

Study on Five Principles of Urban Architecture Design for Sustainable Urban Development

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Abstract: Since, the United Nations conference on environment and development in 1992, the importance of urban architecture for sustainable urban development has come to the fore with an increasing emphasis on the significance of urban development. Sustainable urban development requires active responses to changes in the social, economic and environmental conditions of a city. In the present study, cases of sustainable urban development in advanced countries were investigated to review the theory, literature and previous studies on sustainable urban development. In addition, the limitations and the expression methods of the existing urban development methods were investigated to identify five principles of sustainable urban design.

Key words: Sustainable urban regeneration, urban development, urban planning elements, conference, environment, expression

INTRODUCTION

Background and purpose of study: Due to the rapid urbanization that followed the Industrial Revolution in 1865, exhaustion of resources and environmental pollution have become important social issues. After recognizing the issues, the concept of sustainable development was first introduced in the “Our Common Future” report published by World Commission on Environment and Development (WCED) in 1987. Since, the United Nations conference on environment and development in 1992, the social paradigm of urban development has continuously changed. Sustainable urban development has been actively proposed by advanced countries according to the paradigm change. The urban planning theories include the Soziale Stadt (Social City) program in Germany, the urban village movement, the compact city and the urban regeneration in the UK and Europe and the smart growth and the new urbanism movements in the US and Canada.

In South Korea, indiscriminate quantitative urban expansions are repeatedly performed to accommodate the increasing population that is attributed to the rapid economic growth and material expansion in cities. This is in contrast to expansion efforts that are stimulated by quality-based urban planning. Because of this type of urban planning which did not consider sustainability, the city buildings and infrastructure became old and the urban communities were ultimately disconnected, losing the vitality of cities. To solve the environmental, social

and economic problems, the government is implementing various urban regeneration policies. However, the currently implemented urban regeneration projects are biased as they call for simple development efforts, i.e., the improvement of the physical environment without consideration of the local characteristics (Kim *et al.*, 2008).

These problems are found not only in South Korea but also many other countries, including developing countries, indicating the need for the principles of urban design methods for sustainable development. In theory, these principles may macroscopically reflect the environment, history and social characteristics of individual countries and help cities adapt to the changing conditions. Considering the many problems found in the major cities of the world, the microscopic urban design elements may not be appropriate for the social, economic and historical conditions or the changes in the environment (Kim, 2012, 2013).

In the present study, the following were performed. The theories, literature and previous studies on sustainable urban development, since the 1970's were reviewed, the Korean and international cases of urban development were analyzed and the expression methods of urban planning were classified to investigate the limitations of the existing urban development methods. On the basis of the investigation, five principles of sustainable urban architecture were established and analyzed to identify five principles of sustainable urban design.

MATERIALS AND METHODS

The present study was conducted by the analysis of actual cases and the analysis of a proposed plan. To analyze the trend and types of sustainable urban development, the scope of the present study selected Sheffield in the UK, Ruhr in Germany and Musashino in Japan. These cities represent areas where rapid urbanization occurred due to the industrial revolution and economic growth. The respective countries have vast experiences in sustainable urban development and may provide relevant literature and data. The time scope of the present study for the review of sustainable urban development is from 1987 when the concept of sustainable development was first introduced in the “Our Common Future” report published by World Commission on Environment and Development to the present. In the present study, the sustainable urban development programs of the individual countries were classified and the history of the sustainable urban development was reviewed.

With regard to the methods of the study, the previous studies and the real cases of sustainable urban development in the individual countries were presented by collecting relevant data from books, research articles and information available on the internet. Based on the collected data, the elements of the sustainable urban planning programs in each country were extracted and classified to summarize the sustainable urban design plans to establish the five design principles (Table 1).

Definition of sustainable city: According to the UN-Habitat Report, the urban population was < 2% of the world population at the time of the industrial revolution. However, the explosion of the urban population resulted in a population of 3.3 billion, more than half of the global population, residing in cities in 2008. Continued exponential growth is predicted for the urban population. It is projected to reach approximately 5 billion, approximately 67% of the world population in 2030 and approximately 75% of the world population in 2050. Therefore, the number of megacities is expected to grow to at least 40 in 2050.

