November-December 2019
ISSN: 0193-4120 Page No. 2421 - 2427

Cloud-GIS Core Technology and Development Strategy

Sang-Gug Park
Dept. of It Convergence, Uiduk University, Korea, Skpark@Uu.Ac.Kr

Article Info
Volume 81
Page Number: 2421 - 2427
Publication Issue:
November-December 2019

Article History
Article Received: *5 March 2019*
Revised: *18 May 2019*
Accepted: *24 September 2019*
Publication: *12 December 2019*

Abstract

In this study, the role of Cloud-GIS technology, which is being dramatically changed in the utilization environment while aiming at openness/componentization/hyper-connectivity, while providing guidance services and various combined services, will explain the value of Cloud-GIS technology centered on the application of Cloud-GIS technology that is rapidly spreading. In addition, LiDAR image visualization technology that processes 3D facility data to be recognized by the user, and the m-GIS core technology centered on GIS/CAD data integration and linkage technology that can provide useful information such as building design and urban planning to match the surroundings. Finally the m-GIS technology development direction for the development of these core technologies, the m-GIS technology development road-map based on this, and the application plan for the smart phone platform that reflects this, and the policy proposal to carry out this, proposes a technology development strategy. GIS construction project as a national period industry has undergone a breakthrough development in the Cloud-GIS industry with the popularization of smart phones. In particular, the development of sensor fusion systems equipped with various sensors is expanding the monetization base of the related parts development industry. Therefore, a specialized strategy is needed for global market advantages in domestic related industries. For example, by identifying the preferences of each smart phone user(age, job, etc.), it is necessary to develop and market strategies optimized for this.

Keywords: *Cloud-GIS, hyper-connectivity, LiDAR, GIS/CAD*

---

1. INTRODUCTION

Cloud-GIS(Cloud-Geographic Information System) technology is rapidly evolving toward openness, componentization, hyper-connection. In addition, it is combined with the information processing technology of the smart phone is spreading to real-time location information service technology. UAV(Unmanned Aerial Vehicle) system equipped with advanced multi-sensor, and ground control system through real-time information processing function using sensor data are being developed as a state-of-the-art real-time monitoring system is being developed. Thus, m-GIS technology is being fused with a variety of technologies, such as computer graphics, VR(Virtual Reality), AR(Augmented Reality) and upper-level geometry u-city, telematics, LBS(Location Based Service), urban planning/development, disaster reheating, traffic control and the environment, etc. are becoming the infrastructure technologies of the public and private industries. In particular, according to the 5G mobile communication environment that recently started commercial services, the spatial information utilizing wireless communication and smart phones has been essential information in everyday life, especially in a dynamic environment is a situation that the demand for spatial information is growing.

In this study, the role of m-GIS technology, which is being dramatically changed in the utilization environment while aiming at openness/componentization/hyper-connectivity, while providing guidance services and various combined services, will explain the value of m-GIS technology centered on the application of m-GIS technology that is rapidly spreading. In addition, LiDAR(Light Detection and Ranging) image visualization technology that

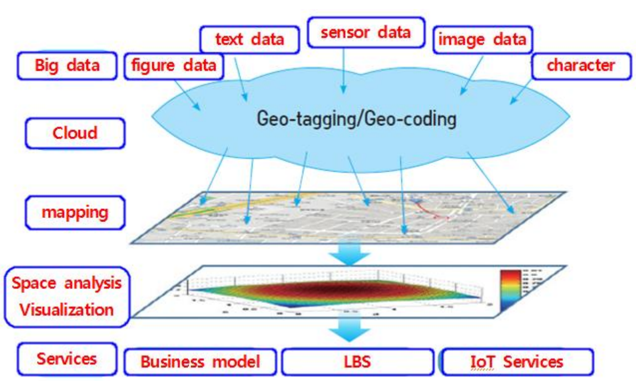
November-December 2019
ISSN: 0193-4120 Page No. 2421 - 2427

processes 3D facility data to be recognized by the user, and the m-GIS core technology centered on GIS/CAD data integration and linkage technology that can provide useful information such as building design and urban planning to match the surroundings. Finally the m-GIS technology development direction for the development of these core technologies, the Cloud-GIS technology development road-map based on this, and the application plan for the smart phone platform that reflects this, and the policy proposal to carry out this, proposes a technology development strategy.

