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The Case of Smart City Istanbul: How to Evaluate the City Region and its Benchmarks with Participatory and Negotiation Processes?

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1 ABSTRACT

Since the 1990s, the Greater Municipality of Istanbul has been investing in intelligent, digital services and supporting infrastructures, while at the same time Istanbul has started to become an important centre for ICT technologies. Recently, the efforts of the municipality and the private stakeholders are significantly up-scaled as the city has become an important international business, transportation and digital hub. One of the most recent efforts to tackle the city's management challenges is the "Smart City Istanbul Program" which covers a range of activities from developing a Smart City benchmark model to the assessment of the metropolitan city with a specific Maturity Model.

The Greater Municipality has recently developed an assessment and monitoring model for Istanbul's development as an international financial sector. The development of other models focusing on particular issues is also on the agenda. In a way, the municipality is trying to establish an information-rich intelligence base that focuses on strategic priority areas. These efforts may contribute to the adaptation of the global and national metropolitan agenda that pushes metropolitan governments to establish evidence-based policies and integrated management supported by indicator systems that allow benchmarking city-regions.

The development of such intelligence capabilities poses significant challenges. Meticulous encouragement of participatory processes by the Greater Municipality of Istanbul itself within its own activities should facilitate the diffusion of its emerging knowledge assets to other stakeholders, thereby creating a dynamic and complex environment of urban intelligence building. Enhancing the quality of participatory processes is thus very important.

The paper provides information on the participatory methodological approach used in the establishment of the Smart City Assessment and Monitoring Model, developed by the authors in collaboration with the Greater Municipality of Istanbul and its affiliate ISBAK. It also discusses the benefits and challenges associated with the Smart City Assessment Models based on a rich literature survey. The approach employed is particularly aimed at avoiding empty signifier problems, feeding participatory processes with rich information, establishing trust among stakeholders, avoiding fuzziness and indecisiveness, and enabling the production of a small set of mutually agreed and selected benchmark indicators which can later successfully inform maturity models.

Lessons learned are: the involvement of specialised practitioners in the Smart City domain in disseminating local information into the process; the use of a layered participatory process to enable evaluation and agreement on a large set of indicators in a relatively short time; and the co-presence of these two processes to help avoid empty signifier problems. The paper suggests that it is possible to tackle the unique challenges associated with Smart City development activities. Enabling repetitive benchmarking processes makes it possible to challenge rapid technological change and achieve convergence. Layered participatory processes work better when practitioner teams also see potentials in collaboration. Also third, feedback mechanisms should be provided at different layers of participatory processes as they enhance decision-making processes.

Keywords: grey relational analysis, participatory process, smart city, benchmark, Istanbul

2 INTRODUCTION

Smart cities are seen as a panacea to achieve sustainable development. They are also expected to create a market as large as $300 billion by the year 2030.[1] Though the Smart City concept is not new, in recent years there has been a rush by cities of all sizes to adopt strategy making associated with the smart city concept. Now a large number of city governments experience challenges of strategy making associated with this dynamic paradigm.

This paper discusses the challenges of smart city associated spatial strategy making in large city-regions. It focuses on the specific topic of building locally informed benchmarking models to evaluate the city's position with respect to its "smart" peers. The paper employs Healey's spatial strategy-making framework (Healey, 2009b) and explores the unique issues relevant to the Smart City Paradigm through the lense of participatory processes, management of knowledge (Liew, 2013) and technological change. After discussing special issues about benchmarking, the paper discusses the relevance of the Delphi Method and the Gray Relational Analysis for facilitating and speeding up participatory processes. Finally, the paper presents the experiences obtained during the recent experience of Istanbul, Turkey in this context (Şeker et al., 2019) and concludes by a discussion on the lessons learned.

3 CHALLENGES IN SMART CITY STRATEGY BUILDING AND THE ROLE OF BENCHMARKING

The origins of the Smart City concept dates back to 1830s, but only after the year 2000 has it become a key global interest though the discourses of sustainable development and smart growth (Albino et al., 2014; Eger, 2009; Susanti et al., 2016) "Smart City" is seen as a vision aiming to constitute the 21st century's efficient, technologically advanced, green, and socially inclusive city (Vanolo, 2014; Yigitcanlar & Kamruzzaman, 2018).

