

Proposal of Human and Technical Support for the Establishment of Spatial Information in Preparation for the Unification of South and North Korea

Park, Seon A¹⁾ · Park, Jin Su²⁾ · Pyeon, Mu Wook³⁾ · Lee, Gyeong Wook⁴⁾

Abstract

This study considered measures to support the establishment of surveying and spatial information in preparation for the unification of South and North Korea and the subsequent construction of national infrastructure. The organization identified and analyzed spatial information about North Korea, road and railway-oriented SOC construction projects, and examined the applicability of the latest technologies to narrow the technical gap with North Korea and quickly establish land spatial information. To prepare a support process appropriate for the situation in North Korea, technical and human support details and considerations were reviewed through a case analysis of spatial information construction for developing countries. In addition, the main result was “Presenting Efficient Utilization of Human Resources and Equipment for the Establishment of Spatial Information in North Korea,” establishing an efficient utilization plan for the human resources and equipment needed in the support process based on technology support. It is expected that the South Korean government will minimize the negative impact on future land infrastructure construction by first conducting research in inter-Korean economic cooperation and national infrastructure construction and establishment of spatial information construction plans.

Keywords : Inter-Korean Unification, Surveying, Spatial Information Construction, Support Process

1. Introduction

Various analyses and studies are being conducted to prepare for the construction of infrastructure such as roads and railways for the eventual unification of South and North Korea (Choi *et al.* (2006); Lim *et al.* (2015); Kang *et al.* (2020)). Spatial information construction and measurement are fundamental stages of SOC (Social Overhead Capital) and infrastructure construction, which form the basis of economic activities and comprise national infrastructure. It

is necessary to prepare measures to nurture manpower and support technology to overcome North Korea's closed social system, which creates differences in surveying technology and related manpower.

Previous studies on North Korea have examined pre-production of terms, compared laws and systems, and attempted to find opportunities for cooperation. Since it is difficult to access details about North Korean infrastructure from the private sector, most research on North Korea is held by state agencies and can be classified into three

Received 2021. 10. 13, Revised 2021. 10. 12, Accepted 2021. 10. 26

1) Member, Dept. of Civil Engineering, Konkuk University (E-mail: tjsdk7009@gmail.com)

2) Member, Staff, ALLforLAND.Co.Ltd, Dept. of Advanced Technology Fusion, Konkuk University, (E-mail: mofeste@all4land.com)

3) Corresponding Author, Member, Dept. of Civil Engineering, Professor, Konkuk University (e-mail: neptune@konkuk.ac.kr)

4) Ph.D. student, Dept. of Civil Engineering, Konkuk University, Seoul 05029, South Korea (E-mail: gwlee@konkuk.ac.kr)

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

major areas. The first includes studies that compare and summarize the terms laid down by South and North Korea to solve communication issues that are related to inter-Korean cooperation. The *“Inter-Korean Construction Standards Terminology Report”* was recently published (Lee *et al.* (2020)) as a result of this strain of research. Second, research has been conducted to present institutional integration and improvement measures focusing on the construction and development of legislation and policy trends for the development of the North Korean region: *“A Study on the Unification Scheme of Surveying Policy and Geographic of South and North Korea”* (Choi *et al.* (2006)) is a major prior study in this field. The study analyzed cases of pre- and post-unification surveying problems in Germany through interviews with experts and visits to related institutions, and examined and analyzed the surveying systems used in South and North Korea. Finally, research has been conducted to develop specific plans and support measures by presenting the implementation system and plans for the North's land development project in preparation for unification. Prior studies in the field include *“An Experimental Project on Land Information Establishment North Korea regarding Rapid Unification”* (Lim *et al.* (2015)) and *“Improvement on the Application of North Korea Land Information for Inter-Korean Exchange and Cooperation”* (Kang *et al.* (2020)).

The aforementioned studies focused on legislative and policy aspects to construct spatial information in North Korea and prepare a system for land development projects for reunification. Thus, there is a lack of research about how to support the establishment of spatial information.

Therefore, this study presents a more specific support system for building spatial information by focusing on the efficient utilization of human resources, equipment, and ways to foster human resources. It is more efficient to create measures to train North Korean survey personnel and provide technical support than the unilateral dispatch of South Korean personnel to build infrastructure on the Korean Peninsula, which will be carried out following the unification of South and North Korea. Referring to the methodology for establishing specific support measures, considerations for supporting spatial information construction in developing countries with relatively similar

spatial information construction environments to North Korea were reviewed.

