



## Position paper: Benchmarking the performance of global and emerging knowledge cities



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### ABSTRACT

Knowledge-based development has become a new urban policy approach for the competitive cities of the global knowledge economy era. For those cities seeking a knowledge-based development, benchmarking is an essential prerequisite for informed and strategic vision and policy making to achieve a prosperous development. Nevertheless, benchmarked knowledge-based development performance analysis of global and emerging knowledge cities is an understudied area. This paper aims to contribute to the field by introducing the methodology of a novel performance assessment model—that is the Knowledge-Based Urban Development Assessment Model—and providing lessons from the application of the model in an international knowledge city performance analysis study. The assessment model puts renowned global and emerging knowledge cities—that are Birmingham, Boston, Brisbane, Helsinki, Istanbul, Manchester, Melbourne, San Francisco, Sydney, Toronto, and Vancouver—under the knowledge-based development microscope. The results of the analysis provide internationally benchmarked snapshot of the degree of achievements in various knowledge-based urban development performance areas of the investigated knowledge cities, and reveals insightful lessons on scrutinizing the global perspectives on knowledge-based development of cities.

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### 1. Introduction

Rapidly globalizing economic phenomenon of knowledge economy that refers to the increased economic significance of knowledge generation, commercialization and use (Cooke, 2002; Cooke & Leydesdorff, 2006), has brought a new perspective to urban planning and development (Van Winden, 2010). In recent years, so-called ‘knowledge-based urban development’ (KBUD) has become a considerably popular urban policy approach for cities aiming to increase their competitive edges (Huggins, 2010; Lonnqvist, Kapyla, Saloniemi, & Yigitcanlar, 2014), upgrading their hard and soft infrastructures (Bulu, 2011; Yigitcanlar, O’Connor, & Westerman, 2008), and improving the quality of (urban) life and place (Yigitcanlar, Velibeyoglu, & Martinez-Fernandez, 2008). Whilst the applications of KBUD policy in the global knowledge cities are widespread—e.g., Austin, Barcelona, Helsinki, Manchester, Melbourne, Singapore (Grodach, 2011; Yigitcanlar, 2009)—during the last decade KBUD has also received an increasing attention from the emerging knowledge cities—e.g., Beijing, Brisbane, Dubai, Istanbul, Kuala Lumpur, Monterrey, Shenzhen (Huggins & Strakova,

2012; Yigitcanlar & Sarimin, 2011; Yigitcanlar & Velibeyoglu, 2008; Zhao, 2010).

To date, the KBUD pursuits of emerging knowledge cities of the world are heavily dependent on lessons from their prosperous global knowledge city counterparts. However, the literature only provides a limited understanding on the KBUD processes and success and failure pathways of the global knowledge cities. Correspondingly, for emerging knowledge cities that are seeking a thriving KBUD, benchmarking is an essential prerequisite for informed and strategic vision and policy making to achieve a similar prosperous development of those global knowledge cities. Nonetheless, benchmarked KBUD performance analysis of global and emerging knowledge cities is an understudied area (Carrillo, Yigitcanlar, Garcia, & Lonnqvist, 2014).

This research paper, therefore, aims to contribute to the understudied area by scrutinizing KBUD in the context of benchmarking the performance of global and emerging knowledge cities. Following a thorough review of the literature on knowledge cities, KBUD, city benchmarking, and performance assessment, this paper introduces the methodology of a novel performance assessment model—i.e., the KBUD Assessment Model (KBUD/AM). Then, it undertakes an empirical KBUD investigation of global and emerging knowledge cities where the performance assessment model puts renowned 11 cities under the KBUD microscope—i.e.,

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Birmingham, Boston, Brisbane, Helsinki, Istanbul, Manchester, Melbourne, San Francisco, Sydney, Toronto, and Vancouver. Subsequently, the paper discusses the results of the analysis, and lastly, in the light of the findings the paper draws insightful lessons on scrutinizing the KBUD performance of cities.

## 2. Literature review

### 2.1. Knowledge cities and knowledge-based urban development

In the era of knowledge economy, sustainable economic growth and prosperity are highly associated with knowledge-based activities, where cities are critical agents of development (Cabrita, Cruz-Machado, & Cabrita, 2013). Pressures and new developments in the global knowledge economy era have prompted cities to focus their competitive strategies on (re)building and improving their knowledge bases—e.g., innovation capabilities (Gabe, Abel, Ross, & Stolarick, 2012). This shift has increased the value of knowledge-based activities in such economies (Hu, Lin, & Chang, 2005). Knowledge-based production, however, generally clusters in areas with a rich base of scientific and cultural knowledge related to specific industries (Baptista, 1996). This spatial imperative has tended to polarize such high-growth activity in a limited number of cities of the world, housing rich clusters of knowledge industries and workers and lifestyle options (Audretsch, 1998; Yigitcanlar, Baum, & Horton, 2007).

The popularity of such high-growth urban locations has led to the formation of a new city brand—i.e., knowledge city that is coined at the end of the last century. Various scholars defined this city brand as: “a city purposefully designed to nurture knowledge” (Dvir & Pasher, 2004, p. 17); “short hand for a regional [knowledge] economy driven by high value added exports created through research, technology and brain power... [and a city that] invests significantly more of the GDP in education, training and research” (Ergazakis, Metaxiotis, & Psarras, 2006, p. 6); “[a] region that bases its ability to create wealth on its capacity to generate and leverage its knowledge capabilities” (Chatzkel, 2004, p. 62), and; “a city purposefully pursuing knowledge as a means for development... in which its citizenship undertakes a deliberate, systematic attempt to identify and develop its capital system, with a balanced and sustainable approach” (Carrillo, 2004, p. 34).

Even though, today knowledge city is a highly popular city brand, as mentioned earlier there are still not that many successful examples of such high-growth urban locations. Buckley and Mini (2000) see the main reason for the limited examples of such successful knowledge cities as either the lack or failure of KBUD policies that aim for the formation of conditions for knowledge economy excellence of cities that results from the effective investment in people and ideas that create an environment where knowledge is produced, exchanged and marketed. In other words, the lack of efficient and effective KBUD planning, implementation and management processes is a reason for the limited success in knowledge city formation efforts (Yigitcanlar & Lonnqvist, 2013). This makes scholars to turn their attention on ways to overcome this deficiency by further exploring the KBUD phenomenon.

The literature emphasizes on various complementary aspects of KBUD. For example, Knight (1995) sees KBUD as a powerful urban policy for the transformation of knowledge resources into local development that provides a basis for sustainable development. In his more recent work, Knight (2008) suggests adoption of KBUD policies to boost the social learning process as a way for citizens to inform and become informed about the nature of changes occurring in their city. According to Kunzmann (2008), KBUD is a policy with sturdy operational perspective since it is a key planning approach that provides an important collaborative development framework for all parties—i.e., public, private, academic,

community—in the development of future strategic and knowledge-intensive urban and regional policies for attracting and retaining knowledge workers and knowledge-intensive industries, as well as nurturing of knowledge cities. Perry (2008) points out to the differing perspectives of KBUD policy as she identifies the three dimensions as process, acquisition and product, where in each case the relative importance of knowledge and space alters. In process-driven KBUD policy, knowledge is central and subject to change as a result of external pressures; whilst in acquisition-driven KBUD policy, knowledge itself is only a small part of the process, embedded in a wider set of economic, social, and cultural processes, and; in product-driven KBUD policy, much like the process-driven one, urban is only implied and peripheral and place is central to the concept of the knowledge city. However, according to her only a combination of all three dimensions into a more holistic KBUD vision can deliver desired outcomes.

