SUSTAINABILITY INDICATORS FOR MUNICIPAL ADMINISTRATION IN SEOUL

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ABSTRACT

Seoul, the capital of the Republic of Korea, needs to develop an indicator set which shows the current status and objectives to improve its municipal sustainability. The purpose of this study is to develop an effective and practical set of sustainability indicators which will be utilized as a policy making tool in Seoul Community Council. The basic procedure and principles of assessing sustainability in this study are summarized as follows :
The initial step for assessing sustainability is to identify the main factors in each resource which have great influence on municipal sustainability. For the purpose of unbiased and democratic identification of the factors, this study conducted plentiful discussions with diverse groups and individuals. Secondly, this study endeavored to introduce certain techniques to measure and normalize the performances in each factor on the basis of measurability, comparability, simplicity and flexibility. Finally, an aggregate index model was established by estimating inter-dependence and relative weights among the selected sustainability factors.
This study expects that the sustainability indicators could help the people who are concerned about our future understand our situation and perspective toward sustainable development.

Key words : Seoul, sustainability indicators, aggregate index model, sustainable development, etc.

1. INTRODUCTION

In 1987, the Brundtland report defined that sustainable development is development which meets the needs of the present without compromising the ability of future generations to meet their own needs. (WECD, 1987) Subsequently, Agenda 21 at the Earth Summit held in Rio de Janeiro announced that every countries and their local bodies should prepare the action plans toward sustainable development. Since then, the concept of sustainable development was embraced by many national governments. The European Community, for example, is performing the research project on establishing the Euro Environmental Pressure Indicator for sustainable development of national and local authorities. U.S. and Japan are independently developing sustainability indicator as well.
For achieving a more sustainable pattern of development for the 21st century, the city of Seoul, the capital of the Republic of Korea, organized the Seoul Agenda 21 Forum. They made a lot of efforts to prepare Seoul Agenda 21, which was promulgated in June 1997. In order to make Seoul Agenda 21 more realistic, this forum revised targets in March 2000. They facilitate diverse actions to make Seoul environmentally sound and sustainable, improving the quality of citizens' lives, and practicing sustainable development. From this

viewpoint, they plan to develop sustainability indicator system which shows the current status and objectives to improve its municipal sustainability.
The objective of this study is to develop an effective and practical set of sustainability indicators which will be utilized as a better policy-making tool in Seoul. The order of this study is as follows : At first, it reviews recent issues of sustainable development and its measurement which can be relevant for use. Five different approaches to sustainable development will be introduced. Second, it attempts to apply to specific issues that can be related to assess sustainable development in Seoul. Then, it identifies the most suitable and unbiased sustainability indicators for municipality. At last, it discusses critical points regarding the indicators development and suggests the direction of the future investigation.

2. INTERNATIONAL DEBATE ON SUSTAINABILITY

Sustainable development is such a multi-dimensional concept by definition that a considerable debate has evolved over the last decade. In particular, after the concept of sustainable development was reinforced by the Brundtland report, there has been a substantial scientific literature aiming to provide sustainable development with a scientific basis.
Ekins and Jacobs (1995) suggested that sustainable development is development based on patterns of production and consumption that can be pursued into the distant future without degrading the human or natural environment. Tietenberg (1984) has remarked that the sustainability criterion suggest that, at a minimum, future generations should be left no worse off than current generations. The European Union speaks that sustainable is intended to reflect a policy and strategy for continued economic and social development without detriment to the environment and the natural resources on the quality of which continued human activity and further development.
Morati et al (1993) have suggested as a result of reviewing over 40 definitions of sustainable development that the central element in most of the definitions of sustainable development are (1) a notion of the environmental decay that has to come to a halt, (2) a notion of intergenerational equity so that future generations will not be worse off than present generations, (3) a notion of intra-generational equity, which has mostly been applied in the North-South context. The various definitions found in the literature differ, however, with respect how these three aspects have been assimilated in the definitions.
As mentioned above, a definition of the concept of sustainable development is not uniform, therefore the exact implications of a development that is sustainable subject to much discussions.

