博士論文

Study on the Evolution of National Spatial Data Infrastructure Development in Indonesia

(インドネシアにおける国家空間データ基盤整備（NSDI）の整備と今後の展開)

タンダン ユリアディ ドゥイ プトラ

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COMMITTEE MEMBERS

Yoshihide SEKIMOTO, Dr. (Chairperson)
Professor, Department of Civil Engineering

Ryosuke SHIBASAKI, Dr.
Professor, Center for Spatial Information Science

Kazumasa OZAWA, Dr.
Professor, Department of Civil Engineering

Wataru TAKEUCHI, Dr.
Professor, Department of Civil Engineering

Toshikazu SETO, Dr.
Project Lecturer, Department of Civil Engineering

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ABSTRACT

The importance of sharing and reusing geographic information for national development programs has led many countries established National Spatial Data Infrastructures (NSDIs) for the past 25 years. Advancement of spatial technology and the Internet have changed the landscape of NSDI. Forthcoming development of SDI will be influenced by the growing use of mobile computing and crowdsourcing, thus lead to the need to integrate various types of data. This means that the aims of an NSDI may not only for sharing and integrating data from static sources but also producing new information. However, the successful of NSDI does not only depends on technical aspect but also agreeing on common policies, standards and institutional frameworks to bring these technologies in to use.

Indonesia is considered as one of the early adopters of the first generation of NSDI. Despite of its early adoption of NSDI concept, geospatial information development in Indonesia still faces some challenges. The main objective of this study is to understand the evolution of NSDI implementation in Indonesia and based on that comprehension develop strategic directions to realize future NSDI. This research is conducted in four major steps that combines both qualitative and quantitative approach. Step two focuses on problems identification of recent NSDI implementation based on the perspectives from participating institutions. The next step is to investigate why do these problems occurred. In the final steps, the results of problems identification and stakeholder analysis are synthesized to produce recommendations for achieving next generation NSDI.

The study found that NSDI in Indonesia has evolved into three periods of time where some changes in identified in the data policy, technological use, and realized user of NSDI. Current NSDI effectively provide data sharing and reduce data duplication but limit their scope into government agencies. The main problems of NSDI implementation in Indonesia are including lack of skilled human resources, low participation of the institutions, and limited availability of large-scale base maps. From the stakeholder analysis, it is evident that the availability of resources influences the level of involvement in NSDI. Furthermore, the force of collaborations among them also affects behavior of the stakeholders. Finally the research concluded by delivering strategic directions in term of institutional, technological, and financial aspects.

Keyword: Spatial Data Infrastructure, NSDI, Stakeholder analysis, Strategic direction

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INTRODUCTION

1.1. Background

The importance of sharing and reusing geographic information for national development programs has led many countries establishing National Spatial Data Infrastructures (NSDIs) for the past 25 years. Basically, an NSDI is a framework of technology, standards, policy and collaboration of different institutions to provide access, exchange and utilization of spatial data at the national level (Rajabifard et al., 2003). From the initial aims to reduce data duplication and improve access to spatial data, NSDI applications nowadays have played important role in the decision making process. Examples can be found in the area of cadastral services (Borzacchiello and Craglia, 2013), disaster risk management (Molina and Bayarri, 2011) and urban planning (Poorazizi et al., 2015).

Since its initial development in the 1990's, NSDI has been evolving into two different generations. The first generation were typically led by national mapping agencies with the main purposes to promote economic development, to stimulate better government and to foster environmental sustainability (Masser, 1999). The second generation focused more on providing service to facilitate data sharing and utilization with the geoportal considered as the key indicator. Subsequently, the next generation of NSDI is expected to be focusing more on fulfilling specific user requirements (Rajabifard et al., 2006).

Advancement of spatial technology and the Internet have changed the landscape of NSDI. Forthcoming development of SDI will be influenced by the growing use of mobile computing and crowdsourcing, thus lead to the need to integrate various types of data (Harvey et al., 2012). Non-traditional data sources, such as local sensor networks and social media feeds can represent better coverage of specific spatial phenomena in almost real time. This means that the aims of an NSDI may not only for sharing and integrating data from static sources but also producing new information and allowing a user to interact directly with the data provider. However, the successful of NSDI does not only depends on technical aspect but also agreeing on common policies, standards and institutional frameworks to bring these technologies in to use (Crompvoets and Bregt, 2007; Diaz et al., 2012). The development of NSDI in each country will be different depending on their objective, resource and capacity.

Indonesia is considered as one of the early adopters of the first generation of NSDI (Masser, 1999). The National Coordinating Agency for Surveying and Mapping (Bakosurtanal)

led the initiative in early 1990's through activities of producing topographic base map and thematic spatial data provided by different government institutions. Its initial objective is to coordinate various Geographic Information System (GIS) data produced by different government agencies and to reduce GIS data duplication among them (Lilywati and Gularso, 2000).

Despite of its early adoption of NSDI concept, geospatial information development in Indonesia still faces some challenges. Scholars identify insufficient skilled personnel and different level of political support from the local authorities (Darmawan et al., 2014). The availability of detailed geospatial data in the form of topographic maps and high-scale urban planning maps is also hampering national development activities (Kompas, 2017). Moreover, ineffective data sharing among government institutions is still happened in public administration processes (Sahroni et al., 2017).

There are several previous studies related to SDI development in Indonesia. For example, Putra (2010) develops a prototype of application for implementing SDI in supporting evacuation plan of Mt. Merapi disaster in Sleman District, Indonesia. In order to portray the status of local government to implement SDI, Sutanta et al. (2014) propose Indonesian SDI Readiness Index that incorporates four aspects of SDI including institutional, technological, human resources, and data. Additionally, several capacity-building activities such as coordination meeting, technical assistance, and cooperation with universities to establish SDI Development Center has been conducted to improve Local SDI (Darmawan et al., 2014). One research about NSDI in Indonesia discussed about the role of the NSDI and Volunteered Geographic Information (VGI) to support spatial planning process (Yudono, 2015). However, No research have been done to investigate the evolution of NSDI development and problems that hamper its implementation. This research aims to fulfill the gap and provide directions for future implementation.

1.2. Research Objectives and Research Questions

The main objective of this study is to understand the evolution of NSDI implementation in Indonesia and based on that comprehension develop strategic directions to realize future NSDI. In order to achieve that, the author determines four main research questions as follows:

- *Research Question 1: How does the development of NSDI in Indonesia?*

  Specific questions:

  - When and how did the NSDI initiative started in Indonesia?
  - What activities have been achieved during that period?

- What are the present status of NSDI development?

- *Research Question 2: What are the problems of NSDI implementation?*
  Specific questions:
  - What are the difficulties faced by public, private and academic institutions?
  - What are their expectations of future NSDI?

- *Research Question 3: Why does the problems happen?*
  Specific questions:
  - What method can be used to analyze the cause of NSDI implementation issues?
  - What is the main cause?

- *Research Question 4: What are the strategic directions for future NSDI implementation?*
  Specific questions:
  - What are the strengths, weaknesses, opportunities, and threats of NSDI development?
  - What directions can be generated based on the research findings?

1.3. Research Methodology

This research is conducted in four major steps that combines both qualitative and quantitative approach. The research questions identified by the background studies were found to be difficult to answer by a single approach. Qualitative research is useful in collecting in-depth opinion from participants through interviews or focus groups discussion whereas quantitative approach provides a suitable process to measure the organizational characteristics and capacities, particularly when a large number of organizational units are being investigated (Dawson, 2002).

The first step is to identify current NSDI implementation in Indonesia. It includes extensive literature review of governmental documents and official reports, legal documents, proceedings of conference, and meeting records. Additionally, a thorough observation to a national geoportal and some public websites were also done to complement findings from literature. The aim of this step is to answer the first research questions by providing a chronological milestones and evolution table of the NSDI development.

Step two focuses on problems identification of recent NSDI implementation based on the perspectives from participating institutions. Semi-structured interviews were used as the method to gather opinion from representatives who work in the government agency, academic institution, and the private sector. Based on the results of interview activities, a fishbone diagram is created to describe the potential causes of NSDI problems.

The next step is to conduct analysis to investigate why do these problems occurred. Stakeholder analysis is utilized since NSDI considered as the complex system where its implementation include dynamic negotiation and arrangement between different actors (Erik de Man, 2006). For collecting data of stakeholders' resource and characteristic, a questionnaire surveys was distributed to the respondents. In addition, this study analyses the cost of NSDI implementation to increase understanding of how the budget is allocated.

In the final steps, the results of problems identification and stakeholder analysis are synthesized to produce recommendations for achieving next generation NSDI. The purpose is to provide detailed strategic directions that can be implemented by NSDI coordinator. The framework of research methodology is illustrated in Figure 1.1.

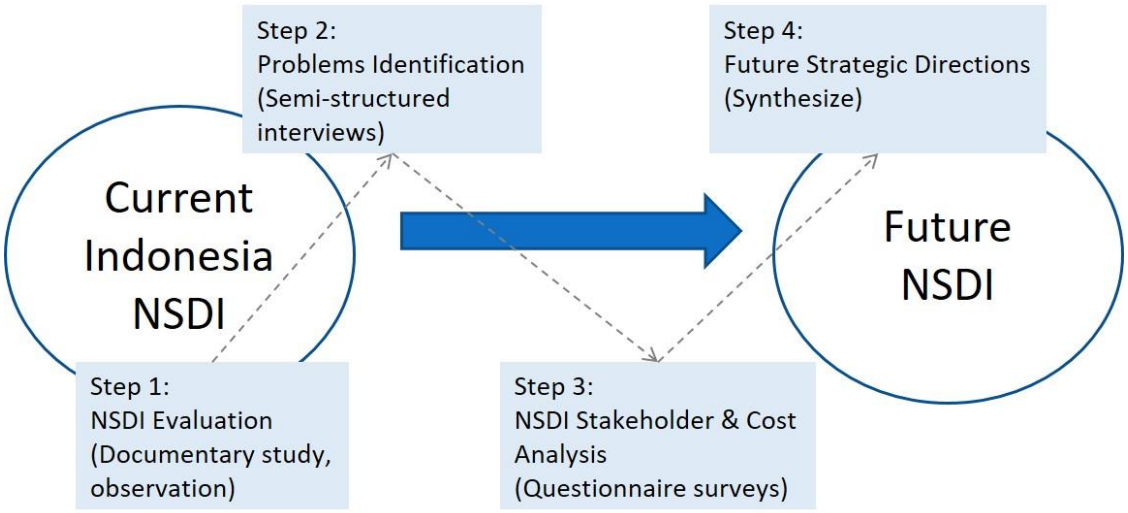


Figure 1.1 Research Framework

1.4. Structure of the Thesis

This thesis consists of six chapters. Chapter 1 provides general overview of the research including research background, research objective, research questions, methodology of the research and organization of the thesis.

In Chapter 2, conceptual theory of Spatial Data Infrastructure (SDI) is reviewed. The chapter introduces a wide variety of SDI definition, SDI development trajectory, and provide general assessment of NSDI development in Asia.

Chapter 3 examines the historical development of NSDI in Indonesia. The milestones concerning legal, organizational and technical aspects are discussed.

In Chapter 4, problem of NSDI implementation from the stakeholders' point of view is identified. Some documentary records and evidence obtained from observation are presented to support the results of interview activities.

Chapter 5 focuses on providing answers to why these problems occurred by utilizing a stakeholder analysis and cost analysis. The general idea of these analyses is explained together with detailed steps, data collection method, and discussion of the results.

Chapter 6 synthesizes the findings from all previous chapters to give recommendation for future NSDI implementation in Indonesia. The author provides a SWOT analysis as the basis for generating strategic directions. These directions are explained in a concrete manner to help NSDI coordinator in applying such deliverables.

Chapter 7 provides summary of the research findings and conclusions. The contribution of the research are described as well as recommendations for future works.

Chapter 2

NSDI THEORY AND PRACTICE

2.1. Concept of Spatial Data Infrastructure

Since the initiative is introduced, many researchers and organizations have been defined the term SDI. With the growing knowledge of geographic information science, the term SDI nowadays is also interchangeably with 'Geospatial Data Infrastructure' or 'Geospatial Information Infrastructure'. Every country that builds SDI may have different definitions depends on the intended purpose. According to Hendriks et al. (2012), the definition varies because at least there are two approaches used in describing SDI, first is by including the SDI components such as technology or human resource and secondly by describing the objective of the SDI initiative. These definitions (presented in Table 2.1) are essential to understand the functional nature of an SDI.

Table 2.1 List of SDI Definitions

No.	Author(s)/Organization	SDI Definition
1.	Executive Order of US President (The White House, 1994)	NSDI means the technology, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve utilization of geospatial data
2.	The Australia New Zealand Land Information Council (ANZLIC, 1996)	NSDI comprises four core components: institutional framework, technical standards, fundamental datasets, and clearing house Networks
3.	Groot and McLaughlin (2000)	Geospatial Data Infrastructure encompasses the networked geospatial databases and data handling facilities, the complex of institutional, organizational, technological, human, and economic resources which interact with one another and underpin the design, implementation, and maintenance of mechanisms facilitating the sharing, access to, and responsible use of geospatial data at an affordable cost for a specific application domain or enterprise
4.	Rajabifard et al. (2003)	Spatial Data Infrastructure (SDI) is an initiative intended to create an environment in which all stakeholders can co-operate with each other and interact with technology, to better achieve their objectives at different political/administrative levels

Table 2.1 (*Continued*)

5.	Global Spatial Data Infrastructure (GSDI) (2004)	The term "Spatial Data Infrastructure" (SDI) is used to denote the relevant base collection of technologies, policies and institutional arrangements that facilitate the availability of and access to spatial data
6.	Commission of the European Communities (2007)	Infrastructure for Spatial Information means metadata, spatial data sets and spatial data services; network services and technologies; agreements on sharing, access and use; and coordination and monitoring mechanisms, processes and procedures, established, operated or made available in accordance with the directive
7.	Van Loenen (2009)	A Geographic Information Infrastructure may be defined as a framework continuously facilitating the efficient and effective generation, dissemination, and use of needed geographic information within a community or between communities

The development of SDIs are ranging from local to state/provincial, national and regional levels. Some nations are also participating in an international initiative to build a global spatial data infrastructure such as GSDI project. Rajabifard et al. (2003) describes the hierarchical nature of SDI which representing interrelations between different administrative/jurisdiction levels. There are two views of this hierarchy, namely the umbrella view, in which the SDI at a higher level encompasses SDI at lower level, and the building block view, in which a lower level of SDI (e.g. state), supports the SDIs at higher levels in the hierarchy (i.e. national, regional level) in term of spatial data needs. Based on the SDI hierarchy (Figure 2.1) decision-makers working at any level can draw on data from other levels, depending on the themes, scales, and coverage of the data required.

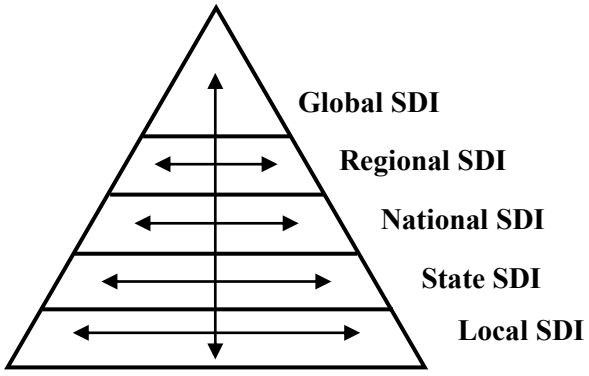


Figure 2.1 Hierarchy of SDI (Adopted from Rajabifard et al. (2003))

We can see from the hierarchy, a National SDI situated in the middle and connects the upper and lower level of SDIs. It has significant role in providing policy or legal foundation for the implementation to the lower level. The National SDI typically defines and collects fundamental data sets from state or local government agencies and integrates them in order to support economic, social or environmental issues. In term of technical standards, a National SDI has direct influence to the upper level by giving feedback on the standards based on the practices from the State and Local SDIs. For that reason, it is not surprising that SDI development begins most from the national level (Masser, 1999).

2.2. Progression of Spatial Data Infrastructure Development

Researchers argued that development of SDI from the time it is introduced have been passed two periods as illustrated in Figure 2.2. Masser (1999) identified the first generation of SDI from eleven nations that have initiated NSDI in early 1990's. They have common motivation to reduce data duplication and using resource more effectively. In this first generation, countries designed and developed SDIs based on their specific national characteristics, requirements, and priorities. The typical stakeholders were mainly government agencies that produce geospatial data with the objective to promote economic development and stimulate better government. The emphasis is more on geospatial data production and collection using centralized system. Creation of large geospatial databases were considered as the main products of this period (Rajabifard et al., 2006).

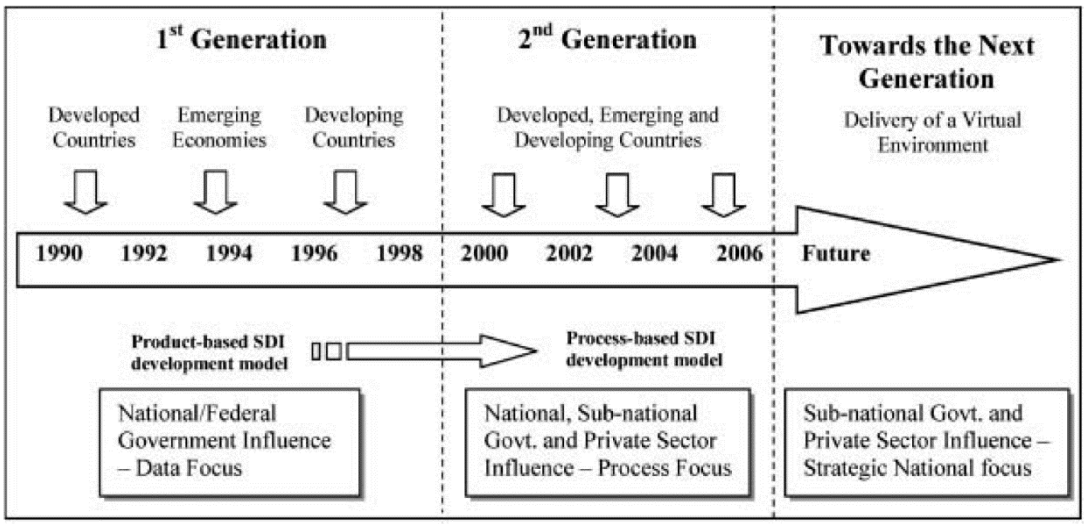


Figure 2.2 Continuum of SDI Development (Rajabifard et al., 2006)

Transitions to the second generation was occurred in 2000 when some of the developed countries realized that the Internet technology has potential in disseminating geographic data

(Masser, 2005). Participants of the SDI were start to understand that information now is available and can be used in multisector area. Therefore, the aim is to provide better communication channels for the community for sharing and using data assets, instead of the linkage to existing databases (Rajabifard et al., 2002). The development model changed from the product-based approach to a more process-based model. This generation focuses in information creation and exchange to fulfill the needs of users. Hence, the existence of Web services and geoportal as the gateway to spatial resources are regarded as the main indicators of the process-based SDI (Crompvoets et al., 2007).

Rajabifard et al. (2006) believed that the next generation of SDI will be driven by a need of a service-oriented infrastructure where citizens and organizations can rely for the provision of specific services. The focus will be on the delivery of a virtual world, which supports decision-making process at community level within a nationwide coverage. Some issues in realizing this concept were mentioned including a clear geospatial information vision of each country (or jurisdiction), sustainable datasets input from both data producers and users, and arrangement of a high degree multilevel stakeholder participation in SDI implementation.

There are a number of other researchers studied about the next generation of SDI. Onsrud et al. (2004) investigates issues related with non-technical aspect and proposes four broad research areas to strengthen the future implementation of NSDI: information policy; access to government geospatial information; economics of information; and integration of geospatial information. De Man (2007) argued that the future SDI will have three characteristics: firstly, SDI with its spatial functionalities may integrated into general information infrastructure, secondly, SDI and other information infrastructures may develop as institutional property of governance and lastly, the implementation likely to be vary at different level of governance due to its diverse awareness and geospatial scope. Moreover, with the increasing use of mobile computing and crowdsourcing, the next generation of SDI will require a capability to integrate various types of data because non-authoritative data sources and location services hold huge potential in new consumer-orientated markets (Harvey et al., 2012).

2.3. Practices of National Spatial Data Infrastructure Development

There are currently many NSDI initiatives established and operating for different political/administrative levels. Although the primary case study for this thesis is Indonesia NSDI, it is important to have a comprehensive understanding of the implementation in other countries by identifying its objective, key components and participating stakeholder. In this section, an assessment of some NSDI practices in Asian region is described, particularly four

nations that were considered as the early adopters of NSDI besides Indonesia: Japan, The Republic of Korea, Malaysia, and Qatar (Masser, 1999). Moreover, the author assess NSDI initiatives of other countries in Asia based on formal documents, publications and observation on their official website.

2.3.1. Japan NSDI

The NSDI development in Japan was introduced by the establishment of a liaison committee of ministries and related agencies concerned with GIS in 1995. The liaison committee was set up in order to manage geospatial information after the Great Kobe Earthquake struck Japan in January 1995 (Murakami, 2008). During the disaster response, GIS was very useful to search best possible route to remove ruins and recovery activities. Having learned the importance of utilizing GIS for emergency operation, the government want to advance its potential use in providing infrastructure information. Several years later, much progress was made on the development of nationwide digital Topographic Maps in 1:25,000 scale and data standards called Japan Profile for Geographic Information Standards (JPGIS), based on the ISO 19100 series standards (Murakami, 2008).

Legal basis for NSDI development in Japan is The Basic Act on the Advancement of Utilizing Geospatial Information (acknowledged as NSDI Act) published in 2007. The vision of this act is to achieve geospatially-enabled society by providing ubiquitous access to geospatial information for all users at any time. The acts identifies two key technologies, GIS and Space-based Positioning, Navigation and Timing which essential for improvement of society and development of the national economy. Capacity building and coordination among relevant institutions are also stated in the NSDI Act. To date, the Government of Japan has the organizational framework for promoting utilization of Geospatial Information under the Cabinet Office, which is assisted by the Geographical Survey Institute (GSI) and the Ministry of Land, Infrastructure, Transport and Tourism (The Government of Japan, 2015).

With the aim to clearly describe the implementation of NSDI in Japan, GSI introduced a concept termed ‘Geospatial Infrastructure’ (Figure 2.3). According to Fujimura (2016), the purpose of Geospatial Infrastructure is to fulfill various needs of geospatial information by using various applications developed by various parties. There are three major components of the operations as follows: Global Navigation Satellite System (GNSS) Continuously Operating Reference Stations (CORS) Infrastructure, Institutional Arrangements, and Web Maps. Other aspects besides the operations such as technology development, human resource development or education although interrelated, are placed outside the concept.

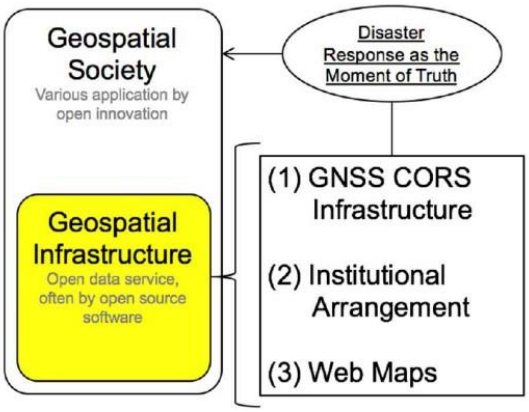


Figure 2.3 Main components of Geospatial Infrastructure (Fujimura, 2016)

The first component, GNSS CORS Infrastructure includes distribution of CORS, its datacenter, and precise position services equipped on the stations (Fujimura, 2016). GSI has established about 1,300 CORS throughout the country of Japan. GNSS CORS observation data are utilized in various areas including surveying and the monitoring of crustal movements. Furthermore, there are 130,000 national control points available (triangulation points, benchmarks and GNSS CORS) used as positioning references for mapping, cadastral investigations, land-use planning, or other purposes (The Government of Japan, 2015).

In term of Earth Observation System (EOS), Japan Aerospace Exploration Agency (JAXA) is the main government agency in charge of space development. JAXA was founded in 2003 after the merger of three governmental aerospace research and development bodies (Nakajima, 2017). Currently, seven Earth Observation Satellites are in operation including Greenhouse Gases Observing Satellite (GOSAT and GOSAT-2), Super Low Altitude Test Satellite (SLATS), Global Precipitation Measurement (GPM), Global Change Observation Mission – Water (GCOM-W), Global Change Observation Mission – Climate (GCOM-C), and Advanced Land Observing Satellite-2 (ALOS-2) (JAXA, 2018). In addition, Japan also has geostationary satellites known as “Himawari” which is operated by the Japan Meteorological Agency to carry out weather observation (Bessho et al., 2016).

The NSDI Act arranges the institutional setting in the development of Geospatial Infrastructure. Geospatial information shall be utilized to improve efficiency and enhance functionality of government administration. The national government has responsibility to comprehensively formulate policies and take measures including legal and financial aspects in promoting utilization of geospatial information. Technical standards to develop Fundamental Geospatial Datasets (FGD) are provided by the national government and when local governments update or revise their maps they should be conformed with the standards (The

Government of Japan, 2007). The local governments utilized FGD in producing thematic maps in their area such as city planning or natural resource management. However, they are not obliged to share these maps to the national government or other institutions (Putra and Shibasaki, 2017).

One of the basic policies of NSDI in Japan is that national government shall facilitate the availability of FGD through the Internet. Presently, there are 10 FGD items maintained by GSI as follows: Geodetic Control Point; Coastline; Administrative Boundary; Road Edge; Railroad Track Centerline; Elevation; Shoreline; Building Outline; Community Boundary; and Street Block Boundary (GSI, 2018). To accomplish this the government released the first version of national geoportal called Digital Japan Web System on July 2003. The aim of Digital Japan is to facilitate user in making and utilizing any kind of geospatial information on the Web. There are three participants who are involved: infrastructure providers, service providers, and service consumers (Fujimura and Ohno, 2006). Subsequent version of Digital Japan was launched in 2013 with the label of GSI Maps (http://maps.gsi.go.jp). Various geospatial information, for example topographic maps, thematic data, and elevation model can be overlaid and shared with the viewer. The portal is also used as the basis of information sharing in disaster emergency response. Moreover, in 2014 GSI has launched the 3D maps that enables users to view any area in Japan and create data for 3D printers (Takakuwa et al., 2014).

2.3.2. The Republic of Korea NSDI

The beginning point for NSDI initiative in the Republic of Korea was the issuance of a Masterplan of National Geographic Information System (NGIS) in 1995 (Han and Cho, 2001; Masser, 1999). The purpose of the NGIS is to develop environmentally reliable land and to promote national competitiveness and productivity. In achieving this goal, four major issues were determined: Establishment of spatial databases, Establishment of data standardization, Assistance of GIS-related technical development, and Development of framework for GIS utilization and application. The implementation of this program was divided into four phases of a five-year period started from 1995-2000 until 2011-2015 (Kim, 2011).

The legal foundation of NSDI implementation in Korea is Act No. 12736 entitled Framework Act on NSDI published on 2014. The new NSDI Act aims to support the development of national economy through the rational use of the national territory and natural resources. To coordinate matters concerning the national data policy, the government established the National Spatial Data Committee under the Ministry of Land, Infrastructure, and Transport. The tasks of the Committee are include formulating a basic plan for the NSDI

implementation every five years and arrange geospatial data distribution. The committee is supported by the National Geographic Information Institute (NGII) in developing NSDI.

Even though it is not specified explicitly in the NSDI Act, seven aspects are considered as the main NSDI components: framework data, metadata and access, standards, technology, human resources, law/institution, and partnership (Kim, 2011). These components become the basis for carrying out NGIS phases mentioned before. Table 2.2 describes some achievements from the three phases that have been conducted.

Table 2.2 Three Phases of Korea NSDI (Kim, 2011)

Component	NGIS Phase 1 (1995-2000)	NGIS Phase 1 (1995-2000)	NGIS Phase 1 (1995-2000)
Data	Creation of digital topographic and cadastral maps	Fundamental data including administrative district, transportation, marine and water resources	National /marine base map, National geodetic control point, national imagery database
Standard	Developments of standard for national base map, standard of underground facility map	Developments of standard for framework, data, distribution and application for NGIS	Re-establishment of framework data standard, modification and supplementation of existing standards
Metadata and access	Pilot project for national spatial clearinghouse	Project for national spatial clearinghouse 70m datasets in 139 categories	Advancement project for management of national spatial clearinghouse
Technology	Mapping technology, database tool, GIS S/W technology	3D GIS, high-resolution RS technology	Intelligent land information based on GIS technology
Human resource	Offline GIS education	Online and offline GIS education, development of educational program and educational textbook	Online and offline GIS education, update of educational program and educational textbook

According to the NSDI Act, fundamental geospatial data in Korea consist of Administrative Boundaries, Transportation, Hydrography, Cadastral Maps, Geodetic Controls, Topographic Maps, Facilities, Satellite imagery & Aerial Photographs. Although digital topographic maps at various scale (1:1,000, 1:5,000, and 1:25,000) are available nationwide, some of other themes are still being built (Kim, 2011). Based on these data, some GIS applications were developed in various domain such as Korea Land Information System (KLIS) and Korea Planning Support Systems (KOPSS).

Korea has established the National Spatial Data Infrastructure Portal (http://www.nsdi.go.kr) in 2016 to distribute and share geospatial data produced by the nation, public, and private sector. This hub of geospatial information has a number of main services including geospatial information search, map services, and open geospatial API. Some examples of the open API are Road Name Address, Architecture Age Information, Land Price Change, Building Information Service, and Land Use Planning Information Service. Moreover, the portal is expected to be able to initiate new industries and expand jobs with geospatial information (Ministry of the Interior, 2016).

In the aspect of standards, there are two levels of standard system adopted for NSDI, Telecommunications Technology Association (TTA) GIS standards and Korean Industrial (KS) GIS standards (Kim, 2011). TTA standards are used at the community level, therefore they are not mandatory. These standards in the beginning developed for distribution of digital map and recently focus more on Framework Data Model and Mobile. Meanwhile, KS standards are for implemented at the national level. Most of them are developed by adoption of ISO 19100 series on geographic information such as metadata, data product specifications, quality principle, etc.

As one of the fundamental geospatial dataset, the Korean government realize the important of establishing EOS to provide satellite images. Korea Aerospace Research Institute (KARI) was founded in 1989 to carry out satellite development and national space program. The satellite development program covers three main areas: science and technology satellites (STAT), low Earth orbit satellites (Korea Multi-Purpose SATellite/KOMPSAT), and geostationary satellites (Communication, Ocean, and Meteorological Satellite/COMS). The high-resolution satellite imagery is produced by the KOMPSAT-series in general and KOMPSAT-2 in particular. Their products are widely applied in land use mapping, change detection, environmental monitoring, and disaster management. Furthermore, KARI has established EOS research groups to support remote sensing applications for addressing socio-economic and environmental problems (H. Kim et al., 2015).

To provide basic position information for national base map and land development, the government established a National Control Point (NCP). It consisted of eight types measurements: Satellite control point (GNSS CORS), Unified control point, Triangle point, Benchmark, Gravity point, Magnetic point, Hydrographic point, and Territorial base point (Kwon, 2012). The NCP is coordinated by NGII. To date, NGII operates 60 GNSS observation stations spread out in about 100,000 square kilometers nationally. They are mainly used for satellite survey support, and NGII services such as network RTK service, online data processing service, and RINEX data (Kim et al., 2017).

2.3.3. Malaysia NSDI

Various Federal and State government agencies in Malaysia have been developing land information system since 1970's. However, they exist as standalone systems, which made the users difficult to access and obtain the data. Based on this situation, the government established the National Infrastructure for Land Information System (NaLis) in 1997 to facilitate data sharing, exchange and use of geospatial information. The NaLis Secretariat was established with the task to conduct development of geospatial data, standards, technologies, regulations, and support for the preparation of the data agencies at all levels of Government (Arshad and Hanifah, 2010; Malaysian Center for Geospatial Data Infrastructure, 2016).

The NaLis Secretariat was replaced by Malaysian Center for Geospatial Data Infrastructure (MaCGDI) in 2012 with the purpose to broaden the utilization of geospatial information for other sectors. MaCGDI is functioned under the Ministry of Natural Resource and Environment, and responsible in developing Malaysia NSDI abbreviated as MyGDI. MaCGDI interacts with MyGDI State Coordinating and Technical Committees, which undertake SDI activities at the State level. Some other government agencies are involved in the implementation, for example the Federal Department of Surveying and Mapping, and Department of Director General of Lands and Mines (World Bank Group, 2017).

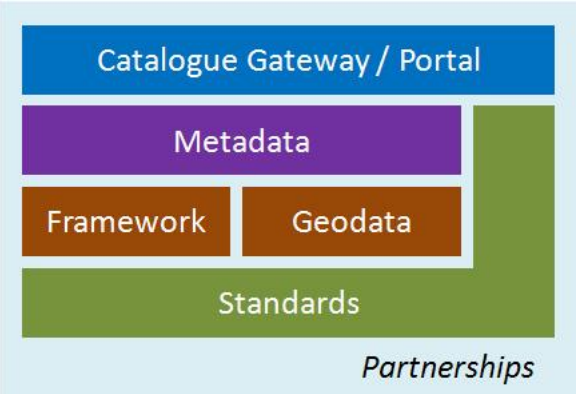


Figure 2.4 Components of MyGDI

There are six components that make up the MyGDI, namely: geodata, framework, metadata, standards, catalogue gateway/portal, and partnership (Malaysian Center for Geospatial Data Infrastructure, 2014a). Geodata refers to a well-defined fundamental geospatial data themes set up mutually among participating stakeholders. Framework emerges as an important reference to eliminate any issues relating to organizational structure, pricing and privacy, which includes policies and institutional set up. Metadata is a description about data in which necessary for identification when distributing geodata between participating

institutions. Standards are important to ensure the reliability and effectiveness of geographic information and services produced by the data providers. The catalogue gateway consists of a distributed network among the producers, managers and users of geospatial information connected electronically, utilizing sophisticated software to facilitate the discovery, evaluation and online access of geospatial data. Partnership is considered as the glue of all other components since the implementation of MyGDI cannot be maintained and operated by a single organization. Figure 2.4 illustrates the six MyGDI components adopted from Malaysian Center for Geospatial Data Infrastructure (2014a).

MaCGDI defines 12 categories as the fundamental data: Aeronautical, Built Environment, Demarcation, Geology, Hydrography, Hypsography, Soil, Transportation, Utility, Vegetation, Special Use and General (Malaysian Center for Geospatial Data Infrastructure, 2014b). These datasets are determined based on high interest and required by many parties to support the design and development of the country. The main reference for the fundamental datasets on features described in the document of Malaysian Standard MS 1759:2015, Geographic Information/Geomatics - Feature and Attribute Codes. MaCGDI also apply three types of geospatial-related standards: contents standards, access standards and exchange standards. Contents standards include land parcel identifier and geographic place names. Whereas access standards adopted from ISO 19100 series and exchange standards related with XML and GML implementation (Malaysian Center for Geospatial Data Infrastructure, 2014c).

The Malaysia Geoportal (https://www.mygeoportal.gov.my) was established in 2010 to provide access for geospatial information services. It allows data producers and users to explore, view, access and evaluate geospatial information through the Metadata Catalogue called MyGDI explorer (World Bank Group, 2017). The portal also provide MyGOS, a platform for government agencies to share their data and publish it into geospatial web services. Moreover, there are other services such as to search geographic names (MyGeoname), to search feature codes and attributes (MS 1759), and MyGeotranslator to help data providers use the geospatial data standards (Malaysian Center for Geospatial Data Infrastructure, 2014d).

Malaysia has established a national agency that arrange the provision of remote sensing in 2008 named Malaysian Remote Sensing Agency (MRSA). The agency, which is coordinated under the Ministry of Energy, Science, Technology, Environment, and Climate Change, aims to develop applications of remote sensing and related technologies for use in agriculture production, natural resources, environment, disaster, security and land development of the country (Malaysian Remote Sensing Agency, 2018). MRSA collaborates with two other

institutions in developing satellite, the National Space Agency (ANGKASA) and Astronautic Technology Sdn Bhd (Geospatial World, 2014). There are two satellites that have been activated, TiungSAT and RazakSAT. TiungSat-1 was launched in 2000 by a join cooperation with United Kingdom and operated for more than 3 years (Subari and Hasan, 2014). It was continued by RazakSAT-1, which was launched in 2009 and operated for about one year. RazakSAT-1 is equipped with a medium-sized aperture camera that has one panchromatic and four multispectral bands. The satellite was mainly used to produce remote sensing data for agriculture, landscape mapping, forestry and urban planning (Ahmad, 2013). The next generation of this satellite is expected to provide not only an operational high resolution imagery but also achieving national space capacity building (Subari and Hasan, 2014).

In the aspect of providing positioning infrastructure, the government has constructed 78 CORS stations managed by the Department of Survey and Mapping (JUPEM). The system which known as Malaysia Real-Time Kinematic GNSS Network (MyRTKnet) offers various services such as Virtual Reference Station (VRS) correction, static correction data, and Differential GPS correction (Jamil et al., 2010). Universiti Teknologi Malaysia (UTM) also established additional CORS network called ISKANDARnet in collaboration with ANGKASA. This network was developed to support high precision GPS applications in urban area, particularly in Peninsular Malaysia. It consists of six CORS stations located in Langkawi, Selangor, Melaka, Kota Bharu, Kuantan, and the main processing center at UTM in Johor Bahru (Yusuf et al., 2014).

2.3.4. Qatar NSDI

Development of NSDI in Qatar was initiated after the government conducted a GIS user need study for the whole country in 1989. The study resulted three recommendations: 1) the need of a national digital mapping database, 2) the necessity to create an integrated GIS, and 3) the requirement to establish a high level GIS national committee to carry out the implementation. One year later, a National GIS Steering Committee and Center for GIS (CGIS) was established. The National GIS Committee coordinated by the Cabinet has the policy and technical responsibility to formulate GIS implementation strategy (Taragi and Balakrishnan, 2003). CGIS is the official geospatial agency and reports to the Ministry of Municipality and Urban Planning. Based on the Emir Decree No. 36/2009, the agency's roles and responsibilities are include providing national topographic database, managing nationwide geodetic network, establishing GIS data access and sharing network, and conducting research development in geographic information fields (Center for Geographic Information Systems, 2018).

CGIS has developed the digital topographic database consisted of four components. First is digital topographic base maps, which is up-to-date and used for making thematic information. Secondly is Digital Elevation Model (DEM) that widely used for generating contours, creating cross sections and three-dimensional terrain. The third component is ortho-imagery produced from aerial photograph that are rectified and reconstructed after removing the distortion. The last component are high-resolution satellite imagery and four directional oblique aerial imagery. To support the database development, a guidance book entitled "National GIS Database Specifications and Data Dictionary – Topographic" was published and distributed to all the government agencies. This specification defines types of data included in the database as well as how it should be structured (Center for Geographic Information Systems, 2018).

The geospatial data sharing between government agencies in Qatar is linked by a high-speed network called GISnet. It connects about 60 agencies and allow user to access all the public GIS data (Hamouda, 2013). CGIS also created a national geoportal (http://geoportal.gisqatar.org.qa/qmape/index.html) to provide users with the tools and information that can be used to publish web maps or build applications. Some examples of the applications are Qatar Area Referencing System, Land Info System, Geo-Statistical Application and Qatar Environmental Map (Center for Geographic Information Systems, 2018).

Related to geodetic network, CGIS maintains approximately 6,000 horizontal control survey monuments and 4,500 vertical control survey stations distributed in the country. The agency defined the Qatar National Datum (QND95) and provided transformation tools for the WGS84 datum. Furthermore, a network of CORS was established to support real-time survey and mapping, emergency, scientific research, automatic machine control system, and precision agriculture system. So far, there are nine GNSS Reference Stations operated all over the country that produce survey class (centimeter level) and mapping class (decimeter level) accuracies (Center for Geographic Information Systems, 2018).

Qatar possess a satellite company named Es'hailSat which is established in 2010 with the aims to provide advanced satellite services to strategic stakeholders and commercial customers (EshailSat, 2018). However, Es'hailSat focuses on communication satellite with the launching of Es'hail-1 that offers broadcasting and broadband telecommunication services. To extend the satellite development, Es'hailSat has signed a cooperation with Qatar Civil Aviation Authority (QCAA) in the aspect of providing satellite service for meteorological department. They decide to create join investment in Earth Observation Satellites and the dissemination of data to stakeholders. The agreement also allows both parties to deliver satellite communications for disaster management activities (Henry, 2016).

