



## The application of urban sustainability indicators – A comparison between various practices

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### A B S T R A C T

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Urban population has been increasing and it is estimated to reach 70% of the total population in the world by 2050. Governments are facing greater challenges every time in providing inhabitants with a good quality of life in their cities. Many cities around the world have developed sustainable urban development plans for leading their urbanization process towards a desired status of urban sustainability. Urban sustainability indicators have been selected as main elements for communicating the status of the practice, which help to determine how successful strategies and policies enforced have been in the attainment of sustainability goals. Different practices use different indicators according to their particular needs, and these have been selected under different methods. However, whilst there are cases where urban sustainability indicators are effectively in use, the experiences gained from each practice have not been shared and used for the development of new urban development plans and for improving the decision-making process in the selection of indicators. This paper examines 9 different practices and proposes a comparative basis, namely, International Urban Sustainability Indicators List (IUSIL), for allowing the better understanding of drivers and goals of each practice and identifying under what circumstances various practices selected their indicators. Discussions made on the comparative analysis are categorized in four different dimensions: environmental, economic, social and governance. Research results show how comparative basis can lead to knowledge sharing between different practices, which can be used to guide the selection of indicators of sustainable urbanization plans and improve the effective communication of the status of practices. The study not only reveals how different indicators are selected but also suggests the need for consistent processes of choosing indicators based on the benchmarks obtained from best practices.

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### Introduction

Urbanization is defined by the United Nations as movement of people from rural to urban areas (2004). It is envisaged that the world, particularly in developing countries such as China and India, will witness an increase in urbanization in the immediate future with these two countries accounting together for about one-third of the increase in the urban population in the coming decades (United Nations, 2008). Developing countries have been implementing urbanization as a national strategy to drive economic development, in particular, to pursue balanced development between urban and rural areas. However, people continue moving into cities to seek a better life and economic opportunities.

Therefore, the practice of sustainable urbanization plays an important role in achieving global sustainability targets.

In line with the promotion of sustainable urbanization, international institutions and governments at different levels are seeking the optimum urban sustainability value. With the aim of understanding on the state of, or changes to, urban areas in relation to better urban sustainability performance, sets of indicators, frameworks and assessment tools, have been developed (Briassoulis, 2001; Davison, 1996). Urban sustainability indicators are crucial for helping on target setting, performance reviews and facilitating communication among the policy makers, experts and public (Verbruggen & Kuik, 1991). A wide range of urban sustainability indicators is therefore in use across the diversity of different cities and regions, which vary according to their particular needs and goals (Brandon & Lombardi, 2005; Verbruggen & Kuik, 1991). However, practical challenges have led to mixed results in applying sustainability indicators in different environments and sometimes

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with little gain in sustainability performance (Alshuwaihat & Nkwenti, 2002; Seabrooke, Yeung, & Ma, 2004; Selman, 1999). It has been argued that one of the main reasons for failing to attain the desired performance is the inadequate selection of indicators guiding and monitoring the sustainable urbanization process (Briassoulis, 2001; Seabrooke et al., 2004). It has also been argued that the lack of consensus on urban sustainability indicators between different practices has been causing confusion when selecting and relating them with the objectives defined or policies implemented (Legrand et al., 2007; Planque & Lazzeri, 2006). Others opined that there are still no standards pertinent and universal methods or criteria for selecting urban sustainability indicators (Kahn, 2006).

Urban sustainability indicators and their appropriate selection play undoubtedly an important role in successfully achieving the attainment of urban sustainability. However, whilst there are several cases where urban sustainability indicators are effectively in use, the experience gained from each practice has not been shared and used for the development of new sustainable urban development plans and for improving the decision-making process of selecting indicators. This appears mainly due to the lack of effective comparative basis, which can allow the comparison of different practices and facilitate the identification of best practices. The identification of best practices can lead to the generation of the benchmarks to be used for the assessment and diagnosis of existing practices.

### Research objectives and methodologies

The aim of this study is to critically examine and compare different sustainable urbanization practices in the process of selecting urban sustainability indicators. This comparative analysis can allow the knowledge sharing and use for future practices. In line with the study aim, several objectives are planned in this research work: (1) to understand the drivers for developing different list of urban sustainability indicators, (2) to compose a primary list of urban sustainability indicators for comparative basis, (3) to identify the indicators list adopted in individual practices in implementing sustainable urbanization plans, and (4) to examine the variations of the different practices with the primary list proposed in objective 2.

A comprehensive literature review was conducted to obtain the information needed for pursuing the objectives of this research. Information was obtained from books, academic journals, government and institutional reports, sustainable urban development plans and websites. A comprehensive list of urban sustainability indicators is composed by using various sets of indicators promoted by international and regional organizations, such as the United Nations (2007), the UN Habitat (2004), the World Bank (2008), the European Foundation (1998), the European Commission on Science, Research and Development (2000), the European Commission on Energy Environment and Sustainable Development (2004). These have been used as references for many countries and communities to develop their own sustainable urbanization indicators systems. These 6 different sets of indicators are integrated in a single list named "International Urban Sustainability Indicators List (IUSIL)". The purpose is to have a comprehensive list as a comparative base. IUSIL includes a wide variety of indicators that determine the urban sustainability performance of a city and are used to examine the variations between individual practices. IUSIL contains 115 indicators, formed into 37 categories in order to better structure the indicators within 4 sustainable development dimensions: environmental, economic, social and governance (See Appendix). IUSIL is proposed as comparative basis for analysing how different practices comply with its indicators

from environmental, economic, social and governance perspectives. Compliance consists in determining which indicators from IUSIL have been included, or have been included in similar terms, and or have not been included in the individual practices.

The research team identified 29 sustainable urban development plans at city level, however only 9 contained sufficient information for the analysis in this study. The information obtained refers to the generalities and description of individual practices, and the complete list of indicators proposed for monitoring the progress of each practice. The examination and comparison of these practices leads to the understanding on what and how indicators are adopted in the current practice. Therefore analysis can be given in whether these indicators are properly selected and whether the performance of sustainable urbanization practices is effectively communicated.

### Significance of sustainable urbanization

The rapid urbanization is often at the expense of the loss of valuable ecosystems and lands for satisfying the urban demands. Moreover, if the current and future urban areas continue with the same resource consumption practices without regarding the future needs, serious environmental, social and economic problems are expected (Daily, 1997; Millennium Ecosystem Assessment, 2003). Therefore, international organizations (e.g., UN Habitat, World Bank, OECD, and European Commission) have committed great efforts in promoting the mission of sustainable urbanization practice and currently the mission is widely addressed among different disciplines. Consequently, many concepts and definitions on sustainable urbanization have emerged. The following ones are between these typical:

- In U.S.A., the President's Council on Sustainable Development (PCSD) in its "1997 Report" defines sustainable communities as "communities that flourish because they build a mutually supportive, dynamic balance between social wellbeing, economic opportunity, and environmental quality" (President's Council on Sustainable Development, 1997).
- Sustainable city is "a city where achievements in economic, social and physical development are made to last" (Soegijoko et al., 2001).
- Urban sustainability is used as a desirable state of urban conditions that persists overtime (Adinyira, Oteng-Seifah, & Adjei-Kumi, 2007). The concept is often characterized by issues such as the proper use of resources to guarantee a generational equity, protection of the natural environment, minimal use of non-renewable resources, economic vitality and diversity, community self-reliance, individual wellbeing, and satisfaction of basic human needs (Choguill, 1996; Hardoy, Mitlin, & Satterthwaite, 1992).
- According to the European Commission (2006), urban sustainability is defined as the challenge to "solve both the problems experienced within cities and the problems caused by cities", recognizing that cities themselves provide many potential solutions.
- Sustainable urbanization refers to the well-balanced relationship between the social, economic and environmental agents in society, so as to accomplish sustainable urban development (Drakakis-Smith, 2000).
- Sustainable urbanization is a dynamic process that combines environmental, social, economic and political–institutional sustainability. It brings together urban and rural areas, encompassing the full range of human settlements from village to town to city to metropolis, with links at the national and global levels (UN Habitat, 2004).