Van Wezemael (2012) emphasizes on the heterogeneous context of KBUD due to its multidisciplinary and multifaceted nature—which is a complex and fuzzy concept—limiting its globally widespread inception. He suggests KBUD policy to reach beyond a neoliberal agenda of economic progress, and be viewed as a multiplicity and offer a rich potential to seek for alternative urban futures. Further dwelling on the idea of alternative urban futures and combination of KBUD perspectives, Maldonado and Romein (2010) argue that a sustainable KBUD policy only rests on a proper balance between: (i) economic quality, which depends on a good business climate to produce prosperity; (ii) socio-spatial quality, which is based on a good people climate for all people, and; (iii) organizational quality, which depends on coherence and consensus in the urban region, as well as a good interaction between main stakeholders (i.e., government, university, industry) to deliver concrete projects and initiatives. In line with their argument, Yigitcanlar (2010, 2011) introduces the four broad policy domains of KBUD—i.e., economic, societal, spatial, and institutional development—and describes KBUD as the new urban development policy of the knowledge era that aims to bring economic prosperity, environmental sustainability, a just socio-spatial order and good governance to cities. Yigitcanlar and Lonnqvist (2013) refer KBUD as a policy targeting of building a place to form perfect ‘climates’ for ‘business, people, space/place and governance’, and emphasize on the balance and integration of these climates. Fig. 1 illustrates the KBUD conceptual framework.

*Economic development* perspective of the KBUD policy aims to place endogenous knowledge assets in the heart of economic activities as it views knowledge as a locally embedded strategic and vital resource rather than exogenous, imported and supplementary (Lever, 2002; Nguyen, 2010). It aspires to build a knowledge economy producing prosperity achieved through strong ‘macroeconomic’ and ‘knowledge economy foundations’, and thus, forming a good ‘business climate’ (Carrillo et al., 2014).

*Societal development* perspective of the KBUD policy aims to increase skills and knowledge of residents as a mean for individual and communal development and societal high-level of achievements (Frane, Tomsic, Ronecevic, & Makarovic, 2005; Ovalle, Marquez, & Salomon, 2004). It seeks to form a knowledge society producing social equity achieved through strong ‘human and social capitals’, and ‘diversity and independency’, and thus, forming a good ‘people climate’ (Carrillo et al., 2014).

*Spatial development* perspective of the KBUD policy aims to promote conservation, development and integration of both natural and built environments, work towards building a strong spatial network relationship between urban development and knowledge clusters while driving an urban and environmental development that is ecologically friendly, high quality, unique and sustainable (Knight, 1995, 2008). It pursues to develop a knowledge milieu producing sustainability achieved through ‘sustainable urban

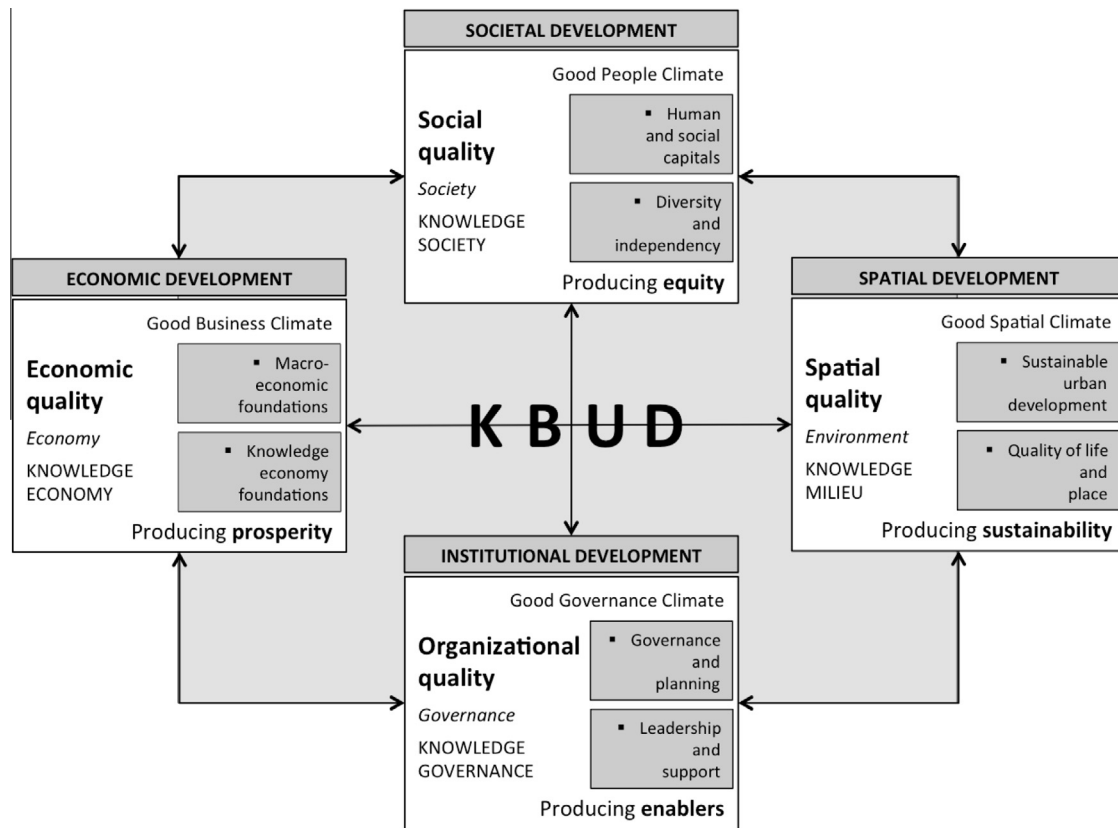


Fig. 1. Conceptual framework (Yigitcanlar & Lonnqvist, 2013, p. 359).

development' and 'quality of life and place', and thus, forming a good 'spatial climate' (Carrillo et al., 2014).

*Institutional development* perspective of the KBUD policy aims to democratize and humanize knowledge, institutionalize interdisciplinary collective learning processes and knowledge-based organizations, and play a critical role in the orchestration of the development. Such orchestration takes place by bringing together actors, stakeholders and sources to prepare a civic vision, plan strategically, and organize and facilitate necessary knowledge-intensive bases and activities (Knight, 2008; Kunzmann, 2008). It focuses on generating knowledge governance producing enablers achieved through strong 'governance and planning' and 'leadership and support', and thus, forming a good 'governance climate' (Carrillo et al., 2014).

