A Proposed Urban Environmental Sustainability Indicators Framework: The Case of Malaysia

CHOON SHAY-WEI* & GOH HAN-HWA
Faculty of Management
Multimedia University
Jalan Multimedia, 63100 Cyberjaya, Selangor
MALAYSIA
swchoon@mmu.edu.my, hhgoh@mmu.edu.my

Abstract: - The process of urbanisation and industrialisation has triggered off the emergence of big cities in Malaysia. The number of big cities exploding in recent years creates not only a huge demand for resources but also a desperate environmental situation. This paper seeks to propose a framework for indicators of urban environmental sustainability in Malaysia from twofold aspects. Firstly, we construct a set of sustainability criteria and indicators for urban environment. Secondly, we devise an integrated index to monitor urban environmental performance as well as to serve as a tool to raise awareness among the local urban authorities in Malaysia. This paper focuses on the four major cities in Malaysia, namely Penang(PG), Malacca (MC), Kuching (KU) and Kota Kinabalu (KK), which are steadily gaining in popularity as a tourist attraction and worldwide recognitions of World Heritage Site in the recent decades. Environmental health and services are the two main criteria proposed in the paper. There are sixteen indicators reflecting these criteria identified in this study. The results show that Penang and Kota Kinabalu have poorer performance than Malacca and Kuching in terms of environmental sustainability, be it environmental health or environmental services. Last but not least, it is interesting to generalise from the results of this study and conclude that various relevant strategies are needed to develop environmental sustainable cities in Malaysia due to the different nature of cities in terms of the level of urbanisation, stages of development, geographical location and historical background.

Keywords: - Urbanisation; industrialisation; urban environmental sustainability; sustainability criteria; sustainability indicators framework; environmental health; environmental services

1. Introduction

The concept of sustainable development has been evolving for more than 30 years since its first public appearance in the World Conservation Strategy (WCS). In accordance with Rio Earth Summit in 1992, there is an urgent need to develop indicators of sustainable development in order to provide solid bases for decision making at all levels, and thus contributing to a self- regulating sustainability of integrated environment and development system. Following the introduction of sustainable development, the concept of sustainable city has come into existence. According to the Summit of Urban 21 in Berlin in July 2000, a sustainable city is defined as the one which shows an increase in the life quality in terms of its ecology, cultures, politics, institution, social and economy, without pressurising the future generation. The pressures may arise in the wake of a deficiency of natural resources and an abundance of local debts. A sustainable city enables its residents to fulfill their basic needs and increase the prosperities without ruining the natural environment as well as the human life at present and in future (Girardet, 2004). In actual fact, there has been no definitive definition of sustainable city thus far (Satterthwaite, 2001). Nevertheless, while there are many discussions carried out on issues of city sustainability, these issues are infinitely complex and mutually related.

Many governments have identified urban growth as a problem yet many of them have used repressive measures to control it (Hardoy & Satterthwaite, 1995). Due to the complexity of city and the issues concerned, it is quite impossible to make a city to sustain. The efforts to measure the level of sustainability of city are strenuous and complex because the city system is interrelated and constantly changing. However, if sustainable development is perceived as a process, then efforts toward the measurement of sustainable city could be realised (Tan et al., 2006). The system of sustainability measurement should be based on clear

and obvious characteristics (Peterson et al, 1999). There is a real challenge on how to carry out a comprehensive evaluation of city sustainability in Malaysia after taking into account of all necessary dimensions of urban sustainability. This arises because Malaysian cities are at different stages of preparedness to face and embrace the challenge of sustainable development. For the sake of urban sustainable development, both the urban decision-makers and the public require information about the current status of the city sustainability. Indicators serve as a useful tool for the decision makers in this context. They provide information not only on some major development issues but also a distinct picture of the progress of sustainable development. Meanwhile, an index is defined as an aggregate of indicators, where it possesses a distinctive role and affords a short and readily understandable sustainability summary.

Environment is the conceptual foundation for sustaining communities. Our ecosystem sustains life and provides a wide range of goods and services for us. It is therefore crucial for us to understand our environment well especially in terms of environmental health and environmental services. This study aims to propose a framework for urban environmental sustainability indicators in Malaysia from two-faceted viewpoints. Firstly, we construct a set of sustainability criteria and indicators for urban environment in Malaysia. Secondly, we also develop an integrated index not only to monitor urban environmental performance but also to serve as a tool to raise awareness among the local urban decision makers to improve their urban management practices.