The purpose of this study is to derive the efficient utilization of human resources and equipment, and ways to foster human resources for the establishment of spatial information in North Korea. Accordingly, the government will analyze the status of spatial information construction in the North Korean region, identify the status of spatial information personnel and technology in South and North Korea, and propose support measures according to the easing of sanctions on North Korea.

The remainder of this paper is organized as follows. Section 2 reviews considerations for establishing support measures based on cases of support for spatial information construction in developing countries. Section 3 analyzes the status and demand of spatial information construction in North Korea. Section 4 proposes support measures according to the scenario for easing sanctions on North Korea, identifies surveyors in South and North Korea, and summarizes human and technical support processes. Finally, we draw conclusions in Section 5.

2. Prior research cases and research methods

2.1. Precedent Study on Support for Spatial Information Construction in Developing Countries

This section analyzes cases of support for building spatial information infrastructure in developing countries and reviews the variables to be considered when establishing support measures for countries with relatively poor spatial information construction environments. Kim *et al.* (2019) presented improvements in the education curriculum through interviews with those who completed the spatial information technology dissemination education conducted by the National Geographic Information Service and the KOICA (Korea International Cooperation Agency). Major improvements include practicing using open-source rather than expensive commercial software, saving time through the unification of similar subjects, and adding intensive learning of subjects with high requirements in developing countries.

Kim *et al.* (2014) suggested that spatial information should be prioritized before establishing an overseas export strategy for the spatial information open platform and mentioned the legal system and policies related to spatial information, organizations, basic spatial information, standards, and technology development environment. Choi *et al.* (2011) analyzed the characteristics of demand that emerge during the developing country's spatial information construction and utilization phase and presented strategies for entering the spatial information market in developing countries by linking SWOT techniques with ERRC (Eliminate, Raise, Reduce, Create) techniques.

North Korea does not have its own technology, and it is difficult to systematically build national spatial information due to its poor institutional and policy conditions. Thus, it does not differ much from developing countries in terms of national spatial information. Therefore, in consideration of the components of the national spatial information infrastructure, specific support measures are established, such as applying the latest technology appropriate to the closed and limited situation in North Korea and training professionals.

2.2. Study Methods

This study was conducted to propose a human and technical support system for the construction of land infrastructure and spatial information between South and North Korea, which will emerge as the most urgent problem in preparation for the unification of the Korean peninsula. To this end, we analyze support cases for spatial information construction in developing countries and prioritize considerations for preparing support processes. To respond to the demand for spatial information of the Korean peninsula after unification, the current status of spatial information in North Korea was analyzed, and the demand for spatial information that is expected to occur over time.

The first task in bridging the technology gap between South and North Korea is the introduction of the latest surveying techniques, but this is practically difficult due to sanctions against North Korea. Therefore, the human and technical support process can be established in consideration of the scenario of easing sanctions on North Korea, which

could act as a major variable in the reunification of South and North Korea.

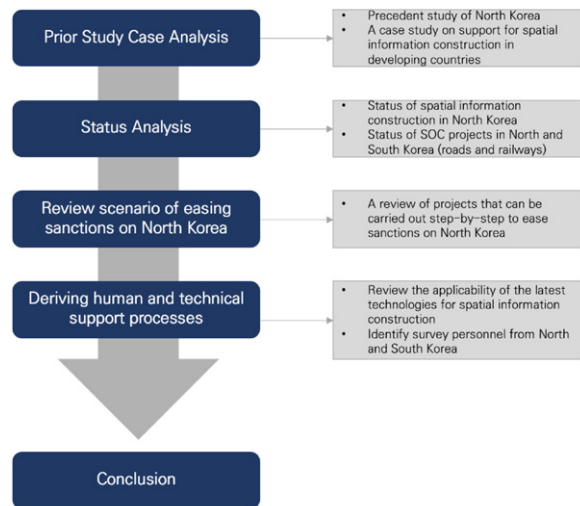


Fig. 1. Study flowchart

3. Current status of North Korea's spatial information construction and inter-Korean SOC construction projects

During the construction process, both survey data as well as constructed spatial information are often required as usable spatial information data. South Korea has long been working on constructing spatial data on North Korea in the form of satellite images and digital data, and has also been carrying out continuous renewal projects. In addition, the resolution of satellite images is increasing and can be used to establish basic plans for civil engineering. Therefore, it is preferable to identify the current status of various numerical map data in the North Korean region that are already in possession and induce them to be used in construction. In particular, various types of theme maps are being constructed and are highly utilizable in the basic construction design process. If exchanges with the North are activated, the quality or property accuracy can be dramatically improved. Therefore, establishing a distribution system that prepares a list of available numerical data for each type of construction in the future and supplies it to institutions or companies that are pursuing projects in North Korea is essential.

