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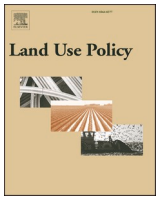

Implementation of the spatial plan information package for improving ease of doing business in Indonesian cities

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ABSTRACT

Land and space are major driving factors in doing business in urban areas. Cities around the world are performing land management techniques to achieve sustainable urban development. The World Bank acknowledges the importance of land management practices and promotes it as the Ease Of Doing Business (EODB) indicators for a supportive environment for economic activities. In improving a city's competitiveness, local governments need to establish a reliable Land Administration System to organize unrenewable urban land and spaces and simultaneously reduce information asymmetry between actors. A modernized LAS is needed to accommodate the four functions of land management: land tenure, land value, land-use planning, and land development. The ISO 19152:2012 on Land Administration Domain Model (LADM) standard offers a foundation to establish information interoperability in land management that is crucial in modeling the relationship between people and land (and space), the geometrical components, as well as documented Rights, Responsibilities, and Restrictions (RRRs) in land. To promote the exchange of information between the domains of land administration domain and spatial planning, an extension of LADM, the Spatial Plan Information Package (SP Package), was proposed to support cities organizing information in land management. This article presents the proposed spatial plan information extension to the LADM country profile for Indonesia. This work also develops a proof-of-concept of the package in the two biggest Indonesian cities (Jakarta and Bandung) with adaptation to the current national data management policies. Our research shows positive results on making the LADM country profile reflect on the real condition and improving LAS's adaptability to be integrated with the Spatial Information Infrastructure.

1. Introduction

Cities are the economic growth engine that stimulates urbanization worldwide (Bloom et al., 2008; Colenbrander, 2016). Since 2007, the total urban population has surpassed that of the countryside (UN-DESA, 2019). Dobbs et al. (2011) projected that the 600 largest cities in the world would be responsible for 60% of GDP until 2025. The European Commission (EC) has identified that 271 metro regions in the European Union (EU) cities already contributed as much as 62% of jobs and 68% of the Gross Domestic Product (GDP) (Dijkstra and Maseland, 2016). These numbers reflect the increasing pressure on urban areas. In responding to this situation, cities often use land management techniques to organize land and space to make economic activities balanced with social and environmental interests. In 2005, UNECE (2005) defines land management as "*the process of putting the physical resources of the land to good effect.*" The role of land management in supporting the economy of a city is well-recognized (Dowall et al., 1996; Fekade, 2000; Shatkin, 2016). In the past decade, land or space management got more highlighted as a factor for business activities. Annually, the World Bank (2014) examines land management practices as an integral part of the Ease Of Doing Business (EODB) reports from 190 countries by using Dealing With Construction Permits and Registering Property as indicators (World

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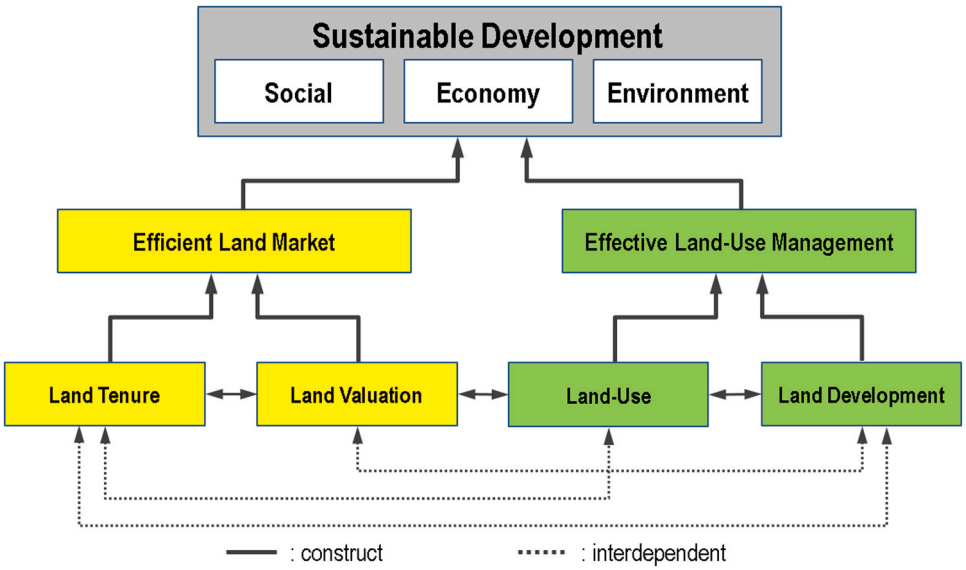


Fig. 1. A global perspective of land administration and its four functions of the land management paradigm. Adapted from Enemark (2005).

Bank, 2014). In this report, the maturity of the Land Administration System (LAS) is surveyed as authorities, and economic actors depend on it to secure their land and property rights and facilitate investment planning and business growth (Indrajit et al., 2020b).

Access to reliable land information is vital for economic actors or landowners in making decisions in doing business or for authorities in constructing public policies in urban areas. In the smart city era, Roche and Rajabifard (2012) argue that the Land Administration System (LAS) must be improved in order to facilitate stakeholders to access relevant information and collaborate in urban management. One improvement will be the representation of all legal spaces in 3D. As human activities, including doing business, happen in 3D space it is beneficial for a city to collaborate with various stakeholders to develop a common multidimensional representation for rights, restrictions, and responsibilities. Therefore, it is urgent to develop a common data model to ensure land information interoperability to make LAS capable of supporting the land management paradigm, including sharing a full 3D representation of the land-use plan to relevant stakeholders.