The concepts presented above are often used indistinctly, even though differences exist. The terms “urban sustainability, sustainable city and sustainable community” refer to the desirable state, while “sustainable urbanization and sustainable urban development” refer to the process towards the desirable state. Whilst the principle of sustainable urbanization refers equal concern to environmental, governance, social and economic sustainability, social sustainability is more difficult to define due to its diverse, wide and subjective characteristics (Western Australian Council of Social Services, 2003). In a typical study by Polése and Stren (1999), social sustainability is described as “the development and/or growth that is compatible with the harmonious evolution of civil society, fostering an environment that encourage social integration, with improvements in the quality of life for all segments of populations”. Social sustainability is considered as one of the indispensable dimensions for measuring urban sustainability.

As the significance of sustainable urbanization has been increasingly appreciated, efforts to promote the practice have led to the development of instruments in form of policies and incentives to effectively integrate the concerns on environmental protection, economy equity and social wellbeing into urban development plans (Choguill, 1993; Holden, Roseland, Ferguson, & Perl, 2008; Marcotullio, 2001). However, the implementation of these policies needs to be monitored, which highlights the necessity to identify and select appropriate sets of indicators as tools for monitoring and providing the feedbacks needed to accomplish the desirable state of urban sustainability.

### Why urban sustainability indicators?

Indicators have the role of measuring performance, and in the process of urban sustainability assessment there is a need of measurable indicators. Several approaches to assess urban sustainability based on indicators have been developed. Ugwu and Haupt (2007) examined available techniques for evaluating different aspects of sustainability through the use of indicators. Zhang, Wen, Du, and Song (2008) used the methodological foundations of various assessment methods to propose a classification, which divided them into three different groups: system engineering, monetary evaluation and biophysical.

Many researches are attempting to document the extent to which cities are or are not becoming sustainable through the use of indicators, and to reveal the practical challenges that are being encountered in the process (see work done by Bell & Morse, 1999; Briassoulis, 2001; Roy, 2009; Tanguay, Rojaoson, Lefebvre, & Lanoie, 2010; Wong, Tang, Van, & Horen, 2006). However, the selection process of indicators should not be about gathering the information for all indicators, but rather selectively analysing the ones which are more fundamental in essence and more likely to produce the most accurate information about the status of practice. Mega and Pedersen (1998) opined that indicators must be clear, simple, scientifically sound, verifiable and reproducible. According to the United Nations Statistical Institute for Asia and Pacific (2007) an indicator must be SMART (i.e. Specific, Measurable, Achievable, Relevant, and Time-related). Zhang, He, and Wen (2003) proposed that urban sustainability indicators should provide at least the following: (1) explanatory tools to translate the concepts of sustainable development into practical terms; (2) pilot tools to assist in making policy choices that promote sustainable development and (3) performance assessment tools to decide how effective efforts have been.

Since early 1990's local and national governments across the world have developed indicators to measure the urban sustainability performance according to their local or national priorities

(Parris & Kates, 2003). Whilst there are various lists of urban sustainability indicators there is no single set of indicators that suits equally to all cities or communities. It is therefore appreciated that the use of common indicators is essential for monitoring and comparing the process of sustainable urbanization in order that this does not remain as an abstract concept. Comparable indicators are important because they allow cities to have a common grid to share and apply successful tools and measures (Ambiente Italia Research Institute, 2003).

### Comparisons in using urban sustainability indicators between practices

#### *Description of the practices*

For understanding the drivers for developing different list of urban sustainability indicators, it is necessary to firstly identify a number of different city sustainable development plans where sustainability indicators are adopted for monitoring the performance of the implementation of the plans. This study focuses on examining the sustainable development plans at city level as this is the level where the application of urban sustainability indicators can be best appreciated and compared. According to Campbell (1996) and Camagni (2002) a growing number of experts recognize that it is at the local scale, i.e. at the level of municipalities, cities or metropolitan regions, that the challenges are best expressed. This paper examines 9 practices selected from both developing and developed countries and regions in the world, including Melbourne, Hong Kong, Iskandar, Barcelona, Mexico City, Taipei, Singapore, Chandigarh and Pune. The generalities of each practice are presented in this section with the aim to show the purposes, goals, boundaries and milestones defined in their sustainable urban development plans. This can help to generate a big picture of each of these practices. In order to collect comparable valid data for comparison between practices, a template is used, which includes headings of “name”, “vision”, “action by”, “participants”, “term”, “date of launch”, “date of update”, “monitoring”, “focus areas”, “remarks”, as shown in Table 1.

#### *Melbourne*

The Melbourne's City Plan 2010 for sustainable development is a plan that defines the long-term vision for Melbourne which identifies four strategic objectives to reflect the aspirations for the sustainable urbanization of the city (Melbourne City Council, 2001). These are: (1) a connected and accessible city, (2) an innovative and vital business city, (3) an inclusive and engaging city, and (4) an environmentally responsible city. The City Council developed an integrated planning framework to ensure that its actions, policies and strategies help achieve the vision expressed in the plan. The vision is for Melbourne to be a thriving and sustainable city that simultaneously pursues a “triple bottom line” which is economic prosperity, social equity and environmental quality. The City Council has also committed efforts to monitoring the city's economic, social and environmental performance and tracking overtime how the city is working towards the vision of sustainability (Melbourne City Council, 2006). The City Council takes responsibility for achieving social, environmental and economic improvements through all their endeavors and reporting on them openly and transparently. According to the triple bottom line approach, the City Council identified and adopted a set of indicators in this plan to measure the city's sustainability performance.