North Korea currently has a total of 308 km of rail extensions, and four main connections with the South as part of an axis of the Gyeongui Line, Geumgangsan Line, Gyeongwon Line, and Donghae Bukbu Line are being pushed. The inter-Korean railway connection project, which was promoted after the land tour was agreed upon in 2004, has been experiencing uncertainty based on the prevalent political situation. This plan is part of a three-stage master plan. The first stage is the inter-Korean railway connection phase, in which logistics projects are promoted through the minimal renovation of inter-Korean railways. The second stage is the renovation of the North Korean railway, which is the expansion of logistics projects and the formation of an international consortium through the modernization of the North Korean railway. Finally, the third stage includes the modernization of the North Korean railway with the aim to complete the Eurasian Land Bridge. However, the issue of the aging of North Korea's railway has been a major obstacle to the inter-Korean railway connection, which requires the integration of construction survey standards and the establishment of manpower training measures to construct spatial information.

South Korea's extension of the secondary road to North Korea's high-speed corresponding to the National is about 8,255.7 km and is divided into five main roads. Five main axes can be identified: the West Sea axis, the East Sea axis, the West-East connection axis, the Northern inland axis, and the East-West border axis. Due to poor economic conditions, North Korea's roads are quite old and many road lines are narrow. Moreover, general roads, excluding expressways, are mostly one-lane with a width of less than 2.4 m. North Korea's road pavement rate is less than 10% except for highways, and most main roads are less than two-lane round trips. In addition, only major sections of the highway, including Pyongyang-Nampo, Pyongyang-Gaesong, Pyongyang-Wonsan, Pyongyang-Hyongsan, and Pyongyang-Nampo, are paved with asphalt.

Although it is difficult to build new roads in North Korea due to the prolonged economic recession caused by international economic sanctions, road renovation and repair appears to be continuing. According to a recent North Korean media report, road renovation and repair projects

are underway in downtown Pyongyang, including road expansion and pavement work and the installation of a median strip. Cheongjin-Laseon road in Hamgyongbuk-do was renovated, the retaining wall of Pyongyang-Wonsan tourist road was repaired, and the Heecheon-Myeongmun-Ganggye the Wonsan-Hamheung roads were renovated. Meanwhile, projects to improve environmental beautification around major roads are also being conducted. In the promotion of inter-Korean economic cooperation, a number of projects related to improving road conditions in North Korea as well as road connections between South and North Korea are expected.

4. Efficient utilization of human resources and equipment and training of human resources

The latest available technologies were investigated in preparation for the construction of land infrastructure in North Korea. This aims to overcome the gap in the quality and quantity levels of spatial information construction between South and North Korea, and supports South Korean spatial information-related companies to establish themselves in North Korea in the future. In this study, we analyzed the technologies and resources needed to prepare for the necessary infrastructure construction plan, considering state-of-the-art and alternative technologies, and finally analyzed the application and utilization of integrated technologies.

4.1. A review of the applicability of the latest technology for integrating spatial information in the Korean peninsula

If the infrastructure construction project in North Korea proceeds rapidly based on the progress of economic cooperation, the spatial information construction system for the North Korean region must be reorganized. It is common for the economic backwardness of a country to be inversely proportional to the spatial and temporal accuracy of national spatial information. Building high-quality land information requires significant time, costs, and a high level of proficiency; therefore, various spatial information in a wide range of areas

Table 1. Measuring devices and processing devices according to the method of obtaining national land information

Method of acquiring national territory information	Measuring Instruments	Processing Instruments	Platforms
Ground Survey	T/S, GPS	Pen Computer, Laptop	Ground
Vehicle Mapping System	Digital Camera, GPS, INS	Desktop	Vehicle
Aeronautical Photogrammetry	Digital Camera, GPS, INS	Workstation	Aircraft
Satellite Remote Exploration	Optical Sensor	Workstation, Desktop	Satellite
Unmanned Aeronautical Survey	Digital Camera	Desktop	UAV
Laser Survey	Laser Sensor	Desktop	Ground, Aircraft

should be considered in a short period of time to quickly establish SOC plans. In addition, it is believed that the rapid introduction of advanced surveying techniques rather than traditional surveying technologies will be necessary to reduce the gap in the quality of spatial information between South and North Korea in a short time frame.