This article applies a Design Research (DR) strategy proposed in Hevner and Chatterjee (2010) to review the implementation of Spatial Plan Information Package (SP Package) extension for the ISO 19152 on Land Administration Domain Model (LADM). We apply the LADM to accommodate land-use planning activities into land administration in Indonesian cities. It assesses how the proposed package may improve the interoperability within the land-use planning domain and how it may promote the ease of doing business. First, this article presents a background and the land management paradigm to achieve sustainable development. Section 3 discusses the spatial plan information package in the proposed revision of ISO 19152 on LADM. The methodology for this study is presented in Section 4. The next section describes the redevelopment of the LADM Country profile in Indonesia. Section 6 illustrates the strategy to provide land information to relevant stakeholders for supporting economic actors in doing business. The development of a proof-of-concept using real land-use plan data is presented and discussed in Sections 7 and 8. This article is concluded with Section 9 that contains conclusions and recommendations.

2. Land management paradigm towards effective land markets and effective land-use management

In the late 1990s, the International Federation of Surveyors (FIG) proposed the Cadastre 2014 vision to kick-start the modernization of the Land Administration System (LAS) around the world (Kaufmann and Steudler, 1998). The Cadastre 2014 vision encourages countries to accelerate their efforts to provide a complete overview of land (and space) and its legal aspects. This vision indicates integrating a modernized LAS with Spatial Information Infrastructure (SII) to safeguard successful land management and improve outreach to relevant stakeholders and communities, particularly landowners, property owners, and economic actors. In 2005, Enemark (2005) proposed the "*Land Management Paradigm*" for achieving sustainable development. This paradigm identifies four functions of land management: land tenure (and cadastre), land value, land-use, and land development (Fig. 1) (Enemark, 2005). Land tenure manages data about rights (public and private laws) on land or properties. Land valuation focuses on fiscal information on land and properties (land price, transaction price, and mass valuation). Land-use and land development planning create zoning regulations that prescribe characteristics (privileges, prohibition, and obligations) on a specific area of land or space. The land management paradigm acknowledges that information gathered from land tenure (registration) and land valuation processes are essential to support an efficient land market. Simultaneously, the land-use plan and land development are utilized to establish effective land-use management. The Cadastre2014 encourages countries to modernize their LAS to manage records and disseminate comprehensive information about the relationship between people and land. In summary, LAS should manage relevant information of all the four functions of land management to achieve sustainable development, especially establishing an efficient land market and effective land-use management for supporting doing business.

3. Spatial Plan Information Package (SP Package)

Since the 2000s, there is an increasing trend for planners worldwide to use the land-use plan as a tool for integrating policies (Van Straalen, 2012). UN-Habitat (2017) recommends that countries and cities need to integrate land-use planning processes to make a city smarter and sustainable. Land-use planning defines how land and space are used optimally and sustainably for achieving national and local objectives. Planners reconcile the competing interests in determining the urban form and functionality, servicing the public good, and representing the collective values in land-use planning. Jacobs (1993) noted that

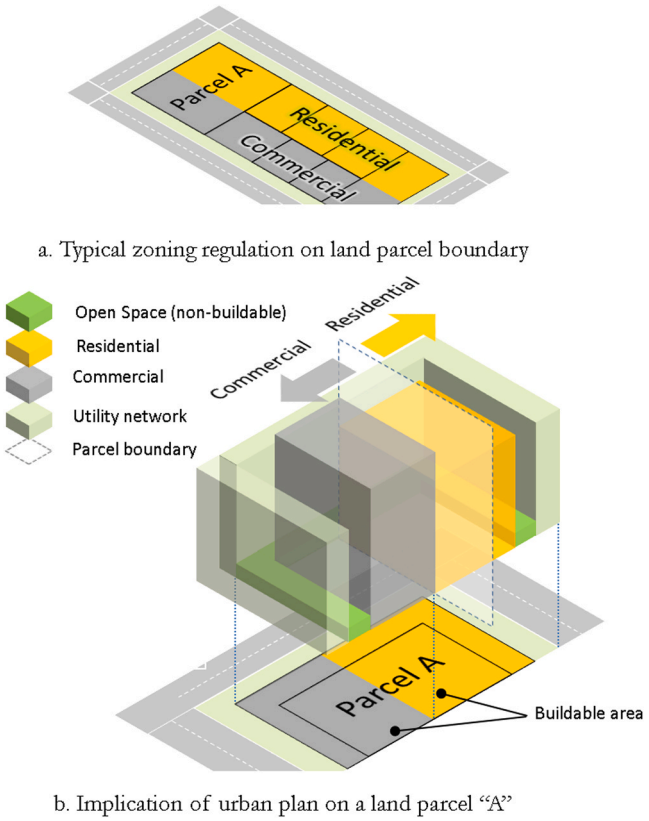


Fig. 2. The element of spatial units in a complex urban setting.

land-use planning is often used to manage land supply for various interests. The land-use plan (or zoning plan) populates and accommodates social, economic, and environmental aspects that influence physical land development. The land-use plan also influences the landowner's property rights by imposing restrictions and responsibilities (Van der Molen, 2015). Logically, for a successful land management program, governments need to collaboratively provide (authoritative) RRR information derived from land-use planning to all stakeholders (governments, landowners, and economic actors). For better personal understanding and improved city-wide decision-making, a country must ensure information interoperability of its spatial plans with information generated from land tenure, land valuation, and land development activities. The level of information interoperability of the land-use plan directly influences the effectiveness of land-use management, and can be expected to have indirect effects on sustainable development (see dashed lines in Fig. 1).

Lemmen et al. (2015) highlighted that standardization within the Land Administration (LA) is useful for making LAS more flexible and interoperable. However, authorities should consider adaptation with local settings (i.e., local requirements, priorities, culture, religion, and behavior) in standardizing their LAS. LASs are commonly used to support land tenure or land registration. Enemark (2005) advocated the modernization of LAS to accommodate all four land management paradigm functions of land tenure (and cadastre), land value, land-use, and land development. At the moment only in a very few countries it also includes land-use plans and documentation of land development. The term "*zoning plan*" is often used as the end product of land-use planning. A zoning plan contains a set of RRRs information for each land unit (allotment) for various applications (i.e., permit, valuation, tax, disaster management) (see Fig. 2a). Authorities organize land-use planning in specific time intervals or sporadically based on political dynamics, acceleration of economic investments, or disaster. These dynamics amplify land information complexity in urban areas where land and spaces are more scarce and stacked vertically. In this setting, the land parcel may contain two or more types of RRRs. For the sake of consistency, this article classifies space into a buildable area, open space, and utility network classes (see Fig. 2b). Each class has different RRRs (i.e., open space as part of a land parcel restricted to build any or permanent construction).

