An Empirical Examination of the Structure of Sustainable Development: South Korea and Thailand Compared*

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Abstract: This research examined empirically the patterning of sustainable development of South Korea and Thailand. For the empirical verification forty indicators were selected drawing upon the conceptual components of sustainable development and they were applied to diverse statistical assessment. The research findings pointed to three facts. Firstly, the indicators held considerably high explanatory power for identifying sustainable development structure of both Korea and Thailand. Secondly, the relative importance of individual indicator and category was significantly different between the two countries whereas the relative importance of dimensions showed the same pattern in that the environment was most important determining the state of sustainable development, which is followed by the social and the economy. Thirdly, during the 10 years period between 1994 and 2003, sustainable development had been shaped with a significant interaction among the environmental, the social and the economic factors in Korea and Thailand alike.

Key words: Sustainable Development Indicator, Structure of Sustainable Development, South Korea, Thailand.

I. RESEARCH AIM

This research attempts to identify the structure of sustainable development of South Korea (hereafter Korea) and Thailand. We are interested in knowing empirically in what way the two countries are structured in terms of sustainable development. The explanation of the relationship between the environment and the economy suggests that environmental problems began to emerge when the economy runs at the chemical power for producing goods and services. As the two countries at examination represent differing industrialization stage — Korea being at the electronic and Thailand at the chemistry — we assume that they are different in a way sustainable development to be shaped. For an empirical verification, we adopted forty indicators that extracted from the review of the conceptual components of sustainable development.

Sustainable development as an idea orienting global social development is now almost twenty years old since the inception by World Commission on Environment and Development (henceforth WCED). Numerous research being undertaken for the last two decades, this research is distinctive in two senses: One is the logic that is used to select indicators to measure the structure of sustainable development; the other is an analytical focus that involves not only the structure in a given time but also the structure of change during the period of ten years time.

Korea and Thailand that are invited for an empirical test represent interesting points for research. These two countries are nothing similar to each other in terms of cultural, political, economic, and historical senses. Korea is a country where a Confucius cultural ethos guides everyday social interaction whereas Thailand is a longstanding Buddhist country. Politically and historically, the former having long experienced unstable political

structure during the twentieth century while going through Japanese colonial legacy, Korean War and military dictatorship it is often said to have achieved democracy within shorter period of time than other developing countries. On the other hand Thailand being treated a buffer zone in South East Asia no war has occurred in the national territory as well as it has not been colonized by any colonizing powers monarchy system rules the country. Thai economy is based on primary and tertiary industry with tourism playing a growingly key national income source. Her manufacturing industry is emerging activating on chemical power. On the contrary, Korea having been ranked among key manufacturers in the world economy the main motion power has been replaced by electric and nuclear energy; also IT and knowledge based economy taking a shape since the mid 1990s.

We assume that these generic differences in country formation affect the patterning of sustainable development structure. Since no research is carried out focusing upon these two countries with sustainable development issue we limit our aim to identifying (fact-finding) the structure.

To achieve the research aim, this paper is structured into four parts. The first part examines conceptual meanings and implications of sustainable development tracing the historical evolution of the concept since the nineteenth century. Drawing upon this work the second part identifies indicators which will be used for an empirical analysis. Using a ten-year time serial data (from 1994 to 2003) that were collected for Korea and Thailand the third part presents research findings on the structure of sustainable development in 1994 and 2003 as well as the change in the structures of sustainable development over the ten year period. The implications of the findings are discussed in the last part.

Ⅱ. SUSTAINABLE DEVELOPMENT: CONCEPTUAL OMPONENTS AND IMPLICATION

Conceptual Components of Sustainable Development

Sustainable development has been a globally circulated term that constructs the discourse of salience of nature for human existence since the work of WCED in 1987. However, 19th century neoclassical economists are said the forerunner to the thinking (Noorman et al., 1998). They argued that the price of goods and services in the market should include the availability of the amount of natural resources that are put into producing them. Scientists in the 1970s revived this idea with a contrasting attitude towards economic growth. The Roma Club warned in their report *The Limits to Growth* that ecological collapse would happen if current growth trends continued in population, industry, and natural resource (Meadows et al., 1972). On the contrary, Kahn and his colleagues (1979) argued that the limits could be overcome by technology innovation as well as economic development on the basis of capital reinvestment.

In the 1980s WCED coined the term sustainable development and promoted it as a yardstick for a long-term environmental policy in a global level. They defined the terms as: a development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs (WCED, 1987: 43). During the 1990s, the concept of sustainable development was extended in its denotation while hotly debated as to its connotation.