In general, smart cities have a high share of knowledge-based businesses and professionals, accommodate creative and innovative activities, sustain a higher quality of life with competitive costs, use efficient and effective resource technologies and green infrastructures, and have output-oriented planning systems and participatory governance procedures (Anthopoulos, 2015; Fernandez-Anez et al., 2018; Nam & Pardo, 2011; Neirotti et al., 2014; Paskaleva, 2011).

The Smart City Paradigm is also supported by technology companies that promote the smart city agenda, through publications, events and benchmarking studies. The New Urban Agenda of Habitat III has played a role in connecting the smart city concept with Sustainable Development Goals, as it is heavily based on indicators and urban data (Caprotti et al., 2017). Many cities and citizens perceive Smart City applications to be beneficial. Large city-regions where half of the global economic production takes place[2] have also become the playground of Smart City applications.

There are now a substantial number of international smart city benchmarking models, which are mostly being prepared by global private enterprises. While they provide the opportunity of quick assessment for planners, they have certain setbacks like opaqueness, selection bias of indicators and year on year variation of rankings. These issues decrease the validity and legitimacy of such benchmarks. Hence scholars and planners face increased demands from local governments to develop tailor-made smart city benchmarking models to be utilised in Smart City-associated spatial strategy making.

3.1 Challenges associated with spatial strategy making and smart city agenda

The processes that generate the making of spatial strategies are complex and delicate (Healey, 2009b, 2009a). In general, spatial strategy-making processes involve understanding and seeking opportunities to be involved in higher hierarchical structures, connecting to other spatial locations, improving the relative position of cities among different socio-spatial contexts and networks and improving internal relations and components in a city. Each city has to find its own way ((Healey, 2006) p.267). The essential steps of spatial

[1] Future Cities Special Interest Group, Accessed at 31st Jan.2020. https://connect.innovateuk.org/web/future-cities-special-interest-group/definition

[2] Global MetroMonitor 2012: Slowdown, Recovery, and Interdependence" by Emilia Istrate and Carey Anne Nadeau, The Brookings Institution – 30th November, 2012. https://www.brookings.edu/wp-content/uploads/2016/06/30-global-monitor.pdf

strategy-making aim to move away from current positions by discovering new opportunities, integrating and gearing up different aspects, leading to the opening up of new possibilities and setting directions (Healey, 2009b). From this perspective, “the smart city associated spatial strategy making” has a similar nature but poses unique challenges.

There are many examples where interventions under the pretext of Smart City discourses have faced strong criticism. Smart city strategies are criticised to be empirically and conceptually shallow and accused of leading to the outsourcing of democratic and environmental resilience to the global technology sector (Viitanen & Kingston, 2014). In accordance, there is limited empirical evidence on smart cities’ ability to form green and inclusive urban environments, or on their ability in dealing with carbon dioxide emissions (Yigitcanlar & Kamruzzaman, 2018), or yielding significant sustainability outcomes (Yigitcanlar & Lee, 2014). In fact, unintended consequences of smart city applications carry the risk of further increases in environmental, social or economic problems (Federico Cugurullo, 2013; Shwayri, 2013), due to the pervasive use of rapidly changing ICT systems and products (Hilty & Aebischer, 2015; Li et al., 2013).

Both (Caragliu & Del Bo, 2012) and (Pancholi et al., 2017) suggest that the incorporation of local communities and actors might help in better addressing and dealing with space-specific societal, economic and environmental challenges. Hollands (2008) suggests that city governments should focus first on people for progressive, sustainable and smart cities, rather than solely focus on economic competitiveness and pervasive use of ICT. A large and varied body of knowledge is embedded in various stakeholders in global city-regions which has strategic value for smart-city associated spatial strategy making. Many stakeholders have their own connections to other spatialities and have the ability to alter the internal structure and functioning of the host city-region. In many aspects, these stakeholders also provide efficient channels to connect to various higher hierarchy structures. So the deployment of such embedded knowledge at the very beginning of analytical processes could be important in shaping the understanding and hence strategy building processes that might serve for the attainment of Sustainable Development Goals.

Therefore smart city spatial strategy makers have to utilise suitable approaches and methods that would effectively extract, relate and utilise the embedded knowledge of stakeholders with factual data, without introducing problems of over-dependence on subjectivity, representation, legitimacy, and consensus-building. Put together with rapid technological change, the complexity of global city-regions and their ever-changing connections to other spatialities, Smart City associated strategy making becomes a huge challenge.

