Sustainability Concepts and Technical Criteria: 
The Case of Eco-city Megaprojects

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Abstract: Several international tools and standards exist for evaluating the level of sustainability of buildings or neighborhoods. Nonetheless, similar tools are still not internationally adopted in the context of new urban development or megaprojects. While such sustainability assessment tools are important, of special interest to practitioners is how to ensure that their requirements are well integrated in a proposed Master Plan. This paper is part of a research study which aims at assisting the design manager, during the pre-project planning stages of a new eco-city megaproject. The purpose is to evaluate the Master Plan alternatives in light of pre-defined sustainability requirements. The study relies on literature review on urban sustainability to infer key sustainability concepts and technical criteria for eco-city megaprojects. The research outcomes will pave the way for proposing a management framework to ensure the integration of sustainability criteria in the proposed master plan for a new eco-city.

Keywords: Eco-city, sustainable city, urban development, urban sustainability assessment, pre-project planning, megaproject design management

DOI: 10.7492/IJAEC.2014.011

1 INTRODUCTION

By the year 2030, urbanization is expected to increase in many developing countries. Approximately 60% of the world’s population will live in cities, consume 73% of the world’s energy and emit 76% of greenhouse gases (World Bank 2010). As such, a paradigm shift is needed in the urban land development practices in order to marry the crucial need to meet sustainable development with this boost in urbanization which is accompanied with exhaustive use of energy and emission of pollutants (Boyle et al. 2010).

1.1 Sustainable Development

Following several acts, international programs, and calls to protect the environment and save Earth, “Our Common Future” - also known as the Brundtland Report - issued by the World Commission on Environment and Development in 1987, introduced the concept of sustainable development (United Nations 1987). Since then, efforts by different interest groups and researchers to elucidate sustainability have led to a variety of definitions, mostly sharing the triple bottom line of environmental, social and economic dimensions of sustainability, nevertheless, with no internationally approved indicator sets (Mori and Christodoulou 2012). Thereafter, in response to the various calls for sustainable development, a new international wave of urban planning and development of the sustainable city - also known as eco-city - has appeared (Alusi et al. 2011). In 2012, the Rio plus 20 United Nations Conference on Sustainable Development reiterated several requirements for sustainable development. For example, the report highlighted the need to reduce the negative environmental impacts by adopting sustainable practices.

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in managing natural resources such as energy efficient measures in urban planning and transportation, reducing, reusing and recycling waste, conserving biodiversity and ecosystems, in addition to diversifying the energy mix with increasing share of renewable energy. In particular, the conference report emphasized the role cities can play in promoting sustainability if they are well planned and developed (United Nations 2012).

1.2 Problem Statement and Paper Contribution

While embarking on the management of a new mixed-use eco-city megaproject, practitioners are faced with many challenges. The project/program design managers are mainly concerned with:

i Identifying the sustainability requirements for the megaproject. There is a need to first consider the general sustainability characteristics that are common to any similar project elsewhere. While such requirements are provided by rating tools and standards at the level of building or neighborhood scale (e.g. SB Tool 07/Canada, LEED/United States (USA), BREEAM/United Kingdom (UK)), they are still not uniform and readily applicable across initiatives at the level of the urban/city scale (Joss et al. 2012). Similar to green buildings assessment tools, the urban sustainability assessment tools are supposed to guide the urban master planner and other multi-disciplinary teams on board (the transport planners, utility engineers, the architects and landscapers), and assist the decision-maker in comparing alternative solutions (Jensen and Elle 2007). Currently, urban sustainability is assessed with reference to indigenous contexts in the absence of internationally agreed upon city sustainability indicators and benchmarks (Mori and Christodoulou 2012). Through this project-specific approach, the derivation of eco-city sustainability requirements depends mainly on the initial involvement of local stakeholders, which may render the identified indicators less replicable, comparable and open to standardization (Joss et al. 2012). ii Ensuring during the early pre-project planning stages that these requirements are well integrated into a proposed Master Plan (MP). Some management tools (e.g. PDRI checklist) have been developed to assist project managers in quantifying the completeness of a project’s scope definition. However, they do not yet explicitly address sustainability objectives (Weerasinghe et al. 2007) and they are not devised to assist the pre-project planning activities for megaprojects such as cities.

