

Space & Environment

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Future Prospects and Strategies for National Arterial Road

Kim Ho-jeong, Kim Sang-rok

1. Backgrounds and Purpose of the Study

- National Arterial Road Network (7X9) project has been implemented since 1992 to complete the entire network by 2020 and continuous discussion is required on the function and roles of the roads after 2020.
- As the time is nearing to renew the highest-level national plans, including Comprehensive National Territorial Plan and National Intermodal Transportation Plan, it is required to build objective and future-oriented prospects for future transportation demands, responding to various changes in national territory environments.
- Among future environmental changes, it is to define various factors, affecting road transportation sectors and develop responding strategy for national arterial road, considering changes in territorial space comprehensively.
 - It is required to review the integrity of territorial plan and transportation plan, based on changes in future territorial

space and establish future prospects of national arterial road, based on changes and key factors in national territorial space.

2. Achievement and Challenge in National Arterial Road Establishment

- It is aimed to review development progress of national arterial road, aligned with national territorial plan since the 1st Comprehensive National Territorial Plan 1972 until the amendment of the 4th Comprehensive National Territorial Plan announced recently. **Fig.1**
- With development of national arterial road network over 45 years, it shortens the travel time between regions 42%, putting the entire nation in 1-day travel range. **Fig.2**

Figure 1.



Source

Comprehensive National Land Development Plan(1972~1981), 3rd Comprehensive National Land Development Plan(1992~2001), 4th Comprehensive National Territorial Plan(2000~2020), 1st Comprehensive National Road Networks Plans(2016~2020).

Challenges in Future National Arterial Road Plan

- Flexibility in responding strategies is not sufficient, to keep up with changing environments including change in territorial space after development of 7×9 arterial road network
- Especially, despite the plan for metropolitan city area beltway plan to respond to expansion of metropolitan area and metropolitan economic zone around big cities, congestion around the cities still remain
- It is required to develop a plan to respond to overall changes in social and economic environments, including rapid population decline and the advent of the 4th industrial revolution.
- It is needed to build future-oriented transportation plan, with various future scenario-based road transportation demand estimates, designed to respond to the rapidly evolving road transportation environments. Fig.3

3. Future Environment Change and Impact on Road Transportation

- For macro forecast on changes in future society, including mega trend, future change in national territory and transportation is forecasted utilizing STEEP analysis and external change factors are defined.
- Also, surveys are conducted with 100 road experts on the

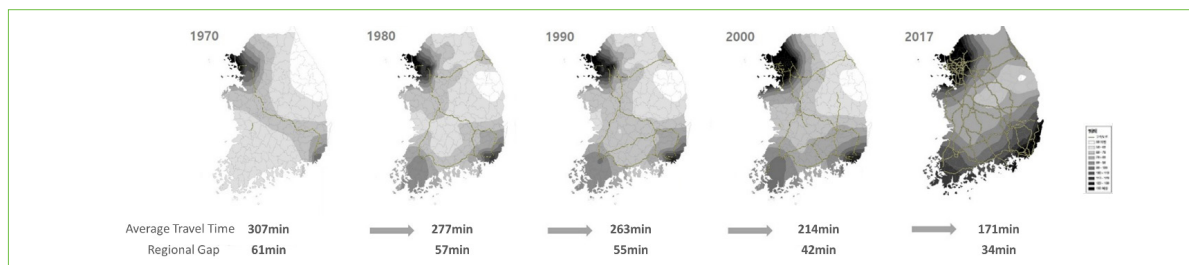
“Direction of Change in National Arterial Roads” and the “What the National Arterial Road Will Look like in 20 Years.”

- Putting the results of the two surveys together, out of future environment changes, 6 mega trends and 18 specific change factors are defined, having close relation with demand and function of national arterial road and among them, 2 key initiatives are selected.
 - ① Will the demand for road transportation continue growing?
 - ② How will the function of national arterial road change?
- The results of the 2 surveys with experts in the sector showed that demand for road transportation is expected to grow 5.1%, affected by changes in future environment and in terms of arterial road function, mobility will remain a key function. Table.1

4. Future Outlook of National Arterial Road

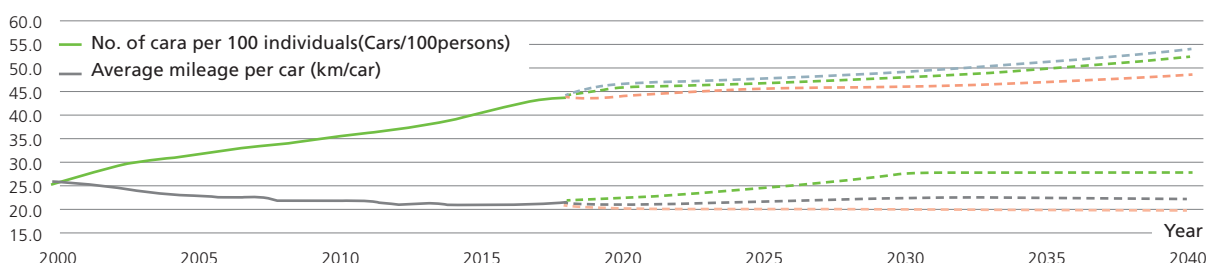
- For future outlook of national arterial road, it defines the ‘direction of road policy development, feasible to respond to changes in road transportation, out of future environmental changes.’
- For the mega trends and specific change factors, defined above, fluctuation in demand and the level of functional changes are surveyed with experts in the sector and the survey results are verified and the policy direction for future national arterial roads prospects is studied to ensure

Figure 2.



Source
Ministry of Land, Infrastructure and Transportation, 2016. 2017 figures are updated by the author, based on the information on P23 of the 1st Comprehensive National Road Networks Plans(2016~2020).

Figure 3.



Source
Created by the Author

efficient response to changes in territorial space.