2.3.5. Other Asian Countries

According the United Nations Statistics Division, currently there are 50 Asian countries divided into five region: Central Asia, Eastern Asia, South-Eastern Asia, Southern Asia, and Western Asia (Statistics Division United Nations, 2018). World Bank classifies there countries based on their income into four categories: High, Upper-middle, Lower-middle, and Low. This categorization is intended to reflect basic economic country conditions. The basis for the categorization is on Gross National Income (GNI) per capita using US Dollars as the units for measurement. The thresholds are determined at the start of the Bank's fiscal year in July and remain valid for one year later (World Bank Data Team, 2018). As of July 1 2018, the new thresholds for classification by income are described in Table 2.3.

Table 2.3 Thresholds of country classification by income (World Bank Data Team, 2018)

Threshold	GNI/Capita (current US$)
Low income	< 995
Lower-middle income	996 – 3,895
Upper-middle income	3,896 – 12,055
High income	> 12,055

In this section, the author conducted Internet research to know about NSDI initiatives in the Asian region. The objective is to identify NSDI development based on official or formal evidences. There are four main characteristics of NSDI constructed for this assessment as follows:

1) Existence of NSDI policy;
2) Existence of NSDI committee/coordinator;
3) Availability of geospatial data; and
4) Existence of geoportal.

The existence of NSDI policy demonstrates the awareness from top-level management in a country as well as back up for its implementation. The types of policy might be different from each country, whether in the form of act, decree, or guidance. Presence of NSDI committee or coordinator body is essential part for institutional arrangement. Most of the NSDI initiatives started from the national mapping agency as the coordinator. NSDI is about sharing and utilizing geospatial data, hence its availability, topographic and/or thematic is required. The last characteristic is existence of geoportal, which is considered as the key product of NSDI implementation.

The data collection method used is by searching evidences from two main Internet resources at the same time (Figure 2.5). At first, the author determine two well-known search engines used for this purpose: www.google.com and www.yahoo.com. Several keywords for searching were entered such as "(name of the country) + Spatial Data Infrastructure", "(name of the country) + NSDI", and "(name of the country) + Geoportal". Secondly, the author also search for publication or previous study by examining scientific journal database through Web of Science (www.webofknowledge.com) and Google Scholar (https://scholar.google.com). The outputs then validated and analyzed by crosschecking with each nation's official website, whether national mapping agency, survey department or other related agencies to NSDI development. Documentary archives found for the assessment is listed in Appendix 2.

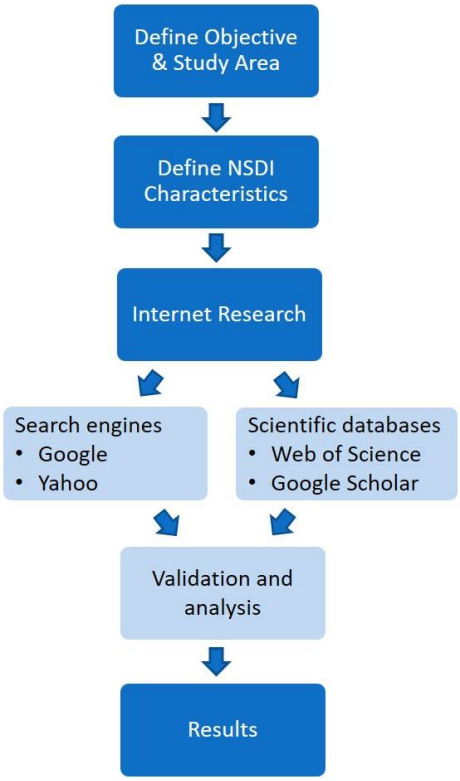


Figure 2.5 Procedure of NSDI assessment using Internet research

The results of NSDI assessment in Asia countries in alphabetical order, excluding Indonesia, Japan, the Republic of Korea, Malaysia, and Qatar is presented in Appendix 1. It shows that from 45 other Asian countries more than half of these nations have been developing NSDI, which is indicated from the presence of the indicators. About 49% of them (22 countries) possess NSDI policy, coordinating body, geospatial data, and national geoportal, whereas four countries (9%) have the policy, coordinator, and data but without a geoportal. Geospatial data availability and geoportal were identified in six countries as well as two countries were

recognized to have only geospatial data, even though they have not established NSDI law and institutionalization. For this case, most of the data is published by the government agency other than the national mapping agency such as Real Estate Cadaster Committee (Armenia), Central Statistical Bureau (Kuwait), or the State Agency for Geology and Mineral Resources (Kyrgyzstan). Meanwhile, there are 11 Asian nations (24%) that seem do not have NSDI initiative as listed: Azerbaijan, Cambodia, Iraq, Democratic People's Republic of Korea, Lebanon, Syria, State of Palestine, Timor-Leste, Turkmenistan, and Yemen.

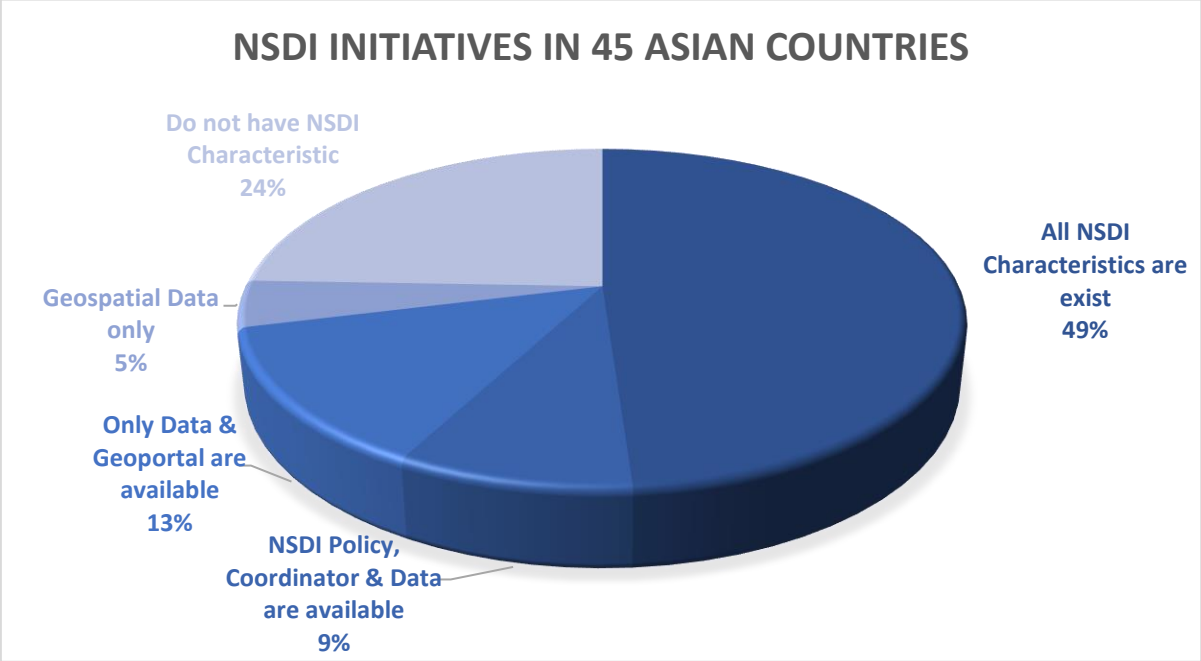


Figure 2.6 Overview of NSDI initiatives in 45 Asian Countries

From the 22 countries that have all the characteristics, 10 of them are High-income countries: Bahrain, Brunei Darussalam, Cyprus, Hong Kong, Israel, Macao, Oman, Saudi Arabia, Singapore, and United Arab Emirates (UAE). Only one High-income country was indicated as not implementing the NSDI, namely Kuwait. Although Kuwait was observed had a geoportal for displaying geospatial data, there is no clear evidence of NSDI development. Kuwait's geoportal is managed by the Central Statistical Bureau and provide socio-economic census 2011 data displayed based on the administrative boundary (Central Statistical Bureau of Kuwait, 2018). Four Upper-middle income countries that have full NSDI characteristics are China, Maldives, Thailand, and Turkey whereas the six Lower-middle countries in this category include Bhutan, Georgia, India, Lao PDR, Philippines, and Sri Lanka. Interestingly, there are two Low-income nations identified, Afghanistan and Nepal. Thus, it can be considered that the economical level of one country does not closely influence NSDI initiatives, although

economical support is essential to sustain the implementation. The complete list of Asian Countries (except Indonesia, Japan, the Republic of Korea, Malaysia, and Qatar) with their status of NSDI characteristics as the results of the assessment is described in Table 2.4.

Table 2.4 List of Asian Countries* with their NSDI status

NSDI Characteristics	World Bank Country Classification			
	High Income	**Upper-Middle Income**	**Lower-Middle Income**	**Low Income**
Existence of: • **NSDI Policy** • **Coordinating Body** • **Geospatial Data** • **Geoportal**	Bahrain, Brunei Darussalam, Cyprus, Hong Kong, Israel, Macao, Oman, Saudi Arabia, Singapore, UAE	China, Maldives, Thailand, Turkey	Bhutan, Georgia, India, Lao PDR, Philippines, Sri Lanka	Afghanistan, Nepal
• **NSDI Policy** • **Coordinating Body** • **Geospatial Data**	-	Iran	Mongolia, Pakistan, Vietnam	-
• **Geospatial Data** • **Geoportal**	Kuwait	Armenia, Kazakhstan	Bangladesh, Kyrgyzstan	Tajikistan
• **Geospatial Data**	-	Jordan	Myanmar	-
Do Not Have NSDI Characteristic	-	Azerbaijan, Iraq, Lebanon, Turkmenistan	Cambodia, Timor-Leste, Uzbekistan	Korea DPR, Syria, State of Palestine, Yemen

* *(not including Indonesia, Japan, the Republic of Korea, Malaysia, and Qatar)*

In the next paragraphs, brief explanation of each country are presented based on the observation of NSDI characteristics. The review starts from the group of High-income countries that possess all the indicators.

A Government Decree initiated Bahrain Spatial Data Infrastructure (BSDI) in 2005, followed with the establishment of the National GIS Steering Committee. The aim is to create an information highway and facilitate smooth transaction and integration of sophisticated geospatial data sets among the stakeholders of government and private sectors as well as other GIS role players in the Kingdom of Bahrain (Central Informatics Organization, 2018a). In order to realize that, some achievements have been conducted by the committee. The national geoportal, named BSDI Portal, was launched in 2005 to display national GIS database that contains important information such as street centerlines, addresses, utilities, and facilities.

Recently, supported by the Central Informatics Organization, BSDI Portal is updated to deliver more than 290 datasets and involved 30 institutions (Central Informatics Organization, 2018b). The National GIS Steering Committee also took the initiative to promote the use of standards for implementing various components of the BSDI. Standards followed by BSDI are officially mandated according to specifications stipulated by international organizations like ISO and Open Geospatial Consortium (OGC). For example Metadata Standard, Spatial Data Accuracy Standard, or Spatial Reference (Central Informatics Organization, 2018c).

The launching of E-Map project in 2007 by The Ministry of Development started the development of NSDI in Brunei Darussalam. It was generated from the awareness of the importance of spatial data in providing services to the country. One year later, the government established Brunei Darussalam Spatial Data Infrastructure (Brunei SDI) with the purpose to enable access, retrieval and dissemination of geospatial data and information in a rapid and secure way. The key features of Brunei SDI include a clearinghouse, a metadata catalogue, and a geospatial warehouse to facilitate the use of fundamental datasets based on national standards (Jamil, 2009). To date, the Survey Department act as the NSDI coordinator and operate a national geoportal that can be accessed by public and registered users (Survey Department, 2018).

Cyprus has a long history in term of NSDI development. The government introduced a program called the National Integrated Land Information System (NILIS) in 1999 with the intention to provide a platform where all governmental agencies with land related activities able to share available (land related) data. The program covers four groups of activities: (a) strengthening and re-computation of the National Grid System; (b) computerization of land records and cadastral planning; (c) development of a Digital Cadastral Data Base (DCDB), a Survey Data Base (SDB) and a Topographical Data Base (TDB); and (d) development of a computerized system for land management (Department of Land and Surveys, 2016). Despite of its geographical location in Asia, in term of implementing NSDI, the government is following direction from Infrastructure for Spatial Information in the European Community (INSPIRE). The country adopted Directive 2007/2/EC of the European Parliament about INSPIRE and issued a National Law No. 43 (I) Year 2010. The Department of Land and Surveys (DLS) under the Ministry of Interior was appointed as the leading organization (Vandenbroucke and Biliouris, 2011). Currently, DLS published a national geoportal that provide various layers, for example: administrative boundary, topographic features, and spatial planning with some Web GIS capabilities such as map viewer, search, print as well as access via web services (Department of Land and Surveys, 2018).

The government of Hong Kong Special Administrative Region (SAR) of the People's Republic of China has objective to build a world-class smart city as specified in the Hong Kong Smart City Blueprint Policy. One of the main strategy to realize that is development of Common Spatial Data Infrastructure (CSDI) by 2023 to facilitate sharing of geo-spatial data across government departments and government-to-business (G2B) applications, including the launch of CSDI portal, 3D digital map, and electronic submission hub for building plans (Innovation and Technology Bureau, 2017). The Survey and Mapping Office (SMO) of the Lands Department is the central authority for land surveys and all types of mapping in Hong Kong. SMO has responsibilities in establishing a comprehensive set of digital map in different scales as well as maintaining geodetic network and land surveys (Survey and Mapping Office, 2012). The office also operates GeoInfo Map, a geospatial portal where users can search, explore, and download various thematic data. However, SMO is not the only agency that produce GIS data. According to a recent report, many government institutions and private sector entities use spatial data to support their daily business and some have developed their own geographic information systems (GIS). These GIS often store spatial data in different standards, definitions, formats with different updating cycles and/or with different levels of completeness and precision (PricewaterhouseCoopers, 2017). The government has realized the difficulty of this information silos, hence the CSDI is initiated to address the full potential of geospatial information for smart city.

Development of NSDI in Israel began with the establishment of inter-ministerial committee for GIS in 1997 formed by a Prime-Minister order. The initial objective was to promote the use of GIS data in the national level and encourage data sharing (Srebro et al., 2010). The committee is managed by Survey of Israel, the national mapping agency that has responsibility in establishing national infrastructure for mapping, geodesy, cadaster, and geoinformation fields. Survey of Israel collaborates with other agencies like Central Bureau of Statistics, Ministry of Interior, Ministry of Construction and Housing, as well as public organizations. Since then several project had been accomplished such as adoption of ISO 19115 metadata, creation of national spatial database, establishment of a national geoportal, and publication of the New Atlas of Israel (Srebro, 2011). Today, the government published GovMap, which is a gateway of geospatial data owned by government agencies and can be accessed publicly (Survey of Israel, 2018).

The utilization of GIS technology by government departments and bureau was considered as the starting point of geoinformation development in Macao SAR. The Cartography and Cadaster Bureau (DSCC - Direcção dos Serviços de Cartografia e Cadastro) initiated the

process with the making of digital base map and cadaster database in 1996. Two years later, DSCC collaborated with Environmental Council to develop a web-based GIS system for providing weather information, air and water quality indexes. Another project was established in 2003 when DSCC launched "Macao GeoGuide" that had map navigation and geographic feature searching functions (Man and Gracias, 2003). At the moment, the government operating national geoportal where users can search various thematic data from government and Macao online map as the map viewer application to explore geographical features like POI, transportation routes or demographics (DSCC, 2018).

Oman is one of the nations that had a clear vision about NSDI development with the issuance of the Royal Decree No. 40/2014. The decree mandated the National Center for Statistics and Information (NCSI) to establish a framework for geospatial standards, policies, institutional arrangements, and technology infrastructure necessary to coordinate, facilitate, and support the sharing and utilization of geospatial Information across multiple government organizations in the Sultanate of Oman (National Center for Statistics and Information, 2017). To implement Oman NSDI, the NCSI has arranged governing body consist of three tiers namely Steering Committee, Technical Executive Committee and Technical Working Groups. The Steering Committee formulates NSDI goals, strategies, policies and coordination with national policies and programs. It is composed from the top leader of major geospatial data producer or consumer at undersecretary level. Technical Executive Committee acts as the technical advisory board for reviewing technical standards, policies and provides intergovernmental arrangement. The member include Heads of GIS units in the major government stakeholders. Lastly, the Technical Working Groups are formed based on geospatial technical experts from key concerned stakeholder organizations with a role to advise the Executive Committe and facilitate the implementation of Oman NSDI (National Center for Statistics and Information, 2018). Besides strengthening the institutional aspect, some projects of data and application development have been reached. The government developed integrated national basemap from 50 cm resolution aerial photos in which fundamental layers such as topographic features, hydrological data, building, and DEM are displayed. NCSI also launched a GeoPlatform that enables user to search, view, and download geospatial datasets. Additionally, various web services were created to be used in different applications like Oman Explorer, Tour Oman, or Government Service Locator (National Center for Statistics and Information, 2017).

Resolution of Council of Minister No. 388 Year 2009 stipulates NSDI initiative in Saudi Arabia. It determined the National GIS Committee as the leading coordinator with responsibilities include establishing vision, mission, strategic planning of NSDI as well as

arranging policies and institutional frameworks (Deputy Chairman of KSA Council of Ministers, 2009). The committee's secretariat operated by General Commission of Survey (GSC) as the national mapping agency. GSC provides fundamental data themes consist of topographic maps, geodetic network, and hydrographic charts used as references by other agencies (General Commission for Survey, 2018a). As part of the NSDI implementation, GSC encourage the use of geospatial standards to achieve interoperability, which will allow easy connection of systems and the exchange of data. Recently, at least there are seven national standards and 45 international standards proposed to be adopted (General Commission for Survey, 2018b). In term of data dissemination, GSC has published a national geoportal that can be accessed by citizens, government agency or professional to explore topographic maps. The geoportal divided into standard and advance version with differences mainly on editing capabilities and uploading/downloading multiple data formats (General Commission for Survey, 2018c).

Singapore is one of the countries that has a high concern on the use of geospatial information and technology. The government launched Singapore Geospatial Collaborative Environment (SG-SPACE) in 2008 to realize NSDI implementation. SG-SPACE aims to provide a mechanism of interoperable, organized, and authoritative geospatial information for national level decision-making with its vision "Towards a spatially enabled nation". The Singapore Land Authority (SLA) and the Info-communications Development Authority of Singapore (IDA) lead the initiative. SG-SPACE based on building blocks classified as the six "M"s called Mandate, Money, Method, Medium, Materials, and Manpower. Mandate is related with institutional arrangements guided by a number of principal committees from multi-agencies. Money means sustainable funding and the government has allocated regular budget to develop and promote NSDI. Material refers to data availability in which SLA develop and maintain a large-scale 3D national topographic map. To implement the NSDI, the government considered standards and fundamental datasets as the method that is essential to be adopted. Two types of medium to deliver geospatial information have been created. Firstly, GeoSpace, introduced in 2011, a national clearinghouse where government agencies able to share data from the various data hubs, discover and use data for planning, analysis, operations, decision making or public service delivery. Secondly is OneMap, which launched in 2010, an integrated map system that enables public users to explore many thematic data, location-based services and applications (SG-SPACE Secretariat, 2012). Recently, the government re-conceptualizes SG SPACE into Geospatial Singapore (GeospatialSG) to reflects the importance of geospatial information and technology in supporting and realizing Singapore's Smart Nation objectives.

GeospatialSG is based on three main pillars: Thriving GeoIndustry, Nation of GeoEmpowered People, and GeoSmart Government. Some new projects have been conducted to implement these pillars including the New OneMap, GeoWorks, and Virtual Singapore (Singapore Land Authority, 2018).

The last High-income country in Asia that was identified have all the characteristics is United Arab Emirates. NSDI initiative was started in the capital by the program Abu Dhabi Spatial Data Infrastructure (AD-SDI) since 2004 (Jayaraman et al., 2012). It is administered within the Abu Dhabi Smart Solutions & Services Authority (ADSSSA) Digital Government program to facilitate the sharing of geospatial data among government agencies and other stakeholders (Abu Dhabi Government, 2018a). The vision is to become a GeoSmart government driven by innovative geospatial thinking and services to empower the Emirate's goal. At present, the stakeholders of AD-SDI are comprised from local and federal government entities, government companies, and non-profit organizations (Abu Dhabi Government, 2018b). A number of strategies have been defined in the official website such as GeoSmart Services, Geo Innovation, Effective SDI Node, Strong Community, and Enhance Outreach (Abu Dhabi Government, 2018a). Additionally, a geoportal is established to provide a single point of access for geospatial information across the entire AD-SDI community. It provides map viewer of topographic maps, environmental data, facilities, spatial planning, and satellite imagery as well as capability to search geographic features and metadata (The Abu Dhabi Systems and Information Centre, 2011).

There are four Upper-middle income countries that was observed have all the NSDI indicators: China, Maldives, Thailand and Turkey. The driving forces of NSDI initiative in China are the rapid increase in social demand for geospatial data and the fast development and popularization of high technology and new technologies, such as Remote Sensing, GPS, and GIS (Chen and Chen, 2003). National Geographic Information Coordinating Council was established in October 1997 to accelerate China's NSDI development and promote geospatial information sharing. The council name then was changed to National Geospatial Information Coordinating Council (NGICC) in April 2000 with the main tasks to coordinate NSDI development, promote fundamental natural resources and create geospatial information database. NGICC involves 21 ministerial departments and hosted by the Department of Regional Economy, National Development and Reform Commission (National Administration of Surveying, Mapping and Geoinformation of China, 2012). China NSDI consists of five components: policy, laws and standards; institution and coordination; geospatial framework datasets; catalog and clearinghouse; and public service systems (Li et al., 2008). Major

achievements in the NSDI implementation have been realized. For example the National Fundamental Geographic Information System that contains nationwide basic geographic data at multiple scales including control points, water systems, residential areas, transportation, boundary, and topographic features. In the aspect of standardization, the government had published 230 surveying & mapping geographic information standards, including 110 national standards and 120 industrial standards (National Administration of Surveying, Mapping and Geoinformation of China, 2013). China also known for their Navigation Satellite System called "Beidou". The country had launched "ZY-3" surveying and mapping satellite in 2012 that provides a numerous imagery covering China and across the world (National Administration of Surveying, Mapping and Geoinformation of China, 2012). Moreover, a national geoportal name The Map World is established since 2011. It integrates geographic information resources such as the nationwide 1:250k public map data, navigation electronic map data, and various resolution remote sensing image in over 300 cities. It allows user to access the national directory service system of surveying and mapping results, relevant thematic geographic information service websites as well as provincial GIS servers (National Administration of Surveying, Mapping and Geoinformation of China, 2013).

Maldives is one of the nations with geographically dispersed islands located in the Indian Ocean. In order to manage all the natural resources including land within the country, the government established Land and Survey Authority (LSA) in 2011. LSA is mandated to establish a National Geographic Information System and Land Information System. The agency also has responsibility in managing land registry and publishing official Atlas of Maldives (Shanna and Aniya, 2017). The National GIS framework was initiated in 2008 through Maldives Environmental Management Project (MEMP) funded by the World Bank. It was designed to assist individual government departments to connect, store and analyze various data sources including spatial, economic, environmental and social data (Ministry of Housing, Transport and Environtment, 2010). Most of the geospatial data is collected by LSA and the national basemap was published in 2008 then updated in 2015 (Shanna and Aniya, 2017). LSA also has published an integrated map system called "OneMap" to provide location based service to the government agencies and public user (Land and Survey Authority, 2018). However, when the author tried to access the geoportal, it requires permission (username and password) and unable to be opened. Despite of the National GIS is being implemented, use of remote sensing and GIS to control, plan and monitor land use change is not being used. Shanna and Aniya (2017), argued that the National GIS hasn't been fully implemented and there is a challenges in the aspect of trained staff in the use of remote sensing tools or GIS technology.

NSDI development in Thailand was started in 2003 with the establishment of the National Geographic Information Committee (NGIC) appointed by the Prime Minister's Office Order. At that time, Geo-Information and Space Technology Development Agency (GISTDA) operate the secretariat of NGIC (Geo-Information and Space Technology Development Agency, 2018a). The NGIC's main tasks are include formulating an NSDI Masterplan, managing fundamental geographic dataset, and establishing a national clearinghouse. NGIC published the first NSDI Masterplan for five years period (2011-2015) with several accomplishments are being established such as 14 national standards in the field of geographic information, 13 layers of geospatial fundamental dataset, and ThaiSDI, representation of the national geospatial data clearinghouse which was launched in 2012 (Meeprom and Nualchawee, 2016). To continue NSDI implementation, the government has published new NGIC structure in 2015 where the NGIC Chairman is the Prime Minister and the NGIC Secretary is the Minister of Science and Technology. NGIC has issued the National Geoinformatics Masterplan (2017-2021), which consists of four strategies: 1) improvement of laws and regulation in the geospatial landscape; 2) establishment of government geospatial data and service center; 3) development of web portal to provide geospatial data to public; and 4) improvement of human capacity in geospatial technology (Chuentragun and Chuthamart, 2016). One of the key products planned to be achieved is National Geoinformatics Infrastructure System (NGIS) Portal. It will provides fundamental geospatial data and OGC web services, as well facility to discover metadata and edit maps for public users (Chuentragun and Chuthamart, 2016). Current NSDI portal is managed by GISTDA (Geo-Information and Space Technology Development Agency, 2018b) but limited for government users since it requires registration if we want to explore the map viewer or access the service.

The motivation to develop NSDI in Turkey is triggered from the e-Government Transformation Turkey Project issued by the Prime Minister in 2003. One of the action plan in that project (Action Plan 47) mandated the General Directorate of Land Registry and Cadaster to conduct Initial Study for Turkish National Geographic Information System. The initiative is continued in the following years with Action Plan 36 (2005) and Action Plan 75 (2006) aimed to determine the concept of the geographic data and the standards of data exchange, and to create a portal that provides sharing geographic information (Yalcin, 2013). Turkish government then established the General Directorate of GIS under the Ministry of Environment and Urbanization via Government Decree No. 644 in 2011. The General Directorate of GIS has responsibilities to coordinate GIS activities, to produce standards, and to determine main policies and strategies in Turkey. In the same year, it started the projects about "Developing

Turkey National GIS (TUCBS or TRGIS in English) standards" and "Developing Turkey Urban GIS standards'' (Yomralioglu and Aydinoglu, 2014). One of TRGIS implementation is the establishment of the National Geographic Data Geoportal launched in 2014. The geoportal performs basic geographic data functions such as serving spatial data sources, metadata searches, editing metadata, display query results as text and graphics, downloading metadata and geographic data according to user authorization. For the second phase of the Geoportal project, implementation of Transformation Service, E-Commerce functionality and Mobile versions are planned (Directorate General of GIS, 2018).

In the meantime, development of NSDI was also recognized in some of Lower-middle income countries. Bhutan, Georgia, India, Lao PDR, Philippines, and Sri Lanka were considered having all of the indicators.

Initiative for utilizing geoinformation system in Bhutan was taking place by the establishment of the National GIS Coordination Committee (NGISCC) in 2003. The committee is instituted under the National Land Commission Secretariat and consists of 32 members representing government agencies, corporations, institutes and NGOs (National Land Commission Secretariat, 2018). In order to provide legal back up for NSDI development, NGISCC has formulated a draft of Geoinformation Policy in January 2016 with assistance from the Netherlands Government, and then updated version was submitted to the parliament on June 2017. The key objectives of this Geoinformation Policy are including to ensure availability of reliable geoinformation, to enhance data discovery, access, and sharing mechanism, and to promote optimal use of geoinformation technologies (National Land Commission Secretariat, 2017). Besides arranging regulation, the government has developed Bhutan Geoportal in 2014 with the support from United States Agency for International Development (USAID), the National Aeronautics and Space Administration (NASA), and International Centre for Integrated Mountain Development (ICIMOD). Currently, the geoportal delivers 94 geospatial datasets and 8 applications from various themes such as administrative boundary, road network, and land use (Centre for GIS Coordination, 2018). The government continue effort of NSDI development with a project supported by Japan International Cooperation Agency (JICA). The two-year project started in 2015 is focusing on three outputs: 1) creation of 1:25,000 digital topographic maps, 2) technology transfer to National Land Commission in the production of 1:25,000 digital topographic mapping, and 3) formulation of NSDI framework based on the model case of 1:25,000 digital topographic mapping (Japan International Cooperation Agency and Pasco Cooperation, 2017).

Georgia initiates NSDI development by a Government Resolution Number 262 published on October 2013. According to the resolution, National Agency of Public Registry was appointed as the NSDI Coordinator with the function to support NSDI activities, provide technical assistance, define strategy, plan implementation methods, and carry out activity related to establishment of National Standards of spatial data and metadata (National Agency of Public Registry, 2018a). Although Georgia specified as one of the Western Asian countries, its NSDI framework is adopting direction from INSPIRE. The country followed five implementing rules related to NSDI based on the Directive 2007/2/EC: Metadata, Functional compatibility of spatial data sets with services, Network services, Data and sharing policy, and Coordinating, monitoring and reporting measures. Moreover, the government established cooperation with Eurogeographics to produce European Global Map and European Regional Map, as well as standardization of spatial data (Meskhidze, 2015). In term of geospatial data provision, the national basemap has been developed which include transport network, settlements and buildings, hydrography, vegetation and POI data (Khardziani, 2017). A national geoportal is published to present a main point of data access and information sharing. It provides description of the NSDI project conducted in Georgia such as its structure, standards, metadata, and services (National Agency of Public Registry, 2018b).

The importance of sharing geospatial data and its applications is the main consideration behind NSDI initiative in India. The government constituted a Task Force with Surveyor General of India as the Chairman in October 2000 to prepare strategy of NSDI development. The action plan was formulated in an International Workshop organized by the Department of Science and Technology in 2001 and discussed by the participants from government officers, academia, industry, and international experts (Department of Science and Technology, 2018a). The purpose of India NSDI is for acquiring, processing, storing, distributing, and improving utilization of spatial data generated by various institutions. To realize this, the government published a resolution entitled Constitution of NSDI in 2006. It specifies the establishment of National Spatial Data Committee (NSDC) lead by the Minister of Science and Technology and consists of members from government agencies. NSDC act as the top national authority for formulation and implementation of appropriate policies, strategies and programs for the establishment, operation, and management of NSDI as well as any other activities related to spatial data in the country. The NSDC is supported by NSDI Executive Committee that undertake any implementing and executive functions on behalf of NSDC including functions to constitute technical, financial, or other subcommittees for NSDI arrangement (Government of India, 2006). The national geoportal was launched in December 2008 with capabilities of

providing OGC compliant web services such as Web Map Service (WMS), Web Feature Service (WFS) and Web Coverage Service (WCS). It also facilitates institutions as the network nodes to uplink their metadata or product catalogue via a secured communication (Department of Science and Technology, 2018b). Despite of its long initiative, India NSDI retains several problems in the institutional aspect. Both the policy and guidelines of the national map policy are silent about partnership process with the major stakeholders as well as duplication of data creation still exists (Singh, 2009).

National Geographic Department (NGD) is considered as the national survey and mapping authority in Lao PDR. NGD has responsibility in the management and the inspection of activities related to surveying, aerial photography and mapping nationwide. During 1998-2003, NGD has received assistance from Finland and Japan for creating digital topographic maps (Janne and Lorkhamyong, 2015). In 2003, the GIS Coordinating Committee was established to coordinate the use and distribution of geographic information since government agencies have their own standards and practices, which are not always coherent (National Geographic Department of Lao PDR, 2015). However, because lack of financial support, the committee was not able to continue its work. With the support from Finnish funded program Strengthening National Geographic Services (SNGS), the committee was re-activated and some geospatial data activities were established in 2010. The SNGS project produced aerial photography (resolution of 0.5 meters) and related orthophoto (in 1:5,000 scale tiles) that covers 2/3 of the country (Janne and Lorkhamyong, 2015). In term of legal support, the government issued a Decree on Surveying, Aerial Photography and Mapping in September 2014. The decree specifies formation of the National GIS Committee under the Ministry of Home Affairs that has duty as the coordinating and informing point for geographic information created by different sectors in government and for further development of that information (National Geographic Department of Lao PDR, 2014). The national geoportal was launched in 2015 to display orthophoto and the seamless map database of NGD that include basemap and DEM (Janne and Lorkhamyong, 2015). Nevertheless, the digital maps are not free. A user have to purchase the data via the NGD website.

Development of NSDI in Philippines (PNSDI) was started through the Interagency Task Force on Geographic Information (IATFGI) created in 1993. The IATFGI lead by the National Mapping and Resource Information Authority (NAMRIA) was primarily tasked to promote and coordinate the efficient development, management, and utilization of geographic information in the country. The effort was continued by developing the PNSDI framework plan with the project from the World Bank Information for Development Program in 2001 (Andres, 2008).

Afterward, NAMRIA updated the document in 2011 by publishing PNSDI Master Plan 2011-2020. The PNSDI vision is to achieve a spatially-enabled nation with a comprehensive and consistent geospatial datasets widely shared for sustainable economic, environment and social development, and management (National Mapping and Resource Information Authority, 2011). To realize it, the PNSDI relies on seven components: 1) Philippine Geoportal, 2) Policies and Standards, 3) Governance Structure, 4) Stakeholders, 5) Infrastructure, 6) Data, and 7) Resources (National Mapping and Resource Information Authority, 2011). The core component of PNSDI is the development of Philippine Geoportal System that initiated in 2011 (National Mapping and Resource Information Authority, 2012). The geoportal provides geospatial data discovery and services published by NAMRIA and other agencies. Up to October 2018 there are 482 layers collected from 83 stakeholders (National Mapping and Resource Information Authority, 2018). Additionally, the geoportal delivers web-mapping applications such as for tourism, routing, disaster management, and infrastructure status reporting that useful for decision-making process.

2.4. Summary

This chapter reviews the concept of NSDI from its variety of definitions and development process. It is clear that NSDI definition is influenced by the initial objective and the components included. NSDI implementation has passed two generations product-based and process-based, although the development will be differ from country to country depends on the resources.

Some NSDI practices in Japan, Korea, Malaysia and Qatar shows that the objective initially is to make geospatial data accessible for government institutions to answer development programs. In order to achieve this, each country have defined their characteristics and at least they include geospatial data, standard, technology, and institutional arrangement. All of them have established NSDI policy as the legal back up for the implementation. The policy is followed by institutional arrangement in which a coordinating body is pointed. The current assessment of NSDI characteristics in Japan, Korea, Malaysia and Qatar is presented in the following table.

Table 2.5 NSDI Characteristics of four NSDI early adopters in Asia

Country	NSDI Characteristics			
	Policy	**Institutional**	**Data & Standard**	**Technology**
Japan	+ NSDI Act	+ National committee	+ Fundamental geospatial dataset	+ National geoportal

	+ NSDI Basic plan + Basic plan for space policy	+ NSDI coordinator (GSI) + Arrangement of central & local government and private sector	+ Digital topographic & thematic maps + Satellite imagery & aerial photos + GNSS CORS network + National standard & ISO 19100 series	+ Earth Observation Satellites + Nationwide 3D maps + Geospatial web services & API + Various GIS applications
Korea	+ NSDI Act + NSDI Masterplan + Space development plan	+ NSDI committee + NSDI coordinator (NGII)	+ Fundamental geospatial dataset + Digital topographic & thematic maps + Satellite imagery & aerial photos + GNSS CORS network + Community & National standard (ISO 19100)	+ National geoportal + Earth Observation Satellites + Nationwide 3D maps + Geospatial web services & API + Various GIS applications
Malaysia	+ NSDI Directive	+ NSDI Committee + NSDI coordinator (MaCGDI)	+ Fundamental geospatial dataset + Digital topographic & thematic maps + Satellite imagery & aerial photos + GNSS CORS network + National standard & ISO 19100 series	+ National geoportal + Earth Observation Satellites + Geospatial web services + Various GIS applications
Qatar	+ CGIS Decree	+ NSDI Committee + NSDI coordinator (CGIS)	+ Fundamental geospatial dataset + Digital topographic database + Satellite imagery & aerial photos + GNSS CORS network + National GIS specification	+ National geoportal + Geospatial web services + Various GIS applications

A brief assessment of NSDI initiatives in 49 Asian Countries (excluding Indonesia) reveals that more than half (30 countries) are already developing NSDI and only 11 Asian nations (22%) that seem have not start NSDI development. There are 26 countries identified have all the indicators, i.e. NSDI Policy, Coordinating Body, Geospatial Data, and Geoportal. From these 26 countries, 13 are from the High-income nations, five from Upper-middle, six from Lower-middle, and two are considered as Low-income countries. It can be said that there

is no strong correlation between economic levels of one country with its NSDI development, although almost all of the High-income nations (except Kuwait) are currently implementing geospatial information infrastructure.

Chapter 3
NSDI DEVELOPMENT IN INDONESIA

3.1. Initiative of Indonesia NSDI

Geospatial information activities in Indonesia were started with several digital mapping projects during 1980s-1990s period. In 1984, Bakosurtanal cooperated with the Ministry of Transmigration and supported by the United Kingdom Government, established Regional Physical Planning Program for Transmigration (RePPPRoT) project to map nationwide land system used for regional planning (Poniman et al., 2004). The RePPPRoT project then continued by Regional Physical Planning, Map Improvement and Training (RePPMIT) project with the purpose to introduce the land system maps to be applied in the provincial government (Ikawati and Setiawati, 2009). Bakosurtanal conducted another mapping activity called Land Resource Evaluation Project (LREP) with the support from Asian Development Bank (ADB). LREP project was divided into two phases, LREP 1 (1986-1991) focused in Sumatra and West Java whereas LREP 2 (1991-1996) located in 13 provinces across Java, Kalimantan, Sulawesi, Nusa Tenggara, Maluku, and Papua islands (Ikawati and Setiawati, 2009). In addition to land resource maps, the government established Marine Resource Evaluation and Planning (MREP) project in 1993 to 1998. The objective was to strengthening marine and coastal planning management and information system by providing base maps and databases (Dahuri et al., 1999). Most of these projects yielded a large number of digital maps in GIS format with various themes and specifications.

Indonesia was initiated the NSDI in 1991 by a first group meeting called SIGNas (Sistem Informasi Geografis Nasional/National Geographic Information System) Forum among different government agencies with the aim to list the availability GIS data produced by various institutions (Lilywati and Gularso, 2000). In that meeting which organized by Bakosurtanal, all the participants were recognized the importance of making GIS data accessible and exchangeable to other institutions, which one of the benefits is to avoid data duplication. Afterwards, the meetings were continued regularly by discussing various related topics. In the third meeting in 1997, introduction of a National Geodatabase was discussed (Matindas et al., 2004).

During the first ten years, NSDI development mainly focuses in providing digital maps using GIS technology. Bakosurtanal conducted digital mapping project in 1993 to produce topographic maps 1:25,000 scale, which cover Java, Bali, Nusa Tenggara, and Maluku islands

with the total mapping area about 215,000 km^2 (Ikawati and Setiawati, 2016). Most of the institutions produced their maps using desktop GIS software and created their own database. Therefore, it required more efforts to overlay layers of different themes (Matindas et al., 2004).

The formal declaration of NSDI was defined in the National Coordination Meeting of Survey and Mapping in 2000 with the term “Infrastruktur Data Spasial Nasional” (IDSN). The objective is to provide good quality, easily accessed and integrated spatial data for national development. In this meeting, IDSN was distinguished into five main components, including Institutional, Policy, Fundamental Data, Science and Technology, and Human Resource (Bakosurtanal, 2008). NSDI Secretariat was established two years after the declaration as a working body to plan and manage all NSDI meetings, agreements, and recommendations (Matindas et al., 2004).

National agencies started to create metadata for each maps produced from the mapping activities in 2002. The Federal Geographic Data Committee (FGDC) metadata standard called 'Content Standard for Digital Geospatial Metadata' was adopted as the standard for developing metadata. Bakosurtanal developed an application to generate metadata information so they can be presented online. In order to collect metadata from data producer, a National Geospatial Data Clearinghouse prototype was established in 2004. The clearinghouse consists of a number of metadata servers that are interconnected via Internet. Each server has metadata server applications that are designed to generate metadata database and transmits the content. The database system used was a distributed system in which each data producers create, store, and maintain their own database and connect it to the clearinghouse (Puntodewo and Nataprawira, 2007).