3. APPROACHES IN MEASURING SUSTAINABILITY

The scientific literatures dealing with sustainable development have obviously not concentrated on establishing exact definitions of sustainable development. Instead of definition setting, adaptation of framework to access sustainable development into real situation, whatever it may be precisely, has become the central cornerstone of the works in progress.
Therefore, there are no formulated methodologies to access sustainability assessment. Based on literatures and research works regarding sustainability measurement, this study classifies frameworks for sustainability indicators into 5 different approaches and reviews

them briefly.

3.1 P-S-R Approach

P-S-R approach divides environmental performance into 3 stages such as pressure on environment, current environmental state and community's response for environmental problem. This approach was suggested firstly by OECD in 1996, and applied into developing "Euro Environmental Pressure Index" in EU.

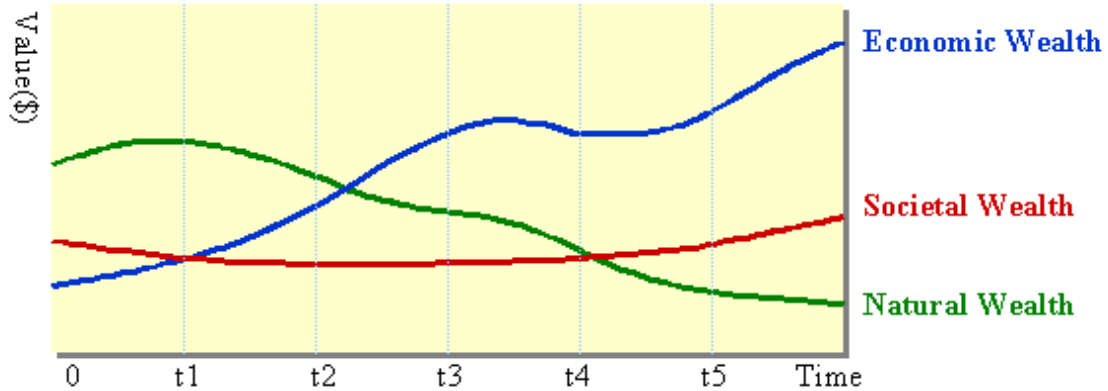
Figure 1. P-S-R system suggested by OECD

Since P-S-R approach identifies the causes and effects of environmental problems, and also measures the efforts to improve environmental performance, it is an effective tool for understanding relationships between environmental pressure and state, and for evaluating the effectiveness of a community's measures on environmental problems.
P-S-R approach, however, can not reflect economic and societal performances which are important components in sustainability issue, because its viewpoint is concentrated on measuring and controlling environmental impact.

3.2 Wealth Approach

It is said that the resources essential to the sustainability of a community are comprised of economic, social and natural resources. And wealth approach is a methodology to determine sustainability condition by measuring the monetary value of these 3 kinds of resources. According to this approach, the sustainability of a community is regarded to be attained when the value of each resource does not decline over time. This approach has been used by World Bank in 1998 for the purpose of establishing National Indicators for Sustainable Development.

Figure 2. A diagram of three different elements in wealth approach



To measure the value of environment or societal condition, valuation techniques on non-market goods are indispensable. But such techniques are still in progress in academic literatures. And more problematic point is that wealth or value can not be a criteria to environmental protection, because wealth or value of a resource is affected by decreasing marginal utility and time preference determined by people's subjective preference. That is to say, conserving environmental wealth does not guarantee the conservation of environmental quality.

3.3 Mosaic Approach

Mosaic approach assorts component parts in the sustainability of a community and suggests principles and objectives in each part. Based on the principles, current state is measured in comparison with objective or optimal state so as to determine how far the community is going toward optimal state. This kind of approach is accepted by several local bodies including Virginia state in U.S. The biggest advantages of this approach are clarity and practicality because it shows definite and practical objectives in each part of citizens' lives.
Mosaic approach, however, also has a weak point that there's no standard to set optimal state. It means that the optimal states or objectives described by mosaic model have no logical relationship with the definition of sustainability.