This paper presents an attempt to tackle the first challenge (i) through a literature review of the literature on urban sustainability with a focus on eco-cities. This results in inferring the key eco-city sustainability characteristics. The objective is to provide practitioners with a proposed preliminary list of basic characteristics of a new eco-city megaproject, which is supposed to facilitate the integration of the technical requirements of sustainability within the project’s MP. Moreover, the list assists decision-makers to achieve a consensus in comparing initiatives of sustainable cities over time and place (Tanguay et al. 2010).

The following section (i.e., Section 2) presents the overall methodology of the ongoing research study which aims at proposing key eco-city sustainability criteria and integrating them into a pre-project planning framework. Section 3 examines the types of sustainable urban areas and identifies the relevant interest groups along with examples of urban sustainability tools. Section 4 defines the term eco-city, describes its evolution, and presents examples of such cities. The key eco-city sustainability characteristics are then synthesized in Section 5. Section 6 concludes and presents the path forward.

2 RESEARCH METHODOLOGY

Literature on sustainable cities consists of disparate streams of work. The methodology adopted by researchers and practitioners in defining, planning for, and assessing urban sustainability is investigated. Findings are synthesized with an attempt to delineate research gaps in academic literature on urban sustainability and eco-cities. In addition, the key common sustainability characteristics among various studies and initiatives are inferred and categorized. This work represents Track 1 of an ongoing research study (Figure 1) which aims at proposing a preliminary set of eco-city key technical criteria, internationally compatible and replicable, to serve during the initiation of a new eco-city megaproject (Alusi et al. 2011).

Furthermore, as sustainability needs to be operationalized (Gilmour et al. 2011), it is vital to ensure the integration of the identified sustainability criteria into an urban development MP. Knowing that planning at early stages increases the potential to meet urban sustainability objectives (Wallbaum et al. 2011), future research efforts (Track 2 in Figure 1) shall concentrate on developing a proposed management framework that assists the eco-city design manager throughout early pre-project planning stages. Activities such as value management, stakeholders’ participation, and use of decision-support tools assist the project’s design manager in aligning the multi-disciplinary teams and enhancing the development and integration of the eco-city megaproject’s sustainability requirements into the proposed MP (Gilmour et al. 2011).

During the last Track 3 of this research study, a case study of an ongoing eco-city megaproject will be investigated. Through content analysis and interviews with design managers, the proposed list of eco-city key
technical criteria and the proposed pre-project planning management framework will be tested, validated, and refined accordingly. Figure 2 illustrates how the proposed list of eco-city key technical criteria may be integrated within a proposed pre-project planning framework for a new eco-city megaproject.

The following section examines the types of sustainable urban areas and identifies the relevant interest groups along with the tools that they can use to ensure a successful implementation of a sustainable urban development.
3 URBAN SUSTAINABILITY

3.1 Types of Sustainable Urban Areas

Urban sustainability is addressed in the literature for existing urban areas or new land developments at the scale of cities or neighborhoods including their supporting infrastructure systems. Most academic articles tackle urban sustainability issues and characteristics in the context of assessing, enhancing, and monitoring sustainability in an existing city, considering its localities and focusing on infrastructure systems such as transportation, water, or energy [e.g. Austin city in Texas, USA; Cork City in Ireland; Heidelberg city in Germany (Yazar and Dede 2012)]. Others address the smaller scale of neighborhood/district [e.g. inner suburban housing subdivision in Perth, Western Australia (Karol and Brunner 2009)] or land development of small towns [e.g. township developments in Malaysia (Alias et al. 2011)]. Fewer researchers address the sustainability characteristics for a new eco-city project in specific, such as Masdar city in Abu Dhabi, United Arab Emirates (Cugurullo 2013; Menichetti and Vuren 2011) and Caofeidian International Eco-City in China (Joss and Molella 2013; Qiang 2009). Table 1 identifies the references that address urban sustainability for the various types and scales of urban areas.