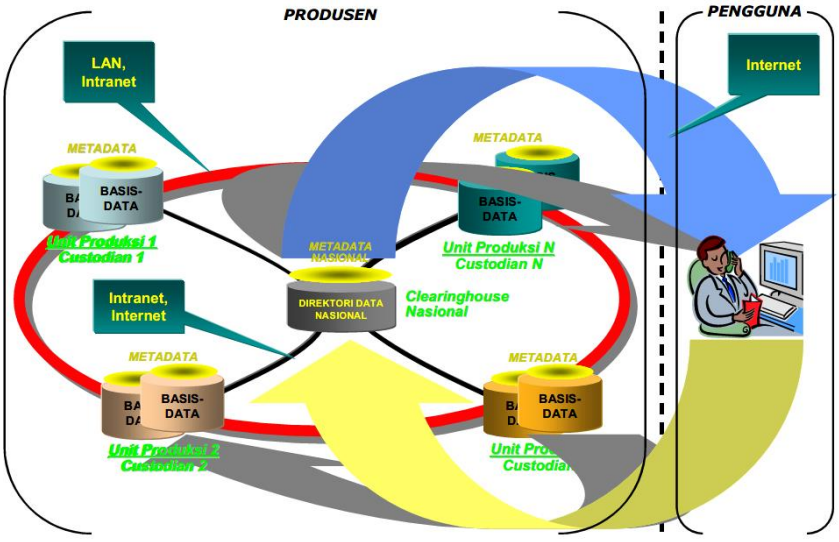


Figure 3.1 Concept of the National Clearinghouse (Bakosurtanal, 2008)

Bakosurtanal was developed a national information system called 'Sistem Informasi Spasial Nasional (SISN)' in 2007 with the aim to deliver a platform for E-Government application based on geospatial data. SISN has three main functions: as a mean of decision making process, as a tool for updating data, and as an integrator of the government information systems. At that time, several government agencies have provided their data including Bakosurtanal, Central Bureau of Statistics, and Coordinating Ministry of People's Welfare (Lilywati, 2007).

Related to the legal arrangement, a step forward was made with the publication of Presidential Decree No. 85 Year 2007 about the National Spatial Data Network. The aim of this rule is to support implementation of IDSN by providing electronic networks as a platform to share and to integrate spatial data among the different levels of government agencies. The legal framework was then strengthened by the publication of the Geospatial Information Law in 2011, which is considered as the main foundation for NSDI implementation. With the enactment of this law, Bakosurtanal was transformed into Badan Informasi Geospasial (BIG) as the national agency organizing all parts of geospatial information. Three years later Government Regulation No. 9/2014 about the implementation of the Geospatial Information Law was issued in which it specifies a more detailed execution of the law. In the same year, the Presidential Decree No. 85/2007 was replaced by the Presidential Decree No. 27/2014 about the National Geospatial Information Network (NGIN).

Although the spirit of data sharing has been introduced through the NSDI initiative, data policy during the 2000s has not yet led to open data. People must pay to obtain digital or hardcopy geospatial data whose prices were regulated in the Government Regulation No. 42/2001 about Type and Tariff of Non-Tax Revenue applicable on Bakosurtanal. The regulation was revised in 2007 by adding several components of revenue rates such as intellectual services and rental of geospatial equipment. With the implementation of Geospatial Information Law, the government began to support open data policy. Besides that, Public Information Disclosure Law (Undang-Undang Keterbukaan Informasi Publik/KIP) No. 14/2008 also mandates each government institutions to define which data are open to public and publish them in an accessible way. Government Regulation No. 64/2014 about Type and Tariff of Non-Tax Revenue applicable on BIG was issued to substitute the previous regulation about geospatial data tariff. Today, the digital topographic maps (excluding hypsography layer), coastal environment and marine maps are free to access. The topographic maps also can be downloaded from national geoportal in the GIS format. However, for the hardcopy version of the maps there is a price in exchange for the cost of printing.

In 2011, the government has launched a national geoportal known as Ina-Geoportal. The portal facilitates geospatial data access and sharing between government institutions. To support the operational of Ina-Geoportal, particularly for providing a reliable online communication networks and managing big geospatial data, BIG has been developing a data center since 2013.

For the past two years, NSDI activity focuses on the One Map Policy (OMP) that was initiated in 2015. OMP aims to tackle overlapping thematic maps among institutions so there shall only one base map to be used as reference by other government agencies (Tim Percepatan Kebijakan Satu Peta, 2017). The Presidential Decree was issued in the following year to accelerate its implementation nationwide and in each big islands such as Kalimantan, Sulawesi, Sumatra, Java, and Papua. The chronological NSDI activities and its milestones in term of legal, organizational and technical development is summarized in the following figure.

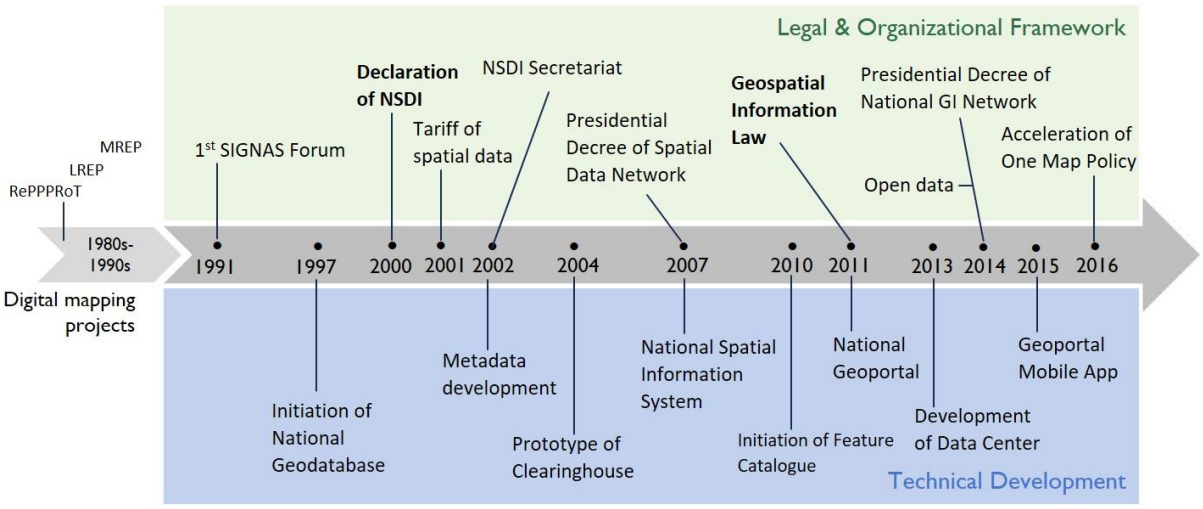


Figure 3.2 Chronological milestones of NSDI development in Indonesia

3.2. Current Status of NSDI Implementation

One of the goals of the Geospatial Information Law is to ensure the availability of, and access to accountable geospatial information. In order to achieve this, a geospatial information infrastructure needs to be established which incorporates five components: policy, institutional arrangements, technology, standards, and human resources. In the following subsection, status of each component is described in more detail.

3.2.1. Policy

Enactment of the Geospatial Information Law in 2011 is a firm evidence that Indonesian government realized the importance of geospatial information to support the multi-sector

development programs. The law states that basic and thematic geospatial information should be available and accessible by central or local government and society. Furthermore, Government Regulation No. 9/2014 about the implementation of Geospatial Information Law specifies more detail about the framework including definition, NSDI components, and the facilitator. In addition to these two legal framework, there are other national policies for the implementation of NSDI as summarized in Table 3.1.

Table 3.1 List of the national policy of NSDI implementation

Policy Number/Year	Title	Contents related to NSDI
Law No. 4/2011	Geospatial Information	Type of geospatial information (article 4), definition of geospatial information infrastructure components (article 53)
Government Regulation No. 9/2014	Implementation of Law No. 4/2011 about Geospatial Information	Detailed description of geospatial information infrastructure components (article 62 to 76)
Presidential Decree No. 27/2014	National Geospatial Information Network (NGIN)	Definition, member of NGIN, role and responsibility of the Network Node and the Network Node Connector
Presidential Decree No. 9/2016	Acceleration of the One Map Policy Implementation at the 1: 50,000 Maps Scale	Data sharing mechanism of the thematic geospatial information through NGIN (article 6)
Government Regulation No. 8/2013	Accuracy of the Spatial Planning Map	Spatial planning map shall be created from reliable basic and thematic geospatial information (article 6)
Presidential Instruction No. 6/2012	Provision, Use, Quality Control, Processing and Distribution of High Resolution Remote Sensing Satellite Data	Provision of satellite image licensed to the Government of Republic Indonesia, distribution of ortho-rectified satellite image via NSDI

The importance of geospatial information is also acknowledged in the National Medium Term Development Plan (RPJMN) 2015-2019. The national government aware about the importance of geospatial information to support decision-making process in economic, social, and environmental sector (State Minister for Chairperson of the National Development Planning Agency, 2016). Therefore, as stated in the RPJMN, seven targets of the geospatial development are specified as follows:

1. Increased coordination of the implementation of geospatial information;
2. Fulfillment of geospatial data and information for development planning of land and sea area in Indonesia;
3. Establishment of geospatial information sharing;

4. Utilization of geospatial information in the development planning process and public policy;
5. Fulfilment of human resource in the field of geospatial information;
6. Institutionalization of geospatial information management;
7. Achievement of supremacy for geospatial science, technology and industry.

Another essential policy related to utilization of geospatial information is the One Map Policy, which declared by the Presidential Decree No. 9/2016. The background of the policy is to response to the inconsistency of land cover map produced by the Ministry of Forestry and Ministry of Environment where it showed different forest coverage area in the same location (Nurwadjedi, 2013). This discrepancy may lead to the overlapping land permits and conflict over space exploitation. Being aware of this issue, the government regulates that all of the thematic geospatial information should refer to the same one geospatial reference, one standard, one database, and one geoportal.

One Map Policy consists of three main activities: compilation of thematic maps, integration, and synchronization. Thematic maps produced by ministries, government agencies, or local governments are collected in the first step. Afterwards, these maps are verified to check its conformity with the base maps. The verification process is conducted based on some parameters of standard and quality control. The standard parameters contain data format, projection system, and scale whereas quality parameters related to positional accuracy and features consistency. If the data have been verified then they can be integrated and be used for the final step. Synchronization process aims to harmonize various thematic maps including resolution of the conflicts that occur as a result of overlapping maps of the integration. Additionally, recommendations for further actions of synchronization issues are generated such as effort to resolve territorial boundaries and forest areas.

Presidential Decree No. 9/2016 defines 85 themes of the geospatial information that classified into three groups: thematic maps of status, spatial planning and potential area. Status thematic maps related to legal aspects of land rights and restrictions meanwhile spatial planning maps contain features for utilization of urban or regional planning. The third thematic group covers information about transportation, utility, environment and potential of the area. According to the recent report, 83 thematic maps have been collected from 19 institutions and two maps (customary land map and village boundary map) are not established yet. Furthermore, 26 maps of the 83 maps collected are covers nation-wide area and the rest are available for certain islands. For example, in 2016 the focus was in Kalimantan island and 63 thematic maps have been integrated (Coordinating Ministry on Economic Affairs, 2017).

3.2.2. Institutional Arrangements

Institutional arrangement of Indonesia NSDI is defined in the Presidential Decree No. 27/2014 about the NGIN. According to the regulation, actors of geospatial information sharing are called network nodes (Simpul Jaringan), which are classified into central and local network nodes. Central network nodes include ministries, state institutions, central government agencies, national police, and national armed force. Meanwhile, local network nodes consist of provincial, municipality, and district governments. Each of the network node has responsibility in the collection, maintenance, update, exchange and dissemination of specific geospatial data. As illustrated in Figure 3.2, the network nodes have their own clearinghouse unit and should connect to the national geoportal.

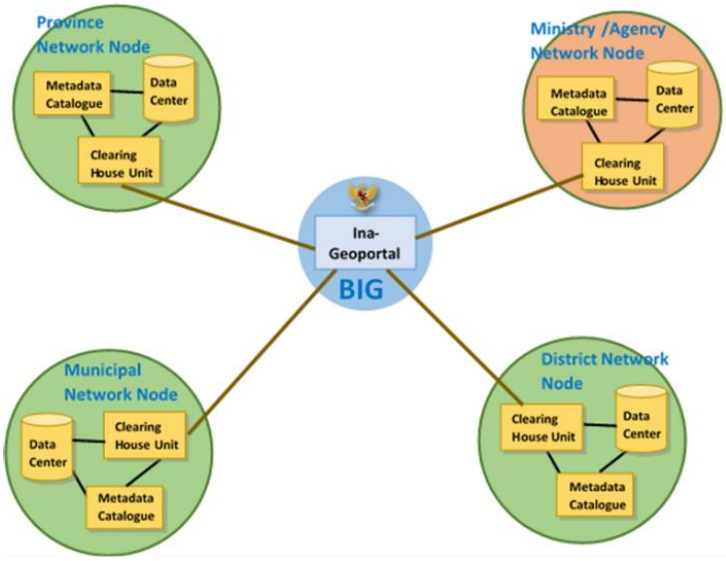


Figure 3.3 Institutional arrangements of Indonesia NSDI

As stated in the NGIN Decree, BIG is mandated as the Network Node Connector that has a duty to develop, integrate and manage the network nodes. Development of the network nodes is conducted by providing guidance, standard or technical specification for implementing data sharing and exchange. BIG also has an obligation to build and maintain communication network systems among network nodes in order to integrate their data. Additionally, supervision and training activities are also essential to increase awareness of the participating institutions. An annual national coordination meeting is mandatory event specified in the NGIN Decree.

The NGIN serves as a means of sharing and disseminating geospatial information to all network nodes. This can be considered as a huge task due to the numerous number of network nodes. In total, there are 622 network nodes from different institutions to be connected. The author conducts a direct observation on Ina-Geoportal in April 2018 and found that only 38

(6.1%) network nodes joined the portal as can be seen in Table 3.1. About half of these connected nodes are from central government institutions, whereas none of the State Institutions are linked. Appendix 1 specifies the connected network nodes resulted from the observation.

Table 3.2 Connected network nodes in Ina-Geoportal (as per April 2018)

Type of Institutions	Number of Network Nodes	Connected to NSDI	Connected to NSDI (%)	To be Connected
State Institutions	8	0	0%	8
Central Government Agencies, Police & Armed Force	66	11	16.7%	55
Provinces	34	17	50%	17
Municipalities/ Districts	514	10	1.9%	504
Total	**622**	**38**	**6.1%**	**584**

3.2.3. Technology

The main technological indicator of NSDI implementation in Indonesia is the operational of Ina-Geoportal. All geospatial data produced by the networks nodes are published and shared in this portal (http://tanahair.indonesia.go.id). The homepage of Ina-Geoportal is more like a catalogue geoportal which emphasize on the map or service repository. It shows gallery of the available data and a dialogue to download basic geospatial information in GIS format such as administrative boundary as listed in Table 3.3 per April 2018. Users can download based on area of interest or based on region freely as long as they registered.

Table 3.3 Basic geospatial information available for download in Ina-Geoportal

No.	Data layer	Scale
1.	Coastline	1:25,000; 1:50,000; 1:250,0000
2.	Hypsography (spot heights, contour)	1:25,000; 1:50,000; 1:250,0000
3.	Hydrography (rivers, lakes, seas)	1:25,000; 1:50,000; 1:250,0000
4.	Toponym	1:25,000; 1:50,000; 1:250,0000
5.	Administrative boundary	1:25,000; 1:50,000; 1:250,0000
6.	Built environment	1:250,0000
7.	Transportation	1:25,000; 1:50,000; 1:250,0000
8.	Utility	1:25,000; 1:50,000; 1:250,0000
9.	Vegetation	1:25,000; 1:50,000;

In addition to download geospatial data, Ina-Geoportal has other functionalities such as searching maps and map viewer. From the homepage, a user can search metadata, maps or applications. The results will be displayed on a thumbnail format with the ability to open its metadata and view the map. Ina-Geoportal adopt metadata standard from ISO 19115:2003 as illustrated in Figure 3.4. Until April 2018, the number of metadata available from the participating network nodes has reached 2,805 metadata.

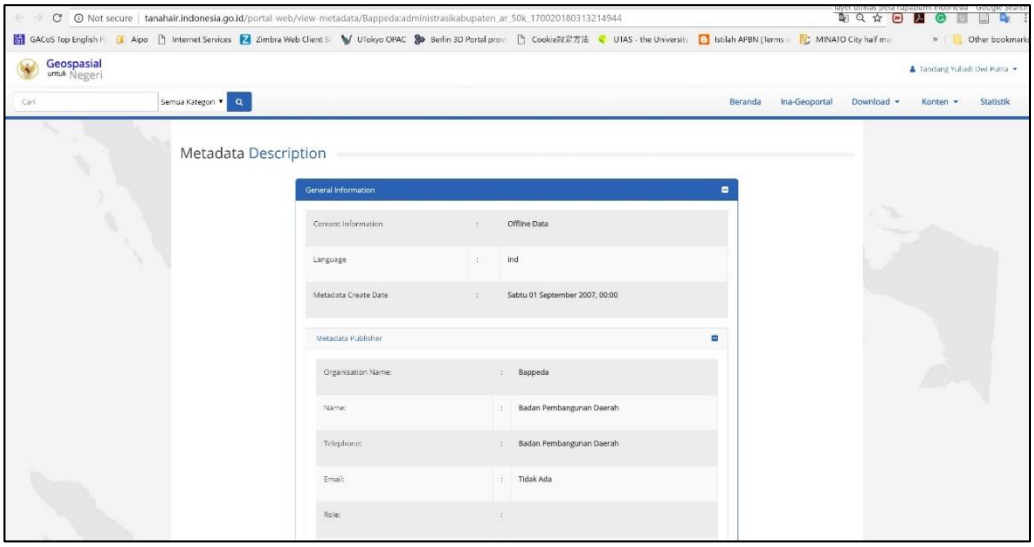


Figure 3.4 Example of a metadata description in Ina-Geoportal

A map viewer in which users can add layers to the base map, navigate the map, identify objects provides the mapping function, and measures distance as well (Figure 3.5).

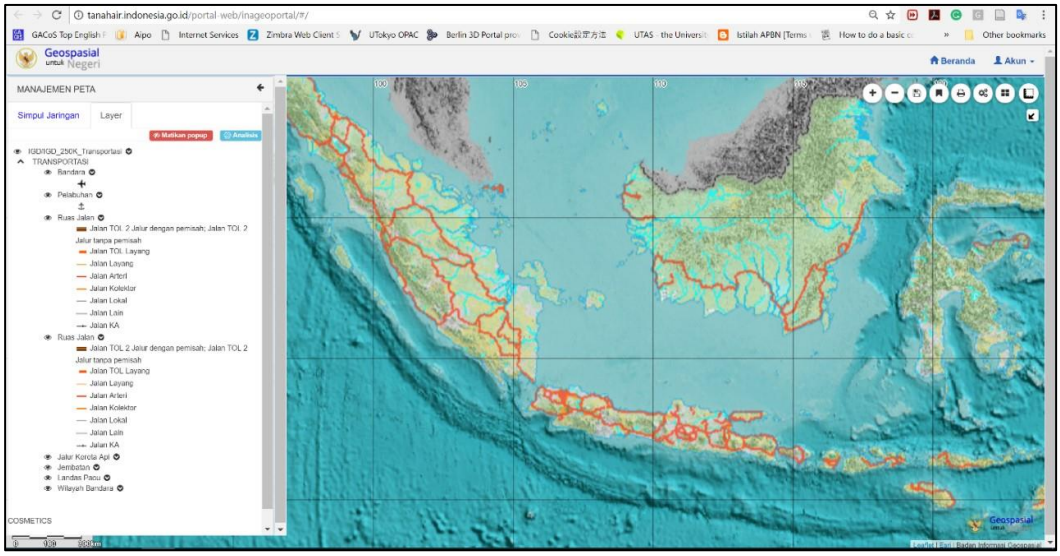


Figure 3.5 Map viewer function of Ina-Geoportal

A user can add layers to the base map in different ways such as from the available predefined GIS Servers published by network nodes or from web services. The Ina-Geoportal supports OGC Web Map Service (WMS), Web Feature Service (WFS) and GeoJSON format. Additionally, a user can add layer to the map viewer from a coma-separated values (CSV) file, a text (.txt) file, an ArcGIS Shapefiles (.shp) or a GPS exchange format (.gpx) file.

The portal also provides Web applications on several theme such as disaster, agriculture, coastal environment mapping, and One Map Policy application. These applications is created by integrating thematic data produced by the network nodes. One example is the One Map Policy application as shown in Figure 3.6.

From the One Map Policy application, a user who wants to know status of mining business can visualize land cover map created by BIG and land right map published by Ministry of Agrarian and Spatial Planning/National Land Agency. Moreover, a mining business permit map published by Ministry of Energy and Mineral Resources can also be added to review and analyze the status. The availability of such application is beneficial to support decision-making process for national development programs.

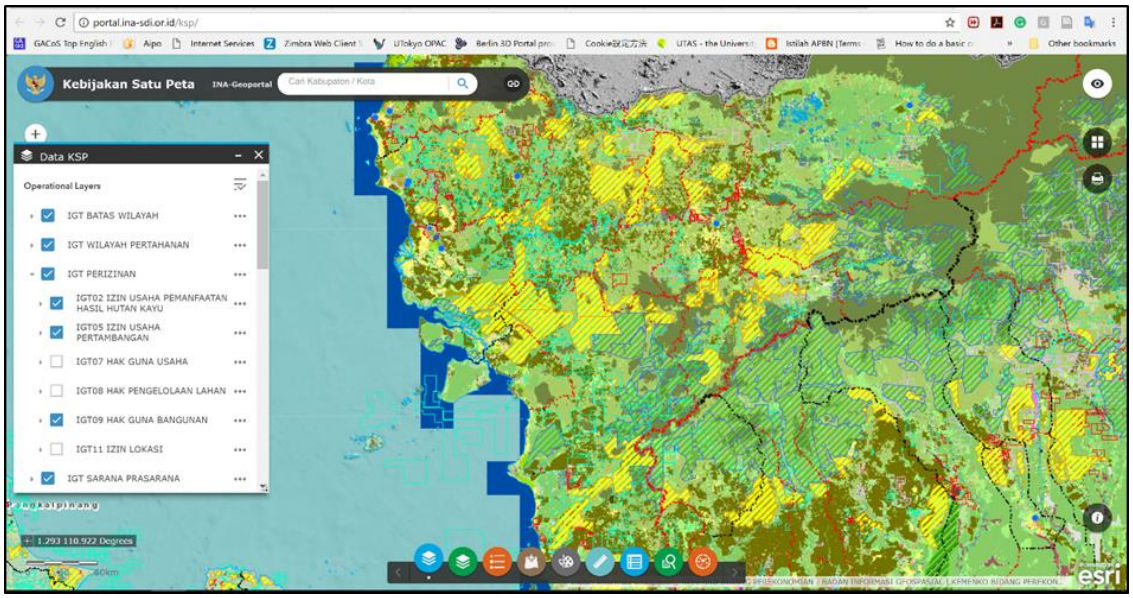


Figure 3.6 One Map Policy Application in Ina-Geoportal

Another technological aspect essential to NSDI implementation is positioning infrastructure. The government has built the national CORS network since 1996 (known as InaCORS) with the aim to provide accurate and precise geodetic reference frame over Indonesian region, and to support a wide range of research and scientific applications (Aditiya et al., 2014). The InaCORS networks is operated mainly by BIG and the National Land Agency (BPN) but other institutions also established CORS observations such as Indonesian Institute

of Sciences (LIPI), GITEWS (German Indonesian Tsunami Early Warning System), Bandung Institute of Technology (ITB), University of Gadjah Mada (UGM), and Sepuluh November Institut of Technology (ITS). At present, there are 134 CORS stations operated by BIG (Badan Informasi Geospasial, 2018), 75 CORS stations by BPN, 18 by GITEWS, 32 by LIPI SUGAR (Sumatera GPS Array), 5 by ITB, 1 by UGM and 1 by ITS (Abidin et al., 2012). The coverage of InaCORS networks maintained by BIG is described in Figure 3.6. They can be accessed online with several services such as RINEX download, post processing and RTK are available.

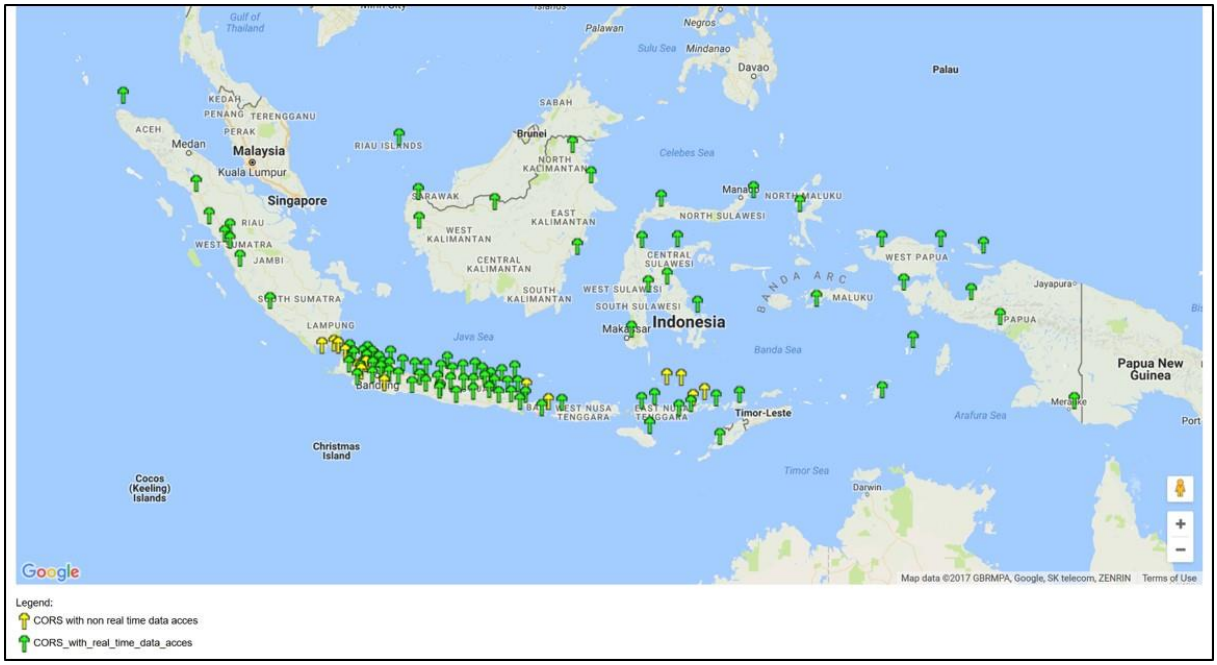


Figure 3.7 InaCORS networks operated by BIG (source: inacors.big.go.id)

In order to effectively operate Ina-Geoportal and maintain the NSDI network, BIG has been developing a data center since 2013. To date, the data center is equipped with more than 300 servers, 3,200 Terabytes (TB) data storage, and Internet bandwidth up to 550 Mbps (international) and 1 Gbps (local). It is also has High Performance Computing for satellite image ortho-rectification process and a disaster recovery center. BIG provides Virtual Private Network (VPN) access to communicate among network nodes and constructed Cloud Computing infrastructure to facilitate the network nodes (Badan Informasi Geospasial, 2017a).

3.2.4. Standards

The need for standardization is stated in the Geospatial Information Law. It covers five aspects of geospatial information development: geospatial data acquisition, information processing, storage and security, information distribution, and information usage. There are two

methods used to compose the geospatial information standards, first by creating a new national standard and secondly by adopting from the ISO 19100 series standards. At present, there are 26 standards adopted from the ISO standards.

The geospatial information standards can be in the form of national standards (Standar Nasional Indonesia/SNI) or technical specifications. BIG has initiated the development these standards since 2000 and had already produced 60 standards (Badan Informasi Geospasial, 2015a) as listed in the Appendix 2. In addition, the government also publishing technical specification, which is stipulated by a decree of the head of BIG. Some examples of the specification are Indonesian Geospatial Reference System named SRGI2013 and Indonesian Geospatial Feature Catalogue (KUGI).

3.2.5. Human Resources

The four major components of NSDI cannot possibly work smoothly together without the work force who operate the system. There are two issues for human resource related to the NSDI: the provider and the general user of geospatial data and information. The first issue involve all the network nodes incorporating central and local government officials who are taking part in geospatial information development. According to a recent report, the availability of qualified manpower working in this group is 8,584 people, in contrast to the demand that is estimated about 31,500 people (Badan Informasi Geospasial, 2015b). To fulfill this demand only approximately 2,500 students graduate from university in Indonesia with a degree in an Earth science subject every year. Inadequate numbers of skilled personnel may lead to low quality of geospatial products produced by the provider. Darmawan et al. (2014) found that the local governments mostly facing this situation, particularly outside Java Island since most of the mapping companies are located in Java.

The quality of the capable work force can be measured in terms of their competence in dealing with geospatial work. With the purpose to generate professional personnel, Indonesia has published the National Working Competency Standard (SKKNI) on Geospatial Information as stipulated in the decree of Minister of Manpower and Transmigration No. 331/2013. Furthermore, Head of BIG has published a regulation No. 9/2014 on the Application of SKKNI in Geospatial Information sector (SKKNI-IG) which applies nationwide and used as a reference when implementing the certification process in the geospatial information field.

The main objective of geospatial information development is to achieve effective and efficient geospatial implementation. To realize the objective, the SKKNI-IG is classified into five key functions namely planning for geospatial information arrangement, collecting

geospatial data, processing geospatial data, managing geospatial data and information, and visualizing geospatial information (Kementerian Tenaga Kerja, 2013). Each of these functions has their own major function and will be derived into unit of competences. There are six fields of competence stated in SKKNI-IG: Terrestrial Survey, Hydrography, Photogrammetry, Remote Sensing, GIS and Cartography. Table 3.4 describes the mapping of geospatial information functions and its number of competency unit adopted from Narieswari (2016).

Table 3.4 Geospatial information functions and units of competence

Geospatial Information Key Function	Major Function	Number of Unit of Competence
Planning	a) Planning of Terrestrial Survey b) Planning of Hydrography c) Planning of Photogrammetry d) Planning of Remote Sensing e) Planning of GIS f) Planning of Cartography	4 units 6 units 5 units 1 unit 2 units 1 unit
Collecting	a) Geospatial data collection of Terrestrial Survey b) Geospatial data collection of Hydrography c) Geospatial data collection of Photogrammetry d) Geospatial data collection of Remote Sensing e) Geospatial data collection of GIS f) Geospatial data collection of Cartography	6 units 9 units 5 units 4 units 2 units 1 unit
Processing	a) Processing of Terrestrial Survey geospatial data b) Processing of Hydrography geospatial data c) Processing of Photogrammetry geospatial data d) Processing of Remote Sensing geospatial data e) Processing of GIS geospatial data f) Processing of Cartography geospatial data	2 units 6 units 6 units 16 units 2 units 2 units
Managing	a) Managing Hydrography geospatial data and information b) Managing GIS geospatial data and information	12 units 6 units

Table 3.4 (*Continued*)

Geospatial Information Key Function	Major Function	Number of Unit of Competence
Visualizing	a) Presentation of Terrestrial Survey geospatial information	2 units
	b) Presentation of GIS geospatial information	1 unit
	c) Presentation of Cartography geospatial information	1 unit

The second issue is capacity building of the general user of geospatial information. As the third generation of SDI evolves, more focus is on facilitating geospatial data ready to the society. Current geoportal applications and Internet technology allow everyone to use maps for daily life and public participation situations. However, providing help and user support in such applications is not enough. The community awareness of geospatial information need to be increased. BIG has established a survey in 2017 to identify level of the awareness and it resulted 6.4 score from maximum 10 (Badan Informasi Geospasial, 2018). It indicates that even though in general citizens understand the usefulness of geospatial information, they rarely use and access data provided by the government.

3.3. Summary

This chapter delivers chronological review and identifies present status of NSDI development in Indonesia. Based on analytical review, the author distinguish three periods of evolution of Indonesia NSDI development. These periods are defined from the technological changes used in arranging NSDI and also from the data management part. The first period happened in its first ten years of development when most of the activities were digital mapping projects. Bakosurtanal mainly managed these products and the data is stored in a centralized geodatabase. Data sharing between governments agencies were rarely exist in this period.

In the second period during 2001 to 2000, there was a change in the data management. With the adoption of a distributed system, government agencies started to share their data. In addition, a national clearinghouse was established to share their metadata. Web mapping applications (SISN) was developed to support decision making process in governmental issues such as health and welfare. The last period is named as open initiative since in this period the government promote open data by providing it in the geoportal. The periods can be characterized by institution involved in NSDI implementation, data and its policy, technological change, and realized users as presented in the table 5.3.

Table 3.5 Three periods of NSDI development in Indonesia

Period	Institution of operating NSDI	Data in NSDI and data policy	Technological changes around NSDI and users	"Realized" users and their applications
1991-2000 **Centralized Data**	National Mapping Agency (Bakosurtanal)	Public data, but user have to pay for hardcopy and digital data (e.g. US$ 35/map sheet for 1:25,000 digital topographic map)	Desktop GIS and geodatabase	National government agencies, major local government, academia, non-profit organization Applications: natural resource management (participating agencies/local governments)
2001-2010 **Distributed System**	Bakosurtanal as coordinating agency, other national government agencies and local governments as participants	Same as above	Web mapping and clearinghouse	The above plus survey and mapping companies Applications: social issues (poverty, education), spatial planning, disaster management (usage of application is still limited to government agencies)
2011-present **Open Initiative**	BIG (formerly Bakosurtanal) act as the Network Node Connector while ministries/national agencies and local governments as Network Nodes	Public and open data. Some efforts are being made to provide web services. Digital base maps are available for download.	Geoportal, participatory mapping, and mobile applications	Government agencies, academia, non-profit organization and web mapping companies Applications: land parcels information, facility monitoring, city dashboard, local geoportal (Users of NSDI may be increasing but slowly)

Chapter 4
NSDI PROBLEMS IDENTIFICATION

4.1. Overview

NSDI development in Indonesia has been conducted for more than 20 years but there are difficulties in its implementation. As mentioned by Sahroni et al. (2017), geospatial data sharing among government agencies is still ineffective due to problems in institutional arrangement such as unclarity of data custodianship and poor planning. Low support from the political leader in local government was also hampering geospatial information activities (Darmawan et al., 2014). Nevertheless, further research is required because previous studies only included problems in government agencies. Perspectives from other stakeholders, for instance private companies and academia are still missing.

Another indication of difficulty in NSDI implementation can be seen in the declining trend of the national geoportal. Based on the recorded data of Ina-Geoportal website from ClustrMap.com, there was a downward trend of visitors in the last three months of 2017. During October to December, the users were decreased from 10,832 to 7,868 as presented in Figure 4.1. It is expected that the Ina-Geoportal experience a rapid increase of users because one of the keys to NSDI success is the utilization of geospatial data provided in the geoportal. This chapter identifies problems of NSDI implementation based on the stakeholders' opinion, as it is necessary to be captured for understanding more about current NSDI operation.

Figure 4.1 Visitors of Ina-Geoportal in 2017

4.2. Method

To identify the NSDI problems, the author used the semi-structured interview method. This method is one of qualitative data collection strategy in which the researcher asks respondents a series of predetermined but open-ended questions (Given, 2008). The author develops a written interview guide in advance that consist of specific worded questions to explore views on the NSDI implementation. There are nine questions separated into three subjects. First part is about profile of the respondent including place of work/institution, educational background and experience in geospatial information field. The second part collects opinion related to NSDI development, role of the institution, and geospatial information activity or project. Subsequently, in the final part, the respondent are asked about problems that occurs and requirement/expectation of future implementation. List of the questions delivered in the interview is shown in Table 4.1.

Table 4.1 List of questions of the semi-structured interview

Subject	Questions
I. Profile of Respondent	I.1. Which institution are you working at? I.2. What is your educational background? I.3. How many years have you been working in GIS-related field?
II. NSDI Development	II.1. What do you think about the NSDI development in your country? II.2. What is the role of you/your institution in the NSDI development? II.3. What kind of activities that your institution has been conducted in term of NSDI development?
III. NSDI Problems and requirements	III.1. In your opinion what are the problems or challenges of NSDI implementation? III.2. What data or application do you/your institution required in the NSDI? III.3. What is your expectation about the NSDI implementation in your country?

Purposive sampling technique is applied to determine the respondents with the criteria that they had particular experience in geospatial information activities and user of geospatial data in NSDI. A discussion with BIG official is conducted to identify potential respondents that have experiences and awareness about NSDI. The aims is not only to collect view from government organizations but also from private companies and academic institutions. The

familiarity of the author with the NSDI initiative in Indonesia also helpful in finding appropriate individuals that have suitable experience and knowledge. The interviews were conducted in June and August 2017 in Jakarta, Bogor, and Bandung with the total duration of interviews around 14 hours 38 minutes. Some of the detailed questions and answers utilized in this research are described in Appendix 3.

4.3. Results and Discussions

4.3.1. Profile of the Respondents

Overall, there were 18 participants of the interviews, in which eight of them (44.4%) represents government agencies, seven (38.9%) are working at private companies, and three (16.7%) are from academic institutions. Job's role of the respondents is varied, for example SDI coordinators at ministries, a key technical SDI manager at local governments, a director of GIS software providers, and an executive of web mapping developer. Table 4.2 presents the detail of interviewee's institution and their position.

Table 4.2 Institution and position of the interviewees

No.	Name of Institution	Type of Institution	Position
1	Center for Regional Potential Development of West Java Province	Provincial Government	Head of Regional Potential Analysis Section as SDI Coordinator
2	Ministry of Public Works and Public Housing	Ministry	Head of Information Technology Service Section as SDI Coordinator
3	National Land Agency (BPN)	Central Government Agency	Analyst of Information System Network
4	Ministry of Environment and Forestry	Ministry	Head of Management of Geospatial Data Network Section as SDI Coordinator
5	Regional Development Planning Agency of Depok Municipality	Municipal Government	Head of Research & Development Subdivision as SDI Manager
6	Geospatial Information Agency (BIG)	Central Government Agency	Head of Dissemination of Geospatial Information Division
7	Spatial Planning and Land Agency of Jakarta Province	Provincial Government	Head of Land Division

Table 4.2 (*Continued*)

No.	Name of Institution	Type of Institution	Position
8	Ministry of Agriculture	Ministry	Analyst of Agricultural Data and Information
9	PT. ESRI Indonesia	Private Company (GIS Software Provider)	Director of National Government Affairs
10	PT. Waindo SpecTerra	Private Company (Survey and Mapping)	Information Technology Manager
11	PT. Tiza Solusindo	Private Company (GIS Application Developer)	Managing Director
12	PT. Qlue Performa Indonesia	Private Company (GIS Application Developer)	Strategist for Public and Government Affairs
13	PT. PAM Lyonnase Jaya	Private Company (Water Supply Service)	GIS Manager
14	PT. WebGIS Indonesia	Private Company (Web Mapping Developer)	Chief Executive Officer
15	PT. Bank Muamalat Indonesia	Private Company (Banking & Finance)	Director of Information Technology
16	University of Gadjah Mada	Academic (Center for SDI Development)	Head of Center for SDI Development
17	Bandung Institute of Technology (ITB)	Academic (Center for SDI Development)	Head of Center for SDI Development
18	University of Pakuan	Academic	GIS Lecturer

The interviewees have different educational backgrounds as described in Figure 4.2. Most of them (56%) hold a bachelor degree in the university while six persons (33%) are graduated from master program. There are only two of the interviewees (11%) have a doctoral degree, in which all of them work in the academic institution.

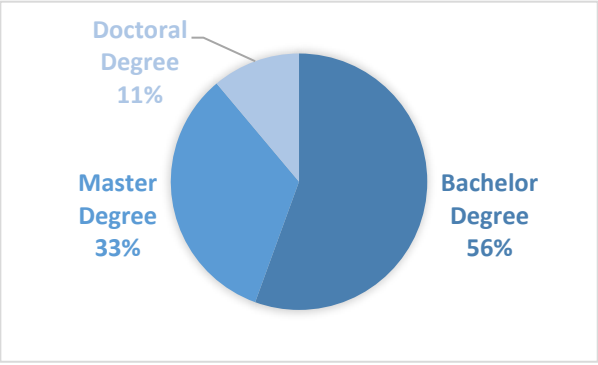


Figure 4.2 Educational degree of the interviewees

Related to the field of education (Figure 4.3), largely the participants are from the geography, geodetic or geomatics science. Three persons (17%) are graduated from the information technology field whereas five participants (28%) originated from other disciplines such as agriculture, management, and mechanical engineering.

