Lesson Learned from Indonesian Spatial Data Infrastructure

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Abstract: Realizing benefits of Spatial Data Infrastructure (SDI) for nationwide development have driven many countries to develop their National SDI. Indonesia was considered as one of the early adopters of National SDI through mapping activities in 1993. This paper describes the history and current status of SDI development in Indonesia based on the five key components: policy, institutional arrangement, technology, standard, and human resources. The paper suggests strategies for each component to better improve National SDI operation.

Keywords: spatial data infrastructure, institutional arrangement, standard, human resources

1. Introduction

Integration of different spatial data sources from government, private sector, and citizens, together with satellite data and statistical records, has been recognized and more likely to growth in the coming years (Carpenter and Snell, 2013). In order to achieve collaborative use of geographic information, a Spatial Data Infrastructure (SDI) is required. This platform facilitates spatial data discovery, access, and sharing, therefore it has capabilities to provide fast and direct information updating that enables interaction among stakeholders.

Realizing benefits of SDI for national development has driven many countries to develop their National Spatial Data Infrastructure (NSDI). According to a broad web survey in April 2005 there were 83 countries who have established national clearinghouses – a key feature of NSDI – that deliver access to nationwide spatial data, and improve the exchange and service of location information between providers and users (Crompvoets and Bregt, 2007).

Indonesia was considered as one of the early adopters of NSDI (Masser, 1999). The initiative was led by the National Mapping Agency through the activities of producing topographic base maps and thematic spatial data provided by different government institutions. This early generation of NSDI development was recognized as a product based approach, focusing on creating a national clearinghouse as the main product.

The remaining part of this paper first reviews past initiatives of the Indonesian SDI before moving on to describe the current status of the NSDI development, based on the five key components: policy, institutional arrangement, technology, standard, and human resources. Finally, the paper elaborates on the lesson learned arising from the implementation of NSDI in Indonesia that might be useful as a lesson learned for other countries in sustaining their NSDI projects.

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2. Initiatives of Indonesian SDI

The NSDI initiative in Indonesia was officially started in 1993 by a first group meeting among central government agencies with the agenda to identify and share GIS data availability between agencies (Matindas *et al.* 2004). The meeting was organized by the National Coordinating Agency for Surveying and Mapping (Bakosurtanal). It was only at the time of the meeting that they realized the importance of making GIS data accessible and exchangeable to other institutions. Afterwards, in the fifth meeting in 2000 some improvements were made, including the agreement to define the initiative as Infrastruktur Data Spasial Nasional (IDSN) and change the forum name into Coordination Meeting of NSDI to be more focused on the development of SDI.

In the period of 2000s there are several achievements in some aspects of NSDI. Formulation of NSDI Secretariat as a working body to host all NSDI meetings and to implement meeting agreements, resolutions and recommendations was established in 2002. In the same year, Bakosurtanal also started to develop a National Geospatial Data Clearinghouse which consists of a number of metadata servers that are interconnected to provide information about spatial data availability in central government agencies (Puntodewo and Nataprawira, 2007). Establishment of the clearinghouse was the entry point to the second generation of NSDI development in Indonesia. Another breakthrough on regulatory aspects occurred in 2007 with the publication of Presidential Decree No. 85 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.

Year 2011 appears to have been the golden year of geospatial development in Indonesia for two reasons. Firstly, in April 2011 the government published Law No. 4/2011 on Geospatial Information which reinforced the previous regulation. One of the law's goals is to ensure the availability of, and access to, accountable geospatial information. In order to achieve this, development of

Geospatial Information Infrastructure, which has the same meaning as SDI, was proposed. With the enactment of this law Bakosurtanal was changed to Badan Informasi Geospasial (BIG) as the national agency organizing geospatial information. Secondly, the national geoportal, namely Ina-Geoportal, was launched in October 2011. The portal facilitates geospatial data access and sharing between government institutions.