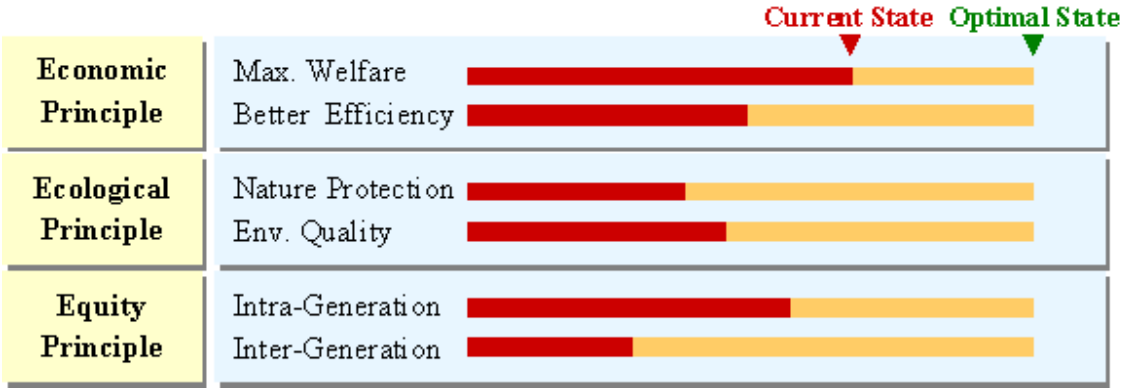


Figure 3. An example of mosaic approach

3.4 System Approach

System approach based on system theory assumes a community as a system, and derives sustainability indicators from identifying system properties. For example, International Institute of Sustainable Development analyzed the properties of viable system and suggested that sustainability indicators should be selected from the basis of system properties such as existence, effectiveness, security, adaptability, etc.
Although system approach has robust and logical foundation in selecting indicator sets preventing selection bias, it has too formulated and comprehensive modeling framework to derive specific indicators which represent the characteristics of a certain community.

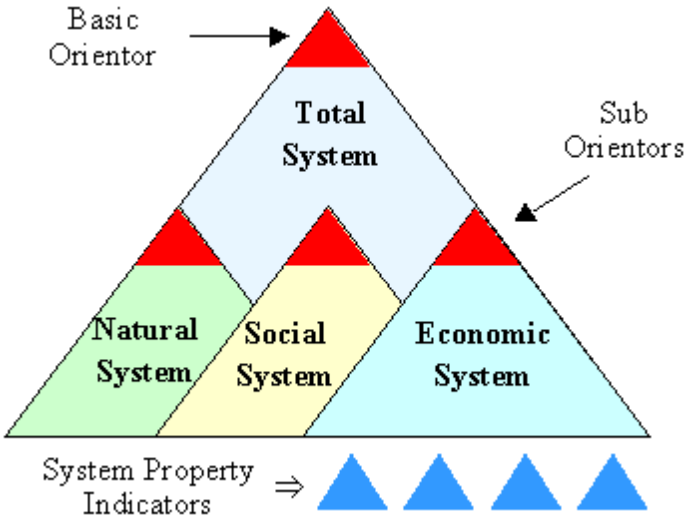


Figure 4. A diagram of total system that depends on subsystems

3.5 Political Approach

Political approach is a procedure to select indicators in terms of citizens' interests. In this regard, a community council composed of civil representatives needs to be established in order to derive indicators by means of sufficient negotiations and debates among the council members.
Accordingly, political approach has very democratic process in selecting indicators, and they represent the opinion of majority. But, the indicators made through this process may not satisfy sustainability condition because they are firmly based on the preference of current generations regardless of the futures.