Recently, various state-of-the-art technologies such as vehicle mapping systems, aerial photography, and satellite remote exploration have been applied to the field of land information construction, and measurement, interpretation devices, and platforms, depending on how land information is acquired, as shown in Table 1. Typically, total station (T/S) and GPS surveying technologies are used to build numerical, continuous, and reference points, while photo surveying and remote exploration technologies are used to create satellite image data. T/S surveying is the most precise measurement method and has the advantage of being widely used in data surveying for coordinate registration of aerial photographs or satellite images in the direct acquisition of data. However, because T/S and GPS measurements are conducted in the field, human, temporal, and economic burdens are imposed, and aerial photographic measurements require consideration of weather conditions and security of the area to be photographed. This limits its application to a wide range of areas in a short period of time. Therefore, in establishing technical support measures for the construction of land spatial information in North Korea, the workflow process that can be obtained only through local surveys or aerial photography was intensively reviewed.

Currently, it is difficult to utilize high-tech surveying tools due to sanctions against North Korea, but this is expected to be overcome naturally.

4.2. Suggestion of assistance measures according to the scenario of easing sanctions on North Korea

Depending on the stage of the easing of sanctions on North Korea, conditions for inter-Korean economic cooperation also changes, and the projects that can be pursued vary from stage to stage accordingly. In the case of construction work targeting North Korea, almost all sanctions, including infrastructure connections with the country and direct investment of foreign capital in the country, are expected to continue in the early stages of economic cooperation. Therefore, it is necessary to establish a systematic strategy related to the support of spatial information and the surveying technology required at each stage.

At the "New Korean Peninsula System and Inter-Korean Economic Cooperation Forum" held by the Korea International Trade Association in March 2019, Yang Moon-soo, vice president of the Graduate School of North Korea, presented changes in inter-Korean economic cooperation in four stages. The first step involves the lifting of the five resolutions from the UN Security Council Resolutions 2270 to 2397, which would allow inter-Korean economic cooperation conditions to return to those before March 2016, and enable all existing inter-Korean economic cooperation projects and small-scale new projects with low risks. The second stage would occur when the U.S. lifts its designation of North Korea being a terrorist sponsor and withdraws its ban on aid from international financial institutions, while the second stage addresses the risk of North Korea's failure to reform and open. In addition, investment projects are possible regardless of strategic material issues and US marketplace issues. In this case, the scale of the first phase

of the project can be expanded, small-scale industrial complexes can be built in some economic development zones, and medium-sized investments aimed at North Korea's domestic market, such as distribution, food, and construction can be conducted. The third stage is when the U.S. relaxes and lifts sanctions on export management orders and relaxes and lifts the international strategic goods control system, and invests in infrastructure in North Korea at the same time as the strategic goods issue is resolved. At this stage, it will be possible to invest in North Korea in industries that can set North Korea's domestic market and foreign markets other than the U.S. as target markets. As a result, possible projects include investments in transportation, energy, telecommunications infrastructure, and large-scale investments in steel, chemicals, machinery, and some ICT (Information and Communication Technology). The fourth stage is when the U.S. eases and lifts import-prohibited high tariffs on North Korea, resolving the U.S. market's problem, enabling investment in North Korea in industries where entry into the U.S. market is crucial. Large-scale investments in textile clothing, home appliances, automobiles, and ICT are also possible to this end. Prospects for inter-Korean economic cooperation by easing sanctions on North Korea and projects that can be carried out are illustrated below (Fig. 2).