3. Recent Status of Indonesian SDI

Development of SDI in Indonesia can be viewed from the five key components: policy, institutional arrangement, technology, standard, and human resources.

3.1. 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. Development of Geospasial Information Infrastructure as a framework to accomplish this goal is specified in the law and further regulated through Government Regulation No. 9/2014 about the implementation of Geospatial Information Law.

Geospatial information also included in the National Medium Term Development Plan (RPJMN) 2015-2019. Based on RPJMN, there are seven targets to be achieved including the fulfillment of geospatial data and information for development planning of land and sea area in Indonesia, establishment of geospatial information sharing, and use of geospatial information in the development planning process and public policy.

As part of the implementation of the Geospatial Information Law, the President of Republic Indonesia issued the 'One Map Policy' in February 2016. This policy can be defined as a concept where Indonesia shall only have one base map to be used as reference by other government agencies in designing their own thematic maps. With the execution of this program, overlapping maps among agencies are expected not to reoccur and land conflicts can be reduced.

3.2. Institutional Arrangement

Institutional arrangement of Indonesian SDI is defined in the Presidential Decree No. 27/2014 on National Geospatial Information Network. According to the decree, the actors for geospatial information sharing are called network nodes (simpul jaringan) classified into central and local network nodes. Central network nodes include ministries and national government agencies while local network nodes consist of provincial, municipal, and district governments. Each node has responsibility in the collection, maintenance, update, exchange and dissemination of specific geospatial data. These nodes will have their own clearing house unit and are connected using the national geospatial information network at Ina-Geoportal. A metadata catalogue should be available in each clearing house unit in order to facilitate data finding. Figure 1 illustrates the institutional structure of the Indonesian SDI.

BIG as network node connector has a duty to develop, integrate and manage these network nodes. This can be considered an onerous task due to the numerous number of network nodes, a total of 601 network nodes composed of 62 ministries/agencies, 34 provinces, 412 municipalities, and 93 districts. By the end of 2015, there were 41 network nodes connected to Ina-Geoportal or only about 7% of the total nodes. More than half of these connected nodes are from central government institutions. Only nine local governments have developed over the last five-year period. Reasons for this low speed of improvement include a lack of internal institutional setting for clearing house units, a shortage of human resource capacity with a geo-information science background, insufficient funding for geospatial activities, and not enough Information Technology Infrastructure within municipalities or districts (Darmawan *et al*. 2014).

3.3 Technology

Since 2011 BIG has been developing a data center to support the distributed network nodes and to manage big geospatial data created by production unit. The data center consists of more than 200 servers, 3,200 Terabytes (TB) data storage, internet bandwidth up to 300 Mbps (international), 1 Gbps (local), and is equipped with High Performance Computing (Badan Informasi Geospasial, 2015a). BIG provides *Virtual Private Network* (VPN) access to communicate among network nodes and constructed *Cloud Computing* infrastructure to facilitate the network nodes.

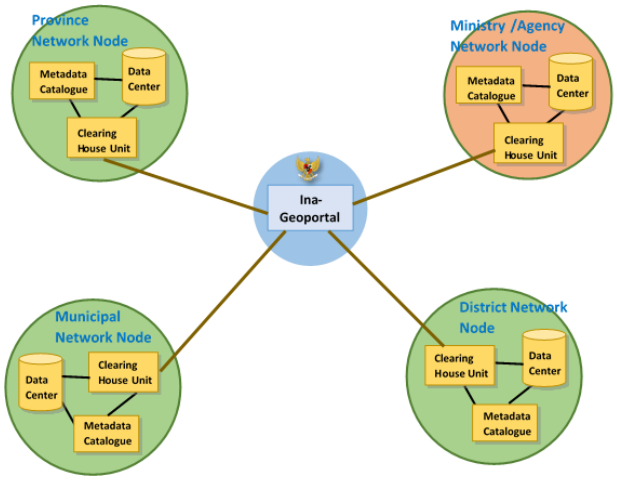

Figure 1. Institutional arrangement of Indonesian SDI

Ina-Geoportal is the core element of NSDI implementation in Indonesia. All geospatial data produced by the networks nodes are published and shared in this portal (http://tanahair.indonesia.go.id). Collaboration between government agencies regarding spatial analysis can now be achieved.