The key debate draws on the definition provided by WCED. It can be interpreted in different ways according to what is meant by development and how broadly (or specifically) the term is defined. The concepts weak and strong sustainability are one

example that the former giving more importance to economic growth whereas the latter to the preservation of nature (Turner, 1998; Bell and Morse, 1999; Rao, 2000). In general, it is agreed that the term ecological sustainability is much clearer than sustainable development in order to indicate the salience of nature over humans.

Some expressed doubt its usefulness as a concept (e.g. Beckerman, 1994, 1995; Daly, 1995; Jacobs, 1995). For example, Lele (1991) strongly criticized that sustainable development is merely another idea promoting different forms of industrialized economic development implying that the sacrifice of nature is an inevitable part of the process of economic development. Cohen (1995) argued that notions like sustainable development or carrying capacity are important but are not concepts with any objective and scientific utility; rather it is inherently normative and value laden.

Such negative or positive arguments over the meaning of sustainable development might arise from the fact that the concept sustainable development is based on the relationship between the economy and the environment. However, only these two components being considered, sustainable development becomes desirable just for economic survival and utility (Pezzey, 1992) or for a successful economy (Lele, 1991).

There can exist, however, many other social factors that decide sustainability in the economy and the environment. The economic and environmental sustainability would be impossible unless other social factors are sustainable; without considering social factors, the concept of sustainable development cannot be realized in its entire form.

Drawing on this notion, a variety of new perspectives on the conceptual components of sustainable development emerged in the 1990s, focusing not only on the conventional components of the economy and the environment but also on social factors that

possibly determine the sustainability of the two dimensions. This is termed a multidimensional approach. Several researchers have joined this discussion. For example, Pezzey (1992) discussed sustainable development in terms of physical, ecological, economic, psychological, social, and historical dimensions. Ekins (1994) suggested biological, economic, and social components of sustainable development. Turner (1998) discussed sustainable development in terms of nature, socio-cultural systems, and the economy. Rao (2000) maintained ecological, social, and economic factors as the conceptual components of sustainable development. Harper (2004) argued for seven requirements for sustainability: population, biological base, energy, economic efficiency, social forms, culture, and world order. These multidimensional concepts can be seen as considering the sustainability of society as a whole, which is termed 'sustainable society'. Then, the concept of sustainable society enables us to extract as many sustainability components as those comprising of a society.

Ecological modernization that was initially advanced by Dutch sociologists in the early 1990s (Spaargarren and Mol, 1992) has been discussed as an alternative to sustainable development for the last ten years (see Lundqvist, 2000; Hills et al., 2003; Harper, 2004; Lenski, 2005; Gonzales, 2006). This is a theory that projects desirable path of development in the late modern society. Spaargarren and Mol argued that the two-hundred year old version of industrial modernization has failed to acknowledge the significance of nature for human welfare. Therefore while maintaining the project of modernity all the trajectory of social process should be made in a way to consider the human impact upon the natural environment. In this sense, the theory of ecological modernization attempts to achieve ecologizing the whole society drawing upon the principles of modernity such as rationality and reason.

Conceptual Implications of Sustainable Development
The review of the conceptual components of sustainable development in the previous section has suggested the following implications:

- Economic development should be advanced in order to meet the human needs. This is the goal of economic development.
- The environment should be preserved because humans cannot survive without nature. This is the goal of environmental preservation.
- However, the two goals are contradictory. The contradiction should be solved in a way that economic development progresses within the carrying capacity of the environment.
- Economic development should meet the needs of the present generation without compromising the ability of future generations to meet their own needs. This is the goal of equity between generations.
- The strong sustainability implies an eco-centric perspective, emphasizing the co-existence between humans and nature.
- The weak sustainability is an anthropocentric perspective, anticipating a possibility to overcome the limit of carrying capacity of the natural environment.
- Sustainable development is a bi-dimensional concept considering the economy and the environment, while sustainable society is a multi-dimensional considering other factors determining the sustainability of the economy and natural environment.
- Sustainable society is a horizontal perspective on the relationships among all the components of sustainable development whereas ecological modernization is a hierarchical perspective giving overarching importance to the environment.

Ⅲ. SUSTAINABLE DEVELOPMENT INDICATORS

The Concept and Usage of Sustainable Development Indicator
  The term indicator is defined as: a proxy measure of a given situation, variable, a concrete and empirical measure representing an abstract concept, and a measure of behavior (Jeong, 2002: 285-287). Then, sustainable development indicator (hereafter SDI) can be considered as concrete and empirical proxy measures that represent the conceptual components of sustainable development.
  Environmental indicators are often used synonymously with SDI. However, they superseded SDIs in their inception, and the two are conceptually different (Opschoor & Reijnders, 1991). Environmental indicators express change in the amounts of emission, discharge, deposition, intervention and so on in a predetermined region for investigation. They can be defined as quantitative descriptors of change in anthropogenic/environmental pressure; or in the state of the environment. Thus, they indicate pressure. Examples of environmental indicators include work developed in Japan (Jeong, 2002: 290-291), the Netherlands (Adriaanse, 1993), and the Organization for Economic Cooperation and Development (hereafter OCED 1994). OECD (1994) used a framework of Pressure-State-Response (PSR). These works were guided by a conceptual definition that focuses on environmental and economic issues; as was revealed in the previous section they are insufficient to measure the multi-faceted concept of sustainable development.
  SDIs are not simply indicators of an actual state; rather indicators of state when compared to certain reference. The reference can be environmental state either in the past, or in the future being regarded more desirable than the present. SDIs are, thus, more than mere descriptors of a state, but a normative measure of the distance in quality between the current state and