In 2012, the International Organization for Standardization (ISO)

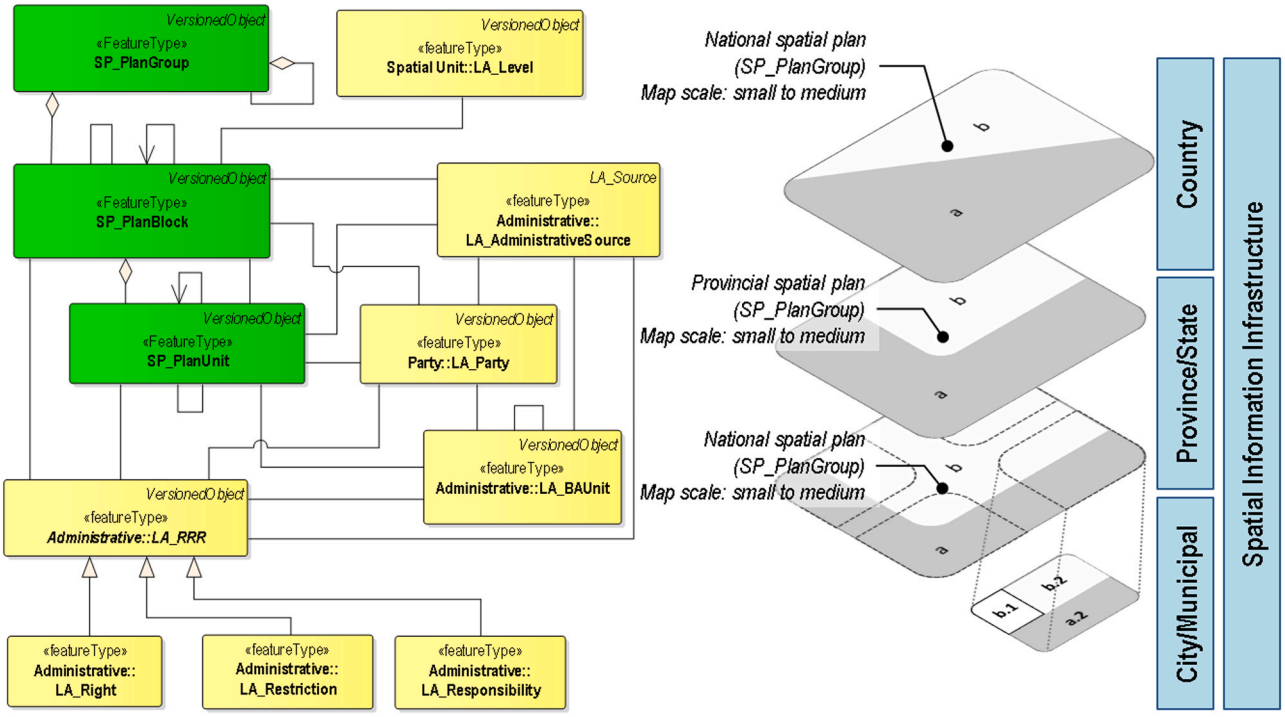


Fig. 3. Classes in the proposed spatial planning information package: SP_PlanBlock; SP_PlanUnit; and SP_PlanGroup (left) and source of spatial planning information corresponds to the hierarchy of spatial planning (right) (Indrajit et al., 2020a).

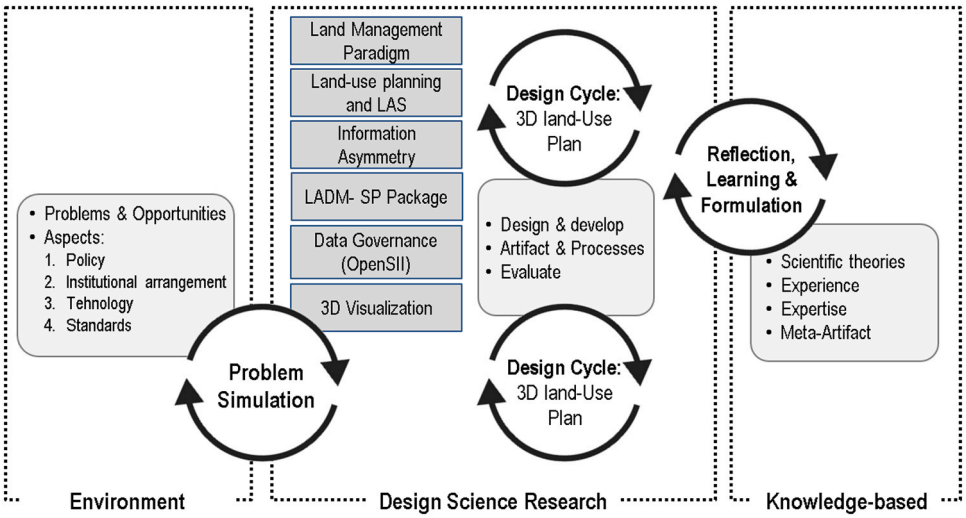


Fig. 4. Methodology: Design Science Research.
Adopted from (Hevner and Chatterjee, 2010).

published the ISO 19152:2012 on the Land Administration Domain Model (LADM) standard to provide a foundation for modeling the relationship between people and land (and space), the geometrical (geospatial) components, as well as documenting Rights, Responsibilities, and Restrictions (RRRs). This standard aims to guide countries in developing LASs through conventional conceptual models (Lemmen et al., 2015). The current LADM standard from 2012 provides sets of guidelines to ensure the information interoperability concerning LA and model the relationship between people and land (or space). LADM introduced a formal language of RRRs information from land management activities (Van Oosterom and Lemmen, 2015). ISO (2012) describes rights as "*activity or class of actions that system participant may perform on or using an associated resource*" with the added note "a *right may provide a formal or informal entitlement to own or do something.*" Restrictions are defined as "*formal or informal obligation to refrain from doing something*" and responsibility as a "*formal or informal obligation to do something*".

