-to-date informative database is needed. However, there is often a serious lack of information about the quantity and quality of urban green spaces in most cities. Information on the quantity and quality of green spaces within urban areas is usually incomplete and fragmented. There is generally no single source and no single accurate set of relevant figures on urban green.

In the second place, urban green and open space planning policies need to be developed locally in order to satisfy local needs and to assist also in the achievement of national and international sustainability objectives.

Thirdly, more integrated approaches as well as an active involvement of the urban community for the development and management of urban green spaces are needed. A collaborative and enabling partnership among local authorities, local businesses and voluntary groups (e.g., NGOs) is also important in this process.

Next, most development plans adopt a simple, population-based standard approach to the need for green space in new housing developments and they largely ignore the other green spaces as part of other developments such as industry, leisure, etc. It is desirable that the planning authorities develop their own local standards for green spaces not only in new housing developments, but also in non-housing developments, such as industry and business.

And finally, an improvement of quantity, quality and accessibility of green spaces in order to form the basis for a vision for urban green space is needed. Therefore, it is of strategic importance to compare and evaluate urban green space policies for highlighting the "best

practices" for relevant policy recommendations and for offering guidance to urban communities and planning authorities to improve the quality of life in cities.

Against this background, the present study investigates urban green spaces from a policy evaluation perspective and analyses European cities in order to obtain strategic and policy relevant information on the key features of urban green. The study aims to compare and evaluate the current management practices in European cities on the basis of the performance of urban green space policies. The next section evaluates "urban green" from a multidimensional approach including ecological, social, economic and planning perspectives. Section 3 gives a description of the study and introduces the artificial intelligence method by means of rough set analysis which is deployed to assess and identify the most important factors that are responsible for successes and failures of urban green space policies. Then, Section 4 compares *"green performance"* of European cities in terms of the present situation and priorities in decision-making and planning on the basis of the empirical results of the rough set analysis deployed in this study. The final section offers some concluding remarks that focus on the critical aspects of green planning policies.

2. Urban green spaces: a perspective

Urban green spaces provide a range of benefits at both the national and the local level and offer many use opportunities to people in different ways. Urban green spaces play a key role in improving the liveability of towns and cities. They help to define and support the identity of towns and cities, which can enhance their attractiveness for living, working, investment and tourism. Therefore, they can contribute positively to the competitiveness of cities. On the other hand, urban green spaces provide many contributions to social and economic life, and to the ecological and planning system, and as a whole to the urban quality of life. Many previous studies have highlighted the contributions of urban green spaces from several perspectives including social, economic, ecological or planning dimensions (see e.g., Baycan-Levent and Nijkamp, 2002, 2004, Baycan-Levent et al., 2003, Dole, 1989, De Groot, 1994, DTLR, 2001, Jacobs, 1961, Hart, 1997, Hough, 1984, Hueting, 1970, Priemus, 1999, Rodenburg et al., 2001, 2004, Scottish Executive, 2001, Stanners and Bourdeau, 1995). We will discuss here several elements of urban green space.

From a ***social perspective,*** appropriate types of green space can offer a greater diversity of land uses and opportunities for a wide range of activities, can help to foster active urban lifestyles, and can be of real benefit to social health. Well-managed and maintained green spaces contribute to social justice by creating many opportunities to people of all ages to interact (Scottish Executive, 2001). Urban green spaces emphasise the diversity of urban areas and reflect the needs of different communities ranging from local to international. They enhance cultural life by providing venues for local festivals, civic celebrations and theatrical performances. Urban green spaces may provide a safe play space for children (Jacobs, 1961, cited in Haughton and Hunter, 1994), contribute to children's physical, mental and social development (Hart, 1997) and play an important role in the basic education of schoolchildren with regard to the environment and nature.

From a ***planning perspective*****,** a network of high quality green spaces linking residential areas with business, retail and leisure developments can help to improve the accessibility and attractiveness of local facilities and employment centres. Well-designed networks of green spaces help to encourage people to travel safely by foot or by bicycle for recreation or commuting (Scottish Executive, 2001). Furthermore, well-designed urban green spaces

provide a barrier to noise and can function as a visual screen for avoiding too much spatial uniformity (Dole, 1989, cited in Haughton and Hunter, 1994).

From an ***economic perspective,*** a green space might deliver products such as wood or fruits and also compost and energy as a result of urban green production. Their presence may create an increase in the economic value of an area and provide new jobs.