These four development perspectives form the main policy domains of KBUD. Along with these domains, their development processes, balance and integration with each other within the 'systems theory' perspective (Bertalanffy, 1969), and incorporation of the 'knowledge-based view' (Grant, 1996) in the spirit of development together with 'organizational and sustainability capacities' (Van Winden, Van den Berg, & Pol, 2007) are among the central determinants of success in KBUD initiatives that support the knowledge city (trans)formation.

## 2.2. City benchmarking

Highly competitive nature of the global knowledge economy era puts cities in almost a desperate need to closely monitor progress and achievements of their competitors. At this point, city benchmarking is a useful method for following others and formulating improvements by making a comparative identification of the key elements, peculiarities and deficits (Luque-Martinez & Munoz-Leiva, 2005). City benchmarking exercise provides lessons

learned from comparisons—in a process whereby cities look beyond their boundaries as a means of learning and stimulating development—and helps in identification of future development and problem solving strategies (Huggins, 2010). This way, city benchmarking allows urban policy organizations to become learning organizations through the identification, comprehension and implementation of successful urban policy and development practices (Greene, Tracey, & Cowling, 2007).

In recent years, city benchmarking exercises have become increasingly widespread within the sphere of urban policy making, with many scholars arguing that careful and meaningful benchmarking is an essential prerequisite for informed and strategic policy making—that may provide a catching up opportunity for newly emerging knowledge cities (Luque-Martinez & Munoz-Leiva, 2005; Malecki, 2007). A number of international city benchmarking indices and studies have been published to assess the relative performance of cities globally focusing on different urban characteristics. These studies have coincided with a more sophisticated understanding of the elements of competition amongst cities. This has resulted in benchmarking against competitor or successfully competing cities becoming an essential tool for progressive city planning, management and development (Rondo-Brovetto & Saliterer, 2007; Stokje, 1999).

In sum, city benchmarking is seen as an invaluable method that can inform strategic planning and urban policy making, and thus can improve competitive positions of cities. Basically, benchmarking allows cities to: (i) take stock of the current situation; (ii) compare itself with cities that are performing better; (iii) identify strategies for improvement; (iv) set targets for future performance; (v) monitor and review progress; (vi) prioritize infrastructure and service funding; (vii) build networks amongst cities, and; (viii) provide opportunity for increased collaboration amongst cities (Holloway & Wajzer, 2008). Even though, many city benchmarking

studies are undertaken, thus far there has been only very limited applications of benchmarking studies specifically on knowledge cities investigating their competitive KBUD edges (see Yigitcanlar & Lonnqvist, 2013).

### 2.3. Knowledge-based urban development performance assessment

Evaluating the knowledge-based development performance of a city requires measurement information that is produced by capturing the values of relevant measurement variables. Today, around the world many public, private, academic and non-for-profit agencies have been developing city benchmarking and performance analysis models, tools or indices. For instance, the following list is only small a part of these city indices that are developed for conducting such measurements on one or more relevant aspects of KBUD (see Carrillo et al., 2014): (i) 2thinknow's Innovation City Index; (ii) A.T. Kearney, Inc.'s Global Cities Index; (iii) Between's Smart City Index; (iv) Charles Landry's Creative Cities Index; (v) GaWC's Globalization and World Cities Index; (vi) Ericsson's Networked Society City Index; (vii) GE's Sustainable City Index; (viii) GUCP's Global Urban Competitiveness Index; (ix) INSEAD's Global Innovation Index; (x) ISIIM's Knowledge City Index; (xi) Knoema's Global City Competitiveness Index; (xii) MERCER's Personal Safety, Quality of Life, and Eco-City Indices; (xiii) Milken Institute's Best-Performing Cities Index; (xiv) Monocle's Most Livable Cities Index; (xv) NEF's Happy Planet Index; (xvi) OECD's Better Life Index; (xvii) QS's World University Rankings; (xviii) Richard Florida's Creative Class Index; (xix) RMIT's Global University City Index; (xx) Siemens's Green City Index; (xxi) Simon Anholt's City Brands Index; (xxii) The Economist Group's Global City Competitiveness Index; (xxiii) The Mori Memorial Foundation's Global Power City Index; (xxiv) UN-HABITAT's City Development Index; (xxv) UN-HABITAT's City Prosperity Index; (xxvi) UN-HABITAT's Urban Governance Index, and; (xxvii) World Bank's Knowledge Economy Index.

Above listed indices are used to benchmark and rank cities globally, nationally or regionally. They are highly useful to determine the performance of a city based on a single or a combination of several KBUD characteristics—for example, knowledge economy or quality of life. However, there are a number of limitations of these indices, which are: (i) first of all, most indicators underlying the aggregate indices are based on variables measured in pieces or weights—in practice the composition of an index has indicators or variables as a basis, classified in dimensions; (ii) additionally, in most cases a subjective weighting has been applied to build the index—and these weights are not necessarily groundtruthed or a sensitivity analysis is conducted; (iii) moreover, individually these indices do not provide the full picture of a city's KBUD performance or achievements—that are indeed multi-facetted rather than single or limited; (iv) furthermore, the application of these indices is not straightforward—many issues, including the choice of factors to measure and data availability, must be considered, and; (v) lastly, a key feature in the existing measurement indices is the use of benchmarking to provide a point of reference for the interpretation of the measurement results (see Huggins, 2010)—nevertheless, as these indices do not provide the complete KBUD performance picture, benchmarked results are questionable when KBUD of cities is concerned (Carrillo et al., 2014). For these reasons, there is a need for an assessment model/index that is specifically designed for comprehensive KBUD performance analysis.

## 3. Empirical study

### 3.1. Methodology

Even though today many cities globally are considered successful in setting examples for implementing KBUD concepts, the

comparative KBUD performances of these cities are understudied, mainly due to the lack of available comprehensive KBUD performance analysis and benchmarking frameworks. The most comprehensive model developed to date for assessing KBUD performances of cities is so-called the 'KBUD Assessment Model' (KBUD/AM). KBUD/AM is a quantitative performance analysis model—or more correctly an index—that evaluates the KBUD achievements of cities and urban regions based on its large multivariable indicator base. One of the distinctive characteristics of this index is that it is specifically tailored for each case study based on the local circumstances, comparison and benchmark characteristics (Yigitcanlar & Lonnqvist, 2013). Moreover, it provides a flexible weighting opportunity for the sensitivity analysis of the results, and additional statistical procedures—i.e., cluster analysis—for better interpretation of the findings.

The KBUD/AM's methodological approach includes: (i) utilizing an indexing framework for KBUD assessment; (ii) determining indicators of the framework; (iii) determining the weightings of the indicators; (iv) collecting data via primary and secondary data collection techniques; using statistical techniques to scale and normalize data for comparison, and; (v) conducting statistical and descriptive analyses of the findings (Carrillo et al., 2014). The index consists of a composite indicator, four indicator categories, eight indicator sets and 32 KBUD indicators. Four of the indicator categories correspond to the four development pillars of KBUD—i.e., economic, societal, spatial and institutional. These pillars and the eight indicator sets are derived from the literature and the KBUD conceptualization earlier shown in Fig. 1.