The SP Package was developed based on the Plan4All project and INSPIRE (Indrajit et al., 2020a). At the time of writing, the SP Package is included as the fifth part of the LADM standard revision proposal. This package contains three main classes: SP_PlanBlock, SP_PlanGroup, and SP_PlanUnit (Fig. 3). SP_PlanUnit class depicts the smallest unit from a zoning plan or a detailed plan and contains a spatial representation (i.e., zoning plan). SP_PlanBlock accommodates land-use functions. Both classes may contain geometry and legal expressions (constructed, agreed, and approved) from spatial planning processes. The SP_PlanGroup class allows hierarchy in spatial planning (e.g., national spatial plan, state/province spatial plan, and city spatial plan). In a specific condition, SP_PlanBlock can be used to model spatial plans at national and provincial levels. The SP_PlanBlock and SP_PlanUnit classes to include administrative and spatial sources and supplementary documents. Administrative and spatial documents are facilitated by LA_AdministrativeSource and LA_SpatialSource classes, respectively (Lemmen, 2012). The administrative package in the LADM provides the abstraction of the three subclasses of LA_RRR: LA_Right, LA_Restriction, and LA_Responsibility, and the class Basic Administrative Unit (LA_BAUnit) (Fig. 3). The LA_BAUnit is associated with zero or more parcels (represented in the class LA_SpatialUnit) with homogeneous RRRs (ISO, 2012). For cities, authorities design land-use plans to prescribe restrictions and responsibilities on particular zones. A land-use plan accommodates criteria in public laws and public aspirations (Indrajit et al., 2020a) (i.e., maximum height restriction for building construction or responsibility to sort waste before disposal). The current version of the LADM provides LA_BoundaryFace class to construct a 3D representation and VersionedObject for accommodating the temporal aspect of RRRs. These two classes are instrumental in constructing 4D (3D and temporal) RRRs crucial in granting location and business permits in Indonesian cities. The revision of the LADM offers two new packages (spatial plan and land valuation information), which helps authorities ensure consistency and integrity of land information (Lemmen et al., 2019).

4. Methodology of implementing SP Package for updating LADM country profile

In Indonesia, the legal framework and policies at the national level mandate government institutions to provide access to land information supporting better collaboration in land management activities. However, land management in Indonesia is facing challenges. Many stakeholders still maintain data silos and develop their own 'standards' for data they produce. This situation leads to the information asymmetry phenomena, resulting in failing integration of RRR information in land-use (urban) plans. We applied a Design Science Research method proposed in Hevner, A., & Chatterjee, S. (2010) to improve the Indonesian LADM country profile from the first version and to develop a data model for the 3D land-use plan for Indonesian cities, using Jakarta and Bandung as case studies (Fig. 4).

This study uses the existing LADM country profile, the proposed SP Information Package in the revised LADM standard, and the 3D prototype as artifacts to be analyzed in the Indonesian context. These artifacts provide a foundation for improving the Indonesia LADM country profile and constructing data models for the land-use plan. The next section shows prototype developments and institutional arrangements for sharing and reusing 3D land-use plans. The problems and artifacts (the LADM country profile and 3D land-use representation) are continually evaluated. Section 4 also contains innovations made from the artifact design and organization intervention, which are: the revised Indonesian LADM country profile, 3D representation of land-use plan, and institutional rearrangement to allow two-ways land information sharing.

5. Implementation in Indonesian cities: updating LADM country profile using SP package

Enemark et al. (2018) highlight positive steps made by Indonesian cities in constructing a supporting environment for the land management paradigm. In Indonesia's constitution, land and space (above and below the Earth's surface) are acknowledged as public goods, but the

