

A COMPARATIVE ANALYSIS OF THE LEVEL OF URBAN RESILIENCE IN THE CITY COMPREHENSIVE PLAN

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ABSTRACT

In recent years, due to rapid changes in society, and climate change, cities have experienced difficulties in predicting various types of upcoming hazards and stresses. Uncertainties about the nature and extent of risks are increased especially when it comes to cities where interactions exist among various elements including human, society, economy, and culture. Considering limited prediction on inherent crises and difficulties in reaction plans, resilience strategy should be implemented prior to prevention strategy. The purpose of this study is to compare urban resilience levels of comprehensive plans for metropolitan areas with a population of over 1 million. Resilience measurements of capacity of resistance, adaptation, and recovery from external shocks and stresses will be applied to evaluate the level of urban resilience of cities in Korea. For the method of the study, it defined concepts of urban resilience through literature review, and derived indexes for urban resilience using preceding researches and case studies. Then, it developed detailed assessment indexes for evaluation of urban resilience level, and, finally, it evaluated and compared urban resilience level of comprehensive plans, using derived assessment indexes. As a result of the study, it suggested 56 assessment indexes and checklists in 8 sectors including land use plan, urban and residential environment, infrastructure, and more. The result of this study can be used as a base data for the future comprehensive plans when developing resilient cities.

Keywords: urban resilience, indicator, city comprehensive plan, checklist analysis.

1 INTRODUCTION

It is impossible to predict various risks such as disasters and economic crises in cities due to globalization and climate change, and the complexity increased due to the interactions of various factors such as humanities, society, and economy. Thus, the unpredictability and uncertainty of risk are maximized. For this reason, it is argued that the urban resilience force should be increased beyond the prevention of individual incidents or local accidents that occur in the city, as the awareness of the limitation on the prevention of urban planning is increasing.

Urban resilience is necessary because city problems cannot be overcome by simply eliminating or preventing a single risk factor from a preventive point of view, but rather mitigating damage, improving vulnerability and adaptability to change. Therefore, it is necessary to have a city-planning strategy to comprehensively consider all factors. Resilience strategy can also be more effective than prevention strategy if the city's potential risk or crisis prediction is limited, and it is difficult to find a countermeasure [1].

The purpose of this study is to analyse the urban resilience level of urban comprehensive plan in order to build resilient cities in a metropolitan. Applying the concept of urban resilience that can cope with external shocks and stresses to domestic cities, diagnose and analyse the resilience of each city, and contribute to sustainable urban development by presenting resilience factors to be reflected in urban planning, it is possible to search for directions.

The purpose of this study is as follows: first, analysing the concrete contents of the city's comprehensive plan, which is a top-level plan established at the city level, and examine the relationship between city comprehensive plan and urban resilience by examining theories, researches, and applications related to urban resilience. Secondly, to establish a resilient



urban plan that reflects local characteristics, we will build an index of urban resilience indicators for each sector and compare the resilience levels of existing city comprehensive plans. Through this, this study will propose a direction and policy and institutional improvement plan which should be aimed at creating a resilient city when establishing the city comprehensive plan in the future.

The spatial and temporal scope of this study covers 4 out of the 5 cities except Seoul, where the 2030 city comprehensive plan was established among more than 1 million large cities in Korea. The contextual scope is limited to assessing the level of resilience through a context analysis and the divisional elements of the city comprehensive plan are reviewed with a focus on urban resilience [2].

The research method is as follows: First, the concept of city comprehensive plan and city resilience is defined through literature review, and diagnosis index related to resilience is derived through precedent research and case study. Second is based on the derived diagnosis index, it analyses the degree of the city's recovery ability in the current city comprehensive plan establishment guidelines and builds detailed evaluation index by each component. Third is a checklist, it was prepared based on the detailed evaluation index to evaluate the urban resilience level of the city comprehensive plan.