From an ***ecological perspective,*** urban green spaces moderate the impact of human activities by, for example, absorbing pollutants and releasing oxygen (Hough, 1984, cited in Haughton and Hunter, 1994), contribute to the maintenance of a healthy urban environment by providing clean air, water and soil (De Groot, 1994), improve the urban climate and maintain the balance of the city's natural urban environment (Stanners and Bourdeau, 1995). They preserve the local natural and cultural heritage by providing habitats for a diversity of urban wildlife and conserve a diversity of urban resources. Despite the enormous benefits that urban green spaces provide there is a serious lack of information about the quantity and quality of urban green spaces. However, in the context of novel integrated approaches to combine strategic planning for green spaces with innovative design and delivery and the active involvement of the community at all stages, urban green spaces can be come part of an *'urban renaissance'* (DTLR, 2001).

In conclusion, urban green spaces provide an added value to the urban environment, by enhancing its diversity and offering many socio-economic opportunities.

3. Evaluation of urban green space policies

3.1. Prefatory remarks

The present study investigates urban green spaces from a policy evaluation perspective and analyses green area policies in several European cities in order to obtain strategic and policy-relevant information on the key features of urban green. The study aims to compare and evaluate the current management practices in European cities by means of the perception of relevant decision-makers regarding the performance of urban green space policies. The data and information used for comparison and evaluation are based on extensive survey questionnaires filled out by relevant departments or experts of municipalities in European cities that aim to share their experience in innovative green space policies and strategies. A recently developed artificial intelligence method, viz. *rough set analysis,* is next deployed to assess and identify the most important factors that are responsible for successes and failures of urban green space policies. In the next sub-section (Sub-section 3.2.) we explain the rough set analysis which is a qualitative multivariate decision-analytic classification method that originates from the artificial intelligence methodology and next, in the second sub-section (Sub-section 3.3.) we describe our case study and database. Then, in the next section (Section 4), we evaluate the empirical results of the rough set analysis that enable us to identify and compare *best practices* in European cities to develop relevant policy recommendations.

3.2. Rough set analysis

Our exploratory framework for the identification of the most prominent characteristics of urban green space management is based on a specific recently developed artificial intelligence method viz. *rough set analysis*. Rough set data analysis (RSDA) is a classification method developed by Pawlak (1991) for the analysis of non-stochastic

(including qualitative and nominal) information. RSDA is an application of Knowledge Discovery in Databases which is concerned with extracting useful information from a complex multivariate data base (Fayyad et al., 1996). Rough set data analysis is based on minimal model assumptions in terms of formal causal specifications and admits ignorance when no proper conclusion can be drawn from the data at hand (Ziarco, 1998). Hence, it is more exploratory and heuristic in nature.

RSDA draws all its information from the a priori given data set. In other words, RSDA remains at the level of an empirical system: more precisely, the implicit formal and the empirical system coincide and the multidimensional scaling acts then the identity function. In RSDA, there is no numerical system that is different from the operationalisation of the observed data, and there are no outside parameters to be chosen, nor is there any deductive statistical model to be fitted. RSDA can be viewed as a preprocessing device to recognize the potentially important explanatory variables. Data reduction is the main feature of RSDA, as it allows to represent hidden structures in the database. It should be stressed here that rule induction in itself is not a part of rough set theory. It can rather be seen as a tool for preparing data for induction especially for defining classes for which rules are generated. The final outcome of the data base is a decision table from which decision rules can be inferred by using rough set analysis. The rules are logical statements (if…then) which represent the relationship between the description of objects and their assignment to particular classes (see Pawlak 1991; 1992). Details on rough set analysis both from a methodological and from an applied perspective can inter alia be found in Degoun et al., 1997, Famili et al., 1997, Fayyad et al., 1996, Pawlak, 1991, 1992, Slowinski, 1992, van Delft et al., 2000, van den Bergh et al., 1998 and Ziarco, 1998.

The rough set analysis in our study is carried out with the help of the computer program Rough Set Data Explorer (ROSE)[1]. This software system is able to deal with the basic elements of rough set theory and the related rule discovery techniques. We use the ROSE software in our study to identify under which conditions, attributes of a green planning system lead to a certain performance score (or success level). In our study, the data system on urban green spaces can be regarded as a mixed (qualitative and quantitative) database that is suitable for classification and explanation. Rough set analysis acts then as a specific multidimensional classification approach that appears to be able to identify various important factors that are responsible for successes and failures of urban green space policies. In the next section, we will offer the results of the rough set analysis applied to several experiences of European cities in planning and management of urban green spaces.

