Designing Open Spatial Information Infrastructure to Support 3D Urban Planning in Jakarta Smart City

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Publication date
2018

Document Version
Final published version

Published in
Proceedings of the 6th International FIG 3D Cadastre Workshop

Citation (APA)
Indrajit, A., Ploeger, H., van Loenen, B., & van Oosterom, P. J. M. (2018). Designing Open Spatial Information Infrastructure to Support 3D Urban Planning in Jakarta Smart City. In P. van Oosterom, & D. Dubbeling (Eds.), *Proceedings of the 6th International FIG 3D Cadastre Workshop* (pp. 329-356). International Federation of Surveyors (FIG).

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Keywords: Land Administration System, Spatial Planning, 3D-visualization, Open Data, SII

SUMMARY

Land administration is essential for urban planning and Spatial Information Infrastructure (SII). Interoperability of land administration and spatial planning will determine the success of SII utilization. This information should be accessible to all member of SII, including businesses and the community. This article proposes spatial planning information as an extension of the Land Administration Domain Model (LADM), the ISO 19152:2012 in order to support spatial planning. The relevance of spatial planning information to be included into LADM is integral to Land Administration System (LAS) development. 3D Spatial planning along with 3D land administration (LA) will provide a complete scene for land tenure, land valuation, land use, and land development to support sustainable development initiatives. Further, the spatial planning extension will contribute to support the UN member countries in obtaining indicators in the Sustainable Development Goals (SDGs) by improving interoperability and by integrating right, restrictions, and responsibilities (RRR) from spatial planning and LA which are often resulted from separate processes by different parties.

SUMMARY

Administrasi pertanahan berperan penting dalam perencanaan kota dan Infrastruktur Informasi Spasial (SII). Interoperabilitas informasi terkait administrasi pertanahan dan perencanaan tata ruang akan menentukan keberhasilan pemanfaatan SII. Informasi ini harus dapat diakses oleh semua anggota SII, termasuk bisnis dan masyarakat. Artikel ini mengusulkan informasi perencanaan tata ruang sebagai perpanjangan dari Domain Administrasi Domain Model (LADM), ISO 19152: 2012 sebagai upaya untuk mendukung perencanaan tata ruang. Relevansi informasi perencanaan tata ruang untuk dimasukkan ke dalam LADM merupakan bagian integral dari pengembangan Sistem Administrasi Tanah (LAS). Perencanaan Tata Ruang 3D bersama dengan administrasi lahan 3D (LA) akan menyediakan adegan lengkap untuk penguasaan lahan, penilaian tanah, penggunaan lahan, dan pengembangan lahan untuk mendukung inisiatif pembangunan berkelanjutan. Selanjutnya, perpanjangan perencanaan tata ruang akan berkontribusi untuk mendukung negara anggota PBB dalam memperoleh indikator dalam Tujuan Pembangunan Berkelanjutan (SDGs) dengan meningkatkan interoperabilitas dan dengan mengintegrasikan hak, pembatasan, dan tanggung jawab (RRR) dari perencanaan tata ruang dan LA yang sering dihasilkan dari proses terpisah oleh berbagai pihak.

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1. INTRODUCTION

In 2014, it was projected that urban areas host 54% of the global population but generate more than 80% of the world's GDP (UNEP 2017). Further, in 2050, UNEP (2012) calculated that urban areas which are only three percents of the earth's surface will be populated with 9 billion peoples (UN-DESA 2014). UN DESA (2014) also reported that inadequately managed urban expansion is causing urban sprawls, in achieving SDGs goals. Urban space and Land Administration (LA) have been at the center of Sustainable Development Goals (SDGs) 1, 2, 5, 11 and 15 (Land Portal 2018) and influencing the other six goals (Todorovski et al. 2017).

Land information provides a reference for many efforts to achieve SDG targets in poverty and hunger alleviation, gender equality, sustainable cities and communities, and life on land. The United Nations have promoted the need for robust land management in the SDGs. UN-ECE (1996) defines land management as the process by which the resources of lands are put to good effect and from environmental and economic perspectives. The spatial planning plays an essential role in this perspective. Urban zonation regulates space utilization and control mechanism based on urban planning allocation, including land use permit, building construction permit and specific activities permit. Urban zonation also assigns certain obligations to the landowner, namely to provide the public facility (e.g., sanitation, emergency.) and to maintain building floor coefficient with open green space.

City governments are urged to build a 3D information system for LAS as well as 3D spatial planning to have better representation of legal space in the city for land management. These tasks are crucial in developing an urban information system which capable to handle 3D-presentation and interoperable to many application. Such system is crucial in supporting land management and the use of land and natural resources which are mentioned in SDGs. In 2012, ISO published ISO 19152:2012 about Land Administration Domain Model (LADM). This standard aims to provide an extensible basis for the development and improvement of efficient and effective land administration systems and to enable involved parties communicating the shared vocabulary implied by the model (Lemmen et al. 2015). Currently, there is no domain model available for spatial planning to ensure integrity and interoperability of information. However, there is a possibility to develop spatial planning domain model as a package of LADM. This article proposes a standardization of spatial data model to address permissions, prohibitions, obligations, and incentives sourced from the spatial planning process for spatial plan to be shared via Spatial Information Infrastructure (SII).

Enemark et al. (2005) advocate an information infrastructure to facilitate data management and information sharing related to land tenure, land value, land use and land development. These types of land information construct a global perspective of a modern land administration system

to achieve sustainable development. Further, Van Oosterom (2009) suggests this information provide a firm foundation for Spatial Information Infrastructure (SII). However, there are challenges related to maintaining and utilizing 3D urban plan in Indonesian big cities, namely Jakarta and Bandung. Many data producers still maintain their spatial information in silos, 3D spatial information has not met national or existing standard, many layers from fundamental datasets are still missing at the appropriate level of detail, existing SII is still a government-centric system, and existing smart city system have not connected with The Jakarta SII. The Jakarta SII has the potential to provide a supportive environment to provide both 2D and 3D spatial information to all phase of urban planning to broader stakeholders, including to citizens and private sectors.

This article presents our experience in designing a Spatial Planning Package using LADM principles to improve interoperability of the 3D urban planning to be shared through Open SII. This paper consists of five sections. The first section introduces the idea of the importance of standardization and integration of LA and spatial planning in a domain model. Section 2 presents the importance of land administration and spatial planning in supporting Sustainable Development Goals. Land Administration and Spatial Planning in Indonesia is explained Section 3. We present the current status of 3D spatial planning in Indonesia in section 4. Section 5 focuses on integrating spatial planning extension into LADM for Indonesia context. The last section contains the conclusion and recommendations.

2. LAND ADMINISTRATION AND SDGs IN DEVELOPING COUNTRIES

Dale and McLaughlin (1999) defined land administration as "the process of regulating land and property development and the use and conservation of the land; the gathering of revenues from the land through sales, leasing, and taxation; and the resolving of conflicts concerning the ownership and use of the land." LA is not only concerned with the provision of security of tenure but also used as a basis for sustainable land use, achieving better management of natural resources, and sustainable development (van Oosterom & Lemmen 2015 and Enemark et al. 2014).
The Bogor Declaration on Cadastral Reform (1996) reiterated the urgency to develop modern cadastral infrastructure to facilitate efficient land and property markets, to protect the land rights, and to support sustainable development (Williamson & Grant 2002). The cadastral infrastructure is not limited to policies, standards, and legal aspects, but also covers technology, data, and capacity building. The Declaration acknowledged the rapid expansion of cities requires a sophisticated LA to support land use planning and to accommodate the significantly increased demand for facilities, resources, and space, mainly where land is scarce or prone to conflicts. Following-up Bogor Declaration, the UN, and LA communities held International Workshop at Bathurst, Australia in the year 1999. The workshop recommends the Bathurst Declaration on LA for Sustainable Development which acknowledged the role of LA in supporting decision- and policy-making for sustainable development. The Bathurst Declaration is confirming the relationship between land registration, land market, land valuation and spatial planning (UN-FIG 1999).

Williamson et al. (2010) stated that land use planning should be placed at the core of environmental issues, social justice, and sustainable development. Spatial planning exceeds the traditional land-use planning by bringing together stakeholders and integrating various policies for the development and use of land with other policies and initiative (Morphet 2010, p.2). However, as a concept, spatial planning operates at different spatial scales and may be defined in various ways in the different administrative hierarchy, such as national, regional and local levels. Nyerges & Jankowski (2009) stated that planning could be affected by official state plans; guidance on planning and coordination; criteria for local planning; provision for regional coordination; ensuring consistency between plans; and guidance for conflict resolution. In general, spatial planning can be defined as the activity of place-shaping and public services delivery (Lyons 2007). Spatial planning is also being used as the basis for determining where and when the infrastructure, investments, and public services will be developed. At the minimum, spatial planning is focused on the handling of growth in a particular administrative territory to meet sustainable development by using land-related information for enhancement of a region. Spatial planning is a mechanism derived from a consensus on critical policies required by a range of government institutions, non-government organizations, and the citizens across multiple legal mandates (UN-Habitat 2016). The result of this mechanism is represented by a spatial plan containing information about the planning used by all parties involved in the development of the specific region. Many parties are collaborating in spatial planning to influence the nature of places and how they function by giving specific permissions, obligation, prohibitions, and incentives to a specific space or on a land parcel (Cullingworth & Nadin 2006).