2 LITERATURE REVIEW

2.1 City comprehensive plan

The city comprehensive plan is a national plan established in accordance with Article 19 (3) of the National Land Planning and Utilization Act and Article 16 is the Enforcement Decree of the same Act, which has the status of a top-level plan established at the city level. The status and significance of the city comprehensive plan are shown in Table 1 and Fig. 1, respectively. It suggests a policy direction that can improve the quality of life of residents by efficiently utilizing the limited resources of the country efficiently and rationally, and to develop the liveable and sustainable. At the same time, it has the character of a comprehensive plan that suggests a structural framework to develop the city spatially over the long term.

Table 1: The significance of city comprehensive plan. (Source: ministry of land and transport affairs, 2015.)

Category		Range
Sustainable		Ensure sustainability of national land management for utilization and development and conservation of the country.
An integrated approach	Environmental	Rapid growth of cities and prevention of spread of global climate change. Active response to global warming and reduction of carbon emissions.
	Economical	Job Creation in the Region. Urban regeneration and activation of local economy. Seek economic efficiency of resource utilization. Achieve cost-effective urban development and achieve low carbon green growth.
	Social	Considering social equity (collecting opinions of various interests of community, reflecting). Contributing to the promotion of social capital (social conflict minimization, integration promotion). Establishing a plan that takes into account social disadvantages (low-income, elderly, disabled, etc.). Enhancing community cultural diversity.



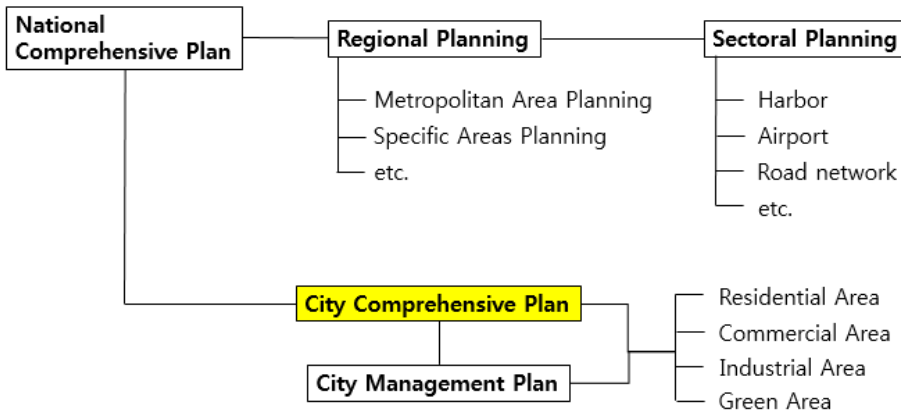


Figure 1: The status of city comprehensive plan. (Source: Ministry of Land and Transport Affairs, 2015.)

Most studies dealing with linkages between urban comprehensive planning and resilience are addressed in the areas of carbon reduction and disaster prevention. “Evaluation of Urban Comprehensive Plan with Disaster Cities Indicators” by Lee Seung-hee (2013), “Assessment and Analysis of Disaster Prevention and Safety Plan Planning by City Comprehensive Plan” by Park, Joon Sung (2014) and “A Comparative Analysis of Carbon Abatement Strategies in the City Comprehensive Plan” by Henan Suo (2014).

2.2 Urban resilience

Resilience comes from the Latin word “Resilio”, which means “To jump back,” and has been applied and spread in various fields such as ecology, engineering, economics, and psychology [3]. Resilience is largely classified into three concepts.

Resilience can be applied at the urban and community level. As urbanization accelerates due to industrialization and technological development, the proportion of the population living in the city has increased, and the quality of life has increased, so that infrastructure, public service and welfare demand are also increasing. On the other hand, as cities become increasingly overcrowded and complicated, they are more likely to be exposed to external risks or shocks as well as more difficult to forecast and the extent of damage is also

Table 2: Three concepts of resilience [4].

Concepts	Characteristic	Focus	Context
Engineering	Recovery period Efficiency	Recovery Robust	Stable Balance state
Ecological	Buffer capacity Shock mitigation Maintain function	Sustainability Durability	Multiple balance
Social-ecological	Maintaining and developing interactions of disability and re-organization	Adaptive Capacity Multi-variate Learning and Innovation	Integrated and active interaction

Table 3: Definition of urban resilience.