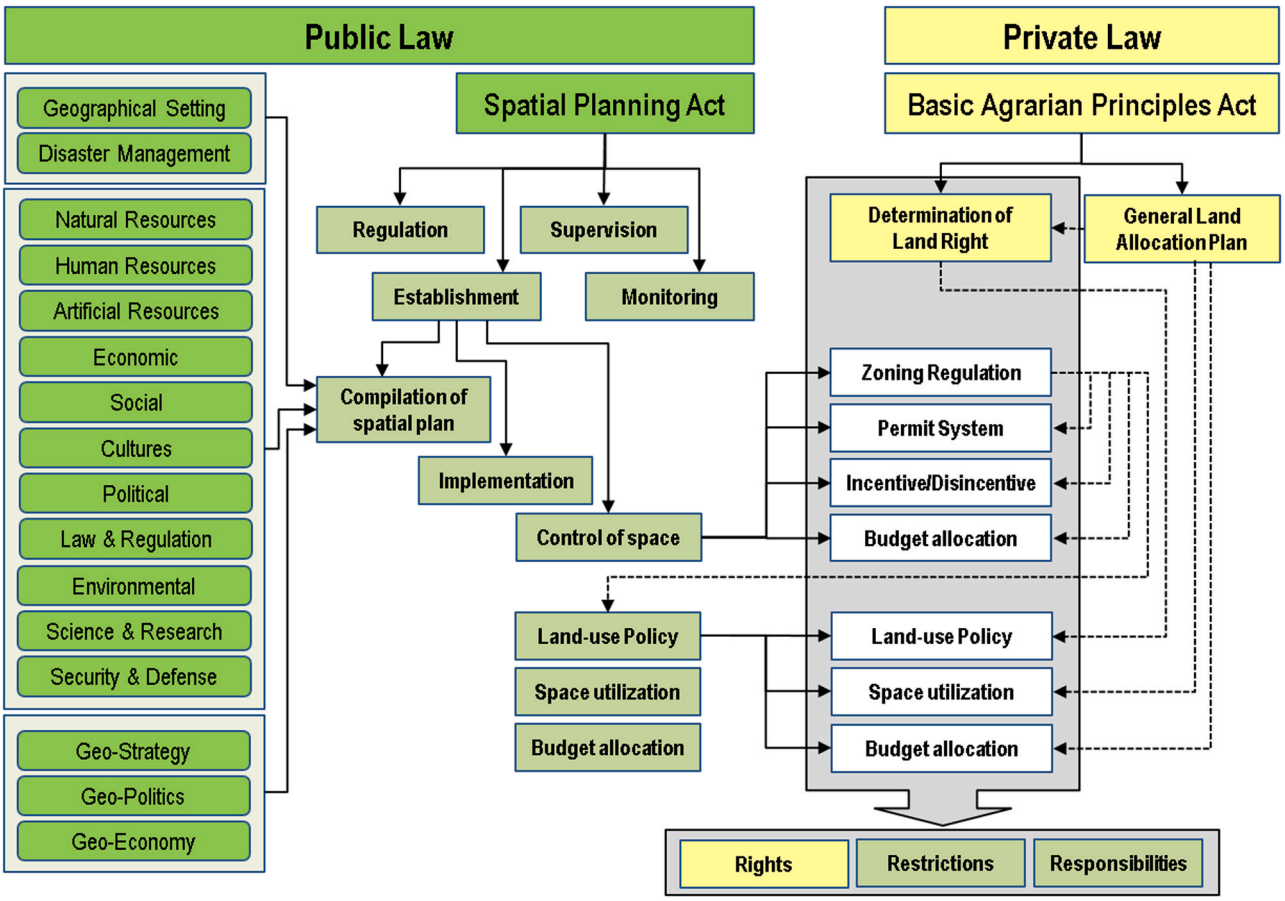


Fig. 5. Relationship between the Indonesian Spatial Planning Act and the Basic Agrarian Principles Act.

state still recognizes private ownership of land and properties. The Disaster Management Act (UU Penanggulangan Bencana) (2007), the Geospatial Information Act (UU Informasi Geospasial) (2011), and the Local Government Act (2014) mandate local governments to establish information systems for organizing and disseminating land information. Badan Perencanaan Pembangunan Nasional (Bappenas), a national development planning agency, implements the "*Thematic-Holistic-Integrative-Spatial*" (THIS) approach for national and local development planning for achieving the Sustainable Development Goals (SDGs) indicators and improving the EODB rank in 2020–2024 (Bappenas, 2019). The Government of Indonesia (GOI) launched the Indonesian Spatial Data Infrastructure (or Indonesian SII) in 2007 to facilitate ministries and local governments in sharing spatial data (Indrajit, 2018), including land information. Guided by a spatial plan and through the permit mechanism, authorities may grant privileges to parties to utilize or profit land or space. Indonesia develops its policy on land management based on the Basic Agrarian Principles Act (UU Pokok Agraria) (1960) and the Spatial Planning Act (2007). Under these laws, Badan Pertanahan Nasional (BPN), a national land agency, is mandated to secure legal certainty (rechtskadaster) of land and space through three elements: cadastral mapping, legal documentation, and land registration. At the time of writing, BPN is operating the Computerized Land Office web-based system (Komputerisasi Kantor Pertanahan/KKP-web), an online application based on the LADM (Pinuji, 2016). The local government may update spatial plans in five years or by responding to various types of disasters. Therefore, a zoning plan must have spatial representation in the Indonesian LADM country profile. In modeling RRRs, we anticipate a land parcel has two or more zoning plans (see land parcel boundary in Fig. 2a). Therefore, we reuse the class LA_BoundaryFace classes to construct a spatial representation of RRRs and anticipate a land parcel's subdivision. The class SP_PlanGroup is used to accommodate land-use policies in the upper levels, such as the National (Rencana Tata Ruang Wilayah/RTRW Nasional) and the Island-based (RTRW Pulau), and the Provincial (RTRW Provinsi) Spatial Planning. The SP_PlanUnit class shall contain the detailed zoning regulation (RDTR) on each allotment or space as regulated in the Spatial Planning Act.

Collaboration in spatial planning in Indonesia is inevitable as the Spatial Planning Act (Undang-Undang/UU Penataan Ruang) (2007) prescribes a hierarchical structure following the administrative jurisdiction (see Fig. 3). The lower spatial planning level must refer to (and comply with) the upper-level spatial plan. Thus, information and knowledge sharing among hierarchical levels and between stakeholders at the same level and between the levels are required by the Spatial Planning Act. The Rencana Detil Tata Ruang (RDTR) (detailed land-use plan) includes a list of construction locations at the lowest spatial planning level, both for public services or private projects. Land development plans use RDTR as the basis for issuing construction permits. In Indonesia, the National Land Agency (Badan Pertanahan Nasional/BPN) is responsible for providing information concerning rights and land supply policies to cities (see Yellow boxes in Fig. 5). Simultaneously, the Spatial Planning Act (2007) mandates that local governments to control the utilization of land and space (Green boxes in Fig. 5). Black lines represent "*elements*," and Dashed Black Lines represent "*referencing*." Local governments maintain the Grey boxes while BPN is mandated to organize blue boxes. The White boxes in Fig. 5 indicate shared responsibilities between local governments and BPN (National Land Agency). The spatial plan aggregates sectoral policies to create restrictions and responsibilities of each allotment or space while land tenure prescribes rights over land parcels. The integration of information about land ownership (private laws) and public laws in investment is mentioned in the Capital Investment Act (UU Penanaman Modal)