the state projected. With such an implication, SDIs focus on the links between environmental impact and socio-economic activity (DEUK, 1996).

SDIs were invented in order to overcome the shortcomings inherent in environmental indicators. For example, Braat (1991) defined SDI as an indicator that provides information of the future — directly or indirectly — as to the sustainability of specified levels of social objectives such as material welfare, environmental quality, and natural amenity. Particularly, development of SDIs has been encouraged since the establishment of UNCSD (United Nations Committee on Sustainable Development) under the United Nations, this being the institutional outcome of 1992 Rio Earth Summit. UNCSD requested the member countries to submit a practice report on the basis of the Agenda 21 including statistical data for Sustainable Development Indicators.

Most work of Sustainable Development Indicators has adopted a DSR framework rather than a PSR (Pressure-State-Response). DSR framework refers to: D (indicating Driving-Force) being defined as the impact of human activities on sustainable development; S (indicating State) as the state of sustainable development resulting from D; and R (indicating Response) as a feedback loop to D (Driving Force). Recently, PSR framework has been more specified: for example, USA (USIWGSDI, 2001) and UK (DEFRA, 2003) adopted DPSIR framework (Drive force-Pressures-State-Impact-Response); and Germany (DB, 2002) used NAPSIR framework (Needs-Activities-Pressure-State-Impact-Response).

SDIs have three geographical application in their use: a local region in a country (e.g. Sustainable Seattle, 1995; LGMBUK, 1995); a whole country (e.g. DEUK, 1996; USIWGSDI, 1998; Eckersley, 1998: 299-327); and a global situation (e.g. UNCSD, 1996; SOEC, 1997; SCOPE, 1997; UNDPCSD, 1997; World Bank, 1997; OECD, 1998; EEA, 1999; Bell & Mores, 1999). What is crucial is that they attempted to develop SDIs in an integrative way,

including the natural environment, the economy, socio-cultural factors, and even institutional factors (e.g. SOEC, 1997; UNCSD, 1996; SCOPE, 1997; World Bank, 1997; UNDPCSD, 1997). From the beginning of the twenty first century, index began to be developed in relation to sustainable development. The examples include sustainable development index (Jeong and Lee, 2003), environmental performance index (WEF, 2005), and environmental sustainability index (WEF, 2005).

Selecting Sustainable Development Indicators

SDIs are the references by which the concept of sustainable development is empirically measured. The selection of SDIs should be made with a reference to the conceptual components of sustainable development. However, we observed that the concept of sustainable development is defined in a wide-range way. This has resulted in a difference in SDIs that are selected. The difference can be identified from SDIs in geographical application of local, national, and global.

Nevertheless, when SDIs are selected — regardless of the geographic application level — three hierarchical divisions are commonly applied. In other words, a generic dimension is decided and then several sub-categories that represent the generic dimension are considered. Individual indicators are selected for each sub-category (e.g. DEUK, 1996; UNCSD, 1996; EU, 1997; OECD, 1998; UNDPCSD, 2001). As for the generic dimensions the environment, the economy, and the social are the most commonly considered.

It is impossible to select the entire sets of indicators representing the conceptual components of the environment, the economy, and the social as the dimensions of sustainable development. In particular, this research being a comparative investigation, indicators should be not only identically chosen but also available in data collection both in Korea and Thailand. With such im-

plications and limitations, we selected 40 indicators using three-layered hierarchical classification mentioned in the above. They are listed in Table 1.