Facing these challenges, spatial strategy makers need to adopt agile approaches that are capable of capturing, processing and representing diverse and immense information in a meaningful, productive and legitimate way in very short time intervals.

Making use of existing smart city indices or benchmarks developed by international organisations might enable fast assessment of cities, but they are inferior tools in establishing power balances. Topics covered could be wide or narrow and irrelevant for a particular city-region’s own assessment. In addition, there is no guarantee that these benchmarks would continue their existence in the near future. Thus, there is a need to establish local benchmarking capabilities that quickly, legitimately and effectively utilise locally embedded knowledge relevant to the connectivity, position, and internal components of the specific city-region.

3.2 Challenges of local development of benchmark models

Planning is a political process of power that acts to build a consensus between conflicting interests (Savini, 2013) It is impossible to deliberately describe and analyse the situation in multiple contexts, while also understanding local capabilities and their interrelationships with regional goals. given the pressing time limits and rapidly changing agendas. However, this gap has to be bridged anyway through a decision-making process which utilises strategic tools (Frenkel & Porat, 2017). Strategic tools enable quick utiliaation of vast amounts of information regarding indeterminate urban systems, and the conflicting agendas as well as different images, visions and capabilities of stakeholders (AlAwadhi & Scholl, 2013; Fernandez-Anez et al., 2018; Santis et al., 2014). They improve punctuality in making decisions regarding building complex and highly valid intelligence.

(Borsekova et al., 2018) focus on the functionality between the size and indicators of smart cities presuming that there is an association between the selection of indicators and city sizes. Their findings on 158 European cities suggest that some indicators (such as ecological awareness) are more important for larger smart cities.

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They also find that larger cities enjoy better sustainable resource management, but they are not as open-minded or innovative as medium-sized cities, concluding that one-size-fits-all type of smart city strategies would be inefficient and ineffective, and positive or negative prejudices on larger cities should be avoided by planners and strategy developers.

From this point of view, using a smart city benchmark model that is based on factual data on global cities but which also takes into account local priorities and concerns becomes an attractive option as it could perform better;

- in the identification of more relevant issues with the subject city and its technology level,
- in framing and focusing on a more relevant set of cities, regions, or networks,
- establishing a familiar conceptual framework but avoiding ubiquitous strategic decision-making processes,
- covering a suitable range of issues on the potential organisational capacity of that particular locality,
- establishing faster and easier consensus on the perceived position of the city within a variety of contexts that are more relevant to the local agenda.

Despite these potential benefits, the development and continued use of a local smart city benchmarking model are challenging. First of all, better performance is conditional on the ability of the benchmarking model to capture relevant locally embedded knowledge and transfer it quickly into the design of the benchmarking model before it is degraded. Second, the method should allow for some flexibility in shaping subsequent versions of the model due to changing contexts. Third, the methods employed should be able to economically include multiple stakeholders for subsequent versions, and thus should not impose high time costs. Otherwise, this may lead to the abandonment of the use of such locally informed benchmarks. As a result, actions and organisational changes may move in incompatible directions and yield irreversible results, which contradicts the inherent aims of strategic spatial planning in general (Albrechts, 2010; Kotter, 1996).

3.3 Participatory Planning Processes and their use in benchmark studies

As Batty(et al. (2012) suggest, smart cities are both automated routine functions serving individual persons, buildings and traffic systems, as well as ways that enable us to monitor, understand, analyse and plan the city to improve the efficiency, equity and quality of life for its citizens in real-time.

It is crucial to distinguish between the data-driven tactical planning approach of smart cities versus the making of spatial strategies for smart cities. Although both are used in successful smart cities, they play different roles. The former implies that decision-making and implementation at tactical or operational levels including day to day planning and servicing of public services and infrastructure. Big data and data automation systems may improve the speed of tactical or operational planning and improve services reliant on them, such as demand management (Jindal et al., 2018).

Spatial strategy making, on the other hand, requires complex social processes to bring out meaningful and relevant knowledge, to establish trust and legitimacy, and to set common agendas, all of which form the basis of strategic intelligence that would carry the city forward in competitive and risky environments as a smart city. Spatial strategy making also monitors the outcomes of the data-driven tactical planning mentioned above, makes use of them as tactical assets for maximising or minimising social, economic, political or other goals. Thus, spatial strategy-making requires different and unique resources and capabilities which are not confined to the responsible authority. Bringing together relevant experts or stakeholders within very narrow timeframes provides the opportunity to create higher-level knowledge. They are key soft ingredients of building intelligence, establishing trust and initiating actions that would serve for success, competitiveness, resilience and perseverance.