3.3. Description of the case study base and database

In this study, we aim to compare the *"green performance"* of European cities in terms of the priorities in decision-making and planning (and their success level) from proper evaluation perspectives. The sample in our study contains many European cities which aim to share their experience in innovative green space policies and strategies. Our sample consists of 23 European cities that we classified in three groups viz. metropolises, big cities and medium-sized cities according to their population size (see Table 1). In this classification, we defined the cities which have a population over 1 million as metropolises, the cities which have a population between 500.000-1.000.000 as big cities and the cities which have a population between 100.000-500.000 as medium-sized cities. Our sample does not contain small cities

[1] The ROSE software is available at: http://www-idss.cs.put.poznan.pl/rose/.

which have a population less than 100.000. Due to the difficulties in gathering data from small cities we did not focus on small cities in this study. These 23 cities in our sample are from 16 countries (see Table 2), from Eastern Europe (i.e., Poland, Bosnia and Herzegovina, Slovenia) to Western Europe (i.e., UK, Ireland) and from Northern Europe (i.e., Finland, Belgium, Germany) to Southern Europe (i.e., Italy, France, Spain). Therefore, our sample is rather representative in terms of both the diversity of countries and also the diversity of the different city sizes to map out the "green picture" of Europe from several perspectives in planning and management of urban green spaces.

Table 1 Three groups of European cities in the sample

Metropolises Pop:1.000.000 +	**Big Cities Pop:500.000-1.000.000**	**Medium-Sized Cities Pop:100.000-500.000**
Berlin	Birmingham	Antwerp
Budapest	Cracovia	Bern
Istanbul	Dublin	Edinburgh
Vienna	Genoa	Espoo
Warsaw	Helsinki	Leipzig
	Malaga	Ljubljana
	Marseilles	Montpellier
	Turin	Salzburg
		Sarajevo
		Zurich

The data and information used for comparison and evaluation are based on extensive questionnaires obtained from relevant departments or experts of municipalities in these European cities. Since our focus in this study is on planning and management aspects of urban green spaces, we evaluate the most important data and information relevant for this purpose that are based on six thematic groups of criteria; *"quantity and availability of green spaces", "importance of green spaces", "changes in green spaces", "financing of green spaces", "planning of green spaces",* and *"level of performance".*

The first group, *"quantity and availability of urban green spaces",* focuses on the most important quantitatively well-definable physical features of urban green spaces. In this group there are two variables/attributes; the first one is the proportion of green spaces with respect to total area (%), and the second one is the proportion of green spaces per 1000 inhabitants (m^2). These variables/attributes may enable us to compare and evaluate the availability of green spaces that the cities provide. The second group, *"importance of green spaces",* reflects the relative importance of urban green spaces to the city compared to other functions. There is only one variable/attribute that defines this group. In the third group, *"changes in green spaces",* recent changes in the total area of green spaces in the last 10 years are examined quantitatively. There is only one variable/attribute that defines the change in urban green spaces in this group. In the fourth group, *"financing of urban green spaces",* the changes in the municipal budget are investigated quantitatively. Due to the missing data about the budget for green spaces related to the total budget of the city, financing of urban green spaces could be evaluated by only one variable/attribute which defines the change in the budget. The representatives of the cities could more easily evaluate and give information about financing of green spaces by the variable/attribute of change in the budget. On the other hand, the available data show that the shares of the budget for green spaces in the total budget of the cities are around 1% for most of the cities. The fifth group, *"planning of green spaces",* contains qualitative criteria referring to the planning system of a city. In this group there are three variables/attributes; the first one is the existence of special planning instruments for urban green spaces, which means whether green spaces is a special planning

