# 3 Benchmarking, profiling, and ranking of cities

## The "European smart cities" approach

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### Introduction: the idea of "smart cities"

Since the late 1990s, the discussion of "smart cities" has become a prominent issue in urban planning and city politics. Globalization and the processes of economic integration have greatly changed the role and importance of cities and metropolises with a growing focus on urban competitiveness and attractiveness (Begg, 1999). As a consequence, economic activities are increasingly allocated to those urban areas that show the most competitive local conditions with regard to production, innovation, and quality of life. Along with the increasing competition of cities, regions, and countries, a vigorous process of urbanization and economic restructuring has led to fast-growing agglomerations based on new economic functions. Former commercial areas have been redeveloped and new urban centres have emerged driven by economic, touristic, and cultural activities in a knowledge-based society.

Due to these trends, many cities have expanded their agglomeration areas far beyond existing administrative city borders and are now confronted with a wide range of new challenges and threats. The emergence of complex economic, social, and environmental problems, which increasingly affect the quality of urban life in a negative way, has enhanced the need for new approaches and solutions in urban politics and planning. In this setting, many cities have started to implement new technologies in order to meet the new challenges in a comprehensive manner: these make use of technical innovations not only to accelerate economic growth and strengthen their "hard" location factors, but also to improve "soft" living conditions, referring to mobility, housing, social benefits, or environmental issues. Thus, the implementation of new technologies has become crucial in many dimensions, requiring an increase in energy efficiency, the mitigation of emissions, and allowing new forms of communication. Therefore, new technologies have become important tools of urban politics, supporting a wide range of goals in different fields of urban development. This trend was the starting point of a rather heterogeneous and fragmented discussion not only on understanding but also on the advantages and risks of the smart city development (Komninos and Mora, 2018).

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In this contribution, we approach the issue from a strategic point of view and try to concentrate on a planning-related question: how can the use of indicators support smart urban development in a place-based (and not only an evidence-based) approach? For that purpose, the next section argues that smart city technologies primarily provide data for specific types of information, which may be used in optimizing evidence-based and real-time decision-making processes. Strategic planning, however, needs additional and different kinds of information, which considers urban areas in a framework of socio-economic and cultural regimes. Therefore, in such an approach, it is necessary to consider specific values and norms that are embedded in the institutional settings of respective territories. Based on these considerations, the approach of the European smart cities (ESC) (ESC-1, 2007) self-evaluation mechanism was developed in 2006/2007 (Giffinger et al., 2007, 2010) and updated in three further versions. It is described in its conception and its relatively simple formal structure below. The following discussion especially concentrates on the policy relevance and place-based quality of the approach, attempting to point out the specific strengths and weaknesses in its implementation and application in practice, which are the base for a critical assessment of the ESC model and an outlook for further improvements.

## The concept of "smart cities" from a strategic planning perspective

In the context of the current trends and challenges mentioned above, the smart city discussion has expanded to other disciplines over the last years, dealing with different aspects and challenges on the issue. For example, Nam and Pardo (2011) underlined technical, institutional, and human factors as decisive for smart city development. Depending on the specific focus of the relevant scientific discipline, corresponding research foci range from technical innovations (Schaffers et al., 2012) to economic and sustainability issues (Caragliu et al., 2011) or from big data issues (Laurini, 2017) to questions of governance (Meijer, 2016). As a consequence, it is not surprising that this kind of fragmented literature is responsible for increasingly heterogeneous understandings and definitions of a smart city (Cocchia, 2014; Komninos and Mora, 2018).

All these different paths of scientific discussion were stimulated and influenced by the new quality and importance of technological progress (European Commission, 2010), which paved the way for new projects collecting and censoring data, for the implementation of evidence-based simulation models, or for the practical use of real-time communication. These projects have had an impact on different fields of urban development, in particular on urban planning (Balducci, 2012). As a result, the concept of "smart" urban development became fashionable, when it was prominently introduced into the field of city marketing and urban planning as a new "label" for the intelligent and sustainable use of new technologies in cities. Even at the European level, political documents such as "Europe 2020" (European Commission, 2010) picked up new terminology (ex. "smart growth"), and the seventh research framework programme of the EU dealt with the issue of "smart cities and communities" as a new field of research under their prioritized energy sector. In that context, the integration of new kinds of information in the processes of urban governance and its impact on decision-making processes is broadly discussed in the literature. Batty et al. (2012) and Berst (2016) describe the advantages of smart city technologies in terms of improved sensors (providing information for situational awareness), real-time optimization (preparing predictive information), and predictive analytics (allowing the forecast of trends).