- Future national arterial road prospects are specified, considering road transportation demand by scenario of change in territorial space and changing functionality of roads.
 - Scenario 1(Strengthened Role of the Nation): With introduction of super high speed transportation, comprehensive measures to utilize road space need to be developed, along with a plan to divert the load of long-distance transportation with development of superhighway
 - Scenario 2(Arterial Service Maintenance and Management): To maintain and manage arterial road functions, it is required to make efforts to connect major big cities and additional maintenance efforts to provide minimum required mobility and access service even for the old road facilities with low usability
 - Scenario 3(Select and Focus) : Strategic management measures need to be established with select and focus approach to provide equal service across the nation with no discrimination in transportation.
 - Scenario 4(Functional Diversification) : To be ready for a hyper-connected society, digital infra. need to be built as the center of the nation and comprehensive use of the ground, underground and even upper parts is required. **Fig.4**

5. Policy Suggestion to Build Future Prospects for National Arterial Road

- (Strengthened Role of the Nation) Sharing the roles and functions of super high speed transportation and introduction of superhighway need to be reviewed to enhance connectivity among meta cities
- (Arterial Service Maintenance and Management) It is required to focus on connected service to the last one mile and management system for old arterial roads needs to be strengthened.
- (Select and Focus Management Approach by Function of Roads) To provide equal mobility service for cities across the nation, strategic management system needs to be established for roads in need of national management and roads capable of serving as arterial roads
- (Diversification of Road Function) ‘Digital infrastructure’ needs to be established to respond to technology change including IoT and autonomous driving and well-aligned plans need to be established to comprehensively utilize the road space including underground-road-ground areas.

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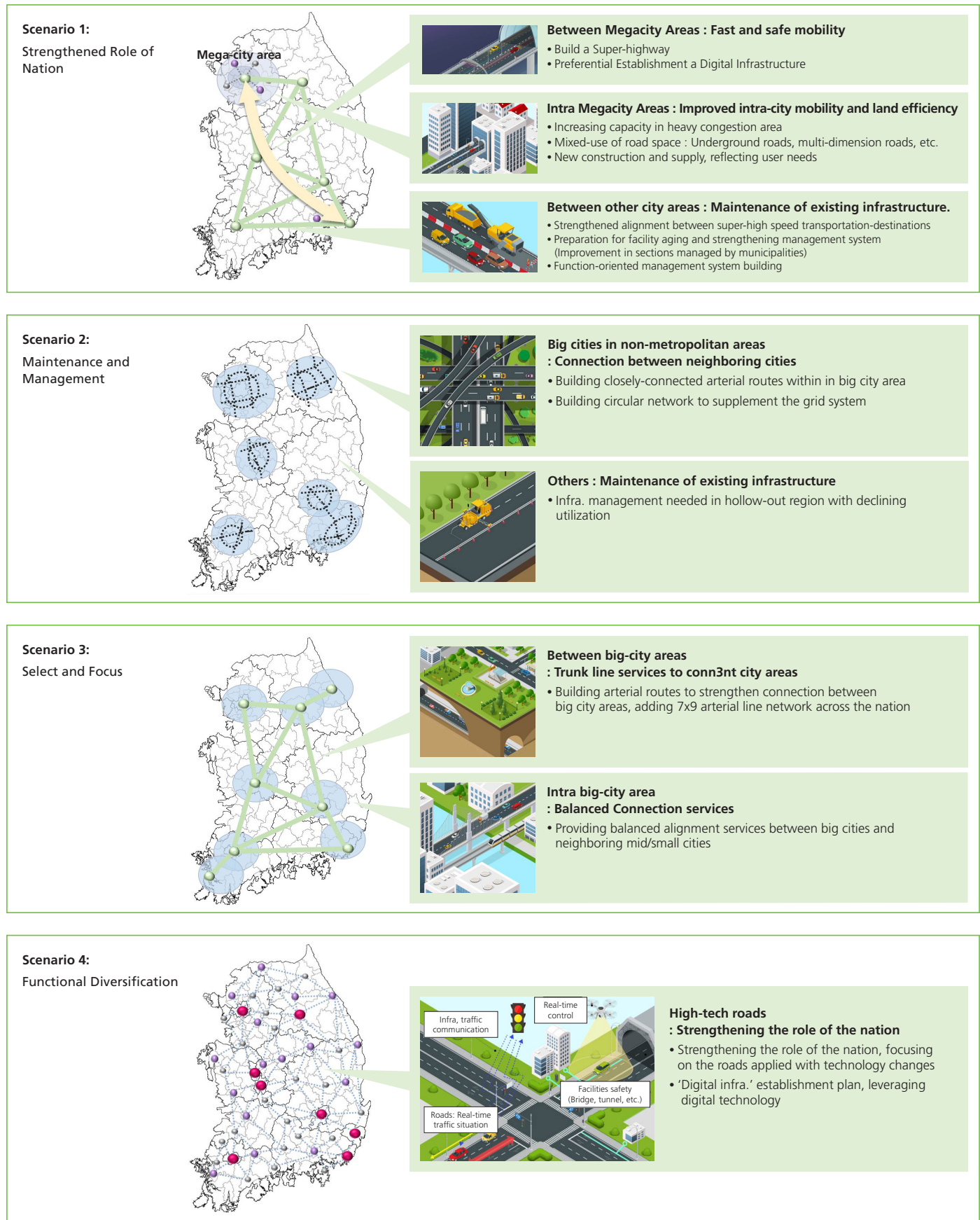
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Table 1.