4. TWO DIFFERENT METHODOLOGIES IN DEVELOPING INDICATORS FOR SUSTAINABLE SEOUL

Since WCED Brutland report raised the concept of sustainable development, a number of researchers and policy-makers have tried to define sustainability conditions. In spite of their passionate efforts, as discussed above, the definitions and approaches to sustainability are still in progress.
This study conducted plentiful discussions with diverse groups and individuals and examined the various approaches with a view to modeling indicator sets which will be utilized for measuring sustainability of Seoul. As the results, the most crucial factor in sustainability approach was said to be the criteria of assessment. Among the criteria suggested, one most persuasive criteria proposed was welfare of citizens' lives, and another was strategically controlled performance of city environment. The former was named Quality of Life Indicators, and the latter was Eco-City Indicators.

4.1 Quality of life indicators

According to quality of life indicators, sustainability is defined as a state to sustain municipal functions from the basis of citizens' welfare. That is to say, the sustainability of

a city is regarded to be attained when welfare of the people who live in a city does not decline over time. Therefore, the basic logic in quality of life indicators is somewhat similar to those in wealth approach.
As an initial step, this study formulates categories of city systems which are the major determinants of quality of life. The formulated categories in a city system are natural, economic and societal system. And these 3 systems are organically inter-dependant within a city structure. From this viewpoint, citizens' total welfare is determined by the 3 different systems, and total welfare is the summation of the welfare from each system.

$$TW = Wn(Kn) + We(Ke) + Ws(Ks)$$

TW : total welfare, Wn, We, Ws : welfare functions in each system
Kn : natural performance, Ke : economic performance, Ks : societal performance

If we define sustainability as the concept of non-decreasing welfare, general condition for sustainability is expressed as follows.

$$dTW / dt \quad 0$$

The general sustainability condition above assumes substitutability among 3 different systems regardless of their characteristics. In reality, however, each system has its own roles and functions which are not compatible with others. Therefore, strict condition for sustainability is expressed as follows.

$$dWn(Kn) / dt \quad 0 \quad .and.$$
$$dWe(Ke) / dt \quad 0 \quad .and.$$
$$dWs(Ks) / dt \quad 0$$

In accordance with the definition of sustainability condition, the performances of each system should be measured to determine whether our community satisfies the sustainability conditions or not. For the purpose of unbiased measurement, indicators which represent the performance of each system need to be selected.
The most important aspect in selecting indicators is logical foundation to explain the representativeness of indicators. In this context, this study adopted system approaches.
According to the system approach made by International Institute of Sustainable Development, the properties of viable system is classified into 9 categories. And this study derives 4 major elements of system viability by abstracting the 9 system properties suggested by IISD. These 4 elements of system viability are considered to be selection basis of sustainability indicators.