In order to evaluate the specific needs of a smart city development, the discussion on the meaning and use of new digital technologies attempts to take a closer look at the technologies used and the information provided:

> There is thus a major distinction between digital technologies being used for the short-term routine management of cities and those for longer-term strategic planning, and this difference is reflected in much of the data, information and knowledge that pertains to the functions that smart city technologies are able to inform.
>
> (Batty et al., 2015, p. 454)

From this perspective, strategic planning aimed at the sustainable positioning of cities needs specific data and information to answer the following two questions. First, which are the recent characteristics and development trends of a city that have to be analyzed in detail? Second, which are the specific differences between cities that have to be registered and clearly pointed out in a comparative way? Evidently, it is necessary to answer these questions thoroughly in order to identify the relative strengths and weaknesses and the most relevant problems of a city. These evidence-based results then form the essential baseline for learning and formulating decision processes, defining medium- and long-term goals, and developing effective strategies. This understanding is informed by Caragliu et al. (2011, p. 70), who emphasized the "importance of [...] sustainable economic growth and a high quality of life, with a wise management of natural resources, through a participated governance."

Correspondingly, strategic planning is challenged to develop policy-related indicators providing information on urban development in terms of use and acceptance by the stakeholders concerned (e.g. participation in elections and political bodies, satisfaction with public supplies, actual use of facilities). In order to provide relevant decision-making tools for the individual positioning of cities, all information used must be made comparable to other cities. Only then can the data shed light on urban assets and deficits and therefore allow specific profiling and benchmarking of cities. Furthermore, a place-based approach should be applied through the integration of local data which is transformed into policy-related indicators. In order to strengthen the goal of sustainable urban development, the data should also cover qualitative information, which considers the interests, conflicts, and preferences of city actors. In that context, Giffinger (2015, p. 14) underlines that "a place based Smart City initiative has to enable urban innovations as a transition process. […] by the interplay of technical innovations and adaptive governance efforts enabling smart communities in a corresponding social learning process." This triggers a need for a place-based approach, which is able to meet the dual challenge of urban policy (Giffinger et al., 2010): a place-based approach has to describe its position and profile based on its characteristics, and it has to stimulate the public discussion of urban policies. This claim follows the insight that strategic planning has to cope with complex developments in different urban key fields in an integrative manner. Hence, the challenge of both improving the competitive position of a city and strengthening the integrative urban development requires a place-based approach and an adequate understanding of urban policies, which is able to make the specific characteristics of different urban societies, governance systems, and economic structures comparable to each other. For that purpose, the quantitative evaluation of individual perceptions and subjective assessments of urban features from surveys (as provided by Eurobarometer[1]) can be a feasible way to achieve comprehensive comparability of differently structured cities.

According to Barca et al. (2012), the main advantage of place-based approaches lies in the fact that they directly refer to social, cultural, and institutional characteristics in a regional and local context. Contrary to that, traditional growth and development theories or even the New Economic Geography theory (Head and Mayer, 2004) largely neglect physical space and focus on sectoral rather than territorial dimensions. Besides, the importance of local knowledge for political intervention and their actors (stakeholders, residents, elites) has to be emphasized. It can be assumed that the effectiveness and importance of decision-making depend on how local knowledge is activated and considered in the process. Therefore, urban or metropolitan development policies must promote the inclusion of private, semi-public, and public actors and encourage their mutual cooperation. Social and economic networks, formal and informal institutions, organizations, and rules constitute the relational capital of a city, which strongly determines urban development. In this understanding, Camagni (2009, p. 123) regards cooperation (strategic alliances, networks, partnerships) and relational capital (capabilities and competences) as two crucial components of territorial development, which have a significant influence on the implementation of planning strategies and their spatial effects. All these approaches and ideas are reflected and taken up in the European smart cities approach, which provides a comprehensive and transparent tool for ranking, profiling, and benchmarking different cities and for developing individual, effective, and place-based strategies for smart urban development.

## The "European smart cities" approach: methodology and implementation

The introduction of the term "smart" in city planning and marketing, however, only makes sense as long as it not only stands for a simple brand but also represents the actual situation and characteristics of a city. Therefore, it is necessary to provide a tool that is able not only to describe but also to assess a city's smartness with regard to given local conditions in a way that allows a comprehensible and transparent comparison with other cities.

