H-8 Study on the Sustainable Compact City and its Facilitation (Abstract of the Final Report)

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1. Introduction

With approximately 30 billion people, more than 48 percent of the world population living in cities and both human activities and the use of energy also concentrated in cities, the urban areas have become the major cause of orientating societies toward mass production, mass consumption and mass dumping of waste. In order to solve global environment problems such as global warming caused by human activities, it is necessary to change a society of heavy energy consumption to a recycling-oriented society where thorough measures are implemented to save energy and resources. Whether in industrialized or developing countries, it has now become an urgent task to transform a city with a heavy concentration of people, goods and money into a recycling-oriented city.

To cope with such environmental problems, a key project of the International Human Dimension Programme (IHDP) that has been designed to look into "human and social aspects of global environmental changes" has already begun studying industrial transformation (IT). Researchers and experts have been researching measures to realize a recycling-oriented society using the rapidly growing information technology based on a reevaluation of the city and its restructuring.

Since all sorts of human activities are concentrated in the city, it is essential to conduct such a reassessment from many and various viewpoints. This is why an interdisciplinary study approach has been expected, involving researchers and experts in the fields of cultural and social sciences, to study the human and social aspects of local environmental changes such as human activities and lifestyles. In addition, researchers in the areas of natural science and engineering have been working to solve environmental problems and studying technical responses.

2. Research Objective

The research project on the compact city, based on an interdisciplinary approach to find solutions to the problems that the cities of both developed and developing countries have been facing, aims

(1) to propose what form a city should take in order to realize the construction of a recycling-oriented society, and

(2) to study policies to realize a sustainable compact city (a city compact enough to perform its functions properly).

This research project employs the compact city as a model of the recycling-oriented city with great emphasis on saving energy and resources, which has been highly reevaluated in Europe and America in recent years, to study ways to build such a city in Japan and other industrialized countries as well as in the developing countries in Asia, and to make policy

proposals to achieve this goal.

This research project consists of the following two sub-themes:

Sub-theme 1: Study on what form a sustainable compact city should take in developed and developing countries

The evolution of cities in industrialized countries including Japan will be analyzed and evaluated from various angles and study how form a compact city should take. The problems facing mega-cities, particularly in developing countries, and the impact that global environmental policies may have on the human and social aspects of global environmental changes, will be analyzed, and steps toward their solution will be studied from the perspective of building the compact city.

Sub-theme 2: Study on how to comprehensively evaluate and realize the sustainable compact city through industrial transformation

A method of evaluating the compact city from various angles will be developed. Policies toward the materialization of the sustainable compact city through industrial transformation will be studied with reference to environmentally friendly technologies. Since the most advanced information technology (IT) is expected to play a significant role in realizing the sustainable compact city, its influence on the industrial activity of cities and the lifestyles of their residents will also be studied. Policy proposals will then follow, based on the results of the studies on both sub-themes 1 and 2 to realize the sustainable compact city.

3. Results and Discussion

3.1 Sub-theme 1(1) Modeling of Compact Cities in Developing Countries

This research aims to examine whether the compact city policy is effective as a sustainable urban development strategy for developing countries where urban population may increase by 4 billion persons until the year 2025.

The concept of compact city has been advocated as a sustainable urban development strategy in developed countries, in particular EU countries, since the beginnings of 1990s. In order to apply this compact policy to the cities in developing countries, however, there is a big difference in its fundamental environmental issue to be solved between developing and developed countries. In the former, problems are caused by an advancement of the quality of life, while reservation of a human security is in question for the latter. This fact makes it difficult to apply the past argument of the compact city performed in developed countries to developing countries as it was.

In this research, thus firstly, the relationship between compact city policy and sustainable development is theoretically explored through literature review. The concept of compact city is advocated of three characteristics of urban formal, spatial and social structure. While the sustainability of urban society is able to be defined in greatest common factors as economical sustainability, environmental sustainability and social sustainability. That is, the concept of a compact city and the requirement for a sustainable city cannot be told on the completely same dimensions. However, it can take common features, such as a breakaway from automobile dependence and revival of the neighborhood nature by high-density habitation.

Secondary, to examine introduction of compact city policy in detail, the study was forwarded in aspect of indexing, growth prediction and urban formation. In order to know

what kind of element of urban living environment are regarded as important by urban residents in developing counties, the questionnaire about the human security, which took in the technique of capability approach, was carried out to the college student in Asia mega cities. The result indicated that among institutional arrangement of social safety, items related to individual safety in particular health was given the highest priority.

Many of problems for megacities in developing countries originate in population explosion. In order to cope with this, the capacity of a city to accommodate population needs to be increased. A rough measure will be considered, (1) absorption by the periphery expansion of the existing city, (2) absorption by the satellite-city construction surround the existing city. Since reservation of efficient infrastructure and social equity is needed for such new developments and the concept of a compact city policy matches these conditions, it is desirable to introduce this policy as a development policy according to city growth. In order to consider the relation between urban form and the sustainability, the amount of traffic movements had made the trial calculation with a theoretical model to which several compact cities exist in urban area. It was suggested by the result that the middle dispersion type is more desirable than large concentrated core type or small-subdivided type.