**Table 1**  
General and comparable attributes of the practices.

Comparable attributes	Melbourne	Hong Kong	Iskandar
Name	City plan 2010	The HK2030 Study	Iskandar development region's comprehensive development plan
Vision	Towards a thriving and sustainable city	Asia's world city	A world class sustainable and environmentally friendly metropolis
Action by Participants	Melbourne City Council Government, academics and NGOs	Hong Kong Government Government, Professional Institutions, Academia and consultations to public	Government of Malaysia Government, Professional Institutions and Academia
Term Launched	10 years	30 years	–
Updated Monitoring	2000	2000	2007
Focus areas	2005	2007	–
Updated Monitoring	2005 & 2007	Every year	–
Focus areas	<ul style="list-style-type: none"> <li>• A connected and accessible city</li> <li>• An innovative and vital business city</li> <li>• An inclusive and engaging city</li> <li>• An environmentally responsible city</li> </ul>	Economy, health and hygiene, natural resources, society and social infrastructure, biodiversity, leisure and cultural vibrancy, environmental quality and mobility <ul style="list-style-type: none"> <li>• Provide a quality living environment</li> <li>• Enhance economic competitiveness</li> <li>• Strength links with Mainland China</li> </ul>	<ul style="list-style-type: none"> <li>• International rim positioning</li> <li>• Establishing hard and soft infrastructure enablers</li> <li>• Investment in catalyst projects</li> <li>• Establishing a strong institutional framework and the creation of a strong regulatory authority</li> <li>• Ensuring socio-economic equity and buy-in from the local population</li> <li>• Attract domestic and foreign investment</li> <li>• Five dimensions: Regulatory, social, physical, infrastructure and commercialization</li> </ul>
Remarks	<ul style="list-style-type: none"> <li>• Integrated planning framework</li> <li>• Triple bottom line: Economic prosperity Social equity Environmental quality</li> </ul>	<ul style="list-style-type: none"> <li>• Sustainable Development for the 21st Century in HK (SUSDEV 21)</li> <li>• Sustainability assessment system</li> <li>• Computer Aided Sustainability Evaluation Tool (CASET)</li> </ul>	<ul style="list-style-type: none"> <li>• Attract domestic and foreign investment</li> <li>• Five dimensions: Regulatory, social, physical, infrastructure and commercialization</li> </ul>
Comparable attributes	Barcelona	Mexico City	Taipei
Name	Sustainable Barcelona	Plan Verde (Green Plan)	Framework for Measuring Taipei's Urban Sustainability
Vision	Barcelona towards urban sustainability	The greenest city in Latin America	Making Taipei a city with sustainability characteristics
Action by Participants	Sustainable Barcelona Civic Forum NGOs, private and civil associations, and local authority	Government of Mexico City Government, Professional Institutions and Academia	Academics Academia, Professional Institutions and NGOs
Term Launched	–	15 years	–
Updated Monitoring	1995	2007	1998
Focus areas	–	–	–
Updated Monitoring	–	–	–
Focus areas	The efficient use of resources, avoid endangering people's health, biodiversity, diversified economy, service access, preserve the mixture of functions, gender equality employment, social work, establishment	Land conservation, Public space, Water, Mobility, Air, Waste, Energy	Ecological sustainability, water resources utilization, economy efficiency, resource self-sufficiency, environmental loading, living comfort, transport efficiency, environmental management, social welfare and public safety, education
Remarks	Barcelona City Council adopted the indicators in 1997	<ul style="list-style-type: none"> <li>• Communication Instrument</li> <li>• 3rd largest metropolitan population in the world</li> <li>• Experts said in 2000: "Total collapse of Mexico City by 2010"</li> </ul>	<ul style="list-style-type: none"> <li>• Signals lights (green, yellow and red)</li> <li>• Never implemented</li> </ul>
Comparable attributes	Singapore	Chandigarh	Pune
Name	Green Plan	City Development Plan of Chandigarh	City Development Plan of Pune
Vision	A model green city	The greenest city of India	An economically vibrant and sustainable city
Action by Participants	Government of Singapore Government, Academia, Professional Institutions and NGOs, Public consultations	Government of Chandigarh Government, Academia, Professional Institutions, NGOs, Public consultations	Government of Pune Government, Academia, Professional Institutions, NGOs, Public consultations
Term Launched	10 years	30 years	10 years
Updated Monitoring	1992 & 2002	2006	2006
Focus areas	1999 & 2002	–	–
Updated Monitoring	Every 5 years	Every year	Every year
Focus areas	Air and climate change, water, waste management, nature, public health, international environmental relations, reduce the ambient particulate matter, improve carbon intensity, reduce per capita water consumption, generate awareness of water resources	Governance, poverty alleviation, economic development, environment, roads, water, solid waste management, transportation, city institutions, municipal finance	Water supply, sewerage, storm water, drainage, solid waste management, transportation and roads, slums and basic services, land use, river conservation, economic development, cultural heritage, urban governance
Remarks	<ul style="list-style-type: none"> <li>• International awards for water management</li> <li>• Partner the 3P (public, private and people)</li> </ul>	<ul style="list-style-type: none"> <li>• Jawaharlal Nehru National Urban Renewal Mission (JNNURM) – 2005</li> <li>• Mandatory consultations</li> </ul>	<ul style="list-style-type: none"> <li>• Jawaharlal Nehru National Urban Renewal Mission (JNNURM) – 2005</li> <li>• Mandatory consultations</li> </ul>

### *Hong Kong*

Hong Kong Government adopted a Sustainability Assessment (SA) system in 2001 after a comprehensive study called the Sustainable Development for the 21st Century in Hong Kong (SUSDEV 21) that started in 1997 (Hong Kong Council for Sustainable Development, 2005; Hong Kong Council for Sustainable Development, 2005; Hong Kong Planning Department, 2001). The study was conceived in response to the need to take account of environmental and social concerns as well as economic aspects when making decisions about the future of Hong Kong. The key outputs of the study were a series of guiding principles and indicators representing the key sustainable development issues relevant for Hong Kong and a Computer Aided Sustainability Evaluation Tool (CASSET) to assist in evaluating the sustainability implications of strategic policy and project proposals. The guiding topics included in SUSDEV 21 are: economy, health and hygiene, natural resources, society and social infrastructure, biodiversity, leisure and cultural vibrancy, environmental quality and mobility (Hong Kong Council for Sustainable Development, 2005). The Hong Kong Government's Sustainable Development Unit, responsible of managing the sustainable urban development strategies, is committed to keeping the SA system and the CASSET effective and up-to-date. To achieve this aim, they update the baseline data of the CASSET indicators regularly. The last update was completed in July 2005.

The latest version launched in 2007 "Hong Kong 2030 – Planning Vision and Strategy" provides broad concepts and planning directions that allow the Government to get prepared for possible development needs. Under the overarching goal for sustainable development, they have set out three broad directions in preparing their planning strategies: (a) providing a quality living environment; (b) enhancing economic competitiveness; and (c) strengthening links with the Mainland China (Hong Kong Planning Department, 2007).

### *Iskandar*

The establishment of the Iskandar Development Region (IDR) in Johor State marked a new era of Malaysia's economy to open up to the world. The model of the development has been designed in IDR's Comprehensive Development Plan (Iskandar Regional Development Authority, 2008). This establishment aims to develop the Region to a developed and sustainable economy by attracting both domestic and foreign investments and the rigorous participation from domestic and overseas construction professionals. The vision and mission of the IDR is "A strong sustainable metropolis of international standing", echoed by the Prime Minister of Malaysia, Haji Ahmad Badawi "A world class sustainable and environmentally friendly metropolis" (Iskandar Regional Development Authority, 2008).