Author	Definition
Godschalk [5]	Ability to resist shock without immediate chaos or permanent deformation or breakage.
Sophie and Cassidy [6]	Ability to resist or absorb dangerous effects through resistance and adaptation that can maintain and restore or recover basic and essential functions and structures in a crisis situation.

increasing. Therefore, it is important to discuss resilience from the perspective of the city and the community.

Resilience in Korea research is expressed in various words such as disinfection ability, and resilience in the area of disaster prevention and the regional policy development. First, the research on the resilience of disaster prevention is based on the “Development of Indicators and Checklist for Urban Disaster Risk Assessment” [2], “Resilience Analysis of Climate Disasters in Local Governments” and Disaster Resilience Measurement (UNDP) (2014), which provides methods for measuring resilience recovery, And the “City Resilience Index” of Arup [1], which summarizes resilience indicators through case studies.

In this study, urban resilience is defined as capacity to improve quality of life and function in urban areas. In order to create a resilient city, it was defined that the qualities of reflective, resourceful, robust, redundant, flexible, inclusive, and integrated were needed.

3 RESEARCH PLAN

3.1 Index set up

Among the literature review and previous research, City Resilience Framework [1], was presented in 100 Resilient cities, which are building urban resilience networks centred on various examples of recent global cities, (reflective, resourceful, robust, redundant, flexible, inclusive, integrated). It was reconstructed to suit the situation in Korea.

In order to derive the index for the detailed evaluation, the criteria of the evaluation items and the keywords of the urban resilience index presented in the literature review were used. It reviews and analyses the contents of each divisional plan of the Urban Comprehensive Plan Establishment Related to Urban Resilience, and presents criteria for a selection of detailed indicators (land-use, infrastructure, urban and residential environment, environmental, conservation and management, green spaces, disaster prevention, safety and crime prevention, development and promotion of economy, industry, society, culture).

However, for the convenience of evaluation, “disaster prevention and safety and crime prevention” among the seven sectoral plans were limited to the disaster prevention sector, and “development and promotion of the economy, industry, society and culture” was limited to the economy and industry. In the case of “infrastructure” and “environmental preservation and management” it was subdivided into transportation facilities, supply processing facilities (water and sewage, energy, waste), environment preservation and management (air quality, water quality and other natural resources). As a result, we have established 56 detailed indicators based on 8 sectors.



Table 4: Selection criteria for evaluation index.

Component	Criteria
Reflective	Analyse the situation and set goals in consideration of the experience from the risk and the local characteristics.
Resourceful	Set up index for resource management.
Robust	Establish a proactive plan
Redundant	Alternative facilities to accommodate the crisis, diversity of systems
Flexible	Step by step planning, monitoring
Inclusive	Accepting various interests and communication
Integrated	Relation between upper-level and related plans and sector-specific plans

Table 5: Category and range of urban resilience index in city comprehensive plan.

	Category	Range
Reflective	land-use	Analysis of inefficient land use area and urban function distortion area
	urban and residential environment	Declining areas in the city (declining trend of business, depreciation of buildings etc.)
	transportation facilities	Regional allocation by transportation
	supply processing facilities	Supply processing facilities (water and wastewater, waste, energy)
	environment preservation and management	Air quality, water quality, other natural resources
	green spaces	Park green space related
	disaster prevention	Analysis of disaster risk factors/disaster prevention systems by disaster type
	economy and industry	Establishment of planning goals through analyzing current economic situation
	Resourceful	land-use
urban and residential environment		Establish planned supply plan for housing
transportation facilities		Establishment of traffic related indicators
supply processing facilities		Providing indicators related to supply processing facilities
environment preservation and management		Establishing indicators related to atmosphere/water environment
green spaces		Establishment of indicators related to parks and green spaces
disaster prevention		Establishment of indicators related to disaster prevention facilities
economy and industry		Establishment of economic scale, industrial structure, income, consumption structure, and financial indicators



Table 5: Continued.