Mega Trend	Specific Change Factors	Change in Demand for Road Transportation		Functional Change
		Direction	Change Rate	
1. Demographic Change	• Low birth rate, population aging	Down	-6.8%	Accessibility
	• Rapid increase of 1-person household	Up	3.2%	Mobility
2. Value Change	• Putting more value on quality of life	Up	7.5%	Mobility
	• Diversification in consumer needs	Up	6.6%	Mobility
	• Acceleration of sharing economy	Up	-0.4%	Accessibility
3. Urban Polarization	• Expansion of mega city	Up	4.1%	Mobility
	• Decline of non metropolitan areas	Down	-2.1%	Mobility
4. Acceleration of Technology Change	• Commercialization of self-driving vehicles	Up	6.8%	Mobility
	• Introduction of super high speed transportation	Up	2.1%	Mobility
	• Digitalization, advent of hyper connected society	Down	-3.6%	Mobility
	• Utilization of upper side of roads and underground space as complex	Up	2.7%	Mobility
5. Economic Globalization and Industrial Structure Change	• Expansion/integration of global economic cooperation	Up	3.7%	Mobility
	• Knowledge/service industry-oriented industrial restructuring	Average	0.5%	Mobility
	• Polarization of industry/region/job	Average	-0.2%	Mobility
	• Weaker economic dynamics in low growth society	Down	-4.3%	Mobility
6. Importance of Environments and Energy Crisis	• Eco friendly roads, including energy generation and storage	Average	1.6%	Mobility
	• Increase of accidents and disasters	Average	-1.6%	Mobility
	• Energy shortage and price increase	Down	-5.0%	Mobility
Average		Up	5.1%	Mobility

Source
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Figure 4.



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Regional SOC Investment and Management Plans for Inclusive Development of National Territory

Kim Joon-Ki

1. Definition and Objectives of Inclusive Development of National Territory

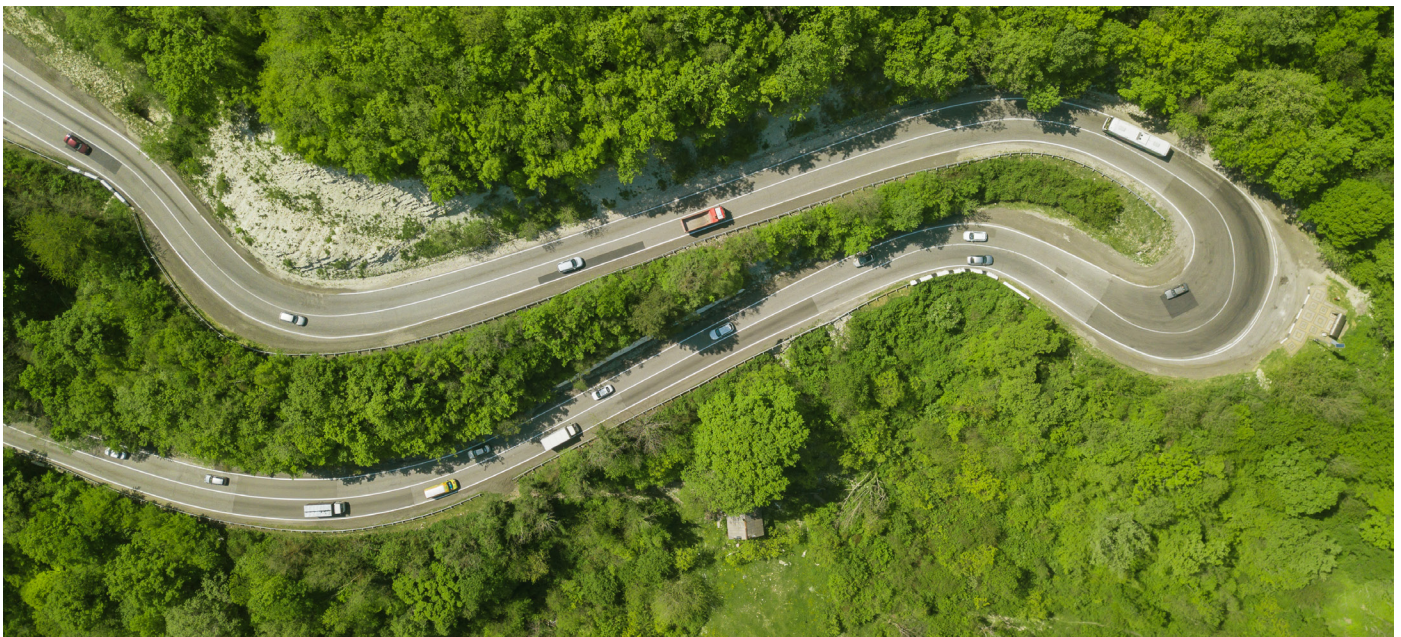
Definition of Inclusive Development of National Territory

The discussion about inclusive growth is increasing mainly from international organizations such as ADB, OECD, and World Bank after the financial crisis that swept through North America and Europe in 2008. Many countries of the world propose better access to the infrastructure for everyday life and public services for the public as a policy direction to achieve inclusive growth and poverty reduction and insist that central and local governments should share their roles and responsibilities (ADB, 2011; OECD, 2014; World Bank, 2015). As for Korea, the policy direction on inclusive national territory and city has been focused on closing development gaps between regions and minimizing social exclusion among

different classes (Moon Jeongho et al., 2016; Byun Miri et al., 2016, Bae Yunkyung et al., 2016). Based on reviews of previous studies at home and abroad that were mentioned earlier, an 'inclusive development of national territory' can be explained as a realization of inclusive national territory'. It contains the topic of balanced national development (engagement of regions) as well as the concept of social inclusion (of different classes).

Objectives of Inclusive Development of National Territory

An 'inclusive national territory' can be defined as a space where no one (region and stratum) is not excluded as stated above. The policy direction on inclusive national territory in Korea, however, has been somewhat far from such meaning. Although previous approach of concentrating on development to maximize the efficiency helped us achieve rapid economic growth, it now causes imbalances between regions and classes, ironically weakening the growth potential. Imbalances occur in both socio-spatial and economic dimensions. Examples include population concentration in metropolitan areas, polarization in city size for socio-spatial aspect and concentration of companies in metropolitan areas and increasing gap of growth regional domestic product (GRDP), respectively. To achieve inclusive development of national territory, investment on social overhead capital (SOC) and its management policy should be established to provide more opportunities to move so that everyone can access to public services and infrastructure in their daily lives no matter where they are.