Table 2 Explanatory variables of management and planning of urban green spaces

			Quantity and availability of green spaces		Importance of green spaces	Changes in green spaces	Financing of green spaces	Planning of green spaces			Level of performance
	Cities	**Countries**	Proportion of green spaces with respect to total area (%)	Proportion of green spaces per 1000 inhabitant (m2)	Importance of green spaces to the city compared to other functions	Recent changes in the total area of green spaces in the last 10 years	Changes in the budget for greenery in the last 2 years	Existence of special planning instruments for urban green	Number of responsible departments for the planning of urban green	Experience with citizens participation	Success level
			A1	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**D**
1	Antwerp	Belgium	11,3	51509	important	increase	decrease	no	one department	yes	very successful
2	Berlin	Germany	14,3	37846	very important	increase	decrease	yes	more departments	yes	marginally successful
3	Bern	Switzerland	10,4	30510	important	increase	decrease	yes	one department	yes	moderately successful
4	Birmingham	UK	14,0	20000	medium	increase	decrease	yes	one department	yes	moderately successful
5	Budapest	Hungary	21,3	61800	medium	decrease	increase	no	more departments	no	marginally successful
6	Cracovia	Poland	2,6	65455	medium	decrease	increase	yes	more departments	yes	marginally successful
7	Dublin	Ireland	16,4	40000	important	no change	increase	yes	more departments	yes	moderately successful
8	Edinburgh	Scotland	25,0	144592	important	decrease	decrease	yes	more departments	yes	marginally successful
9	Espoo	Finland	1,0	140000	important	increase	increase	yes	one department	yes	moderately successful
10	Genoa	Italy	13,1	49394	important	increase	no change	no	more departments	no	marginally successful
11	Helsinki	Finland	7,6	102867	important	decrease	decrease	yes	one department	yes	moderately successful
12	Istanbul	Turkey	0,5	5000	very important	increase	increase	no	more departments	yes	very successful
13	Leipzig	Germany	14,8	93652	medium	increase	decrease	yes	more departments	yes	moderately successful
14	Ljubljana	Slovenia	2,6	25971	medium	decrease	increase	no	more departments	yes	low success
15	Malaga	Spain	59,3	7790	important	increase	increase	no	more departments	yes	moderately successful
16	Marseilles	France	39,3	118225	very important	increase	increase	no	one department	no	very successful
17	Montpellier	France	11,0	33000	important	increase	increase	no	more departments	yes	very successful
18	Salzburg	Austria	11,4	13440	important	decrease	decrease	yes	more departments	yes	moderately successful
19	Sarajevo	Bosnia and Herzegovina	1,2	11000	important	decrease	increase	no	more departments	yes	marginally successful
20	Turin	Italy	13,5	19444	medium	increase	no change	no	more departments	yes	moderately successful
21	Vienna	Austria	14,4	125441	important	decrease	no change	no	more departments	yes	moderately successful
22	Warsaw	Poland	22,3	68499	important	decrease	increase	yes	more departments	yes	moderately successful
23	Zurich	Switzerland	17,4	111919	important	decrease	increase	yes	one department	yes	very successful

issue or is integrated in the urban planning. The second variable/attribute in this group is the number of responsible departments for the planning of urban green spaces, whereas the third variable/attribute is the experience with citizen participation. The last group *"level of performance"* reflects the success level of urban green space policy in light of the objectives of a city from the representatives' own evaluation perspectives. Therefore, there is only one variable/attribute in this group. While the eight variables/attributes of the first five groups constitute condition attributes (in a rough set context), the last group reflects the decision attribute in our analysis. Table 2 offers the data and information according to the six thematic groups and the related nine variables/attributes. The definition for each variable/attribute and their data sources are summarized below.

Proportion of green spaces with respect to total area (%): This is the proportion of total green spaces in terms of land use within the administrative area of the city. Total green spaces consist of gardens, urban parks, quarter parks, historical gardens, green squares and plazas, green playgrounds and other city specific green spaces. This information is obtained by two different questions; while the first one is asking the land use data, the second one is asking the types of urban green spaces.

Proportion of green spaces per 1000 inhabitant (m^2): This data is obtained directly from the representatives of municipalities by questionnaires.

Importance of green spaces to the city compared to other functions: This question is aimed to highlight the importance and the priority of urban green spaces in the city from the perspective of planning authorities. The importance of green spaces is defined in five categories; (1) very important, (2) important, (3) medium, (4) less important, (5) not important.

Recent changes in the total area of green spaces in the last 10 years: This data is obtained directly from the representatives of municipalities by questionnaires. The changes are defined as an increase, a decrease or no change in the total area of green spaces in the last 10 years.

Changes in the budget for greenery in the last two years: This data is obtained directly from the representatives of municipalities by questionnaires. The changes are defined as an increase, a decrease or no change in the budget for greenery in the last two years.

Existence of special planning instruments for urban green: This question is aimed to highlight whether planning of green spaces is a special planning issue or is integrated in the urban planning. This nominal information is obtained directly from the representatives of municipalities by questionnaires in terms of "yes" or "no".

Number of responsible departments for the planning of urban green: This information is obtained directly from the representatives of municipalities by questionnaires in terms of "only one department" or "more than one department".

Experience with citizen participation: This information is obtained directly from the representatives of municipalities by questionnaires in terms of "yes" or "no".

Level of performance: With this question it is aimed to highlight the success level of urban green space policy in light of the objectives of a city from the representatives' own evaluation perspectives. The performance is defined in five categories; (1) very successful, (2) moderately successful, (3) marginally successful, (4) low success, (5) no success at all.