Interestingly, the literature suggests that envisionment of smart cities often takes into account an insufficient amount of social and political questions (Calzada & Cobo, 2015; Cowley et al., 2018; Hollands, 2015; Katz, 2000; Söderström et al., 2014) while the smart city needs to navigate the complexities of multi-faceted urban complexities (Pettit et al., 2018). The inclusion of locally embedded knowledge in the design process of locally informed benchmarking models for smart cities may thus help overcome these issues.

Participatory research design and planning approaches provide important opportunities in the inclusion of locally embedded knowledge in smart city strategy-making processes, particularly in benchmarking efforts. These are:

(1) Better assessment of major issues that are relevant for the subject city's hierarchical networks, position, connectivity, and internal components (as suggested by (Healey, 2009b)).

(2) Quick and legitimate selection of a manageable number of smart city features that can be easily incorporated into the mission statements of associated or partnering stakeholders.

(3) Wiser selection of a set of benchmark cities that not only represent smart city features but are as well important sources for learning from best practices, or are potential partners for building strategic coalitions.

(4) Building consensus on strategic priorities relevant to smart cities that might create competitiveness, and enhance sustainability or resilience.

(5) Information economies of scope and scale for successful strategy development.

Yet there are certain issues that have to be taken into account with decision-making methods. Even large participatory planning events often include an inadequate number of experts, while a large number of decisions have to be made, rendering most statistical methods unsuitable. Non-numerical methods should involve time-consuming iterations as issues discussed are complex and reaching consensus at the first attempt is unlikely. Lastly, locally embedded knowledge is quickly degradable against multi-faceted urban complexities.

3.3.1 The Delphi Method

One of the most commonly used participatory methods is the Delphi Method, used for qualitative evaluation and consensus-building. The underlying principle of the Delphi method is that group-based forecasts are considered to be more accurate compared to individual forecasts. Delphi survey is capable of gathering information from a relatively large number of subjects, accumulating it, and preparing it to support objective decision making. Since the responses of the participants are anonymous, individual panellists don't have to worry about repercussions for their opinions. Consensus can be reached over time as opinions are swayed, making the method very effective. The Delphi method is used extensively in smart city-related works. They can be used directly for the assessment of smart city domains or in capability maturity model works relevant to smart cities (De Bruin et al., o. J.; Lee et al., 2013).

As a relevant example, Anthopoulos & Reddick (2016) wanted to explore existing frameworks and theories of e-government with regard to smart cities and confirm these findings with experts' opinions using a Delphi study spanning multiple years while only involving 16 experts from across the globe. While successful, the long time span raises concerns, as the subject studied is dependent on rapidly changing technologies and political contexts.

The use of the Delphi method is a time-consuming fashion, also not suitable for making repeated benchmarks as it might not be possible to bring a satisfactory number of participants into participation repeatedly. The benefit of agility in benchmarking stems from quickly understanding important priorities and dimensions and taking relevant actions with stakeholders, which provides benefits to the subject city-region similar to an early innovator. Thus, focused and limited use of the Delphi method may be more suitable in Smart City associated spatial strategy-making processes.

3.3.2 Grey Relational Analysis

The Gray Relational Analysis Method is used for numerical evaluation in participatory processes. The GRA Method is part of the Gray System Theory proposed by J.L. Deng in 1982 (Kuo et al., 2008). It is a multi-criteria decision-making model, which is utilised in ranking, categorisation, and decision-making. GRA is known to perform well with small samples, and the calculation process is simple and easy, which makes it an ideal method for the highly challenging Smart City strategy-making processes. As provided below, it allows selection of maximisation, minimisation or idealisation objectives.

A single value is calculated for each alternative decision according to the values attributed to each benchmark indicator (criterion) taken into account during the decision making process. This allows the reduction of the multi-criteria structure into a single and simple Gray relational value.

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A five-step calculation process is utilised to obtain this value: Data preparation, the establishment of a reference series, normalisation of the data set, calculation of the Gray relational quotient and assessment of the Gray relational rank (Wu, 2002). These are demonstrated by x,y,z,e,f,g below.