2. Inclusive Value of SOC (Roads & Railways)

The total economic value of goods and services are classified as use value and non-use value. Preconditions for an inclusive value can be explained as follows: first, an inclusive value is included to the total economic value of goods and services. Second, an inclusive value contribute more to the growth and development of other regions than where I belong. Third, it is a value for the future generation. Therefore, an inclusive value as a non-use value, can be expressed as one that is related to vicarious value, altruistic value, and bequest value from the total economic value.

A survey on roads and railways (500 copies for each item) was conducted and their inclusive values were calculated based on Contingent Valuation Method (CVM). The result found that regional expressway project had the highest value, followed by regional high-speed rail project, metropolitan expressway project, and metropolitan high-speed project. Inclusive values of expressway and high-speed rail were 1.39~1.60 times and 1.09~1.31 times higher than direct use value, respectively.

3. Development of SOC Policy Directions for Inclusive Development of National Territory

Based on analyses of the status and issues of SOC investment and management, conditions for SOC policies,

and interviews with officials from local governments (Daejeon Metropolitan City Government, Cheongchungnam-do Provincial Government, Cheonan City Hall, Gongju City Hall, and Seochon County), 5 policy directions on SOC were developed.

Fig.1

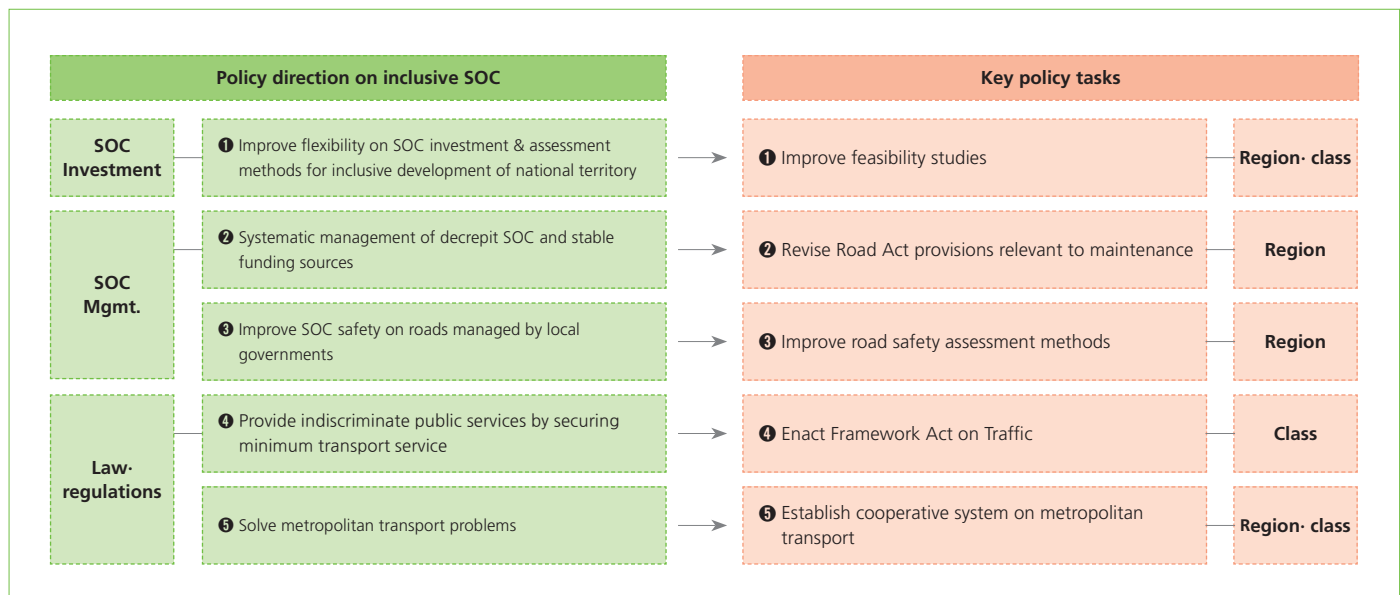
4. Measures to Enhance Regional SOC Investment & Management for Inclusive Development of National Territory

Measures to Improve the Feasibility Study on SOC based on Inclusiveness

Previously, investments on SOC projects were made by stressing the effectiveness and their focus was far from inclusive growth. Therefore, a measure that assesses the validity of SOC project comprehensively based on the policy ideology on inclusive growth of national territory is needed. To this end, an index was prepared by classifying inclusiveness with those related to regions and social classes based on definitions on inclusive growth of national territory as well as case studies at home and abroad.

To be specific, regional inclusiveness was classified with indexes relevant to regional backwardness, transport and life-assisted facilities. The inclusiveness on social stratum was divided as one that classify income bracket and social class and other that indicates capabilities to provide services required for

Figure 1. SOC policy directions for the development of inclusive national territory



the transportation of the vulnerable and they were all included in Analytic Hierarchy Process (AHP). The following indicates key features of comprehensive assessment on SOC investment considering inclusiveness identified after the AHP of 10 transportation experts.

- (Expressway) AHP result considering inclusiveness is similar to the previous preliminary feasibility study method
 - * Project implemented: 0.712 (existing method) → 0.711(including inclusiveness), Project unimplemented: 0.288 (existing method) → 0.289 (including inclusiveness)
- (Urban railway) Precautious implementation of project led to successful results (included in grey area)
 - * Project implemented: 0.382 (existing method) → 0.501 (including inclusiveness), project unimplemented: 0.618 (existing method) → 0.499(including inclusiveness)

Measures to Improve the Maintenance and Safety of SOC based on Inclusiveness

The issue of maintaining bridges and tunnels by local governments is basically related to a lack of funds. Although road management fees are included in local subsidies, such subsidies are considered as an ordinary budget of local governments. In fact, the amount allocated to road management is not used entirely for the original purpose. There are some limits on sufficient management of roads as much of such budget is spent on maintaining outdated decrepit bridges and tunnels by local governments. Maintenance of

bridges and tunnels is directly linked to the safety of people in their daily lives and such issue does not belong to one region only. Therefore, legal grounds for providing subsidies on the maintenance of bridges and tunnels on the roads managed by local governments should be presented by revising Article 86 (Subsidization, etc.) of the Road Act.