	Category	Range
Robust	land-use	Efficient use of land resources (standard)
	urban and residential environment	Balanced regional development strategy (urban/rural, new and old)
	transportation facilities	Utilization of city's internal and external traffic networks and improvement of accessibility
	supply processing facilities	Stable supply plan of supply processing facility
	environment preservation and management	Establish management and reduction plan for environmental pollution (atmospheric environment, water quality environment) by media
	green spaces	Comprehensive green space system plan and plan
	disaster prevention	Disaster prevention plan and disaster prevention plan prepared for damage
Redundant	economy and industry	Establishment of industry-specific (1st, 2nd, 3rd) development plan
	land-use	Securing adequate amount of conservation land
	urban and residential environment	Planning of various types of residential and residential complexes considering regional characteristics and landscape
	transportation facilities	Plan for alternative transportation facilities and spare capacity (transit transportation facility planning)
	supply processing facilities	Planning for alternative supply processing facilities and spare capacity
	environment preservation and management	Environment-friendly development promotion plan
	green spaces	Disaster prevention function and pollutant reduction plan in waterside space and park green space facility
disaster prevention	Plan for spare capacity for alternative disaster prevention facilities and disasters	
Flexible	economy and industry	Specialized industrial plan for strengthening regional competitiveness
	land-use	Step-by-step development plan of developmental land (monitoring)
	urban and residential environment	Urban Renewal Plan
	transportation facilities	Green / New traffic planning
	supply processing facilities	Planning and implementation of resource circulation system (monitoring)
	environment preservation and management	Low carbon green growth plan
	green spaces	Green space planning to respond flexibly to changes in conditions
disaster prevention	Plan for the construction and operation of comprehensive disaster prevention system (monitoring)	



Table 5: Continued.

	Category	Range
Inclusive	economy and industry	Old age industrial park recycling plan
	land-use	Establishment of land use plan considering various stakeholders
	urban and residential environment	Establish measures to improve the living standards of vulnerable groups (low-income families, multicultural families, etc.)
	transportation facilities	Establishment of transportation plan considering social vulnerable classes
	Supply processing facilities	Supply planning of supply facilities in backward region
	environment preservation and management	Environmental preservation and management plan considering various stakeholders
	green spaces	Park green space planning considering regional, intergenerational, and inter-tier equality
	disaster prevention	Preparing measures to reduce disaster damage to poor people (poor)
	economy and industry	Planning for the vulnerable
Integrated		Top and related plans (related planning, divisional planning) and linkages

This study evaluated the urban resilience of the sectoral plans and assessed the urban resilience level of the domestic cities, and the evaluation method of Brody [11], which was used for the evaluation. The evaluation criteria are evaluated as 0–2 according to the degree of the concrete establishment of the plan. If the contents of the plan are not reflected yet, or if the contents of the plan are reflected in the plan in general, or if the plan is reflected in the plan comprehensively, 2 points will be awarded if the plan is reflected specifically in 1 point, the sum of the index values composed of the two-point scale thus calculated is converted into 100 points by the following eqn (1).

$$UR_j = \frac{100}{2m_j} \sum_{i=1}^{m_j} I_i \quad (1)$$

- UR_j : Indicator score of urban resilience type (j)
- m_j : Number of detailed indices of indices of urban resilience type (j)
- I_i : I-th detail indicator score

The scores of each indicator were then averaged by city resilience type to assess city resilience level by city. Eqn (2) is evaluation.

$$L = \frac{1}{n} \sum_{i=1}^n UR_j \quad (2)$$

- L : Level of plan by urban resilience type
- n : Number of indicators by type of urban resilience



4 RESULT OF ANALYSIS

4.1 Urban resilience level assessment

The resilience level of the city was 66.7 in Incheon city, 49.4 in Suwon city, 47.3 in Ulsan city, and 45.5 in Daejeon city, and the average was 52.5. Considering the difference in planning and timing of cities, the score is gradually increasing, which suggests that urban resilience level is improving and developing in urban comprehensive plans [7]–[10].

4.2 Urban resilience level by indicator

The results of the evaluation of urban resilience level for each component are shown in the table above. It can be seen that inclusive and integration are relatively.

The resilience level of the sectoral plans are as follows. The urban resilience level of each sectoral plan shows an almost equal evaluation.

Table 6: Urban resilience level table (components).