Many researchers work on the development of multi-purpose cadastres that will ensure the protection of land rights and will also permit rights to be transferred (or traded) efficiently, simple, securely and at low cost. This includes also rights in spaces above or below the land, such as a unit in apartment building or a subway tunnel (figure 1). Therefore the need to create a LA that offer transparency in the spatial dimensions of RRR's, a so-called '3D cadastre' became apparent (Stoter & Van Oosterom 2006 and Van der Molen 2011). National land administration agencies around the world are in the process of transforming their 2D geometric description of the land parcel and RRR into 3D representation (Aien et al. 2011, Guo et al. 2011, Jeong et al. 2011, Stoter et al. 2012, Vandysheva et al. 2012, and Safitri et al. 2016). LADM indeed support the registration of land with 3D spatial datasets.

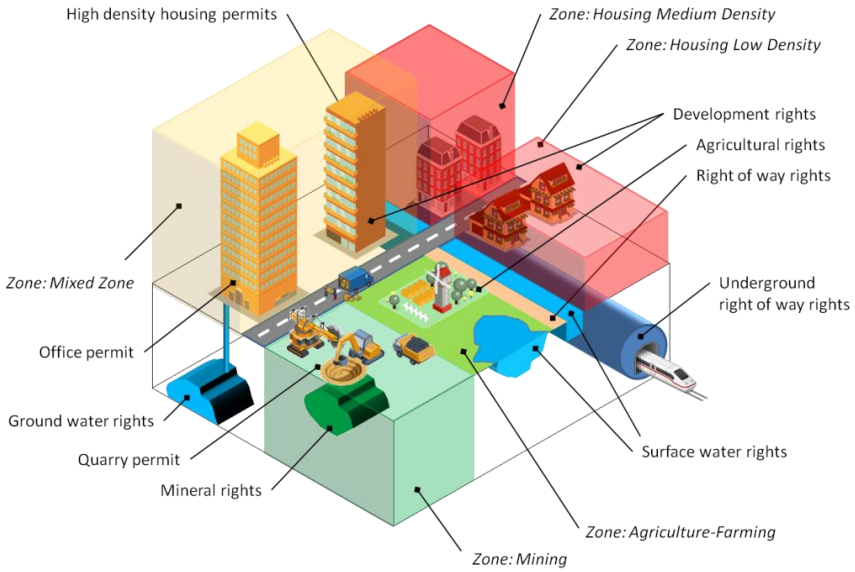


Figure 1. ***The basic building block in 3D land administration system and 3D spatial planning*** **based on Dale and McLauglin (1999) and van Oosterom & Stoter (2010)**

3. LAND ADMINISTRATION AND SPATIAL PLANNING IN INDONESIA: TOWARD THE ONE-STOP-SERVICE

Sustainable development cannot be separated from the availability and accessibility of land information (Ting & Williamson 2000). In order to integrate public services, the Government of Indonesia encourages standardization of all spatial information to ensure interoperability, including in land administration and spatial planning (Karsidi 2017). Access to land-information in Indonesia is indeed taken into account in Capital Investment Law No 25 (2007) by integrating the process of the approval and issuing permits in one-stop services. This law acknowledges the importance of accessibility of standardized information on land administration and spatial planning. The one-stop service is the operation of licensing and non-licensing activities from authority which the whole process managed in one place. This service aims to assist investors in obtaining information on investment, including land information and spatial plans. It is expected that this service leads to simplification and acceleration of the process of issuing permits for land use.

3.1 Information Management in Land Administration: Indonesia Case

According to the Basic Agrarian Principles Law, land administration in Indonesia aims to provide legal certainty on specific land (*rechtskadaster*) by providing three components: cadastral mapping, written legal instruments and effective land registration. These components shall be maintained to be used as the basis of land administration. Government Regulation No, 24 (1997) about Land Registration provides definitions, criteria, and mechanism of land registration. This regulation also provides legal protection for right holders of a land parcel, apartment, or another form of registered space. In the process, this regulation gives a mandate to the government to provide necessary information and access to this information to eligible parties in the legally protected transaction of registered lands and specific spatial units such as apartment or spaces below the ground for orderly land administration implementation. In

managing land information with efficiency and security of tenure to provide complete inventories of land holdings for governments at all levels, Indonesia adopted FIG definition of cadastre as a parcel-based land information system managed by one or more government agencies, and geographically referenced to unique, well-defined units of land (FIG 1995). The government of Indonesia through the National Land Agency (BPN) develops and maintains land administration-related information which is considered as integral part of cadastre management consisting: land parcels, land tenure, and land value. In 2003, Government of Indonesia mandated BPN to develop Land Information System (in Bahasa abbreviation: SIMTANAS) (Noor 2008). This policy instructed BPN to develop the state's land database, land registration (parcels) database, land tenure database, cadastre surveys and mappings, and GIS system for land management.

In the past decade, BPN applies the concept of strata title in registering the ownership rights for vertical buildings. Further, BPN has implementing 3D cadastre at the operational level for an apartment, commercial, and high-rise buildings (Suhattanto 2018) and transforming their 2D geometric description of the land parcel and RRR into 3D representation (Hendriatiningsih et al. 2007, Budisusanto et al. 2013, Safitri et al. 2016). LADM provide standards for 3D geoinformation in which vertical dimension is needed to describe and to register land with 3D spatial datasets. It is said that 3D cadastre provides better accessibility to the legal status and rights of property (Stoter & Van Oosterom 2006 and Van Der Molen, 2001). The spatial plan maps are generally displayed in 2D. Similar to 3D cadastre, the 3D spatial plan is expected to offer better topology in relating legal aspect of spatial planning with vertical dimensions, especially when authorities and citizens can integrate RRR from LA with permits, incentives, disincentives, and sanction from spatial planning. LADM is expected as enabling factor to represent volume as 3D legal space and to ensure data governance for stakeholders in spatial planning. LADM is also hoped to guide stakeholder in using information of the legal aspects, business processes, existing stakeholders, and other regulations when creating, attaching and visualizing spatial zoning in 3D format.

3.2 The relationship between Land Administration and Spatial Planning in Indonesia

The Basic Principles of Agrarian Law mandates the government to regulate and organizes land, water, and air-space, including the allotment, usage, reserve, and preservation, to determine and regulate tenurial rights, and to determine and regulate legal aspects between person and actions. Government regulates the spatial planning processes based on Spatial Planning Law No. 26 (2007). According to this law, the spatial planning is activities to manage space and utilize natural resources in a comprehensive and integrated manner. Spatial planning in Indonesia based on the division of government administration in a hierarchical manner. Spatial planning in Indonesia can be regarded as a method for regional development in three stages: planning, utilization, and control of space.

The planning stage consists of a process for preparing and establishing a spatial plan, including the spatial structure and spatial zoning. The spatial structure contains infrastructure development plans to support socio-economic activities while spatial zoning represents the distribution of a function of the area. Land-related information is used to describe existing land use and to determine spatial zoning, including land allocation in infrastructure development planning. Information in land administration system provides specific criteria and legal aspects

attached to a specific land parcel of block used in spatial planning. The second stage, utilization of space, is defined as an effort to realize the spatial structure (physical development plan) and spatial zoning by the spatial plan through preparation, implementation, monitoring, and evaluation of a development program. In reality, the local government establishes controlled cultivated zones and encouraged their developments. According to the Spatial Planning Law, utilization of space will be implemented through multi-sector programs to meet regional development plan, spatial zones, and strategic areas concerning standards and carrying capacity of the socio-economic conditions and environmental quality. Many local governments use information communication technology (ICT) to improve the quality of public services in granting permits (Juniati 2014). NLIS should be able to support local government in managing land and space by integrating land information, such as right, restriction, and responsibility with criteria in spatial planning (obligation, prohibition, and permission). This integration of NLIS with Spatial Planning Information System (SPIS) is crucial in providing information necessary for the use of space permit applicants, especially for trading businesses permit (SIUP) and company registration p (TDP). NLIS also potential in to support local government to publish building permits, including for vertical space such as housings (e.g., apartment, flat, condominium.), trade and commerce (e.g., mall, office space, market), industries (e.g., factories, mining facilities) and public facilities.