Table 1. The list of indicators for measuring the structure of sustainable development of Korea and Thailand

Dimension	Category	Individual Indicator
The Environment	1. Cause of Environmental Pollution	1. Amount of chemical fertilizer used (kg/ha) 2. Fossil energy among all energies used (%) 3. Energy use per person (TOE/year) 4. CO_2 emission (MT/year)
	2. State of Environmental Pollution	5. COD demand in ocean (mg/l) 6. Concentration of fine dust in air (μg/m3) 7. Concentration of sulfurous acid gas in air (ppm) 8. Concentration of carbon monoxide in air (ppm) 9. Dissolved oxygen in water (mg/l) 10. COD demand in water (mg/l)
	3. Waste	11. Generation of general waste (ton/day) 12. Generation of specific waste (ton/day) 13. Reuse of general waste (%)
	4. State of Environment Preservation	14. Area of natural park (km2) 15. Area of green belt (km2) 16. Water consumption per person (l/day)
	5. Policy for Preserving Environment	17. Clean energy among total energy (%) 18. Environment budget to total government budget (%) 19. Expenditures on pollution abatement and control to GDP (%)
The Economy	6. Economic Activity	20. GDP per capita (USD) 21. Private final consumption expenditure (USD) 22. Government liability to GDP (%)
	7. Economic Inequality	23. Gini coefficient 24. Unemployment ratio (%) 25. Female worker among total workers (%) 26. Female worker wage to male worker wage (%)

The Social	8. Population	27. Total number of population 28. Urbanization (%) 29. Population living in capital area (%)
	9. Safety	30. Number of Offenses (per 100,000 population)
	10. Education	31. Education budget to total government budget (%) 32. Expenditure for primary and secondary school (USD/student) 33. Expenditure for university (USD/student)
	11. Social Welfare	34. Supply of sewer system (%) 35. Supply of tap water (%) 36. Social welfare budget to total government budget (%)
	12. Transportation	37. Number of passengers transported by car 38. Quantity of goods transported by car (ton/year) 39. Road density (road length/national area) 40. Number of cars per 1,000 population

A ten-year time serial data from 1994 for each of the indicators was collected for the two countries. The data is secondary obtained from diverse sets of statistical yearly books for each of the ten years time (1994-2003).

Some cautionary remarks should be made as to the way numerical values of data were operationalized. For example, the category of 'Cause of Environmental Pollution' composes of four indicators. Due to the difference in their measurement units, the original value of the four individual indicators can not be added up for estimating the value of 'Cause of Environmental Pollution'. Therefore, the original values of 40 indicators are all transformed to the standard scores, which enable the value to add up and/or multiply without change in the mathematical meaning of their original value.

Some SDIs (e.g. the proportion of clean energy among total

energy) indicate positive contribution to sustainable development as the value is higher, whereas others (e.g. amount of chemical fertilizer used) being negative as the value higher. Therefore, the direction of their values was operationalized to the way meaning 'the higher the value, the more positive in the contribution to sustainable development.'

Ⅳ. EMPIRICAL ANALYSIS

Structure of Sustainable Development

Many factors influence a society to be structured in a sustainable way. The SDIs selected from the conceptual components of sustainable development (see Table 1) are determinants of the state of sustainable development as its structure. We decided empirically the sustainable development structure of Korea and Thailand by carrying out three statistical examinations using the indicators: explanatory power, relative importance, and relationship among the indicators.

Explanatory Power of the Indicators

The 40 indicators selected do not cover all components, but partial. This means that they cannot explain one hundred per cent of sustainable development in terms of its state to be determined. Therefore, we have to gauge how much the indicators selected can explain the structure of sustainable development to be determined. This is termed explanatory power.

The explanatory power can be measured by the percent total variance which can be estimated from a factor analytic technique (for more details, see Jeong, 2004: 346-385). Principal components method among the factor analytic techniques was used. This is because principal components method considers neither error variance nor specific variance assuming that the variance of each SDI is loaded on common factor extracted.

The analysis showed that explanatory power of the indicators is slightly greater for Korea (77 per cent) than Thailand (65 per cent); other indicators not used in this research explain the remaining: 23 per cent (Korea) and 35 per cent (Thailand).

Relative Importance of the Indicators
As identified in the foregoing the indicators in a total hold different degree of explanatory power for Korea and Thailand. As well, each of the indicators may have different degree influencing sustainable development to be structured. The difference is termed the relative importance of indicators.

The relative importance of the each indicator can be measured by the value of communality estimated by principal components method. The positive and/or negative direction of individual indicator in determining sustainable development also can be estimated on the basis of the factor loading when number of factors to be extracted is fixed at one. The reason for extracting one factor is that such research is not to identify the factor structure of the SDIs as the structural components of sustainable development.

The value of communality (ranging from 0.000 to 1.000) is interpreted in a way that the higher the communality of SDI, the stronger the SDI as a determinant of sustainable development. SDI whose factor loading is positive means that it draws positive impact on sustainable development and vice versa. We examined relative importance of: individual indicator, category, and dimension.

Relative Importance of Individual Indicator
Table 2.1 shows the value and direction of communality of each indicator. Upon assuming the value of communality over 0.900 to be higher the following is found to be significant factors influencing sustainable development.