Component	Daejeon (2013)	Suwon (2014)	Incheon (2015)	Ulsan (2016)	Average
Reflective	66.7	70.8	72.9	66.7	69.275
Resourceful	56.3	54.2	79.2	47.9	59.4
Robust	52.1	54.2	72.9	58.3	59.375
Redundant	37.5	39.6	66.7	50.0	48.45
Flexible	52.1	56.3	72.9	45.8	56.775
Inclusive	29.2	31.3	47.9	35.4	35.95
Integrated	25.0	39.6	54.2	27.1	36.475

Table 7: Urban resilience level table (sectoral plans).

Sectoral Plan	Daejeon (2013)	Suwon (2014)	Incheon (2015)	Ulsan (2016)	Average
Land-use	57.1	57.1	66.7	45.2	56.525
Urban and residential environment	42.9	57.1	69.0	42.9	52.975
Transportation facilities	59.5	66.7	71.4	61.9	64.875
Supply processing facilities	33.3	38.1	64.3	47.6	45.825
Environment preservation and management	42.9	45.2	64.3	52.4	51.2
Green spaces	40.5	57.1	61.9	50.0	52.375
Disaster prevention	47.6	38.1	54.8	33.3	43.45
Economy and industry	40.5	35.7	81.0	45.2	50.6

5 CONCLUSION

The purpose of this study is to analyse the current state of resilience of urban resilience in the current city and county comprehensive planning guidelines through national, internal and external resilience indicators. Based on this, it was applied to the city comprehensive plan in 2030 and established in the metropolitan areas (Daejeon city, Suwon city, Incheon city, Ulsan city) with more than 1 million population in Korea, and the urban resilience level of each city was evaluated.

As a result, the city with the lowest resilience of the city is 45.5, Daejeon metropolitan city which was planned in 2013, and the city with the highest resilience of cities is Incheon Metropolitan City, planned in 2015, with average level of 52.2 points.

In this study, the urban resilience level according to the seven qualities of reflectivity, resource mobilization, durability, substitution, flexibility, inclusion and integration defined as the constituent elements of the resilient city showed the highest reflectivity of 69.3 points, and inclusion and integration were relatively low at 35.9 points and 36.5 points, respectively.

In terms of the level of resilience of cities according to each division, the traffic facilities among the infrastructures were 64.9 points, reflecting the most resilience of cities, and the plans for the disaster prevention and supply treatment facilities were less reflective of urban resilience than other plans do.

The results of this study are as follows:

First, the urban comprehensive plan of the city in 2030 shows that the contents of the urban resilience are gradually reflected and embodied over time, though there is a difference in the degree of concrete content due to the conditions and characteristics of each region.

Secondly, the planning of the divisional plan of most cities is based on the analysis of the current plan, the establishment of the comprehensive direction, and the establishment of the relevant indicators such as the planning of the future (reflectivity, resource mobilization) On the other hand, it is analysed that the link between the plan and the plan considering various stakeholders (especially the socially weak) is rather low. Therefore, it will be necessary to revise the city and county comprehensive planning guidelines so that a plan reflecting the inclusion and integration, a component of urban resilience, can be established in order to establish a resilient city plan.

Based on the checklist presented in this study, we suggest the possibility of reflecting the plan to improve the city resilience in the city comprehensive plan of 2030, which will be established in future, this can be suggested as a basis for establishing measures to promote urban resilience by sector in establishing future urban comprehensive planning policies.

Also. It should be considered to create a resilient city when establishing plans related to cities of various sizes and characteristics, such as urban management plans and district unit plans, as well as urban comprehensive plans by introducing national and internal resilience indicators through literature review and prior research This is because it is easy to analyse the urban recovery force index.

As the limitation of this study, the scope of the study is applied to the entire plan of the sector, and related index is derived to evaluate the level of resilience of the city. There is a need to subdivide the indicators and checklists of the Urban Resilience Test.

In assessing the level of urban resilience, it is necessary to analyse whether the implementation of each plan is enriched in the implementation process of the plan, not to determine whether it is reflected in the plan. Further research is required to analyse the results.

In order to improve the resilience of cities in urban planning, it is necessary to identify the urban recovery indicators that each city should reflect, what plan contents should be specifically set in each divisional plan, I hope that comprehensive research will be carried out to link the subsequent research and city planning with urban resilience in general.



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