If more than three-fourths of humankind resides in cities, the cities in the world will experience excessive population concentration in limited spaces. As a result, most people will live as urban-type humans.

With increasing concerns about mankind’s future due to the urbanization, the concept of “sustainable development” came to the fore. In the UN Conference on the human environment held in Stockholm in 1972, the concept of global urbanization gained global recognition

Table 1: Scope and methods of study

Categories	Data content
Research range	
Target areas	UK Sheffield, Germany Ruhr, Japan Musashino
Time range	From the WCED announcement In 1987 to present
Content scope	Classification of sustainable urban development programs
Research method	Case study based on relevant books, research articles and internet resources
	Trend analysis of sustainable urban development in each city
	Classification of the elements of sustainable urban development in each city and proposal for urban planning

due to concerns about the exhaustion of resources and environmental pollution, since, the Industrial Revolution. The term “sustainable developmen” officially debuted in the WCED report titled “Our Common Future” in 1987. Sustainable development was defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987)”. Since, the UN conference on environment and development in 1992, the social paradigm of urban development has continuously changed (UNCED, 1992). However, sustainability is a highly abstract concept and has been limited to the investigation or diagnosis of the current status using sustainability indicators to establish the directions for future developments. Sustainability is a concept that reinforced the fact that mankind is a part of a continuous system inclusive of the economy, environment and social activities. The objective of sustainable development is to maximize the current potential of the states, cities, societies and economy. The concept also aims to trade off with the needs of future generations, to pursue the preservation of biodiversity and ecosystem and to develop sustainable plans and take appropriate measures to maintain the current capacities (Fig. 1).

Analytical aspects of sustainable urban development: The cities of the world have changed in the period of quantitative expansion since the Industrial Revolution with economic growth and historical influences. The cities have been indiscriminately expanded by industrialization as people leave rural areas and move to urban areas. A number of conceptual models and urban planning theories have been developed through specific discussions on sustainable development to meet people’s desire to live comfortably in urban areas. The three major elements of sustainable urban development are society, environment and economy which are considered in connection with other components when preparing urban development plans. These conceptual models have recently been applied to urban regeneration policies for the management



Fig. 1: Our common future, WCED

of existing urban regions and downtown redevelopment. However, the concept of sustainable development which is comprehensive in meaning has not been consistently defined. Many previous studies have indicated that the application of the various aspects of sustainable urban development plans has limitations with regard to rapidly changing cities where the issues of urban environment, local economic development, sociocultural desire and policies collide.

In the present study, as a new proposal for sustainable development, the following measures were taken. Certain aspects of urban development that may be accepted by the actual urban planning policies were subdivided, the direction of sustainable urban development was established in accordance with the rapidly changing city paradigm and the application of sustainable development to urban planning in South Korea was suggested. As mentioned above, the three major elements of sustainable development are society, environment and economy. Therefore, the analytical aspects of sustainable urban development were reestablished in the present study for case analysis.

The first aspect is the human environment. The goals of sustainable urban development plans should reflect the important activities of groups, societies and communities

to improve the quality of life of the residents. The second aspect is the natural environment. The consumption of natural resources for energy production should be minimized and the effects of sustainable and circulatory energy flow in cities as well as the ripple effects should be analyzed by using objective data. The third aspect is the sociocultural element. The historical importance, sense of place and symbolism of cultural resources should be analyzed to create new cultural spaces in older places to meet the sociocultural desires of citizens and maintain sociocultural sustainability. The fourth aspect is a win-win economy in which everyone benefits. The structure of the local economy should be changed and improved by enhancing employment and creating job opportunities. Employment stimulation would strengthen the competitiveness of the local economy, diversify areas of investment, foster high value-added industries and promote balanced regional development. The fifth aspect is the future environment. The cities should be innovated and changed by strengthening the infrastructure of the fourth industrial revolution and exploring a novel system of a city module.

In addition, based on the analysis of each aspect, the cases of sustainable urban development were analyzed with regard to the five aspects (human environment, natural environment, culture and society, win-win economy and future environment) to determine the implications for future sustainable urban planning (Table 2).