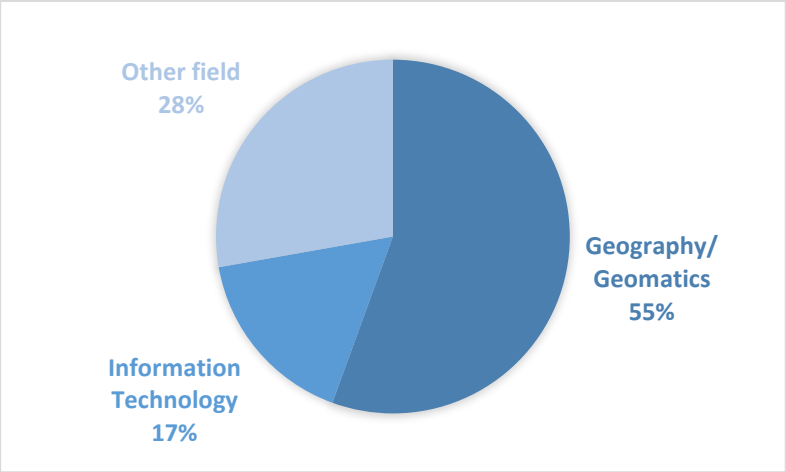


Figure 4.3 Field of education of the interviewees

All of the interviewees have experiences in GIS activities and projects, but varies in the duration. Half of the participants have experiences more than 10 years whereas six people (33%) have been involved in GIS fields for about 4 to 10 years. Meanwhile, only 17% of them practice geospatial information less than three years as illustrated in Figure 4.4.

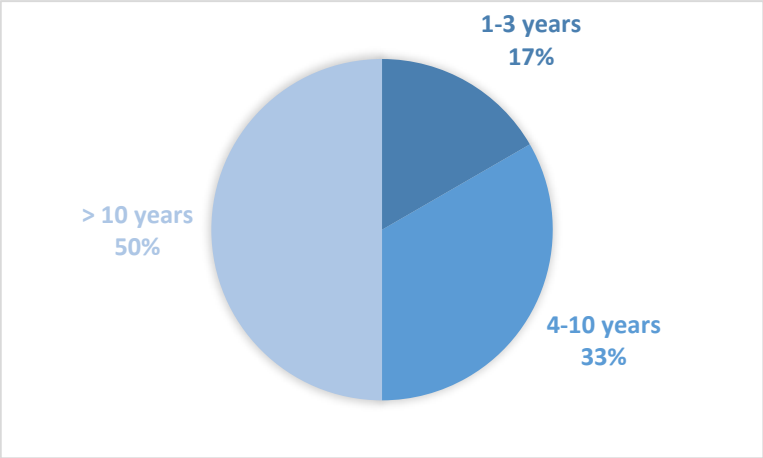


Figure 4.4 Interviewees' experience in GIS activities/projects

4.3.2. NSDI Development

The first question in this topic is opinion about NSDI development in Indonesia. Most of all believe the initiative is important and beneficial for the institutions, particularly for sharing

geospatial data. The initiative allows spatial data produced by the government to be used by other parties such as the private sector and the general public. As some of the interviewees expressed:

> *"**NSDI is very important and we support it because our agency need integrated data for infrastructure planning and development processes**. As you may know when our institution will build public infrastructure, we need clean and clear data because not only our institution are involved. For example we need information about geospatial data related to land status managed by other ministries such as the Ministry of Forestry, Agriculture or National Land Agency […]"*- Official from Ministry of Public Works and Public Housing (refer to Question II.1 – Appendix 3)
>
> *"[…] **we need NSDI to overlay our data with other geospatial data** such as forest boundaries and regional spatial planning […]"* - Official from National Land Agency (refer to Question II.1 – Appendix 3)
>
> *"In my opinion **NSDI is essential because it can support national development**. We are from the private sector, our client usually from government agencies and they really need geospatial data in carrying out their duties"* - Manager of PT. Waindo SpecTerra (refer to Question II.1 – Appendix 3)

However, the progress of the NSDI development was perceived to be slow in which still focused with the provision of geospatial data. Even though the data already exists but the quality is still questionable whether it conforms to the national standards or not. Some of the interviewees stated:

> *"[…] if we observe the NSDI in Indonesia, **I think the development is still in low speed because it mainly depends on the central government agencies** which is a characteristic of the first generation of NSDI that struggling with data provision […]"* - Head of Center for SDI Development of University of Gadjah Mada (refer to Question II.1 – Appendix 3)
>
> *"[…] the development of NSDI in recent years has accelerated but the progress of each component looks different. For example, about the geospatial data standard now we have many national standard. Then related to human resources, the skilled personnel is still lacking. In terms of providing data, currently a lot of geospatial data theme being produced and starting to be structured, but the quality of the data has not met expectations. Meanwhile, about technology, I believe there are quite a lot of developments with the use of open source software and government support. Nonetheless, **I think the last two years have been set back of NSDI development***

because the focus has shifted more to the implementation of one map policy. *In my view, the infrastructure foundation should be strengthened first and then after that we can switch to activity that is more applicable […]"* - Head of Center for SDI Development of Bandung Institute of Technology (refer to Question II.1 – Appendix 3)

The slow development of NSDI was also felt by the private sector who saw the small number of participants and slow geospatial data update. As an interviewee expressed:

"In my opinion, in the beginning NSDI was a good initiative because the concept made it possible to share data across agencies in one system. But ***the implementation is somewhat lacking in the past 2-3 years because the agencies involved have not increased significantly and the geospatial data update is relatively slow*** *[…]"* - Executive of PT. WebGIS Indonesia (refer to Question II.1 – Appendix 3)

The second question collects information on the role of each institution in the NSDI development. In general, the interviewees are working in three types of institutions: government agencies, private companies, and academic institutions. Each type has their specific roles in NSDI development. Government agencies mainly are the geospatial data provider and web service supplier. They are member of the NSDI network that distribute their data via the national geoportal. Additionally, as the network node, they coordinate the management of geospatial data in internal working units as well give assistance in developing thematic maps. An interview expressed that:

"My office acts as an ***integrator of geospatial data*** *produced by related local agencies in the West Java provincial government. Therefore, we are the network node that connects geospatial data of West Java province to BIG. Sometimes we also give* ***training to local agencies*** *in analyzing geospatial and non-geospatial data […]"* - Official from Regional Development Planning Agency of West Java Province (refer to Question II.2 – Appendix 3)

The role of private companies is as the executor of mapping and geospatial information projects carried out by government agencies. They involved in developing basic and thematic digital mapping, provision of satellite imagery, and GIS software. Some of the companies develop GIS applications that are used to improve decision making process or monitoring local government activities as stated in the following records:

*"****Our role is to help developing GIS in government agencies****. When there are tenders for mapping projects, providing satellite imagery or software, and*

providing experts, we commit to supports these activities. We are also ***involved in provision of basic and thematic geospatial information*** *in BIG. In addition, our company also* ***develops GIS applications for desktop, web or mobile platforms*** *with a variety of themes that are needed by the government agencies […]"* - Manager of PT. Waindo SpecTerra (refer to Question II.2 – Appendix 3)

"Our company is ***a geospatial based application developer*** *where we work with local governments to monitor public facilities and utilities using location information […]"* - Officer at PT. Qlue Performa Indonesia (refer to Question II.2 – Appendix 3)

An interviewee expressed that in addition to the governmental project executor, the company also develop GIS application for other business companies:

"[…] Besides working out in the government projects, we also ***develop Web GIS applications for banking companies*** *to monitor bank performance by utilizing geospatial information. In addition, we also build application for finance company that used geotagging data to deliver personal information […]"* - Executive of PT. WebGIS Indonesia (refer to Question II.2 – Appendix 3)

Meanwhile, academic institutions have part in providing human resources for implementing NSDI, particularly the ones that have cooperation with BIG as the Center for SDI Development (Pusat Pengembangan Infrastruktur Data Spasial/PPIDS). PPIDS is also involved in supporting the local government to develop their network node. As some of the interviewees expressed:

"[…] PPIDS ITB was established long enough from 1995. We had a role in helping BIG to develop the SDI concept and gave many suggestions and recommendation of SDI development. Off course, ***the main role as an educational institution is the development of human resources in the field of geospatial information****. In addition to academic education,* ***we also provide courses to government agencies and public*** *[…]"*- Head of Center for SDI Development of Bandung Institute of Technology (refer to Question II.2 – Appendix 3)

"[…] There are three main things about the role of PPIDS, first is as ***a provider of geospatial information human resources****, secondly is* ***collaborating with local governments*** *to develop network nodes in terms of data, technology and standardization. Finally, we are also active in* ***conducting research related to NSDI implementation****. There are several master and doctoral program students in*

my faculty who establish research about SDI […]"- Head of Center for SDI Development of University of Gadjah Mada (refer to Question II.2 – Appendix 3)

*"Our institution plays **a role in the provision of human resources** in the field of geodesy; the focus of the course is not only on survey and mapping knowledge but also on the use of GIS applications. In addition, our lecturers are also often asked to become **experts in NSDI development activities in BIG** […]"*- Lecturer at University of Pakuan (refer to Question II.2 – Appendix 3)

Besides academic organizations, it turns out that private sector also delivers training for the college students and local government staffs as an effort to improve capacity building in geospatial information field as stated by one of the interviewee:

*"[…] when speaking about our business core, my institution is a GIS software technology provider that mainly used by government agencies in managing their geospatial data. But then of course we cannot stop there because we also have to do knowledge transfer. **We are directly involved in human resource development** as we feel some limitations occurred in local government and we believe there are some things we can help with. For example, my institution provide **software grants to universities** since 2015. We also deliver **training and general lectures** for students and staffs. In addition, we also established **a competition for students in creating and utilizing geospatial information** […]"* - Director of PT. ESRI Indonesia (refer to Question II.2 – Appendix 3)

In term of projects or activities related to NSDI implementation that have been done by the interviewee's institution, most of the government agencies are developing their clearinghouse and metadata catalogue. Several agencies have also built a geoportal that can connect internal organization data. As some of the interviewees stated:

*"[…] We built the ministry network node for sharing geospatial data and a data warehouses for non-geospatial data of each internal agencies; We also replicate the NSDI system, so each internal agencies has its own clearing unit and is connected to the ministry clearing unit managed by my division. In addition, we also **developed the GIS Infrastructure portal application** called SIGI; We also formed **a network management team** in the ministry to support the implementation of the NSDI […]"* - Official from Ministry of Public Works and Public Housing (refer to Question II.3 – Appendix 3)

*"[…] Activities carried out related to NSDI include **provision of hardware** such as geospatial servers, **land use mapping** to support land certification programs;*

establishing clearinghouse *at our ministry and developing thematic applications related to land parcels […]"* - Official from National Land Agency (refer to Question II.3 – Appendix 3)

"In supporting the implementation of the NSDI we are ***building a clearing unit*** *to share data between the units of government organizations in both the province and municipality/district. We have two* ***applications****, first is the West Java network node that can be accessed internally and the second is geodatabase application which contains various thematic data such as population, poverty, and education that can be accessed by the public. We also sometimes invite experts from university as resource persons in implementing network nodes […]"* - Official from Regional Development Planning Agency of West Java Province (refer to Question II.3 – Appendix 3)

As the partner of government agency in developing geospatial information, private companies are mostly involved in projects related to data provision and GIS application. For example digital mapping of basic and thematic geospatial data required by ministry and local government. Some of the interviewees expressed:

"[…] We have been involved in several NSDI projects, first of all we assisted the NTT data team in ***developing the national geoportal*** *in 2011; After that we were took part in the geoportal modernization process and maintain updated technology for developing network nodes in both BIG and local governments […]"*- Director of PT. ESRI Indonesia (refer to Question II.3 – Appendix 3)

"[…] Our company is involved in projects such as ***satellite image provision, providing GIS software and digital mapping*** *of basic and thematic geospatial information. Additionally, we also developed a GIS web application to display geospatial information according to the needs of our clients […]"* - Manager of PT. Waindo SpecTerra (refer to Question II.3 – Appendix 3)

"[…] The project we used to do in supporting the implementation of NSDI is to ***develop a Web GIS application*** *for local governments that displays thematic geospatial information needed by policy makers […]"* - Executive of PT. WebGIS Indonesia (refer to Question II.3 – Appendix 3)

However, some other interviewees stated that their company have not had any projects or activities related to NSDI. They just used the data provided in the national geoportal to complete their work. As one of the interviewees mentioned:

*"[…] **we access administrative boundary data from Ina-Geoportal** as the basis for making GIS applications for our clients […]"* - Managing Director of PT. Tiza Solusindo (refer to Question II.3 – Appendix 3)

In the meantime, NSDI activities that have been conducted by PPIDS – besides providing training, are include generating large and medium scale basic maps of local government and developing its geodatabase based on the national standard. As an interviewee expressed:

*"[…] for the provision of data **we assist in the development of large and medium scale maps** for example in Medan Municipality. At the same time, **we also help developing the geodatabase**. Currently we are helping the city of Bandung by implementing the SDI concept in the management of geospatial data […]"* - Head of Center for SDI Development of Bandung Institute of Technology (refer to Question II.3 – Appendix 3)

4.3.3. NSDI Problems and Requirements

A wide variety of problems occurred in NSDI implementation were mentioned in our interviews. The first major problem is low participation of the NSDI network nodes, thus resulting a small number of datasets accessible in Ina-Geoportal. According to the interviewees, low participation may caused by the lack of awareness of NSDI benefits or there is a reluctance to share geospatial data. Some of the interviewees expressed:

*"In my opinion the main problem faced is **the low participation of agencies** which causes the limited availability of data. In terms of thematic data, there is still reluctance by agencies to share data, perhaps because there is no clear protocol of how to do it […]"* - Director of PT. ESRI Indonesia (refer to Question III.1 – Appendix 3)

*"I think that the constraint experienced in NSDI is the reluctance of institutions to share data that resulted in **small number of participating institutions**. There is unawareness of the institution about the importance of the data being disseminated. For example, forestry data is useful for forestry ministries, land data is useful for BPN but never felt useful for other agencies even though other agencies need it. Thus, they do not prepare infrastructure or procedures to distribute the data […]"* - Lecturer at University of Pakuan (refer to Question III.1 – Appendix 3)

*"[…] I also see there is still sectoral ego that causes **low participation of institutions in sharing data**. In our country it still happens like that which can*

hinder the development of NSDI […]" - Official from Spatial Planning and Land Agency of Jakarta Province (refer to Question III.1 – Appendix 3)

In order to know the real condition, a longitudinal observation on Ina-Geoportal was conducted during September 2016 to September 2017. The results shows there is a slight increase of data providers but in contrary, the number of datasets were decreased sharply during this period. This is because some of the institutions discontinue their data services. Five data providers stop their web services in 2017 but at the same time there are eight new data providers as described in Figure 4.5. Significant reduction of dataset availability occurred because most of the quitting institutions have a large number of datasets, for example Aceh Province (257 services) or BMKG (96).

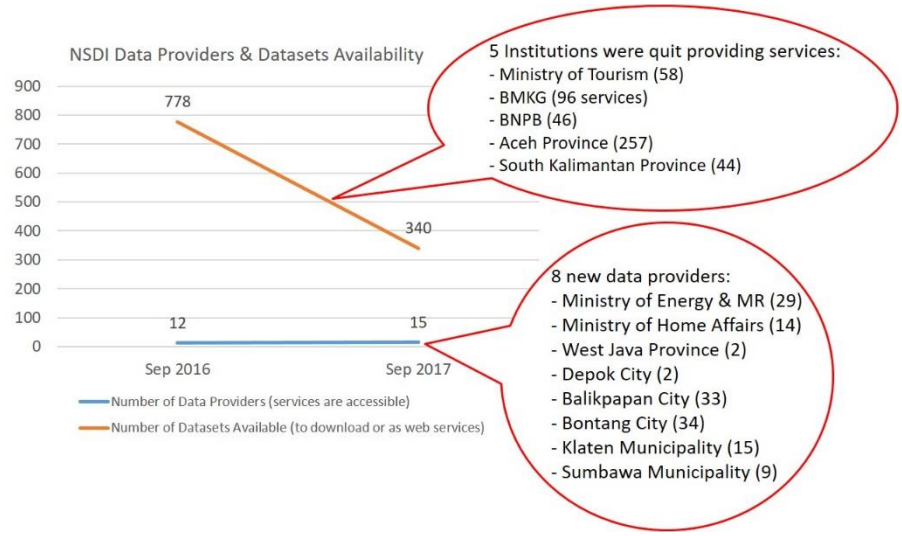


Figure 4.5 Low participation and dataset availability of Ina-Geoportal

The second problem based on the interviews is the lack of large-scale dataset availability. Some of the interviewees were argued that more detail maps in 1:5,000 scale is necessary for creating spatial planning map required in the regional development. As some of the interviewees expressed:

*"**According to us the main problem is data, we need a large-scale base map**. Its availability is very important, especially for BPN in supporting land and parcel mapping […]"* - Official from National Land Agency (refer to Question III.1 – Appendix 3)

*"[…] **Data on administrative boundary with 1: 5,000 scale are still limited** although we require it as the base map in our thematic geospatial information*

product […]" - Official from Ministry of Environment and Forestry (refer to Question III.1 – Appendix 3)

*"[…] **Data availability is still lacking**, especially data used for analysis, for example spatial planning data. Spatial planning requires a more detailed data at least 1: 5,000 scale, which still needs to be accelerated its availability […]"* - Director of PT. ESRI Indonesia (refer to Question III.1 – Appendix 3)

Perspective of the interviewees regarding this problem were in accordance with the recent report by Abidin (2017), who explained that there are only about 1% topographic maps 1:5,000 scale available. Most of the basic maps provided by BIG is in the medium scale e.g. 1:25,000 and 1:50,000 (Table 4.3).

Table 4.3 The availability of Topographic Maps in Indonesia

Map Scale	Nationwide Coverage	Available (Mapsheets)	Available (%)	To be done (Mapsheets)
1:5,000	377,824	3,922	1.04%	373,902
1:25,000	13,036	4,777	36.64%	8,259
1:50,000	3,899	3,402	87.25%	497
1:250,000	309	309	100%	0
1:500,000	103	103	100%	0
1:1,000,000	37	37	100%	0

Subsequently, the third challenge is the lack of human resources that have capability in GIS field. Mainly government institutions recognize this shortfall where employee rotation often occurs. The number of staff who have ability to manage geospatial information and operate geospatial server to publish map services is also limited. As some of the interviewees stated:

*"[…] Moreover, **personnel or staff who has capabilities in geospatial information field is insufficient**; not only in quantity but also related to employee rotations that occur quite often, so we have difficulty finding a replacement […]"*- Official from Regional Development Planning Agency of West Java Province (refer to Question III.1 – Appendix 3)

*"[…] We also have difficulties in human resource aspect. Because of **insufficient skilled personnel**, sometimes operator in the field does not have technical*

background from geospatial science […]"- Official from Ministry of Public Works and Public Housing (refer to Question III.1 – Appendix 3)

"The first challenges in implementing NSDI in our opinion is ***problem of human resources capacity****. We require workforces not only in the field of geography or geodesy, but also in practicing and developing applications of geospatial information system […]"* - Executive of PT. WebGIS Indonesia (refer to Question III.1 – Appendix 3)

Other difficulties identified by the interviewees are include limited Internet and Information Communication Technology (ICT) infrastructure and the national geoportal functionality issue. One of the interviewee expressed:

"In my opinion the most crucial thing is ***the Internet connection and its infrastructure*** *in the local government. Our research in 2015 found that Internet connections are still very weak in provinces and municipalities/districts, especially for publishing geospatial data. If NSDI wants to connect network nodes in all local governments, then this problem must be resolved. Even at the ministry or state institutions, there is still a connection issue but not too many. Secondly, in the aspect of Ina-Geoportal I think we have to make* ***a better geoportal****. The functionality must be further improved. For example, we cannot access metadata even though usually user first time visit geoportal is to search geospatial data via the metadata. We are unable to discover existing web services like WFS or WMS […]"* - Head of Center for SDI Development of University of Gadjah Mada (refer to Question III.1 – Appendix 3)

Four interviewees also mentioned about the quality of the spatial data produced by the data provider. They think it is necessary to improve the quality, particularly its accuracy and temporal update. As some of the interviewees stated:

*"****Quality of the geospatial data is a challenge*** *that I think must be improved. Do not let users have a bad first impression to the data provided by the government, that it is not accurate and up-to-date […]"*- Managing Director of PT. Tiza Solusindo (refer to Question III.1 – Appendix 3)

"[…] Spatial data needs with a large-scale resolution are needed by the government and the private sectors. At the moment, I feel that the ***data is difficult to obtain*** *and even if it is available,* ***part of them are not up-to-date****. This is a challenge for us. The data cycle if it takes too long will be less useful, especially for us in the field of facilities and public utilities. If the government can provide and*

share detailed data with the private sector, we will be very happy. We can also contribute to a mutual cooperation such as in updating this data […]" - Manager at PT. PAM Lyonase Jaya (refer to Question III.1 – Appendix 3)

Another issue that concerns the interviewee is absence of the operational guideline for the implementation of NSDI. As some of the interviewees expressed:

"[…] from the physical side, it is good enough, but from ***the standard operation procedure side it is still lacking****. For example operational guidance for publishing data or standard operation procedure for maintenance the reliability […]"*- Executive of PT. WebGIS Indonesia (refer to Question III.1 – Appendix 3)

"[…] I think until now ***the vision and grand design of the NSDI is not yet available*** *so it is still unclear where the position of the geospatial industry is […]"* - Director of PT. ESRI Indonesia (refer to Question III.1 – Appendix 3)

Furthermore, the interviewees acknowledged other obstacles that happened in their institutions such as limited funding for NSDI operation, low adoption of GIS technology and lack of standard implementation. As some of the interviewees expressed:

"[…] We also have ***limitations in providing funds*** *for maintenance, especially for purchasing GIS software licenses and hardware […]"* - Official from Ministry of Environment and Forestry (refer to Question III.1 – Appendix 3)

"[…] Another problem faced is the ***lack of budget*** *where we need a new strategy to be as efficient as possible through partnership […]"*- Director of PT. ESRI Indonesia (refer to Question III.1 – Appendix 3)

"Actually I think the technology...the GIS technology is growing fast, sometimes we are behind it and at the same time we have to socialize these technologies to our colleagues in the working unit, while we ourselves have not had time to update and master, there are already newer technologies. Therefore, ***the low adoption of technology*** *is an obstacle for us […]"* - Official from Ministry of Public Works and Public Housing (refer to Question III.1 – Appendix 3)

"[…] Another important thing is ***the lack of adaptation to new technology****. We must be able to use and take advantage for emerging GIS technology such as drone or UAV, so we will not to be left behind by other nations […]"*- Managing Director of PT. Tiza Solusindo (refer to Question III.1 – Appendix 3)

"[…] The main challenge is that ***many geospatial data have not been standardized****. When we have project with local government, usually each local agencies have their own data with different format. Therefore, we need more efforts to integrate*

such data […]"- Officer at PT. Qlue Performa Indonesia (refer to Question III.1 – Appendix 3)

Table 4.4 summarizes the problems stated by interviewees from Public (Pu), Private (Pr) and Academic (Ac) institutions, together with the number of times they were stated.

Table 4.4 Interview results of NSDI problems identification

Problems of NSDI	Institutions			Sum
	Pu	Pr	Ac	
Low participation from the NSDI network nodes	5	3	2	10
Insufficient large-scale maps	4	2	2	8
Lack of skilled human resources	4	2	1	7
Limited Internet and ICT infrastructure	2	2	1	5
Limited functionality and reliability of the Ina-Geoportal	1	2	1	4
Low spatial data quality	1	2	1	4
Absence of operational guidance	1	2	-	3
Limited funding	1	1	-	2
Low adoption of GIS technology	1	1	-	2
Lack of standards implementation	1	1	-	2

Most interviewees stated that they require large-scale fundamental datasets to be provided by NSDI. Its availability will be important as the base map to generate other thematic datasets such as urban planning and public utility management. Meanwhile, the majority of respondents from business sector need socio-economic data that represents population distribution and other commercial information. Although the data can be obtained at the Central Bureau of Statistics, it will be more useful if the data is in the form of geospatial services and can be integrated with other applications. Some of the respondents also considered real-time data from weather or environmental sensors is essential particularly to support early warning system. Other data or service required for future NSDI implementation are presented in Table 4.5.

Table 4.5 Interview results of data/services required for NSDI

Required data/services	Institutions			Sum
	Pu	Pr	Ac	
Large-scale fundamental datasets	6	2	1	9
Socio-economic data	-	4	-	4
Real-time weather and environment data	2	1	1	4
Point of Interest (POI) data	-	2	1	3
Disaster risk information	1	1	1	3
Land parcels	1	-	1	2
Spatial planning	1	1	-	2

The interviewees expressed different expectations for future NSDI. In general, they expect to have more geospatial data and applications. They believe NSDI should be able to provide good quality spatial data in term of resolution and completeness as the basis for added-value information creation. Some of the respondents consider future application of NSDI will be integrated with different types of data to support geospatial analytics, which is important for decision makers. Table 4.6 describes the list of their expectations.

Table 4.6 Expectations of future NSDI from users' point of view

Type of Institutions	Expectation
Local government	- NSDI can handle and integrate in situ data which is collected by sensor networks - NSDI should encourage creation of location-based mobile applications - NSDI should support the provision of geospatial data
National Government	- Access to high-resolution spatial data will be more easy and reliable - Integrate various thematic maps and data formats produced by network nodes - The development of NSDI should be sustainable, not a partial project
Private Sector	- NSDI should provide geo-services applications for general user and developer - Improve the quality and reliability of geospatial data - Future NSDI should drive the development of geospatial industry in Indonesia
Academia	- NSDI should increase data coverage and geo-services in remote area - NSDI should promote value-added creation of geospatial data that stimulate innovation - NSDI will increase the awareness of decision makers

4.4. Summary

Indonesia has started NSDI development for more than 20 years; however, there are difficulties faced by the stakeholders. Semi-structured interviews were conducted to identify the problems. Based on the stakeholder's perspectives, the three top problems are low participation from the institutions, insufficient large-scale geospatial data, and lack of skilled human resources. The problems of NSDI implementation can be grouped into four main

category: Data, Technology, People, and Institutional as presented in the fishbone diagram (Figure 4.6).

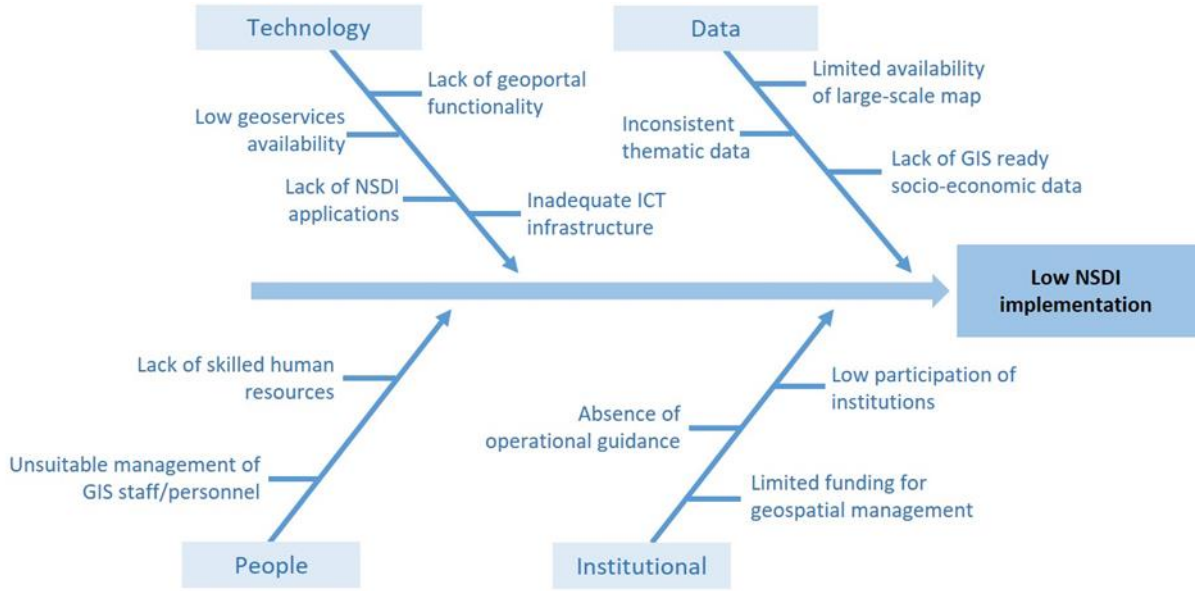


Figure 4.6 Fishbone diagram of NSDI problems

Chapter 5
NSDI STAKEHOLDER AND COST ANALYSIS

5.1. Overview

The previous chapter discusses about the difficulties exist in the NSDI implementation. It is important to investigate why these problems happened in order to offers solutions. Since NSDI is a complex system that involved multi actors and requires financial resource, the author employs approach to analyze the stakeholder and cost. The following subsections explains details of the analyses.

5.2. NSDI Stakeholder Analysis

5.2.1. Literature Review

Stakeholder analysis is widely used by various organizations and institutions in many different fields such as environmental management (Brown et al., 2016) and e-government project (Rowley, 2011). The process typically consists of three steps: identifying stakeholders, differentiating and categorizing stakeholders, and investigating relationships between stakeholders (Reed et al., 2009). Stakeholder analysis can be undertaken throughout all stages of the project cycle. In the early stages of a project, it can be used to inform the development and consideration of alternatives, or if a project has been implemented, it is suitable to manage stakeholders effectively over the duration of the plan (Rowley, 2011).

Despite of several authors have suggested that strengthening the management of stakeholders is the key to NSDI implementation (Castelein et al., 2013; Harvey et al., 2012; Sjoukema et al., 2017), limited research has been conducted in this area. In Hjelmager et al. (2008) stakeholders of SDI is defined and classified into six types (Policy Maker, Producer, Provider, Broker, Value-added Reseller and End User) using Unified Modeling Language (UML) use case diagrams based on the enterprise viewpoint. These types of formal description, known as the International Cartographic Association (ICA) model, then further extended into subtypes with their specific roles because of the influence of Volunteered Geographic Information (VGI) trend (Cooper et al., 2011). The ICA model has been applied in Namibia (Sinvula et al., 2013) and Ghana (Owusu-Banahene et al., 2013) to provide an understanding of present stakeholders' characteristics in each countries. Moreover, (Sinvula et al., 2017) proposes recommendations to refine the typology after conducting a comparative study in three African nations. This model is also used to specify a corporate SDI (Oliveira et al., 2017).

Although the ICA model is useful for identifying roles and responsibilities of NSDI stakeholders, the explanation of how each stakeholder's resource can influence NSDI implementation remains unclear. A more comprehensive stakeholder analysis is necessary to describe the interrelations among them.

5.2.2. Method

The NSDI Stakeholder Analysis Framework follows the three steps process that necessary for stakeholder analysis based on Reed et al. (2009). The framework illustrated in Figure 5.1 consists of identifying stakeholders, categorizing stakeholders, and investigating relationships. In the first step, identification of NSDI stakeholders, we collect documentary evidences, including legal documents, meeting records, and annual reports. The familiarity of the authors with Indonesia NSDI facilitates access to these documents. Additionally, in-depth observation to the national geoportal were conducted for identifying users and participated actors.

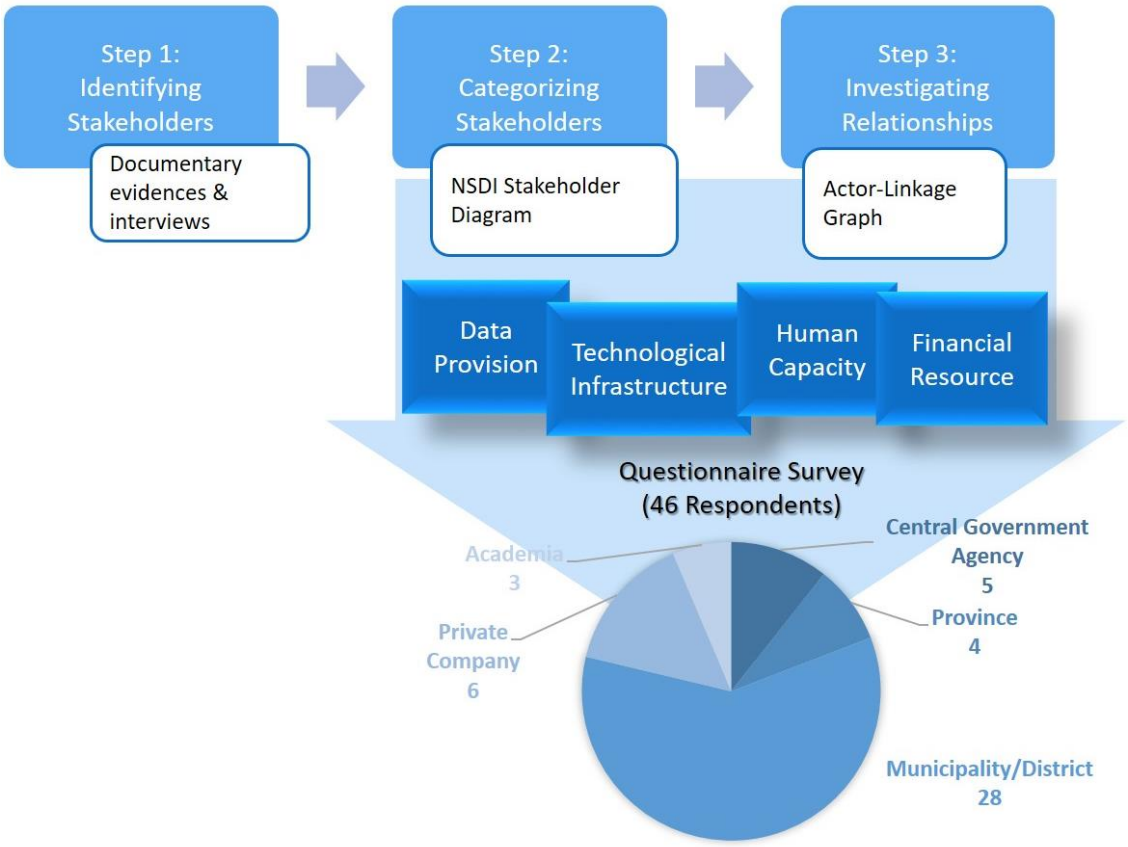


Figure 5.1 Framework of NSDI Stakeholder Analysis

For the next step, categorizing stakeholders, we adopt the Power-Interest Grid method introduced by Ackermann and Eden (2011). It is one of the popular method that classify

stakeholders into four quadrants – Players, Context Setters, Subjects, and Crowd – based on their power to influence and their interest in a project (Ackermann and Eden, 2011; Reed et al., 2009). Stakeholders in the upper two quadrants are those who have the most interest in the project, but with varying degree of power to influence. They are Players – positioned on the right hand side have more power to affect the system, whereas Subjects have less significant influence. The two lower quadrants display stakeholders with less interest; the Context Setter may have a high degree of power while the Crowd show low power and low interest to the system as well (Ackermann and Eden, 2011). Despite of its benefit in classifying stakeholders, this method have limitations that it tends to identify the `usual suspect' and often is used in the absence of direct stakeholder participation in the analysis (Reed et al., 2009). To overcome these biases in determining NSDI stakeholders, we determine four factors that play important role in the implementation of an NSDI: geospatial data provision, technological infrastructure, financial resource, and human capacity. These indicators were excerpted from the questionnaire surveys (described in Appendix 5) to gather more understanding of each stakeholder resources to NSDI implementation. In total, there are 46 participated respondents from different institutions consisting of 5 from central government agencies, 4 from provincial governments, 28 from municipalities/districts, 6 from private companies and 3 represent academia (see Appendix 4 for detailed list of the respondents). The questionnaires were distributed by mail in April 2016 with a collaboration with BIG and PPIDS University of Gadjah Mada, and feedbacks are collected during June-July 2016 and during interview activities in August 2017. Table 5.1 describes the four NSDI features of stakeholder capabilities with the detailed indicators presented using five-point Likert scale.

Table 5.1 NSDI Stakeholder features and their indicators

NSDI Features	Indicators
Geospatial data provision	1 = No geospatial data available
	2 = Non-GIS data format available
	3 = Basic geospatial data available
	4 = Basic and thematic data available
	5 = All of point 4 plus data conform with the national catalogue
Technological infrastructure	1 = No GIS software/hardware and Internet network
	2 = GIS Software or Internet network available
	3 = GIS Software/hardware and Internet network available
	4 = GIS Software/hardware, GIS Server and Internet network available
	5 = All of point 4 plus geoportal and dedicated data center available

Table 5.1 (*Continued*)

Financial resource	1 = No budget for data provision and dissemination 2 = Incidental (non-routine) budget 3 = Annually small budget (< IDR 1 Billion/USD 74,000) 4 = Annually medium budget (IDR 1-5 Billion/USD 74,000-370,000) 5 = Annually large budget (> IDR 5 Billion/USD 370,000)
Human Capacity	1 = No GIS workers available 2 = Small number of GIS workers (1-5 people) 3 = Several GIS workers available (6-10 people) 4 = Large number GIS workers available (>10 people) 5 = Large number and Professional GIS workers

The final step is investigating relationships among the stakeholders involved in NSDI implementation. Actor-linkage table is used to list and describe interrelations in rows and columns. To determine whether the relationships is strong, weak or unconnected, we define three indicators as follows: existence of annual cooperation, presence of regular meetings (at least once a month), and existence of data sharing between them. Based on the table we can draw Actor-linkage graph, which illustrates their connections and degree of centrality.

5.2.3. Results

- **Identification of NSDI Stakeholders**

The NGIN Decree is explicitly specifies the institutions involved in implementing NSDI in Indonesia. They are called as network nodes, which consists of State Institutions, Central Government Agencies, National Police, National Army Force, Provincial Government, and Municipality/District Government. Examples of States Institutions are include House of Representatives, Supreme Court and Supreme Audit Institution whereas Central Government Agencies comprise of ministries and non-ministerial government institutions. Besides the network nodes, the decree also mentioned that general users could participate in the geospatial information networks.

According to NGIN Decree, BIG as the Network Node Connector can establish a cooperation with other institutions to improve NSDI implementation in local government. Therefore, BIG invites local universities with relevant geospatial information expertise to take part in the activities. This collaboration, known as Center for SDI Development (Pusat Pengembangan Infrastruktur Data Spasial/PPIDS) who act as a regional center for innovation and consultation for neighboring local governments. By the end of 2015, there are 13

universities which have been established PPIDS including Gadjah Mada University, and Bandung Institute of Technology (Badan Informasi Geospasial, 2015c).

Figure 5.2 Ina-Geoportal users by type of institutions

In addition to the documentary facts, the author also observed the users of Ina-Geoportal to identify other actors. Based on the data received from BIG, there are 17,397 registered users as per December 2017 (Figure 5.2). Most of the users (55.4%) are come from academia, which includes researchers, lecturers, and students. Visitors from private sectors mainly are surveys and mapping companies, GIS software providers, and geospatial information developers. Moreover, other type of users are including from Non-Government Organizations (NGOs)/Non-Profit Organizations (NPOs), veteran, unemployed, and general citizens.

After analyzing the evidences, we can identify 15 stakeholders involved in Indonesia NSDI as presented in Figure 5.3.