The traffic-related death rate in general national roads and expressways that were managed by the government was reduced to record an 11.2% and 5.2%, respectively, indicating a significant safety improvement. However, the figure in the same category of the regional roads (including cities and provinces) that were managed by local governments was mere 1.3%. Hence, there is a need to enhance the safety of roads managed by local governments. In this study, the Highway Safety Manual (HSM) of the US was adjusted to create an assessment model that included Korea's unique conditions and states so that it could be used to support successful implementation of projects to improve the safety of roads managed by local governments.

Measures to Improve Laws & Regulations Related to SOC Based on Inclusiveness

Transportation is closely related to the quality of life. To make Korea as an inclusive country, there should be institutional grounds that guarantee free movement of people as a basic social right. To make this happen, it is desirable to establish the Framework Act on Traffic to define directions for traffic

“ The goals and objectives of metropolitan transportation organization should be clearly defined by determining the scope of cities included and migrating related tasks ”

related laws and regulations so that such act can be applied to revisions and enactment of relevant acts as a basic norm. Also, roles and responsibilities of the government and other players should be defined within the scope of available funds. The Framework Act should clearly state the source of such funds in order to avoid excessive financial burdens.

precise legal grounds for the source of funds to ensure the effectiveness in solving pending transportation issues with increasing public demands.

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In the meantime, a metropolitan traffic organization as a traffic-related cooperative system among large cities should be adopted in order to solve traffic problems that continue to occur within concerned cities. Such organization should be first led by the metropolitan transportation committee and other agency of the central government and its supervision should be shifted to local governments later. For local governments, there were limits in handling transportation-related issues as they were allowed to cope with ones that were occurred within their jurisdiction. Metropolitan transportation issues that each local government has different opinions cannot be resolved with the sole efforts of one side alone. Based on this, it is considered that the introduction of metropolitan transportation organization in proper form to realize decentralization and provide solutions for transportation issues is necessary, not to mention responsible department, traffic agency, and metropolitan traffic organization of various shapes. The goals and objectives of metropolitan transportation organization should be clearly defined by determining the scope of cities included and migrating related tasks. It should also has

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Applying Mobile Bigdata for Estimation of Living Transport Costs

Kim Jonghak

1. Concept of Cost of Living Transport and Estimation

Living transit is defined as transits from the origin (eup, myeon and dong) to destinations (eup, myeon, and dong) that account for at least 1% of the total transits therefrom, and the cost of living transport is defined as the sum of direct and indirect costs incurred by the living transit. The government has been relatively indifferent in understanding and improving living transits compared to transits between cities, counties and districts. Mobile big data analysis revealed that transits between neighboring eup, myeon and dong account for more than 75% of the total transits. Existing survey-based transport cost estimation represents sample areas only and has limitations in understanding differences between regions due to flat yardsticks applied. Big data technologies such as mobile

big data and web crawling make up for shortcomings of the existing survey-based transport cost estimation and allow for estimating and comparing the costs of living transport between eup, myeon and dong across the country at a low cost. [Fig.1](#)

Estimating Living Transport Costs Using Big Data

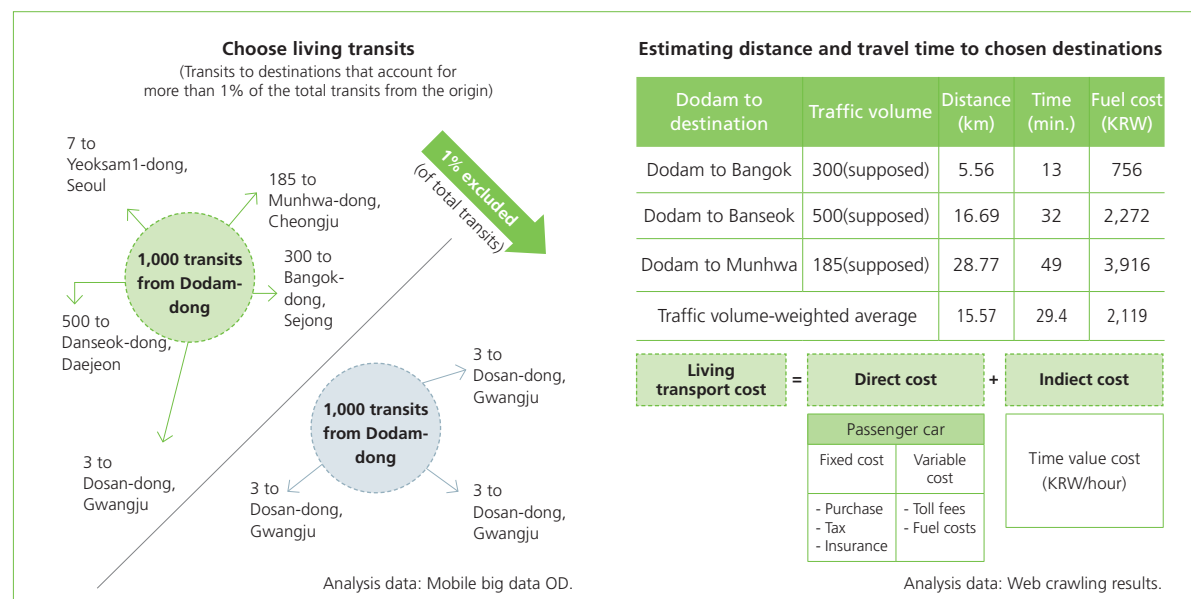
Living transport cost estimation starts with choosing destinations of living transits based on mobile big data on origin-destination traffic. For this study, traffic data in the weekdays of the third week of April 2018 were obtained from the mobile communication service provider SK Telecom. Below is the analysis process. [Table.1](#)

Then information on the travel distance and time of the chosen living transits is collected using web crawling in R, whereby route searches on portal sites were repeated to estimate the living transit distances and times in 560 eup, myeon and dong in Gyeonggi Province. The living transit distances and times in the 560 eup, myeon and dong are traffic-weighted averages, and representative values for each of them were estimated.