Table 2.1. The relative importance of individual indicator determining sustainable development structure of Korea and Thailand

SDI	Korea	Thailand	SDI	Korea	Thailand
1	-0.761	+0.795	21	+0.963	+0.949
2	-0.975	-0.818	22	+0.016	+0.093
3	-0.964	+0.614	23	+0.733	-0.565
4	-0.915	-0.732	24	+0.286	+0.583
5	-0.506	-0.233	25	+0.839	-0.503
6	-0.718	-0.948	26	+0.858	+0.883
7	-0.858	+0.601	27	+0.565	-0.995
8	-0.957	-0.594	28	-0.991	+0.777
9	+0.458	+0.747	29	-0.969	+0.661
10	-0.720	-0.109	30	+0.289	+0.594
11	-0.984	-0.989	31	-0.800	+0.194
12	-0.952	-0.870	32	+0.547	+0.885
13	+0.979	-0.895	33	+0.773	-0.647
14	+0.948	+0.939	34	+0.875	+0.786
15	+0.714	+0.986	35	+0.888	-0.893
16	-0.925	-0.701	36	+0.898	+0.077
17	-0.950	-0.872	37	-0.902	+0.872
18	+0.637	+0.395	38	-0.811	-0.150
19	+0.549	+0.054	39	-0.872	-0.853
20	+0.424	+0.381	40	-0.894	-0.891

Note 1: he name of each indicator is identical with its number of indicators in Table 1; 2. + indicates positive impact and − negative impact; 3. The higher numerical value indicates the stronger impact and vice versa.

Wide area of national park and high level of private final consumption expenditure make greatly positive contribution to sustainable development of Korea and Thailand alike. High rate of reusing general waste (for Korea) and wide area of green belt (for Thailand) are also positive indicators. However, Korea's sustainable development is negatively influenced by: high composition rate of fossil energy to all energies used, high level of energy use per person, high level of CO_2 emission, high concentration of carbon monoxide in the air, great generation of both general and specific waste, low composition rate of clean energy to total en-

ergy, high level of urbanization and population of the capital, and too many passengers transported by car. On the other hand, three indicators — high concentration of fine dust in the air, much generation of general waste, and too many people — are negative sources for Thailand's sustainable development.

Relative Importance of Category and Dimension

The indicators selected for this research come under 12 categories (see Table 1). Each category contains different number of indicators. The direction of each indicator being ignored, the value of communality of each indicator was added up for each category, and then the average was estimated. The average was also estimated for each dimension. The results are presented in Tables 2.2 and 2.3.

Table 2.2. The relative importance of category determining sustainable development structure of Korea and Thailand

Category	Korea	Thailand	Category	Korea	Thailand
Cause of Environmental Pollution	0.934	0.740	Economic Inequality	0.679	0.634
State of Environmental Pollution	0.703	0.537	Population	0.842	0.811
Waste	0.972	0.918	Safety	0.289	0.594
State of Preservation of Environmental	0.863	0.875	Education	0.707	0.575
Policy for Preserving Environment	0.712	0.440	Social Welfare	0.887	0.585
Economic Activity	0.468	0.474	Transportation	0.870	0.692

Table 2.3. The relative importance of dimension determining sustainable develop-
ment structure of Korea and Thailand

Dimension	Korea	Thailand
The Environment	0.814	0.678
The Economy	0.588	0.565
The Social	0.791	0.663

Waste generation category is the strongest determinant of the state of sustainable development of both Korea and Thailand. For Korea the causes of environmental pollution category being the second strongest, four categories are also powerful in deciding the state of sustainable development: social welfare, transportation, the state of environment preservation, and population. On the other hand, the state of environment preservation being the second strongest factor for Thailand, population, the cause of environmental pollution, and transportation are the categories that are powerful.

For the relative importance of dimensions same pattern is identified for Thailand and Korea. The sustainability of the environment is the strongest factor determining the state of sustainable development, followed by the sustainability of the social and the economy.

Mutual Relationship among the Dimensions
The 40 indicators as the determinants of the state of sustainable development do not exist independently, but exist in a way to create their mutual existence mode. The analysis of mutual relationship for this research involves three parts: relationship among the indicators; relationship among the categories; and among the dimensions. The positive and/or negative direction and strength of the mutual relationship can be identified by estimating correlation coefficients. We examined the mutual relationship only among the dimensions. Table 3 shows the result.

Table 3. Mutual relationships among dimensions

Korea				Thailand			
Dimension	1	2	3	Dimension	1	2	3
1	1.000	-0.628	-0.528	1	1.000	-0.510	-0.421
2		1.000	0.641	2		1.000	0.536
3			1.000	3			1.000

Note 1: The Environment 2: The Economy 3: The Social.