In the last stage, controlling the space, local governments together with law enforcement monitor and evaluate the use of space, including preventive and corrective actions against spatial plan violations. Controlling utilization of land may be in the form of zoning regulations, issuance of the permit, incentives, and disincentives, or imposition of fine and sanctions. Zoning regulations are provisions that regulate the use of space and control elements that are arranged for each designation zone by detailed spatial plans. Spatial development plan and spatial zoning maps will be used as guidelines in controlling the use of space. Zoning regulations are prepared as guidelines for controlling spatial utilization. Zoning regulations are provisions that regulate the use of space and control elements that are arranged for each designation zone by detailed spatial plans. Zoning regulations contain permission, obligation and prohibition for action to be carried out in the spatial zoning which may be in form of basic coefficients of green space, basic building coefficients, building floor coefficients, and building demarcation lines, provision of facilities and infrastructure, and other provisions needed to create a safe, comfortable, productive and sustainable space. Both planners and citizens require two working days to acquire information related to spatial planning through BPN Branch Offices and less than an hour through web-based Computerized Land Office system (KKP-Web) portal then National SII geoportal, for developing a spatial plan, using and controlling the use of land (spatial development plan and spatial zoning) (figure 2).

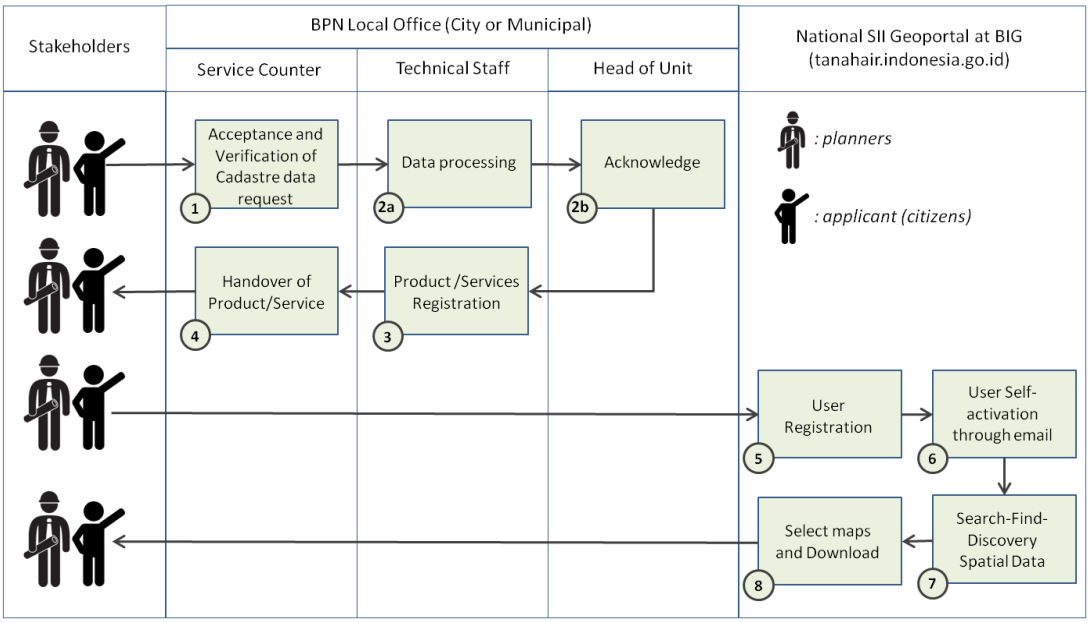


Figure 2. Workflow of access to Cadastre and Spatial planning information based on BPN Decree No. 4 (2017) on Standard of Services and BIG (2012)

3.3 Land Administration and Spatial Planning as Foundation of Permit Systems

In Indonesia, both the land administration and the spatial planning systems are used as a foundation for the issuance of permits on a parcel. In the first stage, the policy is represented by spatial zoning from various development activities along with the supporting facilities and infrastructure. Spatial zoning is then complemented by criteria to guide infrastructure development and activity in using a space or a land parcel. A permit issuance system was established to ensure the compatibility between various development initiatives by the government, communities, and business with spatial planning. The right to access land information by stakeholders is supported by law, particularly information about RRR attached with a space or land from land administration systems and the spatial planning process. In controlling the use of space, a permit provides a foundation to monitor activities of various types of activities which are granted by permits.

Figure 3 shows the relationship between spatial planning systems and its hierarchy with permission, obligation (spatial zoning and incentives), and prohibition (disincentives and sanction). Spatial planning laws along with Environment Protection law mandated this relationship to be applied for almost all activities related to specific space or land. Space or land parcel is located in a spatial zone for which there is nominated to particular land use (e.g. public services); provide services as a particular function (e.g. school); with specific transportation facility (e.g. road) and public facility (e.g. hospital). The land administration characterizes space or land parcel (right, restriction, and responsibility) and spatial planning (permission, obligation, prohibition, incentive, disincentive, and sanction). Information about the rights and restrictions that relate to space or land are separate into two activities: land administration and spatial planning be readily available to anyone undertaking a land transaction. Policy construction of permits of an individual space or land is closely related to land administration

and spatial planning in all jurisdictions, including technical specifications, applied in a building or an activity in using a space or land parcel.

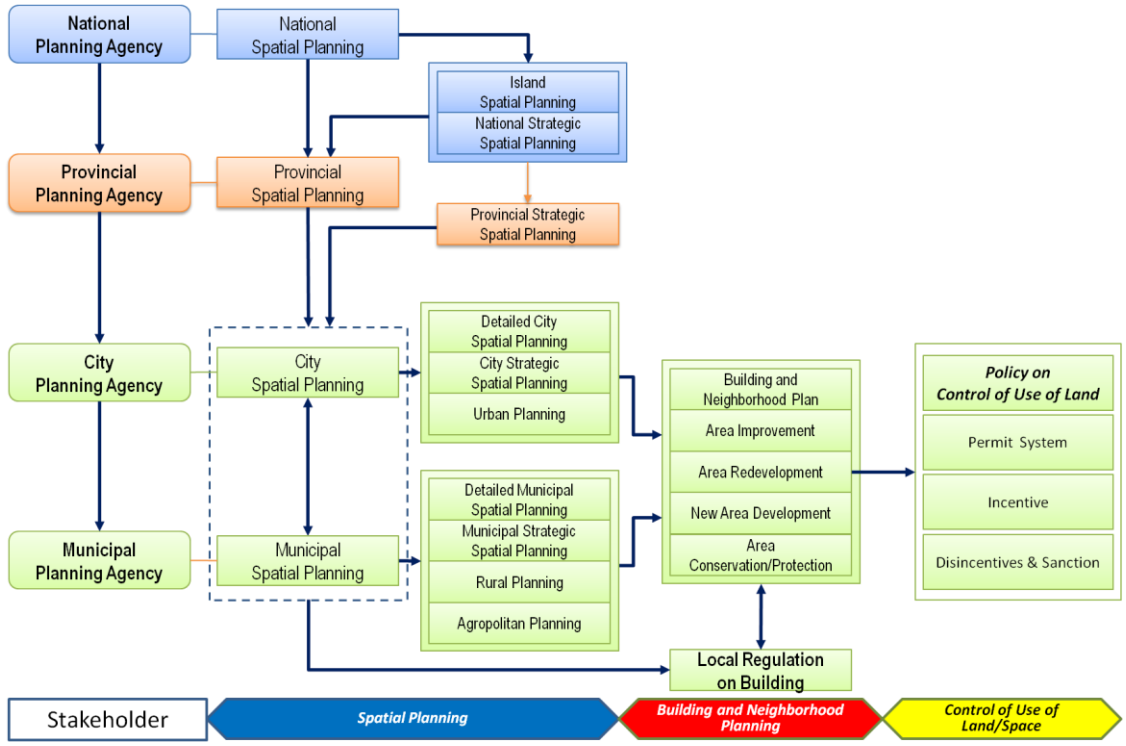


Figure 3. Hierarchy in Indonesian Spatial Planning based on Spatial Planning. Blue is Central government, Red is Provincial Government, and Yellow is City/Municipal Government

Land permits and rights are related to RRR which are regulated in land administration. In Indonesia, RRR is in land rights, building rights (*usufructuary* rights), and land ownership rights (figure 4).

Location permits will be used as a basis for the land transaction and land acquisition through specific methods and land management. Location permit and land right are determined from land suitability analysis and environmental assessment analysis. Local government entities are responsible for publishing location permit, including Secretary of Local Government, City/Municipal Planning Agency, Spatial Planning Office, District Official (*Camat*), and other Sectoral Offices. RRR is attached in a location permit and will be used in the transaction of obtaining a space or land parcel. Monitoring and evaluation of the use of land shall be performed and compared with RRR attached in location permit. According to spatial planning law and the basic principle of agrarian law, land rights are not considered as a permit.