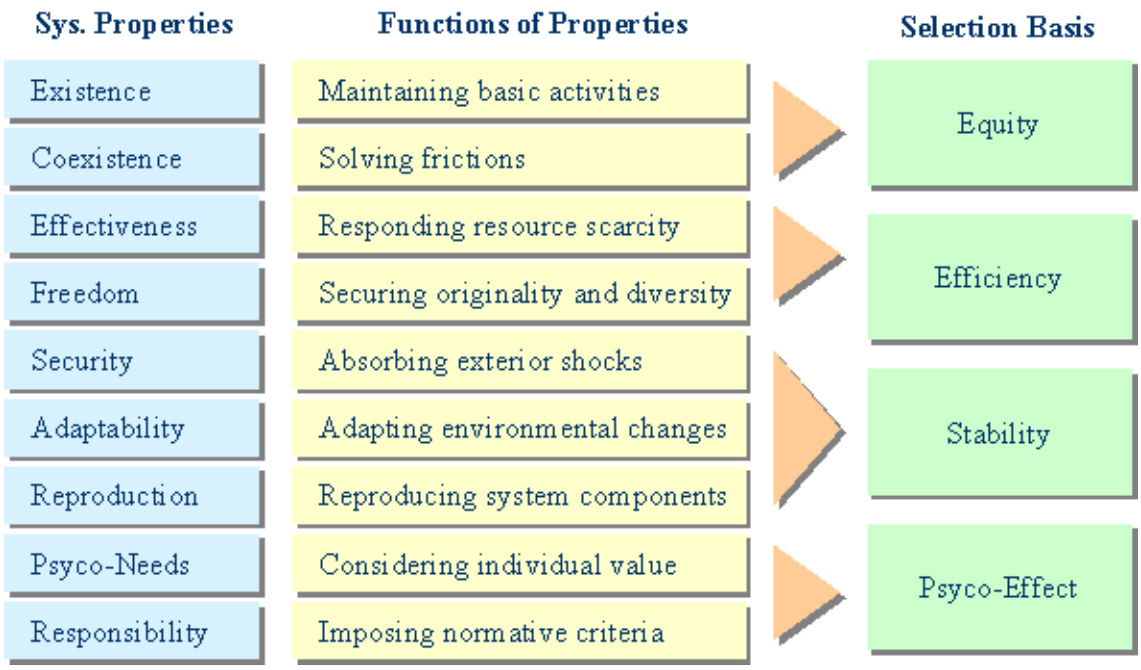


Figure 5. The four elements of system based on nine system properties

Combining the selection basis into 3 different systems, we can derive a matrix which is suitable for explaining the representative of indicators. The example of indicator selection matrix to explain the performance of city system in Seoul is as follows. The detailed sets of indicators in each system is illustrated in Appendix 1

Systems / Basis	Economic System	Societal System	Environmental System
Equity	Basic Necessity Income Distribution	Public Aid Equal Opportunity	Land Use Resource Use
Efficiency	Local Economy Infra. & Technology	Human Capital Information	Production Impact Consumption Impact
Stability	Employment Median Class	Social Security Health & Safety	Quality of Env. Ecosystem
Psychological Effects	Cost of Living Household Economy	Culture Private Activity	Open Space Aesthetic Value

Figure 6. The indicator sets by each three systems

These 24 sets of indicators are regarded as representatives of performances in each 3 systems. If such indicators are accurate criteria in measuring performance, we can estimate welfare variation heuristically by placing weights on each indicator.
If we assume a linear welfare function, citizens' welfare variation in a certain period expressed by indicated performance variation is as follows

$$dWn = wn1\ dkn1 + wn2\ dkn2 + \quad + wnm\ dknm$$
$$dWe = we1\ dke1 + we2\ dke2 + \quad + wem\ dkem$$
$$dWs = ws1\ dks1 + ws2\ dks2 + \quad + wsm\ dksm$$
$$dTW = \quad wni\ dkni + \quad wei\ dkei + \quad wsi\ dksi$$

(dTW : variation of total welfare, d*k*ij : performance variation measured by each indicator)

In this equation, the coefficient *wij* is a weight factor imposed on each indicator, which is determined by subjective importance valued by citizens. Therefore, we can not but use valuation technique to derive the welfare weights on each indicator. Among the various economic literatures regarding valuation, one most persuasive approach for this kind of tasks is contingent valuation method which is a direct survey tool to elicit people's willingness-to-pay. Contingent valuation, however, requires detailed situation setting and so many painful procedures to be adapted in this study.
Hence, this study conducted simple willingness-to-pay survey regardless of detailed performance measurement to certify relative weights among indicators. A noteworthy point is that simple WTP survey instead of CVM requires normalization of each factor's performance.
Normalization of data is very important and sophisticated procedure in this study, because the property of each data is very heterogenious. Even though we can elicit relative welfare weights on indicators, normalization of data is essential because the volatility of each indicated performance may vary in a great degree.
For the purpose of normalizing data, statistical normalization technique is used in this study. And the performance measured by indicators can be normalized by its variance from past performances.

$$dzij = \{\ dkij - E(dkij)\ \} / SE(dkij)$$

E(dkij) : average of performance variation over time measured by indicator kij
SE(dkij) : standard error of performance variation measured by indicator kij

After normalizing data, we can re-express welfare function as follows.

$$dTW = wni\ dzni + wei\ dzei + wsi\ dzsi$$

In this equation the weight factors represent just relative importance among indicators and total welfare can be measured by normalized performance data irrelevant to volatility.
In short, this equation explains how much the variations of system performance affects quality of life in a city, and what factors are important determinants to citizens' welfare. And also, it shows dynamic pattern of welfare variation in each system, and we can determine whether we're going toward sustainability or not by examining the sign of welfare movement measured by the indicators.