3.2 Urban Sustainability Interest Groups

Literature on urban sustainability addresses two main categories of readers or interest groups:

i The theorists, visionaries and activists: including the environmentalist, the socialist, and the economist. This group focuses on the ecological and humanitarian perspectives of urban sustainability, including issues such as social ecology, equity, employment, bioregionalism, and climate change (Haughton 1997; Tanguay et al. 2010; Agudelo-Vera et al. 2012).

ii The practitioners: including the urban planner, the architect, the engineer, and the transport planner. This group focuses on the physical, technical, and specific characteristics of urban sustainability, irrespective of global concerns, including issues like infrastructure system for clean energy production, wastewater treatment, attractively designed features and public spaces (Kenworthy 2006; Lechtenböhmer et al. 2012; Mulligan et al. 2011; Wallbaum et al. 2011).

Table 2 classifies the peer reviewed journals that published articles on urban sustainability based on the main interest group they address. The main concern of the first group is to define the sustainable city for its image, promoting it through policies and regulations to ensure a healthy environment. The second group’s main concern is to find practical and innovative solutions through urban planning and design for constructing the sustainable city (Roseland 1997; Guy and Marvin 1999).

The following section describes the tools available for practitioners to assess, enhance, and monitor the degree/level of sustainability for an existing urban area.

3.3 Tools of Urban Sustainability

Different urban sustainability tools exist at the scale of an existing city or neighborhood such as Ecological Footprint, Environmental Sustainability Index, Dashboard of Sustainability (Mori and Christodoulou 2012) and other locally-developed indicators or indices (Tanguay et al. 2010).

In the context of a new eco-city, the practitioner is interested in two key types of urban sustainability tools that lead the launching of the project:

i Performance design guides: These are assessment tools (criteria, indicators or indices) that weigh different aspects of sustainability, with the aim of maintaining a functional standard based on the required sustainability goals and representing sustainable urban models (e.g. Jensen and Elle 2007; Yip 2008; Paranagamage et al. 2010; Yazar and Dede 2012).

Table 1. The sustainable urban areas in literature

<table>
<thead>
<tr>
<th>Urban Area</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eco-town</td>
<td>Ercoskun and Karaaslan 2011; Alias et al. 2011</td>
</tr>
</tbody>
</table>
Table 2. Peer reviewed journals addressing the theorists and the practitioners

<table>
<thead>
<tr>
<th>Title</th>
<th>Publisher</th>
<th>Impact Factor (2011)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addressing Theorists</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Pollution</td>
<td>Elsevier</td>
<td>3.746</td>
</tr>
<tr>
<td>Ecological Indicators</td>
<td>Elsevier</td>
<td>2.695</td>
</tr>
<tr>
<td>Environmental Impact Assessment Review</td>
<td>Elsevier</td>
<td>2.596</td>
</tr>
<tr>
<td>Resources, Conservation and Recycling</td>
<td>Elsevier</td>
<td>1.759</td>
</tr>
<tr>
<td>European Urban and Regional Studies</td>
<td>Sage</td>
<td>1.673</td>
</tr>
<tr>
<td>Environment and Urbanization</td>
<td>Sage</td>
<td>1.667</td>
</tr>
<tr>
<td>Cities</td>
<td>Elsevier</td>
<td>1.143</td>
</tr>
<tr>
<td>Addressing Practitioners</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Science and Technology</td>
<td>American Chemical Society</td>
<td>5.228</td>
</tr>
<tr>
<td>Indoor and Built Environment</td>
<td>Sage</td>
<td>2.000</td>
</tr>
<tr>
<td>Sustainable Development</td>
<td>Wiley</td>
<td>1.043</td>
</tr>
<tr>
<td>Journal of Urban Planning and Development</td>
<td>American Society of Civil Engineers (ASCE)</td>
<td>1.032</td>
</tr>
<tr>
<td>Sustainability</td>
<td>MDPI</td>
<td>0.656</td>
</tr>
<tr>
<td>Planning Practice &amp; Research</td>
<td>Taylor &amp; Francis</td>
<td>0.510</td>
</tr>
<tr>
<td>Urban Design International</td>
<td>Palgrave Macmillan</td>
<td>0.500</td>
</tr>
<tr>
<td>Journal of Urban Technology</td>
<td>Taylor &amp; Francis</td>
<td>0.414</td>
</tr>
<tr>
<td>Canadian Journal of Civil Engineering</td>
<td>NRC Research Press</td>
<td>0.334</td>
</tr>
<tr>
<td>Transport</td>
<td>Proceedings of the Institution of Civil Engineers</td>
<td>0.333</td>
</tr>
<tr>
<td>Municipal Engineer</td>
<td>Proceedings of the Institution of Civil Engineers</td>
<td>0.288</td>
</tr>
<tr>
<td>Urban Design and Planning</td>
<td>Proceedings of the Institution of Civil Engineers</td>
<td>0.263</td>
</tr>
<tr>
<td>Journal of Green Building</td>
<td>College Publishing</td>
<td>0.215</td>
</tr>
<tr>
<td>International Journal of Sustainable Development and Planning</td>
<td>WIT Press</td>
<td>0.080</td>
</tr>
</tbody>
</table>