2. Difference in Living Transport Costs Between Eup, Myeon and Dong in Gyeonggi Province

The estimated living transport costs in 560 eup, myeon and dong in Gyeonggi Province were: KRW 200,000 a month in

Figure 1.



Source

Kim Jonghak (2019.1). KRIHS Policy Brief. Big data reveal the costs of living transport in your community. p2.

the southern Gyeonggi area adjacent to Seoul; KRW 400,000 a month in the northern Gyeonggi area adjacent to Seoul and the rest of the southern Gyeonggi area, twice as high as that in the former; and KRW 700,000 in Gyeonggi outskirts, 3.5 times as high. [Fig.2](#)

Difference in Living Transport Costs by Income Level

Living transport costs account for approximately 9% of the monthly income in Gyeonggi Province, and the higher income level, the lower share of living transport costs. The estimated parameter value in medium low-income eup, myeon and dong was 16.105 (t : 7.384), meaning that below-average earners pay KRW 160,000 more compared to high-income counterparts (KRW 5.2-6.6 million). And people living in low-income eup, myeon and dong pay KRW 140,000 more than second-to-bottom eup, myeon and dong, or KRW 300,000 more than high-income ones. [Table.2](#)

3. Policy Implications

Need to estimate living transport costs by big data convergence.

To harness the power of big data for public policy, convergent efforts are needed to improve understanding between big data producers and processors on the characteristics of raw data and pros and cons of big data.

Need to develop measures to reduce regional gaps based on the understanding of living transport costs.

Improving gaps in living transport services should start with understanding living transport costs by eup, myeon and dong, and time-series accumulation and monitoring of data. It would better serve to developing concrete solutions to present quantitative data than merely giving qualitative descriptions. For example, it would be more helpful to pinpoint a two-fold gap in living transport costs, rather than saying residents in Namyang-eup in Hwaseong New Town have difficulties in their daily transportation.

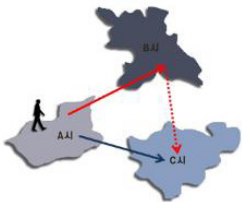

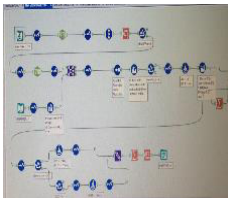
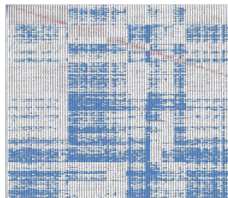
Need to develop measures to reduce gaps based on the understanding of living transport costs by income level.

Big data allow for comparing living transport costs in different eup, myeon and dong by their income level, thereby helping pinpoint who to target when developing living transport cost improvement policies in consideration of income levels. The results of income level-specific living transport cost analysis in Gyeonggi Province reveal the gaps in living transport costs by income level, hence useful for setting quantitative policy goals.

Need to add living transport infrastructure to the list of social overhead capital.

It is needed to identify directions for efficient investment by adding living transport infrastructure to the government's

Table 1.

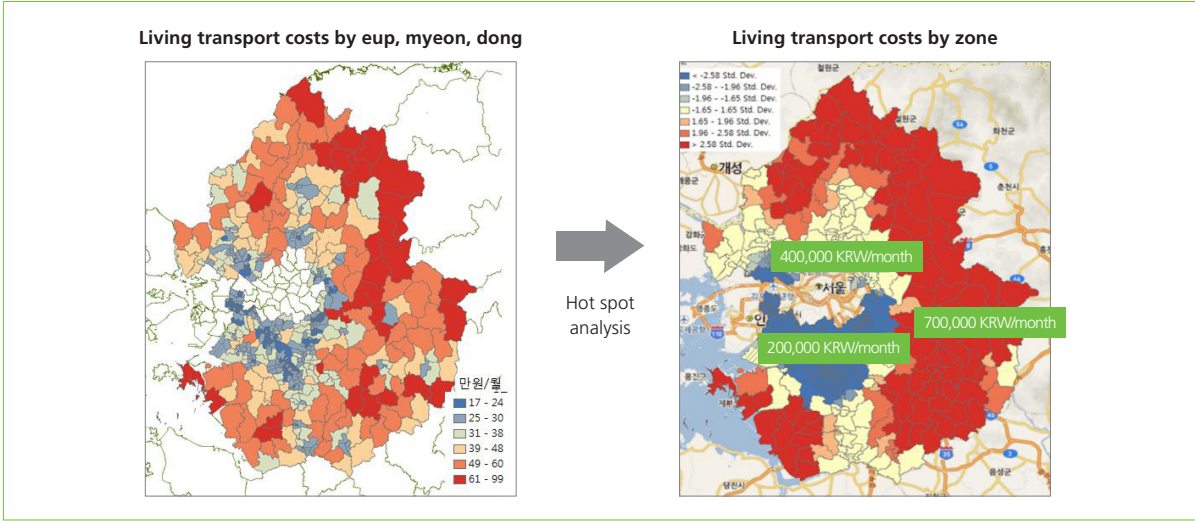
Step 1: Standard setting	Step 2: Data generation	Step 3: Data processing	Step 4: OD generation
Information collection cycle - By transport zone - By date - By time zone	Identifying user locations based on the standard set in Step 1 (after anonymization)	Post-processing of in-zone and inter-zone traffic data and estimating traffic volume between the origin and each destination	Expansion using census data
			

Source
Kim Jonghak et. al.
2018.
Origin-destination
traffic volume
estimation using big
data and applications.
p21

10 major projects for living social overhead capital. For example, building a mid-size library with a bigger collection and improving accessibility thereto by improving living transport infrastructure would benefit more citizens compared to building small libraries indiscriminately. **Fig.3**

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Figure 2.



Source

Kim Jonghak (2019.1). KRIHS Policy Brief. Big data reveal the costs of living transport in your community. p4.