### *Methodology: hierarchical and place-based approach*

For that purpose, evidence-based evaluation approaches need a detailed and specific assessment of urban development in different dimensions, to be able to reveal relevant discrepancies in the form of local assets and deficits. Therefore, the European smart cities approach[2] aims at a highly differentiated indicator-based evaluation of "smart" city characteristics but in an easily comprehensible way.

The evaluation of a city's smartness follows a place-based approach, which collects and combines comparable data of urban development and provides empirical results on different levels of detail (see Figure 2.1): the lowest level of domains, the interim level of key fields, and the upper level of the city in general. In a comprehensive understanding, the hierarchical approach describing smart performances distinguishes six urban key fields which represent the most important dimensions in urban development discourses, and each key field is defined on the lower level by a group of the most relevant domains which again consider the most important dimensions of the respective key field. Then, the smart performance of cities is empirically based on a large set of indicators whereby each domain is described by a certain group of indicators, respectively, and each key field by the aggregation of the values of the respective group of domains. In that way, the empirical evidence can either be highly specific in a certain field of investigation or rather general in the broad categories of "smartness." This integrative understanding of assessment is based on a wide range of indicators (see the following two sections) for a defined set of selected medium-sized European cities and provides evidence-based results in the form of city profiles on the level of specific urban "domains" or "key fields" of smartness. The most aggregated level of evaluation provides the general position of a city in the form of a rank within the system of selected cities. In that manner, this approach helps to identify a specific individual and the multidimensional profile of each city, which is able to describe its relative "smartness" in comparison to other cities. Therefore, it allows a fair method for benchmarking with other cities in a well-documented and reproducible way which goes far beyond a simplistic ranking. Under these requirements and taking up the topical idea of smart city development, any city can be related to and compared with similar cities of the same type or size on the empirical base of transparent and comprehensive data-based profiles. Providing more detailed evidence, the individual profiles use simple diagrams (see Figure 2.2) to present a city's performance in different key fields or domains of smart development in comparison to the average of the whole sample, which allows a transparent indication of relative strengths and weaknesses with regard to other comparable cities.

In that way, the ESC approach creates an integrative method to profile and benchmark European medium-sized cities, which follows a broad understanding of "smart" city development. A smart city is a city that performs well in six relevant key fields, built on the "smart" combination of endowments and activities of self-decisive, independent, and aware citizens (Giffinger et al., 2007, p. 3). The core of this approach is a straightforward assessment tool, which is able to compare cities with regard to a broad variety of "smart" characteristics in a transparent way in order to provide individual city profiles for evidence-based benchmarking. Based on available and reliable statistical data, the indicators used are not limited to local facilities or endowments only but also include social, institutional, cultural, and environmental conditions related to territories, covering the awareness and participation of self-decisive citizens. The methodology of the approach, especially the definition, combination, and weighting of indicators was designed to provide simple, comprehensible, and transparent results (Giffinger et al., 2010).

In order to fulfil these requirements, the ESC approach profiles selected medium-sized cities in Europe according to their "smartness" based on a broad variety of relevant location factors. In that way, the evaluation method aims at describing the cities' ability to meet the challenges of increasing city competition in the knowledge-based economy of the 21st century and to find effective solutions for complex urban transition processes. For that purpose, the indicators must go beyond conventional facilities of endowment and describe the cities from a functional perspective, including the factual activities of the relevant stakeholders and local citizens. To meet these ambitious requirements, it was intended to define several indicators that reflect the individual attitudes, preferences, and habits of the citizens on the one hand, and the actual activities and performances on the other. Therefore, different kinds of "soft" factors as social, institutional, cultural, and environmental conditions and of governance were considered. Due to the poor availability of relevant data, however, the operationalization of suitable and applicable indicators in the relevant fields of urban development turned out to be a major challenge. In some cases, it was necessary to overcome this deficit by using "proxies" that only describe single aspects of the phenomenon.

### *Implementation and metrics of the ESC evaluation tool*

In the original version of the European smart cities approach (ESC-1, 2007), which was first published in 2007 (Giffinger et al., 2007), the cities are profiled in six key fields of urban development which are broken down into 33 relevant domains (see Table 3.1). The domains of each city are described by 74 indicators, which are filled with available data from different European data sources (e.g. Urban Audit, ESPON, Eurostat, Eurobarometer). Due to the lack of significant data, however, 2 domains could not be described by appropriate indicators (highlighted in italics), which reduced the number of implemented domains to 31. Although the majority of all indicators (65%) could be implemented at the city level, the lack of available local data in all fields meant that the rest often had to be complemented with