Note: * - The impact factor is calculated through scopus.

ii Process guides: These are planning or design management roadmaps and frameworks that describe the steps to be followed in project management towards sustainability (e.g. Jensen and Elle 2007; Yip 2008; Ercoskun and Karaaslan 2011; Yazar and Dede 2012).

In this paper, the key findings of a literature review on the first type of urban sustainability tools (performance design guides) are presented. Future research efforts (Track 2) shall include reviewing the literature on the second type (i.e. process guides). The literature review suggests that, while several international sustainability tools (e.g., SB Tool 07/Canada, LEED/USA, BREEAM/UK) exist for evaluating the level of sustainability of buildings or neighborhoods (Jensen and Elle 2007; Karol and Brunner 2009), and some devised indicators and indices for civil infrastructure systems (Dasgupta and Tam 2005; Yigitcanlar and Dur 2010; Shen et al. 2011), there are still no available international sustainability assessment tool in the context of a new eco-city. Eco-city sustainability is only described through concepts, principles, dimensions, characteristics and tailored guidelines, spun-out from local contexts, with lack of a scientifically-proven internationally approved sustainability tool (Yip 2008; Joss 2011). The following section defines the term Eco-city and presents examples of such cities.

4 ECO-CITY

4.1 Definitions

The concept of a sustainable city is looked at differently by different researchers. Many authors stress the objective of conserving the city’s resources and minimizing waste and pollution; in this regard, they call it the ecological city or simply eco-city or low/zero-carbon city (Roseland 1997; Kenworthy 2006; Yip 2008; Qiang 2009; Joss 2011; Menichetti and Vuren 2011; Joss et al. 2012; Eryildiz and Xhexhi 2012; Cugurullo 2013). Others highlight the importance of high density and mixed-use land and designate it by the term compact city (Kenworthy 2006; Jenks and Jones 2010) or resilient city which is characterized by flexibility and adaptation to change (Haughton 1997; Agudelo-Vera et al. 2012). Several authors emphasize the role of technology, referring to the sustainable city as smart/intelligent city (Abdoullaev 2011) or eco-tech city (Ercoskun and Karaaslan 2011; Joss and Molella 2013). Recently, some authors describe eco-city as a ubiquitous city or u-city, focusing on the role of information and technology infrastructure in providing continuous services to its inhabitants (Shwayri 2013). It is noted that most of the characteristics of the different terminologies that define a sustainable city are embedded within the term eco-city which is mainly used across this paper.