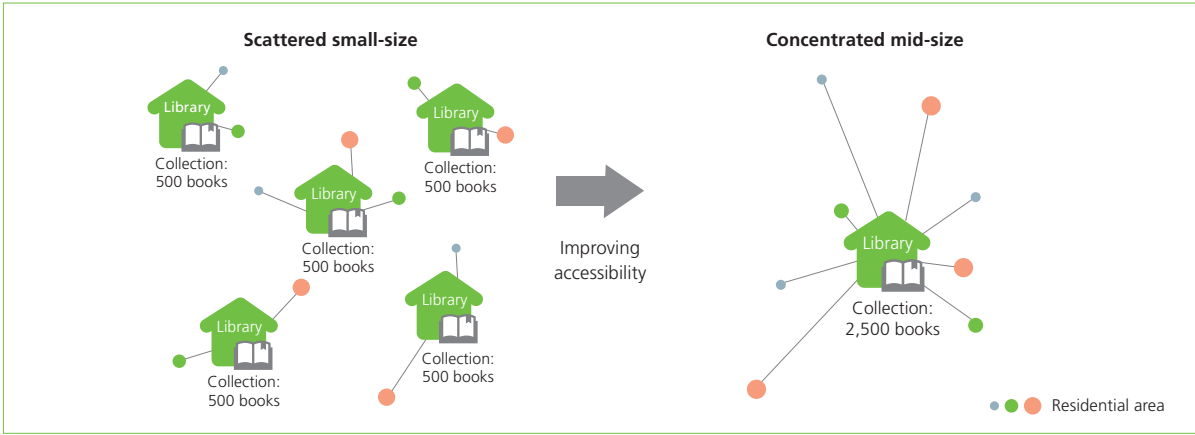
Table 2.

Income class (10,000 KRW/month)	Living transport cost (10,000 KRW/month) parameter	Standard deviation	t value	Significant level
Intercept	26.396	1.866	14.143	.000
Low (250 or lower)	30.091	2.511	11.985	.000
Medium low (250-317)	16.105	2.181	7.384	.000
Medium (320-400)	3.337	1.999	1.669	.096
Medium high (400-520)	1.510	2.062	.732	.464
High (520-660)	0 (standard for comparison)	.	.	.

Source

Kim Jonghak (2019.1). KRIHS Policy Brief. Big data reveal the costs of living transport in your community. p5.

Figure 3.



Source

Kim Jonghak (2019.1). KRIHS Policy Brief. Big data reveal the costs of living transport in your community. p6.

Developing the Disaster Response Routes of Korea

Donghyung Yook

1. Background

Earthquakes and global warming are becoming a global issue and Korea is the exception from these environmental changes. Because of the fact that the disasters are not predictable and the road infrastructure is shaped in the form of the linear structure, seemingly the road infrastructure is vulnerable to the external impact. The disasters also affect the economies of the regions as it interferes with mobilization of people and goods produced in the region. Despite high vulnerability of the road infrastructure, the roles and importance of road infrastructure is becoming even greater upon the disaster. When disaster occurs, roads serve as the route to carry goods and workforce for emergency rescue and to provide the escape route for residents in the affected region. However, as the measure of the preparedness for disasters, the disaster response route has not been established in Korea. The study aims to designate the disaster response routes designed to be suitable for the environment of Korea.

2. Objectives of the Study

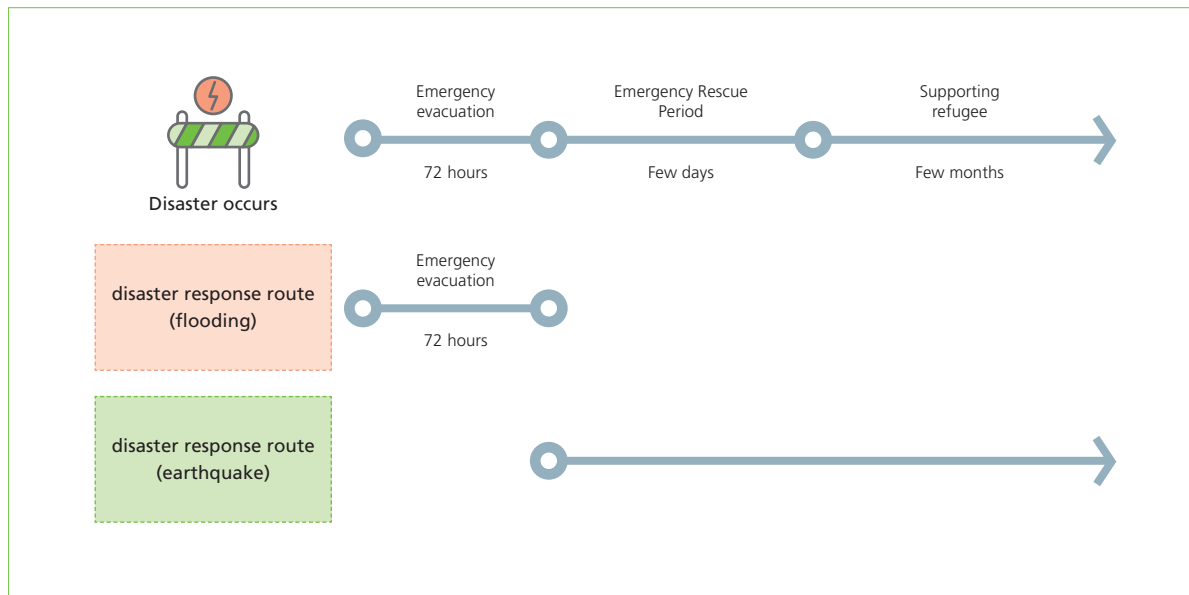
The study is to suggest a basic guideline to select disaster response routes which is designed to minimize damage and to facilitate the restoration process from the disaster.