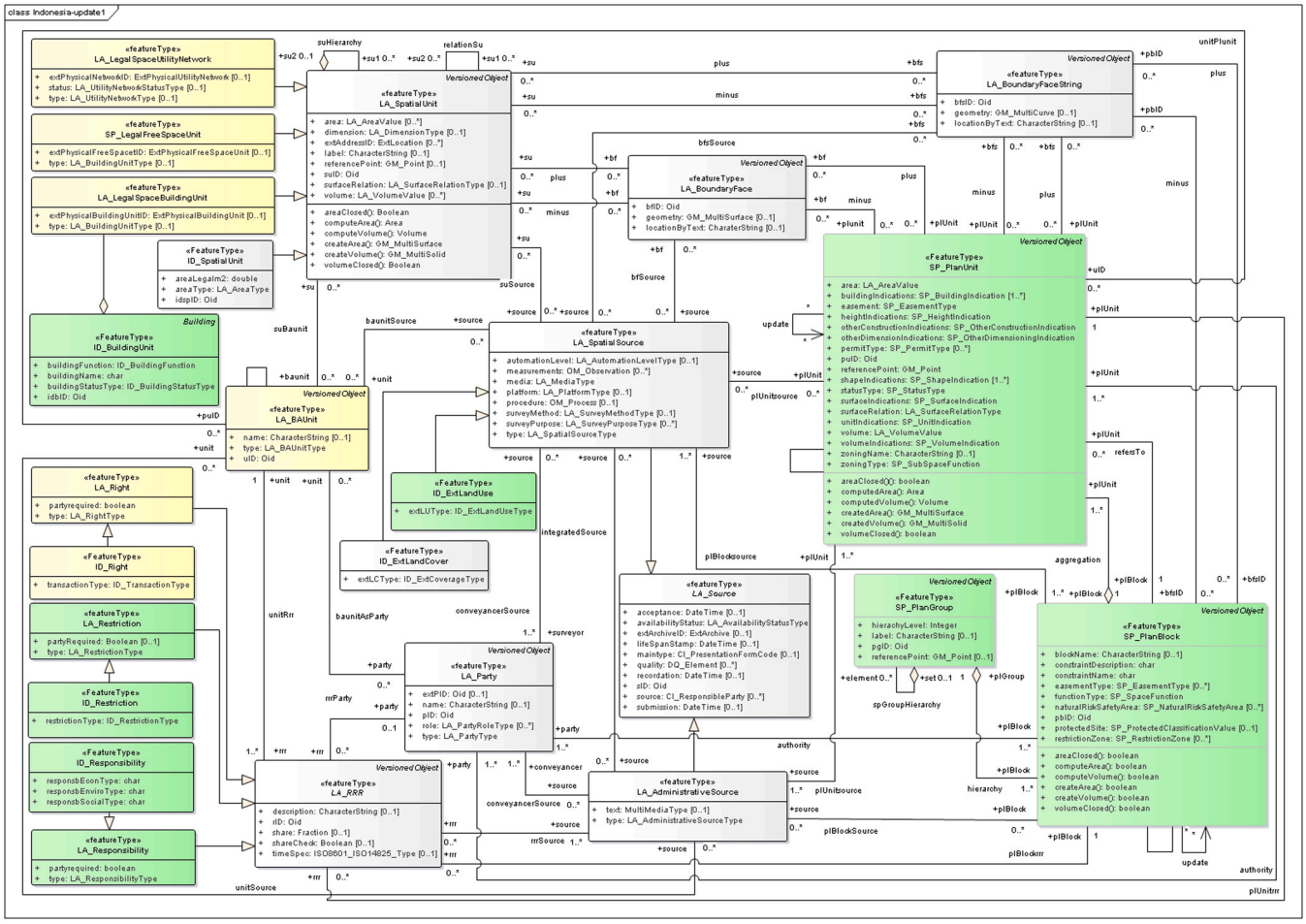


Fig. 6. Improved Indonesia LADM Country Profile using Spatial Plan Information Package.

(2007). The Local Government Act (UU Pemerintahan Daerah) (2014) promotes spatial plan as they must have data for public services and mandates local governments to develop and maintain information systems. Also, the Spatial Planning Regulation (2010) instructs the authorities to disseminate spatial plans to government institutions and communities. However, there are gaps in integrating private and public laws concerning land management at national and local levels (Bappenas, 2012). In 2016, the National Development Planning Agency (Bappenas) (2016) identified a lack of interoperability, data completeness, data silo practices, and lack of data quality as major drawbacks in spatial planning processes.

This article considers three aspects for adding spatial information constructing a country profile: 1. Identification of spatial units from land-use planning; 2. Identification of parties on land tenure and land-use planning; and 3. Identification of RRR information from zoning regulation of each allotment or space from land tenure and land-use planning. In Indonesia, land-use plans are containing zoning plans and criteria for non-buildable areas within the land parcel. Most cadastral activities in Indonesia are using 2D, with 3D only applied for apartments and tall buildings as strata title. The Indonesian LADM country profile uses the Spatial Plan Information Package from Indrajit et al. (2020a). Land tenure registers rights on each land parcel. Land-use planning accommodates multiple sectoral policies (i.e., social, environment, economy). Fig. 6 shows the result of the LADM country profile for Indonesia using the SP Package. The core LADM classes (light blue boxes) are by law mandated to BPN (National Land Agency). In contrast, the local governments will supervise spatial plan information classes (blue boxes). The white boxes are the shared classes and will be managed collaboratively between BPN and local governments, while pink boxes contain typical RRRs setting according to the Indonesian legal framework. (see Fig. 6).