In order to implement the governmental mission of the IDR, The Iskandar Regional Development Authority (IRDA), established by a Federal Act of Parliament of Malaysia – IRDA Act 2007 (Act 664), has developed a Comprehensive Development Plan for Iskandar to steer the overall development framework (Iskandar Regional Development Authority, 2007). The purpose of Iskandar, providing a livable and sustainable conurbation, is clearly defined in the plan. Development strategies have been set to ensure the balance between these needs against economic growth, environmental quality, social and community development. As presented in the plan, five strategic pillars have been defined, including (1) International Rim Positioning, (2) Establishing hard and soft infrastructure enablers, (3) Investment in catalyst projects, (4) Establishing a strong institutional framework and the creation of a strong regulatory authority, and (5) Ensuring socio-economic

equity and buy-in from the local population. These pillars are driving forces for implementing IDR strategies and initiatives across five dimensions covering the regulatory, social, physical, infrastructure and commercialization aspects.

### *Barcelona*

The Sustainable Barcelona Civic Forum is an initiative for citizens participation that emerged as a response to a social need which was generated within the Federation of Neighborhood Associations at the command of a civic platform called Barcelona Energy Saving in 1995 (Gómez, 1998). Indicators were selected for determining the sustainability in the city of Barcelona based on ten principles leading to a sustainable city in the environmental, economic and social fields. The ten principles are: (1) the efficient use of resources (2) avoid endangering people's health (3) biodiversity (4) diversified economy (5) service access (6) preserve the mixture of functions (7) gender equality (8) employment (9) social work and leisure (10) establishment of alliance with other cities. The selection of indicators involved multidisciplinary working groups which held meetings on voluntary basis for defining the indicators and the methodology for measuring them. In October 1997, the Sustainable Barcelona Civic Forum and their indicators were recognized and adopted by the Barcelona City Council (ICLEI, 2000). Barcelona has been an example for other cities in Spain in promoting the application of sustainability indicators towards the sustainable urban development.

### *Mexico City*

The Mexico City's Green Plan ('Plan Verde' for its name in Spanish) launched in June 2007 is a body of strategies and actions to ensure the sustainable development of the city in a 15 years plan (Mexico City Government, 2007). 'Plan Verde' represents a communication instrument for informing the inhabitants of Mexico City about the government's sustainability targets. The plan is divided into seven thematic actions: land conservation, public space, water, mobility, air, waste and climate change and energy. One of the main measures of this plan is to restrict traffic, the main cause for the city's notorious smog. Many objectives contained in this plan were proposed in respond to the warnings from experts of a total collapse of the city by 2010 (Garza, 1996; Izazola, 2000). By meeting the proposed objectives, Mexico City's government intends to convert the city in the greenest one in Latin America.

### *Taipei*

In a manifestation that proposes the sustainable urban development of Taipei, Huang, Wong, and Chen (1998) conducted a research work to develop a sustainability indicator framework for measuring Taipei's urban sustainability. The main drivers were to reinforce the city's metropolitan life-support system through its economic vitality and make Taipei a city with sustainability characteristics. 80 indicators were selected with the participation of non-governmental organizations. These indicators were grouped into 10 general public indicators: ecological sustainability, water resources utilization, economy efficiency, resource self-sufficiency, environmental loading, living comfort, transport efficiency, environmental management, social welfare and public safety, and education. These are evaluated using signals lights (green, yellow and red), which help policy makers to determine the city performance and identify the priorities. For instance, if the performance of an indicator is fair, it is classified as 'yellow' light; but if the trend of this indicator moves towards sustainability, the rating of this indicator is regarded as "yellow to green" light.

### Singapore

The Singapore Green Plan (SGP) was issued in 1992 as a ten years plan towards sustainability. It described the policy directions that Singapore would take to become a model “green city” by the year 2000 (Chew, 2008). However, in 1999 a review of this first green plan was initiated to take into account new ideas and concerns, resulting in an outcome the SGP 2012 launched in August 2002. More than 17,000 people participated in the review through various platforms such as Internet survey and a public exhibition. It has brought out key environmental issues like climate change and resulted in a robust plan able to address emerging environmental challenges. With the new plan, Singapore wanted to move beyond just being clean and green and pursue attaining sustainability. In 2005, another extensive review was conducted, and the revised edition of the SGP 2012 was released in March 2006 (Ministry of the Environment and Water Resources, 2006). This revised edition covers six focus areas: air and climate change, water, waste management, nature, public health and international environmental relations. Four new targets were added to the previous edition: reduce the ambient particulate matter, improve carbon intensity, reduce Singapore’s per capita domestic water consumption, partner the 3P (public, private and people) sectors to generate greater awareness of water resources.

### Chandigarh

The city is known as one of the best experiments in urban planning and modern architecture in the twentieth century in India. It is also one of the fastest growing cities with a population decadal growth rate of 40.30%. The unique nature makes the city the name of ‘The City Beautiful’ and it is one of the greenest city of India (Chandigarh Administration, 2006). The city was planned to be developed in three phases, phase one started in early 1950’s and currently phase three is in progress. Phase three has been highly influenced by the emerging needs of a sustainable urbanization and the previous two phases are in the process of an urban renewal mission. Jawaharlal Nehru National Urban Renewal Mission (JNNURM) launched by the Government of India in 2005 selected Chandigarh City as a strategic area of development (National Institute of Urban Affairs, 2006). A City Development Plan (CDP) was required and a series of consultations were organized involving a wide spectrum of stakeholders. Consultations were mandatory in the preparation and finalization of master plan by Chandigarh Administration (National Institute of Urban Affairs, 2006). The discussions during consultations facilitated identification of needs, their prioritization and preparation of an accepted development plan for the city focusing on key sectoral areas including governance, poverty alleviation, economic development, environment, roads, water, solid waste management, transportation, city institutions, and municipal finance. The CDP comprises of 30 years outlining policy framework and investment interventions to achieve the vision of leading Chandigarh as a Global City following the principles of sustainable development (Chandigarh Administration, 2006). The CDP identified performance-monitoring/sustainability indicators to assist the City to review the progress of the CDP on an annual basis and to enable them in setting the agenda for the future.

### Pune

Pune is a city that has been functioning as one of the engines powering the economy of India (Pune Municipal Corporation, 2006). The city has been experiencing rapid urbanization, population growth and growing economy, which has led to the usual

problems of a developing metropolis such as garbage accumulation, traffic congestion, deteriorating roads, pollution, and excessive use of civic supplies like water, drainage and electricity. Similar to the case of Chandigarh City previously described, Pune City has also been benefited by the JNNURM (National Institute of Urban Affairs, 2006). Intense discussions with numerous stakeholders were conducted on the city’s strengths and potentials, as well as futuristic desires and perspectives which brought as a result the City Development Plan (CDP) of Pune. The development plan includes a clear vision for the city to be achieved by 2016 which was described as follows: “An economically vibrant and sustainable city with diverse opportunities and rich culture; where all citizens enjoy safe and livable environment with good connectivity” (Pune Municipal Corporation, 2006). This vision was translated into achievable objectives and strategies were developed to achieve these objectives which mainly focus on water supply, sewerage, storm water drainage, solid waste management, transportation and roads, slums and basic services, land use, river conservation, economic development, cultural heritage and urban governance.