2. Value of Cloud-GIS Technology

2.1 Role of Cloud-GIS Technology

Cloud-GIS technology aimed at openness, componentization, and ultra-connectivity provides the value of smart phones equipped with intelligent sensors to share information over the Internet. In particular, as the real-time data of the invitation capacity that is generated exponentially through the sensor is stored in the cloud computing system, the amount of information and the utilization environment has been drastically changed. Location information data can be mapped on a map, and is utilized for decision-making and business decisions by analyzing patterns and characteristics through spatial analysis and visualizing the results. Furthermore, by identifying the location of the user or object in real time through the interface connecting the digital virtual space and the real space to map to the map, and applying a specific algorithm or rule provides location-based services such as tracking, navigation, Geo-Fencing[1]. Using this spatial information to improve the business or create new services, the IoT(Internet of Things) is increasing the value of m-GIS technology through the utilization of spatial data demand and spatial information to meet the environment. (See Figure 1)

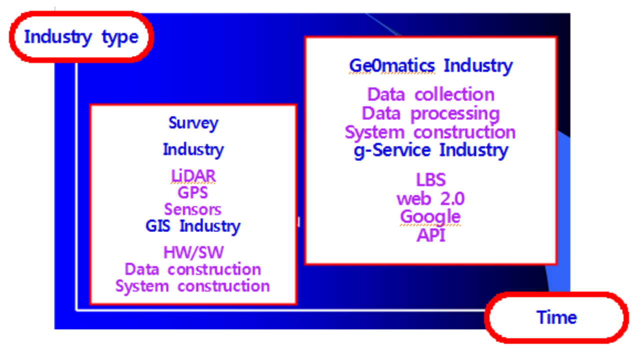


* Source : Korea Research Institute for Human Settlements(17 October 2017).

Figure 1 : Role of Cloud-GIS Technology

2.2 Application of Cloud-GIS Technology

Cloud-GIS technology application market has been increasing rapidly in recent years, in particular recently, Google/Naver/Cacao, etc., while providing a variety of combination services and map services, etc. has been spreading very rapidly. The form that Cloud-GIS technology is most commonly utilized is Geo-Fencing and path analysis. This technology is currently being utilized in a variety of industries, in particular in stores instead of the existing Bluetooth-based beacon in stead of the virtual boundary specified in advance or when entering a specific area it appears to be utilized prominently in the marketing of the way to send a message. In the case of beacons, Geo-Fencing technology, unlike the usage distance of up to 100 m, has the characteristic that it can be utilized without distance restrictions if only the point to specify the appropriate distance or area. In addition to the coupon transmission in other stores, it is also useful to analyze each section to read the user's behavior pattern[2][3]. The application of m-GIS technology is shown in Figure 2.



* Source : ComputerWorld(31 August 2018).

Figure 2 : Application of Cloud-GIS Technology

3. Cloud-GIS Core Technology

3.1 LiDAR Image Visualization Technology

3D image by LiDAR is DEM(Digital Elevation Model) and topographic data, such as aerial photography or satellite imagery on the image data, such as bridges, buildings, roads on the main facilities expressed using these facility data it is a process that allows the user to recognize a similar appearance to the actual terrain on the PC. In order to visualize the LiDAR image as 3D map data, the following advanced technology is required[4][5]:

- Technology that automatically classifies LiDAR images and analyzes image information for each classification and produces 3D map data.
- Technology to visualize map data by fusing 3D images taken with 1D map data.
- Software technology and facility data processing technology that can combine 3D images by LiDAR

November-December 2019
ISSN: 0193-4120 Page No. 2421 - 2427

with virtual reality to create 3D-Studio design images.
- Large-capacity image processing algorithm technology using terrain processing algorithm and texture compression technique using DHLoD(Dynamic Height-field level of Detail).

There is a sensor web as a representative platform technology for integrating and processing u-GIS data. This is a concept that can be installed and connected to the web to monitor facilities and environment, traffic conditions, disasters, etc. with a computer function in artifacts or natural materials. In the future, it is expected that these sensor webs will be connected throughout the city to build u-cities, or even connect to a global network that covers the entire planet, developing into an intelligent global space environment in the form of the USN(Ubiquitous Sensor Network).