This study found at least eighteen rights on land parcels, eight restrictions, and five responsibilities related to land tenure and land-use planning (see Tables A.1–A.3 in Appendix A). We implement the extended abstraction of RRRs proposed by Paasch et al. (2016). The RRRs information from private laws is assigned in separate classes: LA_Right, LA_Restriction, and LA_Responsibilities. We attached supplementary sources with classes in LADM (LA_Source and subclasses), such as regulations, surveying data, or other legally-binding documents. LA_BoundaryFace class was used to describe a 3D volumetric land parcel (space) by boundary surfaces. In contrast, LA_BoundaryFaceString class represented more traditional 2D parcels, but with the interpretation as a column of volumetric space (see land parcel boundary in Fig. 2b). In the Indonesian setting, land tenure activities register types of rights on each land parcel. At the same time, zoning plans represent the aggregation of multiple sectoral policies (i.e., social, environment, economy) (see Fig. 5).

6. Integrating land information into Spatial Information Infrastructure

For prospective investors and landowners the availability and accessibility of a land-use plan are vital. The plan may impose restrictions and responsibilities on land in the form of a limitation on activities, obligations to perform activities, or loss of opportunity. On the contrary, land-use planning may also grant privileges or benefits to

landowners or land rights-holders. Stakeholders in land management rely on interoperability in order to be able to reuse the published land information. Kaufmann and Steudler (1998) warned that traditional LAS might be vulnerable to information asymmetry when incomplete and unreliable land information is used by a broad range of legal land applications. Information asymmetry is a phenomenon when some actors hold more knowledge than others. Spence (1973) proposes the "*signaling*" concept where a credible party conveys some information about the product to other parties. Authorities disseminate public information (i.e., land-use plan) as "*signals*" to all for business activities. Economic actors perform "*screening*" accessible information. Screening includes accessing, filtering, and reusing the accurate information of specific commodities (i.e., land or space) being released into the market. Information asymmetry can also be considered a sign of an unhealthy land market (Feder and Feeny, 1991).

There is a higher risk of information asymmetry when land management functions are delegated to separate authorities (Bennett et al., 2006). When the lack of interoperability and building silos of information occurs, LAS may be subject to information asymmetry and impede stakeholders to integrate land information. Information asymmetry may cause an uneven opportunity among economic actors. In the long-term, unequal access to land information may stimulate an uneven distribution of prosperity (Jetzek et al., 2013), which hinders the city's sustainable development efforts. To sum up, RRRs information asymmetry may create legal and financial uncertainty on land and property against unpublished zoning regulation for landowners and prospective investors alike. Information interoperability plays an essential role in overcoming information asymmetries between data ecosystems and allowing the optimal reusability of land-use plans. Information interoperability is beneficial for stakeholders in understanding and representing legal (RRRs) and physical objects (i.e., building, pipeline, cable network, urban furniture) and non-physical objects (Basanow et al., 2008). The land-use plan needs to be interoperable for further integration with other data, such as 3D cadastre and 3D land-use plans for disaster management. Lack of interoperability of the land-use plans may also create unwanted information asymmetry, at least for some time. A modern LAS shall facilitate stakeholders by transmitting information via an information infrastructure, such as a Spatial Information Infrastructure (SII). Economic actors can perform "*screening*" (discovery, search and use) of land information via information infrastructure before making decisions (i.e., selecting the location and acquiring the land or property), obtaining the construction permits for their facilities, and registering their (immovable) properties. Van Oosterom et al. (2009) introduce four maturity levels for LAS with standardization as the basic criteria (first level) to ensure interoperability for the whole system. The second level is the existence of connectivity to exchange land information between stakeholders. The capability of LAS to facilitate information integration is the sign of the third level of maturity. The highest level is reached if LAS can outreach broader communities to reuse land information.

In 2014, The Presidential Decree on National SII (2014) was enacted to allow citizens to perform a two-way information flow to access and contribute spatial data into Indonesian SII systems. This decree is in line with the Public Information Disclosure Act (2008) that includes spatial information funded by the government budget as public information, including spatial information, to be accessible to the public. The "*THIS*" approach mentioned in Section 5 will require a robust LAS and SII for allowing all stakeholders to access land information for decision making. Governments and businesses utilize land information for the processes of selecting sites for investments, monitoring business performance, and evaluating real-time situations for planning for growth. Thus, for making THIS approach works for land management into reality, it is useful for the authorities to integrate spatial data with information of RRRs, to make land information interoperable and accessible. Failure to ensure information and technological interoperability will create asymmetric information among stakeholders in land management. The initial Indonesian country profile was included in Annex in the ISO 19152:2012. To support data-driven decision making, the Government of Indonesia (GOI) initiated a series of discussions since 2006 how to strengthen the national data management as part of Open Government Indonesia (Bappenas, 2012). In 2019, GOI decreed the "*One Data Indonesia*" (ODI) regulation to ensure the availability, quality, integrity, accessibility of data for planning, implementation, evaluation, and development control. Data producers within government institutions do submit and store data to data custodians in each institution. Transparency and reliable information infrastructures are needed to facilitate data sharing and reduce the information asymmetry among stakeholders (Indrajit et al., 2019). The GOI launched the "*One Map Policy*" (OM) Policy as part of the 8th of Economic Stimulus Package Policy in 2016 to ensure the quality of spatial information managed by government institutions. This policy aims to provide quality thematic maps at 1:50,000 to handle boundary dispute-triggered conflicts and overlaps in land utilization permits and enforce spatial plans implementation.

7. Case study: Indonesian cities

The New Urban Agenda acknowledges the land management paradigm by encouraging countries to establish a robust land information inventory (UN-Habitat, 2017). Geospatial communities acknowledge interoperability as the critical element of a spatially enabled society (Steudler and Rajabifard, 2012). UN-Habitat (2017) promotes transparency to be implemented in national and sub-national governments for effective policy and land management towards sustainable development. This document also promotes the development and enhancement of a participatory data platform for sharing spatial information and knowledge among stakeholders. However, in reality, many government institutions are still practicing "*silo thinking*" instead of delivering land information to governmental institutions and broader society (Ferraro, 2008; Thellufsen et al., 2009; Pettit et al., 2019). In her fundamental work, Arnstein's (1969) prescribed transparency as the foundation of participative activities. The Open Definition 2.1 characterizes "*open*" as allowing "*anyone can freely access, use, modify, and share for any purpose*" through open works and open licenses (Open Knowledge Foundation, 2017). OECD (2017) highlighted the G20's Open Data Principles: 1. open by default; 2. timely and comprehensive; 3. accessible and usable; 4. comparable and interoperable; 5. for improved governance and citizen engagement; and 6. inclusive development and innovations. Scientific communities introduced Findable, Accessible, Interoperable, and Reusable (FAIR) Guiding Principles as a "*technical specification*" to improve discovery, access, integration, and reuse of scientific materials for wider stakeholders (Wilkinson et al., 2016). FAIR Guiding Principles aim to implement '*good data management*' practices to improve information interoperability for knowledge integration and reuse of information by relevant stakeholders. FAIR Guiding Principles recommends standardization to make open data interoperable, machine-readable, and machine-actionable.