### The comparison

The list IUSIL developed in previous section is used to assist in conducting comparative analysis between these 9 available cases. Due to the fact that indicators can be described or measured in different ways, for instance air pollutants indicators, which can be expressed by toxicity, quantity emitted or CO<sub>2</sub> content. Therefore, for the purpose of proper analysis, the descriptions and units of measurement for the indicators included in IUSIL must be clear and distinct indicators in order to avoid repetitions and a better classification. Indicators such as the ones related with water for example, there are different definitions and ways to be measured, which determine their classification under three different dimensions, namely, environmental, economic and social, as appreciated in Table 2.

The lists of indicators identified in each of the 9 practices selected are subjected to a compliance analysis for each of the 37 categories included in IUSIL. The compliance analysis consists in determining which indicators from IUSIL have been included in the individual practices, denoted by “✓”; which have been included in similar terms, denoted by “○”; and which have not been included, denoted by “-”. The results of the analysis are presented in Table 3 and the data in the table are also highlighted in various figures (i.e. Figs. 1–6) to facilitate the comparison analysis. In Figs. 1–4, 100% represents full compliance with IUSIL and the bars indicate the ratio of the included and similar indicators in each practice to the total

**Table 2**  
Classification of water related indicators.

<b>Environmental</b>	
Freshwater	Proportion of total water resources used Water use intensity by economic activity Presence of faecal coliforms in freshwater Biochemical oxygen demand in water bodies
Wastewater	Percentage of city population served by wastewater collection Percentage of wastewater receiving no/primary/secondary/tertiary treatment
<b>Economic</b>	
Water	Price of water Domestic water consumption per capita
<b>Social</b>	
Water Access	Percentage of city population with potable water supply service Number of interruptions in water service

**Table 3**  
Compliance of practices with IUSIL.

Category		Cities								
		C1	C2	C3	C4	C5	C6	C7	C8	C9
<b>Environmental</b>										
En1	Geographically balanced settlement	✓	○	–	✓	○	✓	–	○	✓
En2	Freshwater	–	–	○	✓	○	✓	✓	✓	✓
En3	Wastewater	–	–	○	✓	✓	✓	✓	✓	✓
En4	Quality of ambient air and atmosphere	✓	✓	–	✓	✓	–	✓	✓	–
En5	Noise pollution	✓	✓	–	✓	✓	–	–	✓	–
En6	Sustainable land use	–	✓	○	○	✓	○	–	✓	○
En7	Waste generation and management	–	–	✓	✓	✓	✓	✓	–	–
En8	Effective and environmentally sound transportation systems	✓	–	–	✓	✓	–	–	–	–
En9	Mechanisms to prepare and implement environmental plans	✓	–	✓	–	✓	–	✓	–	–
En10	Biodiversity	✓	✓	✓	○	✓	–	✓	–	–
<b>Economic</b>										
Ec1	Consumption and production patterns	–	✓	○	✓	○	○	○	–	–
Ec2	Economic development	○	✓	✓	–	–	○	–	✓	✓
Ec3	Finance	–	–	–	–	–	–	–	✓	✓
Ec4	Water	✓	✓	–	✓	–	–	–	–	–
Ec5	Strengthen small and microenterprises	–	–	○	–	–	–	–	–	–
<b>Social</b>										
So1	Energy Access	–	–	✓	–	○	–	○	–	–
So2	Water Access	–	–	✓	✓	✓	✓	✓	✓	✓
So3	Education	○	○	–	✓	–	–	–	–	–
So4	Health	–	✓	–	✓	–	–	○	–	○
So5	Safety	–	–	–	✓	–	○	–	–	–
So6	Fire & Emergency Response	–	–	–	–	–	–	–	○	–
So7	Poverty	–	–	✓	○	–	–	–	✓	–
So8	Transportation	✓	✓	✓	✓	✓	✓	–	–	✓
So9	Natural hazards	–	–	–	–	–	–	–	–	–
So10	Adequate housing	–	✓	✓	✓	–	○	–	–	✓
So11	Shelter	○	–	✓	–	–	○	–	○	✓
So12	Security of tenure	–	–	–	–	–	–	–	–	–
So13	Access to credit	–	–	–	–	–	–	–	–	–
So14	Access to land	–	–	✓	–	–	–	–	–	–
So15	Promote social integration and support disadvantaged groups	–	✓	✓	–	✓	–	–	✓	–
So16	Culture	✓	✓	○	○	–	–	–	✓	✓
So17	Recreation	–	✓	–	–	✓	–	–	–	○
So18	Availability of local public green areas and local services	✓	✓	○	○	✓	○	–	✓	○
<b>Governance</b>										
Go1	Participation and civic engagement	✓	✓	✓	–	–	✓	–	–	✓
Go2	Transparent, accountable and efficient governance	–	–	–	–	–	–	–	✓	○
Go3	Government	–	–	–	–	–	–	–	–	–
Go4	Sustainable management of the authorities and businesses	–	–	–	–	–	–	–	–	○

Keys: ✓ Included, ○ Similar, – Not included; C1 – Melbourne, C2 – Hong Kong, C3 – Iskandar, C4 – Barcelona, C5 – Mexico City, C6 – Taipei, C7 – Singapore, C8 – Chandigarh, C9 – Pune.

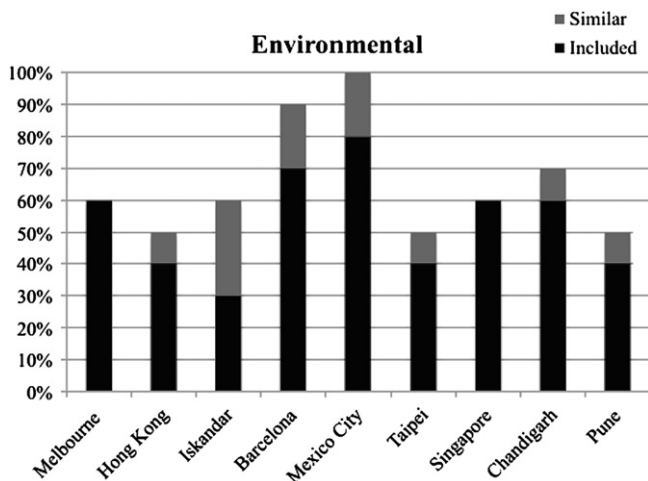


Fig. 1. Environmental dimension.

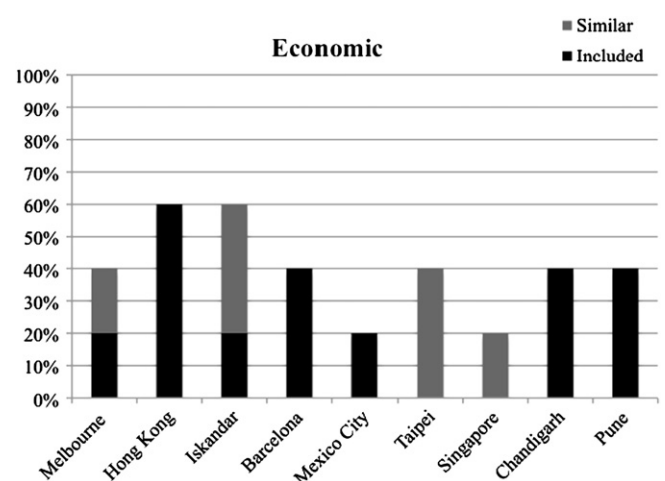


Fig. 2. Economic dimension.