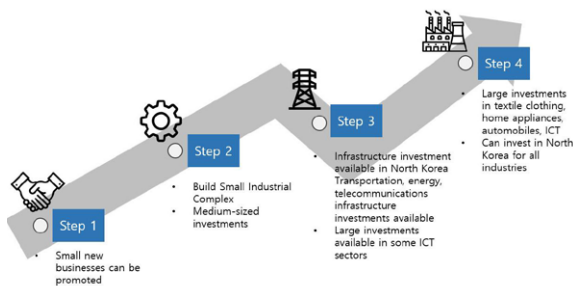


Fig. 2. Prospect of inter-Korean economic cooperation if sanctions are lifted

4.3. Identification of survey personnel from South and North Korea and efficient utilization of human resources and equipment

Before analyzing the cost of consumption by project timing, it is necessary to find ways to recruit and train manpower to perform projects and to prepare and secure additional

necessary equipment by identifying the current status of equipment. Based on these analyses, timely preparation and feasibility review of budget proposals should be carried out in the future to prepare specific budget proposals for the efficient use of cooperative agencies, human resources, technologies, and equipment.

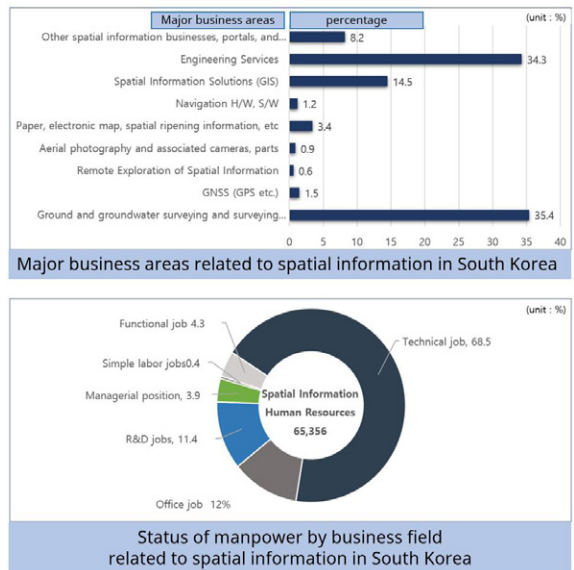


Fig. 3. Status of human resources in major business areas and business areas of the spatial data industry

As shown in Fig. 3, the main business sectors of the spatial information industry in South Korea are ground/underground/water surveys and survey organizations (35.4%), engineering services (34.3%), and spatial information workers (68.5%) (Kim, (2020)). As a result, policy decisions should discover new demands for the spatial information industry in preparation for unification of the Korean Peninsula.

In terms of equipment such as Hardware and Software, spatial information construction equipment and utilization software tend to rely on foreign equipment, and it is necessary to attempt to minimize unification costs by preparing GIS localization strategies in the future.

Information on spatial information related to educational institutions in North Korea is currently not accessible. However, as shown in Table 2, it is generally understood

Table 2. North Korea's construction/survey education institution

Name of university	Department	Location	Remark
Kim Il Sung University	Department of Geodetic Map	Pyongyang City	Number of professor: 102
Kim Chek University of Technology	Department of Geology, Department of Survey	Pyongyang City	
Pyongyang University of Construction	Department of technology survey	Pyongyang City	
Sariwon Geosciences College	Department of Geophysical Exploration	Sariwon, North Hwanghae Province	Geological Expedition, Survey Squad
Sariwon Agricultural College	Department of Land Construction and Protection	Sariwon, North Hwanghae Province	
Chongjin Mines Metal University	Department of technology survey	Chongjin City, North Hamgyeong Province	
Dancheon Exploration College	Department of Geology Department of Drilling	Dancheon City, North Hamgyeong Province	Placement of Expeditionary Squad
Hamhung Repair Power College	Department of Civil Engineering Department of Mathematics	Hamheung City	Reclaimed land, Placement of Business
Haeju Agricultural College	Department of Land Construction and Protection	Haeju City, South Hwanghae Province	
Wonsan Agricultural College	Department of Land Construction and Protection	Wonsan City, Gangwon-do	
Pyongsong Coal Industry College	Department of Geology	Pyeongseong-si, South Pyeongan Province	Placement of Expeditionary Squad, Academy of Sciences

that relevant training is being conducted in construction departments and institutions. In the future, university research institutes and companies in the South need a system that encourages them to construct spatial information in North Korea through cooperation with specialized educational institutions.

If North Korea constructs homeland information that is directly related to national security in a very military-exclusive and conservative situation through the use of North Korean personnel, it will help the infrastructure construction project proceed relatively smoothly. In addition, choosing standards for education and training should be prioritized over establishing measures to foster human resources.