*Table 3.1* Characteristics of Key Fields and Domains of the "European Smart Cities" Approach

| | |
|---|---|
| **Smart Economy (Competitiveness)** | **Smart People (Social and Human Capital)** |
| • Innovative spirit | • Level of qualification |
| • Entrepreneurship | • Affinity to lifelong learning |
| • Economic image and trademarks | • Social and ethnic plurality |
| • Productivity | • Flexibility |
| • Flexibility of labour market International embeddedness | • Creativity |
| | • Cosmopolitanism/open-mindedness |
| • *Ability to transform* | • Participation in public life |
| **Smart Governance (Participation)** | **Smart Mobility (Transport and ICT)** |
| • Participation in decision-making | • Local accessibility |
| • Public and social services | • (Inter-)national accessibility |
| • Transparent governance | • Availability of ICT infrastructure |
| • *Political strategies and perspectives* | • Sustainable, innovative, and safe transport systems |
| **Smart Environment (Natural Resources)** | **Smart Living (Quality of Life)** |
| • Attractiveness of natural conditions | • Cultural facilities |
| • Pollution | • Health conditions |
| • Environmental protection | • Individual safety |
| • Sustainable resource management | • Housing quality |
| | • Education facilities |
| | • Attractiveness to tourists |
| | • Social cohesion |

Source: Giffinger et al. (2010).

data at the regional level or even at the national level. In order to provide a representative sample of comparable medium-sized cities in Europe, the cities selected must meet some basic conditions: First, the city has to host at least one university and the population size must range between 100,000 and 500,000 inhabitants. Furthermore, it has to be characterized by a predominantly monocentric structure and not be part of a polycentric larger metropolitan agglomeration. Finally, the availability of reliable statistical data was a highly pragmatic selection criterion, which only a small part of potential candidate cities was able to fulfil. Still, the selection of 77 cities did not guarantee a complete data set for all of them, but in the end more than 87% of all required data could be collected, with all cities showing a reasonable degree of data coverage. By all means, the availability of data is an obligatory precondition for being part of the city sample.

Following a hierarchical approach, the values of the 74 indicators are standardized through a *z*-transformation (with an average value of 0 and a standard deviation of 1), which makes the values comparable and appropriate for any aggregation procedure. The values of the 31 domains finally covered in the model represent the arithmetic mean of all values of a group of corresponding indicators. Correspondingly, the evaluation of the six urban key fields results from an

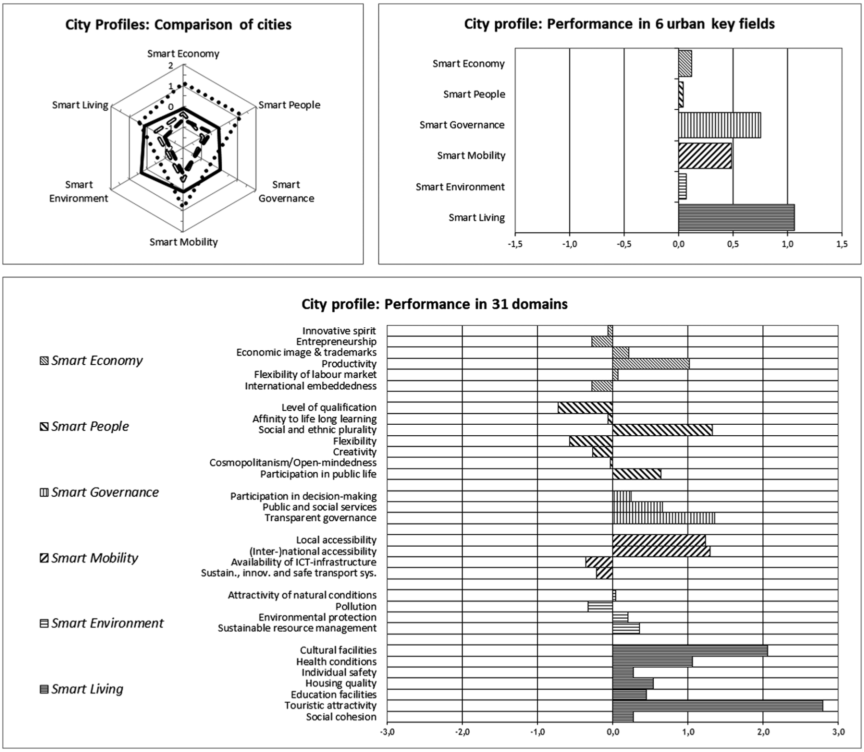


*Figure 3.1* Visual Representation of City Profiles. Source: Authors' own presentation.

unweighted aggregation of the respective domain values. In that way, city profiles can be elaborated on different levels of detail and illustrated in different kinds of visual representation (see Figure 3.1). Finally, the cities are ranked according to the average value of all indicators, which is, however, a less significant result compared to the detailed city profiles.