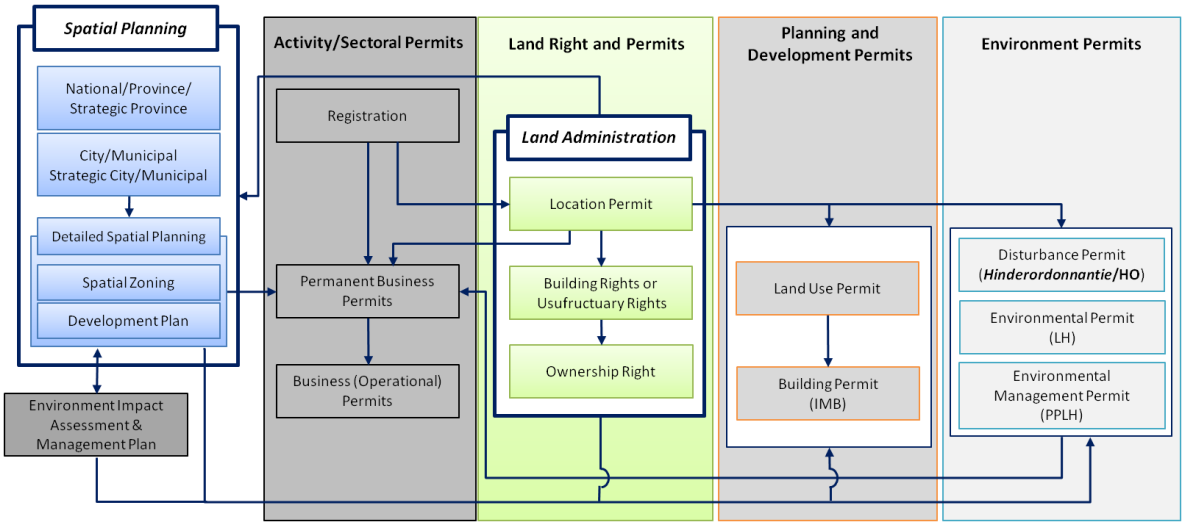


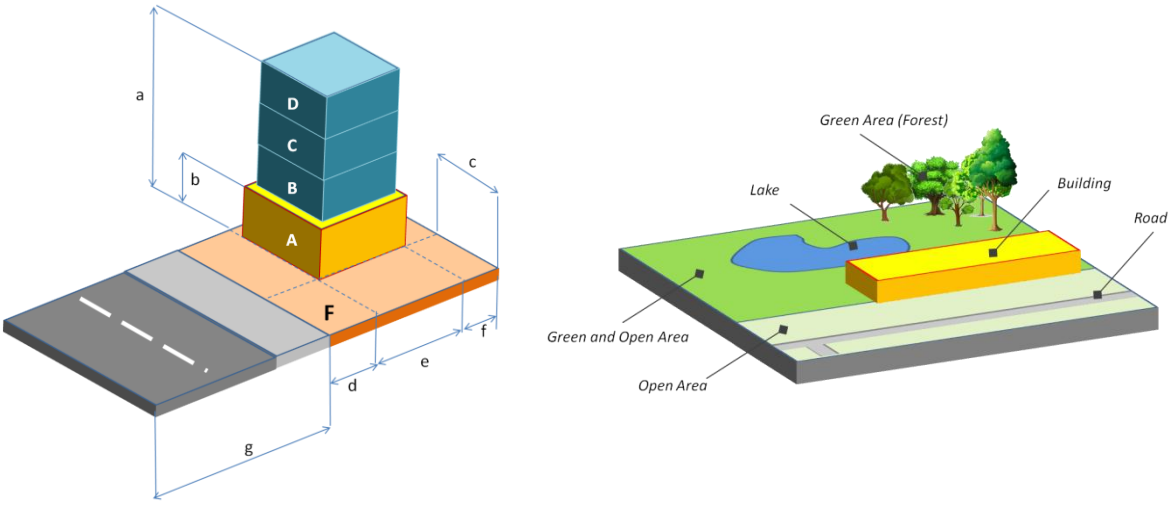
Figure 4. Land Administration and Spatial Planning as the foundation of Business Permits issuance in Indonesia based on Spatial Planning Law, Basic Principle of Agrarian Law, Environmental Protection Law, and Capital Investment Law

However, it can be considered as approval for the right holder to perform activities in space or on land. Type of land rights is characterized by the rights holder and the nature of the activity. At the larger capacity or size of a space, the rights granted as collective ownership depending on the type of activity. The individual rights of land can be determined from collective rights. Planning permit can be requested only after location permit obtained. This permit represents the actual permission in using a space or land parcel and as a statement of the approval of conducting activity in detail based on a study of Detailed Spatial Planning at a particular area of development. In publishing the planning permit, the local government considers the availability and accessibility of facilities and infrastructure that will support requested activities and compliance to the spatial zoning. Every use of space or land which uses a building requires a building permit (IMB). This permit sets the standard for the feasibility of the structure and shape of the building based on the assessment of engineering designs, site plans, and architectural designs. The local government issues are building permits by referring to the ministry of public works and public housing standards and regulations.

Environment-related permits aim to ensure environmental feasibility of an activity conducted in a space or land parcel. There are three types of permits related to the environment, namely: *Hinderordonantie* (HO) permits, environmental permits, and environmental management permits. HO permits issued by local governments are intended for business activities which have a minimum or no impact to the environment. An environmental permit is a permit given to every person who conducts a business or activity that is required by Environment Impact Assessment in the context of environmental protection and management. The environmental permit is a prerequisite for obtaining a business or activity permit. The environmental protection and management permit is approval granted to every person or company who conducts business or wastewater management activities, emissions, air, hazardous and toxic waste materials, hazardous and toxic materials or disturbances that affect the environment or human health.

3.4 The Importance of 3D Land Administration and 3D Spatial Planning in Indonesia

As a continuation of the spatial planning process, the Building and Neighborhood plan (in Bahasa: *Rencana Tata Bangunan dan Lingkungan*/RTBL) guides the construction design and activity that is intended to control the intensity of space utilization, structuring buildings and the environment, as well as containing the subject matter of building and environmental program provisions. A 3D spatial planning model derived from geospatial information technologies are used to support decision makers in spatial planning processes, including in providing guidelines, monitoring and evaluation, determination of incentives and disincentives, law enforcement and sanctions, and disaster management purposes. RTBL regulates space or land utilization in term of building guidance. This guidance consists of criteria, namely Basic Building Coefficient (KDB), Building Floor Coefficient (KLB), Building Demarcation Line (GSB), Free Building Distance (FBD), and Height of Building (TB) (figure 5a). RTBL also regulate neighborhood criteria through Green and Open Spaces (RTH), and Green Coefficient (RH) which demands a rights-holder in the neighborhood in using its space and land (figure 5b). KDB is the percentage of the comparison between the area of the entire ground floor of the building (A) and land parcel (F) based on spatial planning and RTBL. KLB is the percentage comparison between the total floor areas of a building (A+B+C+D) the width of land parcel (F). GSB (d) represents virtual line on the parcel which is the minimum clear distance from the outer field of the building that is allowed to be constructed at a certain distance to the road boundaries, parcels, and river boundaries. FBD (c and f) represent the distance between buildings and parcels while TB (a/d) is the distance between the cutting line of the roof surface and the face of the building's exterior and the ground floor surface.



(a.) **(b.)**

Figure 5. 3D policy in land parcel derived from spatial planning process (Building and Neighborhood Plan) Notes: A: Ground floor; B-D: Upper floors; F: Land Parcel; a: total height of the building; b: height of ground floor; c: side free distance; d: front free distance; e: floor width; f: back free distance; and g: road area

4. CURRENT STATUS OF 3D SPATIAL PLANNING IN INDONESIA

The government of Indonesia through the National Land Agency (BPN) develops and maintains land administration information which is considered as part of cadastre: land parcels, land tenure, and land value. These types of information are shared and publicly accessible through the agency's website (http://peta.bpn.go.id) (figure 6) and national SII geoportal (http://tanahair.indonesia.go.id/). In 2003, Government of Indonesia mandated BPN to develop Land Information System (in Bahasa abbreviation: SIMTANAS) (Noor 2008). This policy instructed BPN to develop the state's land database, land registration (parcels) database, land tenure database, cadastre surveys and mappings, and GIS system for land management.