4.2 Origins

The concept of an eco-city was first introduced in 1987 by Richard Register, a leading theorist and author in ecological city design and planning (Ecobuilders 2012). Since then, eco-city initiatives have evolved through three stages (Joss 2011). A theoretical normative perspective characterizes the first stage (1980s to early 1990s). The second stage (1992 to early 2000s) is characterized by a regulatory perspective with some local and national eco-city pilot projects such as Curitiba in Brazil, Waitakere in New Zealand, and Schwabach...
in Germany, and several cities in China. The last and current stage (2000s to present) is characterized by an innovative perspective resulting in an attempt to reduce CO₂ levels (Yip 2008; Joss 2011).

Today, some international actors, leading companies, and governmental bodies are working on promoting and guiding eco-cities initiatives. The World Bank launched the ECO² Cities Program to support cities in promoting ecological and economic sustainability through integrated urban planning and management (World Bank 2010). The United Nations issued the UN urban indicators guidelines. Eco-City Builders, a non-profit organization founded by Register in Berkeley, California, organized several international eco-city conferences (Ecobuilders 2012). The joint initiative between the Clinton Climate Initiative and the U.S. Green Building Council is working with world’s largest cities committed to taking action on climate change (Alusi et al. 2011).

### 4.3 International Initiatives

Eco-city initiatives differ in their type of development; some are new city projects, while others are expansion of existing urban area or urban retro-fit projects (Joss 2011). To initiate a new eco-city project, Joss (2011) delineates six possible driving factors: environmental challenges, socio-economic pressures, business development, cultural branding, political leadership, and international co-operation. Nevertheless, three key considerations are critical to embark on an eco-city project: (i) the scale, in terms of project area, infrastructure and innovation; (ii) the sectors, including housing, transport, energy, waste, water, and land; and (iii) policy processes (Joss 2011).

Since the early 2000s, geographically diverse new eco-city initiatives have been undertaken with different aims, partnerships, financing schemes, and relative emphases on technology versus real estate development (Alusi et al. 2011). Several eco-cities are located in Europe, mainly in Scandinavian countries, for example UK and Germany; the second largest concentration is in Asia/Australia, followed by North America, Africa, Latin America and the Middle East (Joss 2011). Examples include: cities in China [e.g. Dongtan first announced new eco-city project in 2005 (Eryildiz and Xhexhi 2012), Tangshan Caofeidian (Joss and Molella 2013; Qiang 2009), Changxing Eco-City in Beijing (Yip 2008), Sino-Singapore Tianjin (Alusi et al. 2011)], Korea [e.g. Songdo (Alusi et al. 2011; Shwayri 2013)], U.K. [e.g. NW Bicester eco-town (Joss 2011)], U.S.A. [e.g. New Destiny Florida (Joss 2011)], United Arab Emirates [Masdar zero-carbon city (Menichetti and Vuren 2011; Cugurullo 2013)], and Saudi Arabia (the newly planned King Abdullah City for Atomic and Renewable energy).

As such, this fast-growing eco-city trend calls for international urban sustainability indicators, standards, and related certification schemes similar to those available for buildings and neighborhoods (Joss et al. 2012). The following section examines the sustainability characteristics of eco-cities.

### 5 ECO-CITY SUSTAINABILITY CHARACTERISTICS

This paper builds on the findings of the literature review on the sustainability aspects of different urban areas (Table 1) to describe the ecological city and infer its characteristics. In addition to new eco-city initiatives, urban sustainability characteristics of existing cities, neighborhoods, and urban land development throughout literature are considered to infer the sustainability requirements for a new eco-city megaproject.

Urban sustainability has been introduced through vague definitions that entail a gap between theory and practice (Keirstead and Leach 2008). In this regard,
the paper categorizes the eco-city characteristics into two sets, theoretical concepts and technical criteria, with an attempt to differentiate between theory and practice. Top level-statements describing eco-city sustainability are considered as theoretical concepts (e.g. reduced consumption behavior, biodiversity, urban harvesting, human well-being). On the other hand, technical criteria such as water recycling, dense and compact housing structures, and low carbon transport technologies are reflections on the high-level concepts that render them more functional.