The results in Table 3 indicate the following points:
- As the theories suggest, sustainable development in the two countries is in progress taking a shape of a mutual relationship among the environment, the economy, and the social.
- The strength of their mutual relationship is much stronger in Korea than in Thailand.
- In terms of the direction of their relationship, the two countries show the same pattern that the higher the sustainability of the economy and the social, the lower the sustainability of the environment.
- The two countries show that the higher the sustainability of the economy, the higher the sustainability of the social.

Change in Sustainable Development Structure
The structure of sustainable development in a given time is likely to change over time. The analysis of the change in a structure can be analyzed in terms of the following three aspects: the change in the structure of sustainable development; the structure of change in sustainable development; and the change in relative position of sustainable development dimensions.

The change in the structure is defined as the differences in a system identified at different time. Such an approach to change has been developed in environmental sociology when urban socio-ecological structure was analyzed in the 1970s (e.g. Janson,

1978). In this research, two-point for the time period is the years of 1994 and 2003.

For this research, change in structure is based on a comparison between the two structures after separate analyses are carried out in terms of, as specified in the previous section, explanatory power of the 40 SDIs, their relative importance, and their mutual relationships. The first two require another set of a 10-year time series data from 1984 to 1993 and that is beyond the current research inquiry. Thus, this research analyzed the structure of change in sustainable development and the changing process of each sustainable development dimension.

The Structure of Change in Sustainable Development

The concept and the analytic technique of the structure of change were frameworked in urban socio-ecological change analysis in the 1970s (e.g. Hunter, 1971). It is assumed that the process of change over time does not take place in disorder, rather in a patterned configuration. The patterned configuration is defined as the structure of change. In other words, the structure in Time A (T1) is likely to become a new structure in Time B (T2) through a process of change (P). The value of P should be created as a new set of data which is termed change coefficients. The change coefficients are created from the value of change in each corresponding SDI between two points for the time spot considered.

It may be, therefore, maintained that the structure of change is based on, at least, a trichotomous causal model which implies the structural components of Time A as an independent variable, the structural components of Time B as a dependent variable, and the structural components of changing process as an intervening variable. This causal model can be analyzed by path analysis. The result of path analysis was diagrammed as Figures 1 and 2 and the coefficients presented are those significant at 90

per cent reliance level.

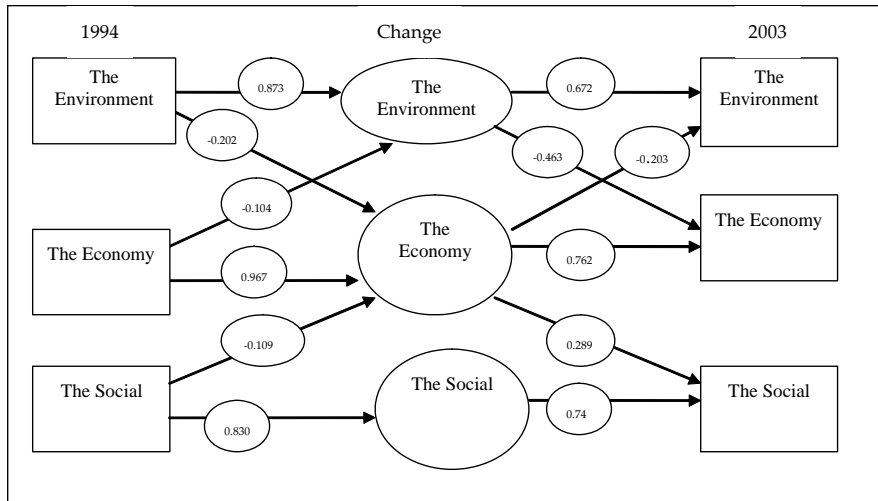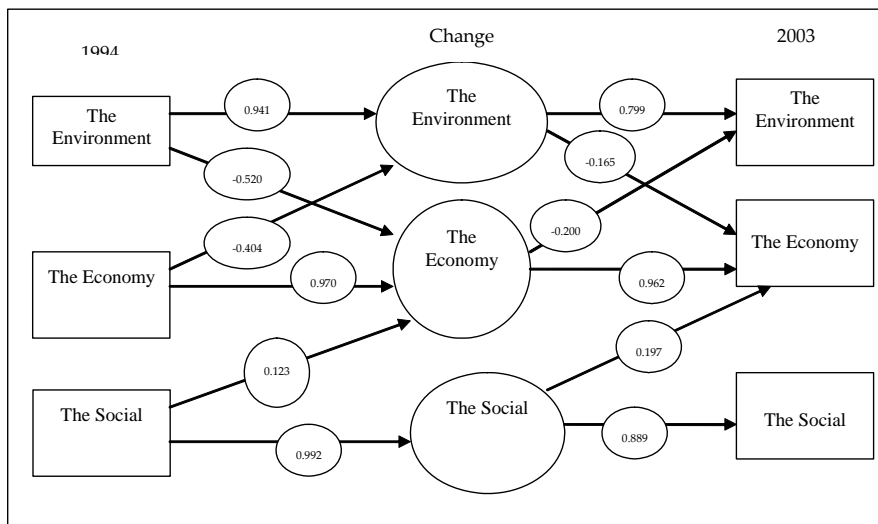**Figure 1.** The structure of change (1994-2003) in sustainable development – Korea