### *Further versions of the ESC evaluation tool*

A first model update was formalized in 2013 when several Austrian medium-sized cities expressed a strong interest in more recent results for improving the in-depth evidence of their specific strengths and weaknesses (ESC-2). Due to the fact that some relevant data sources changed their focus of the investigation or their survey method, the list of indicators had to be adapted in order to maintain the basic idea of the assessment. Therefore, some relevant topics that cover important aspects of smart urban development had to be redefined or adapted with regard to different definitions of new data. The difficulty of this adaptation was enhanced by the fact that the changes mainly affected soft factors (e.g.

social, institutional, and environmental conditions; individual attitudes, preferences, and habits; or the actual activities of the citizens), which are rare and hard to quantify. Although the new data framework required a slight adaptation of indicators in ESC-2, the aggregated levels of domains and key fields remained unchanged in the new version. In that way, the general comparability of results over time could be guaranteed in spite of some different and more detailed indicators. A change in the selected indicators (the total number was extended to 82), the update of some data sources, and the participation of other cities (which explicitly showed their interest in the assessment), finally resulted in a change in the number of participating cities, which was slightly reduced to 71 in ESC-2, although the basic criteria of selection remained the same.

As a major part of the FP7-project "PLEEC" (European Commission, 2020), which was funded by the European Union to develop policy strategies for the enhancement of energy efficiency in six European medium-sized cities (Eskilstuna, Jyväskylä, Santiago de Compostela, Stoke-on-Trent, Tartu, and Turku), the European smart cities approach was adapted and updated again in 2014 (PLEEC, 2014). Considering the experiences of the first two versions and referring to the individual needs of the six partner cities, the assessment model (ESC-3, 2014) included 77 cities using a sample of 81 indicators in the same six key fields of urban development. In this project, the specific profiles gave clear evidence on the assets and deficits of the six partner cities, which allowed transparent profiling and benchmarking in a sample of comparable (and therefore also competing) cities across Europe. The results were used not only to provide in-depth evidence on local strengths and weaknesses but also, and especially, to trigger discussions with relevant stakeholders.

The latest update of the ESC approach took place in 2015, when the city of Krakow and the Polish region of Malopolska asked for strategic advice in developing a comprehensive smart city development strategy. The need for a reliable database was the starting point with the fundamental adaptation of the evaluation in a new version of the assessment tool (ESC-4, 2015). Since Krakow has a population of almost 800,000 and therefore plays a more prominent role in the European city system (in comparison to the middle-sized cities considered before), the city sample had to be changed. ESC-4 shifted its focus to cities with populations of between 300,000 and 1 million across Europe, which required further adaptation of the indicators. Although the specific data was partly adjusted to the actual challenges of cities of this size and range, the main idea of grouping 90 indicators into 27 relevant domains and 6 key fields of smart city development remained unchanged. Again, the selection of cities had to consider the availability of recent data (especially from the Urban Audit database of the EU), which finally resulted in a new sample of 90 university cities from 21 countries. The processing, preparation, and presentation of the data, however, followed the original approach and resulted in individual smart city profiles, which reveal specific assets and deficits and allow differentiated and specific benchmarking as a starting point for strategic discussions of urban stakeholders and the definition of strategic projects.

## The European smart cities approach: assets, limits, and conceptual connections

Generally speaking, the ESC evaluation is based on the stepwise aggregation of single indicators to give a comprehensive picture of relevant domains and key fields of urban development. This two-step hierarchical aggregation procedure assumes that a city should perform well in different dimensions which are more or less interlinked. This assumption, however, requires the calculation of the mean values of related indicators without considering the intensity of interrelations between them. The allocation of single indicators to the defined domains was done in a heuristic way as the outcome of comprehensive discussions of scientists, architects, and city planners. Therefore, the quantitative evaluation of cities delivers a detailed insight into a city's specific smartness and allows the efficient identification of assets and deficits in urban performance, but does not allow any analytical explanation or conclusion on mutual relations, interdependencies, or contradictions of the single indicators.