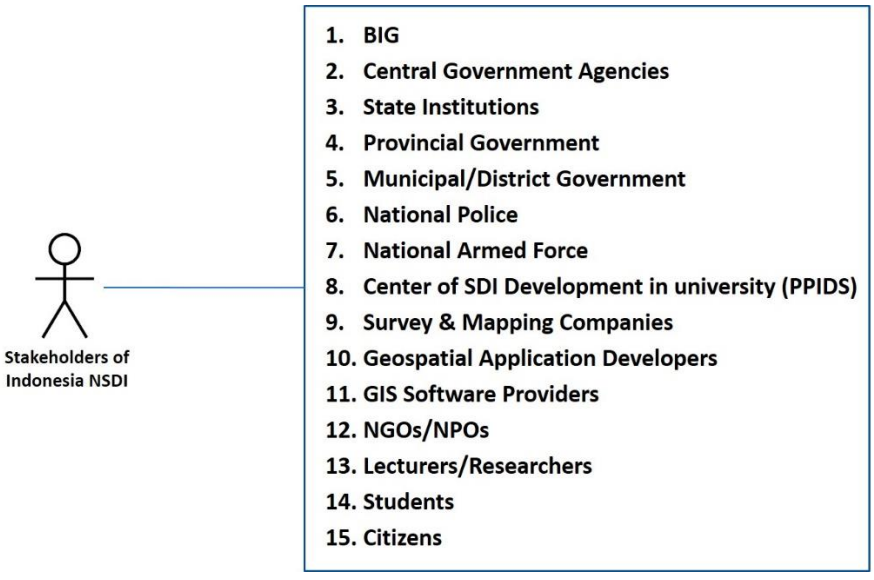


Figure 5.3 Stakeholders of Indonesia NSDI

Seven of the NSDI stakeholders are from the government agencies (number 1 to 7). Each of this institution is responsible in providing geospatial data based on their particular function. For instance, BIG as the national mapping agency has a duty to produce basic geospatial maps which include topographic layer, coastal and marine environment. In case of Central Government Agencies, they consist of 34 ministries and 30 non-ministerial government institutions. Presidential Decree No. 9/2016 specify some of the thematic data that should be arranged by these institutions. Table 5.2 outlines data contents of some Central Government Agencies.

Table 5.2 Data contents of the Central Government Agencies

Name of Institution	Data Content
BIG	Topographic maps, coastal maps, geodetic networks
National Institute of Aeronautics and Space (LAPAN)	Satellite imagery
Central Bureau of Statistic (BPS)	Demography, socio-economic data
Meteorological, Climatological, and Geophysical Agency (BMKG)	Meteorological and climatological data
Ministry of Agrarian and Spatial Planning/National Land Agency (BPN)	Cadaster, land use, nation-wide spatial planning
Ministry of Environment and Forestry (KLHK)	Forest zoning and exploitation permit, forest resources, watershed
Ministry of Public Works and Housing (KPUPR)	National road network, dam, landfill, harbor, water resources, public housing
Ministry of Energy and Mineral Resources (KESDM)	Geological map, electricity network, mineral resources map
Ministry of Transportation (Kemenhub)	Transportation network and infrastructure
Ministry of Marine Affairs and Fisheries (KKKP)	Fisheries resources and management area, sea conservation area, fishing port
Ministry of Agriculture (Kementan)	Soil map, crop land area & production, peatland
Ministry of Home Affairs (Kemendagri)	Administrative boundary, customary land map

- **Categorization of NSDI Stakeholders**

Each of the stakeholders defined in the previous step has their own interest and power to affect NSDI implementation. Power refers to the capability of stakeholders to arrange their own

SDI and is explicitly mandated as the network node by the regulation. For example, the Central Government Agencies have interest in NSDI because they want to collect topographic maps, exchange thematic data with other institutions, and access the geospatial web services as well. They are considered have a high power because based on Presidential Decree No. 27/2014 they have responsibility to build network node. They are able to establish internal policy to support NSDI implementation and they have ability to provide resources such as budget to operate it.

Meanwhile, some of the stakeholders (number 8 to 15) are examined have low power to influence since they are not explicitly mandated by the regulation. They are considered as the user of NSDI with no obligation to publish geospatial data in the national geoportal. Based on the interview and secondary documents, the author creates Table 5.3 to list of the interests and power of each stakeholders.

Table 5.3 Interest and power of NSDI Stakeholders

No.	Stakeholder	Interest	Power to influence
1.	BIG	- Disseminate basic geospatial information - Collect thematic data - Establish network nodes connection - Access web services	- Has the function as the Network Node Connector (Presidential Decree No. 27/2014)
2.	Central Government Agencies	- Collect topographic maps - Share thematic data - Access web services	- Has the function as member of the Network Node (Presidential Decree No. 27/2014)
3.	State Institutions	- Collect basic geospatial data	- Has the function as member of the Network Node (Presidential Decree No. 27/2014)
4.	Provincial Government	- Collect topographic maps and thematic data - Integrate data from local government agencies - Access web services	- Has the function as member of the Network Node (Presidential Decree No. 27/2014)

Table 5.3 (*Continued*)

5.	Municipality/ District Government	- Collect topographic maps and thematic data - Integrate data from local government agencies - Access web services	- Has the function as member of the Network Node (Presidential Decree No. 27/2014)
6.	National Police	- Collect basic and thematic data	- Has the function as member of the Network Node (Presidential Decree No. 27/2014)
7.	National Armed Force	- Collect topographic maps and thematic data	- Has the function as member of the Network Node (Presidential Decree No. 27/2014)
8.	PPIDS	- Collect basic and thematic data - Access web services - Research on SDI - Collaborate with network nodes	- Has a Memorandum of Understanding with BIG
9.	Survey and Mapping Companies	- Collect basic and thematic data	- Act as NSDI user (not a member of the network nodes)
10.	Geospatial Application Developers	- Collect basic and thematic data - Access web services	- Act as NSDI user
11.	GIS Software Providers	- Collect basic and thematic data - Provide software for network nodes	- Act as NSDI user
12.	NGOs/NPOs	- Collect basic and thematic data - Access web services	- Act as NSDI user
13.	Lecturers/ Researchers	- Collect basic and thematic data - Access web services	- Act as NSDI user
14.	Students	- Collect basic and thematic data - Access web services	- Act as NSDI user
15.	Citizens	- Access Ina-Geoportal	- Act as NSDI user

Referring to the table of interest and influence, we draw the Power-Interest Grid of NSDI Stakeholders in Indonesia (Figure 5.4). In general, the Key Players are mainly from governmental institutions as well as the Context Setters. Most of the stakeholders have high interest in NSDI and seven of them are in the Subjects grid. Meanwhile, only citizens is threated as the Crowd since they have low interest and low power.

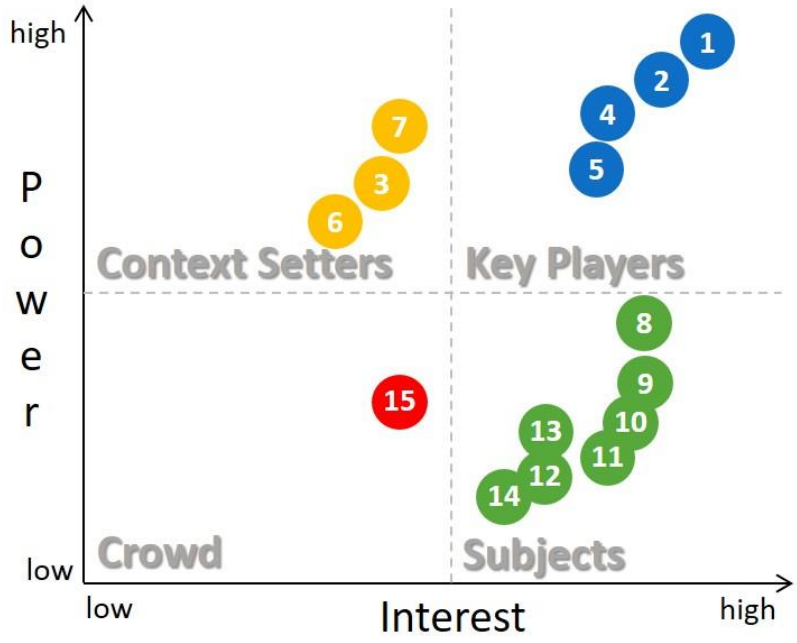


Figure 5.4 Power-Interest Grid of NSDI Stakeholders

Four institutions positioned as the Key Players (blue color) are BIG, Central Government Agencies, Provincial Government, and Municipality/District Government. They have high interest in utilizing geospatial information particularly collecting basic and thematic maps. All of these stakeholders were specified in the NGIN Decree as the Network Nodes while BIG had an additional role as the Network Node Connector, hence its position is slightly higher than other stakeholders.

Central Government Agencies, Provincial Government, and Municipality/District Government have the same role as member of the network nodes. However, the data coverage of the Central Government Agencies is nationwide data so that the position is above the other two. Likewise, the Provincial Government based on administrative regulations has a higher position than the Municipality/District Government. They have issued their own regulation to arrange the resource needed for NSDI implementation. For example, the Ministry of Forestry and Environment published Ministerial Decree No. P28/Menlhk/Setjen/KUM.1/2/2016 about Geospatial Information Network as well as West Java Province issued Governor Decree No. 80/2015 for One Data Development in West Java. Key Players influence the NSDI since

generally they provide geospatial data and web services in NSDI Network that can be accessed by other institutions.

The second grid reflects the Context Setters (yellow color), in which they have the capability to affect NSDI operation but possess little interest. Stakeholders in this group are State Institutions, National Police and National Armed Force. In Indonesia, the State Institutions are those who have the authority granted by the 1945 Constitution such as House of Representatives, Regional Representative Board, Supreme Court, and Supreme Audit Investigation.

All of these stakeholders is defined as the member of central network nodes. The position of the National Armed Force is to some extent higher than both others since it has a working unit of geospatial information, called Topographic Directorate of Army. Meanwhile, State Institutions are considered have higher power than the National Police, for example the House of Representatives, which has the authority to make laws. Nevertheless, the Context Setters interest in NSDI is still limited to collect basic geospatial data.

There are seven stakeholders in the Subjects grid (green color) that can be classified into institutions from private sectors, academia, and NGOs/NPOs. Most of them have strong interest in collecting geospatial data and accessing the services from geoportal, particularly for the researchers and students. PPIDS has more importance since they perform cooperation with BIG in supporting some research related to the utilization of geospatial information as well cooperating with local government to improve human resource capacity. In the meantime, the private sectors have roles in the geospatial data acquisition and in developing geospatial applications. Most of private sectors are Survey and Mapping companies in which they get the project from government institutions, so that their position is somewhat above Geospatial Application Developers and GIS Software Providers. Furthermore, Lecturers/Researchers, NGOs/NPOs, and Students have the same interest and power, the slight difference is Lecturers/Researchers have more impact on its utilization of geospatial data for research.

The last grid is the Crowd (red color), which generally consist of the citizens who mainly access the national geoportal to explore map visualization and look for basic geospatial information.

Despite of its advantage in characterizing the stakeholders according to their interest and influence, the Power-Interest Grid is unable to provide correlation with their resources. Therefore, the author creates NSDI Stakeholder Diagram to overcome this limitation. The results of the questionnaire surveys to identify four features of NSDI Stakeholders is used as the foundation for composing the diagram.

The questionnaire results in term of data availability of each stakeholder is described in Figure 5.5. This figure shows that BIG and 60% of the Central Government Agencies have largely geospatial data that can be integrated since they conformed with the national catalogue. State Institutions, National Police and a small number of Municipalities/Districts have data related to location but in non-GIS format such as pdf or Microsoft Excel files. Meanwhile, most of the Subjects Stakeholders are equipped with basic geospatial data except PPIDS that also possess thematic data.

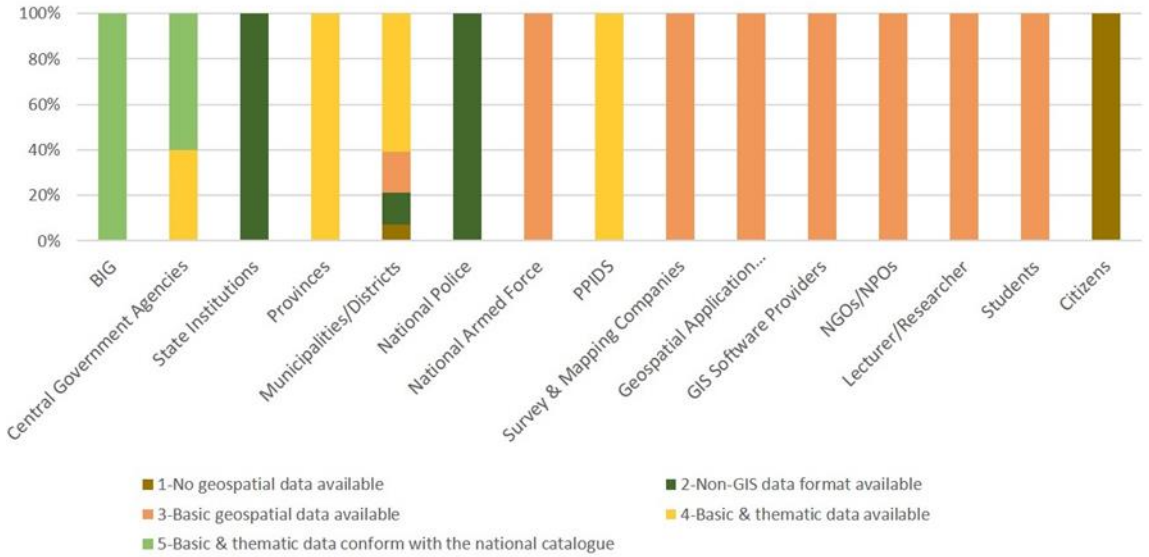


Figure 5.5 Questionnaire results on data provision of the stakeholders

From the questionnaire results related to technological infrastructure, we can see most of the Key Players have good resource (Figure 5.6). However, some of Municipalities/Districts do not possess GIS Software nor Internet connections and only 20% are capable in publishing data.

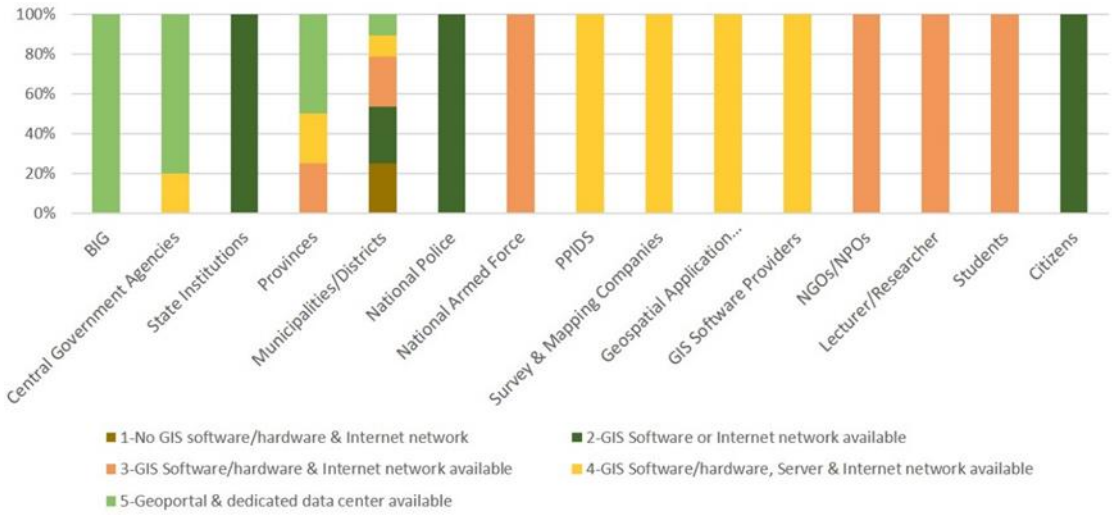


Figure 5.6 Questionnaire results on technological infrastructure

In the aspect of human capacity, BIG and Central Government Agencies are supported with a large number of skilled personnel as well in the private sectors. Insufficient number of GIS personnel are happened mostly in seven institutions of the NSDI Stakeholders including Provinces, Municipalities/Districts, and State Institutions as illustrated by Figure 5.7.

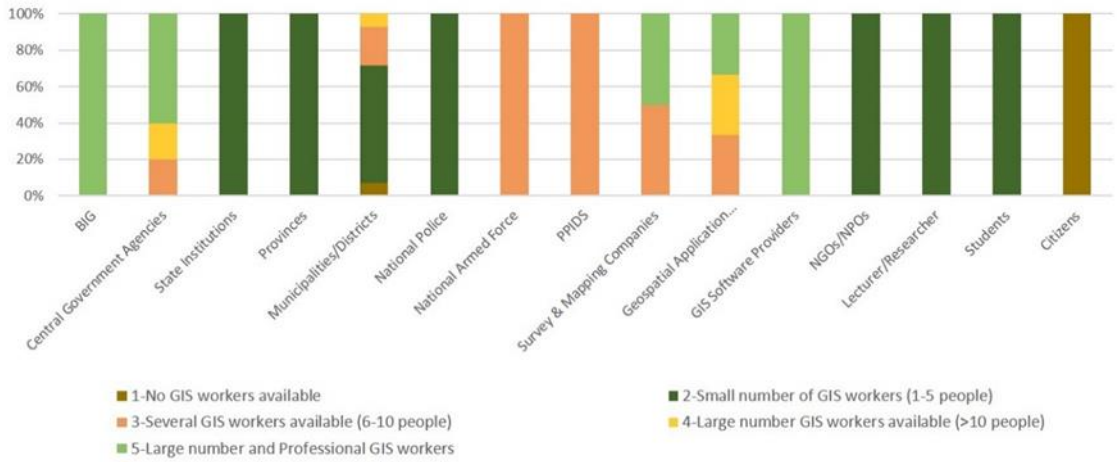


Figure 5.7 Questionnaire results on human capacity resource

Results on the financial resource reveals that BIG and Central Government Agencies backed up with appropriate sustainable budget for geospatial data provision and dissemination (about 5 Billion IDR/USD 370,000 annually). The financial support in Municipalities/District are varied with half of them do not have budget. Meanwhile, some of the stakeholders including State Institutions, NGOs/NPOs and researcher are usually only have incidental or project based financial support. Figure 5.8 presents the questionnaire results related to financial support for NSDI activities of each stakeholders.

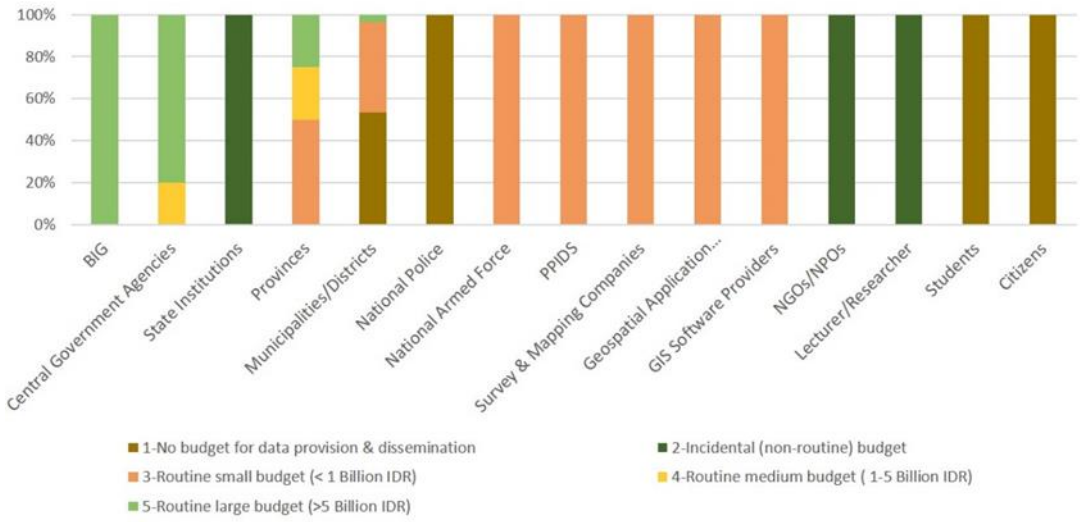


Figure 5.8 Questionnaire results on financial resource

From the questionnaire results, we determined the average value of five-point Likert scale of the four NSDI features. Table 5.4 describes value of each stakeholder in term of data provision, technological infrastructure, human capacity, and financial resource.

Table 5.4 Average Likert Scale values of NSDI Stakeholder Features

No.	Stakeholder	Data Provision	Technological Infrastructure	Human Capacity	Financial Resource
1.	BIG	5.0	5.0	5.0	5.0
2.	Central Government Agencies	4.6	4.8	4.4	4.8
3.	State Institutions	2.0	2.0	2.0	2.0
4.	Provinces	4.0	4.2	2.0	3.8
5.	Municipal/ District Government	3.3	2.5	2.3	2.0
6.	National Police	2.0	2.0	2.0	1.0
7.	National Armed Force	3.0	3.0	3.0	3.0
8.	PPIDS	4.0	4.0	3.0	3.0
9.	Survey and Mapping Companies	3.0	4.0	4.0	3.0
10.	Geospatial Application Developers	3.0	4.0	4.0	3.0
11.	GIS Software Providers	3.0	4.0	4.0	3.0
12.	NGOs/NPOs	3.0	3.0	2.0	2.0
13.	Lecturers/ Researchers	3.0	3.0	2.0	2.0
14.	Students	3.0	3.0	2.0	2.0
15.	Citizens	1.0	2.0	1.0	1.0

Based on this calculation we illustrated the association between stakeholders' interest and power with their existing resource in an NSDI Stakeholder Diagram (Figure 5.9). This is helpful in providing some answers to the second research question, 'Why do problems of NSDI implementation happened?'

One of the main problem identified in interview activities is lack of skilled human resources. Based on the NSDI Stakeholder Diagram it is clear that the distribution of skilled personnel is disproportionate. Most of the GIS staffs are working at the Central Government Agencies and Companies. The local governments mainly face this condition where they also experienced fast rotation of the personnel. Additionally, according to interview results, the capacity building activities like training and education for existing staff is also limited. Besides local government agencies, this condition also happened with other stakeholders such as State Institutions, National Police, and National Armed Force.

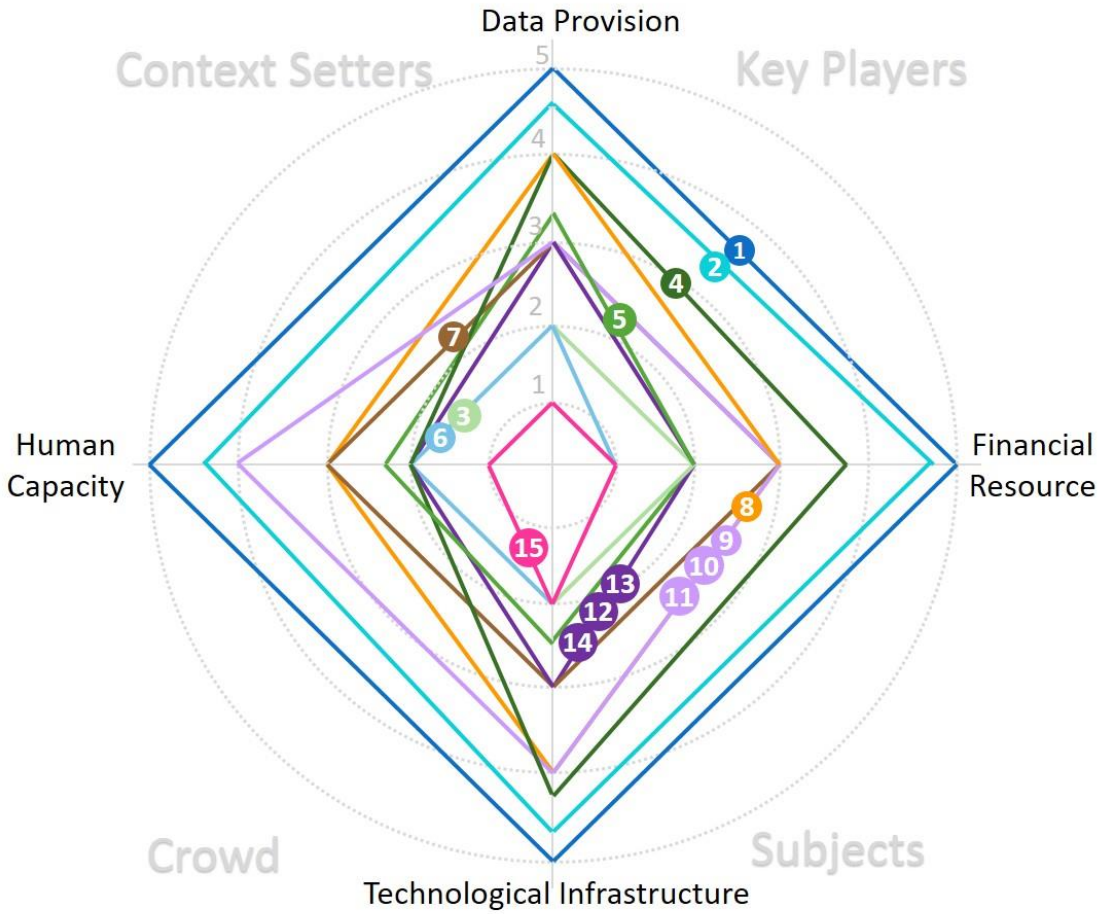


Figure 5.9 NSDI Stakeholder Diagram

The second big problem is low participation from the institutions. By looking at the NSDI Stakeholder Diagram, we can understand that in the Key Players quadrant, only BIG (1) and Central Government Agencies (2) have the adequate resources. All the others actors, although they possess strong interest and influence but have limitations in their resources. For example, Municipalities/Districts (5) have shortcomings in the aspect of human capacity, technical infrastructure, and financial support that causes them passively contribute to NSDI network. In case of the Context Setters, it is evident that State Institutions and National Police have lack of the NSDI features as they only score 2.0 for most of the indicators.

- **Relationships of NSDI Stakeholders**

In order to examine the interrelations between the NSDI stakeholders, at first we create the Action-linkage table. This table represents three indicators of relationships: existence of annual cooperation, presence of regular meetings, and existence of data sharing between stakeholders. For instance, in 2017 BIG has established Memorandum of Understanding (MoU)

regarding utilization of geospatial information with four Central Government Agencies, conducted one regular meeting monthly with them, and frequently shared seven geospatial datasets such as administrative boundary, building and transportation layers. Since the indicators have been fulfilled, we consider that strong relationship is exist between BIG and Central Government Agency. The Action-linkage table of some NSDI stakeholders is described in Table 5.5. The green color refers to a strong connections represented by existence of annual cooperation, regular meeting, and frequent data sharing. Meanwhile, the yellow color describes a weak connection where cooperation and meeting between the related actors are incidental as well as infrequent data sharing. Lastly, the red color labels no communication nor data sharing between them. The complete Action-linkage table is presented in Appendix 6.

Table 5.5 NSDI Action-linkage table of some stakeholders

Stakeholder	BIG	Central Government Agencies	Provincial Government	State Institutions
BIG		- 4 MoU - 1 meeting record - 7 datasets	- 5 MoU - 5 meeting records - 7 datasets	- No cooperation - No meeting - No data sharing
Central Government Agencies	- 4 MoU - 1 meeting record - 7 datasets		- 1 cooperation - 1 irregular meeting - 1 datasets	- No cooperation - No meeting - No data sharing
Provincial Government	- 5 MoU - 5 meeting records - 7 datasets	- 1 cooperation - 1 irregular meeting - 1 datasets		- No cooperation - No meeting - No data sharing
State Institutions	- No cooperation - No meeting - No data sharing	- No cooperation - No meeting - No data sharing	- No cooperation - No meeting - No data sharing	

Table 5.6 shows the total numbers of each connection among all the stakeholders. It can be seen that most of strong connections is dominated by BIG, followed by Survey and Mapping Companies, Provincial Governments, and Municipal/District Governments. Survey and Mapping Companies have four strong relations, where all of them is with government agencies since they are establishing mapping projects every year.

Meanwhile, strong relations exist between Provincial and Municipal/District Governments as they conducting cooperation and regular meeting as well as exchanging thematic datasets such as spatial planning map. Central Government Agencies have solid connections with BIG and Mapping Companies but relatively weak in collaboration with local government in term of geospatial information usage.

Table 5.6 Number of connections among NSDI Stakeholders

No.	Stakeholder	Number of connections
1.	BIG	5 strong, 4 weak
2.	Central Government Agencies	2 strong, 4 weak
3.	State Institutions	No connections
4.	Provincial Government	3 strong, 4 weak
5.	Municipal/ District Government	3 strong, 4 weak
6.	National Police	No connections
7.	National Armed Force	1 strong
8.	PPIDS	1 strong, 2 weak
9.	Survey and Mapping Companies	4 strong, 1 weak
10.	Geospatial Application Developers	4 weak
11.	GIS Software Providers	5 weak
12.	NGOs/NPOs	1 weak
13.	Lecturers/Researchers	1 weak
14.	Students	1 weak
15.	Citizens	1 weak

According to the table above, five actors (National Armed Force, NGO's/NPO's, Lecturers/Researchers, Students and Citizens) are considered only have one weak relations. This connection is appears mainly between them and BIG for incidental cooperation and frequent geospatial data access. Moreover, two stakeholders are identified have no connections based on the survey result: State Institutions and National Police.

Based on the number of connections results we can draw the NSDI Actor-linkage Graph as presented in Figure 5.10, to illustrate the interrelationships among each stakeholders in four quadrants of the Power-Interest Grid.

We can see that most of the strong interrelations exist between governmental agencies in the Key Players, since BIG coordinates NSDI implementation of Central Government Agencies, Provinces, and Municipalities/Districts. Nevertheless, BIG needs to raise communication with the Context Setters as currently only with the National Armed Force cooperation have been conducted. State Institutions and National Police are member of the NSDI Network who has high power in term of they are mandated to arrange their own network node. Therefore, it is important to increase their participation. BIG should initiates meeting or dissemination of geospatial information benefits to support their functions.

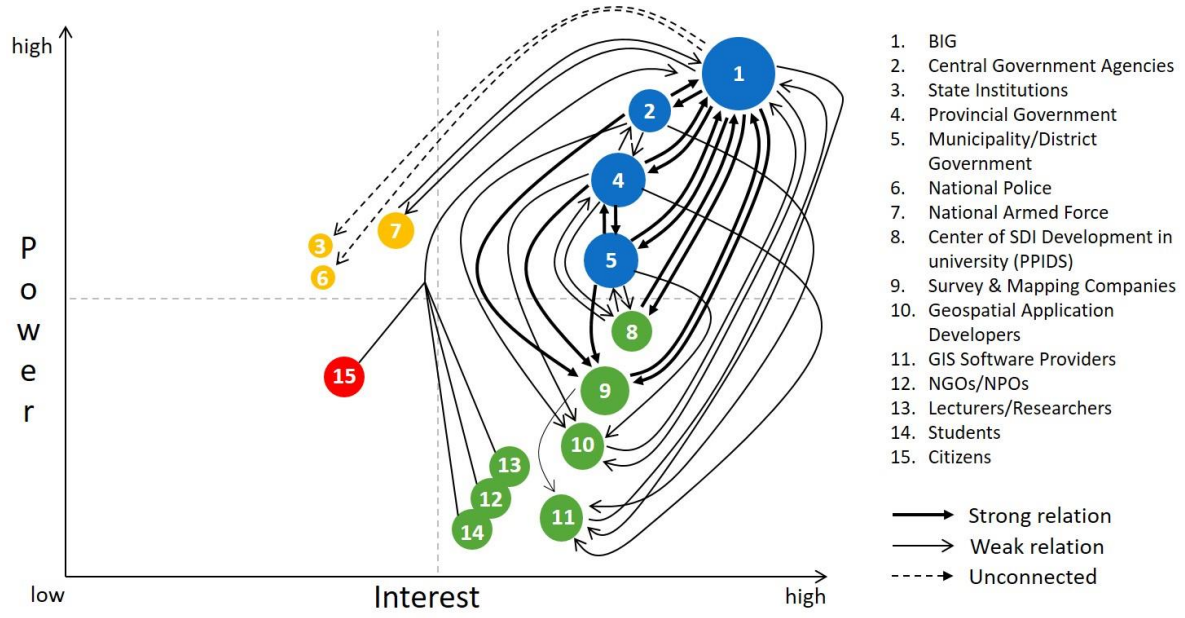


Figure 5.10 NSDI Actor-linkage Graph

The graph also reflects connections with the private sectors are varied. Mainly the strong connections are exist between Government Agencies with the Survey and Mapping Companies because of cooperation on digital mapping projects. Meanwhile, weak connections are identified between the Key Players and Geospatial Application Developers (four weak relationships) and GIS Software Providers (five weak relationships). As the next generation of NSDI will require variety of geospatial applications that can be used to help society, strong collaborations with the Application Developers and GIS Software Providers is needed.

From the graph, we understand that other member of the Subjects grid (Lecturers/Researchers, NGOs/NPOs, Students) and the Citizens are having weak connections with BIG. Potential stakeholders will only become active participants if they see advantages for their organizations and if they do not feel threatened by the infrastructure. This geospatial community can be encouraged to take part in the NSDI implementation by involving them with participative mapping, for example adding POI data or validating toponym layer.

5.3. NSDI Cost Analysis

5.3.1. Literature Review

Cost analysis can be defined as the process of developing and analyzing cost data from separate business elements and estimating incremental or total resources needed to support current and future business strategies (InvestorWords.com, 2018). The purpose of cost analysis is to help determine which programs or projects achieves the greatest efficiency

as well to increase understanding of how budget is used. In this study cost analysis is utilized to understand how the NSDI budget is being allocated and to investigate efficient method for providing large-scale base maps.

Limited publications about analyzing cost subject on the development of NSDI have been issued. Researchers were focused on the cost benefit analysis of an SDI project as summarized in Table 5.6. All of the studies were conducted in developed country and as far as the author's knowledge, no NSDI cost analysis research have been done in a developing country in Asia.

Table 5.7 Previous studies related to cost of an NSDI

Author (Year)	Study Area	Method	SDI Cost Components
Nogueras-Iso et al. (2007)	Cross-border area between France and Spain	Cost estimation using normalized working days as the unit cost to complete project activities	Reusable activities (e.g. definition of metadata profiles, development of metadata tools and geoportal); Context-specific activities (e.g. re-engineering the data, configuration of catalog and portrayal services)
Almirall et al. (2008)	Catalonia, Spain	Cost Benefit Analysis where benefit is calculated by total time savings hours/month	Metadata creation and catalog, Geoportal, WMS Client, Web Geoservices, Data publishing, Applications, Web and Map Servers, Management
Ecorys & Grontmij (2009)	The Netherlands	Cost Benefit Analysis where benefit is calculated from efficiency advantages to data providers and users	Investment cost, Coordination cost, Friction cost, Structural cost
Campagna & Craglia (2012)	Lombardy, Italy	Estimation of cost and time saving based on the questionnaire survey of 27 respondents	SDI management, Geocoding services, Hardware and software development, Software maintenance and licenses

5.3.2. Method

The NSDI cost analysis consists of two steps. First step is identifying and defining the existing NSDI cost components based on documentary evidence. An extensive study on budgetary document is reviewed, particularly the budget of BIG for the past five years as the network nodes connector of Indonesia NSDI.

The second step is calculating the unit cost for the production of large-scale maps, which considered as one of the main hindrance of NSDI implementation. This calculation aims to determine how much cost is needed to fulfill the nation-wide topographic maps in 1:5,000 scale. BIG has published standard cost specification for geospatial information (Head of BIG Regulation No. 11/2016) and it is used as the reference for this calculation.

5.3.3. Results

- **NSDI Implementation Costs**

Based on the analysis, NSDI development can be classified into four main cost components including data provision, NSDI network node, organizational, and capacity building as described in Figure 5.11. According to the annual budget document from 2013 to 2017, the average total cost for NSDI development every year is around US$ 38.8 Million. There are fluctuations in the budgeting where the lowest allocation happened in 2013 whereas the highest in 2014 with about US$ 42.7 Million. In general, most of the budget is allocated for producing geospatial data, followed by activities for establishing NSDI network node. It can also be seen that the funds for capacity building is still low with only 2% (US$ 0.8 Million) of the total average cost as well as organizational arrangements (about US$ 1 Million/year in average).

	2013	2014	2015	2016	2017
Capacity Building	0.5	0.4	0.8	1.4	1.1
NSDI Network Node	6.3	6.7	2.8	6.4	5.9
Organizational	0.8	0.5	0.8	1.6	1.3
Data Provision	24.6	35.1	33.9	29.5	33.8

Figure 5.11 Costs of NSDI development in Indonesia from 2013-2017

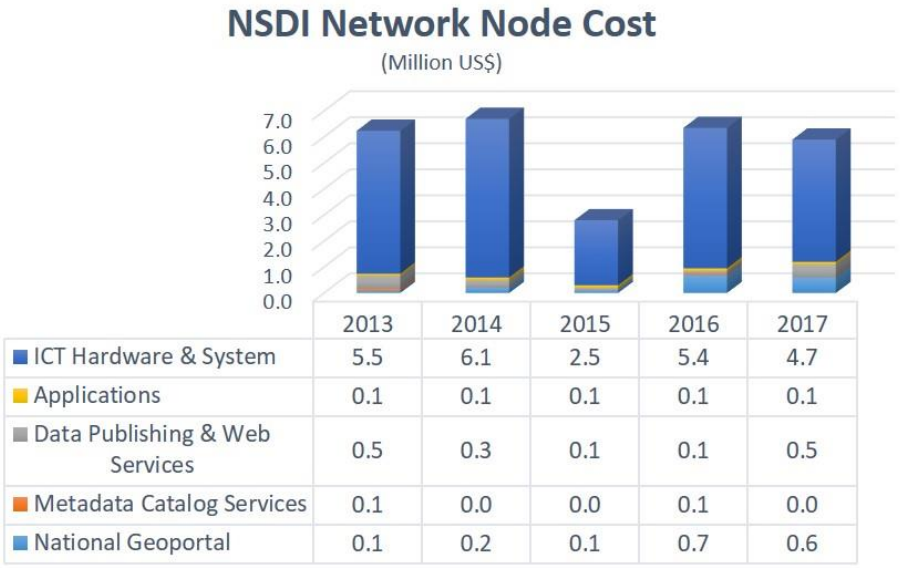
The cost for data provision is consist of budget for developing geodetic networks and CORS infrastructure, providing basic geospatial data, and creating thematic maps as presented in Figure 5.12. In the last five years, most of the allocation is for completing digital topographic maps particularly the medium 1:25,000 scale. The production of large-scale maps (1:5,000) started in 2013 in the north Bandung area and continued in the following years. There was a significant increase in 2014 and 2015 budget due to a grant aid from Japan International Cooperation Agency (JICA) for digital mapping in Sumatra Island. Meanwhile, cost for thematic mapping has increased significantly during the past two years in order to accelerate the One Map Policy program.

	2013	2014	2015	2016	2017
Geodetic & CORS Networks	1.7	1.6	2.7	2.8	4.0
Thematic Data	5.3	4.0	5.3	7.7	7.2
Basic Geospatial Data	17.6	29.5	25.9	19.0	22.6

Figure 5.12 Cost for data provision

The second cost components is related to technical operation of the NSDI network node. Figure 5.13 describes this component, which include ICT hardware and software system, geospatial applications, data publishing & Web services, developing metadata catalog, and improving the National Geoportal. Most of the budget (about 85%) was assigned to setting up the system including computer hardware, software license, and Internet leased line. The average cost for these activities is US$ 4.8 Million for the past five years.

The figure also shows limited funding for developing geospatial applications, where in total US$ 0.5 Million spent during the period. This condition supports the finding of low interrelations with Geospatial Application Developers from the stakeholder analysis. Meanwhile, the development of metadata catalog services seems not an annual activity since only twice conducted in 2013 and 2016. For the last two years BIG increases the budget for improving the national geoportal, unfortunately it has been mainly to pay the server license since Ina-Geoportal was built on proprietary software.



	2013	2014	2015	2016	2017
ICT Hardware & System	5.5	6.1	2.5	5.4	4.7
Applications	0.1	0.1	0.1	0.1	0.1
Data Publishing & Web Services	0.5	0.3	0.1	0.1	0.5
Metadata Catalog Services	0.1	0.0	0.0	0.1	0.0
National Geoportal	0.1	0.2	0.1	0.7	0.6

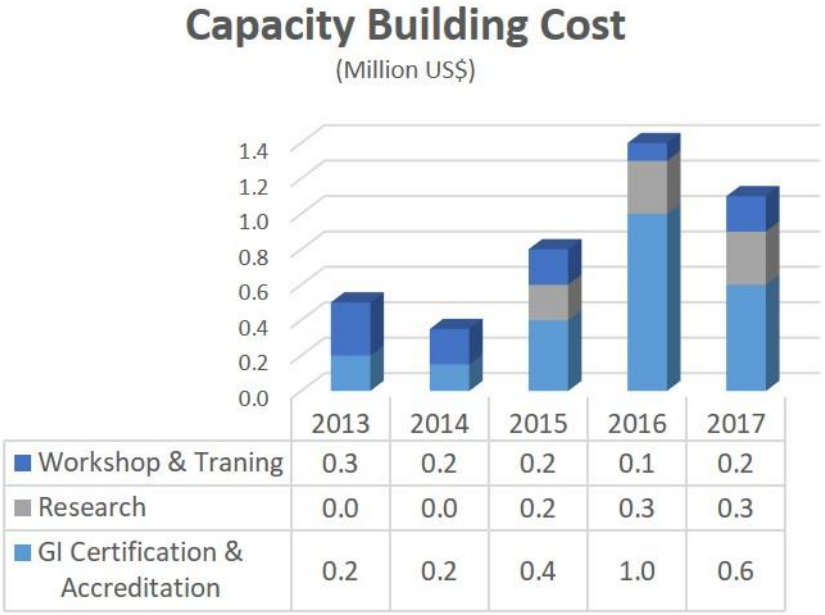
Figure 5.13 Cost for developing NSDI network node

Another important cost in implementing NSDI is organizational arrangements. This include funds for developing geospatial information standards and guidance, and for conducting coordination with the NSDI network nodes as illustrated in Figure 5.14. Since BIG has a role as the Network Node Connector, national and regional coordination meetings established every year with the average budget US$ 0.6 Million. In the meantime, standard development costs have reached US$ 2.1 Million until 2017 and yielded 60 national standards. Additionally, BIG also developed technical specifications used for geospatial information activities for example Technical Specification for Village Map Presentation (Head of BIG Regulation No. 3/2016).