Environmental health and environmental services are the two major issues discussed in this study. According to the definition of WHO, environmental health covers all the physical, chemical, and biological factors external to a person, as well as all the relevant factors that affect behaviour. It encompasses the assessment and control of those environmental factors that can potentially affect our health. Besides, it is also targeted towards preventing disease and creating health-supportive environments. Meanwhile, based on the definition of OECD, environmental services refer to qualitative functions of natural non-produced assets of land, water and air (including related ecosystem) and their biota. These services include the provision of raw materials and energy used to produce goods and services, the absorption of waste from human activities, and the basic roles in life support as well as the provision of other amenities such as landscape.

There has scant research studied on the environmental health and environmental services, especially on the issues of urban environmental sustainability indicators in Malaysia. Unprecedentedly, this study therefore attempts to fill the literature gap by proposing a framework for urban environmental sustainability indicators as well as development of an integrated index in Malaysia. Malaysia is chosen because it is one of the Asian countries that have achieved sustainable growth for the past 40 years yet its environmental quality has deteriorated in the recent decades. The scope of this paper focuses on the four major cities in Malaysia, namely Penang(PG), Malacca (MC), Kuching (KU) and Kota Kinabalu (KK). These cities have been selected due to their worldwide recognitions in terms of the cultural and natural heritage. In recent years, they are steadily gaining in popularity as a tourist attraction of World Heritage Site by receiving various acknowledgements from several international organisations such as UNESCO, UN and WHO. For this reason, it is interesting to investigate the environmental sustainability performance especially in these four major tourist attraction cities in Malaysia.

2. Background of the Four Cities in Malaysia

Malaysia, a federal constitutional monarchy located in Southeast Asia, consists of thirteen states and three federal territories. It has a total landmass of 329,847 square kilometres (127,350 sq mi) separated by the South China Sea into two similarly sized regions, Peninsular Malaysia (also known as West Malaysia) and East Malaysia (Malaysian Borneo). Malaysia today is a newly industrialised market economy, ranked third largest in Southeast Asia and 29th largest in the world. It is a founding member of the Association of Southeast Asian Nations, the East Asia Summit and the Organisation of Islamic Cooperation, and a member of Asia-Pacific Economic Cooperation, the Commonwealth of Nations, and the Non-Aligned Movement.

Penang consists of a 285 sq. km island connected via a 13.5 km bridge to an additional 763sq. km of

mainland, referred to as Seberang Perai. It is situated along the north-western coast of the Peninsular Malaysia. Penang is an island city. The total population of the state of Penang is approximately 1.5 million. About 90.8% of the residents are urban population (DOS, 2010). Known as the "Pearl of the Orient" for its natural beauty and cultural heritage, Penang was declared as a World Heritage Site by UNESCO on 7 July 2008.

Malacca consists of 1,649.83 sq. km. It is situated along the southwestern coast of the Peninsular Malaysia. Malacca is a seaside city rich in history and culture. The total population of the state of Malacca is approximately 0.7 million. About 86.5% of the residents are urban population (DOS, 2010). In recognition of its rich historical pasts, Malacca was declared as the "Historical City" on 15 April 1989 and it was later listed as a World Heritage Site by UNESCO on 7 July 2008.

Kuching is situated at the banks of Sarawak River on the northwestern part of island of Borneo (i.e. East Malaysia). It was conferred a city status on 1 August 1988. Due to its vastness in geographical area, the city is divided into two administrative areas in the north and south. Kuching North consists of369.48 sq. km while Kuching South consists of 61.53 sq. km. The total population in Kuching is approximately 617,887 in 2010 (DOS, 2010). It is the largest urban centre in the state of Sarawak. Kuching is considered one of the cleanest cities in Malaysia and it was previously voted as one of the world's healthiest cities, recognised and awarded by United Nations (UN) and World Health Organisation (WHO) as well as the Alliance for Healthy Cities (AFHC) in Suzhou, China.

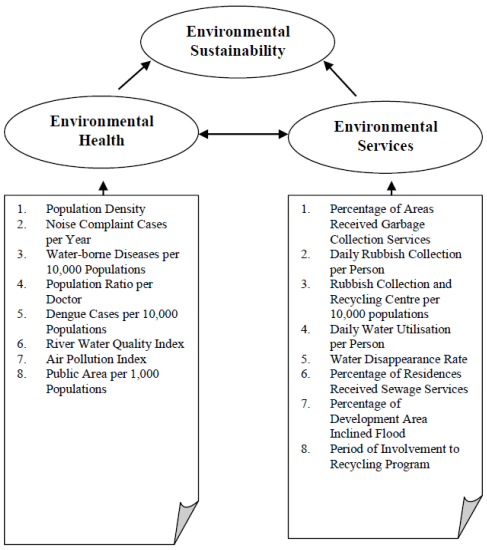
Kota Kinabalu is located on the northwest coast of Borneo (i.e. East Malaysia) facing the South China Sea. The total population in Kota Kinabalu is approximately 462,963 in 2010 (DOS, 2010). Consisting of 277 sq. km, Kota Kinabalu is the largest urban centre in the state of Sabah. Kinabalu National Park is the first World Heritage Site in Malaysia declared by UNESCO in December 2000owing to its outstanding universal values and role as one of the most important biological sites in the world.