5. Conclusion

This study aimed to identify measures to support the construction of survey and spatial information to prepare for the unification of South and North Korea and the subsequent

construction of national infrastructure. The main findings are as follows.

First, we investigated construction and spatial data about North Korea held at home and abroad and analyzed the demand for surveying and spatial information in North Korea through the SOC construction project.

Second, to prepare support measures suitable for the situation in North Korea, which is relatively lacking in spatial information construction, prior research on spatial information construction support was analyzed for developing countries.

Third, based on the scenario of easing sanctions on North Korea, possible projects were reviewed and the order of infrastructure construction was determined by accordingly selecting the project execution cycle and inter-industrial priorities.

Fourth, the two Koreas sought to develop more specific human support measures by identifying survey personnel. In this process, South Korea was able to accurately identify

survey-related industry workers, but a survey of North Korea's personnel was conducted by surveying related educational institutions and through a rough estimation.

In investigating closed and difficult-to-obtain data from North Korea, it was challenging to define specific support measures because the data were relatively less accurate than that of South Korea or it was not possible to collect the latest data. Future research is expected to more accurately identify North Korean surveys and spatial information-related personnel by conducting interviews with North Korean defectors who are engaged in surveying or have experience in related educational institutions.

Based on the progress made in this study, the timely preparation and feasibility review of budget proposals should be carried out in the future to identify suitable partner institutions and prepare specific budget proposals for the efficient use of human resources, technology, and equipment.

Acknowledgements

This research was supported by the Ministry of Science and ICT (MSIT), Korea, under the National Program for Excellence in SW (No. 2018-0-00213, Konkuk University) supervised by the Institute of Information & Communications Technology Planning & Evaluation (IITP) in 2021.

References

- Choi, Y.S., Park, H.G., Lee, H.N., (2006), *A Study on the Unification Scheme of Surveying Policy and Geographic of South and North Korea*, Vol. 24. No. 2, pp. 193-200. (in Korean with English abstract)
- Jo, B.H., (2015), *Establishment and Challenges of North Korea's Land Information Infrastructure for Unification*, Report 11, Real Estate Focus Vol. 86, pp. 49-62. (in Korean)
- Kang, M.J., Lim, Y.H., Lee, S.J., Lee, S.S., Lee, H.J., Kim, M.A., Lee, J.H., (2020), *Improvement on the Application of North Korea Land Information for Inter-Korean Exchange and Cooperation*, 979-11-5898-530-1, Korea Research Institute for Human Settlements, Sejong, Korea
- Kim, S.Y., (2020), *2020 Spatial Information Industry Survey Report* (as of 2019), 11-1613000-000926-10, Ministry of Land, Infrastructure and Transport, Sejong, Korea, pp. 39,51. (in Korean)
- Kim, B.S. and Kim, K., (2019), *A Study on Improvement Plan of Korean Geospatial Information Education Systems for Developing Countries*, The Korean Cartographic Association, Vol.19, No.2, pp. 79~89, (in Korean with English abstract)
- Kim, K., Jeong, J.D., Lee, J.Y., (2014), *A Study on Abroad Export Strategy by Country of Spatial Open Platform -Focused on the Kingdom of Cambodia and the Emirate of Abu Dhabi*, ISSN No. 2287-9242, Journal of Korea Spatial Information Society, Vol.22, No.3, pp. 9-21. (in Korean with English abstract)
- Lim, H.T., Lee, Y.J., Lee, K.J., Yang, S.C., Lee, S.H., Shin, D.B., Ahn, J.W., (2015), *An Experimental Project on Land Information Establishment North Korea regarding Rapid Unification*, ISBN No. 978-89-98590-98-7 , LX, Seoul, Korea
- Pyeon, M.W., Kim, Y.I., Shin, D.B., Kim, C.J., (2020), *Establishment of Spatial Information Roadmap for Supporting the Infrastructure Construction of the Unified Korean Peninsula*, National Geographic Information Institute, Suwon, Korea
- Seo, S.W., (2011), *A Study on the Cadastral Survey of North Korea after the Unification*, Master's thesis, Myungji University, Seoul, Korea, 70p. (in Korean with English abstract)
- Yang, M.S., (2019), North Korea-U.S. negotiations and the direction of inter-Korean economic cooperation under the New Korean Peninsula system, *New Korean Peninsula System and Inter-Korean Economic Cooperation Forum*, Korea International Trade Association, 19 March, Seoul, Korea, pp. 1-14.