Figure 2. The structure of change (1994-2003) in sustainable development – Thailand

The following facts are found to be significant from Figures 1 and 2:

- For the two countries, the sustainability of the three dimensions (the environment, the economy and the social) in 1994 exerts an *indirect* impact on their sustainability in 2003 through the structure of changing process.
- Except one path the two countries show the same structure of change in the formation of sustainable development pattern from 1994 to 2003. The exceptional path concerns Thailand in which the changing process of the sustainability of the economy influences the dimension of the social to be sustainable in 2003.
- The strength of the influence of the three dimensions differs between the two countries. For example, the negative influence of the environmental sustainability in 1994 on the determination of economic sustainability is 0.520 for Korea, but 0.202 for Thailand.
- It is concluded that the two countries have experienced the same pattern of the structure of change with different strength of influence among the environment, the economy and the social from 1994 to 2003.

The Change in Relative Position of Sustainability Dimensions

The analysis of sustainability in terms of its structure and change explained above is an approach to sustainable development as a whole. However, it is assumed that each dimension of sustainable development is different in the degree of sustainability in a given time, and the difference will change over time. In this sense, it is valuable to examine the relative position of the sustainability level of the three dimensions – the environment, the economy and the social.

The technique of estimating relative deviation index (hereafter called RDI) can be applied to this analysis (Jeong,

1997: 375-376). The RDI is a statistical measure indicating the deviation of each dimension from the total values of all dimensions as a base criterion in a set of time-serial data. In this research, the total value as the base criterion is the total sum of the values of the environment, the economy and the social from 1994 to 2003.

The RDI of each dimension in a given year can be compared to that of other dimensions. If this comparison is undertaken on the sustainability degree of the dimensions through all years, the result enables us to identify the changing process of the relative position of each dimension in terms of sustainability level.

The RDI 0.000 reflects no deviation when compared to the base criterion that is measured by total values of all dimensions. Thus, the dimension whose RDI is 0.000 is interpreted as to be in medium in terms of sustainability level in a given year. The dimension whose value is minus and/or plus reflects relatively lower and/or higher level of sustainability compared with other dimensions. Table 4 shows the RDI of each dimension from 1994 to 2003 in Korea and Thailand. Figures 3 and 4 provide a graphical description of the results in Table 4.

Table 4 can be interpreted in two ways: one is the comparison among the three dimensions by year; and the other is the comparison of each dimension by year. The example of the former is that the economic sustainability is relatively higher in 1994, and followed by the environmental and social sustainability. This research will interpret Table 4 in terms of the latter.

Figure 3. A graphic presentation of the changing process of RDIs of the sustainable development dimensions – Korea
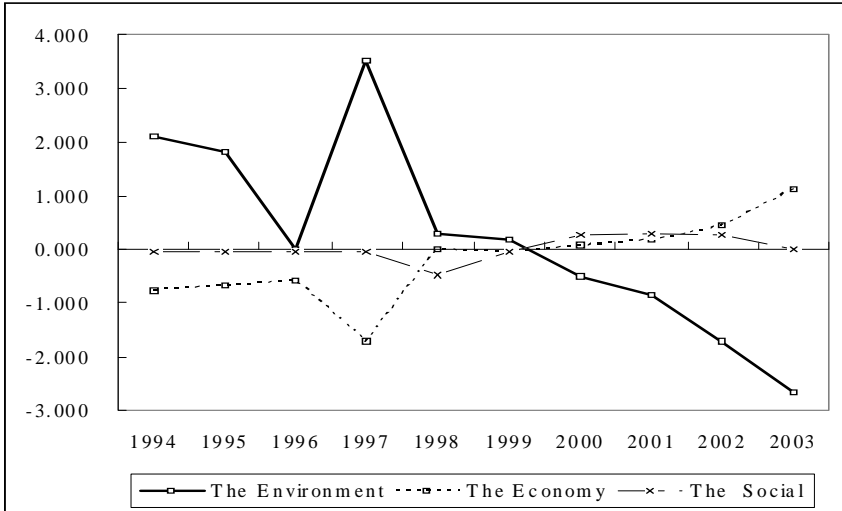