Aerial photos, satellite imageries and field survey were utilized to produce topographic maps. Up to 2015 the digital topographic maps at medium 1/50,000 scale is available countrywide. However only small area of large scale maps have been done for cities in Indonesia, therefore acceleration strategy is required.

3.4. Standard

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

These standards can be in the form of national standards (Standar Nasional Indonesia/SNI) or technical specifications. BIG has initiated the development of national standards on geospatial information since 2000 and had already produced 60 standards by 2015 (Badan Informasi Geospasial, 2015b). In addition to the national standards, BIG also developing 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.

3.5 Human Resources

The four major components of NSDI cannot possibly work smoothly together without the manpower 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 group 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, 2015c). 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 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 to communicate in community and public participation situations. However, providing help and user support in such applications is not enough, people's spatial literacy need to be increased otherwise they may be discouraged while beginning to explore geospatial data.

The quality of the capable manpower can be measured in terms of their competence in dealing with geospatial work. With the purpose to generate professional personnel, Indonesia has published National Standard of Competency on Geospatial Information in 2013. There are six fields of competence stated in this standard: Terrestrial Survey, Hydrography, Photogrammetry, Remote Sensing, Geographic Information System and Cartography. Anyone who intends to be a professional in a specific geospatial field must have sufficient knowledge, skill, and attitude that meets the standard.

4. Lesson Learned and Strategies

Based on the current experience, lesson learned from the Indonesian SDI development can be summarized according to each SDI components. Some suggestion strategies to better improve National SDI operation are also proposed in the following table.

Table 1. Lesson learned and proposed strategies

NSDI Component	**Lesson Learned**	**Strategies**
Policy	Important to have strong support from leaders	Improve understanding of geospatial policy at all levels of decision-makers
	Provide clear vision and sustainable development plan	Establish practical regulation with comprehensive plan through national and local scope vision
Institutional Arrangement	Limited funding of network node development at local level	BIG support assistance and partnership on institutional setting
	Lack of sustainability in operating the network nodes	Conduct regular coordination meeting to identify problems
	Slow response of institutional participations	Develop network node coaching model and award of appreciation

Technology	Absence of technology infrastructure	Utilization of cloud computing services for local government
	Incomplete metadata in network node clearinghouse	Provide training and metadata manual development which comply with the national standard
	Limited number of large scale maps	Encourage local government to conduct mapping
Standard	Geospatial data interoperability and different feature cataloguing	Distribution of interoperable national topographic map and dissemination of KUGI to all network nodes
	Monitoring implementation of national standard	Reinforcement of technical committee of geospatial information standardization
Human Resources	Lack of GIS/geospatially skilled personnel in local government	Cooperation with universities to provide education and training for local government officials
	Low level of competency of network node provider	Enforcement of standard competence and operationalization of professional certification body
	Increase spatial literacy of public user	Regular workshops, seminar, competition, and geospatial related events

5. Conclusion

Indonesia, as one of the early adopters of NSDI development in Asia, has experienced significant milestones over the last two decades. Starting from the digital map-making activities and now entering the era of a spatially enabled society. The development of Indonesian NSDI is characterized by five pillars: policy, institutional arrangement, technology, standard, and human resource. Linkage between these components is important in providing easy access to geospatial data among network nodes, which eventually will be used for making well-informed decisions.

Many challenges have been encountered in the implementation, including financial problems of the participating institutions, inadequate technology infrastructures in rural areas, interoperability problems, and shortage of competent human resources. BIG as the national agency responsible for NSDI development, has formulated strategies to ensure sustainability of the operation. Although this review is based on single case analysis of Indonesia, lesson learnt from its experience can be useful for other developing countries.

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