3.2 GIS/CAD data Integration and Linkage Technology

u-City oriented u-GIS information should be able to efficiently provide users with optimal spatial/location information anytime, anywhere. Existing GIS has mainly provided a building and facility information(2D or 2.5D) of the outdoor utilizing a triangular mesh technique and a 3D image processing system. CAD and BIM(Building Information Modeling) in the field of construction and construction has provided information focused on the detailed building information(2D or 3D, including contextual information for design/construction/management) of the indoor[2]. By integrating two spatial information with different processing levels into one, it is possible to provide a new u-GIS service. That is, by actively utilizing various GIS data related to the surrounding information of the building(building/road/facilities/environment, etc.) in the design stage of the construction and construction field, it is possible to design a building that is compatible with the surroundings, and it is possible to provide useful information in terms of urban planning. It is especially useful when designing tunnels or bridges between buildings. This information can also be integrated with location-based services and CAD data to provide users with features with door-to-door navigation capabilities. In particular, it can be applied to emergency rescue services to find a building with a patient in the event of an emergency patient, finding the fastest optimal route in the building. In addition, in the event of a national disaster, it can be applied to disaster management services to quickly analyze the capacity of each building in the city to establish an optimal preparedness strategy. In the future, 3D-GIS technology is expected to evolve to reflect a variety of technical characteristics, such as the addition of expansion/time concepts for u-city deployment, expansion into the interior space, and main memory-based/hybrid-based systems. In order to implement GIS/CAD data integration and linkage technology based on 2D map data entry and operation technology, hardware characteristics with the following advanced features are required[6][7]:

- Geotiff DEM/Generic Binary/ASCII terrain data format function and topographic data processing function capable of processing 200×200m(7200×7200 vertex) area by estimating 30m-class DEM when using main memory 1GB.
- Image processing function with swapping function that can process 130GB of images based on image format using commercialization format such as Geotiff/RGB Binary/RS tool and 1m-class IKONOS satellite image.
- Facility data processing function capable of processing objects of 50-1 million Vertex or more.

4. Analysis of Cloud-GIS marketability

4.1 LBS Analysis of Platform marketability

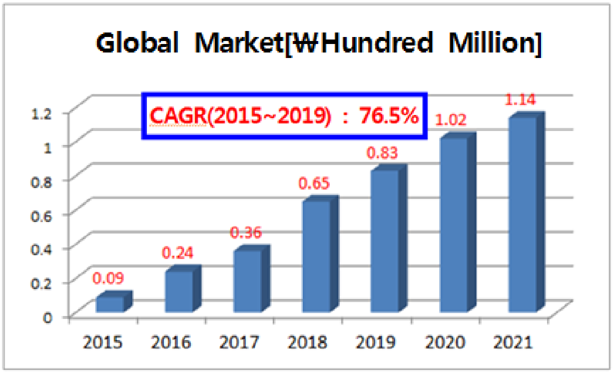
The capital investment market for the cloud GIS industry is a rapidly expanding service focused on location information linkage, thanks to the launch of smart phones with GPS capabilities from around 2010, expansion of the lateral system, and liberalization of networks platforms. The global market size of the LBS platform is expected to form a large market of 9 million dollars in 2015 and 114 million dollars in 2021 from 65 million dollars in 2018[6][7][8][9]. (CAGR(2015~2021) 76.5% altitude growth) (See table 1)

Table1 : Growth Trend in Domestic and Global LBS Platform Market

	2018	2019	2020	2021	CAGR [%]
Domestic Market [₩Hundred Million]	226.2	301.5	383.8	449.0	48.9
Global Market [$Hundred Million]	0.65	0.83	1.02	1.14	76.5
Total	226	302	384.82	450.14	62.70 (Ave.)

TEST Engineering & Management

November-December 2019
ISSN: 0193-4120 Page No. 2421 - 2427



* Source : Sang-jun Park et al.(Dec. 2018), KIAT(2017), technavio insights(2018) / re-composition.

4.2 Expected effects

By visualizing the location information of a large variety of 3D map data, there is an effect that can derive valuable insights. There is an effect that can be used to provide a targeted for large amounts of public data through selective data services that facilitate data utilization. In particular, there is an effect that anyone can easily utilize the spatial data and fuse without going through the pre-treatment and rework process. In addition, VR/AR/MR(Virtual Reality/Augmented Reality/Mixed Reality) can provide a service to meet the needs of consumers through a variety of experiences, such as[8]. This will enable you to build a customized cloud GIS environment that takes into account the data characteristics and utilization environment. These cloud GIS technologies are land information systems and land aptitude assessments, urban planning information systems, rural area development space information, urban regeneration strategy and revitalization plan, urban regeneration comprehensive information system, land space planning support system, park green management system, urban information system, urban planning engineering, street lamp management system, development act permission management system, shared property survey management, etc. are being utilized in a wide variety of fields for smart city constructions[10][11]