4.2 Eco-city indicators

A set of eco-city indicators for municipal administration has been developed for the purpose of monitoring rate of progress toward sustainable development.
The set of eco-indicators has been constructed in a specific way to interpret the sustainability of municipal development in environmental and ecological significances.
Based on the critical findings and systematic approaches derived from past research experiences, primarily by international agencies such as OECD and UNCSD, intensive efforts have been made on the application of appropriate framework, selection of indicators that reflect municipal level of sustainability, categorization of indicators into major sustainability themes and identification of effectiveness and limitation of the proposed indicator set.
Although, short of an ideal set of indicators for measuring and advancing progress, the selected set could serve as an important assessment tool in supporting the municipal policy decision-making process in the context of sustainable city development.

4.2.1 Requirements of eco-city indicators

Based on the extensive discussions with experts from city-government, civil, academic and research institutions, the need for a scientific requirement of the indicator system has been confirmed and for example, the OECD indicator system emphasizes policy relevance and measurability of indicators as basic requirements. For the eco-city indicator system, following requirements has been esteemed most crucial to ensure the integrity of the indicator system. A key scientific requirement for the eco-city indicators is the consideration of ecological significance, which involves the integration of indicators with similar environmental consequences. For functional purpose, the indicators should be comprehensible and measurable and the system must contain appropriate environmental variables reflecting political concerns.

4.2.2 Framework for Indicators

In developing the basis framework for organizing the eco-city indicators, the widely-used

P-S-R model has been adopted and slightly modified to facilitate the categorization of indicators into different themes and dimensions of sustainability.
The P-S-R model is based on environmental pressures, environmental conditions or states and human responses to those conditions. The P-S-R framework distinguishes pressure indicators as pressure on the environment caused by anthropogetic activities, state indicators as quality and capacity of the environment and response indicators as societal reactions to the environmental problems such as reinforcement of regulations, increase in investment and technology development.

4.2.3 Classification of sustainability issues

Within the P-S-R structure, the eco-city indicator framework is categorized into multi-dimensions of major sustainability issues, i.e. urban environmental quality, natural resources management, ecosystem protection and global environmental influence.
Each sustainability issue is divided into sub-categorized environmental themes that are estimated most relevant to the corresponding issue. For instance, urban environmental quality issue is divided into 4 sub-categories representing air quality, water quality, waste generation and noise exposure. This classification according to the nature of environmental problems enables the aggregation of indicators with similar effects. The classification of sustainability issues for the eco-city indicator system is represented in table 1.

Table 1. Sustainability issues and environmental themes of the eco-city indicator system

Sustainability issues	Environmental themes
Urban environmental quality	Air quality/ water quality/ waste generation/ Noise exposure
Natural resources management	Water resources/ Energy
Ecosystem protection	Land use/ Bio-diversity
Global environmental influence	Global warming/ Ozone depletion/ Acid rain

4.2.4 Criteria for selection of indicators

To generate the eco-city indicator set, some couple of hundreds candidate indicators were collected. Through workshops and discussions among expert panel and citizens review, the suggested indicators have been evaluated with respect to the criteria :

- environmental and ecological significance for the sustainability issue
- measurability and data availability
- policy relevance

Based on the evaluation results, most suitable indicators have been selected. Taking environmental and ecological significance into consideration is crucial to achieve the goal of the eco-city indicator system, which is to describe the influence of changes in environmental pressure and state on the sustainability of municipal development.
Measurability and data availability must be taken into account as the critical selection requirement for the indicator system to fulfill for pragmatic reason and finally, comprehensibility and reflection of political concerns are considered to be important criteria that ensure the relevance of the indicator set for the target group involved, i.e. policy makers.