The index has a large and flexible indicator base that is specifically determined for each comparative knowledge city study. Hence, the indicator set provides a valid broad picture view of KBUD despite the potential limitations of individual measures. These indicators are selected from the prominent KBUD literature (e.g., Carrillo & Batra, 2012; Carrillo et al., 2014; Grant & Chuang, 2012; Lin & Edvinsson, 2012; Scheel & Rivera, 2013; Veugelers, 2011; Yigitcanlar & Lonnqvist, 2013; Yigitcanlar, Metaxiotis, & Carrillo, 2012) with involvement of 25 international KBUD experts on the basis of the following key principles: (i) measurability; (ii) analytical soundness; (iii) comparability; (iv) geographic coverage; (v) data availability, and; (vi) relevance and suitability.

KBUD/AM, as default, uses an equal weighting for its indicators. However, to consider the potential benefits of assigning alternative weightings that may potentially improve the accuracy of the index findings, we determined suitable weighting options for the indicators of the index. The weighting options are determined as a result of a three round Delphi exercise conducted with the abovementioned 25 international KBUD experts (for more information see Carrillo et al., 2014). In this Delphi exercise, on top of the original: (i) equal category and indicator weighting systems, our experts suggested to consider; (ii) equal category and variable indicator weighting, and; (iii) variable category and indicator weighting systems. Table 1 illustrates the KBUD/AM structure and alternative indicator weightings.

Following the selection of indicators, KBUD/AM, firstly, requires standardization or in other words normalization of the indicator values. The index utilizes the z-score normalization technique to reflect the specific distribution of the indicator values and present a relative scale according to the best and worst performers. The z-score normalization of indicator values is calculated in accordance with the following formula:

$$z = \frac{(x - \mu)}{\sigma} \quad (1)$$

where  $z$  corresponds to the normalized indicator value,  $x$ ,  $\mu$  and  $\sigma$  subscripts denote data, mean and standard deviation values, respectively. Once normalized values are entered into the index,

**Table 1**  
Index structure, indicator descriptions and weighting options.

Composite indicator	Indicator categories	Indicator sets	Indicators	Indicator descriptions	Equal category & indicator weightings	Equal category & variable indicator weightings	Variable category & indicator weightings	
Knowledge-based urban development	Economic development	Macro economic foundations	Gross domestic product	Gross domestic product (GDP) per capita in USD purchasing power parities	0.03125	0.03114	0.0340	
			Major international companies	Number of global top 500 companies located	0.03125	0.02793	0.0279	
			Foreign direct investment	Ratio of international share in foreign direct investments	0.03125	0.02791	0.0290	
			Urban competitiveness index ranking	Global urban competitiveness index ranking	0.03125	0.03220	0.0323	
			Knowledge economy foundations	Innovation economy	International city ranking in innovation economy	0.03125	0.03258	0.0351
			Research and development	Ratio of research and development expenditure in GDP	0.03125	0.03415	0.0391	
		Patent applications	Patent Cooperation Treaty patent applications per million inhabitants	0.03125	0.03202	0.0349		
		Knowledge worker pool	Ratio between professionals and managers and all workers	0.03125	0.03208	0.0324		
		Category total		0.25000	0.25000	0.2647		
		Societal development	Human and social capitals	Education investment	Ration between public spending on education and GDP	0.03125	0.03583	0.0376
				Professional skill base	Ratio of residents over 18 years with tertiary degree (certificate, bachelor, master, PhD)	0.03125	0.03254	0.0324
				University prestige	World university rankings	0.03125	0.03329	0.0314
	Wireless broadband coverage			Ratio of access to fixed broadband subscribers per capita	0.03125	0.02768	0.0277	
	Diversity and independency			Cultural diversity	Ratio of people born abroad	0.03125	0.02984	0.0302
				Social tolerance	International country tolerance ranking	0.03125	0.03271	0.0320
	Socio-economic dependency		Ratio between the elderly population and the working age (15–64 years population)	0.03125	0.02993	0.0302		
	Unemployment level		Ratio of unemployment	0.03125	0.02817	0.0260		
	Category total			0.25000	0.25000	0.2476		
	Spatial development		Sustainable urban development	Eco-city formation	International city ranking in eco-city	0.03125	0.02855	0.0291
		Sustainable transport use		Ratio of sustainable transport mode use for commuting	0.03125	0.03188	0.0313	
		Environmental impact		CO <sub>2</sub> emissions in metric tons per capita	0.03125	0.02977	0.0258	
		Urban form and density		Population density in persons per km <sup>2</sup>	0.03125	0.03289	0.0327	
		Quality of life and place	Quality of life	International city ranking in quality of life	0.03125	0.04042	0.0377	
			Cost of living	International city ranking in cost of living	0.03125	0.02645	0.0229	
			Housing affordability	Ratio between GDP per capita and median dwelling price	0.03125	0.02675	0.0249	
		Institutional development	Governance and planning	Personal safety	International city ranking in personal safety	0.03125	0.03329	0.0331
				Category total		0.25000	0.25000	0.2375
				Government effectiveness	Level of government effectiveness	0.03125	0.03396	0.0367
	Electronic governance	International city ranking in e-government	0.03125	0.02613	0.0256			
	Strategic planning	Level of KBUD strategies in strategic regional and local development plans	0.03125	0.03613	0.0340			
	City branding	International city ranking in city branding	0.03125	0.03013	0.0320			
	Leadership and support	Effective leadership	Level of institutional and managerial leadership in overseeing KBUD	0.03125	0.02874	0.0293		



Strategic partnership and networking	Level of triple-helix and public-private-partnerships and global networking-global city ranking	0.03125	0.03258	0.0332
Community engagement	Level of institutional mechanisms for community building and public participation opportunities	0.03125	0.02961	0.0303
Social cohesion and equality	Level of income inequality (national gini coefficient)	0.03125	0.03273	0.0290
Category total		0.25000	0.25000	0.2502
Index total		1.00000	1.00000	1.0000

all indicators are assigned their weightings to calculate the indicator set scores, as specified by the following equation:

$$\begin{aligned}
 I_{MEF} &= \sum_{i=1}^n \frac{MEF_i}{n} * w_i; & I_{KEF} &= \sum_{i=1}^n \frac{KEF_i}{n} * w_i; \\
 I_{HSC} &= \sum_{i=1}^n \frac{HSC_i}{n} * w_i; & I_{DI} &= \sum_{i=1}^n \frac{DI_i}{n} * w_i; \\
 I_{SUD} &= \sum_{i=1}^n \frac{SUD_i}{n} * w_i; & I_{QLP} &= \sum_{i=1}^n \frac{QLP_i}{n} * w_i; \\
 I_{PL} &= \sum_{i=1}^n \frac{GP_i}{n} * w_i; & I_{SP} &= \sum_{i=1}^n \frac{LS_i}{n} * w_i
 \end{aligned} \tag{2}$$