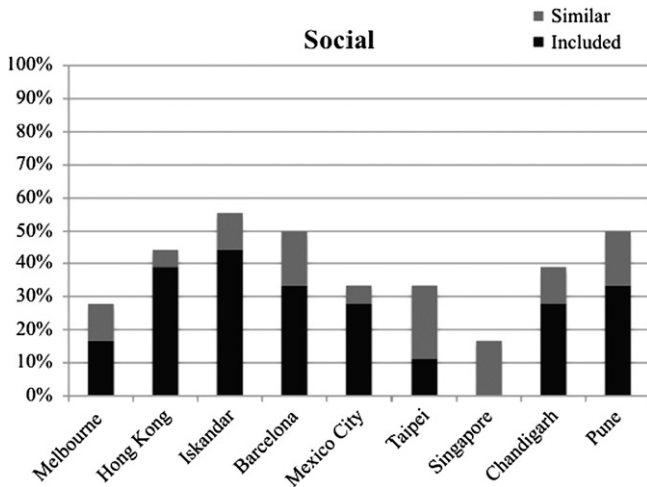


Fig. 3. Social dimension.

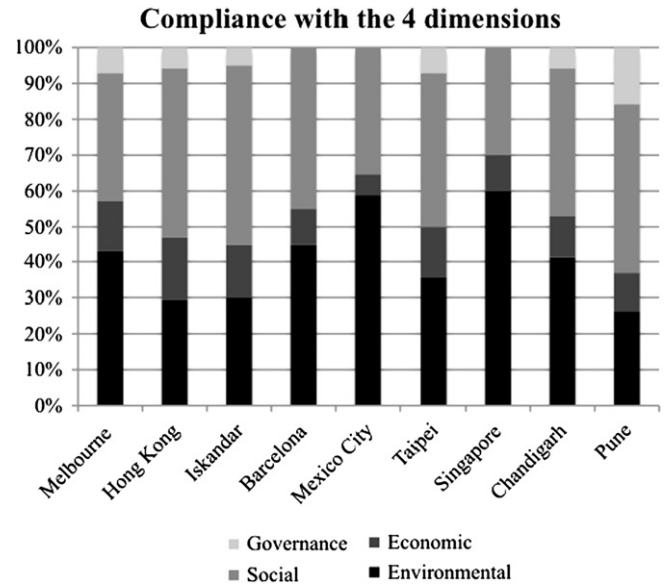


Fig. 5. Compliance with the 4 dimensions.

indicators included in IUSIL in each dimension accordingly. In Fig. 5, 100% represents the totality of indicators in each practice and the bars indicate the proportional compliance of each dimension. In Fig. 6, 37 represents the totality of categories included in IUSIL and the bars indicate the number of categories addressed by each practice.

**Discussions**

The above different practices tell us different stories of development of sustainable urbanization plans, the selection of urban sustainability indicators and their application. These plans were developed in different time, under different circumstances, and for varied purposes but by large for achieving sustainable urbanization. The differences between practices also reveal the difficulties in applying a set of common urbanization indicators. In the following section, discussions are made regarding the differences between the selected practices in compliance with the dimensions included in IUSIL.

*Discussion on environmental dimension*

In the practice of the environmental dimension as shown in Fig. 1, it is appreciated that Barcelona and Mexico City are the practices with higher compliance. For the case of Barcelona this could be understood because the inhabitants proposed the indicators of this practice, therefore the indicators and its targets represent a way of resident’s demands to the city council of Barcelona to meet the highest standards towards an outstanding urban sustainability performance. On the other hand, Mexico City case is different. Even when experts warned several times the importance to take actions to improve the environmental performance of Mexico City, these were not taken until the city was in a critical situation. Therefore, in Mexico City case it can be found that most of their indicators are focused in environmental issues, which represent the urgent needs of the city.

Chandigarh and Pune are cities with different priorities on environmental performance even when these two belong to the same country (i.e. India). Chandigarh focuses on the environment

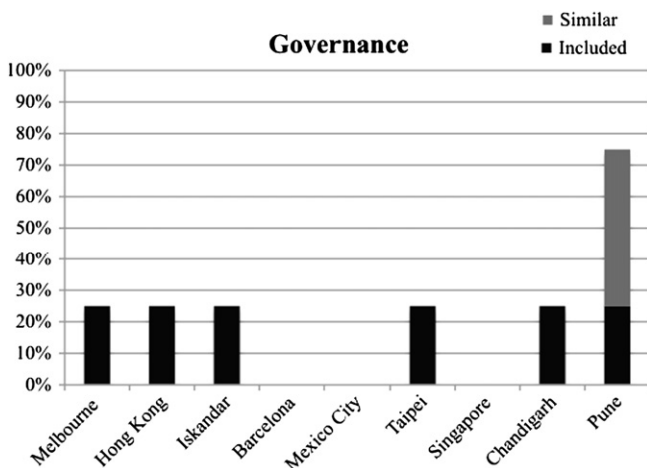


Fig. 4. Governance dimension.

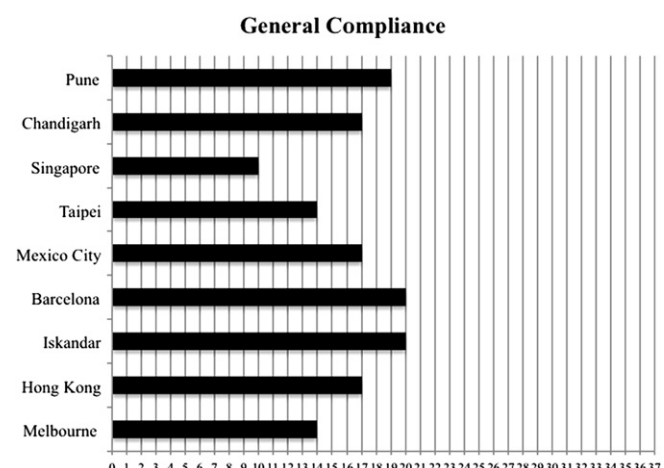


Fig. 6. General compliance.



dimension, while Pune on the economic dimension. Even when Chandigarh is already recognized as one of the greenest cities of India, their plan has a high compliance in environmental dimension. This is because, good environmental performance is a status they want to maintain and lead it to reach the position of the greenest city of India in a term of 30 years. On the other hand, even though Pune has more environmental problems, they have decided to address only the most important ones based on their needs and focus their efforts to improve them in a shorter term of 10 years.

#### *Discussion on economic dimension*

In the practice of economic dimension, as shown in Fig. 2, Hong Kong has the highest compliance. However, it is also appreciated that Hong Kong is the practice that has addressed a more balanced compliance with IUSIL across the four dimensions, while this is not the case for Mexico City and Singapore which practices only meet a high compliance in the environmental dimension. Hong Kong could be truly manifesting a practice towards urban sustainability by addressing the balance between the four dimensions. Probably this is also due to the mature characteristics of a city like Hong Kong.