Although the ESC approach uses place-based data, it is not sensitive with regard to the diverging importance of indicators for different cities, which is supposed to be the same everywhere. Evidently, this is a rather problematic assumption, considering that the relevance of certain characteristics cannot be separated from the geographical context and specific local conditions. As an example, the PLEEC project clearly proved that basic conditions such as population densities play a totally different role in a city like Jyväskylä (an urban administrative and business centre surrounded by forests and lakes) than in Santiago de Compostela (a touristic Spanish city with a historic centre) or in Stoke-on-Trent (a city with a long industrial history). Since the comparison of cities with regard to single characteristics always has to consider the regional and historic context, it is highly advisable to restrain from discussing single indicators but to use only the average value of combined characteristics at the level of domains or key fields to obtain more reliable results as a robust base for strategic policy advice. Still, the ESC approach is a place-based approach, which is sensitive to the actual awareness and preferences of the citizens, as it defines a group of indicators which are expressing the perception and acceptance of urban endowments by the residents. The number of such indicators in particular increased in each step of the evaluation, since the European database of "Urban Audit Perception" provides relevant information on the personal opinions and evaluations of citizens, which is available for each city with more than 100,000 inhabitants in a representative way.

Additionally, the place-based orientation of the ESC approach supports the effective identification of local assets and deficits in evidence-based city profiles. They enable common learning processes in specifically targeted and individually designed workshops of stakeholder groups. In these events, indicator-based city profiles are provided, discussed, and evaluated on the level of domains or key fields (as shown in Figure 3.1). In consensus with Director General Internal Policies (2014), we understand "smart city" initiatives as multi-stakeholder and municipally based partnerships aimed at addressing urban challenges and problems – based on various tools from the field of information and communications technologies, which underpin the "smart" classification.

The comprehensive understanding of the ESC approach to assessing the "smartness" of a city in a multidimensional way is similar to the idea of sustainability. It is based on the three interconnected pillars of environment, economy, and society with consideration of the given cultural, technological, and political framework. In close connection to the ideas of Jones (2015, pp. xv–xxi), who describes the urban profile process as "circles of sustainability" in four domains (economics, ecology, politics, culture), which are each divided into seven subdomains, the ESC concept follows the idea of six key fields of urban development, which describe different aspects of "smartness" using a number of relevant domains separately but with consideration of their mutual interrelations. In this comprehensive view, smart urban development can only happen when all dimensions of smartness are considered and linked. Although the ESC assessment defines six specific key fields of smart urban development, they can easily be related to the three pillars of sustainability as they integrate a broad range of relevant issues and aspects in a common and connected evaluation system.

Considering the main structure of the ESC approach, there are some remarkable similarities with the diagnostic tool to measure the resilience of a country as defined by the World Economic Forum (2013, p. 37), which claims that resilience against external risks can be measured with regard to five "subsystems":

- economic subsystem (markets for goods and services, financial and labour market)
- environmental subsystem (natural resources, ecological system)
- governance subsystem (institutions, government, policies, law)
- infrastructure subsystem (communication, transport, energy, and health infrastructure)
- social subsystem (human capital, community)

Although this taxonomy deviates from the six characteristics of the European smart cities approach in its level of detail, there are some clear analogies with regard to the "economy," "governance," and "environment," which appear in both classifications. Additionally, besides these small deviations, both approaches share the conviction that theoretical constructs such as "smartness" and "resilience" need a differentiated, quantitative, and robust description. Further development of the ESC approach describing urban and regional resilience must consider the vulnerability and adaptive capacity of urban–regional systems in order to increase their explorative and policy-related power (Meerow et al., 2016).

## Conclusions and outlook

To put it in a nutshell, the approach has been applied and implemented for the strategic consultation of city stakeholders in the process of developing comprehensive positioning or marketing strategies for future urban development. Generally speaking, the graphic representation of results delivers a specific profile of a city, which is able to point out relevant local conditions as the main base for strategic planning discussions. In that way, the profiles provide empirical evidence on the specific assets and deficits of urban cities, which allow transparent benchmarking and positioning against other cities. This allows to identify comparable cities for closer cooperation, mutual lesson-drawing, and the exchange of best-practice examples (Giffinger et al., 2010). The ESC approach also allows monitoring progress and planning improvements over the course of time. In any application, the data-driven individual city profile gives a transparent picture of a city on different levels of detail, thereby effectively leading stakeholders to investigate the meaning of "smart" local conditions in a place-based way.

The smart city approach is able not only to provide empirical evidence regarding the profile of a city in a differentiated way but also to identify groups of cities with similar profiles. Consequently, the smart city approach can be used for selecting cities with comparable structures, challenges, and problems, which might facilitate shared learning processes or knowledge transfer. From that point of view, these multidimensional city profiles can be used as a profound base for drawing inter-urban lessons since the exchange of experience is expected to be of greater benefit when cities are relatively similar in their strengths and weaknesses (Robertson, 1991). In this sense, subjective identification and political values seem to be crucial in directing the search with a clear target: Evidence of soft factors, such as ideological compatibility, psychological, or cultural proximity, is needed to assess the degree of interdependence when selecting cities (Rose, 1991).