	2013	2014	2015	2016	2017
Standardization & Guidance	0.4	0.2	0.2	0.6	0.7
Coordination & Arrangement	0.4	0.3	0.6	1.0	0.6

Figure 5.14 Cost for organizational arrangements

The last component of NSDI Costs is capacity building to improve the ability of stakeholders in operating NSDI. The capacity building activities include conducting workshops and trainings, research, and certification of geospatial information workers (Figure 5.15). We can see that currently the focus is to give additional knowledge for the personnel involved in NSDI network. This is understandable because many of them do not have enough skill to manage GIS data, particularly in local governments as identified in the stakeholder analysis. Meanwhile, during 2013-2017 period budget allocation for research and development is only about 2% (US$ 0.8 Million) of the total average cost (US$ 41.1 Million). Therefore, if the government want to expand NSDI implementation it is necessary to increase budget allocation for research activities in the aspects of technology adoption, geospatial data acquisition, or geospatial applications.



	2013	2014	2015	2016	2017
Workshop & Traning	0.3	0.2	0.2	0.1	0.2
Research	0.0	0.0	0.2	0.3	0.3
GI Certification & Accreditation	0.2	0.2	0.4	1.0	0.6

Figure 5.15 Cost for capacity building

- **Allocated Budget vs Realization**

The calculation of NSDI cost is basically based on the budget allocation of BIG from 2013 to 2017. In order to understand whether there is a gap between the allocated budget and its realization, the author examine budget expenditure documents in the same periods. However, the only available document is from the Government Instance Performance Report (Laporan Kinerja Instansi Pemerintah/LAKIP) from 2014-2017 where the described realization components are not in detail (Badan Informasi Geospasial, 2018, 2017b, 2016a, 2015d). Only examination for the data provision is obtainable in these reports.

Total allocated budget for data provision in 2014 is US$ 35.1 Million and the realization reached US$ 32.4 Million (92.31%). There is a gap about 7.69% of the budget in 2014. Respectively, the difference occurred in the following years were 12.98% (2015), 7.46% (2016), and 6.51% (2017) as presented in Figure 5.16. In the average, from annual US$ 33 Million budget for establishing geospatial data the realization reaches 91.31% (US$ 30.2 Million).

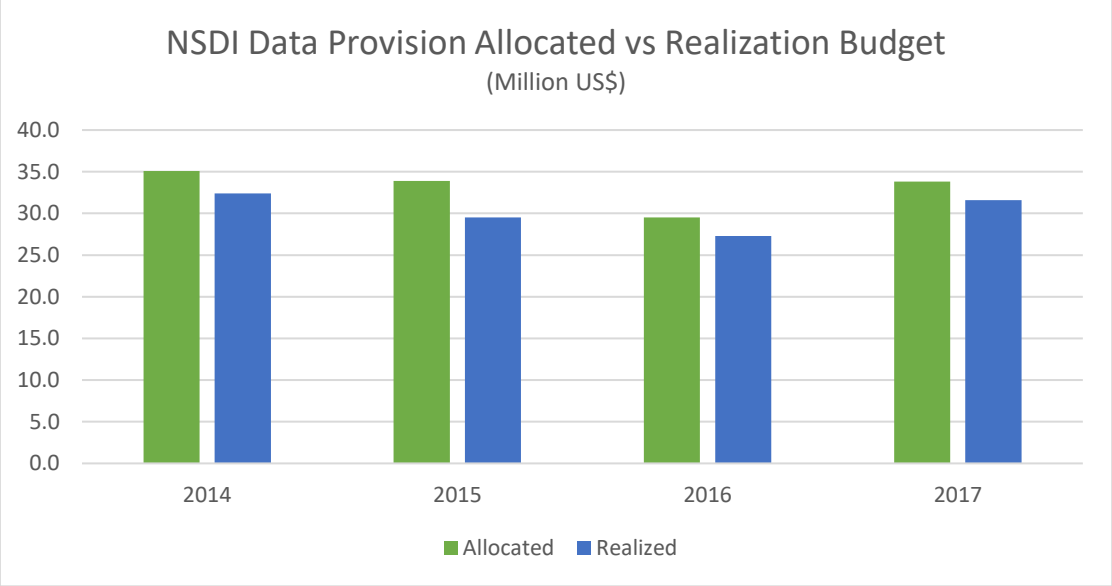


Figure 5.16 Allocated vs Realization Budget of NSDI Data Provision

- **Cost for Completing Basic Map**

As we can identify from the data provision cost, producing basic maps requires huge amount of money. Nevertheless, it is important to examine the unit cost for completing nationwide basic geospatial information, in this case 1:5,000 scale topographic maps. There are two acknowledged method for generating topographic maps, first by conducting aerial photo mapping and secondly by using ortho-rectified satellite imagery. Aerial photo surveys for mapping the territory of Indonesia was begun in 1969 with the project of producing topographic maps 1:50,000 scale in West Kalimantan area (Bakosurtanal, 2008). Whereas, the use of ortho-rectified satellite image for providing large-scale basic maps was initiated by the Presidential Decree No. 6/2012 about Provision, Use, Quality Control, Processing and Distribution of High Resolution Satellite Image.

Digital mapping based on aerial photo comprises four main procedures: data processing, field survey, creating geodatabase, and data visualization. Data processing consist of preparation, stereo plotting, topology editing, Digital Terrain Model (DTM) and contour

editing. Meanwhile creating geodatabase include feature editing and topology validation, and metadata creation. Each of these steps has cost components that may contain cost for manpower, tools (hardware and software), stationery, accommodation, or transportation. Table 5.7 describes cost components in each procedures of digital mapping using aerial photo.

Table 5.8 Cost components of aerial photo mapping

Procedure	Subprocedure	Cost Component
Data processing	• Preparation	Manpower, hardware, software, stationery
	• Stereo plotting	
	• Topology editing	
	• DTM & contour editing	
Field survey		Manpower, hardware, software, stationery, accommodation, transportation
Geodatabase	• Feature editing & topology validation	Manpower, hardware, software, stationery
	• Metadata creation	
Visualization		Manpower, hardware, software, stationery

In order to calculate the unit cost of producing large-scale topographic maps using aerial photo method, the author conducts simulation of cost calculation for area in Cibinong district with the size 56.2 km^2 or equal to 58 mapsheets. Cibinong is located in West Java Province and there are some assumptions used for the aerial photo surveys as follows:

- The weather is good and clear
- The object's density level is medium
- Topography of the area is flat
- The difficulty of accessibility is low

For the simulation, the author collects appraisal documents related to digital mapping from BIG and use the standard cost component specified in the Head of BIG Regulation No. 11/2016 about standard cost of geospatial information activities budget year 2017.

Table 5.9 Cost calculation of aerial photo method

Procedure	Subprocedure	Cost (Rp)	Cost (US$)
Data processing	• Preparation	112,346,540	8,322
	• Stereo plotting	2,710,592,500	200,785
	• Topology editing	218,127,500	16,158

	• DTM & contour editing	854,725,000	63,313
Field survey		1,880,748,200	139,315
Geodatabase	• Feature editing & topology validation	436,877,750	32,361
	• Metadata creation	10,095,000	748
Visualization		31,029,050	2,298
Total cost for 58 mapsheets		**6,254,541,540**	**463,300**
Unit cost per mapsheets		**107,963,871**	**7,988**

Result of the simulation is presented in Table 5.8 where cost displayed in currency of Indonesia Rupiah (Rp) and United States Dollar (US$). The exchange rates used is Rp. 13,500/ US$ 1. We can see that the total budget required to produce 58 mapsheets using aerial photo method is about US$ 463,300 and the unit cost for each mapsheets is US$ 7,988. Stereo plotting process seems to be the highest consumption followed by the field survey. Detail of of the cost components can be found in the Appendix 9.

With the same approach, simulation of creating topographic maps by ortho-rectified satellite image is also calculated. One main different of the process is that ortho-rectified image do not need stereo plotting and contour editing. The assumption is that DTM data has been extracted from the satellite image. Therefore, activities in the data processing are 2D digitizing and topology editing. The estimation of the required cost is described in Table 5.8 below.

Table 5.10 Cost calculation of ortho-rectified image method

Procedure	Subprocedure	Cost (Rp)	Cost (US$)
Data processing	• Preparation	77,426,550	5,735
	• 2D digitizing	218,127,500	16,158
	• Topology editing	218,127,500	16,158
Field survey		1,866,345,600	138,248
Geodatabase	• Feature editing & topology validation	444,317,750	32,912
	• Metadata creation	10,095,000	748
Visualization		24,911,300	1,845
Total cost for 58 mapsheets		**2,859,351,200**	**211,804**
Unit cost per mapsheets		**49,299,159**	**3,652**

From the comparison of both methods, we can identify that more than half of the cost can be reduced by applying ortho-rectified image. If the government want to complete all the remaining 373,902 mapsheets, then it will cost about US$ 1.36 Billion using ortho-rectified image or US$ 2.99 Billion by aerial-photo mapping. In the previous subsection on the NSDI

implementation cost, we know that the annual budget for producing basic geospatial data is more or less US$ 23 Million. As a result, it will take around 60 years for completing it as illustrated in Table 5.9.

Table 5.11 Comparison of both costs

	Cost of Aerial Photo (US$)	**Cost of Ortho-rectified Image (US$)**
Unit cost per mapsheets	7,988	3,652
Estimated cost required to complete 373,902 mapsheets	2.99 Billion	1.36 Billion
Estimated time needed if the annual budget is US$ 23 Million	130 years	60 years

5.4. Summary

In this chapter, we conduct analysis to find out the cause of problems in implementing NSDI. Two strategies is being used. First is stakeholder analysis to identify who involved in Indonesia NSDI and to understand why does low participation of the actors happened. Some remarks from the stakeholder analysis have been extracted as follows:

- There are 15 types of stakeholders exist in Indonesia NSDI that can be distinguished as the key players, context setters, subjects, and crowd;
- The key players of Indonesia NSDI are mainly from government agencies that have resources on data, budget and technological infrastructure;
- Municipalities/Districts governments have limitations in publishing their geospatial data hence resulted in lack of participation;
- The awareness of geospatial information benefits need to be raised to the context setters (State Institutions, National Police, National Armed Force)
- Currently the relations between private sectors and government institutions is still weak, therefore collaboration is required to broaden the scope of NSDI, not to only for sharing governmental geospatial data but also provide applications for community;
- Geospatial community is in the early stage and it required coordination and integration to support NSDI.

The second approach is using cost analysis to determine component of NSDI cost as well as to investigate the cause of limited large-scale maps availability. The results can be summarized in the following points:

- The NSDI implementation costs consist of four components including data provision, NSDI network node, organizational, and capacity building;
- The main consumption of NSDI cost is for producing geospatial data followed by the operation of NSDI network system;
- Hardware provision and software licenses (Oracle, ArcGIS & Networking) is about 65% (3.9 Million US$) of the NSDI Network Node Cost while developing applications is too small;
- Budget allocation for NSDI research is still very limited (<1%);
- Utilization of ortho-rectified satellite image can reduce the cost of topographic mapping more than 50%.

Chapter 6
STRATEGIC DIRECTIONS FOR FUTURE NSDI

6.1. Overview

This chapter is intended to propose the solutions for the identified causes of NSDI problems. A number of strategic directions are presented with the consideration mainly to tackle institutional, technological and financial matters. The directions is generated based on the findings in Chapter 4 and Chapter 5, which presented in a SWOT Analysis. Each of the directions is corresponding to one or more elements stated in the SWOT Analysis.

6.2. SWOT Analysis

The SWOT analysis examines current internal environment (Strengths and Weaknesses) and external factor (Opportunities and Threats) that influence implementation of NSDI. It provides information that is helpful in matching the organization's resources and defining future strategic directions (Gurel and Tat, 2017). The analysis is generated from results of the interviews as well as stakeholder and cost analysis. The strengths, weaknesses, opportunities, and threats are presented below.

Strengths:

1. The head of government of Indonesia has a good awareness about the geospatial information benefits of supporting national development program. The understanding is represented in the National Medium Term Development Plan (RPJMN) 2015-2019. The support is also demonstrated with the establishment of One Map Policy.
2. Geospatial Information Law as the legal foundation of NSDI development has been established since 2011. The law is reinforced by the issuance of several government regulations such as Government Regulation No. 9/2014, and Presidential Decree No. 27/2014. These regulations act as the umbrella of the NSDI initiative.
3. The national geoportal is available as the key product of NSDI development. It provides geospatial data for the users, and facilitates sharing and the exchange of geographic services between the stakeholders.
4. The government has published geospatial information standards to support interoperability and harmonize technical specifications. Currently, there are 60 standards available including standards of metadata, data quality, web services, and data collection.

Weaknesses:

1. Participation of the institutions in the NSDI network is low. According to the stakeholder analysis, we found that BIG and Central Government Agencies are active participants. Local governments are hampered by their availability of resources, whereas private sectors are constrained by the limited role in the NSDI implementation.
2. The availability of human resources with skills in GIS field is insufficient. As mentioned in the interview activities, Provincial and Municipal/District Governments often experience fast rotation of employees. GIS departments in local governments hardly exist, and staff who were not part of any particular department, executed GIS tasks repeatedly (Darmawan et al., 2014). Lack of GIS employees was also recognized by the other stakeholders including State Institutions, National Police, and National Armed Force.
3. The availability of the large-scale basic geospatial data is incomplete. Because of the obtainable data is mostly medium scale (1:25,000), local governments have difficulties in generating urban planning, and land management.
4. Although the legal foundations have been established, the NSDI grand design has not been created yet. The grand design is important as it provides visions, action plans, and time management of the implementation. The absence of this guidance may lead to obscurity of the project activities for participating institutions.

Opportunities:

1. Awareness of geospatial information is growing in society. People are now starting to use maps in their daily lives, for example, to order online transportation (e.g. Grab), or food delivery service (e.g. Uber Eats). The demand of geospatial related applications can be an opportunity to leverage NSDI data and services.
2. The government has launched the open data initiative, and one of the benefit is that geospatial data can be downloaded freely. This encourages interactions between public authorities and private companies, and may help generate value-added products.
3. There are emerging trends in GIS application, Remote Sensing, Global Navigation Satellite System, Cloud Computing, and Internet of Things. Adopting state-of-the-art technologies will provide the innovation for geospatial applications to support public services.

Threats:

1. Local governments consider Internet and ICT infrastructures to be a barrier to publishing geospatial data, and communicating with the national geoportal.
2. Reluctance to share geospatial data between NSDI institutions was identified during interview activities. They argued that misuse of data, ownership, and privacy issues are the major concern.
3. Sustainable funding for supporting NSDI activities only exist at BIG, and Central Government Agencies. Financial support from other key stakeholders is unreliable.

6.3. Proposed Directions

6.3.1. Establishing NSDI Committee

One of the main problems revealed in the implementation of Indonesia NSDI is low participation from stakeholders (Weakness No. 1). In order to overcome this, our first direction is establishing NSDI Committee as the executor of policy and leader of the collaboration among different institutions. Learning from the previous experience, commitment from the top leaders in this case the president, is very important to drive the development of NSDI. The President's leadership could minimize governmental organization conflicts and weak interrelations among the network nodes. The proposed chairperson of the NSDI Committee is Coordinating Minister of Economy since his authority is slightly above the ministries and the success of NSDI implementation will be beneficial in improving national economy sector. As currently the NSDI initiated by government agencies particularly BIG, it is important inviting other stakeholders from academia and private sectors to broaden the scope of NSDI. In addition, the committee should also embrace ministries that have potential roles for reducing resource limitation encountered by stakeholders. For example, Ministry of Communication and Informatics to support Internet infrastructure in local governments (Threat No. 1), Ministry of Home Affairs to coordinate arrangement in the provincial and municipal/district governments (Threat No. 2) and Ministry of Finance to provide sustainable budget (Threat No. 3). The proposed structure of NSDI Committee is displayed in Figure 6.1.

The main task of NSDI Committee is to organize strategic coordination of the NSDI implementation in Indonesia. The functions should include 1) formulating the grand design for NSDI development, 2) setting up policies and regulations for harmonizing and sharing geospatial information, 3) searching and securing the financial aspect for NSDI development, and 4) coordinating collaborations and partnerships among NSDI stakeholders.

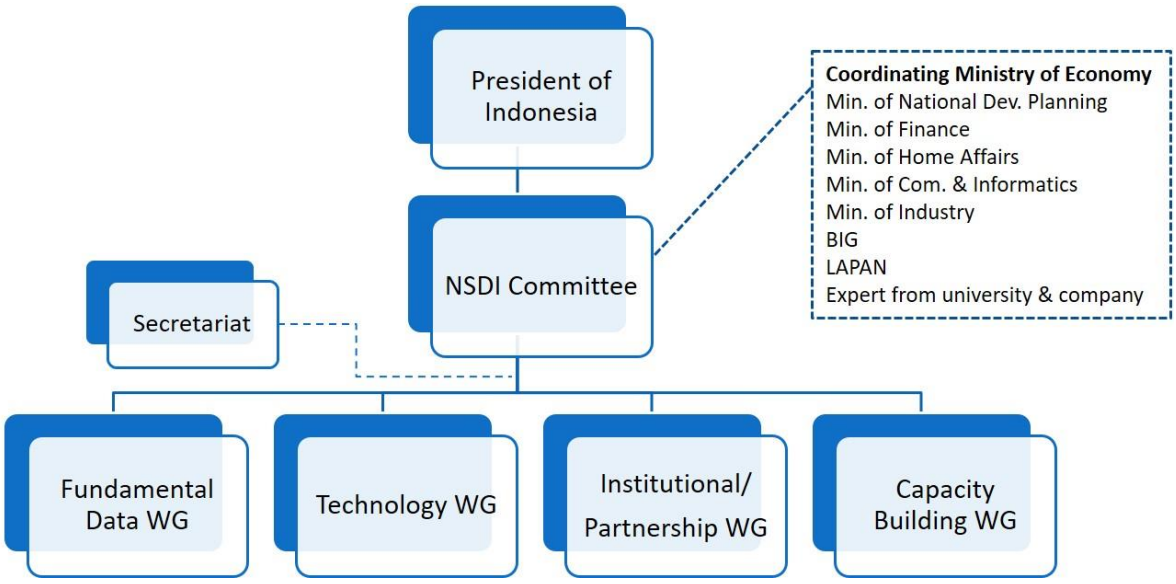


Figure 6.1 NSDI Committee for stakeholder's engagement

The NSDI Committee should have a secretariat that handle the operational of committee programs and activities. BIG as the Network Node Connector, which mandated by Presidential Decree No. 27/2014, is suitable for this role. NSDI covers multifaceted aspects of geospatial information system, hence the committee should have technical working group that focused on specific NSDI problems such as fundamental data, technology, partnership, and capacity building. Some explicit issues that identified in the interview activities related to these working groups is presented in the following table.

Table 6.1 The NSDI Working Groups and its related issues

NSDI Working Group	Specific Issue(s)
Fundamental Data	• Large-scale topographic map • Digital thematic map • Village boundary map • National Geospatial Feature Catalog • Geospatial data quality assurance • Socio-economic geospatial data • National reference system • Data standardization
Technology	• National Geoportal • Open Source Geospatial Software • Utilization of UAV or drone for mapping • Application Programing Interface (API) for geospatial services
Institutional/Partnership	• Geospatial working unit in local governments

	• Geospatial data license/privacy • Governance policies and legislation • Business model for NSDI
Capacity Building	• Competency standard of geospatial information • Raising awareness of NSDI importance • NSDI workshops for operators and managers • Curriculum about NSDI for students

In order to sustain the NSDI programs, it is necessary to conduct regular coordination meeting of the committee as well as the working groups. As stipulated in Presidential Decree No. 27/2014 article 10, one of the tasks of the Network Node Connector is to conduct national coordination meeting on NSDI. Previous NSDI coordination meeting focused in increasing the role of central and local government to support implementation of geospatial information. Results of the meeting were used as input in national policy formulation (Badan Informasi Geospasial, 2015e). Further strategies are needed regarding the arrangement of succeeding coordination meetings. First, since the implementation of NSDI involve central government agencies and local government institutions, it is essential to gather insights from them comprehensively. Therefore, BIG should invites more of these stakeholders as well as representatives from geospatial business sector, academia, and users. In the previous coordination meeting, 50% of the participants were coming from BIG (Badan Informasi Geospasial, 2015e), so the perspectives of other parties was still lacking. The author suggest to conduct coordination meeting at the provincial level for local government networks nodes to achieve effectiveness and efficiency. Secondly, typical coordination meeting is to discuss about problems faced by the Network Nodes in implementing NSDI. Although this method is effective in identifying issues for further policy formulation, the Network Nodes might not get the direct benefits from the meeting. The author proposes to establish coordination meeting by means of a workshop or conference. Besides discussion on the specific NSDI issues, the National NSDI Conference can provide opportunity to present best practices of geospatial information utilization from the Network Nodes. In this way, they can learn and share experience in implementing NSDI. Another event in the workshop may include technical guidance given by BIG for the Network Nodes to publish or develop their geospatial data services. This will help to improve their capacity building and the same time increase availability of the data in the national geoportal.

6.3.2. Developing NSDI Grand Design

The second direction after establishing NSDI Committee is to develop goals setting plan in the form of a NSDI Grand design. It is necessary to structure the NSDI output and objectives in a detailed manner so the stakeholders will have comprehensive guidance for the implementation. The absence of NSDI Grand design is realized as one of the shortcomings of current development (Weakness No. 4).

In order to create the NSDI Grand design, the author propose to use the logic modeling method. Basically, a logic model is a graphic representation of how inputs and activities connect to the expected outcomes. The advantage of using logic models include builds a common understanding of the programs in a systematic way and provide measurement for evaluation (Knowlton and Phillips, 2013). Additionally, logic models also incorporates communication with the stakeholders involved in the program.

The creation of NSDI logic model begins by determining the intended impact. The ultimate impact is to achieve geospatially-enabled societies, which is a condition where location and geospatial information are commonly available to citizens and businesses to support innovation by encouraging creativity and product development.

The next step is to define outcomes of NSDI implementation. We parsed the expected outcomes by time increments into short, intermediate, and long term. Short-term outcomes are planned to be realized in 1 through 3 years, intermediate-term outcomes 4 through 6 years, and long-term outcomes in 7 through 10 years.

Short-term outcomes are related to changes in the aspect of geospatial data quality, awareness of the NSDI benefits, and knowledge of geospatial information. The geospatial data quality here is also including the completeness and coverage of the large-scale maps that urgently required by stakeholders. If data quality can be improved then the intermediate-term outcome expected is the decision-making process will be better. Additionally, increased awareness will result in better participation from network nodes and partnerships among stakeholders, as well as increased knowledge produce improved skill and technology adoption. If we accomplish these three intermediate outcomes, then the change in national development and geospatial industry hopefully will be secured in the long term.

Subsequently, we have to identify all the activities required to generate the outcomes. There are six main strategies proposed: mapping activities, One Map implementation, improving data access and sharing, promoting geospatial community, capacity building, and developing NSDI practices. Each of these strategies will produce outputs that collaboratively resulted in the model's outcomes.

The purpose of mapping activities is to produce large-scale topographic maps that most users required. These basic maps then are used as the foundation of developing thematic maps produced by a variety of institutions. With One Map implementation, problems in overlapping land status for instance, can be tackled and the integrated thematic maps will increase the quality of geospatial products. Moreover, research outputs from the capacity building activities may also support the improvement in terms of accuracy of the products.

An enhanced geoportal platform is the main output of improving data access and sharing activities. It is expected to have more functionalities and support marketplace for the private sector to stimulate innovation. We also believe participation from group of users that sharing similar interest in geospatial information is need to be raised. Activities to promote geospatial communities should be determined in order to encourage them creating Location Based Service (LBS) applications and participating in adding Point of Interest (POI) database. This initiative will require support from business sector and academia. If the geoportal is running well and provide useful applications, then the awareness of geospatial information benefits will be increased for decision-makers and general users as well.

Capacity building activities can be related with the human, technological, and institutional aspects. As discovered in the previous subsection, it is important to overcome insufficient skilled human resources in GIS field. In addition, formulation of competency standards are also required to guarantee the quality of the workforce.

One of the problems identified in NSDI implementation is the absence of operational guidance. Local governments expect that best practices of NSDI in terms of technical and institutional issues are available. For example, practical guideline is needed in setting up a clearinghouse and data sharing management with other agencies. NSDI Practices activities aims to provide such documents and assistance in order to increase the knowledge of NSDI stakeholders.

The final step is to determine resources for the effective NSDI operation. We distinguished seven inputs including geospatial data, policy, funds, institutional arrangements, technological facility, standards, and human resources. In case of Indonesia, most of them are already available because the NSDI initiative has been started more than two decades ago. The complete NSDI logic model is presented in Figure 6.2.

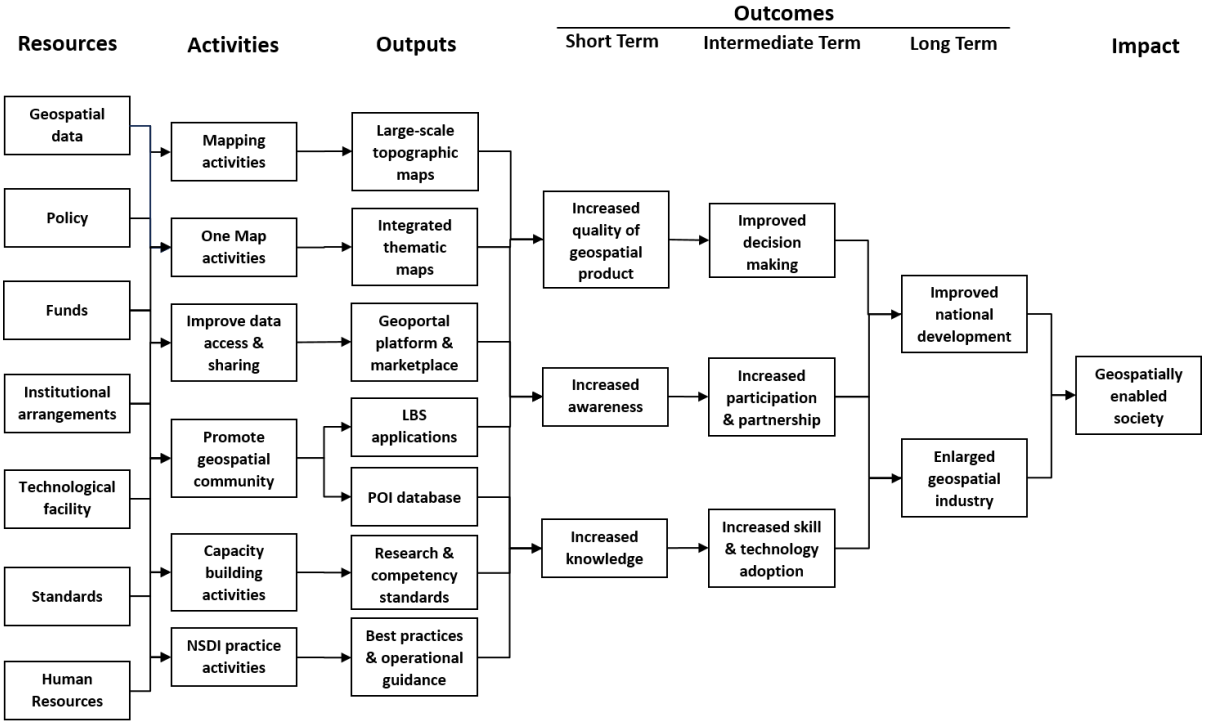


Figure 6.2 NSDI Grand Design using a logic modeling approach

The NSDI Logic Model describes an overview of the strategic directions for NSDI implementation. Nonetheless, it can also be breakdown to provide a more in depth view of the activities and intended outputs. The model can be used to measure evaluation of the activities by generating Key Performance Indicators (KPIs). KPIs is defined as a set of measures focusing on those aspects of organizational or project performance that are the most critical for the current and future success of the organization (Parmenter, 2007). In term of an SDI assessment, Giff and Crompvoets (2008) cautioned that similar to its nature, the development of indicators to assess its performance is also complex. Therefore, to generate effective KPIs it should also include the methodologies, cost, personnel and details involved in the collection of SDIs' performance information.

One of the recognized methodology to derive KPIs is KPI Karta®. It offers a procedure to identify persons, departments and information sources for creating and supporting KPIs. Specifically, the KPI Karta® is a logical process designed to facilitate understanding among the stakeholders involved to achieve outputs (KPI Karta, 2015). The advantage of using this method is it allows to create actionable performance indicators that inform how the project is achieving.

There are five steps of generating measurable and actionable KPIs based on the KPI Karta® method as illustrated in Figure 6.3.

Figure 6.3 Five steps of deriving actionable KPIs (Enhorning, 2013)

The first step is to set our goals and objectives. After that we define Critical Success Factors (CSFs), which are a limited number of key activities that an individual, department, or organization should focus on to be successful. CSFs are specific conditions that measure or facilitate the meeting of business goals and objectives within set periods. A critical success factor is not a KPI. CSFs are elements that are vital for a strategy to be successful. They are usually consist of two elements: a measurable activity and a specific time frame. The next step is establishing KPI from CSF. KPIs are calculated measures that quantify the CSFs and enable the measurement of that strategic performance. KPIs are always calculations of Measures, which are collected in the fourth step. Measures are raw numbers that in and of themselves have limited usefulness, but ultimately need to be related to each other to extract the most meaningful information possible. Some example of Measures are number of visitors or number of data downloads. Relevant Measures need to be gathered so we can determine Metrics for the subsequent step. The final step is calculating Metrics from Measures. The Metrics are expressed as ratios, averages, rates, or percentages. As mentioned before, all KPIs are Metrics, but not all Metrics are KPIs. To be determined as a KPI, the Metric needs to be important enough to inform how the program is performing.

By applying the above procedure, we determine the KPIs for Mapping Activities. The goal is to increase the availability of large-scale topographic maps. In order to achieve that we need four Critical Success Factors (CSF). Firstly, increasing the production of 1:5,000 scale topographic maps with the KPI is percentage of the nationwide availability. To create the large-scale maps we will need to increase ortho-rectified images, DEM, and GCPs distributions, hence they are also defined as KPIs for Mapping Activities as described in Table 6.2.

Table 6.2 KPIs for Mapping Activities

No	Step of Actionable KPI	Description
1	Goal & Objective	Increase the availability of 1:5,000 scale topographic maps
2	Critical Success Factor(s)	a. Increase production of 1:5,000 scale topographic maps over the next 3 years
		b. Expand Ortho-rectified satellite images in the following 3 years
		c. Increase Digital Elevation Model (DEM) availability over the next 3 years
		d. Expand Ground Control Points (GCPs) distributions over the next 3 years
3	Key Performance Indicator(s)	a. Percentage of production of nationwide 1:5,000 scale topographic maps
		b. Percentage of Nationwide ortho-rectified images
		c. Ratio of Nationwide DEM coverage
		d. Percentage of Nationwide distributions of GCPs
4	Measures	• Number of 1:5,000 scale topographic maps produced • Number of ortho-rectified images • DEM coverage produced • Number of GCPs • Number of Geodetic Control Network
5	Metrics	• Percentage of production of nationwide 1:5,000 scale topographic maps (KPI) • Percentage of Nationwide ortho-rectified images (KPI) • Ratio of Nationwide DEM coverage (KPI)
		• Percentage of Nationwide distributions of GCPs (KPI) • Average topographic maps produced • Average ortho-rectified images created • Rates of DEM produced • Average GCPs established

In term of One Map Activities, the objective is to expand the availability of integrated thematic maps. The three phases of One Map Policy that stated in the Presidential Decree No. 9/2016 can be defined as the CSFs of this initiative. They are increase collection of the thematic maps produced by government agencies, integrate the thematic maps to conform to standards, and increase the synchronization of thematic maps to support national programs. The measures

for these CSFs include number of thematic maps, geospatial data standards, and integrated thematic maps. Subsequently, we generate six metrics, which three of them are determined to be the KPIs since their importance in achieving One Map Policy as showed in the Table 6.3.

Table 6.3 KPIs for One Map Activities

No	Step of Actionable KPI	Description
1	Goal & Objective	Expand the availability of integrated thematic maps
2	Critical Success Factor(s)	a. Increase collections of thematic maps in the next 3 years
		b. Integrate thematic maps based on standards throughout 3 years
		c. Increase synchronization of thematic maps over the following 3 years
3	Key Performance Indicator(s)	a. Percentage of thematic maps per theme
		b. Ratio of thematic maps that conform with standards
		c. Ratio of national programs used thematic maps to total national priority programs
4	Measures	• Number of thematic maps • Number of geospatial data standards • Number of integrated thematic maps • National programs
5	Metrics	• Percentage of thematic maps per theme (KPI) • Ratio of thematic maps that conform with standards (KPI)
		• Ratio of national programs used thematic maps to total national priority programs (KPI) • Percentage of synchronized thematic maps • Average thematic maps produced • Coverage of thematic maps

Another example of the derivation of KPI is regarding the data access and sharing. The goal is to improve the national geoportal and provide marketplace platform as well. To achieve this, we need solid CSFs related to geospatial web services, functionality of the national geoportal, metadata availability, participation from data providers, and collaboration with private sectors. Some of the measures that can be used are number of geospatial web services,

metadata, users, data downloads, data providers, and geospatial companies. As the result, we can determine five KPIs of the Data Access and Sharing Activities as illustrated in Table 6.4.

Table 6.4 KPIs for Data Access and Sharing Activities

No	Step of Actionable KPI	Description
1	Goal & Objective	Improve the national geoportal and provide marketplace platform
2	Critical Success Factor(s)	a. Increase geospatial web services in the next 3 years
		b. Improve functionality of Ina-Geoportal for the next 3 years
		c. Enlarge metadata availability during 3 years
		d. Increase data providers in the following 3 years
		e. Expand collaboration with private sectors in the next 3 years
3	Key Performance Indicator(s)	a. Percentage of geospatial web services in Ina-Geoportal
		b. Rates of usability and user satisfaction of Ina-Geoportal
		c. Percentage of metadata published in Ina-Geoportal
		d. Percentage of data providers connected to Ina-Geoportal
		e. Percentage of cooperation with geospatial company
4	Measures	• Number of geospatial web services • Number of metadata • Type of geoportal functions • Number of Ina-Geoportal users • Number of geospatial data downloads • Number of data providers • Number of geospatial companies
5	Metrics	• Percentage of geospatial web services in Ina-Geoportal (KPI) • Rates of usability and user satisfaction of Ina-Geoportal (KPI) • Percentage of metadata published in Ina-Geoportal (KPI) • Percentage of data providers connected to Ina-Geoportal (KPI) • Percentage of cooperation with geospatial company (KPI)

		• Rates of geospatial data downloads • Average Ina-Geoportal users

6.3.3. Adopting New Technology

From the cost analysis in Chapter 5, it is clear that the utilization of ortho-rectified satellite images can reduce cost for producing large-scale topographic maps. One of recent development in mapping technology is Unmanned Aerial Vehicle (UAV) that can be used in collecting high-resolution spatial data. UAV has low manufacturing and operational cost of the systems and the flexibility of the aircraft to eliminate of the risk of pilots in difficult missions (Akar et al., 2017). The application of UAV as a geographic data collecting tool found in various field such as topographic mapping (Tampubolon and Reinhardt, 2014), disaster management (Car et al., 2016), vegetation mapping (Kaneko and Nohara, 2014), coastal environment (Darwin et al., 2014), and archeology (Mouget and Lucet, 2014).

To know the potential cost that can be reduced, the author calculate cost component for UAV mapping as presented in Table 5.2. The calculation is based on the boundary mapping project of 1:5,000 scale map in the Central of Kalimantan with the area size 80 km^2 (20 mapsheets). The result shows that there is a major reduction of the cost from US$ 3,652 to US$ 2,017 (about 45%) if using UAV method compare to ortho-rectified image method. Therefore, adopting to UAV technology is important to tackle insufficient large-scale geospatial data (Weakness No. 3). The adoption will require extensive research activities in this area. Therefore, the government should increase budget of research and development.

Table 6.5 Cost calculation of UAV method

Procedure	Subprocedure	Cost (Rp)	Cost (US$)
Preparation	Flight plan & camera calibration	53,685,000	3,977
Field survey	• Premarking	148,411,500	10,993
	• Toponym survey	41,128,500	3,047
Image acquisition		141,268,000	10,464
Data processing		73,093,000	5,414
Visualization		86,982,500	6,443
Total cost for 20 mapsheets		**544,568,500**	**40,338**
Unit cost per mapsheets		**27,228,425**	**2,017**

Despite of its potential in providing geographic data more efficient, there are several issues identified in UAV applications. First, it is related with the geometric accuracy of

representations of the earth surface generated from UAV mapping. The products must fit the geometric accuracy standard specified by BIG. The geometric accuracy refers to the value that describes the uncertainty of the coordinate positions of an object on the map compared to the coordinates of the object in the actual position. It consists of horizontal and vertical accuracy that categorized into Class 1, Class 2, and Class 3. Table 6.6 defines the geometric accuracy standard for different map scales stipulated in the Head of BIG Regulation No. 15/2014. The standard uses Root Mean Square Error (RMSE), which is the square root of the average of the set of squared differences between dataset coordinate values and coordinate values from the reference data for the same objects.

Table 6.6 Standard of Geometric Accuracy for Topographic Mapping

Map Scale	Contour Interval (m)	Class 1		Class 2		Class 3	
		Horizontal Accuracy (m)	Vertical Accuracy (m)	Horizontal Accuracy (m)	Vertical Accuracy (m)	Horizontal Accuracy (m)	Vertical Accuracy (m)
1:1.000.000	400	200	200	300	300	500	500
1:500.000	200	100	100	150	150	250	250
1:250.000	100	50	50	75	75	125	125
1:100.000	40	20	20	30	30	50	50
1:50.000	20	10	10	15	15	25	25
1:25.000	10	5	5	7.5	7.5	12.5	12.5
1:10.000	4	2	2	3	3	5	5
1:5.000	2	1	1	1.5	1.5	2.5	2.5
1:2.500	1	0.5	0.5	0.75	0.75	1.25	1.25
1:1.000	0.4	0.2	0.2	0.3	0.3	0.5	0.5

According to Sanz-Ablanedo et al. (2018) accuracy of UAV is influenced by various factors, including flight design, camera image quality, camera modelling methodology, and geo-referencing strategy. In case of large-scale topographic mapping, it is important to incorporating the optimum amount of GCPs in the UAV photo data processing to increase the accuracy (Martínez-Carricondo et al., 2018; Tampubolon and Reinhardt, 2014).

The second issue in utilizing UAV is the authorization aspect. Currently the legal basis for conducting UAV mapping in Indonesia is arranged by the Minister of Transportation Regulation Number PM 47/2016. It specifies some prerequisites for getting the permission such as flight plan, technical specification of the UAV, competency of the pilot, recommendation letter from the authorization body, and insurance. UAV flights are prohibited in controlled

airspace, prohibited areas and restricted areas. However, UAV flights are allowed to be operated within uncontrolled airspace but only up to 150m.