GRA alternatives xi and the criteria xi (k) are computed as in equation 1 and equation 2:

$$x_i = \left(x_i(1),\ x_i(2),\ x_i(3), \dots, x_i(k)\right) \qquad (1)$$

$$k = 1,2,3, \dots ,n \ \ ve \ \ i = 1,2,3, \dots, m \qquad (2)$$

In the next step, an X matrix is established for alternatives to be assessed in the multi-criteria decision-making problem as in equation 3.

$$\boldsymbol{X} = \begin{bmatrix} x_1(1) & \dots & x_1(n) \\ \vdots & \dots & \vdots \\ x_m(1) & \dots & x_m(n) \end{bmatrix} \qquad (3)$$

The matrix X consists of „m“ alternatives and n criteria relevant to the problem in question. Thus the matrix is also recalled as the “Decision Matrix.” A reference series, which is a hypothetical series, is established by the utilisation of the Decision Matrix. The series is established by using the best value of each criterion. The reference series is given in equation 4. This vector is then added to the Decision Matrix to acquire the matrix given in equation 5.

$$x_0 = \left(x_0(1),\ x_0(2),\ x_0(3), \dots, x_0(n)\right) \qquad (4)$$

$$\boldsymbol{X_{yeni}} = \begin{bmatrix} x_0(1) & \cdots & x_0(n) \\ \vdots & \ddots & \vdots \\ x_m(1) & \cdots & x_m(n) \end{bmatrix} \qquad (5)$$

The criteria found in equation 5 may be subject to different scales and thus are normalised to be free of scale. In addition, the normalisation procedure narrows down the transition interval since the series located in the matrix may have a wide “transition interval.” This normalisation process is called as “Gray Relational Formation” (Tsai, Chang ve Chen, 2003). There are three different calculation methods according to three objectives during the normalisation process: “higher is better,” “lower is better,” ideal value is better” (Wu and Chen, 1999).[3]

(a) If the expectation is that the higher value is better, then equation 7 (as in the case of calculations associated with utility)

$$x_i(k) = \frac{x_i{}^{(0)}(k) - \min x_i{}^{(0)}(k)}{\mathrm{mak}\, x_i{}^{(0)}(k) - \min x_i{}^{(0)}(k)} \qquad (7)$$

(b) If the expectation is that the lower value is better, then equation 8 (as in the case of calculations associated with costs or errors)

$$x_i(k) = \frac{mak\ x_i{}^{(0)}(k) - x_i{}^{(0)}(k)}{\mathrm{mak}\, x_i{}^{(0)}(k) - \min x_i{}^{(0)}(k)} \qquad (8)$$

(c) If the expectation is that the ideal is better, then equation 9.

$$x_i(k) = 1 - \frac{x_i{}^{(0)}(k) - x^0}{\mathrm{mak}\, x_i{}^{(0)}(k) - x^0} \qquad (9)$$

After the normalisation of the criteria in the new Xnew matrix, the Gray relational coefficient is calculated. Gray relational coefficient is used to assess how near is the xi(k) to x0(k)’. When the Gray relational coefficient takes a large value, it is an indicator that demonstrates that xi(k) and x0(k) approaches to each other. Equation 10 provides the formula for the calculation of Gray Relational Coefficient.[4]

[3] $x_i(k)$: Gray relational value, $\min x_i{}^{(0)}(k)$: $x_i{}^{(0)}$ minimum value, $mak\ x_i{}^{(0)}(k)$:$x_i{}^{(0)}$ maximum value, x^0 : target value

[4] δ: Is a distinguishing coefficient and takes values between 0 to 1.

$$\gamma\big(x_0(k), x_i(k)\big) = \frac{\Delta_{min} + \delta\Delta_{max}}{\Delta_{0i}(k) + \delta\Delta_{max}} \quad (10)$$

$$k = 1,2,3, \dots, n \ \ and \ \ i = 1,2,3, \dots, m \qquad n, m \in N \quad (11)$$

Gray relational degrees are determined by the matrix that involves the Gray relational coefficient calculations. The formula to calculate the Gray relational degree is given in equation 12. The Gray relational degree is determined by the calculation of the mean of Gray relational coefficients of each alternative.

$$r(x_0, x_i) = \frac{1}{n}\sum_{k=1}^{n} \gamma\big(x_0(k), x_i(k)\big) \quad (12)$$

r(x_0,x_i),represents the Gray relational degree between x_i and x_0. The alternative with the highest Gray relational degree with the reference series is the series which is the most similar series and therefore is the best choice (Kuo, Yang ve Huang, 2008).