5. Technology Development Strategy of Cloud-GIS

5.1 Technology Development Direction

Korea launched 5G mobile communication commercial service in April 2019. Based on this, the company plans to build the world's first 1Gbps wireless network, a 10Gbps wired network, and a 10Gbps IoT network by 2020. We have established the "K-ICT Super-Connected Intelligence Network Development Strategy", which contains these details, and decided to build the world's first ultra-connected intelligence network by 2020[10][11]. Cloud-GIS technology is essential to building this ultra-connected intelligence network. m-GIS technology development direction can be divided into spatial information acquisition and construction field, space information management and convergence field, space information utilization and service field[8]. (See Table 2)

Table 2: Technology Development Direction of Cloud-GIS

	Technology Development Direction
Acquisition of spatial information and deployment	- Developing effective and efficient spatial information building, renewal, and automation technology - Securing high value-added information fusion and processing technology
Spatial information management and convergence	- Homeland information of each social sector/real-time data - Securing data-automatically convergence technology - Real-time information integration and convergence technology based on spatial information
Utilizing spatial information and service sectors	- Guidance service utilizing convergence space information for public, corporate, and public - Development of application technologies, visualization of guidance services - Indoor and outdoor real-time positioning/Geo-fencing/AI-based customization - Space information automatic recommendation rider (LBS for wearable devices, etc.) - Collecting/ judgment/forecasting information for decision-making by public institutions/private enterprises / Recommended services - Multidimensional(3D/4D) map with multi-scopic display(hologram) development of visualization technology

* Source : Dong-hoon Jeong(31 December 2017) / re-composition.

These steps can be accessed by separating ⅰ)he data of reality, ⅱ)the information of the data, ⅲ)the service of the information. GIS technology ⅰ)associated with the GIS technologies are the location and posture determination/space observation sensor, ⅱ)associated with the GIS technologies are the space data fusion/spatial data analysis, iii)associated with the GIS technologies are the reactive and customized contents/intelligent search distribution may be the case[10].

5.2 Cloud-GIS Technology Development Road-map

Short-term(2015~2025) Cloud-GIS technology development TRM(Technical Road Map) is Table 3. Based on this technology development road-map, a strategy is needed to revitalize the cloud-GIS technology market[9][12][13].

Table 3 : Cloud-GIS Technology Development Road-map_2015~2025

	2015~2025
Acquisition and Build	- Miniaturization and weight of digital measurement technology (Total Station/LiDAR, etc.) - Detection and analysis of satellite/aerial photography-based indicators - Ground/Underground/Indoor 3D modeling - Precision road map construction and renewal (Driverless cars/traffic weak, etc.) - GNSS, Network-RTK, SBAS - Participatory spatial information platform, etc.
Convergence and Management	- Cloud computing technology - Big Data Analysis Technology - AI-based spatial statistics and spatial analysis - Policy Maps, Space Infographics - Building and modernizing personal spatial information systems, etc.
Utilization and Service	- Multimodal Route Guide (Pedestrian/public transport/car). - Diversification of location-based SNS and O2O services (Taxis, rental cars, accommodation, etc.) - VR and AR spatial information visualization - BI technology based on spatial information, etc.(g-CRM, etc.)

※ *The period was set from 2015 to 2025, since the domestic GIS construction project, which is the basis of the m-GIS industry, which has been promoted mainly by the Ministry of Land, Infrastructure and Maritime Affairs, was carried out from 1995 to 2015, and the road-map has been presented since then.*

* Source : Korea Research Institute for Human Settlements(2017), National Information Society Agency(2018), UN-GGIM(2018) / re-composition.

5.3 How to Apply by Smart-phone Platform

In order to effectively apply LiDAR image visualization technology and GIS/CAD data integration and linkage technology based on the above m-GIS technology development road map to a variety of smart phone platforms requires large-capacity topographic processing algorithms, large-capacity image processing algorithms and facility data processing technology [6][7][14][15][16]:

- Using a large-capacity geospatial processing algorithm capable of processing large-capacity terrain information USGS(United States Geological Survey-DEM: U.S. Geological Survey-numerical figure) based on 64 sheet(7200×7200 vertex) scale as a large-capacity terrain data processing function capable of real-time processing every 15minutes there is a feature that can remove unnecessary altitude data and represent a wider area.
- Large-capacity image processing algorithm applies texture compression techniques to enable the display in a smaller memory area through conventional image compressor method and other graphics hardware in the compressed image restoration process. In addition, there is a feature that can represent a wider area of the image of a larger area only by applying a swapping processing technology to quickly find the image area to be represented on the current screen from the large amount of image data.
- Facility data processing technology is a step of 3D map data production is completed as a technique expressed by mapping to a real value on top of the 3D satellite image using the data produced by the modeling software for the designer, such as 3D-Studio.