Figure 3 represents the research methodology in developing the eco-city sustainability characteristics throughout Track 1 of the research study. For new eco-city megaprojects, technical criteria represent the basis to develop a guiding tool or performance design guide that assists the practitioner in judging the progress towards meeting the theoretical concept of sustainability in eco-cities.

5.1 Theoretical Concepts

Urban sustainability concepts may be used in urban planning to describe the abstract intangible, and non-spatial characteristics [e.g. ways of living, economic activities] (Yip 2008). The triple bottom line of sus-

<table>
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<tr>
<th>Key concept</th>
<th>Description</th>
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<tr>
<td>One system approach</td>
<td>The whole urban system is planned, designed, integrated, and managed through systems thinking, understanding “how the parts fit into the whole” (Engel-Yan et al. 2005; World Bank 2010). Address resource flow through integrated infrastructure system design and management of different sectors i.e. transport, energy, water, and waste management, in addition to green buildings and urban forestry (Engel-Yan et al. 2005; World Bank 2010). Interaction, linkages within and among infrastructure systems, and with the surrounding region (Engel-Yan et al. 2005; World Bank 2010).</td>
</tr>
<tr>
<td>Habitat for biodiversity</td>
<td>Protect habitat of natural and biological functions and processes (Jepson Jr and Edwards 2010)</td>
</tr>
<tr>
<td>Self-reliance, resilience and urban harvesting</td>
<td>Demand minimization by changing behavior or installing technologies</td>
</tr>
<tr>
<td>Social aspect</td>
<td>Socially diverse, housing affordability for all income groups (Jepson Jr and Edwards 2010; Sharifi and Murayama 2013)</td>
</tr>
<tr>
<td>Economic aspect</td>
<td>The investment framework values sustainability and resilience (World Bank 2010; Alusi et al. 2011; Joss et al. 2012). Economic diversity and vitality (Lehmann 2007; Jenks and Jones 2010); small-medium enterprises (Sharifi and Murayama 2013) Employment is provided through innovation and the unique local environment including environmental and social quality of the city's public places (Kenworthy 2006)</td>
</tr>
<tr>
<td>Planning and decision-making practices</td>
<td>The integrated sustainability “planning for the future of the city is a visionary ‘debate and decide’ process, not a ‘predict and provide’” (Kenworthy 2006; Joss 2011). Eco-city development is “formulated as, embedded in, and supported by, policy processes” (Joss 2011)</td>
</tr>
</tbody>
</table>
tainability comprising the social, economic, and environmental dimensions, dominates the literature on the sustainable urban environment (Tanguay et al. 2010; Mori and Christodoulou 2012). The major concepts entailed within the three dimensions are synthesized and listed in Table 3 to describe the theoretical characteristics of a new eco-city megaproject.

5.2 Technical Criteria

Mulligan et al. (2011) pinpoint the need to differentiate between sustainability characteristics that “guide internal design issues” (the technical) and those that describe sustainability performance (the conceptual). For instance, biodiversity, measured by the number of

Table 4. Eco-city key technical criteria

<table>
<thead>
<tr>
<th>Design niche</th>
<th>Key technical criteria</th>
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<tbody>
<tr>
<td>Land use urban form urban design</td>
<td>Suitable accessible location (Eryildiz and Xhexhi 2012; Sharifi and Murayama 2013)</td>
</tr>
<tr>
<td>Efficiency through appropriate transport infrastructure</td>
<td>Reduce car/motorcycle use through de-emphasized freeway and road infrastructure and restricted parking (Kenworthy 2006; Qiang 2009; Jenks and Jones 2010; Alias et al. 2011)</td>
</tr>
<tr>
<td>Reduced energy consumption through appropriate energy-supply infrastructure</td>
<td>Reduced energy demand for city transport through low carbon technologies and CO2 neutral/electric transport system (e.g. eco-friendly buses, fully electric cars and plug-in hybrid cars (Menichetti and Vuren 2011; Eryildiz and Xhexhi 2012)</td>
</tr>
<tr>
<td>Technology</td>
<td>Reduce and recycle domestic and construction waste (Yip 2008; Jenks and Jones 2010)</td>
</tr>
</tbody>
</table>