where *I* and *w* correspond to the indicator score and the weight, and *MEF*, *KEF*, *HSC*, *DI*, *SUD*, *QLP*, *GP* and *LS* subscripts represent macro-economic foundations, knowledge economy foundations, human and social capitals, diversity and independency, sustainable urban development, quality of life and place, governance and planning, and leadership and support indicator sets, respectively. Then, indicator domain scores for each development domain are calculated, as specified by the following equation:

$$\begin{aligned}
 I_{EcoDev} &= \sum_{i=1}^n \frac{EcoDev_i}{n}; & I_{SocDev} &= \sum_{i=1}^n \frac{SocDev_i}{n}; \\
 I_{EnvDev} &= \sum_{i=1}^n \frac{SpaDev_i}{n}; & I_{InsDev} &= \sum_{i=1}^n \frac{InsDev_i}{n}
 \end{aligned} \tag{3}$$

where *I* corresponds to the indicator score and *EcoDev*, *SocDev*, *SpaDev* and *InsDev* subscripts represent economic, societal, spatial and institutional development indicator categories, respectively. Lastly, the composite indicator scores are calculated, as specified by the following formula:

$$I_{KBUD} = \sum_{i=1}^n \frac{KBUD_i}{n} \tag{4}$$

where *I* corresponds to the indicator score, *KBUD* corresponds to the *KBUD* composite indicator and *KBUD<sub>i</sub>* corresponds to each of the economic, societal, spatial and institutional development indicator category scores. After calculation of the *KBUD* performance scores and rankings of the case cities, the methodology of the *KBUD/AM* includes one last step—i.e., cluster analysis. This statistical analysis is undertaken to understand how assessed cities are grouped together. The cluster analysis provides an additional angle in the interpretation of the results—revealing insights on better understanding the similarities and differences between cities and the gap between them.

### 3.2. Application of the model and results

In the era of a global knowledge economy, cities that seek to increase their competitive edge, become destinations for talent and investment and provide prosperity and high quality of life to their inhabitants have little chance of achieving these goals without forming effective *KBUD* strategies (Yigitcanlar, 2009; Yigitcanlar & Dur, 2013). However, knowing the exact standing of a city in the global stage is important to adjust its *KBUD* policies to retain or improve its *KBUD* performances. In this study, *KBUD/AM* is applied to measure, compare and evaluate *KBUD* performances of 11 global and emerging knowledge cities—namely Birmingham, Boston, Brisbane, Helsinki, Istanbul, Manchester, Melbourne, San Francisco, Sydney, Toronto, and Vancouver. Among these case cities, eight of them are considered as globally well-known knowledge cities—that are Boston, Helsinki, Manchester, Melbourne, San Francisco, Sydney, Toronto, and Vancouver—and three of them are as emerging knowledge cities—that are Birmingham, Brisbane, and Istanbul (see Garcia, 2012; Garcia & Leal, 2012; Gonzalez & Carrillo, 2012). The city-regions of these global and emerging knowledge cities are considered in the analysis to take their metropolitan impacts in the account.

The overall benchmarked *KBUD* performance analysis provides useful findings. The results of the *KBUD/AM* global and emerging knowledge cities indexing exercise are listed in Table 2. The analysis ranks all case study cities based on their *KBUD* characteristics. In two out of three weighting systems Toronto comes as the top knowledge city—where San Francisco leads in one of them. According to the cluster analysis Toronto, San Francisco, Boston, Vancouver, Helsinki, Melbourne and Sydney group closely together, where the ranks of these cities change in the differing weighing systems (see Fig. 2). The ranking of the last four cities stay the same in all weighting options. However, Istanbul city shows a significant lower performance than Manchester, Brisbane and Birmingham, and thus not located in the second-tier cluster with these cities. The cluster analysis forms three significant city clusters according to their performances—see Clusters A, B, C in Fig. 2. The detail case study raw data and equal weighted index scores are placed in Appendix A.

In order to provide a more detail understanding of *KBUD* performances, as an example, here we focus on the *KBUD* indicator category results of the emerging knowledge cities—Manchester, Brisbane, Birmingham (Cluster B) and Istanbul (Cluster C)—by using the equal weighting calculation (see Appendix A). In spite of the overall *KBUD* ranking of these four cities—Manchester the best performer, Istanbul the worst, and Brisbane and Birmingham to follow Manchester—*KBUD* performances show variety in different *KBUD* indicator categories—i.e., economic, societal, spatial and institutional development. Although in the economic and institutional development categories Manchester leads the other three

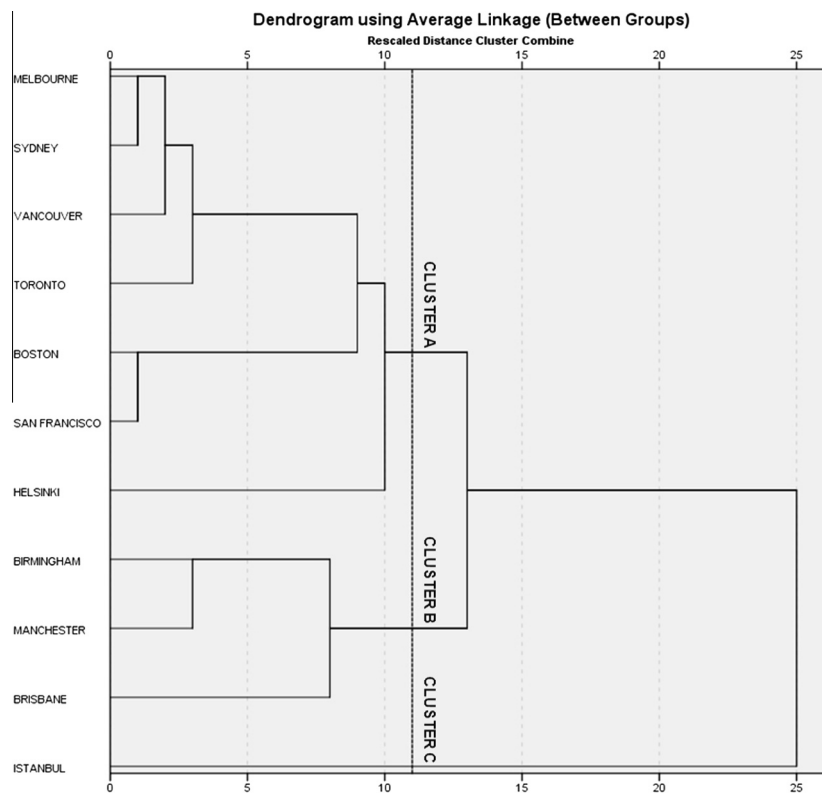
**Table 2**  
Index scores and ranking.