Lastly, the city growth simulator by SD model in which policy evaluation can be made based on the prediction of economy and population dynamics was developed taken Bangkok as a case study city, to examine how a compact city policy can be realized. The model also gives an output of the energy consumption and the CO_2 emission and concludes that even though population increases abruptly, energy demand become a chance of increasing gently by the appropriate adoption of the compact city policy.

3.2 Sub-theme 1(2) Modeling of Compact Cities in Developed Countries

This study aims at carrying out the following contents. (1)Collecting data and research inspection of compact cities in Denmark and Sweden including Copenhagen and Stockholm cities. (2)Constructing a computable general equilibrium (CGE) model for Obihiro metropolitan area (Obihiro city, Otohuke town, Menuro town, and Makubetsu town) taking account of waste generation, abatement, and recycling. (3)Constructing a Dynamic Optimal Compact City model.

The outcomes are summarized as follows: (1)Due to the simulation results of CGE model for Obihiro metropolitan area, imposing tax on households is more effective to reduce waste than on industries. However this model does not incorporate the material circulation, thus it could be a further study to examine the economic effects of material recycling. (2)Three cases including business as usual case are simulated by the Dynamic Optimization Compact City Model. This model incorporates 10 zones which are linearly located. Due to the hypothetically numerical simulation results, effects of compact city policy on spatial structure including population density, land use etc., and on economic variables including land rent and production are clarified. Moreover, sustainability of a city can be evaluated by comparing with dynamic paths of the social welfare function.

3.3 Sub-theme 1(3) Development of Urban Database

The objective of this study is to construct the common database of statistical data of the cities in Japan and in the world in our research project, and to analyze them to define the index of sustainable compact city.

By compiling and analyzing the statistic data on city functions which are collected and compiled in a database, this study extracted "the cities of high convenience in the living area by walk", as a reference index to consider the image of sustainable and

environment-conscious compact city, and researched the structure and attitude of the citizens of the representative cities. As a result, the following things were revealed.

1. The cities of high convenience in the living area by walk also arrange the economical, industrial, and environmental elements for sustainable maintenance and development.
2. Among the cities above, the one within the area of the top three mega-cities in Japan is totally occupied by urban land use, on the other hand the one in the local city area has its downtown compactly around the traffic-base such as a station. The common characteristic of these cities is the satisfaction of the public facilities.
3. The citizens of the cities above evaluate the living convenience of their city, on the other hand they demand the policies on welfare, medical, and environmental matter.

3.4 Sub-theme 2(1) Comprehensive Framework for Evaluation of Compact City

The purpose of this research is to develop comprehensive framework for evaluating city environmental condition and its sustainability. To discuss whether compact city might be one of the sustainable one, basic evaluation has been carried out based on the method focusing energy consumption and pollutant load which cause urban environmental degradation and global warming. The comprehensive framework integrates socio-economical, environmental and compact aspects and comprises global city database and conducted an assessment of urban environments with a focus on population density, which is one factor in the creation of compact cities.

From the assessments, the authors obtain the following results:

1. The city environmental assessment with various indicators from the macro viewpoint indicated the need for a certain economic power and high population density, up to a certain level, in achieving a comfortable living environment. However, when population density exceeds about 200 people/ha, both commuting distance and commuting time tend to increase. And also, the exhaust gas from traffic tends to decrease up to a population density of 100 people/ha, but gradually increase as populations grow beyond 100 people/ha. These results suggest that excessive concentration may lead to an increased burden.
2. The investigation of city form and population density from developing to developed countries showed clear changes in form and population density with each year, indicating the need for planned development in order to create compact cities.
3. The results obtained from comparative assessments of sustainability among cites utilizing Ecological Footprint (EF) indicators showed the possibility that excessively high densities in cities may lead to overconsumption of resources
4. The integrated assessment among population density, economy, environment and social compactness indicated that, up to a certain level, population density increases with economic growth while waste production declines and social compactness increases. However, after economic status and population density reach a certain level, waste production begins to increase and social compactness keeps the same level, suggesting that there is a limit to the benefits of improving spatial compactness. The results indicate that an appropriate spatial compactness is needed in the creation of a compact city.

3.5 Sub-theme 2(2) Industrial Ecosystem and City Metabolism

Cities have been identified as the core of the sustainability, as their metabolisms ultimately stress their surrounding ecosystems. The research identifies cities as the systems that pose significant threats, by creating resource imbalances with their hinterlands. The purpose of this research is to examine the relationship between industrial ecosystem and the

emergence of compact city. The research consider community awareness as a key element of sustainable compact community, and pay a particular attention to how the community awareness and industrial structural change react each other.