Fig.1: Process of calculation for Gray Relational Analysis (GRA)

The GRA is an efficient method as it does not require great computational power or sophisticated software, and it operates with a low number of cases and a large set of variables, where results can be provided almost instantly, during a participatory meeting session, providing strategic advantages over other quantitative methods. It is possible to quickly create a ranking of importance, which, can then feedback into the Delphi Method in iterative rounds within minutes. In such a way, it allows a more reliable, valid and economic way of designing and developing a Smart City Benchmarking Model.

4 THE CASE OF ISTANBUL SMART CITY

Below we provide an example of the proposed process in the case of Smart City Istanbul Benchmarking Model Development work, which was executed by the authors of this paper from Urban Policies Applied Research Centre of Istanbul University under the supervision of the Greater Municipality of Istanbul's Directorate of Smart City and POE ISBAK (Istanbul Information Technologies and Smart City Solutions Corporation).

Since the 1990s Greater Municipality of Istanbul has been investing in the intelligent, digital services and supporting infrastructures. Recently, these efforts are strongly upscaled as the city has become an important international hub in finance, business, transport, and ICT industries. One of the most recent efforts is the Smart Cities Program which covers a range of activities from developing a Smart City benchmark model to the assessment of the metropolitan city with Maturity Models.

The Greater Municipality of Istanbul has also commissioned other benchmarking works previously. As an example, last year an assessment and monitoring model was developed by the authors of this paper aiming to serve Istanbul's development as an international financial centre with a higher quality of life.

Benchmarking works are important for Istanbul as tasks of spatial strategy making and urban planning face significant challenges due to the sheer size and complexity of the Greater Municipality of Istanbul, as well as due to the diversity of stakeholders in a 16 million city. Conflicting agendas leading to incompatible directions have often been an important concern. On the other hand, meticulous encouragement of

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participatory processes in various stages of commissioned works by the Greater Municipality of Istanbul itself has enabled a suitable atmosphere for effective spatial strategy making. Still, time is invaluable in Istanbul, requiring effective and agile approaches to facilitate participatory processes.

4.1 Smart City Monitoring System Development

This emphasis on participatory processes has also been present in the recent project on Smart City Monitoring System Benchmarking Model Development, executed by the authors of this paper. The applied research team employed a variety of techniques which is believed to have improved the participatory processes in at least six ways:

- Improvement of the richness of information provided to the participatory process,
- Establishing trust among participants and practitioners by providing an up to date literature survey which associates domains and practical organisational forms with the Smart City Agenda,
- Improvement of communication across a wide range of heterogeneous stakeholders in a relatively limited amount of time,
- Eliminating indecisiveness, fuzziness, and inconsistencies that arise during large participatory events which evaluate, discuss and decide on a mixture of strategic and tactical aspects of Smart City Monitoring activities,
- Pragmatic and economic transfer of a large variety of opinions and decisions into the development of a set of benchmarking indices addressing a variety of Smart City domains,
- Provide adequately deep but small enough data to sustain a set of indicators to inform Smart City Maturity models to be developed at later stages.

Reducing the costs of updating and increasing the validity and reliability of the benchmarking model which opens up opportunities for long term assessment and evaluation. Furthermore, participatory processes achieved some gender targets where around 40% of external experts and 50% of executive teams consisted of women, including some top managers at IBB and ISBAK.

4.2 Focused Literature Survey, Text Mining, and Selection of Benchmark Cities

The team employed text mining techniques to a thoroughly evaluated body of existing indices or monitoring reports providing a strong coverage of important concepts relevant to particular domains of the Smart City paradigm. The synchronous literature survey did not solely focus on standard Smart City domains but rather functioned to enrich information and deepen understanding of identified domains. There were nine key domains identified as necessary by the associated departments of the Greater Municipality of Istanbul and its enterprise ISBAK. Initially, a total of 311 indicators were selected as the most relevant indicators with smart city domains and covering these nine functional areas. By iterative steps of evaluation between the research team and IBB and ISBAK teams, an initial set of 50 cities from the world was chosen as cases to be included in the benchmarking model, depending on data availability, institutional priorities and opinions of higher-level management.

4.3 Utilisation of Decision-Making Methods for Dimension Reduction, Weight Assessment and Computation of Benchmarking Indices

After the literature survey, text mining and secondary and primary data collection, a participatory workshop was held by the participation of 85 experts (of which 40% were women) from diverse backgrounds. The level of diversity was arranged so as to cover all the nine key domains and represent relevant academic, public, non-governmental and private stakeholders. The experts were chosen so as to attain gender equality in the best way possible, given differences across academic disciplines and professional positions.