Finally, quantitative indicators and benchmarking are critically assessed in politics. So, a valid set of indicators may support reaching certain objectives in urban and regional policies as they will describe trends or may even support modelling efforts in a predictive way. The integration of data describing real-time situations with information on trends and development provides new possibilities for simulations and forecasts and decision-making as already described in Batty et al. (2012). However, the build-up of data banks with policy-related indicators remains complicated for two reasons. First, due to the changing conditions of development and increasingly strong transformation processes, distinct indicators providing specific information are losing their validity over time. Second, the accuracy of an indicator may cause problems for politicians if the objectives are not clearly reached; and for this reason, politicians are careful in the implementation of quantitative information systems when their political utility will become risky for the next elections.

## Appendix 1: Domains and Indicators

| *Code* | *Field* | *Domains* | *Indicators* | *Year* | *Level* |
|---|---|---|---|---|---|
| Eco_1a | Smart economy | Innovative spirit | R&D expenditure in percentage of GDP | 2003 | Regional |
| Eco_1b | | Innovative spirit | Employment rate in knowledge-intensive sectors | 2004 | Regional |
| Eco_1c | | Innovative spirit | Patent applications per inhabitant | 2003 | Regional |
| Eco_2a | | Entrepreneurship | Self-employment rate | 2001 | Local |
| Eco_2b | | Entrepreneurship | New businesses registered | 2001 | Local |
| Eco_3a | | Economic image and trademarks | Importance as decision-making centre | 2007 | Regional |
| Eco_4a | | Productivity | GDP per employed person | 2001 | Local |
| Eco_5a | | Flexibility of labour market | Unemployment rate | 2005 | Regional |
| Eco_5b | | Flexibility of labour market | Proportion in part-time employment | 2001 | Local |
| Eco_6a | | International embeddedness | Companies with HQ in the city quoted on the national stock market | 2001 | Local |
| Eco_6b | | International embeddedness | Air transport of passengers | 2003 | Regional |
| Eco_6c | | International embeddedness | Air transport of freight | 2003 | Regional |
| Peo_1a | Smart people | Level of qualification | Importance as knowledge centre | 2007 | Regional |
| Peo_1b | | Level of qualification | Population qualified at Levels 5–6 ISCED | 2001 | Local |
| Peo_1c | | Level of qualification | Language skills | 2005 | National |
| Peo_2a | | Affinity to lifelong learning | Book loans per resident | 2001 | Local |
| Peo_2b | | Affinity to lifelong learning | Participation in life-long-learning in percentage | 2005 | Regional |
| Peo_2c | | Affinity to lifelong learning | Participation in language courses | 2005 | National |

(*Continued*)

**Appendix 1: Continued**

| *Code* | *Field* | *Domains* | *Indicators* | *Year* | *Level* |
|---|---|---|---|---|---|
| Peo_3a | | Social and ethnic plurality | Share of foreigners | 2001 | Local |
| Peo_3b | | Social and ethnic plurality | Share of nationals born abroad | 2001 | Local |
| Peo_4a | | Flexibility | Perception of getting a new job | 2006 | National |
| Peo_5a | | Creativity | Share of people working in creative industries | 2002 | National |
| Peo_6a | | Cosmopolitanism/ open-mindedness | Voters turnout at European elections | 2001 | Local |
| Peo_6b | | Cosmopolitanism/ open-mindedness | Immigration-friendly environment | 2006 | National |
| Peo_6c | | Cosmopolitanism/ open-mindedness | Knowledge about the EU | 2006 | National |
| Peo_7a | | Participation in public life | Voters turnout at city elections | 2001 | Local |
| Peo_7b | | Participation in public life | Participation in voluntary work | 2004 | National |
| Gov_1a | Smart governance | Participation in decision-making | City representatives per resident | 2001 | Local |
| Gov_1b | | Participation in decision-making | Political activity of inhabitants | 2004 | National |
| Gov_1c | | Participation in decision-making | Importance of politics for inhabitants | 2006 | National |
| Gov_1d | | Participation in decision-making | Share of female city representatives | 2001 | Local |
| Gov_2a | | Public and social services | Expenditure of the municipal per resident in PPS | 2001 | Local |
| Gov_2b | | Public and social services | Share of children in daycare | 2001 | Local |
| Gov_2c | | Public and social services | Satisfaction with quality of schools | 2005 | National |
| Gov_3a | | Transparent governance | Satisfaction with transparency of bureaucracy | 2005 | National |
| Gov_3b | | Transparent governance | Satisfaction with fight against corruption | 2005 | National |