Different to the case in the practice of environmental dimension, it can be seen that Barcelona, Chandigarh and Pune are with good level of compliance in this dimension. However, for Chandigarh this represents a plan for improvement in a term of 30 years and for Pune is about maintaining the good performance and strength it in a shorter period.

#### *Discussion on social dimension*

Iskandar is the practice with the highest compliance in the social dimension, as revealed in Fig. 3. Iskandar is a new development region and it is intended to be a place where investors can feel comfortable and their employees can fulfill their needs. Malaysian Government has clearly addressed a great deal on social issues in their plan for Iskandar to ensure the conditions and the environment needed to meet the expectations of the foreign investors.

Melbourne practice surprisingly does not comply much on the indicators of social issues. This is surprising because it is stated in their plan that one of the main drivers to develop an urban development plan that is in line with the principles of sustainable development was the increasing population growth in Melbourne. It could be interpreted that Melbourne social system is already good enough, which may be only subject to monitoring of issues out of control or with space for improvement.

#### *Discussion on governance dimension*

For most of the practices among the selected cities, indicators of governance dimension are not included as a specific section in their plans. However it could be found that some practices included indicators that belong to this dimension but were allocated in others. Barcelona, Mexico City and Singapore are practices that did not include any indicator related to this dimension, as illustrated in Fig. 4. Other practices did not comply more than 30% of the total indicators included in this dimension. The major reason for this is considered as that governance is well developed in most of the practices. The only exception was Pune, complying with more than 70% and this can be explained by understanding the JNNURM promoted by the Government of India (National Institute of Urban Affairs, 2006). The JNNURM stated that all those cities proposing their development plans in India, for instance the cases of Chandigarh and Pune, should modify their government structure to demonstrate the compromise and responsibility to achieve the goals stated in their plans towards sustainable urbanization.

Chandigarh government having already demonstrated efforts on environmental and social issues, it was only required to build a transparent, accountable and efficient governance. While in the case of Pune, a greater compromise was required.

#### *Discussion on the compliance with the 4 dimensions*

Fig. 5 can help to understand the dimensions that are under a stricter monitoring, which represent higher importance to assess the successful enforcement of policies in line to the achievement of the objectives towards a better urban sustainability performance. It is therefore shown that priority is given to environmental and social dimensions by all practices. It puts on evidence that efforts made by international institutions like United Nations and the World Bank, promoting sustainable development, has clearly influenced the local governments and particularly in addressing more efforts to enforce plans and policies to ensure a better environmental performance and to improve the wellbeing of their inhabitants.

#### *Discussion on the general compliance with IUSIL*

Fig. 6 demonstrates the general compliance of the list of indicators included in each of the practices with IUSIL and it can be seen that Barcelona and Iskandar are the ones that comply the most. However the effective use of indicators is not related to the number of these included for monitoring the practice but their proper selection to produce the most accurate information about the status of the practice (Adinyira et al., 2007; Tanguay et al., 2010). In the case of Barcelona, as previously mentioned, the inhabitants mainly selected the indicators. Their lack of expertise may have influenced the inclusion of indicators without enough foundations proving the importance of the inclusion or linking them with specific objectives or policies. Iskandar practice is a lot different, this is a region under development and the Malaysian government wants to ensure that it is built under enough monitoring that can accurately communicate an effective sustainable urbanization practice.

Mexico City and Hong Kong, are at the same level of compliance but with different needs, objectives and missions. Mexico City wants to be the greenest city in Latin America, while Hong Kong the Asia's world city. Mexico city with a considerable higher compliance than Singapore, these two focused on the environment dimension, but Singapore already with a long track on this commitment since 1992, while Mexico just started in 2007 and has a lot more urgent needs than Singapore.

#### *General comments*

The comparison between the nine practices can lead to the following general comments:

- Melbourne's City Plan 2010 appears to be more a statement of desired directions and this may convert its indicators more abstract. It may be worth to clearly identify the key issues expected rather than just providing a brief and very general discussion of emerging challenges. These challenges can be related to plan's goals and pathways. Moreover, some indicators do not have targets, making it appear like if these indicators are considered unimportant.
- The Hong Kong practice is different from the other ones, in which the government spent considerable time in selecting the indicators that are more applicable to Hong Kong. This practice instead of defining targets for each indicator, they have designed a tool that can assess the development plans and determine if these are in line with the sustainable development of the city.

- The set of indicators for Iskandar were developed for a projected urban area where the attraction of investment is important but rules have been determined in order to develop this area under the principles of sustainable development. Therefore, these indicators work more as guidelines since there is not enough available information at the moment in order to assess the sustainability performance.
- The limitations in Taipei case are evident. This is a research work, which aimed to measure Taipei's urban sustainability. However, the list of indicators is extensive and these are not validated by the government nor the citizens. No target values for each indicator had been defined yet. Nevertheless, the indicators proposed in this approach may represent valuable reference for Taipei's authorities to establish its indicator system.

## Conclusions

It is appreciated that the use of indicators for assessing urban sustainability performance is an important tool and has been widely adopted. Whilst various indicators have been applied in different ways, the aim pursued is the same, for attaining urban sustainability. Due to the differences between individual practices, the selection of indicators should be done with the clear understanding of the needs where these are going to be applied. A short list of indicators at the beginning of application is recommended,

and during later revisions more indicators can be added or eliminated according to the emerging needs and gained experience in individual cases. The integration of short term and long-term sustainable urban development plans should be encouraged and their continuity should be assured. Involvement of different sectors in the definition of objectives and strategies may represent an important step for obtaining the recognition and support when adding efforts to accomplish them.

It is important to emphasize that any attempt proposing a set of objectives and strategies to be applied indistinctly in all communities can be arguable. On the other hand, sharing experiences generated from different practices can eliminate the barriers that lead to the maturity of sustainable urbanization as a common practice. This can be done through the use of common comparative basis to differentiate the strategies and evaluate the results obtained from their implementation. The use of IUSIL in this study has demonstrated the importance of having comparative basis. It is envisaged that the continuous comparison of more practices can lead to the development of standard processes, which can be used to guide the development of particular plans, selection of indicators, objectives and strategies for implementing the sustainable urbanization practice in other communities.

## Appendix

International Urban Sustainability Indicators List (IUSIL).