4. Empirical results: best practices in European cities

As mentioned above, rough set analysis is essentially a classification method devised for non-stochastic information. The application of rough set analysis proceeds in two successive steps: the construction of an information survey, and the classification of information contained in the survey. In our case, the information survey consists of experiences of European cities in planning and management of urban green spaces that were obtained by questionnaires. This information survey which contains characteristics (attributes) of the performance of urban green space policies in European cities is given in Table 2. The rough set approach requires the quantitative data to be converted into qualitative or categorical data by means of a proper codification. As can be seen in Table 2, our data set contains both quantitative and qualitative or categorical data. Therefore, a classification of information is necessary for our data set. This step is one of the most problematic issues in the application of rough set analysis, as the chosen thresholds are not always unambiguous and hence may also lead to information loss. In general, some sensitivity analysis on the classification used is meaningful, as a balance needs to be found between homogeneity and class size. In our case, after some sensitivity analyses the categories for each relevant attribute are defined and listed in Table 3. The sensitivity analyses we applied did not only need to categorize the quantitative data but also to change the categories of some qualitative or categorical attributes. For example, importance of urban green spaces to the city classified as 'important' and 'medium', while the 'very important' category is combined with the 'important' category. The categories of the decision attribute, success level, also changed by decreasing the number of categories, with the category of 'very successful' combined with the category of 'moderately successful' leading to a heading 'successful', and the category of 'marginally successful' combined with the category of 'low success' to a new category of 'less success'. On the basis of these categories, the resulting coded information table could be constructed (Table 4).

In the application of the rough set analysis, three main sets of indicators and outputs, viz. the reducts and the core, the lower and upper approximation, and rules, can be calculated.

(1) The *reduct* -in other words, *a minimal set of attributes*- is the least minimal subset which ensures the same quality of classification as the set of all attributes. Intersection of all reducts/minimal (in other words, an attribute that appears in all minimal sets) is defined as the *core.* The core is a collection of the most significant attributes for the classification in the system. For our data set, without any limit on the number, all possible reducts are given in Table 5. Seven sets of reducts and one core attribute are found. The core attribute of our sample is *A1 (proportion of green spaces with respect to total area (%)).* As can be seen in Table 5, without this characteristic it is impossible to classify the results of the performance or success level of the cities in planning and management of urban green spaces. This means that this attribute strongly influences the success level from a policy perspective.

Table 3 Classification of variables investigated

Proportion of green spaces with respect to total area (%)	
1	higher than 30%
2	20%-30%
3	15%-20%
4	10%-15%
5	5%-10%
6	lower than 5%
Proportion of green spaces per 1000 inhabitants (m^2)	
1	higher than 125.000
2	100.000-125.000
3	75.000-100.000
4	50.000-75.000
5	25.000-50.000
6	lower than 25.000
Importance of green spaces to the city compared to other functions	
1	important
2	medium
Recent changes in the total area of green spaces in the last 10 years	
1	increase
2	decrease
3	no change
Changes in the budget for greenery in the last 2 years	
1	increase
2	decrease
3	no change
Existence of special planning instruments for urban green	
1	yes
2	no
Number of responsible departments for the planning of urban green	
1	one department
2	more than one department
Experience with citizen participation	
1	yes
2	no
Success level	
1	successful
2	less successful

Table 4 Coded table for rough set analysis

			Quantity and availability of green spaces		**Importance of green spaces**	**Changes in green spaces**	**Financing of green spaces**	**Planning of green spaces**			**Level of performance**
	Cities	**Countries**	Proportion of green spaces with respect to total area (%)	Proportion of green spaces per 1000 inhabitant (m2)	Importance of green spaces to the city compared to other functions	Recent changes in the total area of green spaces in the last 10 years	Changes in the budget for greenery in the last 2 years	Existence of special planning instruments for urban green	Number of responsible departments for the planning of urban green	Experience with citizens participation	Success level
			A1	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**D**
1	Antwerp	Belgium	4	4	2	1	2	2	1	1	1
2	Berlin	Germany	4	5	1	1	2	1	2	1	2
3	Bern	Switzerland	4	5	2	1	2	1	1	1	1
4	Birmingham	UK	4	6	2	1	2	1	1	1	1
5	Budapest	Hungary	2	4	2	2	1	2	2	2	2
6	Cracovia	Poland	6	4	2	2	1	1	2	1	2
7	Dublin	Ireland	3	5	2	3	1	1	2	1	1
8	Edinburgh	Scotland	2	1	2	2	2	1	2	1	2
9	Espoo	Finland	6	1	2	1	1	1	1	1	1
10	Genoa	Italy	4	5	2	1	3	2	2	2	2
11	Helsinki	Finland	5	2	2	2	2	1	1	1	1
12	Istanbul	Turkey	6	6	1	1	1	2	2	1	1
13	Leipzig	Germany	4	3	2	1	2	1	2	1	1
14	Ljubljana	Slovenia	6	5	2	2	1	2	2	1	2
15	Malaga	Spain	1	6	2	1	1	2	2	1	1
16	Marseilles	France	1	2	1	1	1	2	1	2	1
17	Montpellier	France	4	5	2	1	1	2	2	1	1
18	Salzburg	Austria	4	6	2	2	2	1	2	1	1
19	Sarajevo	Bosnia and Herzegovina	6	6	2	2	1	2	2	1	2
20	Turin	Italy	4	6	2	1	3	2	2	1	1
21	Vienna	Austria	4	6	2	2	3	2	2	1	1
22	Warsaw	Poland	2	4	2	2	1	1	2	1	1
23	Zurich	Switzerland	3	2	2	2	1	1	1	1	1