Rank	City	Equal weighted score <sup>*</sup>	City	Semi-equal weighted score <sup>**</sup>	City	Variable weighted score <sup>***</sup>	Cluster
1	Toronto	0.020695	Toronto	0.020746	San Francisco	0.020730	A
2	San Francisco	0.020421	San Francisco	0.020456	Toronto	0.020720	A
3	Boston	0.019303	Boston	0.019438	Boston	0.019730	A
4	Vancouver	0.019032	Vancouver	0.019072	Helsinki	0.019097	A
5	Helsinki	0.018909	Helsinki	0.019060	Vancouver	0.018965	A
6	Melbourne	0.017511	Sydney	0.017484	Sydney	0.017428	A
7	Sydney	0.017500	Melbourne	0.017470	Melbourne	0.017392	A
8	Manchester	0.013159	Manchester	0.013145	Manchester	0.013091	B
9	Brisbane	0.012439	Brisbane	0.012303	Brisbane	0.012105	B
10	Birmingham	0.011801	Birmingham	0.011805	Birmingham	0.011728	B
11	Istanbul	0.006003	Istanbul	0.005831	Istanbul	0.005704	C

<sup>\*</sup> Equal category and indicator weighted score.

<sup>\*\*</sup> Equal category and variable indicator weighted score.

<sup>\*\*\*</sup> Variable category and indicator weighted score.



**Fig. 2.** Cluster analysis dendrogram.

cities, the city comes second in the societal and third in the spatial development categories. In the societal and spatial development categories Brisbane has its dominancy over Manchester, Birmingham and Istanbul, but Brisbane gets the third place in the economic and institutional development categories. Birmingham receives the second place in the economic, spatial and institutional development categories, but underperforms as coming third in the societal development category. In the case of Istanbul, the city ranks last in all of the KBUD categories far behind other emerging knowledge cities. Amongst these four emerging knowledge cities Manchester and Brisbane are in a tough competition for becoming a prosperous knowledge city, where Birmingham follows them from slightly behind, and Istanbul has much more to invest and achieve to catch them up (see Appendix A).

Beyond the above reported overall ranking, clustering and indicator category results, it is also important to look into each

indicator set and indicator results, and to examine them in great detail. In doing so, it is also essential to double check the results with experts from these cities—for groundtruthing—and undertake sensitivity analysis on the findings. However, these analyses are beyond the scope of this paper (for more in depth analyses see Carrillo et al., 2014).

#### 4. Concluding remarks

The research reported in this paper revealed a number of insights for the benchmarked KBUD performance assessment of global and emerging knowledge cities.

In more broadly, this paper, through the reviewed literature and advocating benchmarked KBUD assessment, highlights a number of key opportunities for cities and their administrating

**Table A1**  
Index raw data.

Indicators	Birmingham	Boston	Brisbane	Helsinki	Istanbul	Manchester	Melbourne	San francisco	Sydney	Toronto	Vancouver
Gross domestic product	31421	64568	31600	47672	13498	31532	38141	76727	41891	40394	38675
Major international companies	0	5	0	1	1	0	4	10	3	9	0
Foreign direct investment	0.035	0.178	0.023	0.003	0.006	0.035	0.023	0.178	0.023	0.018	0.018
Urban competitiveness	83	13	113	16	136	36	22	9	31	11	47
Innovation economy	65	1	85	42	89	32	17	2	20	10	49
Research and development	0.018	0.027	0.021	0.035	0.007	0.018	0.021	0.027	0.021	0.020	0.020
Patent applications	37.7	581.0	69.0	529.0	15.5	58.4	113.7	676.1	154.6	247.6	159.1
Knowledge worker pool	0.275	0.463	0.313	0.494	0.252	0.275	0.351	0.453	0.370	0.444	0.432
Education investment	0.054	0.055	0.044	0.061	0.041	0.054	0.044	0.055	0.044	0.048	0.048
Professional skill base	0.280	0.390	0.295	0.348	0.075	0.310	0.336	0.404	0.346	0.408	0.390
University reputation	67	2	65	89	401	29	31	11	38	23	51
Broadband access	0.316	0.276	0.242	0.286	0.104	0.316	0.242	0.276	0.242	0.298	0.298
Cultural diversity	0.169	0.168	0.349	0.086	0.004	0.106	0.289	0.300	0.317	0.499	0.396
Social tolerance	10	8	5	19	34	10	5	8	5	1	1
Socio-economic dependency	0.238	0.184	0.192	0.185	0.076	0.220	0.183	0.181	0.176	0.158	0.169
Unemployment level	0.083	0.041	0.042	0.051	0.155	0.064	0.043	0.044	0.039	0.069	0.042
Eco-city formation	55	25	23	3	121	47	25	32	46	39	13
Sustainable transport use	0.230	0.171	0.129	0.420	0.420	0.250	0.136	0.189	0.204	0.442	0.256
Environmental impact	8.5	17.9	9.1	10.6	4	8.5	18.6	17.9	18.6	16.3	16.3
Urban form and density	2864	2009	1007	162	1409	385	495	474	357	921	776
Quality of life	52	36	34	35	112	57	18	30	11	15	5
Cost of living	150	129	22	42	70	148	21	106	14	59	65
Housing affordability	0.127	0.199	0.069	0.107	0.251	0.133	0.065	0.128	0.061	0.089	0.057
Personal safety	53	53	24	2	187	44	25	53	25	17	17
Government effectiveness	0.910	0.900	0.960	0.990	0.650	0.910	0.960	0.900	0.960	0.970	0.970
Electronic governance	4	2	8	19	69	4	8	2	8	3	3
Strategic planning	68.75	87.50	75.00	87.50	50.00	75.00	93.75	93.75	81.25	87.50	93.75
City branding	61	23	99	36	42	61	8	7	1	14	16
Effective leadership	62.50	81.25	50.00	87.50	50.00	76.25	91.25	87.50	77.50	81.25	90.00
Strategic partnership and networking	56.25	90.00	60.00	68.75	60.00	73.75	77.50	95.00	93.75	91.88	81.88
Community engagement	90.63	96.88	50.00	90.63	80.00	90.63	90.63	96.88	90.63	93.75	93.75
Social cohesion and equality	0.345	0.378	0.394	0.259	0.409	0.345	0.336	0.378	0.336	0.324	0.324

organizations. First of all, in line with [Holloway and Wajzer's \(2008\)](#) findings, benchmarked KBUD assessment helps in stock taking the current KBUD state of the city. This way urban administrators, policy makers and planners have a more clear idea in their existing KBUD strengths and potentials. Secondly, benchmarked KBUD assessment is particularly useful in comparing the city with others that are performing equally well or better. This helps in keeping eye on the potential competitors and following the emerging trends. Thirdly, clearly understanding the KBUD states of the city and its competitors leads to identify more effective vision, strategies and policies for improvement that aids the catching up or pioneering process. Fourthly, benchmarked KBUD assessment provides insights beyond short-term policy development. It helps in setting targets for mid- and long-term KBUD performance enhancement. Fifthly, when used continuously benchmarked KBUD assessment may serve as a KBUD progress monitoring and reviewing vehicle. This helps in securing public support behind the KBUD initiatives, and also prioritizing necessary infrastructure and funding. Lastly, benchmarked KBUD assessment practices helps in building global networks and increased collaboration with other prosperous and emerging knowledge cities.

More specifically, the paper through the introduced benchmarked KBUD assessment tool (i.e., KBUD/AM) reveals a number of insights for cities and their administrating organizations.