Category	Indicator
<i>Environmental</i>	
En1 Geographically balanced settlement	En1-1 Population growth En1-2 Planned settlements
En2 Freshwater	En2-1 Proportion of total water resources used En2-2 Water use intensity by economic activity En2-3 Presence of faecal coliforms in freshwater En2-4 Biochemical oxygen demand in water bodies
En3 Wastewater	En3-1 Percentage of city population served by wastewater collection En3-2 Percentage of wastewater receiving no/primary/secondary/tertiary treatment
En4 Quality of ambient air and atmosphere	En4-1 Number of times the limit values for selected air pollutants are exceeded En4-2 Existence and level of implementation of air quality management plan En4-3 Emissions of greenhouse gases En4-4 Consumption of ozone depleting substances
En5 Noise pollution	En5-1 Share of population exposed to long-term high level of environmental noise En5-2 Noise levels in selected areas En5-3 Existence and level of implementation of a noise action plan
En6 Sustainable land use	En6-1 Artificial surfaces as a percentage of the total municipal area. En6-2 Extent of derelict and contaminated land En6-3 Number of inhabitants per Km <sup>2</sup> En6-4 Quota of new edification taking place on virgin area and quota taking place on derelict and contaminated land in % per year. En6-5 Restoration of urban land  a) Renovation, conversion of derelict buildings b) Redevelopment of derelict land for new urban uses c) Cleansing of contaminated land
En7 Waste generation and management	En6-6 Protected areas as a percentage of total municipal area En6-7 Land affected by desertification En6-8 Area under organic farming En6-9 Proportion of land area covered by forests En7-1 Percentage of city population with regular solid waste collection En7-2 Percentage of solid waste disposed to sanitary landfill/incinerated and burned openly/disposed to open dump/recycled/other En7-3 Total solid waste generation per capita En7-4 Generation of hazardous waste En7-5 Waste treatment and disposal En7-6 Management of radioactive waste

## Appendix: (continued)

	Category		Indicator	
En8	Effective and environmentally sound transportation systems	En8-1	Travel time	
		En8-2	Transport modes	
		En8-3	Energy intensity of transport	
En9	Mechanisms to prepare and implement environmental plans	En9-1	Local environmental plans	
		En9-2	Latest approval date of Master Plan	
En10	Biodiversity	En10-1	Proportion of terrestrial area protected	
		En10-2	Management effectiveness of protected areas	
		En10-3	Area of selected key ecosystems	
		En10-4	Fragmentation of habitats	
		En10-5	Change in threat status of species	
		En10-6	Abundance of selected key species	
		En10-7	Abundance of invasive alien species	
<i>Economic</i>				
Ec1	Consumption and production patterns	Ec1-1	Material consumption	
		Ec1-2	Material intensity of the economy	
		Ec1-3	Domestic material consumption	
		Ec1-4	Annual energy consumption, total and by main user category	
		Ec1-5	Share of renewable energy sources in total energy use	
		Ec1-6	Intensity of energy use, total and by economic activity	
Ec2	Economic development	Ec2-1	Macroeconomic performance  a) Gross domestic product (GDP) per capita b) Gross saving c) Investment share in GDP d) Adjusted net savings as percentage of gross national income (GNI) e) Inflation rate	
		Ec2-2	Employment  a) Employment-population ratio b) Vulnerable employment c) Labor productivity and unit labor costs d) Share of women in wage employment in the non-agricultural sector	
		Ec2-3	Information and communication technologies  a) Internet users per 100 population b) Fixed telephone lines per 100 population c) Mobile cellular telephone subscribers per 100 population	
		Ec2-4	Research and development  a) Gross domestic expenditure on Research and Development as a percent of GDP	
		Ec2-5	Tourism  a) Tourism contribution to GDP	
Ec3		Finance	Ec3-1	Debt service ratio
			Ec3-2	Tax collected as percentage of tax billed
			Ec3-3	Own-source revenue as a percent of total revenues
			Ec3-4	Capital spending as percentage of total expenditures
Ec4		Water	Ec4-1	Price of water
	Ec4-2		Domestic water consumption per capita	
Ec5	Strengthen small and microenterprises	Ec5-1	Informal employment	
<i>Social</i>				
So1	Energy Access	So1-1	Percentage of city population with authorized electrical service	
		So1-2	Total electrical use per capita	
		So1-3	Number and duration of electrical interruptions per year per customer	
So2	Water Access	So2-1	Percentage of city population with potable water supply service	
		So2-2	Number of interruptions in water service	
So3	Education	So3-1	Percentage of children completing primary and secondary education	
		So3-2	Percentage of school aged children enrolled in schools (by gender)	
		So3-3	Student/teacher ratio	

(continued on next page)

## Appendix: (continued)

Category	Indicator		
So4	Health		
	So4-1	Mortality a) Under-five b) Mortality rate c) Life expectancy at birth d) Healthy life expectancy at birth	
	So4-2	Health care delivery a) Percent of population with access to primary health care facilities b) Contraceptive prevalence rate c) Immunization against infectious childhood diseases	
	So4-3	Nutritional status a) Nutritional status of children	
So5	Safety	So4-4	Health status and risks a) Morbidity of major diseases such as HIV/AIDS, malaria, tuberculosis b) Prevalence of tobacco use c) Suicide rate
		So5-1	Number of homicides per 100,000 population
		So5-2	Number of sworn police officers per 100,000 population
		So5-3	Violent crime rate per 100,000 population
So6	Fire & Emergency Response	So6-1	Number of firefighters per 100,000 population
		So6-2	Number of fire related deaths per 100,000 population
So7	Poverty	So6-3	Response time for fire department from initial call
		So7-1	Income poverty a) Proportion of population living below national poverty line b) Proportion of population below \$1 a day
		So7-2	Income inequality a) Ratio of share in national income of highest to lowest quintile
		So8	Transportation
So8	Transportation	So8-1	Km of transportation system per 100,000 population
		So8-2	Annual number of public transit trips per capita
		So8-3	Commercial Air Connectivity
		So8-4	Average travel speed on primary thoroughfares during peak hours
		So8-5	Transportation fatalities per 100,000 population
		So8-6	Number of daily trips and time taken per capita by type of trip and by mode of transport
		So8-7	Total average daily distance covered per capita by type of trip and by mode of transport
		So8-8	Mode of transportation used by children to travel between home and school
So9	Natural hazards	So9-1	Percentage of population living in hazard prone areas
		So9-2	Human and economic loss due to natural disasters
So10	Adequate housing	So9-3	Disaster prevention and mitigation instruments
		So10-1	Durable structures
		So10-2	Overcrowding
		So10-3	Right to adequate housing
So11	Shelter	So10-4	Housing price and rent-to-income
		So11-1	Percentage of city population living in slums
		So11-2	Area size of informal settlements as a percent of city area and population
So12	Security of tenure	So12-1	Secure tenure
		So12-2	Authorized housing
		So12-3	Evictions
So13	Access to credit	So13-1	Housing finance
So14	Access to land	So14-1	Land price -to-income
So15	Promote social integration and support disadvantaged groups	So15-1	Poor households
So16	Culture	So16-1	Number of cultural establishments per 100,000 population
So17	Recreation	So16-2	City expenditures on culture as a percentage of overall city budget
		So17-1	Square meters of public recreation facility space per capita
		So17-2	City expenditures on public recreation as a percentage of overall city budget
So18	Availability of local public green areas and local services	So18-1	Citizens' access to nearby public green areas and basic services

## Appendix: (continued)

Category		Indicator	
<b>Governance</b>			
Go1	Participation and civic engagement	Go1-1	Citizens participation
		Go1-2	Voters participation
		Go1-3	Civic associations
Go2	Transparent, accountable and efficient governance	Go2-1	Transparency and accountability
Go3	Government	Go3-1	Corruption
		Go3-2	Percentage of population having paid bribes
Go4	Sustainable management of the authorities and businesses	Go4-1	Share of public and private organizations adopting and using environmental and social management procedures

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