Table 5 Reducts and core

Reduct	Set no. 1 {A1, A2, A3, A5, A6}
	Set no. 2 {A1, A2, A4, A5, A6, A7}
	Set no. 3 {A1, A2, A4, A5, A7, A8}
	Set no. 4 {A1, A3, A4, A5, A8}
	Set no. 5 {A1, A2, A3, A8}
	Set no. 6 {A1, A2, A4, A6, A7, A8}
	Set no. 7 {A1, A3, A5, A7, A8}
Core	{A1}

The relative frequency of appearance of the condition attributes in the reducts is given in Table 6. After core attribute A1, three other attributes, viz., A2 (proportion of green spaces per 1000 inhabitants), A5 (changes in the budget for greenery in the last 2 years), and A8 (experience with citizen participation), appear as relatively important attributes with the same frequency rate. On the other hand, attribute A6 (existence of special planning instruments for urban green) appears as a relatively less important attribute with the lowest frequency rate.

Table 6 Frequency of attributes in reducts

Attribute	**Frequency**	**Frequency %**
A1. Proportion of green spaces with respect to total area (%)	7	100
A2. Proportion of green spaces per 1000 inhabitants (m^2)	5	71,43
A3. Importance of green spaces to the city compared to other functions	4	57,14
A4. Recent changes in the total area of green spaces in the last 10 years	4	57,14
A5. Changes in the budget for greenery in the last 2 years	5	71,43
A6. Existence of special planning instruments for urban green	3	42,86
A7. Number of responsible departments for the planning of urban green	4	57,14
A8. Experience with citizen participation	5	71,43

(2) The *lower and upper approximation* -and derived accuracy of relationships for each value class of the decisional variable- is another indicator from a rough set analysis. The latter is the lower divided by the upper approximation of each class. Accuracy and quality of classification can also be derived from the choice of thresholds. The results are shown in Table 7. For all classes of the success level the accuracy appears to be 1. Also the accuracy and quality of classification are equal to 1. This value is the maximum value in all these cases. This means that on the basis of the chosen characteristics the cities in our sample are fully discernible regarding the two classes of the success level.

Table 7 Accuracy and quality of the classification of the success level

Success level class	**Accuracy**	**Lower approximation**	**Upper approximation**
Successful	1	16	16
Less successful	1	7	7
Accuracy of classification:	1		
Quality of classification:	1		
Note: The accuracy for each class is the lower divided by the upper approximation.			

(3) The *rules* -exact or approximate relationships between explanatory variables and dependent variables- offer the possibilities to extract conditional causal structures from our data set. Decision rules are conditional statements that are expressed in the form of "if-then" statements. A rule may be exact or approximate. An exact rule (or deterministic) guarantees

that a particular combination of categories of the condition attributes results in only one particular category of the decision attribute (same conditions, same decisions). An approximate rule (or non-deterministic), on the other hand, states that a particular combination of categories of the condition attributes corresponds to more than one category of the decision attribute (same conditions, different decisions). Therefore, only in the case of exact rules, using the information contained in the decision table, it is always possible to state with certainty whether an object belongs to a certain class of the decision variable. The quality of the decision rule is indicated by its strength. The strength of a rule represents the number of observations or cases that are in accordance with that rule. Table 8 shows the rules and their strengths that can be generated from our data set. We only use the rules with strength of two or more. This means that the relation described in the rule appears at least two times in the data set, but in some cases it also appears eight times. This information enables us also to classify the cities under which conditions they are successful and which kind of similarities can be found among them in terms of policies that they are running.