Firstly, a comprehensive approach is a necessity to develop knowledge cities as highlighted by the KBUD conceptual framework (see [Fig. 1](#)). Solely focusing on economic means proved not to be successful. Therefore, cities pursuing such prosperous development should give enough and equal attention to all pillars of KBUD—i.e., economic, societal, spatial and institutional. Beyond these pillars, the comprehensive KBUD approach should also

embed a strong balance, integration, sustainability and organizational capacity in its core development process. As also stated by [Carrillo et al. \(2014\)](#) KBUD/AM is proved to be a highly suitable tool to measure these aspects of our cities.

Secondly, KBUD is a daunting task, and therefore, city administrations, planners and policy makers need powerful decision and policy support tools and systems to make informed decisions and policies. In this regard, KBUD/AM is a suitable indexing model for providing a snapshot of benchmarked KBUD performances of cities. However, due to the highly complex nature of KBUD decision and policy making, the index needs to be further developed as an integrated system containing an expert system for better support the policy making processes of our cities—e.g., including expert systems, scenario building tools.

Thirdly, although experiences from other cities and exogenous assets are most valuable in strategizing KBUD, policy makers also need to build their niche along with their unique development characteristics based on their endogenous assets ([Velibeyoglu & Yigitcanlar, 2010](#)). Only this way, cities can achieve a successful and most importantly a sustained KBUD that will help them to become successful knowledge cities. In short, the balance between exogenous and endogenous assets, investment and talent plays a role on determining the sustainability and longevity of KBUD and the success of the city. For our KBUD/AM indexing model, this means a further calibration concerning this issue.

Fourthly, assessment and benchmarking analyses, like KBUD/AM presented, are highly useful in helping cities to determine and compare their potential and achievements and then benchmark their progress against the high achiever global knowledge cities. It is the benchmarking and comparative analysis that makes possible a clear gap analysis. This also informs the specifics of



**Table A2**  
Equal weighted normalized index scores.

Indicators	Birmingham	Boston	Brisbane	Helsinki	Istanbul	Manchester	Melbourne	San francisco	Sydney	Toronto	Vancouver
Gross domestic product	0.008692	0.028500	0.008803	0.020059	0.001584	0.008761	0.013213	0.030642	0.015936	0.014843	0.013596
Major international companies	0.006445	0.022112	0.006445	0.009138	0.009138	0.006445	0.018989	0.030377	0.015625	0.029669	0.006445
Foreign direct investment	0.012976	0.030537	0.010705	0.007449	0.007892	0.012976	0.010705	0.030537	0.010705	0.009783	0.009783
Urban competitiveness	0.006471	0.024367	0.002099	0.023720	0.000680	0.018704	0.022334	0.025177	0.020053	0.024779	0.015625
<b>Macro economic foundations</b>	<b>0.008646</b>	<b>0.026379</b>	<b>0.007013</b>	<b>0.015092</b>	<b>0.004823</b>	<b>0.011721</b>	<b>0.016310</b>	<b>0.029183</b>	<b>0.015579</b>	<b>0.019769</b>	<b>0.011362</b>
Innovation economy	0.005967	0.027388	0.002050	0.013832	0.001590	0.017773	0.023186	0.027182	0.022195	0.025259	0.011156
Research and development	0.009755	0.024752	0.014936	0.030491	0.000625	0.009755	0.014936	0.024752	0.014936	0.013147	0.013147
Patent applications	0.006216	0.028834	0.007418	0.027692	0.005440	0.006997	0.009335	0.030177	0.011264	0.016013	0.011484
Knowledge worker pool	0.003927	0.026408	0.007464	0.028593	0.002469	0.003927	0.012264	0.025501	0.014947	0.024601	0.023281
<b>Knowledge economy foundations</b>	<b>0.006466</b>	<b>0.026846</b>	<b>0.007967</b>	<b>0.025152</b>	<b>0.002531</b>	<b>0.009613</b>	<b>0.014930</b>	<b>0.026903</b>	<b>0.015836</b>	<b>0.019755</b>	<b>0.014767</b>
<b>Economic development</b>	<b>0.007556</b>	<b>0.026612</b>	<b>0.007490</b>	<b>0.020122</b>	<b>0.003677</b>	<b>0.010667</b>	<b>0.015620</b>	<b>0.028043</b>	<b>0.015708</b>	<b>0.019762</b>	<b>0.013065</b>
Education investment	0.023308	0.024806	0.005584	0.030048	0.002548	0.023308	0.005584	0.024806	0.005584	0.012088	0.012088
Professional skill base	0.009801	0.023540	0.011632	0.018564	0.000120	0.013560	0.016997	0.024932	0.018305	0.025300	0.023540
University reputation	0.016335	0.023081	0.016558	0.013885	0.000052	0.020450	0.020243	0.022241	0.019508	0.021062	0.018105
Broadband access	0.025368	0.018267	0.011269	0.020265	0.000118	0.025368	0.011269	0.018267	0.011269	0.022497	0.022497
<b>Human and social capitals</b>	<b>0.018703</b>	<b>0.022423</b>	<b>0.011261</b>	<b>0.020691</b>	<b>0.000709</b>	<b>0.020672</b>	<b>0.013523</b>	<b>0.022561</b>	<b>0.013667</b>	<b>0.020237</b>	<b>0.019058</b>
Cultural diversity	0.009620	0.009546	0.023730	0.004530	0.001686	0.005553	0.019336	0.020203	0.021496	0.029885	0.026436
Social tolerance	0.015147	0.017764	0.021482	0.005059	0.000160	0.015147	0.021482	0.017764	0.021482	0.025582	0.025582
Socio-economic dependency	0.002232	0.013904	0.011525	0.013601	0.031064	0.004786	0.014208	0.014818	0.016349	0.021612	0.018468
Unemployment level	0.008184	0.022572	0.022264	0.019280	0.000096	0.014600	0.021950	0.021631	0.023174	0.012801	0.022264
<b>Diversity and independency</b>	<b>0.008796</b>	<b>0.015947</b>	<b>0.019750</b>	<b>0.010618</b>	<b>0.008251</b>	<b>0.010021</b>	<b>0.019244</b>	<b>0.018604</b>	<b>0.020625</b>	<b>0.022470</b>	<b>0.023187</b>
<b>Societal development</b>	<b>0.013749</b>	<b>0.019185</b>	<b>0.015505</b>	<b>0.015654</b>	<b>0.004480</b>	<b>0.015347</b>	<b>0.016384</b>	<b>0.020583</b>	<b>0.017146</b>	<b>0.021353</b>	<b>0.021122</b>
Eco-city formation	0.009509	0.021030	0.021741	0.027356	0.000136	0.012467	0.021030	0.018395	0.012855	0.015625	0.024917
Sustainable transport use	0.012553	0.007000	0.004094	0.028692	0.028692	0.014676	0.004510	0.008537	0.009934	0.029477	0.015321
Environmental impact	0.025638	0.005930	0.024651	0.021781	0.030068	0.025638	0.004864	0.005930	0.004864	0.008853	0.008853
Urban form and density	0.030902	0.027918	0.015926	0.004919	0.021759	0.007238	0.008576	0.008311	0.006918	0.014621	0.012453
<b>Sustainable urban development</b>	<b>0.019651</b>	<b>0.015469</b>	<b>0.016603</b>	<b>0.020687</b>	<b>0.020164</b>	<b>0.015005</b>	<b>0.009745</b>	<b>0.010293</b>	<b>0.008643</b>	<b>0.017144</b>	<b>0.015386</b>
Quality of life	0.009531	0.015968	0.016804	0.016386	0.000180	0.007777	0.023013	0.018456	0.025224	0.024008	0.026796
Cost of living	0.002185	0.004501	0.026634	0.023214	0.016874	0.002356	0.026775	0.008475	0.027678	0.019513	0.018088
Housing affordability	0.013647	0.002812	0.024446	0.017602	0.000460	0.012388	0.025033	0.013368	0.025573	0.021105	0.026097
Personal safety	0.013751	0.013751	0.020813	0.025236	0.000073	0.015988	0.020585	0.013751	0.020585	0.022353	0.022353
<b>Quality of life and place</b>	<b>0.009779</b>	<b>0.009258</b>	<b>0.022174</b>	<b>0.020609</b>	<b>0.004397</b>	<b>0.009627</b>	<b>0.023851</b>	<b>0.013513</b>	<b>0.024765</b>	<b>0.021745</b>	<b>0.023334</b>
<b>Spatial Development</b>	<b>0.014715</b>	<b>0.012364</b>	<b>0.019389</b>	<b>0.020648</b>	<b>0.012280</b>	<b>0.012316</b>	<b>0.016798</b>	<b>0.011903</b>	<b>0.016704</b>	<b>0.019444</b>	<b>0.019360</b>
Government effectiveness	0.014782	0.013467	0.021208	0.024474	0.000072	0.014782	0.021208	0.013467	0.021208	0.022368	0.022368
Electronic governance	0.020473	0.021623	0.018040	0.011154	0.000055	0.020473	0.018040	0.021623	0.018040	0.021054	0.021054
Strategic planning	0.005486	0.021234	0.010016	0.021234	0.000308	0.010016	0.025764	0.025764	0.015625	0.021234	0.025764
City branding	0.005638	0.019864	0.000464	0.014574	0.012138	0.005638	0.025025	0.025310	0.026849	0.023146	0.022460
<b>Governance and planning</b>	<b>0.011595</b>	<b>0.019047</b>	<b>0.012432</b>	<b>0.017859</b>	<b>0.003143</b>	<b>0.012727</b>	<b>0.022509</b>	<b>0.021541</b>	<b>0.020431</b>	<b>0.021950</b>	<b>0.022912</b>
Effective leadership	0.005859	0.019940	0.001352	0.024325	0.001352	0.015906	0.026404	0.024325	0.016935	0.019940	0.025762
Strategic partnership and networking	0.002338	0.025371	0.003703	0.008785	0.003703	0.012722	0.015917	0.027829	0.027298	0.026400	0.019610
Community engagement	0.018376	0.023619	0.000071	0.018376	0.008806	0.018376	0.018376	0.023619	0.018376	0.021134	0.021134
Social cohesion and equality	0.016531	0.007298	0.004137	0.030766	0.002175	0.016531	0.019201	0.007298	0.019201	0.022489	0.022489
<b>Leadership and support</b>	<b>0.010776</b>	<b>0.019057</b>	<b>0.002316</b>	<b>0.020563</b>	<b>0.004009</b>	<b>0.015884</b>	<b>0.019975</b>	<b>0.020768</b>	<b>0.020452</b>	<b>0.022491</b>	<b>0.022249</b>
<b>Institutional development</b>	<b>0.011185</b>	<b>0.019052</b>	<b>0.007374</b>	<b>0.019211</b>	<b>0.003576</b>	<b>0.014306</b>	<b>0.021242</b>	<b>0.021154</b>	<b>0.020442</b>	<b>0.022221</b>	<b>0.022580</b>
<b>Knowledge-based urban development</b>	<b>0.011801</b>	<b>0.019303</b>	<b>0.012439</b>	<b>0.018909</b>	<b>0.006003</b>	<b>0.013159</b>	<b>0.017511</b>	<b>0.020421</b>	<b>0.017500</b>	<b>0.020695</b>	<b>0.019032</b>