4.2.5 Proposed set of eco-city indicators and present implementation

About 50 indicators have been selected through the evaluation process involving workshops and discussions among expert panel and citizens review and the proposed set of eco-city indicators is represented in Appendix 2.
For the reason of the short-term application, annual trends of the indicators are assessed with respect to the corresponding targets of the municipal administration, providing both qualitative and quantitative analysis in the context of sustainability.

4.2.5 Future work on eco-city indicators

The most feasible starting point for further investigation and refining of the eco-city indicators in the context of long-term sustainability would be to examine and enhance the linkage and inter-dependency between the selected pressure-state-response indicators. Based on a greater understanding of cause-effect relationship between indicators, prioritizing and assigning appropriate weights to the 50 indicators depending on their potential impacts on long-term sustainability will be conducted.
Ultimately, the indicators will be combined into aggregated indices, which will represent the interactions and relative importance of sustainability issues, to enable a comprehensive assessment and provide general perspective of sustainability of municipal development.
Yet, different degrees of aggregation, inexact categorization of indicators, and uncertainties related to most appropriate measures would be the challenge factors to be worked out in the next stage for further development of the eco-city indicators.

5. LIMITATION AND FUTURE WORK

This study shows the various ways that sustainable development can be defined and measured. And it confirms the possibility of adapting two approaches of sustainable development to municipal administration in Seoul.
There are a few limits in this study. In case of quality of life indicators, the representative of each indicator to each category may be doubted. For example, how the percentage of employment among women is a good representative of equity in societal system can be an issue. It is also difficult to measure the present state of each indicator numerically due to their subjective qualities. Because each relative weight is determined by way of direct survey to citizens in Seoul, it can be changeable as the case may be.
In eco-city indicators, at first it has difficulty in normalization of such scientific data. Especially, imposing the weight to each indicator through the survey is next to be impossible. And also, it may be lacking in data availability since all the data needed cannot be examined at the level of city.
Although it has many difficult points, it is believed that indicators and categories in this study can be a useful tool to investigate sustainable development of a city. Besides, the efficient use of these indicator sets depends on the availability and reliability of data necessary to construct the indicators, and the precision of weight imposing to each indicator measured.

Appendix 1. Indicators for quality of life in Seoul

1. Economic System

Basis	*Indicators*
Basic Necessity	- Homeownership rates - Tap water supply rates - Electric power supply rates
Income Distribution	- Ratio of top 10% to bottom 20% by income - Ratio of highest income district to lowest district
Economic Scale	- Regional gross domestic products - Regional gross domestic products per capita
Infra. & Technology	- Paved road rates - Ratio of people using public transportation - Number of patent registered in a year
Employment	- Unemployment rates - Ratio of new firms to bankruptcy
Median Class	- Ratio of population with median income±30% - Ratio of median income growth to RGDP growth
Cost of Living	- Regional retailed price index - Cost of living index
Household Economy	- Amount of savings deposit per capita - Average household debts

2. Societal System

Basis	*Indicators*
Public Aid	- Ratio of people with minimum wage or less - Amount of public aid to people living in poverty
Equal Opportunity	- Women employment rates - Handicapped employment rates - Number of job training facilities for unemployed
Human Capital	- Average education years - Ratio of uneducated - No. of obligatory education centers per pop.1,000
Information	- Ratio of household equipped with PC - Ratio of internet users
Social Security	- Crime rates - Traffic accidents rates
Health & Safety	- Number of medical doctors per pop.1,000 - Infants death rates - Life insurance coverage rates
Culture	- Number of public cultural facilities per pop.1,000 - Ratio of participants in art and cultural activities
Individual Life	- Suicide rates - Alcoholic rates - Amount of donation to charity pot per capita

3. Natural System

Basis	*Indicators*
Land Use	- Residential space per capita - Ratio of development area to conservation area
Resources	- Amount of water used per capita - Amount of power used per capita
Production Impact	- Amount of waste per capita - Amount of CO2 emission - Number of waste water emission sources
Consumption Impact	- Waste recycling rate - Market share of eco-labeled goods
Env. Quality	- Number of ozone warning days a year - Average BOD of Han river - Average traffic noise
Ecosystem	- Number of animal species living in national parks - Density of trees in forest areas
Open Space	- Ratio of public open space to total urban space - Number of urban parks per pop.1,000
Aesthetic Value	- Ratio of tree lined streets - Number of urban landscape architectures