3. Methodology

Referring to Figure 1, the framework for urban environmental sustainability indicators in Malaysia is proposed based on two criteria: environmental health and environmental services. Under these two criteria, there are sixteen indicators selected with justification.

Figure 1:

A Proposed Urban Environmental Sustainability Indicators Framework for Malaysia



Note that there should be a satisfactory number of indicators to capture thoroughly the multidimensional nature of sustainable development. If there are too many indicators used in the study, the results would likely be too complicated to interpret. Besides, the indicators need to be clear and unambiguous. The indicators selected for this study are based on the Four Pillars that help achieve sustainability of cities, which are developed by United Nations (UN)/ Development Policy and Analysis Division (DESA). The indicators are then modified to be best suited to the Malaysian scenario. This approach to sustainable cities has been echoed by the Rio+20 Declaration (United Nations, 2012) and the United Nations System Task Team on the Post-2015 UN Development Agenda (2012). Achieving the sustainability of cities would entail the integration of four pillars: social development, economic development, environmental management, and urban governance. In this study, the pillar of economic development is not adopted since the objective of the study is merely to focus on environmental dimension. The ways in which a city is able to build sustainability will reflect its capacity to adapt, within the context of its

particular history, to the policy priorities and goals defined by each pillar (DESA, 2013). For the purpose of this study, we use the secondary data collected from various government departments in Malaysia such as Department of Statistics, Department of Town and Country Planning and Ministry of Health.

3.1. Calculation and Analysis

The indicators concerned are chosen from various sources by means of frequency of selection, representation of the indicators and data availability in Malaysia. Generally, environmental data involves various units of measurement. According to Mayer, A.L. (2007), different units of measurement should be standardised for aggregation. This study has chosen the standardisation method [0, 1] by the use of minimum and maximum values for each indicator serving as an objective indicator. This method has widely been used by UNDP in developing Human Development Index in 1990 and Human Poverty Index in 1997. Besides, the method is also adopted by Zhang, M. (2002); Roldan, et al (2002) and Lee, et al (2007) in their studies respectively. All indicators chosen will be given a positive or negative sign to show their impacts on the sustainable level. A positive indicator means an increase in its value, which represents better sustainability, and vice versa. The study does not fix a standard value as a benchmark for each indicator due to lack of participation of stakeholders. The standardisation formula is shown as below.

$$Index = (Actual\ X\ Value - Minimum\ X\ Value) / (Maximum\ X\ Value - Minimum\ X\ Value)$$

Based on the literature review, the usage frequency of equal weight is very high in developing a sustainability index. Equal weight has been adopted by UNDP (1995); EPU (2004); Roldan, et al (2002); YCELP & CIESIN (2005) and Lee, et al (2007). Therefore, the criteria and indicators are equally weighted in this study. For aggregation, average method is adopted. Theoretically, the score on the urban environmental sustainability index varies from 0 to 1 where the value closer to 1 shows a better sustainable development, and vice versa. Nevertheless, the sustainability value cannot constantly be determined objectively, nor will it always be a constant over time (Kerk & Manuel, 2008). In addition, sensitivity analysis has been conducted to test the robustness of standardisation formula, where there is a change of use from mid-point to standard deviation method in the study. The minimum value is chosen as the base value, which has been adjusted its positive or negative impact to sustainable level. The sub-index of each indicator is obtained via multiplying the standard score by 10 and adding or minus 100. If the sub-index and the composite index are higher than 100, it shows a better sustainable development, and vice versa. This method is modified from the formula used by EPU (2004) in developing Malaysian Quality of Life Index. The formula is as below.

$$Index = (Actual\ X\ Value - Minimum\ X\ Value) / Standard\ Deviation$$

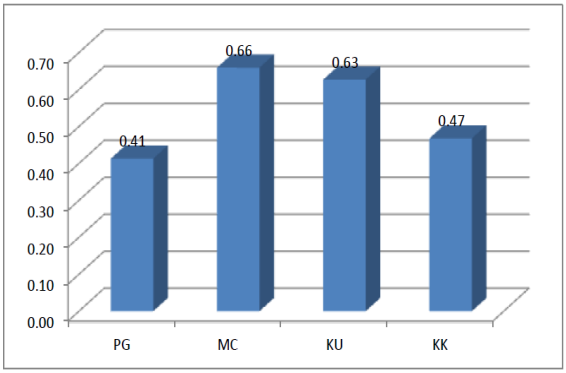
By using standard deviation method, we have found that the results of performance and ranking among the selected cities towards environmental sustainability are not vastly different than that of mid-point method.