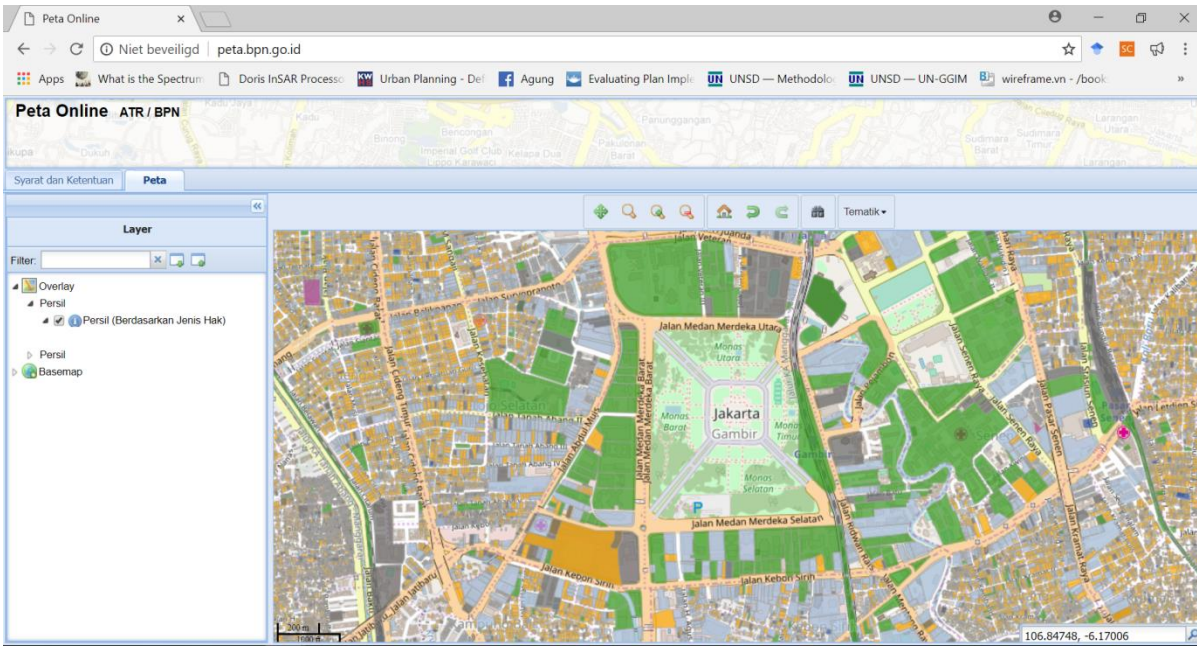


Figure 6. KKP-Web provide Land Registration over internet (http://peta.bpn.go.id)

The 3D spatial information over the web is still emerging. Only recently, the Open Geospatial Consortium (OGC) has approved the OGC Indexed 3D Scene Layer (I3S) and the Scene Layer Package (*slpk*) as community standards for 3D high-performance visualization in different geometry type, including 3D objects, integrated meshes, point features and point clouds (OGC 2017). Currently, there are two initiatives from government institutions in Indonesia using 3D visualization technology in presenting and sharing their information through National SII. These initiatives aimed to develop a platform for sharing the source of spatial information that able to support decision-making in short- and medium-term, such as land management, disaster management, and spatial planning. With the recent advancement in 3D visualization (Hudson-Smith et al. 2005, Paar, 2006, and Stoter 2016), BIG has started 3D visualization project to disseminate its 3D datasets to the public in 2015. In 2016, Province of Jakarta developed 3D SiPraja (Jakarta Spatial Planning System), a 3D visualization model of spatial planning using ESRI technology. This web-application shares 3D urban plan to the public via the Internet as part of the spatial planning process. The Government of Jakarta intended to use this web-app to provide a guideline for its citizens in using space or land which are stated in Detailed Spatial Planning and Building and Neighborhood Planning as mentioned in the previous section (figure

7). The i3S arranges data is split into regions (nodes) and organized it in a hierarchical data structure to enable fast discovery for the user to access data and to allow the server is locating the data requested by the client (OGC 2017). This service provides a 3D presentation in indexed scene format to a dedicated web client/consumer. This service uses ESRI's ArcGIS API for JavaScript which is designed to consume indexed scene. The capability of i3S is similar to OGC's 3D Portrayal Service which specifies three ways to access 3D presentation: *GetCapabilities*, *AbstractGetPortrayal*, and *AbstractGetFeatureInfo* (Table 1).

Table 1. OGC's 3D visualization capabilities currently used in a 3D web application in Indonesia (OGC 2017)

Capability	Function
GetCapabilities	provides information about the available request methods, and layer styles, the extents of the data, data layers (e.g., buildings, road, pipe, vegetation), and streaming formats.
AbstractGetPortrayal	retrieval of a scene includes: • *GetScene* (client), and • *GetView* (server) for rendering scene.
AbstractGetFeatureInfo	requesting metadata of scene features, includes: • *GetFeatureInfoByObjectId* for query with object; • *GetFeatureInfoByPosition* for requesting information by interaction with object on screen, and • GetFeatureInfoByRay for requesting information about features by selecting them through a virtual ray

The BIG's 3D DEM and Jakarta's 3D SiPraja are designated to three purposes. Firstly, to provide a platform for disseminating spatial data in 3D visualization, based on the requirement that a 3D format can support spatial planning and land administration as stated in National Mid-Term Development Plan 2014-2019. Second, to improve SII ability in sharing 3D spatial information for policy- and decision-making in solving national and local problems, based on the assumption that a 3D visualization can improve spatial cognitive ability. Thirdly, a 3D spatial information platform is believed to stimulate research in geospatial technologies from universities and research organizations. In this paper, we present the 3D SiPraja which was built from ESRI's i3S (*Indexed 3D Scene Layer*) platform, an indexed 3D Scene format and Scene Layer Package (slpk) encoded using JSON (ESRI 2016) (figure 7).

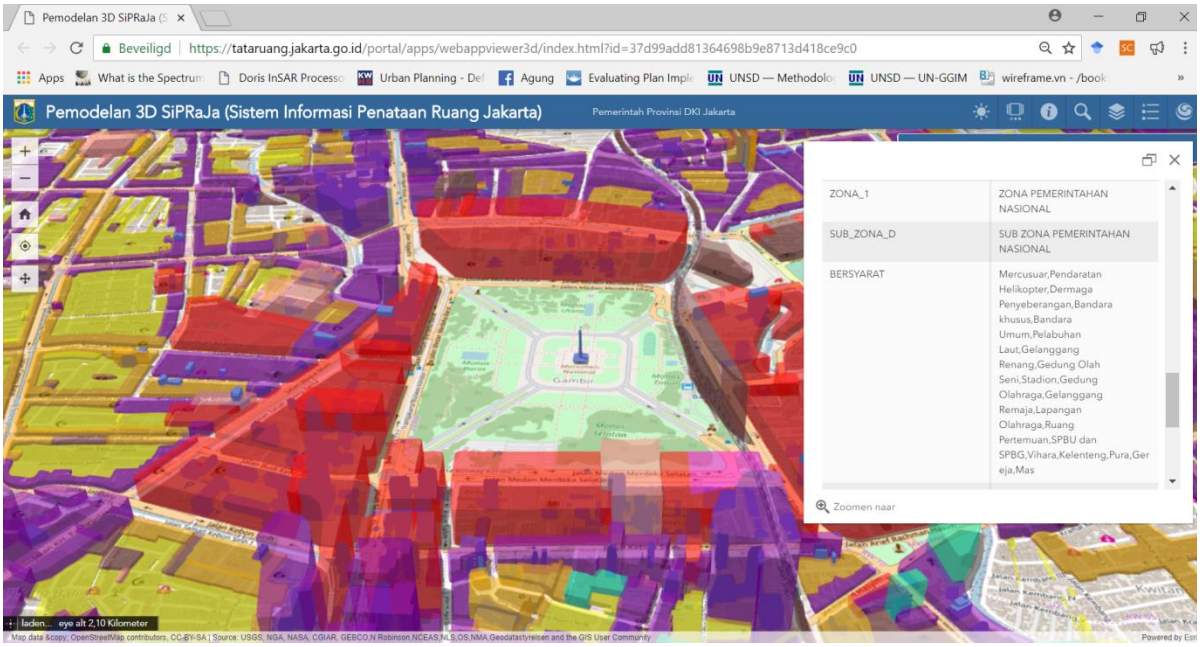


Figure 7. Spatial Planning of Province of Jakarta is presented in LOD (Level of Detail) 1 (https://tataruang.jakarta.go.id/portal/apps/webappviewer3d)

The i3S provides streaming and distributing large volumes of 3D data throughout enterprise systems. 3D *SiPraja* used i3S as content delivery for the *GetScene* request and *GetFeatureInfoByPosition* request. The i3S consist of server components, cloud-hosted components, and desktop, web and mobile clients (ESRI 2016). ESRI recommends the slpk format to contains indexed 3d scene which includes *metadata.json* and *3dSecenelayer.json* (ESRI 2016). The slpk format arranges features, geometry, textured, and attribute in *3dNodeIndexDocument.json*.