Grey water systems, recycling water for gardening and car washing, reuse water for green spaces (Engel-Yan et al. 2005; Qiang 2009; Alusi et al. 2011; Piechowski and Weerakkody 2011; Eryildiz and Xhexhi 2012; Sharifi and Murayama 2013) |

Environmental technologies: low carbon technologies (LCTs) used in the corresponding urban infrastructure fields of buildings, electricity use, transport and energy supply, water management (Lechtenböhmer et al. 2012); technological innovation for low energy demand and low-carbon energy production (e.g. renewable energy supplied through solar hot water technologies and photovoltaic’s, wind energy systems) (Kenworthy 2006; Joss 2013); waste management technologies (waste to energy) (Joss and Molella 2013); decentralized environmental technologies (for water treatment, renewable energy supply, waste management, electric vehicle) (Kenworthy 2006); water technologies (e.g. harvesting and storage techniques at a local level) (Jepson Jr and Edwards 2010; Jenks and Jones 2010; Eryildiz and Xhexhi 2012); transport technologies (e.g. electrically powered vehicles using renewable energy sources); waste management and sewage treatment technologies (Kenworthy 2006); energy efficient buildings (passive house standards, reduced heat and electricity demand and efficient supply through efficient electric appliances, resource sharing between buildings) (Aegude-Vera et al. 2012) |
species in an area, does not guide the design for this area, while the square meter of area to be assigned to a habitat may be a viable design indicator (Mulligan et al. 2011). As such, urban sustainability criteria consist of physical tangible, spatial, and technical elements (e.g. land use and MP features, transportation system, wastewater treatment etc.) of urban areas (Yip 2008). As proposed by Keirstead and Leach (2008), urban sustainability criteria are best categorized by niche, such as energy, water, transport, and waste management. Hence, based on the findings from the literature survey (a survey-based selection strategy as adopted by Tanguay et al. 2010), a descriptive list is developed and presented in Table 4. It identifies the common key niches proposed to be considered in planning for eco-cities, along with their corresponding key technical criteria.

6 CONCLUSIONS AND PATH FORWARD

This paper presents the findings of a critical review of literature on urban sustainability with the aim of inferring key technical criteria to be considered while planning for a new eco-city megaproject. Eco-city is defined; its evolution and initiatives are described, with some examples presented. Different types of sustainable urban areas are examined (existing and new cities, neighborhoods, etc.) and their sustainability characteristics investigated. Two interest groups of sustainable urban areas are classified as theorists (focusing on sustainability concepts under the triple bottom line of environmental, economic, and social dimensions) and practitioners (addressing technical design aspects of the physical built environment).

As such, the paper categorizes the eco-city characteristics into two sets, theoretical concepts and technical criteria, with an attempt to differentiate between theory and practice. Yet, the literature review is not comprehensive and the proposed list may not represent all sustainability requirements for a new eco-city megaproject. Thus, more future research on eco-cities refines and completes the proposed list. In addition, the proposed criteria may be better listed based on a selection strategy that weighs each criterion and prioritizes the outcomes based on their recurrence across literature.

Furthermore, urban sustainability tools need to entail national/local policies and respect the unique place-specific urban conditions of the eco-city project. This calls for a bottom-up approach during the pre-project planning stage, that is enhanced through the participation of different project stakeholders (e.g. client, urban planner, transport planner, utility engineer, landscape architect) in the eco-city criteria selection and prioritization process. As such, with reference to the list of key technical criteria proposed in this paper, the pre-project planning team can develop a more project-tailored performance design guide.

Future research efforts (Track 2) will focus on reviewing literature on pre-project planning practices and management tools (e.g. IDEF0 model, PDRI checklist) with emphasis on megaprojects and urban land developments. The work will also include developing a pre-project planning framework that assists in developing and integrating the performance design guide requirements into the eco-city Master Plan. During Track 3 of this research study, the investigation of a case study of an ongoing eco-city megaproject shall help validating and refining the outcomes of Tracks 1 and 2.

REFERENCES