Figure 4. A graphic presentation of the changing process of RDIs of the sustainable development dimensions – Thailand
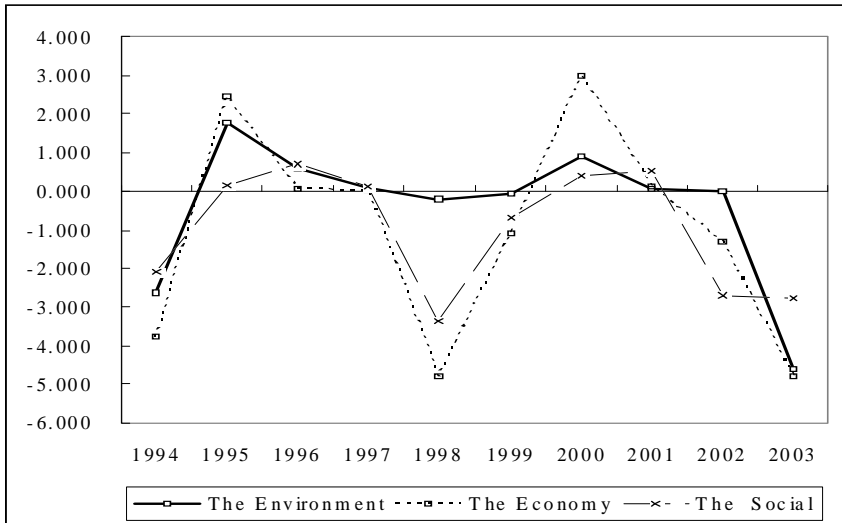
Table 4. Relative deviation index of the sustainable development dimensions: 1994-2003

	Korea			Thailand		
	The Environment	The Economy	The Social	The Environment	The Economy	The Social
1994	2.111	-0.781	-0.038	-2.646	-3.782	-2.083
1995	1.817	-0.664	-0.037	1.794	2.464	0.173
1996	0.015	-0.581	-0.036	0.609	0.055	0.698
1997	3.511	-1.716	-0.045	0.092	0.024	0.114
1998	0.292	-0.008	-0.493	-0.212	-4.781	-3.373
1999	0.180	-0.036	-0.057	-0.065	-1.071	-0.665
2000	-0.513	0.075	0.274	0.906	2.993	0.385
2001	-0.852	0.162	0.298	0.059	0.125	0.547
2002	-1.717	0.447	0.266	-0.011	-1.312	-2.704
2003	-2.652	1.118	0.002	-4.621	-4.792	-2.751

For Korea, the environment was relatively more sustainable from 1994 to 1999 than the economy and the social, but less sustainable from 2000 than the economy and the social. The economy and the social being compared, the social was relatively more sustainable than the economy from 1994 to 1997, and less sustainable than the economy from 1998. In 2003, the economy was most sustainable, followed by the social and the environment.

For Thailand, the relatively higher position of sustainability among the three dimensions by year varies a great deal: for example, the economy was least sustainable in 1994; but it became most sustainable in 1995, whose pattern keeping to 1999 from 1996. In contrast, the environment was in the middle in terms of the relative level of sustainability for the 10 year period.

Ⅴ. DISCUSSION

Achieving sustainable development is a top priority in the twenty first century that every nation state is aimed at. To real-

ize the aim we need to understand situations that influence sustainable development to be shaped. In this sense this research approached the concept of sustainable development in terms of the state of the environment, the economy, and the social factors and the key aim was devoted to measuring empirically the state of the three sustainable development dimensions in terms of structure and its change. This research inquiry was cross-cultural involving Korea and Thailand and longitudinal covering a ten-year period between 1994 and 2003. To represent the three sustainable development dimensions we used 40 indicators, these being tested with principle component method of factor analysis technique that endorses empirical justification for the selection of the indicators for further analysis by showing their strong explanatory power for both Korea and Thailand.

Diverse interpretations having been made over the concept of WCED on sustainable development, the function of the three generic systems of the environment, the economy, and the social are often recommended to maximize when sustainable development is treated as a goal to realize (Humphrey et al., 2002). For this issue our findings indicated that neither Korea nor Thailand has been successful as the relationships among the three dimensions are not equally positively linked. On the other hand the two countries showed unlike pattern in the structure of sustainable development in a way that significant indicators influencing the structure are different and also their influence powers are not equal.

What would explain these differences between Korea and Thailand? The literature of sustainable development has not been fully mature to respond to this question as its main contour involves either conceptual debate of the meanings of sustainable development or empirical study of 'fact-finding' of sustainable development state in a certain time. Therefore we can only suggest the following points for a possible explanation of our research

findings. At a macro level the two countries are very different in terms of cultural principle, political structure, economic situation, and historical background. In a specific term the two countries have possibly taken a different process of industrialization since 1994 particularly in handling the 1997 IMF crisis. Also Korean and Thai governments might have responded differently to the aim of achieving sustainable development by launching different policies and also granting a different priority among the policies adopted. A further study will verify these propositions.

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