6.3.4. Optimizing Data Center

Lack of Internet and geospatial data publishing infrastructure are identified as the reason of low participation from NSDI actors (Weakness No. 1 and Threat No. 1). On the contrary BIG has invested more than US$ 23.7 Million for the past five years to set up the data center. Today, BIG Data Center equipped with more than 300 servers, 3,200 Terabytes (TB) data storage, and High Performance Computing for satellite image analysis. With state of the art Cloud Computing Technology, optimization can be conducted to facilitate the network nodes who have limitations in the technical matters.

In the typical NSDI Network, each of institutions has to arrange local GIS production and data publication system then connect them to the national geoportal using a VPN. Each network nodes requires budget for data production and publication. For example, a municipality has to provide desktop computers, servers, software, networking peripherals, and leased line as illustrated in Figure 6.4.

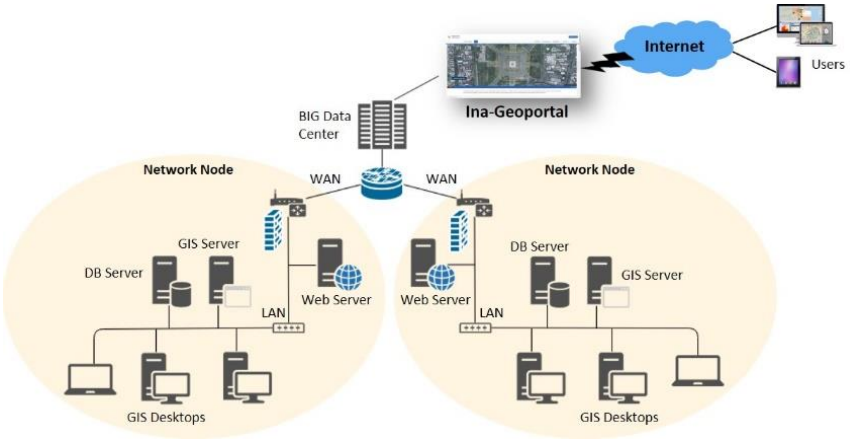


Figure 6.4 Typical NSDI Network Nodes

One of the options for optimizing data center is by creating an Infrastructure as a Service (IaaS). IaaS refers to on-demand provisioning of infrastructural resources, usually in terms of virtual computers, servers or networking services (Zhang et al., 2010). IaaS enables users to configure, deploy, and run Operating Systems (OS) and applications customized for their requirement. BIG should provide IaaS in its data center thus network nodes can have their own virtual GIS infrastructure and publish their geospatial data to Ina-Geoportal (Figure 6.5). Each of the administrator from local governments will have their own authentication to access the resources. After login, they can manage geospatial data using GIS Server and Database Server

provided by the data center. Administrator also has capability to create web services that can be published via the Ina-Geoportal. Therefore, optimization of the data center will also help local governments or state institutions reducing the investment cost of infrastructure.

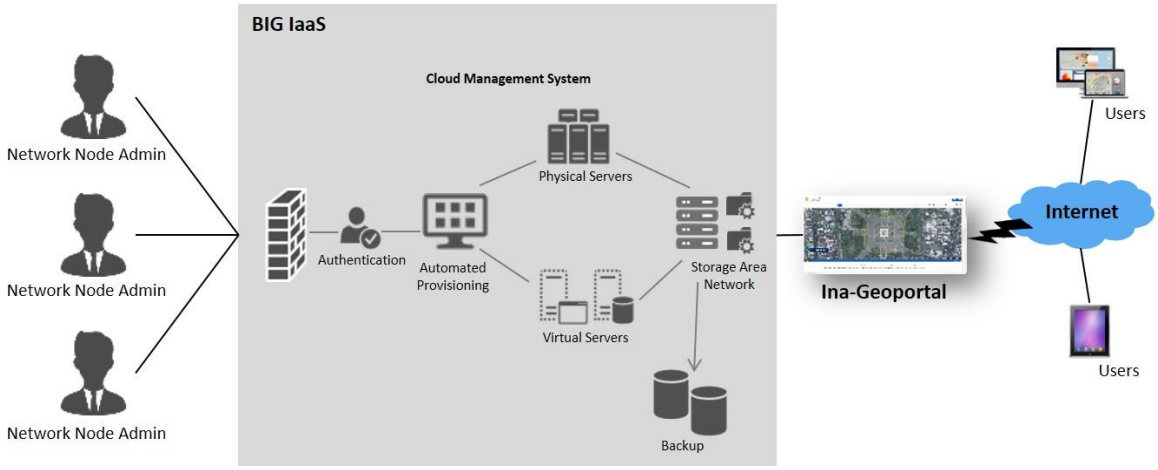


Figure 6.5 IaaS as one option to optimize data center of BIG

One of the issue in data center operation is its reliability. Indonesia is prone to natural disaster due to its geographical and geological conditions. At least there was 2.175 disaster events in 2017 with more than 335 victims and 30.000 building damages (Kompas Cyber Media, 2017). In order to prevent the possible disruption to the data center, BIG has initiated a Disaster Recovery Center (DRC) through a cooperation with Batam Indonesia Free Zone Authority (BP Batam) in 2014 and renewed in 2017 (Badan Informasi Geospasial, 2017c). The geographical position of Batam Island is considered to be at lower risk of natural disasters, hence it is selected for the DRC. Moreover, BP Batam provides suitable facilities including 24 hours electricity supply, fiber optic network, and spacious building capacity and safety standard system (Badan Informasi Geospasial, 2014).

6.3.5. Promoting Geospatial Marketplace

The final proposed direction for implementing future NSDI is by promoting geospatial marketplace and community. Based on the findings in NSDI Problems Identification, there is an increasing demand of various geospatial data and growing awareness of geospatial applications benefit for society (Opportunity No. 1). Private sectors requires structured geospatial data that can be embedded in their system without building a new system from scratch. One of the interviewee from a finance industry expressed:

"[…] *If possible, we want geoportal is more advanced by providing geospatial information related to banking. For example, providing socio-economic API data that can be easily integrated with other systems. In addition, if geoportal can display data from other agencies such as socio-economic data (BPS) and industrial and tourism, it will be nice* […]" - Director of PT. Bank Muamalat Indonesia (refer to Question III.1 – Appendix 3)

Another respondent also mentioned the needs of POI data, which will be useful in developing web-based or mobile geospatial applications:

"[…] *I think the data provided by government must be in accordance with the needs of the general public, for example demographic and socio-economic data that must be spatially visualized or provide their web services. And we also need POI data which include public facilities* […]*"* - Officer at PT. Qlue Performa Indonesia (refer to Question III.1 – Appendix 3).

At present, most of the data producers are from government agencies that supply basic geospatial data as illustrated in the right side of Figure 6.6. We can see the left side of the figure describes types of data wanted by geospatial data users. In order to resolve the gap, NSDI coordinator should capture this opportunity by developing a marketplace to accommodate providers of geospatial product (data, services, or applications) and potential buyers (whether individuals or companies).

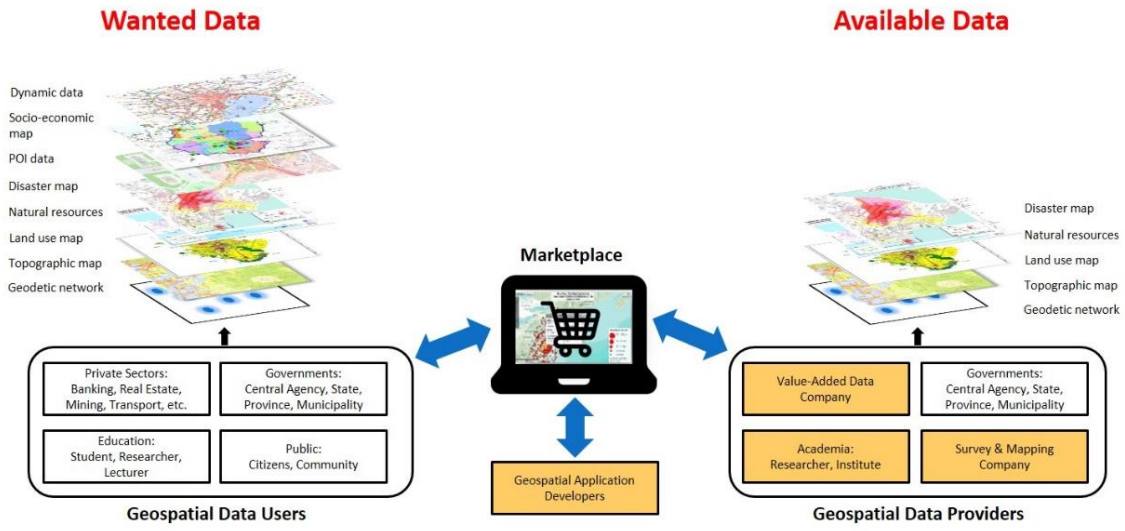


Figure 6.6 Geospatial Marketplace to broaden the scope of NSDI

The marketplace is the place where users can find and get geographically referenced products and services that are personalized to their needs and ready to-use. It is beyond of the

traditional approaches such as making metadata catalogues of geospatial data available to the client or providing information and access via geoportal. With the marketplace, the public data offered freely by the government can be used and by modified to produce added value products. The Survey and Mapping Company and Value-Added Data Business can provide the specific information that is not supplied by the government. Research Institutes also have the opportunity to distribute their products generated from research activities. It will broaden the data availability as well as the variety of geospatial services.

The existence of the marketplace might also invites more Geospatial Application Developers to create location-based applications. More disaggregated data could be delivered to a greater variety of business user that intend to capitalize geospatial data for their strategic decision making activities. According to the interview results, currently developer employ data from a third party company such as Google or OpenStreetMap (OSM). However, these data are mainly generated by the community whereas the Developer is expected to have in-depth data that generated by the official. One example is PT. Qlue Performa Indonesia, a developer of city dashboard application that requires a detailed public utilities owned by local government.

With the operation of geospatial marketplace, interconnections among the geospatial stakeholders can be increased which can result in leveraging the geospatial industry in Indonesia. Currently, the industry is dominated by the data provision projects, particularly developing digital basic and thematic maps. Based on the data from the enterprises association (Asosiasi Perusahaan Survei dan Pemetaan Informasi Geospasial, 2017), there are at least 128 private companies deal with geospatial business. Most of them were located at Java Island particularly Jakarta and West Java as shown in Figure 6.7. Most of the companies (114) are doing business in survey and mapping whereas only few of them develop applications such as urban planning (8) or Web GIS applications (5). A survey result conducted by BIG to 74 geospatial companies stated that in 2016, most of them have revenue less than 74 thousand USD (1 billion IDR) with more than 60% of the fund are come from the government budget (Badan Informasi Geospasial, 2016b). As GIS is being used in different industries and applications, the marketplace is expected to enlarge their revenue and to grow new companies that engaged in different business types such as service integrators, data analytics, or solution providers.

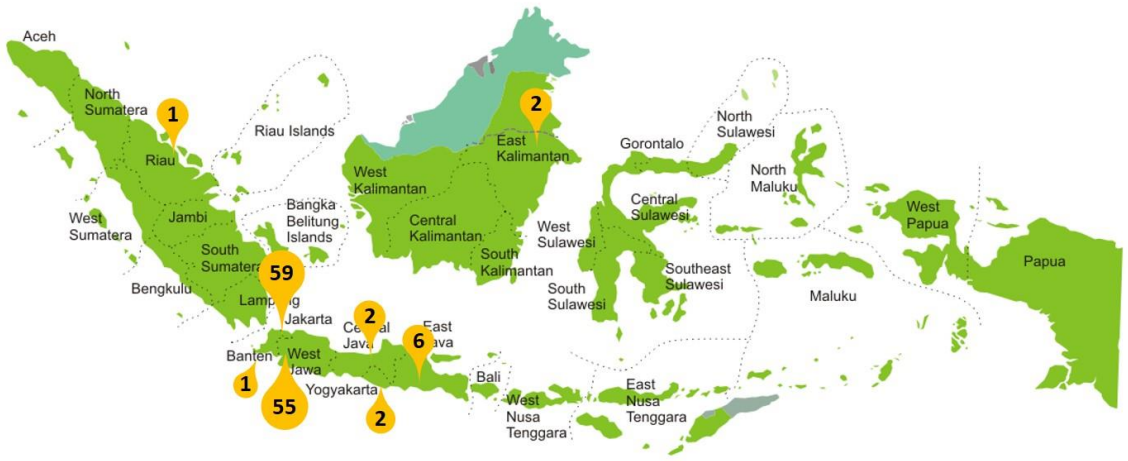


Figure 6.7 Distribution of Geospatial Companies in Indonesia

Geographic data and services considered as the intermediate goods in the sense that often the consumers are using them to help engage in other activities. For example, mobile digital maps used for reducing the journey time and fuel savings from more efficient navigation. It involves integration of many data formats, semantics, software systems, providers, and users with different requirements. As consequences, the products to be offered within a geospatial marketplace should cover a broad spectrum:

- Data and added services for users (business or individuals), for example, maps with statistical socio-economic data of particular city for a finance company;
- Data and added services as intermediate products for providers of the geospatial value chain, e.g., environmental and traffic data for an application provider as a basis for developing logistics system end product;
- Geospatial APIs that enable software applications to communicate with each other to share data. They deliver interoperability between applications and facilitate direct connectivity between businesses;
- Earth observation data and services that link and provide free access to the open-data from government repository and products from commercial satellites;
- Geospatial applications where (business or individuals) can search, exchange and purchase applications that enhance the data management, visualization, and analysis of location-based information;
- Real-time and dynamic data that is can be used to simultaneously analyze, and display streaming data from many sensors, devices, and social media feeds;
- Consultation service, e.g., consulting about usability of geographic data sets or applications.

One of good example of the marketplace is G-Spatial Information Center (https://www.geospatial.jp) in Japan developed based on the Basic Plan of Advancement of Utilizing Geospatial Information. The main purpose of the center is to be a distributed and integrated hub for various geospatial information (Kato, 2017). It was launched in November 2016 and within a year have already hosted 615 data collections from 75 different providers with more than 2,000 registered users (G-Spatial Information Center, 2017). There are four types of stakeholders involved in the center. First is the institutions from authorities represented by ministries, agencies, and incorporated administrative agency. The next stakeholder is autonomous bodies from prefectural governments, cities, and districts. Third stakeholder is representative from private sector e.g. mapping companies, surveying companies, car navigation services and infrastructure providers. The last actor is academic institutions from universities or research institutes. The major function of G-Spatial Information Center (Figure 6.8) is as a platform of distributing and exchanging geospatial data from public, private and academic sectors. A user can discover data based on category, geographic areas or keywords. The difference with the general geoportal is that it offers value-added data from private companies and a user can directly purchase the data online. Beside static data, it also provides dynamic data such as spatio-temporal population distribution as well as geospatial applications e.g. My City Forecast (Kato, 2017). The data available in this portal is categorized into free data and non-free data.

Figure 6.8 G-Spatial Information Center of Japan

Chapter 7
CONCLUSIONS

7.1. Summary of Research Findings

The objective of this study is distinguished into four major research questions that were addressed as follows:

- *Research Question 1: How does the development of NSDI in Indonesia?*

The evolution of Indonesia NSDI is described systematically in Chapter 3, starting from the first time it was initiated through the National GIS Forum (SIGNas) until recent progression regarding One Map Policy. Many achievements in the aspect of legal and organizational framework as well as technological development were explained in this chapter. NSDI in Indonesia has evolved into three periods of time where some changes were identified in the institution involved, data policy, technological use, and realized user of NSDI (the NSDI periods is presented in Table 3.5).

The first ten years period called Centralized Data where the focus is more on geospatial data production and collection using centralized geodatabase system and coordinated by the National Mapping Agency. In the next period, improvement of the database system is made by utilizing a distributed system in which each data producers create, store, and maintain their own database and connect it to the Clearinghouse. Hence, this period is named as Distributed System. Some of the national and local government agencies are started to participate in the system. In addition, web mapping applications are beginning to be developed to support social issues such as poverty and disaster management but the data usage is still limited to the government agencies. The third period has been started in 2011 with the enactment of the Geospatial Information Law and establishment the Ina-Geoportal. The government has realized the importance of open data and facilitated digital base maps and thematic web services to be accessed freely in the geoportal. More and more institutions from ministries and local governments are involved in the NSDI network. With the open data initiative, the NSDI begins to attract users from academia, private companies, and public. It is evident that the current NSDI in Indonesia effectively provides data sharing and reduce data duplication, but the scope is still limited to data and stakeholders from government agencies.

Present status of NSDI development in Indonesia is also described in Chapter 3. Based on the Geospatial Information Law, the NSDI consists of five components include policy, institutional arrangement, technology, standards, and human resource. In term of policy, the

government has issued several implementing regulations to back up the initiative (the list can be seen in Table 3.1). The importance of geospatial information is also recognized in the National Medium Term Development Plan (RPJMN) 2015-2019. Moreover, the government has launched One Map Policy with the aim to provide consistent geospatial information that refer to the same one geospatial reference, one standard, one database and one geoportal.

- *Research Question 2: What are the problems of NSDI implementation?*

The identification of problems faced by the stakeholders in implementing NSDI is presented in Chapter 4. Based on the interview results from the government officials, private company's officer, and academia, the problems can be grouped into four main category: Data, Technology, People, and Institutional.

The top two problems are low participation of the institutions in NSDI networks and limited availability of large-scale base maps. For the first problem, it is evident that until 2018, only 38 (6.1%) from the expected 622 institutions are connected to the national geoportal. A deep observation on data sharing availability in the geoportal during 2016-2017 showed a slight increase of data providers, but in the opposing part, number of datasets availability were decreased sharply from 778 datasets into 340 dataset in that period. The significant reduction is occurred because some of institutions that offer a large number of datasets stopped their services. The second main problem identified in the interview is inadequate large-scale topographic maps. Report from the BIG support this finding where up to 2017 only 1% of the national coverage 1:5,000 topographic maps are available.

In term of expectations for future NSDI, different answers were mentioned by the respondents. In general, they expect to have more geospatial data and applications. They believe NSDI should be able to provide good quality spatial data in term of resolution and completeness as the basis for added-value information creation. Some of the interviewees consider future application of NSDI will be integrated with different types of data to support geospatial analytics, which is important for decision makers.

- *Research Question 3: Why does the problem happen?*

Chapter 5 provides explanations about the reasons that hampered NSDI implementation. Stakeholder Analysis and Cost Analysis are used to understand the source of problems. From the Stakeholder Analysis, we identified 15 types of stakeholders in Indonesia. Each of the stakeholder possess its own interest and influence which can be listed in a power and interest table. By completing the table, we can draw an NSDI Power-Interest Grid that classifies the stakeholders into four quadrants specifically: Key Players, Context Setters, Subjects, and

Crowd. NSDI Stakeholder Diagram is created to understand the stakeholders capacity and their resource. The diagram uses four features of NSDI including Data Provision, Technological Infrastructure, Financial Resource, and Human Capacity. It is evident that the availability of resources of each stakeholders influences the level of involvement in NSDI. The Key Players of Indonesia NSDI are come from government agencies, particularly BIG and Central Government Agencies that have suitable resources on data, budget, and technological infrastructure. However, Municipalities/Districts governments have limitations in publishing their geospatial data thus resulted in lack of participation. The awareness of benefits of geospatial information need to be raised to the Context Setter (State Institutions, National Police, and National Armed Force) if the government want to improve their participations in the NSDI networks.

Stakeholder Analysis also provides assessment of the way interrelations among those 15 stakeholders. There are three indicators defined for this purpose: existence of annual cooperation, presence of regular meetings, and existence of data sharing. We can identified whether the stakeholders have strong relations, weak or no connection at all using the NSDI Action-linkage table. Based on how many connections have been established, we can create an NSDI Action-linkage Graph that illustrates relationships of the stakeholders in NSDI activities. It is clear that most of the strong and active relationships come from government related agencies. At the moment, relationship between private sectors and government agencies is limited to the data provision projects; hence collaboration is encouraged to broaden NSDI implementation.

Cost Analysis is conducted to give understanding how the NSDI budget is being used and to investigate efficient method for fulfilling large-scale base maps. The NSDI development cost components is classified into data provision, NSDI network node, organizational arrangements, and capacity building. In Indonesia, most of the NSDI budget is allocated for producing geospatial data, followed by developing NSDI network node. In term of for producing geospatial data, calculation of the unit cost by using two different technical approach indicates that the ortho-rectified image method can reduced the cost more than 50%.

- *Research Question 4: What are the strategic directions for future NSDI implementation?*

To answer the last question, Chapter 6 delivers strategic directions with a careful consideration of institutional, technological, and financial aspect. The SWOT Matrix of current NSDI implementation in Indonesia is utilized as the basis for this synthesis. First direction is the establishment of NSDI Committee to tackle problem in low participation of the institutions.

In addition, the committee should also embrace ministries that have key role to support NSDI development such as Ministry of Communication and Informatics in providing Internet Infrastructure for local governments.

Developing NSDI Grand Design is proposed as the second direction since its absence is realized as one of the weaknesses. An NSDI Logic Model is created as the approach to visualize the NSDI program in a systematic way and offers measurement for the evaluation. The model then detailed into activities and intended outputs to generate KPI for the implementation. The third direction is adoption of new technology such as UAV that can be implemented to reduce some cost of large-scale basic maps production. Next direction is related to the threat of inadequate Internet infrastructure faced by local governments for participating in NSDI networks. Cloud computing services like IaaS were proposed to help the government used their resource efficiently. Finally, the proposition of geospatial marketplace and community is suggested with the aim to overcome the lack of financial resource and participation from geospatial industry players.

7.2. Contribution of the Research

The research delivers a comprehensive image of the NSDI implementation in Indonesia by clarifying its developmental process over twenty years of its initiation. The findings provided in depth study on the legal, institutional, and technical history of NSDI, which shapes current implementation. The study also identifies current problems based on the perspective of NSDI actors and validate them via real observation of the operating NSDI. It is expected to contribute to enhance the understanding of NSDI implementation in one of the developing country and in some way also countries in Asia.

The research provides a method to assess the behavior of NSDI stakeholders by creating NSDI Stakeholder Diagram and NSDI Actor-linkage Graph. The application of Stakeholder Diagram is useful in classifying NSDI Stakeholders based on their interest, influence and capacity. Meanwhile, Actor-linkage Graph delivers identification and description of inter-relationships among the stakeholders. This method can be a valuable addition to the current knowledge base of NSDI program evaluation.

7.3. Research Limitation and Further Study

The NSDI Stakeholder Analysis conducted in this research is limited to the context of Indonesia. As the NSDI implementation in one country may differs from another depends on the political settings or economic condition, it is necessary to carry out future study in other

nations. The study will be important to recognize how the stakeholder contributes to NSDI development in different landscape.

Our study provides five key strategic directions for future NSDI implementation in Indonesia. However, measuring the successfulness of these directions is no mean feat. It will require longitudinal observation of the specific activities as well as evaluation of KPIs. Our study indicates that the directions can tackle weaknesses and threats identified in the operation of NSDI. Further research is needed to validate the strategic directions, particularly the implementation of NSDI Grand Design.

APPENDIX 1

NSDI ASSESSMENT IN ASIAN COUNTRIES*

Country Name	World Bank Category	NSDI Characteristics			
		Policy	NSDI Coordinator	Data	Geoportal
Afghanistan	Low income	Geospatial data classification & data standard policy	Afghanistan Geodesy & Cartography Head Office	Administrative boundary, aerial photo, DEM, transportation, settlements	http://asdc.immap.org
Armenia	Upper-middle income	-	-	Topographic maps, cadaster, satellite image	https://www.e-cadastre.am/en/map
Azerbaijan	Upper-middle income	-	-	-	-
Bahrain	High income	Government decree	National GIS Steering Committee	Topographic maps, utilities, transportation, land use, satellite image	- http://www.bsdi.gov.bh - https://www.ma-investment.gov.bh
Bangladesh	Lower-middle income	-	-	Administrative boundary, building, DEM, transportation, facilities, vegetation	https://nsdi.gov.bd/
Bhutan	Lower-middle income	Geoinformation policy (draft)	National GIS Coordination Committee	Administrative boundary, land use, DEM, infrastructure, road network, satellite image	http://geo.gov.bt/
Brunei Darussalam	High income	Government decree	Survey Department	Administrative boundary, transportation, building, POI	http://www.geoportal.survey.gov.bn
Cambodia	Lower-middle income	-	-	-	-
China	Upper-middle income	Regulation on administration of maps	National Geospatial Information Coordinating Council	Topographic maps, thematic data, navigation maps, satellite image, DEM	http://www.tiandiditu.gov.cn/
Cyprus	High income	NSDI law	Department of Land and Surveys	Topographic maps, cadaster, administrative boundary, spatial planning	http://eservices.dls.moi.gov.cy/#/national/geoportalmapviewer

** Excluding Indonesia, Japan, Republic of Korea, Malaysia, and Qatar*

Georgia	Lower-middle income	Government resolution on NSDI	National Agency of Public Registry	Topographic maps, cadaster, transportation	http://nsdi.gov.ge/en
Hong Kong (China region)	High income	Hong Kong smart city policy	Survey and Mapping Office, Land Department	Topographic maps, land boundary, DEM, 3D data, aerial photo, thematic data	http://www.map.gov.hk
India	Lower-middle income	Government resolution on NSDI	National Spatial Data Committee	Topographic maps, thematic data, transportation	https://nsdiindia.gov.in/nsdi/nsdiportal/index.jsp
Iran	Upper-middle income	Government development plan	National Cartographic Center	Topographic maps	-
Iraq	Upper-middle income	-	-	-	-
Israel	High income	Government resolution	Survey of Israel	Topographic maps, cadaster	https://www.govmap.gov.il
Jordan	Upper-middle income	-	-	Topographic maps, aerial photo, geology, satellite image	-
Kazakhstan	Upper-middle income	-	-	Geological data	http://www.geoportal-kz.org
Korea DPR	Low income	-	-	-	-
Kuwait	High income	-	-	Administrative boundary, statistical data	https://gis.csb.gov.kw/en/
Kyrgyzstan	Lower-middle income	-	-	Geological data	http://www.geoportal-kg.org/
Lao PDR	Lower-middle income	Government decree	National Geographic Information Committee	Administrative boundary, topographic maps	http://www.ngd.la
Lebanon	Upper-middle income	-	-	-	-
Macao (China region)	High income	Government decree	Cartography and Cadaster Bureau	Topographic maps, thematic data, aerial photo, cadaster	https://www.gis.gov.mo/geoportal/eng/
Maldives	Upper-middle income	Government mandate	Maldives Land and Survey Authority	Administrative boundary, POI, satellite image	http://www.onemap.mv/
Mongolia	Lower-middle income	NSDI Act (draft)	Administration of Land Affairs, Geodesy and Cartography	Topographic maps	-
Myanmar	Lower-middle income	-	-	Topographic maps	-
Nepal	Low income	Government regulation	Survey Department	Administrative boundary, topographic maps	http://nationalgeoportal.gov.np/
Oman	High income	Royal decree	National Center for Statistics and Information	Topographic maps, thematic	http://nsdig2gapps.ncsi.gov.om/ns

				data, satellite imagery	diportal/index.aspx
Pakistan	Lower-middle income	Surveying and mapping rule	Survey of Pakistan	Topographic maps, aerial photo	-
Philippines	Lower-middle income	NSDI master plan	National Mapping and Resource Authority	Topographic maps, thematic data, satellite imagery, aerial photo	http://www.geoportal.gov.ph
Saudi Arabia	High income	Council of Minister's Resolution	National GIS Committee	Topographic maps, geodetic & hydrography data, satellite imagery	http://geoportal.sa/start/index.html
Singapore	High income	Singapore Geospatial Collaborative Environment	Singapore Land Authority	Topographic maps, thematic data, satellite imagery, 3D data, cadaster	https://www.onemap.sg
Sri Lanka	Lower-middle income	Government mandate	Survey Department	Topographic maps, aerial photo, satellite imagery	https://www.survey.gov.lk/nsdi/
Syria	Low income	-	-	-	-
State of Palestine	Low income	-	-	-	-
Tajikistan	Low income	-	-	Geological data	http://www.geoportal-tj.org/
Thailand	Upper-middle income	Prime Minister Order	National Committee on Geoinformation	Topographic maps, aerial photo, satellite imagery	- http://www.ngis.go.th/home/ - http://thaisdi.gistda.or.th/
Timor-Leste	Lower-middle income	-	-	-	-
Turkey	Upper-middle income	Government decree	General Directorate of GIS	Topographic maps, cadaster, orthophoto	https://www.geoportal.gov.tr/
Turkmenistan	Upper-middle income	-	-	-	-
United Arab Emirates	High income	NSDI plan	Abu Dhabi Smart Solution and Services Authority	Topographic maps, facilities, satellite image	https://geoportal.abudhabi.ae/geoportal/
Uzbekistan	Lower-middle income	-	-	-	-
Vietnam	Lower-middle income	Geodesy and Cartography law (draft)	Ministry of Natural Resources and Environment	Topographic maps, aerial photo	-
Yemen	Low income	-	-	-	-

APPENDIX 2

NUMBER OF DOCUMENTS FOUND IN THE NSDI ASSESSMENT OF ASIA

Country Name	Type of Document						Sum
	Journal/ Book	Conference Paper	Conference Presentation	Official Report	Legal Document	Website Article	
Afghanistan		1		2			3
Armenia	1	1					2
Azerbaijan				1			1
Bahrain			1	1		3	5
Bangladesh				1		1	2
Bhutan				1	1	1	3
Brunei Darussalam		1	1			1	3
Cambodia				1		2	3
China	1	4				1	6
Cyprus				1		2	3
Georgia		1	1			2	4
Hong Kong			1	2		1	4
India	1	1		2	1	2	7
Indonesia	1	5	1	5	4	1	17
Iran	1	2	1				4
Iraq							0
Israel		2				1	3
Japan		2	3	5	3	1	14
Jordan	2			1			3
Kazakhstan		1				1	2
Korea DPR							0
Kuwait				1		1	2
Kyrgyzstan			1				1
Lao PDR		1			2	1	4
Lebanon							0
Macao		1				1	2
Malaysia	1	1	3		1	1	7
Maldives			1	2		1	4
Mongolia		1	2	1			4
Myanmar			2				2
Nepal	1			1			2
Oman		1	2	2			5
Pakistan		3		1	1		5
Philippines			1	3		1	5
Qatar		1	4	1			6
Rep. of Korea	1	2	1	2	2		8
Saudi Arabia		1		1	1	1	4
Singapore	1			2			3
Sri Lanka			1	1			2

Syria	1						1
State of Palestine							0
Tajikistan						1	1
Thailand		2	1	1		2	6
Timor-Leste				2			2
Turkey		5	1			1	7
Turkmenistan							0
United Arab Emirates		1		1		3	5
Uzbekistan		1					1
Vietnam		2	1				3
Yemen							0
Total	**12**	**44**	**30**	**45**	**16**	**34**	**181**

APPENDIX 3

LIST OF CONNECTED NETWORK NODES OF INDONESIA NSDI

No.	Type of Institution	Name of Institution
1	Central government agency	Geospatial Information Agency (BIG)
2	Ministry	Ministry of Public Works
3	Ministry	Ministry of Agriculture
4	Ministry	Ministry of Marine Affairs and Fisheries
5	Ministry	Ministry of Energy and Mineral Resources
6	Ministry	Ministry of Home Affairs
7	Ministry	Ministry of Village, Development of Disadvantaged Regions, and Transmigration
8	Central government agency	National Statistics Agency
9	Central government agency	National Police Force
10	Central government agency	National Disaster Relief Agency
11	Central government agency	National Land Agency
12	Local government (Province)	West Java Province
13	Local government (Province)	Central Java Province
14	Local government (Province)	Jambi Province
15	Local government (Province)	Riau Province
16	Local government (Province)	Riau Islands Province
17	Local government (Province)	Bengkulu Province
18	Local government (Province)	Central Kalimantan Province
19	Local government (Province)	North Kalimantan Province
20	Local government (Province)	Central Sulawesi Province
21	Local government (Province)	Lampung Province
22	Local government (Province)	West Papua Province
23	Local government (Province)	Papua Province
24	Local government (Province)	North Sumatra Province
25	Local government (Province)	Yogyakarta Province
26	Local government (Province)	Bangka Belitung Islands Province
27	Local government (Province)	Maluku Province
28	Local government (Province)	North Maluku Province
29	Local government (Municipality)	Depok Municipality
30	Local government (Municipality)	Mojokerto Municipality
31	Local government (Municipality)	Balikpapan Municipality
32	Local government (Municipality)	Bontang Municipality
33	Local government (District)	Bojonegoro District
34	Local government (District)	Lebong District
35	Local government (District)	Banyuwangi District
36	Local government (District)	Sleman District
37	Local government (District)	Bogor District
38	Local government (District)	Sumbawa District

APPENDIX 4

LIST OF GEOSPATIAL INFORMATION STANDARDS IN INDONESIA

No.	National Standards Code	Title (Bahasa Indonesia)	Title (English)
1	SNI 19-6724-2002	Jaring kontrol horizontal	Horizontal control network
2	SNI 19-6988-2004	Jaring kontrol vertikal dengan metode sipatdatar	Vertical control network by levelling method
3	SNI 19-7149-2005	Jaring kontrol gayaberat	Geoid control network
4	SNI 7646:2010	Survei hidrografi menggunakan singlebeam echosounder	Hydrographic survey using singlebeam echosounder
5	SNI 7716:2011	Pemetaan habitat perairan laut dangkal - Bagian 1: Pemetaan terumbu karang dan padang lamun	Mapping of shallow marine water habitat - Part 1: Mapping of coral reefs and seagrass beds
6	SNI 7717:2011	Survei dan pemetaan mangrove	Survey and mapping of mangrove
7	SNI ISO 19113:2011	Informasi geografis - Prinsip kualitas	Geographic information - Quality principles
8	SNI ISO/TS 19104:2011	Informasi geografis - Terminologi	Geographic information - Terminology
9	SNI 7802:2013	Prosedur pemotretan udara analog	Procedure of analog aerial photography
10	SNI 7803:2013	Prosedur pengumpulan nama rupa bumi	Procedure of toponym survey
11	SNI 7924:2013	Instalasi stasiun pasang surut	Installation of tidal station
12	SNI 7925:2013	Pemetaan lahan gambut skala 1:50.000 berbasis citra penginderaan jauh	Mapping of peatlands 1:50.000 scale based on remote sensing image
13	SNI 7963:2014	Pengamatan pasang surut	Tidal observation
14	SNI 7964:2014	Prosedur pembangunan Continuously Operating Reference Station (CORS)	Procedure of Continuously Operating Reference Station (CORS) development
15	SNI 7965:2014	Prosedur pemotretan udara digital	Procedure of digital aerial photography
16	SNI 7966:2014	Spesifikasi teknis triangulasi udara	Technical specification of air triangulation
17	SNI ISO 19131:2014	Informasi geografis – Spesifikasi produk data	Geographic information - Data product specifications
18	SNI ISO/TS 19138:2014	Informasi Geografis – Ukuran kualitas data	Geographic information – Data quality measures
19	SNI 7988:2014	Survei batimetri menggunakan multibeam echosounder	Bathymetric survey using multibeam echosounder
20	SNI 7989:2014	Prosedur pemetaan tingkat kesesuaian agroklimat	Procedure of mapping of agro climate suitability level
21	SNI ISO 19156:2015	Informasi geografis - Pengamatan dan pengukuran	Geographic information - Observations & measurements

22	SNI 8197:2015	Metode pemetaan rawan banjir skala 1:50.000 dan 1:25.000	Method of flood prone mapping 1:50,000 and 1:25,000 scale
23	SNI 8200:2015	Prosedur penentuan batas daerah aliran sungai (DAS) untuk peta skala 1:250.000	Procedure of watershed boundary for map 1:250,000 scale
24	SNI ISO 19157:2015	Informasi geografis - Kualitas data	Geographic information - Data quality
25	SNI 19-6502.1-2000	Spesifikasi teknis peta rupabumi skala 1:10.000	Technical specification of topographic mapping 1:10,000 scale
26	SNI 7336:2008	Pertukaran data lintang, bujur, dan tinggi lokasi geografis	Data exchange of latitude, longitude and height geographic location
27	SNI ISO 19111:2011	Informasi geografis - Pereferensian spasial dengan koordinat	Geographic information - Spatial referencing by coordinates
28	SNI ISO 19114:2011	Informasi geografis - Prosedur evaluasi kualitas	Geographic information - Quality evaluation procedures
29	SNI ISO/TS 19139:2012	Informasi geografis - Metadata - Implementasi skema XML	Geographic information – Metadata XML schema implementation
30	SNI 7987:2014	Klasifikasi liputan dasar laut	Classification of Seabed cover
31	SNI 7645-1:2014	Klasifikasi penutup lahan - Bagian 1: Skala kecil dan menengah	Classification of Landcover - Part 1: Small and medium scale
32	SNI ISO 19133:2014	Informasi Geografis – Layanan Berbasis Lokasi – Penjejakan dan navigasi	Geographic information - Location based service – Tracking and navigation
33	SNI 6728.4:2015	Penyusunan neraca spasial sumber daya alam Bagian 4: Sumber daya dan cadangan mineral dan batubara	Development of spatial balance of natural resource Part 4: Mineral and Coal resource and deposit
34	SNI ISO 19125-2:2015	Informasi geografis – Akses fitur sederhana – Bagian 2: Pilihan SQL	Geographic information - Simple feature access - Common architecture
35	SNI ISO/TS 19127:2015	Informasi geografis - Kode dan parameter geodetik	Geographic information - Geodetic codes and parameters
36	SNI ISO 19110:2015	Informasi geografis - Metodologi penyusunan katalog unsur geografis	Geographic information - Methodology for feature cataloguing
37	SNI ISO 19144-1:2015	Informasi geografis - Sistem klasifikasi - Bagian 1: Struktur sistem klasifikasi	Geographic information - Classification systems – Part 1: Classification system structure
38	SNI 19-6725-2002	Peta lingkungan bandar udara Indonesia skala 1:25.000	Airport environmental map scale of 1: 25,000
39	SNI 19-6726-2002	Peta dasar lingkungan pantai Indonesia skala 1:50.000	The basic map of coastal environment of Indonesia scale of 1: 50,000

40	SNI 19-6727-2002	Peta dasar lingkungan pantai Indonesia skala 1:250.000	The basic map of coastal environment of Indonesia scale of 1: 250,000
41	SNI 6502.2:2010	Spesifikasi penyajian peta rupa bumi - Bagian 2: Skala 1:25.000	Specification of topographic map presentation – Part 2: scale 1:25,000
42	SNI 6502.3:2010	Spesifikasi penyajian peta rupa bumi - Bagian 3: Skala 1:50.000	Specification of topographic map presentation – Part 3: scale 1:50,000
43	SNI 6502.4:2010	Spesifikasi penyajian peta rupa bumi - Bagian 4: Skala 1:250.000	Specification of topographic map presentation – Part 4: scale 1:250,000
44	SNI 7657:2010 dan Amd:2011	Singkatan nama kota	Abbreviation of city name
45	SNI ISO 19115-2: 2012	Informasi geografis - Metadata – Bagian 2: Ekstensi untuk citra dan data grid	Geographic information - Metadata – Part 2: Extensions for imagery and gridded data
46	SNI ISO/TS 19129:2014	Informasi geografi - Kerangka kerja (framework) untuk citra, data grid, dan coverage	Geographic information - Imagery, gridded and coverage data framework
47	SNI ISO/TR 19121:2015	Informasi geografis - Citra dan data grid	Geographic information - Imagery and gridded data
48	SNI 8196:2015	Spesifikasi penyajian peta curah hujan	Specification of precipitation map presentation
49	SNI 7644:2010	Basis data spasial oseanografi: Suhu, salinitas, oksigen terlarut, derajat keasaman, turbiditas dan kecerahan	Oceanographic spatial database: temperature, salinity, dissolved oxygen, degree of acidity, turbidity and brightness
50	SNI 7335:2008	Metadata spasial	Spatial metadata
51	SNI ISO 19101:2011	Informasi geografis - Model referensi	Geographic information - Reference model
52	SNI ISO 19112:2011	Informasi geografis - Pereferensi spasial dengan identifikasi geografis	Geographic information - Spatial referencing by geographic identifiers
53	SNI ISO 19115: 2012	Informasi geografis - Metadata	Geographic information - Metadata
54	SNI ISO 19128:2012	Informasi geografis - Antarmuka web map server	Geographic information - Web map server interface
55	SNI ISO 19119:2014	Informasi Geografis - Layanan	Geographic information - Services
56	SNI ISO 19142:2014	Informasi geografis - Layanan fitur berbasis web	Geographic information - Web Feature Services
57	SNI ISO 19116:2015	Informasi geografis - Layanan penentuan posisi	Geographic information - Positioning services
58	SNI ISO 19144-2:2015	Informasi geografis - Sistem klasifikasi – Bagian 2: Meta language penutup lahan/ Land Cover Meta Language (LCML)	Geographic information - Classification systems -- Part 2: Land Cover Meta Language (LCML)

59	SNI ISO/TS 19158:2015	Informasi geografis - Jaminan kualitas penyediaan data	Geographic information - Quality assurance of data supply
60	SNI 8202:2015	Ketelitian peta dasar	Accuracy of base map

APPENDIX 5

INTERVIEW RECORDS

(Question II.1) What do you think about the NSDI development in your country?
"NSDI is very important and we support it because our agency need integrated data for infrastructure planning and development processes. As you may know when our institution will build public infrastructure, we need clean and clear data because not only our institution are involved. For example we need information about geospatial data related to land status managed by other ministries such as the Ministry of Forestry, Agriculture or National Land Agency […]" ● **Official from Ministry of Public Works and Public Housing** *"[…] we need NSDI to overlay our data with other geospatial data such as forest boundaries and regional spatial planning […]"* ● **Official from National Land Agency (BPN)** *"In my opinion NSDI is essential because it can support national development. We are from the private sector, our client usually from government agencies and they really need geospatial data in carrying out their duties […]"* ● **Manager of PT. Waindo SpecTerra** *"[…] the development of the NSDI has run quite well with some spatial data being accessed in geoportal even though not all agencies have published the data. In the future, I think it needs to be complemented by involving the local government because most detailed data is managed by the local agencies".* ● **Official from Spatial Planning and Land Agency of Jakarta Province** *"[…] if we observe the development of NSDI in Indonesia, it still depends on the central government agencies which is a characteristic of the first generation of NSDI that struggling with data provision […]"* ● **Head of Center for SDI Development of University of Gadjah Mada** *"[…] the development of NSDI in recent years has accelerated but the progress of each component looks different. For example, about the geospatial data standard now we have many national standard. Then related to human resources, the skilled personnel is still lacking. In terms of providing data, it has started a lot and now is starting to be structured, but the quality of the data has not met expectations. Meanwhile, about technology, I believe there are quite a lot of developments with the use of open source software and government support. Nonetheless, I think the last two years have been set back of NSDI development because the focus has shifted more to the implementation of one map policy. In my view, the infrastructure foundation should be strengthened first and then after that we can switch to activity that is more applicable […]"* ● **Head of Center for SDI Development of Bandung Institute of Technology**

(Question II.1) What do you think about the NSDI development in your country?