3. Major Findings

Fundamentals for Establishing Disaster Response Route

First, disaster response route should be selected based on the vulnerability analysis. The vulnerability of the road network needs to be based on disaster forecast to ensure effectiveness of the results of the selection. Second, it is required to select disaster response route by the type of disaster. The road or road facilities like bridges constructed in escalated area are relatively safe from flooding. Thus, these roadway facilities are expected to be able to maintain their function as the escaping routes. Whilst bridges are highly vulnerable to vibration from earthquake. In this case, the bridges should be avoided for selection of the disaster response route. Third, the disaster response route should be selected to be suitable and functional for evacuation activities. The most important evacuation activity should be decided according to the disaster type and then the route that supports the activities should be identified. **Fig.1**

Figure 1. Major Activities Targeted by Disaster Response Route by Disaster Types



Source
Yook et al. (2018)

Disaster Response Route Selection Procedure

The concept of disaster response route by disaster type is defined and the disaster response route selection procedure is outlined as follows. The disaster response route for flooding should serve as the route for safe and rapid evacuation of the residents in affected areas to nearby shelter aiming to minimize casualties and property damage from flooding. The following procedures are suggested.

- Identifying the areas expected to be affected by heavy rain, utilizing flood analysis model
- selection of temporary shelter for residents (schools, community centers, city hall)
- selection of disaster response route to facilitate people's movement to the shelter from flooding areas

The road should serve as route to minimize damage from disaster with efficient and quick delivery of disaster recovery goods and ensure basic livelihood of the damage victims during the disaster and recovery process and for this purpose, the following selection procedures are suggested.

- Identifying the sections where the road is expected to properly function, with earthquake simulation
- selection of temporary shelter for residents (schools, community centers, city hall)
- selection of the hub of disaster recovery for rescue activities (hospitals, fire stations, police stations)
- Connecting these major facilities using the shortest path algorithm

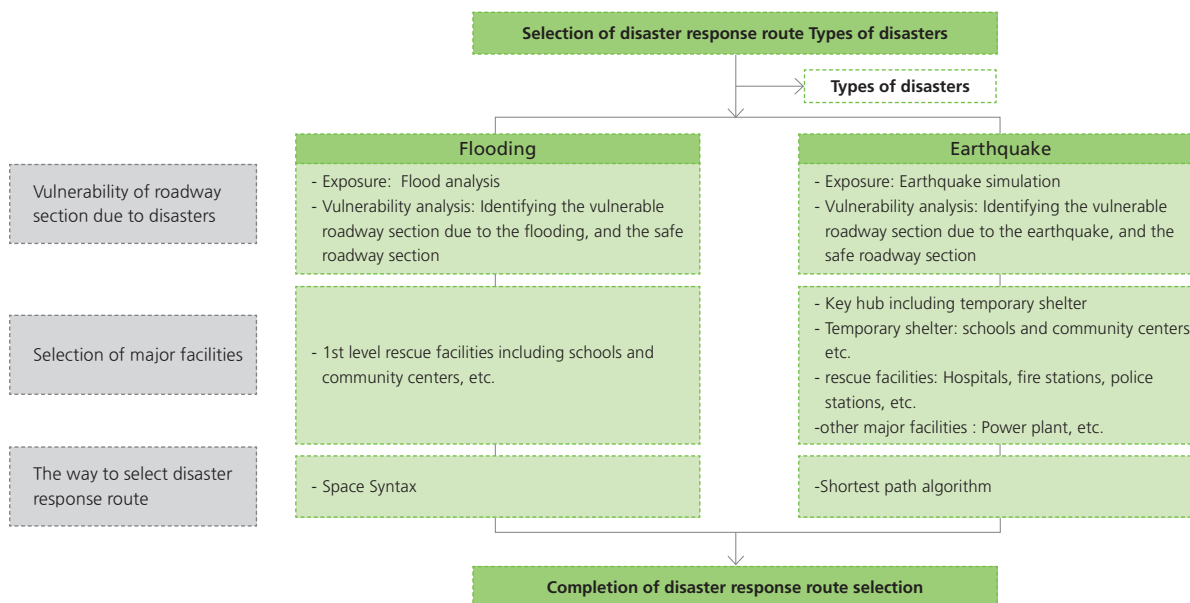
Maintenance and Management of Disaster Response Route

It is necessary to develop a maintenance scheme that differentiates the target status of facilities, depending on the importance of the disaster response route. It should be designated as the facilities defined in the Act on the Management of Disaster and Safety to receive emergency safety inspection and the strengthened maintenance standards by adjusting the grade for major disaster response routes and facilities. To this end, the report suggests integrated management system of disaster response route. This should be the target-oriented disaster response route management system, rather than just seeking maintenance/management of the facility.

Legal and Regulatory Amendment for Maintenance and Management of Disaster Response Route

The laws and regulations should be amended to support the changes from strengthened maintenance and management level as the existing roads are designated as disaster response route. When it is designated as the targets for emergency safety inspection, under urgent situation, emergency safety inspection should be conducted. The regulatory system needs to be amended to have the disaster response route with higher importance included as Type 2 facilities in the categorization of Type 1, Type 2 and Type 3 under the Special Act of the Safety Control of Public Structures to receive safety check and inspection on a regular basis.

Figure 2. Disaster Response Route Selection Procedure by Disaster Type



4. Conclusions

The study was conducted to provide the guideline for designating the disaster response route in consideration of the situation of Korea where no disaster response route is designated yet. To this end, the study suggested the way to develop methodology to select disaster response route, to operate the disaster response route upon disasters and lastly, to adjust legal and regulatory system for selection of disaster response route and its operation. Based on the study results on selection procedures and maintenance & management of disaster response route, policy suggestions were made, which emphasizes the necessity of disaster response route, systemization of maintenance and management of the route, and its promotion. The suggested policies based on the research results are as follows. It is required to mandate to designate and operate the disaster response route at municipalities considering the vulnerability to disasters. Once the disaster response route is determined, disaster tolerance of the route should be improved to ensure the selected route to serve for the purpose and follow-up policy on maintenance/management of the route. Also the study developed standards on disaster resistance by disaster type and guideline on maintenance. It is also required to develop and distribute the manual for operating the emergency response, including the contents on disaster response route to be utilized when disasters occur.

References

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