In order to effectively build 3D-GIS using the visualization completed 3D map data, visual effects function, 3D-Author and 3D-Scene Builder function, 3D-Scene Builder function, user interface function using 3D coordinates(keyboard/mouse/joystick, etc.), the property information of the captured object is required for data information representation technology, such as the object property information expression technology displayed on the 3D screen in Korean and English. Data pre-processing tools include 3D-author and 3D-scene builder that can easily use the macro 3D representation using 3D facilities. In addition, the software required to build a 3D-GIS system by visualizing the 3D LiDAR image requires an API-based graphics development environment, such as Visual C++ and Microsoft DirectX9 with real-time 3D rendering processing that can show immediate response according to the user operation. These data pre-treatment tools provide a visual service to express 3D images such as clouds, fog, sea level, and light sources in a more natural image. 3D map data application examples include real-time aerial view design and 3D viewing system, road network design and simulation.

5.4 Policy proposals

Billions of mobile/smart devices equipped with sensors are connected to the Internet and are developing into a hyper-connected society that shares information with anyone(including objects), anytime, anywhere. IoT technology is driving the fourth industrial revolution, bringing about changes in economic, social, cultural, and lifestyle. Accordingly, the government needs to develop the following policies and strategies to respond to the core(source) technology and infrastructure environment required by a super-connected society and promote research and development and investment projects at the national level[1]:

- It is necessary to dramatically improve the precision and accuracy of the location and space(geography) information connecting the device/object/person/place.
- It is necessary to build 3D spatial geographical information with an interface that can connect the physical environment and the digital space, such as smart cities.
- Space(geography) information is being shifted from infrastructure-to-infrastructure to utilization center, and it is necessary to establish a close cooperation system as well as establishing a role to meet.
- It is necessary to build a data distribution innovation system that applies linked data technology that can quickly and easily search and utilize the exploding spatial data (public data, big data, etc.).
- It is necessary to focus on creating a close cooperation ecosystem between government departments, public officials, and domestic and foreign companies, between space information and utilization sectors, and ict and spatial information technology.

6. CONCLUSION

The Korea GIS construction project, which is the basis of the Cloud-GIS industry, was divided into major application projects and general application projects at every five-year stage from 1995 to 2015. The main application project is six projects, including which was promoted mainly by the Ministry of Land, Infrastructure and Transport. The project covers local governments throughout the country and is the basis for the prevention of redundant investment and the utilization of spatial information through the initiative of the central government. General application projects were developed in various fields such as underground, water, cultural properties, environment, agriculture, forestry, forestry, marine, and statistics as 27 projects for supporting and administrative services and services based on GIS[17]. With the popularization of smart phones, the GIS construction project as a national period industry has undergone a breakthrough development in the mobile GIS industry. In order to effectively build m-GIS, a five-step technology development methodology for first and foremost 2D map data input and manipulation<*step 1_2D representation stage for 3D terrain analysis, step 2_3D terrain analysis stage, step 3_to visualize the computer graphics analysis results in 3D terrain, step 4_computer graphics and VR(Virtual Reality) to build a variety of 3D virtual cities using technology, step 5_active virtual 3D-GIS terrain and facilities interlocking steps*> it is necessary to materialize it. It is completed through query and analysis technologies. In order to implement this, it must be able to visualize the state-of-the-art aerial survey equipment LiDAR images as 3D map data. m-GIS technology is rapidly becoming popular. Global market size (sales) related to high-precision positioning systems and LBS platforms is expected to form a large market of approximately 114million dollars by 2021[18][19]. Therefore, a specialized strategy is needed for global market advantages in domestic related industries. For example, by identifying the preferences of each smart phone user (age, job, etc.), it is necessary to develop and market strategies optimized for this. In particular, it is necessary to focus on developing a service that can be applied to the recently commercialized 5G smart phones. This will be able to lead the CPND (Contents/Platform/Network/Device) technology of the 5G mobile communication technology market.