The workshop aimed at the improvement of the representation power of the benchmark indices and establishing a consensus about the content across different disciplines and professions and across institutions.

Both the Delphi Method and the Gray Relational Analysis were used iteratively to extract locally embedded knowledge and reach a consensus on the content of indices representing selected Smart City Domains. The Delphi method is employed because it assumes that group-based forecasts are more accurate compared to individual forecasts as mentioned above, which becomes a concern where the subject topic is complex and information is incomplete. The Delphi Method relieves panellists from worrying about repercussions for their opinions since the responses of the participants are anonymous, and consensus can be reached over time as opinions are swayed.

First, the Delphi technique was employed to practically evaluate information and quickly provide feedback to associated participants to improve their decision making. The participants were organized according to 9 domains. In contrast to Anthopoulos & Reddick (2016), the method was used to returns within the same session to facilitate the advantages of time-saving. Similar to the work of Anthopoulos & Reddick (2016), participants were allowed to offer new indicators in the first session, which were not present in the preliminary work of researchers. This helped in the fine-adjustment of the focus in a very short time. Then, another grading was allowed. After the final group grading of domain indicators, there were 311 indicators in total for further assessment.

Then the next step started. Following real-world examples of strategic plans in Vienna and Seoul, the research team set the objective to decrease the large set of indicators to a smaller, manageable set. For this purpose, the Gray Relational Analysis method was used. The participants were asked to evaluate 310 indicators in terms of their importance, which, then lead to a ranking of indicators. A Likert scale was used where a score of "1" indicated that the indicator was not important and a score of "5" indicated that the indicator in question was very important. After diagnostic[5] procedures, the data set has become suitable for Gray Relational Analysis to evaluate the importance of indicators. The morning session was then completed.

In the afternoon session, overall results were provided to all experts and a participatory discussion with a time limit was allowed, similar to a Delphi Method. Then, participants were asked to grade the importance of each of the nine domains over 100 points. The ranking of the importance of domains established the basis for weighted calculations. The results were presented in real-time to all the participants. No objections were received to the ranking of nine domains and the procedure was stopped and the workshop ended.

After the workshop, indicators were short-listed by the research team, through a complex process of negotiation. These were the important factors in the elimination of tens of indicators from the model:

- Presence and ease of collection of data,
- Data availability for the subject city Istanbul,
- Ranking of each indicator, based on the Gray Relational Analysis of indicators by participants in the workshop.

As a result, the number of indicators were reduced from 311 to 143, spanning in nine domains. This is a higher number compared to other indicator systems used in Vienna and Seoul's strategic urban plans, still easily manageable.

The overall Smart City Benchmark Index was computed by these 143 indicators in 9 domains and the use of weights provided for 9 domains by the Gray Relational Ranking scores obtained from the participatory workshop. The benchmarking index was calculated for Istanbul and 45 world cities as data for other cities could not be reached. Finally, it was agreed by expert supervisors and the research team that the benchmarking model represented the relative position of Istanbul against other smart world cities.

As the methods and approach employed in the overall process were in general found to be suitable, valid, and economic by the commissioners, a monitoring plan was suggested. The plan incorporated repeated cycles of updating the list of indicators and the literature and a re-assessment of the new set of indicators through the use of the same approach every three years.

5 CONCLUSION

One of the lessons learned is that the involvement of Smart City domain-specialised teams of practitioners in the design of participatory processes enhances the possibility of inclusion of highly informed participants that have deep information in the embedded problems and future potentials of the city concerning available technological choices.

A second lesson learned is that a large variety of information can be quickly evaluated and incorporated in a participatory process without compromising the quality of decision making if domains are based on a well-

[5] The details of such procedures can be shared upon request. They are not provided here due to constraints on page size.

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matched combination of empirical and theoretical literature as well as existing organisational structures with the precondition that there are not strong information barriers between these domain-based organisational structures that allow flow of information and joint decision-making processes.

A third lesson learned is that learning by doing processes enables practitioners to provide rich local information to researchers and enable negotiation processes which help eliminating empty signifier problems. This enhances conceptual frameworks through mutual cognitive processes, eliminating risks when larger groups of stakeholders are included in further steps of building decision-making models and thus open the road to mutual intelligence.

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