Table 8 Rules generated by the rough set analysis

Rules	**Description of rules**	**Strength (#)**	**Strength (%)**	**Cities**
Rule 1	(A7 = 1) => (**D1 = 1**)	7	43,75	1, 3, 4, 9, 11, 16, 23
Rule 2	(A1 = 4) & (A3 = 2) & (A8 = 1) => (**D1 = 1**)	8	50,00	1, 3, 4, 13, 17, 18, 20, 21
Rule 3	(A4 = 1) & (A6 = 2) & (A8 = 1) => (**D1 = 1**)	5	31,25	1, 12, 15, 17, 20
Rule 4	(A1 = 6) & (A4 = 2) => (**D1 = 2**)	3	42,86	6, 14, 19
Rule 5	(A7 = 2) & (A8 = 2) => (**D1 = 2**)	2	28,57	5, 10

As can be seen in Table 8, all rules generated in the success level of our information survey (using the classes of Table 4) are deterministic, in other words, all rules generated from our data set are exact rules. Therefore, we can say that these exact rules offer a sufficient condition of belonging to a decision class.

An overall evaluation of the decision rules shows that especially four condition attributes, viz., A1 (proportion of green spaces), A4 (changes in the total area of green spaces), A7 (number of responsible departments), and A8 (experience with citizen participation) determine the success level. While (i) a relatively higher proportion of green spaces, (ii) an increase in the total area of green spaces and (iii) experience with citizen participation contribute positively to the success level, we also derive that (i) a lower proportion of green spaces, (ii) a decrease in the total area of green spaces and (iii) a lack of experience with citizen participation are related to a less successful level. The number of departments, on the other hand, determines very strongly the success level. While one responsible department supports the success level, we can also infer that on the contrary, the existence of more than one responsible department may decrease the success level of cities.

When we examine the rules separately by city groups, or in other words, the rules supported by cities, we may derive some interesting information from these rules (see Figure 1). The first rule states that *if* there is only one responsible department for the planning of urban green, *then* the cities tend to be successful in planning and management of urban green spaces. The cities of Antwerp, Bern, Birmingham, Espoo, Helsinki, Marseilles, and Zurich are in this successful group. This group is a combination of big and medium-sized cities and, except Marseilles, they are Northern European cities. According to this rule, it can be said that cities' representatives feel that they well plan and manage their urban green spaces when the responsibility is taken by one institution. This central mechanism in decision-making may facilitate the planning and application process. The centrally taken decisions may also lead to avoid conflicting decisions and planning principles and unfeasible applications.

The second rule describes that *if* (i) the proportion of green spaces in the total area is between 10%-15%, (ii) the importance of green spaces to the city is medium, and (iii) there is an experience with citizen participation, *then* cities are likely successful. This rule is supported by the largest group of cities in our sample. Antwerp, Bern, Birmingham, Leipzig, Montpellier, Salzburg, Turin, and Vienna constitute this group. Except Vienna as a metropole and Birmingham and Turin as big cities, the other cities of this group are medium-sized cities. As observed in the city group which supports the first rule, here once more, the Northern and some Central European cities, except Montpellier and Turin, emerge as successful cities. This rule shows that a relatively higher proportion of urban green spaces and experience with citizen participation positively contribute to the success level of cities. It can be said that a certain level of availability of urban green spaces associated with citizen support may both satisfy planning authorities and citizens. This can also be evaluated as a justification process of the urban planning activities. When the citizens participate in the planning process, this means they support the planning activities. This cooperation between planning authorities and citizens, as a result, may increase the success level of cities.

The third rule states that *if* (i) there is an increase in the total area of green spaces, (ii) green planning is a part of city planning, and (iii) there is an experience with citizen participation, *then* the cities are successful. Five cities, Antwerp, Istanbul, Malaga, Montpellier, and Turin constitute this successful group. This group represents the Southern European cities except Antwerp, and as a group it is a combination of medium and big cities. Istanbul is the exceptional metropolitan city of this group. It is obvious that an increase in the total area of green spaces would be a great contribution to the success level of cities. Besides the citizen participation, this rule emphasize also that a comprehensive and integrated planning approach may increase the success level of cities. Instead of a partial planning approach in terms of green planning, to plan the green spaces as an integrative part of the city development may increase the success level of cities.

The fourth rule defines the conditions for a less successful outcome. *If* (i) the proportion of green spaces is lower than 5% and (ii) there is a decrease in the total area of green spaces, *then* the cities are less successful. Cracovia, Ljubljana, and Sarajevo constitute this less successful group. It is very interesting that all these cities are Eastern European cities and except Cracovia they are medium-sized cities. This rule clearly shows that -although the cities have a small amount of green spaces- if they lose also their scarce green spaces, then, this would be of course an undesirable situation for the planning authorities. It can be said that in these cities there can be a big pressure on urban land or some political priorities may also create pressure on the planning system.