KBUD strategies, and how they could be reformulated in this specific city case to close the gap and move the city in the needed KBUD progress direction.

Moreover, the value of KBUD performance measurement was evaluated from two perspectives. At a general level, the key strength is that the indicator system makes it possible to present

and analyze complex phenomena, such as KBUD of a city in a compact manner, and provide the big picture view. Benchmarking also provides a point of reference to the results. Furthermore, the analysis proved invaluable in better understanding investigated KBUD performance of our cities. Thus, the KBUD/AM process is applicable and provides value for analysis.

Furthermore, KBUD/AM represents the logic of a contemporary multivariable comprehensive KBUD analysis. The model certainly has room for further improvements—particularly in the aforementioned areas. Therefore, the empirical measurement results presented in this paper should not be regarded as the absolute truth of investigated cities' KBUD. Rather, it should be considered as an indication of the status of key KBUD variables and as a trigger for debate, further analysis and learning. Furthermore, the carefully described KBUD performance measurement process of KBUD/AM shows how such measurements can be undertaken and which of the key phases should be included in the process. This can be also used as a basis for the design of similar studies or more pragmatic analyses and for the further development of the measurement methodology.

Lastly, the recent literature indicates the lack of comprehensive KBUD performance assessment models for cities (Sarimin & Yigitcanlar, 2012). The KBUD/AM indexing model so far is the only decision support tool that can be used to measure, benchmark and evaluate KBUD of cities in a comprehensive manner. The literature emphasizes on the usefulness of integrating expert systems—computer systems that emulate the decision-making ability of a human expert (Jackson, 1998)—with the decision support systems in the case of such multidimensional and complex cases in order to enhance the capacity and accuracy of the urban policy making process (Kim, Wiggins, & Wright, 2011). Currently the KBUD/AM index as a decision support tool does not link with an expert system. In the literature such interlinked systems are referred as integrated systems. An integrated system includes both analytical—i.e., decision support system—and intuitive—i.e., expert system—systems, and it is widely claimed that a decision support system would be able to support higher levels of decision making if one or more of its subsystems—e.g., database, model base and user interface—is improved or enhanced by artificial or expert system reasoning (Witlox, 2005). Therefore, we are currently working on further developing the index particularly investing on its data entry automation, user-friendly single platform development, and along with the quantitative data being able to process the qualitative data via an expert system. Furthermore, in our future research the KBUD/AM index is planned to factor in the longitudinal data to undertake time-series analysis. The index is also going to contain a scenario-building component for estimating and evaluating the future policy scenario alternatives. Thus, KBUD/AM with its improved and integrated system is aimed to further support urban administrators, planners and policy makers dealing with complex decision situations in our cities.

## Appendix A

Index raw data and equal weighted normalized index scores are given in Tables A1 and A2

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