This 3D visualization of the spatial planning of Jakarta is a straightforward model which can be accessed through the web-based application (see figure 8). However, this model was not developed based on LADM as the purpose is to visualize spatial planning in 3D to provide better navigation and cognitive understanding for the user. Our model will try to improve 3D spatial planning to represent real rights, restrictions, and responsibility within the context of Indonesia, notable permissions of space and land utilization for each land parcel. This paper promotes LADM principles as the basis for 3D spatial planning to facilitate the integration of 3D spatial planning and land administration. The prototype of 3D *SiPraja* facilitates user with 3D navigation and simple query for each sub-block of spatial planning in Central Jakarta. This web-app contains information about administrative units, block identification, information about spatial zoning, permission regulated in RTBL (KDB, KLB, GSB, FBD, and TB) and Detailed Spatial Planning.

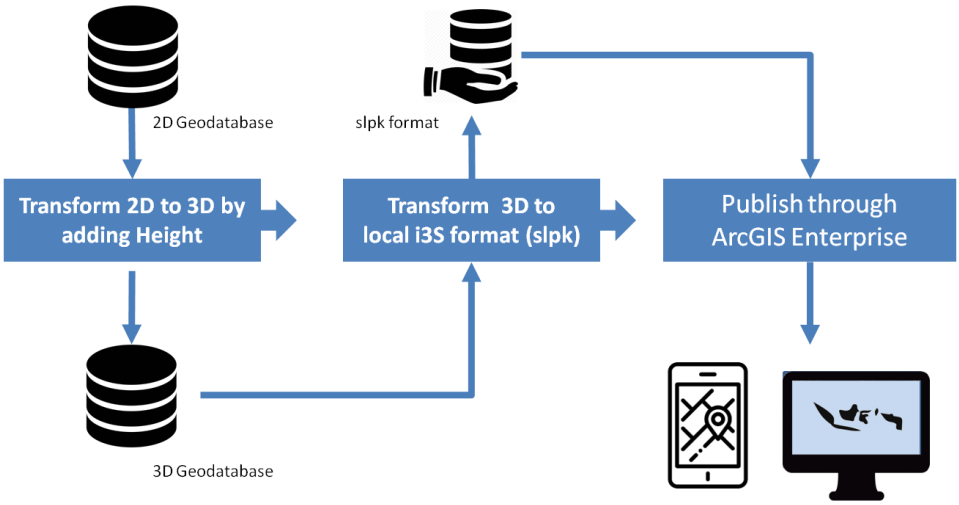


Figure 8. Generalized workflow of 3D spatial planning web-application using ESRI's i3S for 3D SiPraja

5. INTEGRATING SPATIAL PLANNING EXTENSION INTO LADM: INDONESIA CASE

Indonesia's decentralization program involves a transfer of significant responsibility and authority in spatial planning and land management to encourage local economic development, (Firman 2014). With more local autonomy in spatial planning and land management, it is expected to improve the quality of public services provision, more effective in spatial planning and local development. The government of Indonesia introduces policy using land information as one of the elements of the basis for planning, developing and controlling the use of natural resources in its National Middle-term Development Plan 2014-2019 (Bappenas 2014). This policy mandates government entities to ensure availability and accessibility of necessary spatial information in supporting policy- and decision-making for land administration and spatial planning at all level of government. Knowing the importance of l, and as limited natural resource and interdependency, between the land administration and spatial planning, President Joko Widodo promotes BPN to Ministry Agrarian and Spatial Planning/National Land Agency in 2014 (figure 9). This ministry aims to improve coordination and implementation in policy-making on land administration and spatial planning, including to provide public services.

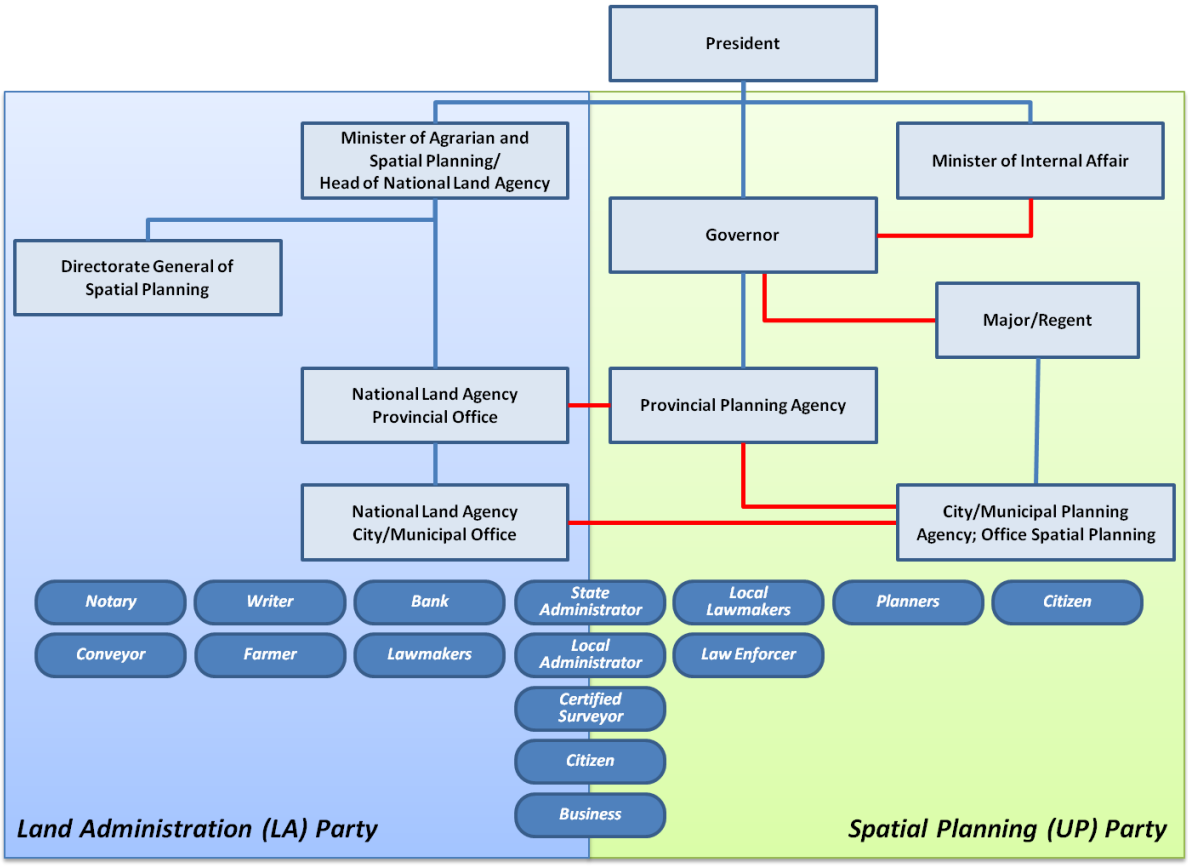


Figure 9: Stakeholder of Land Administration (sectoral division) and Spatial Planning (spatial division) in intergovernmental decentralization policy of Indonesia (Status 2014-2019) derived from Spatial Planning Law, Environmental Protection and Management Law, Basic Principle of Agrarian, and Capital Investment Law

5.1 Data Model for Integration of Land Administration and Spatial Planning

It is commonly understood that decentralization creates complications in the local development process in Indonesia. This mainly because of interrelated spatial, stakeholder and time-related trends, and multiple stakeholders. The Spatial Planning Law and Basic Principles of Agrarian Law instructed that spatial planning and land administration is a data-driven process. The spatial division of a city or municipality into smaller units is essential for spatial planning and land administration activities. LADM used in NLIS should be possible to combine the generic subdivision of administration unit, spatial zoning and thematic maps with spatial clusters. By using the generic subdivision of administrative unit, it is expected to be able to integrate of this unit with other datasets, namely land registration and spatial plan maps (Turkstra et al. 2003). Since its independence, Indonesia's administrative structure is stratified as a province, city or municipality/district, sub-district, village, hamlet, and neighborhood (figure 10). Hamlet (*Rukun Warga*) and neighborhood *(Rukun Tetangga*) are not a real administrative unit. However they are commonly used to divide the population census, and in some case, they are used as an alternative to house addresses. Village (*Kelurahan/Kampong*) is often used for dividing systematic land registration while sub-district (*Kecamatan*) commonly represents the unit in detailed spatial planning. Categorization of urban and rural is mostly happened in Municipality (*Kabupaten*) to represent characteristics of the area. Road centrelines and natural boundary (e.g., rivers, valleys, ridges) are used to define the administrative boundary and also in the

dividing block into sub-block in spatial planning. Land administration uses the sub-block to divide block and parcel.