Another group of cities which are less successful is described by the fifth rule. *If* (i) there is more than one responsible department and (ii) a lack of citizen participation, *then* the cities are less successful. Budapest and Genoa are the examples of these less successful cities. These cities are big or metropolitan and represent the Southern and Eastern European cities. This rule shows that more departments may lead to more problems and a less successful appreciation from city representatives' perspectives. More departments will mean shared responsibilities among different institutions, may lead to a weak coordination, conflicting decisions, a more bureaucratic planning system, a slow working process in planning and application, and so forth. More departments may also be seen as a more complex structure, and in this complex structure there is less space for citizen participation. As a result, these conditions may decrease the success level of cities.

This evaluation of the rules generated by the rough set analysis offers two important and interesting results. The rules, on the one hand describe the critical success conditions in planning of urban green spaces, and on the other hand, they show the green picture of Europe in terms of geographical and regional characteristics in their success level.

Figure 1 City groups by success level

5. Policy relevance for planning and management of urban green spaces

From a *policy perspective*, it is of strategic importance to compare and evaluate urban green space policies for identifying the *best practices* for relevant policy recommendations and guidance for society and planning authorities in order to improve the quality of life in cities. From this need, the present study investigated urban green spaces from a policy evaluation perspective and analyzed European cities in order to obtain strategic and policy-relevant information on the key features of urban green.

The results of our comparative analysis on the current management practices in European cities by means of the perception of relevant decision-makers regarding the performance of urban green space policies showed very interesting results. According to the results of our rough set analysis, the critical success conditions in planning and management of urban green spaces have emerged in four factors/attributes, viz., proportion of green spaces, recent changes in the total area of green spaces, number of responsible departments for urban green spaces, and experience with citizen participation. These attributes determine very strongly the performance and success level of cities. While a relatively higher proportion of green spaces, an increase in the total area of green spaces and experience with citizen participation contribute positively to the success level, a lower proportion of green spaces, a decrease in the total area of green spaces and a lack of experience with citizen participation tend to lead to a less success level. Number of department determines also very strongly the success level.

However, each of these factors should not be seen as an absolute condition for success in all cities, because the results reflect first a combination of these attributes, and second, incorporate the subjective judgment of the city representatives. When each attribute is examined separately, our sample shows interesting and conflicting judgments with these attributes generated by the rough set decision rules. For example, Istanbul has the lowest proportion of urban green spaces in the sample, but the success level of the city evaluated as successful by the city representative. However, the city shows an increase in the total area of urban green spaces, an increase in the budget for greenery, and experience with citizen participation, and therefore, the reasons behind this judgment can be explained by these attributes. Another interesting example can be inferred from the success level of the cities which have more than one responsible department for planning of urban green spaces. Leipzig, Montpellier, Salzburg, Turin, and Vienna appear to be successful cities, although they have more than one responsible department. Therefore, it can be said that if a good cooperation between different authorities can be provided, then the cities can be successful in planning and management of green spaces. With a good cooperation, the potential problems of the shared responsibilities may be transformed to advantages. On the other hand, the cities of Helsinki, Salzburg, Vienna, and Zurich offer examples of other successful cities, although they have a decrease in the total area of urban green spaces. As a result, these attributes can be seen generally as determinant attributes of the success level in green planning; however, there can always be some exceptional examples meaning that their success level may be determined by local conditions. If the cities have a big natural heritage by means of urban forest, for example, a decrease in the green spaces would not cause a disaster or a less success level for these cities. Therefore, the availability of green spaces cannot be a real success that the cities achieve from this perspective.

The critical success conditions defined by the results of rough set analysis draw attention to two crucial aspects of the planning system. Our results pinpoint an integrated and coordinated planning system on the one hand, and an active involvement of the community in the

planning process on the other hand. A collaborative and enabling partnership not only among local planning authorities, but also among local businesses and voluntary groups is necessary for a successful urban development.

The comparative evaluation of our analysis shows also some interesting results in terms of geographical and regional characteristics in success level. We can say that three geographical regions with different success levels and characteristics have emerged in the green picture of Europe. In this picture, generally Northern European cities represent successful models with a certain amount of green spaces, a coordinated planning system, and an involvement of the community in the planning process, while Southern European cities represent other successful models which are in a developing process especially with their increasing urban green spaces. Finally, Eastern European cities represent less successful models with their small amount of green spaces, decreasing green spaces, less coordinated planning systems, and lack of involvement of community in the planning process.

However, an overall evaluation emphasizes especially the importance of local conditions and local needs. Although some general principles can be formulated for planning of urban green spaces, the development of a new approach and new principles which satisfy the needs at the local level and which assist the achievement of objectives at the national level is necessary. Planning authorities should develop their own local standards for green spaces and planning policies should give a high priority to ensuring that new green spaces are of sustainable high quality, if necessary at the expense of quantity.

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