Korea's cloud GIS-based spatial information industry is somewhat sluggish in the private sector, with approximately 80% of the public sector including the government and the municipalities, including the production/distribution/utilization of GIS data. Accordingly, the spatial information industry is a situation that does not depart from the public order business. It is therefore necessary to focus on the excavation of new convergence demand, such as strong traffic and construction of spatial properties. In addition, it is necessary to provide a basis for providing the space information of public institutions efficiently to the private sector to enable services for the convenience of private operators, such as portal sites or API(Application Programming Interface). In particular, the lack of

November-December 2019
ISSN: 0193-4120 Page No. 2421 - 2427

standardization to ensure interoperability between spatial information business is insufficient, and the joint use of information, and has become an inhibitory factor in the associated industrial development, such as U-City building. In this case, smart safety, education, defense and culture are necessary measures that can contribute to the revitalization of the services of the people's life[11, 20-21].

REFERENCES

1. Korea Research Institute for Human Settlements, **Human Settlements Brief**, 17 October 2017.
2. ComputerWorld, **GIS in all world**, 31 August 2018.
3. <http://www.comworld.co.kr/news/articleView.html?idxno=49498>
4. Jong-duk Kim et al., **Development and Application of Rada Sensor Technology**, Electronic Communication Trends Analysis Volume 27, Korea Electronics and Telecommunications Research Institute, December 2017.
5. Jae-Jun Yoo, **Trends in Technology and Standardization**
6. **of Indoor Location-Based Services**, Korea Electronics
7. and Telecommunications Research Institute, 2018.
8. **Large-capacity image data 3D visualization solu_3D-TIME**
9. <Three Core, http://www.3gcore.com>
10. 6. Sang-jun Park et al., **Research on Location Information**
11. **Services(LBS) Technology and Market Trends Analysis**, Broadcasting & Communication Convergence Policy
12. Research KCC-2015-(42), Korea Electronics and
13. Telecommunications Research Institute, December 2018.
14. 7. **LBS Technology and Market Trend Research Report**,
15. KIAT, 2017.
16. 8. technavio insights, **Global Indoor LBS Market.** 2015~2019", 2018.
17. 9. technavio insights, **Global LBS Platform Market,** 2015~2019", 2018.
18. 10. https://gractor.tistory.com/entry/
19. 11. Sang-Gug Park, Se-Hwan Park, **IoT-based Smart City Platform Development Trends**, IJCC 2018, AACL11 Proceedings, Jan. 31~Feb. 7. 2018.
20. 12. **Super-Connected Intelligence Network' connects all things to people**(Yonhap News, 28 September 2015.
21. <https://www.yna.co.kr/view/AKR20150925166400017>
22. 13. Dong-hoon Jeong, **Basic Research for the Promotion of The Space Information Industry : 2017 Space Information Industry Status and Outlook,** Korea Land Information Corporation Space Information Research Institute, 31 December 2017.
23. 14. **The Role and Direction of Spatial Information Policy for Location-Based Social Media Activation**, Korea Research Institute for Human Settlements, 2017.
24. 15. **Strategy for Utilizing Spatial Information Services for Smart Social Implementation**, National Information Society Agency, 2018.
25. 16. UN_GGIM, **Future trends in geospatial information management: the five to ten year**, 2nd Edition 2018.
26. 17. Se-Hwan Park, **m-GIS, Fusion Wind Ride Evolves into Industry-based Technology**, HelloT Advanced News, 7 February 2017.
27. <http://www.hellot.net/new_hellot/magazine/magazine_read.html?code=205&sub=006&idx=32917&page=&list=>
28. 18. **Status of LBS Business Escrow and Location-Based Services**, Broadcasting and Telecommunications Commission, 2018.
29. 19. Ministry of Land, Infrastructure and Transport, **National**
30. **GIS-Supported Research Project_National GIS Project Evaluation and Implementation Plan Establishment Research**, 2018, p.57.
31. 20. Bačík, R., Fedorko, R., Abbas, E. W., Rigelský, M., Ivanková, V., & Obšatníková, K. (2019). The impact of selected quality management attributes on the profitability of top hotels in the Visegrad Group countries. Polish Journal of Management Studies, 19 (1), 46-58.
32. 21. Jabarullah, N.H., Razavi, R., Hamid, M.Y., Yousif, Q. A. & Najafi, M. (2019) Potential of Ge-adopted Boron Nitride Nanotube as Catalyst for Sulfur Dioxide Oxidation, Protection of Metals and Physical Chemistry of Surfaces, 55 (4), 671-676.