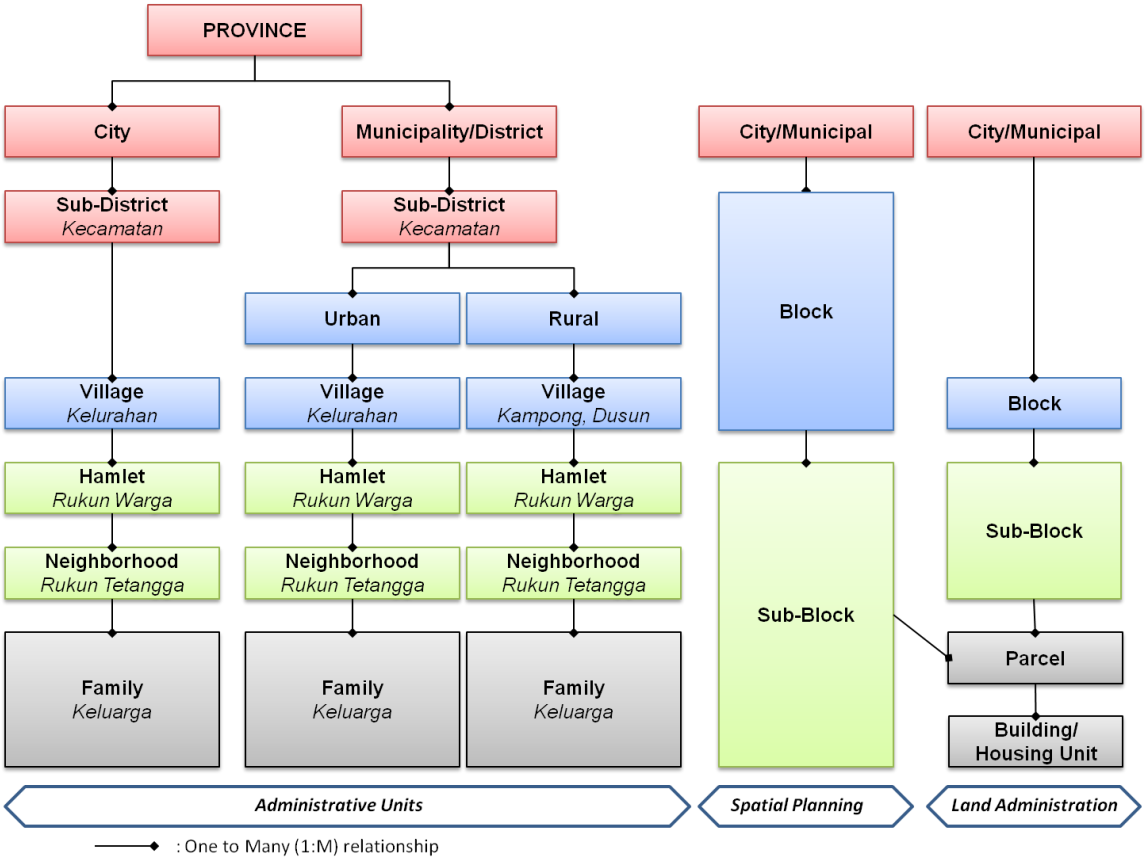


Figure 10. Entity Relationship Model of Spatial Planning Units and Land Administration Unit concerning Administrative Units in Indonesia

5.2 Proposed Country Profile of LADM for Integration of Land Administration and Spatial Planning in Indonesia

BPN as the core member of National SII, also implement One Map Policy to improve interoperability and quality of its spatial information management, including in data acquisition in land registration and standardization on other land-related information, such as land use, land value, and spatial zoning (Pinuji, 2016). The standardization of the quality of land registry and documents is prerequisite to be integrated into National SII. In the current situation BPN is updating the NLIS in line with an acceleration of data acquisition and improvement of data management related to land registration program simultaneously (Kusmiarto 2017). The improvement of the NLIS should be able to model the more realistic relationship between human and land or space which is defined in ISO 19152 as RRR (Rights, Restriction, and Responsibility). This relationship in Indonesian context is realized through modeling of the land tenure, land ownership, land use, and land utilization. The model should represent regulation, functionality, and interoperability to be able to support land administration as well as spatial planning.

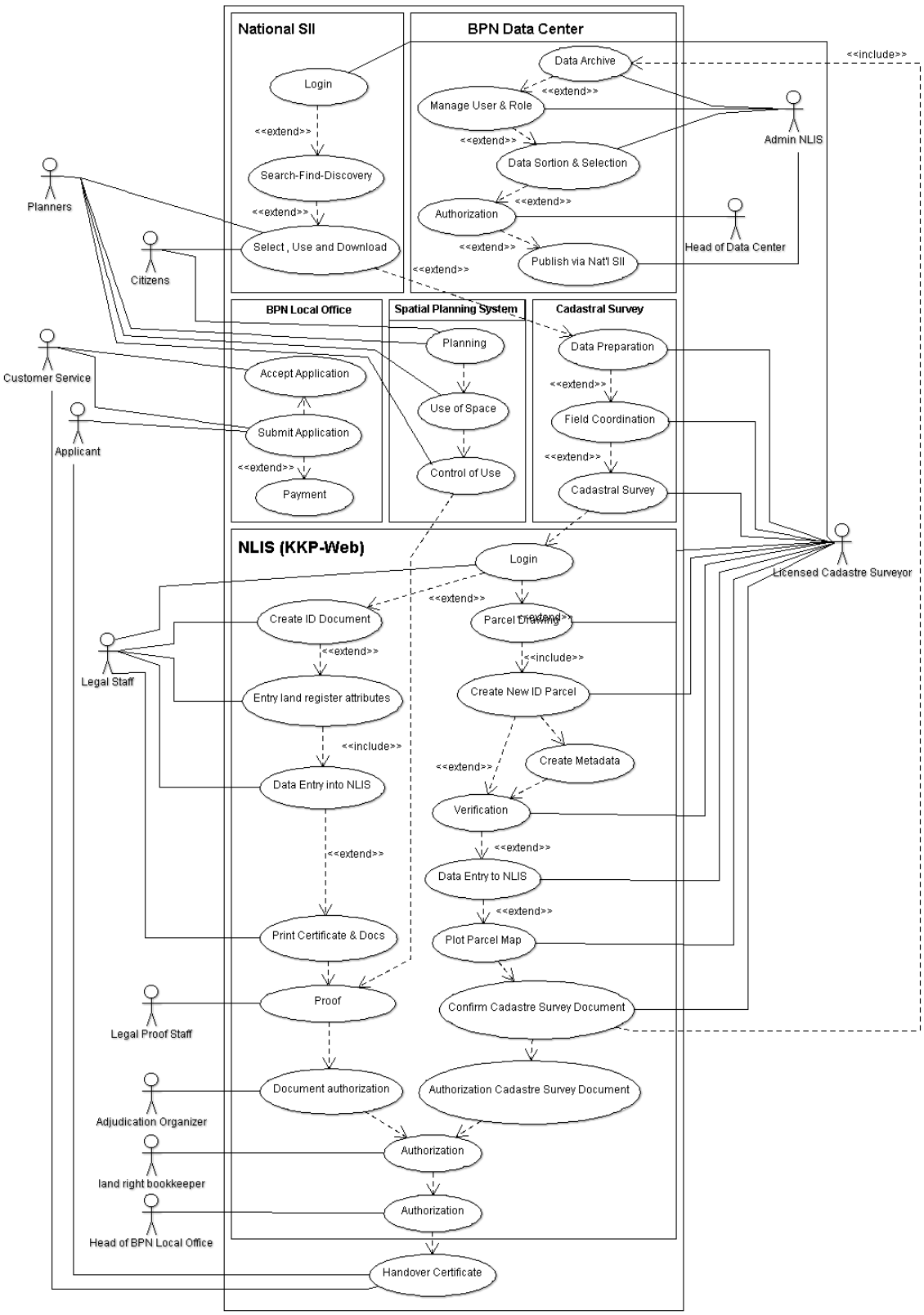


Figure 11. UML use case for proposed workflow in Indonesian NLIS to integrate Land Administration and Spatial Planning. Based on BPN Decree No 35 (2016) on Acceleration of Comprehensive Land Registration

The proposed use case for improved NLIS is shown in figure 11. The proposed main classes of the party package in LADM are class LA_Party and UP_Party with its specialization *LA_GroupParty*, *UP_GroupParty*, and *UP_Party-Member*(optional). A *UP_Party Member* represent registered parties and part of *UP_Group Party*. A *UP_Party* is a person or organization that plays a role in spatial planning. An organization can be a business, a municipality, the province, or a local community. These classes are dynamic and subject to change over time.