Analysis of overseas cases and sustainable urban development for each step

Sheffield, England: Sheffield, England is the center of the Yorkshire Region located approximately 250 km North of London. The 1970's decline in the steel industry which used to be the foundation of industry, since, the Industrial Revolution, the damage by indiscriminate development and the weakened city competitiveness in comparison with nearby big cities such as Manchester and Leeds, caused severe urban degeneration problems as approximately one third of the city's major facilities were left unused. In 1984, to overcome these problems, the City of Sheffield began implementing a sustainable urban development plan. The plan was to establish a new industrial strategy for strengthening the IT, precision machine and modern leisure industries and fostering tourism and culture projects (Table 3 and Fig 2 and 3).

Ruhr Mining Area, Germany: The Ruhr Mining Area refers to the industrial region in the Nordrhein-Westfalen State of Northwest Germany. The region was named after the Ruhr River which flows from the East to the West of

Table.2: Analytical aspects and key strategies for sustainable cities

Analytical aspects	Key strategies
Human environment	
Humanity and participatory access	
Improvement in communication and quality of citizen's lives, considering the demand for human society, including the needs for social demand and welfare	City management based on citizen's participation and creation of spaces for mutual cultural exchange
Policy-making through the formation of effective governance system; extension of participation through communities (settlement of social agreement)	Preparation of environment to increase local resident's identity and pride
	Transforming into public places for citizens
Natural resources	
Environment-friendly and ecosystem-conservational access	
Sustainable energy consumption through the use of eco-friendly resources and energy systems	Eco-city
Preparation of an eco-friendly and healthy urban environment	Conservation of natural environment through recycling and preservation of resources
Establishment of sustainable ubiquitous systems and eco-friendly network	Use of new, eco-friendly renewable energy sources and establishment of recycling urban eco-system
	Metabolism-based access (circulation of urban resources)
	Increase of local self-purification capacity through efficiency enhancement and reuse of energy, advancement of recycling and reuse, consideration of urban capacities, preservation of natural resources etc.
Culture and society	
Utilization of historical and cultural characteristics	
Effective circulation of social, economic and physical resources, considering the historical importance, sense of place and symbolism of cultural resources	Preparation of list of traditional buildings and relics to be conserved
Creation of new cultural spaces by using older places	
	Creation of synergic effects based on the sense of place of locations with temporal, spatial and spiritual importance
	Utilization of industrial heritage as a new means of local regeneration
Win-win economy	
Self-contained city and balanced economic development	
Strengthening of local economic competitiveness and fostering of high value-added industries by enhancing employment and creating job opportunities	Industrial activities considering external resource input and internal resource flow
Establishment of economy-related circulation system in a city, including production, exchange, consumption and distribution	Fostering of cultural content industry and knowledge-based industry
	Development of a win-win economy through the fostering of retail shops and the promotion of education, culture, housing, and retail industries
Future environment	
Future development in preparation of fourth industrial revolution	
Establishment of high-tech-led urban infrastructure considering accessibility, diversity, stability, efficiency, and amenities	Smart city development: Intelligent urban development, integrated land use and formation of efficient mass transportation system
Development and conservation of pattern-based spatial structure for entire city system and integrated land use	Data-based city operation, utilization, and conservation
Future R&D city for innovation and changes	

the industrial region. The Ruhr Mining Area was the largest mining and heavy industrial region in Europe from the 19th century to the middle of the 20th century, although the mines are not used at present. However, as the coal mining industry declined in Germany from the 1980's, the Ruhr Mining Area rapidly degenerated. The Ruhr Mining Area, devastated by the long years of mining, suffered an extreme economic recession and severe environmental contamination. The Ruhr Mining area prepared the Emscher-Park Project for more than 10 years from 1989 to implement a culture-led sustainable urban development. The sustainable urban development was focused not on the economic improvement or urban development but on the improvement of the quality of life of local residents. The initiative concentrated on the issues of the environment and the ecosystem. As a result, the buildings for the conventional industries and the mining facilities began to be used for new purposes and the ecosystem of the Emscher River was recovered (Yum, 2016).