Appendix 2. Proposed set of eco-city indicators

1. Urban Environmental Quality

Sustainability issues	*Pressure*	*State*	*Response*

Air quality *Water quality* *Waste generation* *Noise exposure*	- Daily average of No. of vehicles in traffic - Amount of usage of heating fuel - Daily generation amount of food waste - Annual generation amount of waste - Annual usage amount of hazardous chemicals - Number of business units with waste gas emission - Number of business units with waste water discharge	- Annual average concentrations of atmospheric O_3/ SO_2 / NO_x - Annual average concentrations of BOD/ total-N/ total-P in Han-river - Traffic noise level in downtown	- % ratio of separate gathering of waste - No. of annual supervisions of pollution business units - Annual amount of municipal grant for environmental technology - Annual environmental investment of industries - No. of patent registration for environmental technology - Annual number of certifications for environmental marks - Annual capacity for sewage treatment - % ratio for waste recycling

2. Natural Resources Management

Sustainability issues	*Pressure*	*State*	*Response*
Water resources *Energy*	- Annual consumption amount of municipal water - Annual consumption of electricity - Annual consumption amount of vehicle fuel	- Available water resources amount per capita - Available electricity per capita - Annual amount of oil imports	- % ratio for water – recycling system coverage - Annual replacement ratio for water supply pipings - % ratio of public transportation to total traffic - Daily traffic mileage - Market share for energy-efficient goods - % ratio for energy recycling

3. Ecosystem Protection

Sustainability issues	*Pressure*	*State*	*Response*
Land use *Bio-diversity*	- Annual rate of increase in population - Annual number of newly built structures - Annual deforestation area due to exploitation	- % ratio of development area to reserve area - % ratio of green area - Forestation density - Bio-diversity in national park: fauna and flora	- Area of greenbelt - No. of design-ations for ecological district - Annual amount of tree plantings - No. of campaigns for ecology protection

4. Global Environmental influence

Sustainability issues	*Pressure*	*State*	*Response*
Global warming *Ozone depletion* *Acid rain*	- Annual discharge amount of CO_2/ SO_2/ NO_2/ CFC	- Annual average of surface ultraviolet radiation intensity - Annual average of acidity of rainwater	- % ratio for clean fuel substitution - No. of industrial applications for clean technology - % ratio for TMS installation - % ratio for CFC substitution

REFERENCES

Rainer Walz, *Development of Environmental Indicator Systems : Experiences from Germany,* Environmental Management Vol. 25, No. 6, pp. 613-623, 2000

David Pearce and Giles Atkinson, *Measuring Sustainable Development*, The Handbook of Environmental Economics, Chapter 8, 166-181, 1995

Sander de Bruyn, Michiel van Drunen, *Sustainability and Indicators in Amazinia-conceptual framework for use in Amazonia*, Report No. W-99/37, 1999

Commission for Sustainable Development, *Implementation programme of indicators of sustainable development of the commission of sustainable development*, UN-DPCSD, New York, 1996

OECD, *Environmental Indicators*, OECD, Paris, 1994

City of Seoul , *2000 An Environmental White Paper*, 2000

The World Bank, *Expanding the Measure of Wealth : Indicators of Environmentally Sustainable Development*, 1997

Hart Bossel, *Indicators for Sustainable Development : Theory, Method, Applications*, International Institute for Sustainable Development, 1998

City of Austin's Sustainable Communities, *Central Texas Indicator 2000,* 1st Sustainability Indicator Project Report, 2000

Jacksonvile Community Council, *Quality Indicators for Progress*, Sustainable Comunities Network, Case Studies, 1995

The Thomas Jefferson Sustainability Council, *Indicators of Sustainability : Interim Report*, Thomas Jefferson Planning District Commission, Charlottesville, Virginia, U.S. 2000