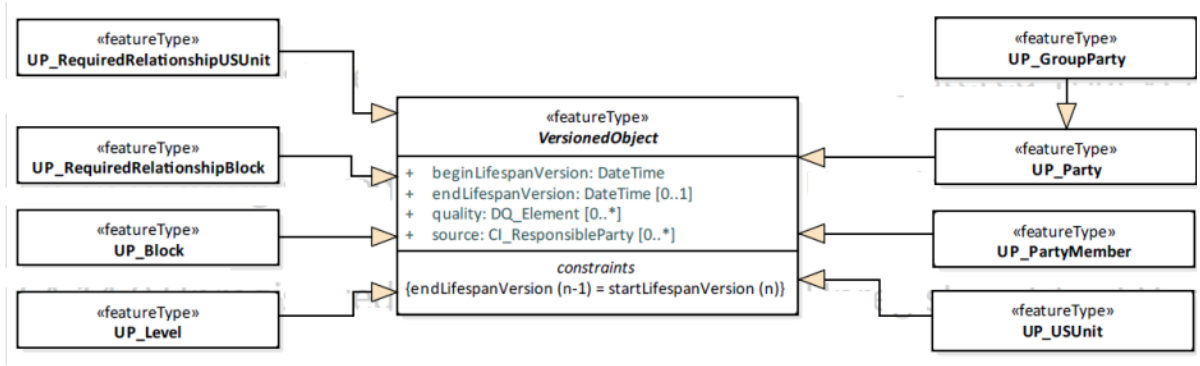


Figure 12. Spatial Planning Sub-Package for integration of Spatial Planning in LADM

Derived from previous sections, with the premise of the requirement of one-stop-service, we develop sub-package in LADM to allow the integration of spatial planning and land administration. This integration is vital in the development of the integrated electronic system as instructed in Government Regulation No. 24 (2018) on Electronic based Integrated Permit System. This model aims derive RRR from spatial planning and land administration, which ensure validity, factuality, and interoperability in operationalization and maintenance of the system (see figure 12). We propose the addition of classes in LADM in Table 2. In Indonesia, RRR is derived from the land administration and spatial planning. We provide a comprehensive literature study on recent law and regulation to identify guideline affecting in land administration and spatial planning. Indonesian laws and regulations stratify information with land rights and spatial zones to provide a complete RRR with permission, incentive, disincentives, and sanctions. We propose new classes in the spatial unit package into LADM with UP_Block, UP_Level, and UP_RequiredRelationshipBlock. These classes represent a single area (or multiple areas) of land (or water) or a single volume of space (or multiple volumes of space) according to spatial zoning and its relationship. A UP_Block structured to represent the spatial zoning as a polygon or as a 3D volume with or without topology. A UP_Level is a collection of spatial units with a geometric and thematic coherence in spatial planning. The proposed integration of spatial planning package into LADM is represented in Figure 13.

Table 2. Proposed Classes in Spatial Planning Package in LADM

Proposed Classes	
UP_Party	A class containing a person or organization that plays a role in spatial planning. Purpose: to represent data of stakeholder related to space or land in spatial planning.
UP_PartyMember	A 'party member' is a constituent of a party or group party in spatial planning Purpose: to represent a group of party
UP_GroupParty	Some parties forming a distinct entity in spatial planning
UP_USUnit	A single (or multiple) areas of land and/or water, or a single (or multiple volumes) of space in spatial planning
UP_Block	A single (or multiple) areas of land and/or water, or a single (or multiple volumes) of space in spatial planning
UP_Level	An instance of a class associated with class UP_USUnit
UP_RequiredRelationshipUSUnit	An instance required a relationship between UP_USUnit
UP_RequiredRelationshipBlock	An instance required a relationship between UP_Block

6. CONCLUSION AND RECOMMENDATION

In Indonesia context, the development of one-stop-services for electronic permit systems requires the integration of the 'domains' of Land administration and Spatial planning to provide complete information and transparency. Currently NLIS, which is maintained by BPN, is not connected with the Spatial Planning System developed by local governments. The development of 3D SiPraja to provide 3D visualization of spatial planning in Jakarta may be improved with information on 'real rights and restrictions' by integrating NLIS to support one-stop-services. Based on our study on the feasibility, we conclude that LADM principles can also be used in 3D spatial planning. The current LADM is projected to be capable of facilitating both land administration and spatial planning parties. We developed a spatial planning sub-package of LADM with classes in order to integrate the spatial planning blocks and relate them to the land parcel. By ensuring interoperability of land administration and spatial planning, we believe that this information will be useful as the core services in SII.

The integration of spatial planning and land administration require high quality and large-scale geo-information (minimum scale 1:5000). Further, the detailed shape of a building must be represented better at least in LOD 2. We recommend that local governments provide 3D city models at least in scale 1:2500 and BPN to provide accurate land information in scale 1:2500. To integrate NLIS and 3D spatial planning, we recommend implementing LADM principles, including introducing spatial planning packages which will facilitate stakeholders as new 'party' and the spatial planning block as a new 'spatial unit' in ISO 19152. We recommend that SII should include a 3D web service to facilitate 3D spatial planning and 3D land administration. We also strongly recommend the development of 3D-visualization and its linkage to 3D legal aspect in BPN and share them through SII to be accessed openly to all stakeholders.

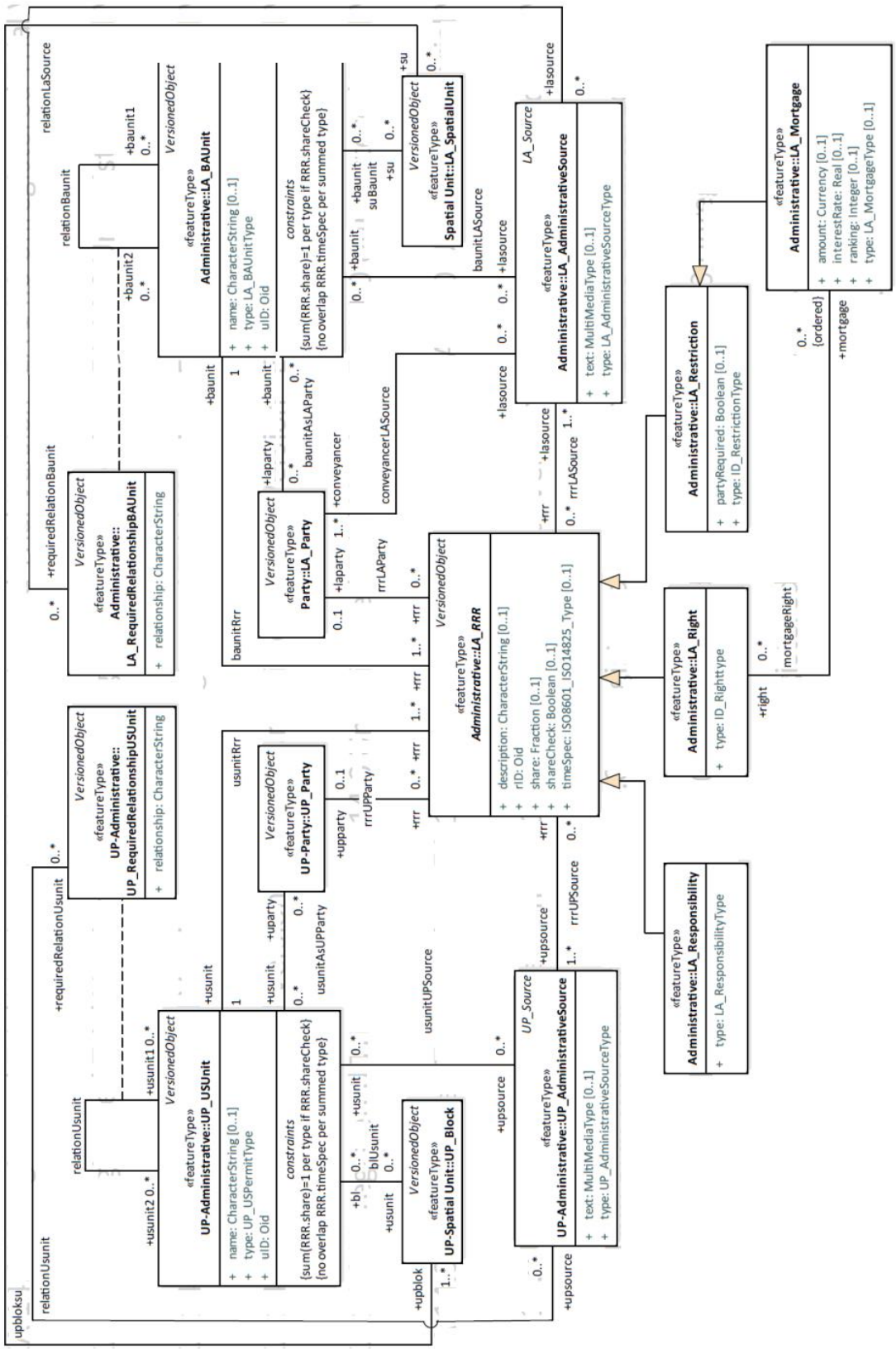


Figure 13. Proposed LADM Indonesian Country Profile with Integration of Spatial Planning Sub-Package

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