"[…] the IDSN concept is applied in West Java Province where we create network nodes with working unit members and this concept is very useful in avoiding overlapping data and regional planning processes […]"

● **Official from Regional Development Planning Agency of West Java Province**

"In my opinion, in the beginning NSDI was a good initiative because the concept made it possible to share data across agencies in one system. But the implementation is somewhat lacking in the past 2-3 years because the agencies involved have not increased significantly and the geospatial data update is relatively slow […]"

● **Executive of PT. WebGIS Indonesia**

"As far as I know, the development of NSDI at the national level has been good enough with data from some ministries and institutions already being connected. However, I think with the local governments the coordination is still lacking. Perhaps coordination can be optimized at the provincial level where province can act as administrator and BIG is just monitoring it […]"

● **Official from Regional Development Planning Agency of Depok Municipality**

"I think the NSDI implementation has been supported by regulation but the technology used is not reliable, sometimes it can be accessed sometimes not. Sectoral ego is still occurring so that some data owned by government agencies is not available […]"

● **Managing Director of PT. Tiza Solusindo**

(Question II.2) What is the role of you/your institution in the NSDI development?

"[…] when speaking about our business core, my institution is a GIS software technology provider that mainly used by government agencies in managing their geospatial data. But then of course we cannot stop there because we also have to do knowledge transfer. We are directly involved in human resource development as we feel some limitations occurred in local government and we believe there are some things we can help with. For example, my institution provide software grants to universities since 2015. We also deliver training and general lectures for students and staffs. In addition, we also established a competition for students in creating and utilizing geospatial information […]"

● **Director of PT. ESRI Indonesia**

"Our role is to help developing GIS in government agencies. When there are tenders for mapping projects, providing satellite imagery or software, and providing experts, we commit to supports these activities. We are also involved in provision of basic and thematic geospatial information in BIG. In addition, our company also develops GIS applications for desktop, web or mobile platforms with a variety of themes that are needed by the government agencies […]"

● **Manager of PT. Waindo SpecTerra**

"Our institution plays a role in the provision of human resources in the field of geodesy; the focus of the course is not only on survey and mapping knowledge but also on the use of GIS applications. In addition, our lecturers are also often asked to become experts in NSDI development activities in BIG […]"

● **Lecturer at University of Pakuan**

"My office acts as an integrator of geospatial data produced by related local agencies in the West Java provincial government. Therefore, we are the network node that connects geospatial data of West Java province to BIG. Sometimes we also give training to local agencies in analyzing geospatial and non-geospatial data […]"

● **Official from Regional Development Planning Agency of West Java Province**

"Our company is a geospatial based application developer where we work with local governments to monitor public facilities and utilities using location information […]"

● **Officer at PT. Qlue Performa Indonesia**

"[…] Besides working out in the government projects, we also develop Web GIS applications for banking companies to monitor bank performance by utilizing geospatial information. In addition, we also make application for finance company that used geotagging data to deliver personal information […]"

● **Executive of PT. WebGIS Indonesia**

"[…] PPIDS ITB was established long enough from 1995. We had a role in helping BIG to develop the SDI concept and gave many suggestions and recommendation of SDI development. Off course, the main role as an educational institution is the development of human resources in the field of geospatial information. In addition to academic education, we also provide courses to government agencies and public […]"

● **Head of Center for SDI Development of Bandung Institute of Technology**

"[…] There are three main things about the role of PPIDS, first is as a provider of geospatial information human resources, secondly is collaborating with local governments to build network nodes in terms of data, technology and standardization. Finally, we are also active in conducting research related to NSDI implementation […]"

● **Head of Center for SDI Development of University of Gadjah Mada**

(Question II.3) What kind of activities that your institution's has been conducted in term of NSDI development?

"In supporting the implementation of the NSDI we are building a clearing unit to share data between the units of government organizations in both the province and municipality/district. We have two applications, first is the West Java network node that can be accessed internally and the second is geodatabase application which contains various thematic data such as population, poverty, and education that can be accessed by the public. We also sometimes invite experts from university as resource persons in implementing network nodes […]"

● **Official from Regional Development Planning Agency of West Java Province**

"[…] We built the ministry network node for sharing geospatial data and a data warehouses for non-geospatial data of each internal agencies; We also replicate the NSDI system, so each internal agencies has its own clearing unit and is connected to the ministry clearing unit managed by my division. In addition, we also developed the GIS Infrastructure portal application called SIGI; We also formed a network management team in the ministry to support the implementation of the NSDI […]"

● **Official from Ministry of Public Works and Public Housing**

"[…] Activities carried out related to NSDI include provision of hardware such as geospatial servers, land use mapping to support land certification programs; establishing clearinghouse at our ministry and developing thematic applications related to land parcels […]"

● **Official from National Land Agency**

"[…] We have been involved in several NSDI projects, first of all we assisted the NTT data team in developing the national geoportal in 2011; After that we were took part in the geoportal modernization process and maintain updated technology for developing network nodes in both BIG and local governments […]"

● **Director of PT. ESRI Indonesia**

"[…] Our company is involved in projects such as satellite image provision, providing GIS software and digital mapping of basic and thematic geospatial information. Additionally, we also developed a GIS web application to display geospatial information according to the needs of our clients […]"

● **Manager of PT. Waindo SpecTerra**

"[…] The project we used to do in supporting the implementation of NSDI is to develop a Web GIS application for local governments that displays thematic geospatial information needed by policy makers […]"

● **Executive of PT. WebGIS Indonesia**

"[…] we access administrative boundary data from Ina-Geoportal as the basis for making GIS applications for our clients […]"

● **Managing Director of PT. Tiza Solusindo**

"[…] we use basic data provided by the provincial government and there are other data from third parties […]"

● **Officer at PT. Qlue Performa Indonesia**

"[…] for the provision of data we assist in the development of large and medium scale maps for example in Medan Municipality. At the same time, we also help developing the geodatabase. Currently we are helping the city of Bandung by implementing the SDI concept in the management of geospatial data […]"

● **Head of Center for SDI Development of Bandung Institute of Technology**

(Question III.1) In your opinion what are the problems or challenges of NSDI implementation?
"In my opinion the main problem faced is the low participation of agencies which causes the limited availability of data. In terms of thematic data, there is still reluctance by agencies to share data, perhaps because there is no clear protocol of how to do it. Data availability is still lacking, especially data used for analysis, for example spatial planning data. Spatial planning requires a more detailed data at least 1: 5,000 scale, which still needs to be accelerated its availability. Another problem faced is the lack of budget where we need a new strategy to be as efficient as possible through partnership. I think until now the vision and grand design of the NSDI is not yet available so it is still unclear where the position of the geospatial industry is. Then lastly is the limited human resources in the field of geographic information, especially those with information technology capabilities […]" ● **Director of PT. ESRI Indonesia** *"I think that the constraint experienced in NSDI is the reluctance of institutions to share data that resulted in small number of participating institutions. There is unawareness of the institution about the importance of the data being disseminated. For example, forestry data is useful for forestry ministries, land data is useful for BPN but never felt useful for other agencies even though other agencies need it. Thus, they do not prepare infrastructure or procedures to distribute the data. Another constraint is related to data availability. Provincial and district/city governments need 1:5,000 scale data, but only recently these data have been started to be generated, so that BIG needs to provide nationally […]"* ● **Lecturer at University of Pakuan** *"In my opinion the most crucial thing is the Internet connection and its infrastructure in the local government. Our research in 2015 found that Internet connections are still very weak in provinces and municipalities/districts, especially for publishing geospatial data. If NSDI wants to connect network nodes in all local governments, then this problem must be resolved. Even at the ministry or state institutions, there is still a connection issue but not too many. Secondly, in the aspect of Ina-Geoportal I think we have to make a better geoportal. The functionality must be further improved. For example, we cannot access metadata even though usually user first time visit geoportal is to search geospatial data via the metadata. We are unable to discover existing web services like WFS or WMS […]"* ● **Head of Center for SDI Development of University of Gadjah Mada** *"The problems happened when implementing NSDI is that we face difficulties in applying data standards in working units of local agencies. Besides that, the availability of large-scale basic maps for several regions is not available. Moreover, personnel or staff who has capabilities in geospatial information field is insufficient; not only in quantity but also related to employee rotations that occur quite often, so we have difficulty finding a replacement […]"* ● **Official from Regional Development Planning Agency of West Java Province** *"The main problem in the national level I think basically is limited human resources from all levels, starting from operators, management to decision makers. Because many of them do*

not understand, the development of NSDI resources is hampered. Our challenge is how can we give them a comprehensive understanding of the NSDI concept. I am sure that if they already understand, other aspects such as regulation, funding and operationalization will not become obstacles. Another challenge is the participation of institutions that are still low and do not increase significantly […]"

● **Head of Center for SDI Development of Bandung Institute of Technology**

"Actually I think the technology...the GIS technology is growing fast, sometimes we are behind it and at the same time we have to socialize these technologies to our colleagues in the working unit, while we ourselves have not had time to update and master, there are already newer technologies. Therefore, the low adoption of technology is an obstacle for us. We also have difficulties in human resource aspect. Because of insufficient skilled personnel, sometimes operator in the field does not have technical background from geospatial science. Regarding the data, there are still some government agencies whose data is not yet open for public so that the number of data providers in geoportal is still low […]"

● **Official from Ministry of Public Works and Public Housing**

"According to us the main problem is data, we need a large-scale base map. Its availability is very important, especially for BPN in supporting land and parcel mapping. Then regarding types and coverage of data is still low as well as the data quality itself. Another problem when we are looking for data in Ina-Geoportal sometimes the data is not available or when we access it, the service is offline. We also think the coordination between institutions is not optimal and number of the human resource is inadequate […]"

● **Official from National Land Agency (BPN)**

"In our opinion, the agencies involved in NSDI are still few so the data is incomplete. We also have limitations in providing funds for maintenance, especially for purchasing GIS software licenses and hardware. Data on administrative boundary with 1: 5,000 scale are still limited although we require it as the base map in our thematic geospatial information product. Another difficulty is lack of operational guideline to publish data or how to maintenance the hardware […]"

● **Official from Ministry of Environment and Forestry**

"The first challenge in my opinion is the lack of human resources. Actually, we have tried to overcome it with the functional mapping position, but the rules are not up to date, so it is less attractive to employees, especially the benefits. Then in terms of data, the problem is still not diverse and the available data scale is not too detail. And lastly the low participation and coordination of agency members of the NSDI network nodes is still low. I believe BIG should encourage and raise awareness of the local governments […]"

● **Official from Regional Development Planning Agency of Depok Municipality**

"Quality of the geospatial data is a challenge that I think must be improved. Do not let users have a bad first impression to the data provided by the government, that it is not accurate and up-to-date. I also think that the national geoportal need to be enhanced the functionality because the data is still incomplete. Another important thing is the lack of adaptation to new

technology. We must be able to use and take advantage for emerging GIS technology such as drone or UAV, so we will not to be left behind by other nations. In addition, I think the availability of the data providers is still limited. Only several government agencies and ministries provide their data […]"

● **Managing Director of PT. Tiza Solusindo**

"I think the main problem faced is the lack of Internet bandwidth and network infrastructure in the local government. As we know the speed of Internet bandwidth in Indonesia is still below other countries such as Japan. So far, each government agencies provide the Internet individually to the private sectors. If, for example the Ministry of Communication and Information can provide access for government agencies, it will be very good. Another obstacle is the participation of local governments in the NSDI network, which is still low. With the One Map Policy, it should be able to drive government agencies in providing data. It will be useless to build expensive NSDI if it is not used for national benefits […]"

● **Official from Geospatial Information Agency (BIG)**

"[…] So the problem that we experienced in the field is that Internet connection is still inadequate, especially in the eastern of Indonesia. Then the second challenge is maintenance of the hardware and software that might need updating. Sometimes the local governments forget about this maintenance. Next problem is about human resources, I think it is necessary to supply information on the latest technology and deliver trainings. In addition, if there is an employee rotation, the transfer of knowledge must reach the person who replaced it. Sometimes a classic problem occurs when the person who replaces does not know what data has been generated […]"

● **Manager of PT. Waindo SpecTerra**

"[…] Constraints experienced by local governments are limited human resources and frequent organizational structure changes. In general, local government has difficulties if there is a transfer of employees whose educational backgrounds or skills are different with the new position. For example, a Head of Population and Civil Registration Agency is reassigned to a Spatial Planning Agency that has different expertise needs, it will require time to settle. I also see there is still sectoral ego that causes low participation of institutions in sharing data. In our country it still happens like that which can hinder the development of NSDI […]"

● **Official from Spatial Planning and Land Agency of Jakarta Province**

"[…] The main challenge is that many geospatial data have not been standardized. When we have project with local government, usually each local agencies have their own data with different format. Therefore, we need more efforts to integrate such data. Secondly, I think the data provided by government must be in accordance with the needs of the general public, for example demographic and socio-economic data that must be spatially visualized or provide their web services. And we also need POI data which include public facilities […]"

● **Officer at PT. Qlue Performa Indonesia**

"[…] In my view the main challenge faced today is the lack of functionality of the national geoportal. If possible, we want geoportal is more advanced by providing geospatial information related to banking. For example, providing socio-economic API data that can be easily integrated with other systems. In addition, if geoportal can display data from other agencies such as socio-economic (BPS) and industrial and tourism, it will be nice […]"

● **Director of PT. Bank Muamalat Indonesia**

"[…] Spatial data needs with a large-scale resolution are needed by the government and the private sectors. At the moment, I feel that the data is difficult to obtain and even if it is available, part of them are not up-to-date. This is a challenge for us. The data cycle if it takes too long will be less useful, especially for us in the field of facilities and public utilities. If the government can provide and share detailed data with the private sector, we will be very happy. We can also contribute to a mutual cooperation such as in updating this data […]"

● **Manager at PT. PAM Lyonase Jaya**

"In our case the main obstacle is the lack of GIS software technicians for data management. We currently have mapping staffs but do not have expertise in operating GIS software. Therefore, it is very important for human resources in the field of information technology that understands geospatial […]"

● **Official from Ministry of Agriculture**

"The first challenges in implementing NSDI in our opinion is problem of human resources capacity. We require workforces not only in the field of geography or geodesy, but also in practicing and developing applications of geospatial information system. The second challenge is the information network infrastructure and internet bandwidth in each agency. Especially in BIG, which is the network node connector, must be prepared first. From the physical side, it is good enough, but from the standard operation procedure side it is still lacking. For example operational guidance for publishing data or standard operation procedure for maintenance the reliability […]"

● **Executive of PT. WebGIS Indonesia**

APPENDIX 6

LIST OF THE QUESTIONNAIRE SURVEY RESPONDENTS

No.	Name of Institution	Type of Stakeholder	Position
1	Ministry of Environment and Forestry	Ministry	Director of Forest Resource Inventory and Monitoring
2	Ministry of Agrarian and Spatial Planning/National Land Agency	Ministry	Acting Head of Center for Land Data and Information
3	Ministry of Public Works and Housing	Ministry	Head of Center for Data and Information
4	National Institute of Aeronautics and Space	Central Government Agency	Center for Remote Sensing Data & Technology
5	Ministry of Transportation	Ministry	Head of Data Management Division
6	North Kalimantan Province	Provincial Government	Head of Regional Development Division
7	West Kalimantan Province	Provincial Government	Head of Development Data Division
8	East Kalimantan Province	Provincial Government	Head of Infrastructure & Regional Development Division
9	Central Java Province	Provincial Government	Head of Statistics, Control & Evaluation Unit
10	Banda Aceh Municipality	Municipality Government	Head of GIS Technical Unit
11	Bangli District	District Government	Head of Regional Development Planning Agency
12	Central Bangka District	District Government	Staff of Infrastructure and Physical Facility Division
13	Kepahiang District	District Government	Head of Statistics and Electronic Data Processing Unit
14	Kulonprogo District	District Government	Head of Regional Development Planning Agency
15	Tebo District	District Government	Head of Spatial Planning Division
16	Depok Municipality	Municipality Government	Head of Spatial Planning and Physical Infrastructure Division

No.	Name of Institution	Type of Stakeholder	Position
17	Kuningan District	District Government	Staff of Development Planning Agency
18	Pangandaran District	District Government	Head of Infrastructure and Facility Unit
19	Sragen District	District Government	Head of Regional Development Planning Agency
20	Demak District	District Government	Head of Infrastructure and Utility Division
21	Semarang Municipality	Municipality Government	Head of Spatial Utilization Unit
22	Sampang District	District Government	Head of Regional Development Planning Agency
23	Batu Municipality	Municipality Government	Head of Infrastructure and Environment Division
24	Situbondo District	District Government	Staff of Regional Development Planning Agency
25	Balikpapan Municipality	Municipality Government	Head of Regional Development Planning Agency
26	Penajam Paser Utara District	District Government	Head of Infrastructure & Regional Development Division
27	West Lampung District	District Government	Head of Spatial Planning and Environment Division
28	Lombok Timur District	District Government	Head of Agriculture Infrastructure and Facility Division
29	Belu District	District Government	Head of Public Works and Housing Agency
30	Negekeo District	District Government	Head of Spatial Planning Division
31	Jayapura Municipality	Municipality Government	Staff of Regional Development Planning Agency
32	Fakfak District	District Government	Head of Infrastructure and Utility Division

No.	Name of Institution	Type of Stakeholder	Position
33	Bantaeng District	District Government	Head of Spatial Planning Authorization Unit
34	Palu Municipality	Municipality Government	Head of Statistics Unit
35	Muara Enim District	District Government	Head of Regional Development Planning Agency
36	Lahat District	District Government	Head of Spatial Planning and Environment Division
37	West Nias District	District Government	Head of Infrastructure & Spatial Planning Division
38	University of Gadjah Mada	PPIDS	Head of Center for SDI Development
39	Bandung Institute of Technology (ITB)	PPIDS	Head of Center for SDI Development
40	Pakuan University	Lecturers/Researchers	Lecturer
41	PT. ESRI Indonesia	GIS Software Provider	Director of National Government
42	PT. Waindo SpecTerra	Survey & Mapping Company	Information Technology Manager
43	PT. Tiza Solusindo	Geospatial Application Developer	Managing Director
44	PT. Qlue Performa Indonesia	Geospatial Application Developer	Strategist for Public and Government Affairs
45	PT. PAM Lyonase Jaya	Survey & Mapping Company	GIS Manager
46	PT. WebGIS Indonesia	Geospatial Application Developer	Chief Executive Officer

APPENDIX 7

QUESTIONNAIRE OF NSDI IMPLEMENTATION

Profile of the Respondent

Name	:	…….
Position	:	…….
Institution	:	…….
Municipality/District	:	…….
Province	:	…….
Telephone	:	…….
E-mail	:	…….
Website of institution	:	…….

I. Policy, Institutional and Financial Aspects

1. Is there any masterplan of information technology available as the basis for developing and implementing e-government in your institution?
   a. No b. Yes
2. Is there any strategic plan or a roadmap of the implementation of geospatial information?
   a. No b. Yes
3. Is there any regulation in your institution for implementing geospatial information as stated in Presidential Decree No. 27/2014?
   a. No b. Yes, please specify……
4. Is there any formal directive to conduct geospatial data sharing in your institution?
   a. No b. Yes, please specify……
5. Is there any formal directive to arrange licensing of geospatial data utilization by society/company?
   a. No b. Yes, please specify……
6. Is there any formal directive to arrange security of geospatial data in your institution?
   a. No b. Yes, please specify……
7. Is there any formal directive about classification of open, restricted, or secret geospatial data and information in your institution?
   a. No b. Yes, please specify……
8. Is there any *Standard Operating Procedure* (SOP) for conducting geospatial information activities in your institution?
   a. No b. Yes, please specify……
9. Does your institution specify prerequisite of competency certificate for geospatial projects obtained by the third party?
   a. No b. Yes

10. Does the geospatial information activity included in your institution Development Planning?
    a. No b. Yes
11. Does your institution allocating routine budget for NSDI implementation?
    a. No b. Yes, please specify……..……...……million Rupiah/year
12. Does your institution has budget for providing and developing geospatial information software or applications?
    a. No b. Yes, please specify……..……...……million Rupiah/year
13. Does your institution has budget for providing ICT hardware for geospatial information?
    a. No b. Yes, please specify……..……...……million Rupiah/year
14. Does your institution has been establishing regular internal meeting to discuss geospatial information utilization?
    a. No b. Yes, please specify……..……...……times
15. Is there any working unit in your institution that has role in managing geospatial data (maps)?
    a. No b. Yes
16. Is there any working unit in your institution that has role as a production unit of geospatial data?
    a. No b. Yes
17. How many internal working unit that involved in geospatial information network? ….working unit
18. Is there any working unit in your institution that has role as a distribution unit of geospatial data?
    a. No b. Yes
19. Does your institution has policy to give incentive/disincentive for the working unit, which contributed in geospatial information implementation?
    a. No b. Yes
20. Does your institution has leader/personnel who act as a champion in promoting, design and implementing geospatial information activities?
    a. No b. Yes
21. Does your institution has been establishing cooperation with government institutions in implementing NSDI?
    a. No b. Yes, please specify……
22. Does your institution has been establishing cooperation with private sector or community in implementing NSDI?
    a. No b. Yes, please specify……
23. Do you think the decision makers in your institution have strong commitment in implementing NSDI?
    a. No b. Yes
24. Please write if you have additional comments regarding Policy, Institutional and Financial Aspects

    ……
    ……
    ……

II. Human Capacity Aspect

1. How many staff(s) with educational background from geomatics/geodesy/geography work in your institution? ……person(s)
2. How many staff(s) with educational background from information technology/computer science work in your institution? ……person(s)
3. How many staff(s) that have skill in managing geospatial server for publication and distribution geospatial data work in your institution? ……person(s)
4. How many staff(s) involved in geospatial information activity that have no geospatial nor information technology educational background? ……person(s)
5. How many staff(s) that have attended training/course related with Geographic Information System (GIS)? ……..…person(s)
6. How many staff(s) have functional position of survey and mapping? ……..……..…person(s)
7. How many staff(s) have functional position of computer institution? ……person(s)
8. How many staff(s) have functional position of planner? ……..…person(s)
9. Does your institution has regular capacity building program about geospatial information?
   a. No b. Yes
10. Does your institution has education improvement program in geospatial information field?
    a. No b. Yes
11. Does your institution has career development program for staff working in geospatial information?
    a. No b. Yes
12. Does in the rotation of staff consider the same qualification level of the replacement?
    a. No b. Yes
13. Is there any plan to recruit new staff with geospatial information background?
    a. No b. Yes
14. Please write if you have additional comments regarding Human Capacity Aspect

    ……
    ……
    ……

III. Technological Aspect

1. Do you use open-source GIS software to collect, edit, manage, and utilize geospatial data?
   a. No b. Yes, please specify……
2. Do you use commercial GIS software to collect, edit, manage, and utilize geospatial data?
   a. No b. Yes, please specify……
3. Do you use open-source Remote Sensing software to collect, edit, manage, and utilize geospatial data?
   a. No b. Yes, please specify……

4. Do you use commercial Remote Sensing software to collect, edit, manage, and utilize geospatial data?
   a. No b. Yes, please specify……
5. Do you use GIS Server to publish and distribute geospatial data?
   a. No b. Yes, please specify……
6. Does your institution has official Website?
   a. No b. Yes, please specify……
7. Is there any maps (format PDF, JPG, PNG, or TIFF) available on the website?
   a. No b. Yes, (number of)……maps
8. Does your institution has geoportal for sharing/distributing geospatial information?
   a. No b. Yes, please specify……
9. The number of geospatial data theme available in the geoportal are……..theme
10. The number of web map services available in the geoportal are……..service
11. The number of web feature services available in the geoportal are……..service
12. The number of geospatial data theme that can be downloaded in the geoportal are……..theme
13. Does your institution has WebGIS/WebMapping application?
    a. No b. Yes, please specify……
14. The number of geospatial data theme presented in the WebGIS are……..theme
15. Please specify the hardware that are available for handling geospatial information in your institution:

Hardware Specification	Description
Computer/Workstation	…….unit(s)
Server for geospatial data management	…….unit(s)
Subscribed to cloud-based server	Yes / No
Data center/Dedicated server room	Yes / No
Storage capacity of server	……...Terabyte
Internal computer network	LAN / WAN / Not available
Status of internal computer network	Owned / Rental
Internet bandwidth	……...Mbps

16. Is there any backup power supply facility (high capacity UPS/generator set) available?
    a. No b. Yes
17. Please write if you have additional comments regarding Technological Aspect

    ……
    ……

IV. Data and Standard Aspects

1. What type of geospatial data are available in your institution?
   a. Analog (hardcopy) b. Digital (softcopy)

2. What format of the digital geospatial data stored in your institution?
   a. File-base (e.g. *shp, dxf, mif*) b. Database (e.g. *PostgreSQL, geodatabase, Oracle Spatial*)

3. Please specify the theme of digital geospatial data available in your institution:

No.	Geospatial data theme	Coverage	Scale/Spatial resolution	Metadata (Y/N)	Available online (Y/N)
1.	*(e.g. Topographic maps)*	……...	……...	……...	……
2.	……	……...	……...	……...	……

4. Is there any procedure of quality control in the geospatial information arrangement?
   a. No b. Yes

5. Is there any procedure of quality assurance in the geospatial information arrangement?
   a. No b. Yes

6. Does the development of geospatial information has conformed to the Indonesian National Standard or Technical Specifications?
   a. No b. Yes

7. Does the metadata stored with the digital geospatial data?
   a. No b. Yes

8. Is there any catalog of the geospatial data?
   a. No b. Yes

9. Does the catalog of the geospatial data available online?
   a. No b. Yes

10. Is there any place to store and archive the geospatial data?
    a. No b. Yes

11. Please write if you have additional comments regarding Technological Aspects

    ……
    ……

APPENDIX 8

THE ACTION-LINKAGE TABLE OF NSDI STAKEHOLDERS

Stakeholder	BIG	Central Government Agency	State Institutions
BIG	5 strong relations, 4 weak	- Annual cooperation (4 MoU) - Regular meeting (1 record) - Frequent data sharing (7 datasets)	- No communication - No data sharing
Central Gov. Agencies	- Annual cooperation (4 MoU) - Regular meeting (1 record) - Frequent data sharing	2 strong relations, 4 weak	- No communication - No data sharing
State Institutions	- No communication - No data sharing	- No communication - No data sharing	no strong or weak relations
Provincial Government	- Annual cooperation (5 MoU) - Regular meeting (5 records) - Frequent data sharing (7 datasets)	- Incidental cooperation - Occasional meeting - Infrequent data sharing	- No communication - No data sharing
Municipality/District Government	- Annual cooperation (12 MoU) - Regular meeting (1 record) - Frequent data sharing (7 datasets)	- Incidental cooperation - Occasional meeting - Infrequent data sharing	- No communication - No data sharing
National Police	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
National Armed Force	- Annual cooperation (1 MoU) - Regular meeting (1 record) - Frequent data sharing (7 datasets)	- No communication - No data sharing	- No communication - No data sharing
PPIDS	- Annual cooperation (1 MoU) - Regular meeting (1 record) - Frequent data sharing (7 datasets)	- No communication - No data sharing	- No communication - No data sharing
Survey & Mapping Companies	- Annual contract - Regular meeting	- Annual contract - Regular meeting	- No communication - No data sharing
Geospatial Apps Developers	- Incidental cooperation - Occasional meeting	- Incidental cooperation - Occasional meeting	- No communication - No data sharing
GIS Software Providers	- Incidental cooperation - Occasional meeting	- Incidental cooperation - Occasional meeting	- No communication - No data sharing
NGOs/NPOs	- Incidental cooperation - Occasional meeting - Infrequent data sharing	- No communication - No data sharing	- No communication - No data sharing
Lecturers/ Researchers	- Incidental cooperation - Frequent data request	- No communication - No data sharing	- No communication - No data sharing
Students	- Incidental cooperation - Frequent data request	- No communication - No data sharing	- No communication - No data sharing
Citizens	- Incidental cooperation - Infrequent data request	- No communication - No data sharing	- No communication - No data sharing

Stakeholder	Provincial Government	Municipality/District Government	National Police
BIG	- Annual cooperation (5 MoU) - Regular meeting (5 records) - Frequent data sharing (7 datasets)	- Annual cooperation (12 MoU) - Regular meeting (1 record) - Frequent data sharing (7 datasets)	- No communication - No data sharing
Central Government Agencies	- Incidental cooperation - Occasional meeting - Infrequent data sharing	- Incidental cooperation - Occasional meeting - Infrequent data sharing	- No communication - No data sharing
State Institutions	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
Provincial Government	3 strong relations, 4 weak	- Annual cooperation - Regular meeting - Frequent data sharing	- No communication - No data sharing
Municipality/District Government	- Annual cooperation - Regular meeting - Frequent data sharing	3 strong relations, 4 weak	- No communication - No data sharing
National Police	- No communication - No data sharing	- No communication - No data sharing	No strong and weak relationships
National Armed Force	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
PPIDS	- Incidental cooperation - Occasional meeting - Infrequent data sharing	- Incidental cooperation - Occasional meeting - Infrequent data sharing	- No communication - No data sharing
Survey & Mapping Companies	- Annual cooperation - Regular meeting	- Annual cooperation - Regular meeting	- No communication - No data sharing
Geospatial Application Developers	- Incidental cooperation - Occasional meeting - Infrequent data sharing	- Incidental cooperation - Occasional meeting - Infrequent data sharing	- No communication - No data sharing
GIS Software Providers	- Incidental cooperation - Occasional meeting - Infrequent data sharing	- Incidental cooperation - Occasional meeting - Infrequent data sharing	- No communication - No data sharing
NGOs/NPOs	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
Lecturers/ Researchers	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
Students	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
Citizens	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing

Stakeholder	National Armed Force	PPIDS	Survey & Mapping Companies
BIG	- Annual cooperation (1 MoU) - Regular meeting (1 record) - Frequent data sharing (7 datasets)	- Annual cooperation (1 MoU) - Regular meeting (1 record) - Frequent data sharing (7 datasets)	- Annual contract - Regular meeting - Frequent data sharing (7 datasets)
Central Government Agencies	- No communication - No data sharing	- No communication - No data sharing	- Annual contract - Regular meeting - Occasional data sharing
State Institutions	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
Provincial Government	- No communication - No data sharing	- Incidental cooperation - Occasional meeting - Infrequent data sharing	- Annual contract - Regular meeting - Occasional data sharing
Municipality/District Government	- No communication - No data sharing	- Incidental cooperation - Occasional meeting - Infrequent data sharing	- Annual contract - Regular meeting - Occasional data sharing
National Police	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
National Armed Force	1 strong relationship	- No communication - No data sharing	- No communication - No data sharing
PPIDS	- No communication - No data sharing	1 strong relationship, 2 weak	- No communication - No data sharing
Survey & Mapping Companies	- No communication - No data sharing	- No communication - No data sharing	4 strong relations, 1 weak
Geospatial Application Developers	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
GIS Software Providers	- No communication - No data sharing	- No communication - No data sharing	- Incidental cooperation - Occasional meeting - Infrequent data sharing
NGOs/NPOs	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
Lecturers/ Researchers	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
Students	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
Citizens	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing

Stakeholder	Geospatial Application Developers	GIS Software Providers	NGOs/NPOs
BIG	- Incidental cooperation - Occasional meeting - Infrequent data sharing	- Incidental cooperation - Occasional meeting - Infrequent data sharing	- Incidental cooperation - Occasional meeting - Infrequent data sharing
Central Government Agencies	- Incidental cooperation - Occasional meeting - Infrequent data sharing	- Incidental cooperation - Occasional meeting - Infrequent data sharing	- No communication - No data sharing
State Institutions	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
Provincial Government	- Incidental cooperation - Occasional meeting - Infrequent data sharing	- Incidental cooperation - Occasional meeting - Infrequent data sharing	- No communication - No data sharing
Municipality/District Government	- Incidental cooperation - Occasional meeting - Infrequent data sharing	- Incidental cooperation - Occasional meeting - Infrequent data sharing	- No communication - No data sharing
National Police	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
National Armed Force	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
PPIDS	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
Survey & Mapping Companies	- No communication - No data sharing	- Incidental cooperation - Occasional meeting - Infrequent data sharing	- No communication - No data sharing
Geospatial Application Developers	4 weak relations	- No communication - No data sharing	- No communication - No data sharing
GIS Software Providers	- No communication - No data sharing	5 weak relations	- No communication - No data sharing
NGOs/NPOs	- No communication - No data sharing	- No communication - No data sharing	1 weak relation
Lecturers/ Researchers	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
Students	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
Citizens	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing

Stakeholder	Lecturers/ Researchers	Students	Citizens
BIG	- Incidental cooperation and meeting - Frequent data access	- Incidental cooperation and meeting - Frequent data access	- Incidental cooperation and meeting - Frequent data access
Central Government Agencies	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
State Institutions	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
Provincial Government	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
Municipality/District Government	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
National Police	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
National Armed Force	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
PPIDS	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
Survey & Mapping Companies	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
Geospatial Application Developers	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
GIS Software Providers	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
NGOs/NPOs	- No communication - No data sharing	- No communication - No data sharing	- No communication - No data sharing
Lecturers/ Researchers	1 weak relation	- No communication - No data sharing	- No communication - No data sharing
Students	- No communication - No data sharing	1 weak relation	- No communication - No data sharing
Citizens	- No communication - No data sharing	- No communication - No data sharing	1 weak relation

APPENDIX 9

COST DETAIL OF LARGE-SCALE MAPPING USING AERIAL PHOTO

Procedure	Subprocedure	Activity	Cost Component	Cost (IDR)
Data Processing	Project preparation	- Preparation of tools and personnel	Work forces Stationary	53,000,000 260,000
		- Creation of detailed working plan	Work forces Tools Stationary	26,500,000 5,374,000 312,540
		- Report development	Work forces Tools Stationary	3,900,000 8,220,000 260,000
	Data preparation	- Preparation of tools and personnel	Work forces Tools	3,080,000 585,000
		- Data assessment	Work forces Tools	3,080,000 335,000
		- Report development	Work forces Tools Stationary	6,160,000 1,020,000 260,000
	Subtotal Preparation			*112,346,540*
	Stereo plotting	- Preparation of tools and personnel	Work forces Tools	930,800 871,700
		- Stereo plotting all objects	Work forces Tools	1,619,650,000 1,081,700,000
		- Report development	Work forces Tools Stationary	6,160,000 1,020,000 260,000
	Subtotal Stereo plotting			*2,710,592,500*
	Topology editing	- Preparation of tools and personnel	Work forces Tools	930,800 521,700
		- Topology creation and editing	Work forces Tools	80,982,500 23,635,000
		- Polygon creation and editing	Work forces Tools	80,982,500 23,635,000
		- Report development	Work forces Tools Stationary	6,160,000 1,020,000 260,000
	Subtotal Topology editing			*218,127,500*
	DTM creation	- Preparation of tools and personnel	Work forces Tools	930,800 521,700
		- DTM creation and editing	Work forces Tools	215,951,400 63,028,600

		- Report development	Work forces Tools Stationary	6,160,000 1,020,000 260,000
	Contour creation and editing	- Preparation of tools and personnel	Work forces Tools	930,800 521,700
		- Contour editing	Work forces Tools	323,930,000 94,540,000
		- Spot height creation	Work forces Tools	107,978,600 31,511,400
		- Report development	Work forces Tools Stationary	6,160,000 1,020,000 260,000
	Subtotal DTM and contour editing			*854,725,000*
Field Survey	Survey preparation	- Preparation of tools and personnel	Work forces Tools	930,800 487,800
		- Mobilization	Work forces Transportation	3,660,000 1,400,000
		- Coordination with institutions	Work forces Transportation Tools	4,654,100 8,474,450 593,750
		- Demobilization	Work forces Transportation	3,660,000 1,400,000
		- Secondary data collection	Work forces Tools	1,861,600 525,000
		- Manuscript map creation	Work forces Tools Stationary	35,093,480 13,142,800 18,127,320
		- Creation of detailed survey plan	Work forces Tools	930,800 262,500
		- Survey form	Work forces Tools Stationary	15,500 3,050 260,000
		- Report development	Work forces Tools Stationary	6,160,000 1,020,000 260,000
	Field survey	- Preparation of tools and personnel	Work forces Tools	1,680,800 1,844,450
		- Mobilization	Work forces Transportation	7,410,000 1,400,000
		- Topographic feature verification	Work forces Transportation Tools	61,514,800 46,162,200 41,945,600
		- Boundary identification	Work forces Transportation Tools	38,448,200 28,849,200 26,216,000

		- Toponym collection	Work forces Transportation Tools	553,668,000 415,465,600 377,493,000
		- Accuracy test	Work forces Transportation Tools	4,627,600 3,523,400 5,398,000
		- Data processing	Work forces Tools	60,476,600 87,701,800
		- Demobilization	Work forces Transportation	5,160,000 1,400,000
		- Report development	Work forces Tools Stationary	6,160,000 1,020,000 260,000
	Subtotal Field survey			*1,880,748,200*
Geodatabase	Feature editing	- Preparation of tools and personnel	Work forces Tools	930,800 521,700
		- Feature and attribute editing	Work forces Tools	269,943,600 78,781,400
		- Edge matching	Work forces Tools	64,786,000 18,908,000
	Topology validation	- Topology editing and validation	Work forces Tools	2,327,080 679,170
	Subtotal Feature editing and topology validation			*436,877,750*
	Metadata creation	- Metadata editing	Work forces Tools Stationary	8,021,600 1,813,400 260,000
	Subtotal Metadata creation			*10,095,000*
Visualization	Large-scale map presentation	- Preparation of tools and personnel	Work forces Tools	930,800 575,300
		- Lay outing	Work forces Tools	132,980 35,470
		- Map printing	Work forces Tools Stationary	66,480 149,480 806,540
		- Final report writing	Work forces Tools Stationary	15,910,000 3,070,000 9,352,000
	Subtotal Visualization			*31,029,050*
Total Cost				***6,254,541,540***

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