(*Continued*)

**Appendix 1: Continued**

| *Code* | *Field* | *Domains* | *Indicators* | *Year* | *Level* |
|---|---|---|---|---|---|
| Mob_1a | Smart mobility | Local accessibility | Public transport network per inhabitant | 2001 | Local |
| Mob_1b | | Local accessibility | Satisfaction with access to public transport | 2004 | National |
| Mob_1c | | Local accessibility | Satisfaction with quality of public transport | 2004 | National |
| Mob_2a | | (Inter-)national accessibility | International accessibility | 2001 | Regional |
| Mob_3a | | Availability of ICT infrastructure | Computers in households | 2006 | National |
| Mob_3b | | Availability of ICT infrastructure | Broadband internet access in households | 2006 | National |
| Mob_4a | | Sustainable, innovative, and safe transport systems | Green mobility share | 2001 | Local |
| Mob_4b | | Sustainable, innovative, and safe transport systems | Traffic safety | 2001 | Local |
| Mob_4c | | Sustainable, innovative, and safe transport systems | Use of economical cars | 2006 | National |
| Env_1a | Smart Environment | Attractivity of natural conditions | Sunshine hours | 2001 | Local |
| Env_1c | | Attractivity of natural conditions | Green space share | 2001 | Local |
| Env_2a | | Pollution | Summer smog | 2001 | Local |
| Env_2b | | Pollution | Particulate matter | 2001 | Local |
| Env_2c | | Pollution | Fatal chronic lower respiratory diseases | 2004 | Regional |
| Env_3a | | Environmental protection | Individual efforts on protecting nature | 2004 | National |
| Env_3b | | Environmental protection | Opinion on nature protection | 2006 | National |
| Env_4a | | Sustainable resource management | Efficient use of water (use per GDP) | 2001 | Local |
| Env_4c | | Sustainable resource management | Efficient use of electricity (use per GDP) | 2001 | Local |

(*Continued*)

**Appendix 1: Continued**

| *Code* | *Field* | *Domains* | *Indicators* | *Year* | *Level* |
|---|---|---|---|---|---|
| Liv_1a | Smart living | Cultural facilities | Cinema attendance per inhabitant | 2001 | Local |
| Liv_1b | | Cultural facilities | Museums visits per inhabitant | 2001 | Local |
| Liv_1c | | Cultural facilities | Theatre attendance per inhabitant | 2001 | Local |
| Liv_2a | | Health conditions | Life expectancy | 2001 | Local |
| Liv_2b | | Health conditions | Hospital beds per inhabitant | 2001 | Local |
| Liv_2c | | Health conditions | Doctors per inhabitant | 2001 | Local |
| Liv_2d | | Health conditions | Satisfaction with quality of health system | 2004 | National |
| Liv_3a | | Individual safety | Crime rate | 2001 | Local |
| Liv_3b | | Individual safety | Death rate by assault | 2001–2003 | Regional |
| Liv_3c | | Individual safety | Satisfaction with personal safety | 2004 | National |
| Liv_4a | | Housing quality | Share of housing fulfilling minimal standards | 2001 | Local |
| Liv_4b | | Housing quality | Average living area per inhabitant | 2001 | Local |
| Liv_4c | | Housing quality | Satisfaction with personal housing situation | 2004 | National |
| Liv_5a | | Education facilities | Students per inhabitant | 2001 | Local |
| Liv_5b | | Education facilities | Satisfaction with access to educational system | 2004 | National |
| Liv_5c | | Education facilities | Satisfaction with quality of educational system | 2004 | National |
| Liv_6a | | Touristic attractivity | Importance as tourist location | 2007 | Regional |
| Liv_6c | | Touristic attractivity | Overnights per year per resident | 2001 | Local |
| Liv_7a | | Social cohesion | Perception on personal risk of poverty | 2006 | National |
| Liv_7b | | Social cohesion | Poverty rate | 2005 | national |

## Notes

1 Eurobarometer was launched in 2007 to collect public opinion on citizens' attitudes on issues. More information is available from www.europarl.europa.eu/at-your-service/en/be-heard/eurobarometer.
2 More on the approach is available at www.smart-cities.eu/

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