We have conducted Pearson product–moment correlation coefficient (Pearson's r) to study the relationship between environmental health and environmental services. The result shows that the correlation coefficient between environmental health and environmental services is 0.83, which implies that there is a strong relationship between environmental health and environmental services. In other words, effective environmental services may affect environmental health, and vice versa.

4. Result and Discussion

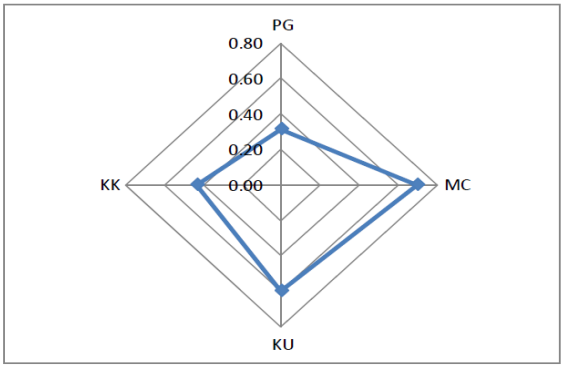
By applying the above-mentioned method, we have developed an environmental sustainability composite index for the selected cities. Referring to Diagram 1, Malacca (MC) shows a better environmental sustainability of 0.66, followed by Kuching (KU), Kota Kinabalu (KK) and Penang (PG) respectively.

Diagram 1: Environmental Sustainability Composite Index



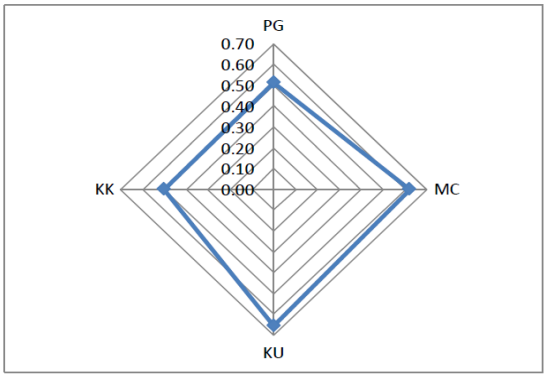
For the criteria of environmental health, as shown in Diagram 2, PG and KK have performed below the mean level, which is lower than 0.51. Both have a weak position in the criteria with the scores of 0.31 and 0.43, respectively. On the other hand, MC has a strong position with the score of 0.70, followed by KU 0.60.

Diagram 2: Environmental Health Composite Index



Referring to Diagram 3, in terms of environmental services, KK and PG have also performed below the mean level, which is lower than 0.57. Both are weak in the criteria with the respective scores of 0.50 and 0.51. KU has a strong position with the score of 0.66, followed by MC 0.62.

Diagram 3: Environmental Services Composite Index



To study the reasons behind, we have to analyse the performance of indicators for each criterion. Referring to Diagram 4, we have found that KK and PG are weak in population density (1). High density in these cities is more likely to cause environmental deterioration. In terms of noise complaint cases (2), PG and KK show higher rate of complaint cases than that of KU and MC. This may be either due to lack of proper noise management system in PG and KK or there is an effective channel for the residents to make a complaint. MC shows the highest rate of waterborne diseases (3) compared to KK, the lowest rate of the diseases. For the ratio of population per doctor (4), the result obviously shows that doctors are in short supply in East Malaysia (i.e. KK and KU). For dengue cases (5), KK shows the lowest rate of the diseases in comparison with PG, the highest incidence of dengue cases among the selected cities. KU shows the cleanest river water quality (6) as compared to MC, KK and PG. For air pollution index (7), PG shows the best performance. Besides, PG, KK and KU are lacking public area (8) for recreational facilities compared to MC with a large score gap.