It investigates the issue of city and the material cycle, taking an example of household waste. A series of surveys were carried out to collect Japanese local governments' strategies on household waste management. Through these surveys, the research discovers notable types of strategic directions observable among the chosen local communities in Japan. There are two major policy emphases to develop sustainable city metabolism: 1) community awareness enhancement, and 2) waste volume control, while "bottom-up" action forms the principle for the former case, with the "top-down" action is the norm for the latter case.

The typology of the local community strategies, identified by the research, is a key to analyze the potential of the community to develop industrial ecosystem. The bottom-up approach has a gradual, but indispensable influence to form the "social motivation" for establishing community waste management system and industry, whereas the top-down approach often has a limited impact on their substantial development.

Then, we compared the number of stakeholders involved for community waste management programs and degree of waste reduction. The research reveals that 11.4% cities successfully reduced waste volume per capita. This suggests that the more stakeholders involved, the more successful in reducing waste volume. Number of stakeholders participated can be a clear indicator for successful waste volume reduction.

Through these findings, we discussed to establish a methodology to quantitatively assess the effectiveness of local community participation into waste management functions. And we proposed the establishment of environmental management system for developing sustainable city metabolism.

3.6 Sub-theme 2(3) Rebuilding Big City to Compact City

Recently, a society is become stock type from flow type. Proximity of the home to the office is necessary because of the revitalization of the existent stock of the big city, reinvigoration of hollowing out of the city and the compact housing. Additionally, the reduction of the environmental load and construction of a residential environment for the elderly people are essential for the perspective of the earth environment and the aging society. The revitalization of the existent stock of the big city has much to do and many issues to manage, such as the building maintenance and preservation, the environmental management, rebuilding and the revitalization of the crowded city blocks of wooden dwellings.

The purpose of this study is to make policy proposals, for the residence in the city for the reduction of the environmental load and implement the realization plan for compact city based on the examination and analysis of the progress of compact urbanization.

We make the following policy proposals in this study.

1. Restructuring of the residence in the city and realization plan
   1) The utilization of the existing stocks by the conversion of the office buildings
   2) The coordination with the house linkage system and the conversion system
2. The realization policy of the environmental load reduction
   1) An environmental load reduction by the promotion of conversion of the existent stock
   2) Securing the green space in the city and environmental load reduction by the density growth of the buildings
   3) Saving of energy by the utilization of the renewable energy (solar electric generation, wind power and biomass energy etc.)
   4) Construct a circulative system of the energy by the recycling of waste
3. The realization policy from the social system and economic system
   1) The coordination with the environmental policy and housing policy

2) The policy-support of the renewable energy use (subsidies from the national government etc.)
3) The Raising of environmental awareness by the NPO activities and the corporate efforts
4) The coordination with the welfare policy and housing policy
5) The reduction of environmental loads by the waste reduction and the promotion of recycling

3.7 Sub-theme 2(4) Information Technology (IT) for Realization of Compact City

This study group aims at pursuit of potentiality of IT to facilitate overall urban efficiency through compact cities provided with wide transformation of life style. It is suggested to apply on-line trading into operation of the total energy system. There are already utilized a variety of IT devices in traffic systems. Answers on public inquiry brought many practical suggestions toward modified achievement of a town rent-a-cycle system supported by IT as a social experiment. The renewal of the urban soundness is a world- wide proposition centering on our life style. At the same time civil participation on ICT is actively prevailing. It will be very effective to organize the environmental IT platform to show each enterprise performance. And also, repeated testing RPG has made progress to lead public consensus for actions toward eco-community. As a link of the environmental platform to enhance public participation, the present status of the urban sustainability indicators in Europe and the United States is overviewed. Finally, personal preference of planning experts related to various aspects of compact cities is obtained through a questionnaire, which shows general support to their concept.

4. Concluding remarks

This research project is designated as an important project for current and future environmental policy making. So we asked three experts and researchers who are very famous in the field of urban design and regional planning as members of Advisory Board of this project. There were 6 advisory board meetings during this project, and from the meetings, we had good suggestions and directions of our activities. Then, we held many steering meetings along with some workshops and symposium panels to proceed the interdisciplinary research project efficiently.

The major questions raised during discussion between researchers and advisors are 1) definition of sustainability and compactness of cities which are still contraverial, 2) inter-linkage between the projects objectives and each sub-theme research, especially models, indexing, and countermeasures, and 3) common urban database for modeling, environmental index, and assessment of the cities.

This project has finished with fruitful results described above. However there are still some research topics which have to be solved in near future for realizing a compact city in developed countries and developing countries as follows.

1) City data development: relatively limited data on city is available in this project. Currently many international and regional organizations are now developing city database for management and policy of cities.
2) Comprehensive indicator: Development comprehensive indicator system is necessary for evaluating sound city planning and management.
3) Integrated city model: Development of an integrated and comprehensive city model which can simulate all the aspects of cities is necessary for quantitative assessment of compact cities.
4) Case study: Case study work is necessary for realizing a compact city concept.