Fig. 2: UK sheffield view



Fig. 3: Victoria and riverside

Table 3: Sustainable urban characteristics of Sheffield, England

Aspect	Application elements and methods
Human environment	Utilization of council house and city government buildings as centers of urban activities Preparation of houses for the low-income class (Devonshire Green Urban Village, etc.) Improvement of mass transportation system and pedestrian environment (public parking lots in outskirts of downtown)
Natural environment	Securing of green spaces and public spaces (Tudor Square, Peace Garden, etc.) Re-development of waterfront spaces (Victoria Quays and riverside, etc.)
Culture and society	Conservation of traditional buildings and cultural heritages and preparation of list of cultural resources to be conserved Improvement of appearance of historical buildings and streets and conservation of street scenery Construction of libraries, public facilities and cultural facilities (Millennium Gallery, etc.)
Win-win economy	Fostering of a win-win economy as the center of education, culture, residence, retailing and leisure activities Improvement of access to downtown through various transportation means Fostering of retail shop street (The New Retail Quarter, etc.)
Future environment	Establishment of high-tech-led foundation of urban economy (Sheaf Valley e-Campus, etc.) Activation of IT projects through the spatial and functional partnerships with the high-tech industrial areas and Hallam University-Analysis of data from fundamental investigation and utilization and conservation of existing urban tissues

Musashino, Japan: Musashino, in the west of the Tokyo's 23 special wards is located between Tokyo and Tama Ward and approximately 12 km away from downtown. Musashino is a sustainable city formed by the voluntary participation of its citizens and the cooperation of the government and has been evaluated as a "life core city". However, the city was not one of the social cooperation from the beginning. The long-term sustainable urban development plan that would be established as a site for a refuse disposal plant was determined by the participation of the citizens through the mutual cooperation between the city council and the residents (Table 4 and Fig 4 and 5).

Comprehensive case analysis of sustainable cities in advanced countries: Table 6 shows further details of the aspects of sustainable urban development found in the advanced cases of sustainable urban development. The cities that were analyzed with regard to the sustainable urban development. The cities that were analyzed with regard to the sustainable urban development had different local characteristics. Sustainable urban development measures were carried out by different methods including

Table 4: Sustainable urban characteristics of Ruhr Mining Area, Germany

Aspect	Application elements and methods
Human environment	Conversion of past industrial zones to public places for citizens Formation of identity and pride of one united Ruhr region for local residents Creation of spaces for 'mutual cultural exchange' between various immigrants
Natural environment	Utilization of new renewable energy sources on the city scale Ecosystem recovery project for the Emscher River Conversion of ironworks to eco-parks
Culture and society	Utilization of industrial heritages as new tools for local regeneration (Red Dot Design Museum etc.) Conversion of old facilities into new cultural spaces
Win-win economy	Utilization of Internationale Bauausstellung Emscher Park as a culture project Preparation of cultural experiences for 96% of visitors based on survey results
Future environment	Attraction of cultural contents production companies and provision of studios Formation of cultural heritage network for the entire Ruhr region



Fig. 4: Germany Ruhr mining area view



Fig. 5: Zollverein

resident participation and government-led development. However, the cities shared common characteristics in the aspect of the human environment. The local resident's pride and sense of belonging were strengthened by various social education programs (Lee *et al.*, 2010).

Table 5: Sustainable city characteristics of Musashino, Japan

Aspect	Application elements and methods
Human environment	Thorough resident participation by the Musashino method Formation of waterfront walkways and citizen-participatory parks
Natural environment	Formation of low environmental load city through citizen's voluntary efforts Environment improvement projects considering the green spaces and the ecosystems in private lands Establishment of green zone network-connecting parks
Culture and society	Operation of community bus system using Mubus Reconstruction of schools and childcare centers in consideration of rapid aging of the community
Win-win economy	Reduction of waste generation based on the basic act on circulatory type society formation promotion Tax break measures for green zones through a citizen green zone system
Future environment	Promotion of recycling for efficient use of resources Introduction of new renewable energy system replacing fossil fuel (resource recovery system etc.) Publication of local living environment indicators based on annual data



Fig. 6: Japan Musashino view

Public places and walking spaces were provided for the citizens to promote social exchange and communication. As for the aspects of the natural environment, the win-win economy and the future environment, the sustainable urban development plans were partially led by the private sector in Musashino but by the public sector in other cities because of the difference in the master plans. However, many attempts

have been made to promote the cooperation between the private sector and the public sector, especially with respect to the environmental aspects, including recycling of resources and data-based urban development. Earnest efforts have been made in all three cities to secure green spaces and waterfront spaces and to form a network between the environment-friendly spaces. In addition, various open spaces have been arranged in locations of important cultural activities to promote the communication between local residents and visitors (Table 5 and Fig 6).