Diagram 4: Environmental Health' Indicators Performance for 4 Cities

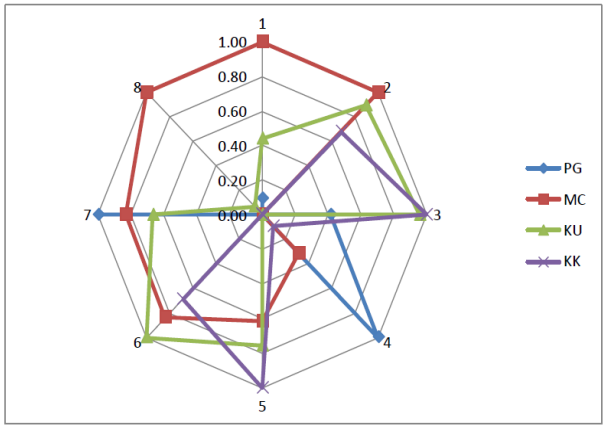
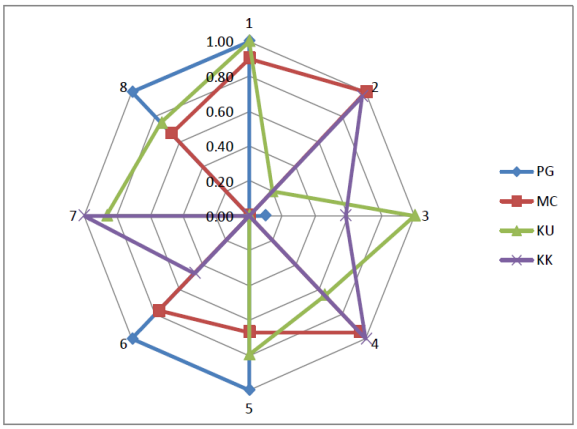


Diagram 5: Environmental Services' Indicators Performance for 4 Cities



Based on Diagram 5, we have found that all the residents in PG and KU have received garbage collection services (1). Almost 100% of the residents in MC have also received garbage collection services. KK is found to be weak or inefficient in providing the garbage collection services to its residents. Some approaches therefore need to be adopted to improve it. In terms of daily rubbish collection (2), PG and KU generate more wastes than KK and MC. Obviously, East Malaysia shows insufficient facilities of rubbish collection and recycling centers (3). Besides, the water consumption (4) in the selected cities is very high. KK and MC show better performance compared to PG and KU. KK is found to be weak in water supply system followed by MC, KU and PG, which could be linked to the highest water disappearance rate (5) in KK. KU is the weakest in providing sewage services (6) compared to KK, MC and PG. There is a large score gap between KU and the other three cities. This can be concluded that there are obviously insufficient sewage services in East Malaysia. All the development areas in PG and MC are inclined to be stricken with floods (7). Relatively, around 50% of the development areas in KU and KK tend to be flood stricken. This may be due to poor drainage system in these cities. PG shows the longest involvement in recycling programs (8) followed by KU, MC and KK.

From the study, we have found that PG and KK are generally weaker than MC and KU in terms of environmental sustainability, be it environmental health or environmental services. However, PG and KK are likely to perform better at environmental services than environmental health with a moderate score gap of 0.20 and 0.07 respectively. MC tends to perform better in environmental health compared to KU. Conversely, KU tends to perform better in environmental services compared to MC. Besides, East Malaysia tends to be weaker than West Malaysia in providing facilities such as rubbish collection centers, recycling centers and sewage services as well as water supply system. All the four cities have a high rate of water consumption and wastes. West Malaysia, on the other hand, tends to be weaker at providing and maintaining a smooth drainage system. In conclusion, we have found that all the four selected cities in this study have their own strengths and weaknesses due to their differences in the level of urbanisation, stages of development, geographical location and historical background. Generally, MC, among others, has performed better in environmental sustainability. All these strengths and weaknesses need to be taken into due consideration by the respective local urban decision makers or authorities in order to improve their urban management practices and develop sustainable cities in Malaysia.

5. Conclusion

The concept of urban sustainable development is basically both complicated and interrelated. The definition of the concept is very subjective. In terms of methodology, there are various selection methods of criteria, indicators and weight age that come into existence. All these different methods will to some extent affect the validity of the result. Besides, the availability and reliability of data are also being called into question. With all these difficulties, our knowledge on sustainability seemed to be incomplete in drawing a definitive conclusion and it thus leaves vast room for improvement and further

researches. Nevertheless, indicators have long been used as a tool by urban decision makers to obtain information on major issues, to determine the current level of urban sustainable development as well as to identify the weaknesses and strengths of the cities. As such, we have used sixteen indicators to reflect the two main criteria of environmental health and services identified in this study. From the results of this study, it is found that various relevant strategies are needed to develop environmental sustainable cities in Malaysia due to the different nature of cities in terms of the level of urbanisation, stages of development, geographical location and historical background.

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