RESULTS AND DISCUSSION

The present study was conducted to review the concept of sustainable urban development which came to the fore as a global issue due to the excessive urbanization following the industrial revolution. The macroscopic, abstract and comprehensive concept of sustainable urban development was subdivided into five accepted aspects which are human environment, natural environment, culture and society, win-win economy and future environment. The purpose of the classification was to propose a new paradigm of sustainable urban development in the rapidly changing urban climate. The sustainable urban development cases of the UK, Germany and Japan were analyzed and reviewed to derive the characteristics of the five aspects (Table 6 and Fig. 7).

The result of the present study showed that sustainable urban development embraces the following five principles (Li *et al.*, 2010):

- Sustainable urban architecture for human environment-participatory access by groups, societies and communities
- Sustainable urban architecture for natural environment-environment-friendly access for ecosystem conservation
- Sustainable urban architecture for culture and society-access based on cultural heritage conservation, local characteristics, history and temporal significance
- Sustainable urban architecture for win-win economy-access considering self-contained economic foundation and balanced development
- Sustainable urban architecture for future environment-access to the future in preparation of fourth industrial revolution considering accessibility, diversity and stability

Table 6: Summary of case analysis

Aspect/Items	Application elements and methods	Sheffield	Ruhr	Musashino
Human environment				
Promotion of resident participation	Presentation of various opinions through town meetings		•	•
	Operation of various social education programs	•	•	•
Improvement of quality of life of residents	Urban development considering vulnerable groups	•		•
	Securing of public community facilities for citizens	•	•	•
	Formation of landmarks for local community	•	•	
Natural environment				
Utilization of new renewable energy sources and preservation of resources for natural circulation in city	Use of natural energy sources such as solar energy and wind power		•	•
	Energy recycling: Utilization of rainwater and recycled water	•	•	•
Minimization of environmental pollution through the utilization of unused buildings and resources	Building design for efficient energy utilization	•		•
	Internal and external space plans for using unused buildings	•	•	
	Utilization of natural spaces including water front spaces	•	•	
Securing and systemization of natural resources	Total redevelopment or renovation of existing residential areas		•	
	Development of unused areas	•	•	
Culture and society				
Creation of cultural spaces	Creation of cultural spaces for residents	•	•	•
Discovery and conservation of historical and cultural heritage	Conservation and construction of traditional buildings and heritage	•	•	
	Creation of synergistic effects based on the sense of place of locations	•	•	•
Win-win economy				
Establishment of self-contained local economy system	Attraction of urban factories	•		
	Fostering of localized industries and facilities	•	•	
	Functional connection with nearby regions	•	•	•
Discovery of resources	Revitalization of traditional shopping streets and plazas	•		
Establishment of urban circulatory system	Consideration of external and internal flows of resources	•	•	
Future environment				
Local development in preparation of fourth industrial revolution	Intelligent urban development	•		•
	Constitution of efficient network system	•		•
Systemization of development process	Systematic and stepwise development based on Master Plan	•	•	
	Comprehensive development based on urban design guidelines	•	•	
Data-based urban development	Urban utilization and conservation using data	•		•



Fig. 7: Musashino clean center

CONCLUSION

In this study, we have compared the examples of developed countries that experienced urban decline cause by rapid urban development and are systematically

pushing for sustainable urban development to solve it. In the last 60 years, the cities in South Korea have undergone quantitative expansion with the rapid economic growth. The cities devastated by the Korean war were rapidly recovered by the industrialization. The urban areas expanded as many people left rural regions and moved to urban regions. The policies for the growth of the cities were focused on the physical and quantitative development rather than the quality of life for the residents of the society. These immature policies caused many different problems in the cities. The overseas cases of sustainable urban development reviewed in this article and the five principles of sustainable urban development summarized in the present study may contribute to the appropriate urban regeneration in South Korea cities. Sustainable urban development is the common goal of both the residents and the local governments, requiring the participation of the parties as well as improved awareness in sustainable urban development.

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