A modern LAS can be part of the spatial data-sharing ecosystem to allow more stakeholders to share land information. The United Nations - Global Geospatial Information Management (UN-GGIM) (2015) includes land information into Fundamental Geospatial Data Themes (FGDT) for SDGs (Hadley and Agius, 2018) and recommends these layers through National SII (Scott and Rajabifard, 2017). Cadastre and land-use were included as FGDT. For this reason, countries establish SIIs to enable participation from all stakeholders by exchanging land information. An increase in the land transaction or transfer of land and property rights demands some degree of "*openness*" of LAS and SIIs to facilitate experts and society. The value of maps depends on their usage and the societal benefit (Van Loenen and van Rij, 2008), so does land management (Elwood, 2010). The open data principles can make society spatially enabled by creating values from reusing spatial information (Van der Molen, 2015; Williamson et al., 2010). Therefore, it is natural for LAS to

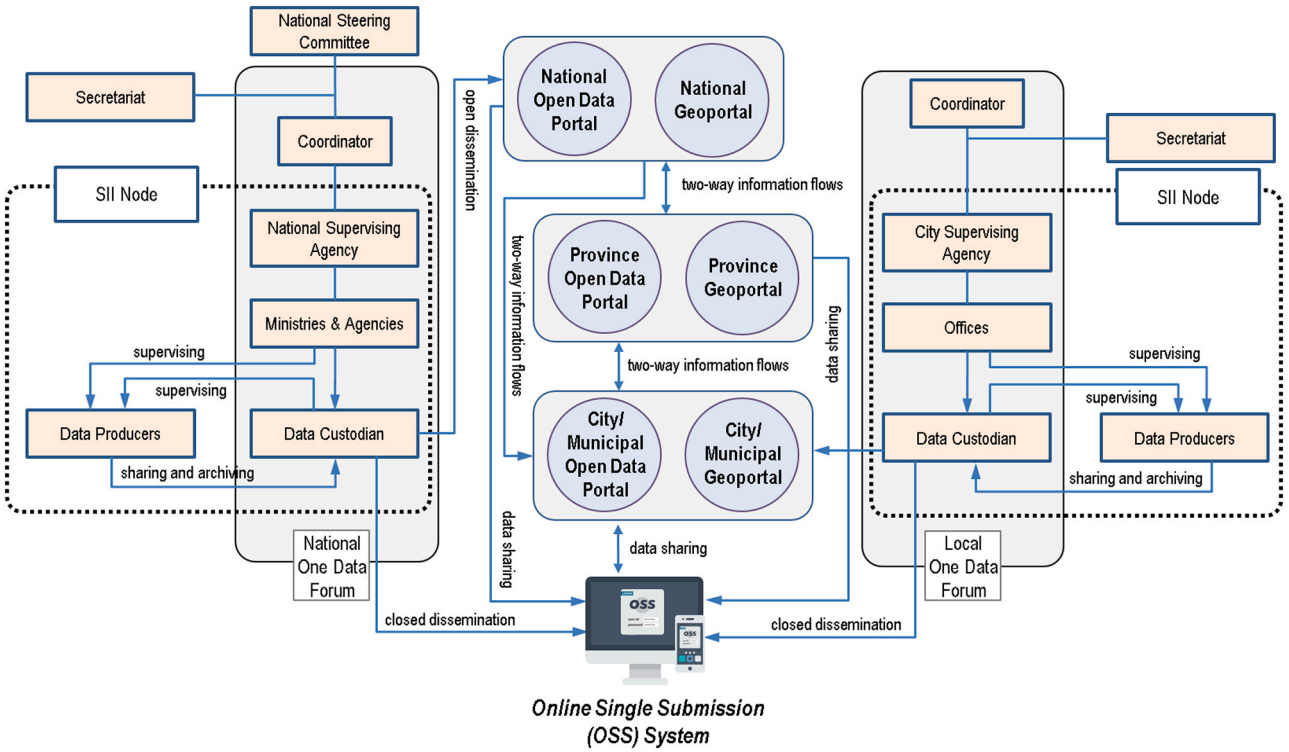


Fig. 7. Spatial Information Infrastructure (SII) and the Online Single Submission (OSS) system under the '*One Data*' Indonesia Regulation with the national level (left) and the provincial/city level (right).

be connected and built on the same platform as the SII systems (Van Oosterom et al., 2009; Roche et al., 2012) to facilitate stakeholders in sharing and reusing spatial information (Van Loenen, 2006). SII has the potential to harness new sources of data from authorities, landowners, and economic actors, including non-traditional and low-skilled spatial data producers.

In 2018, the GOI launched *Online Single Submission* (OSS), an online application for the single nation gateway for issuing permits (Deloitte, 2018). The ODI regulation provides a legal foundation for government institutions in performing as data producers and data custodians to support the OSS systems with the three-tier hierarchy described in Fig. 7. The OSS attempts to simplify the process to obtain business permits, such as construction permits and business licenses. BPN supports the information of land registration managed in the KKP- web while the local government shares the land-use plan to the OSS system. BPN and local governments are the responsible parties in compiling the RRRs

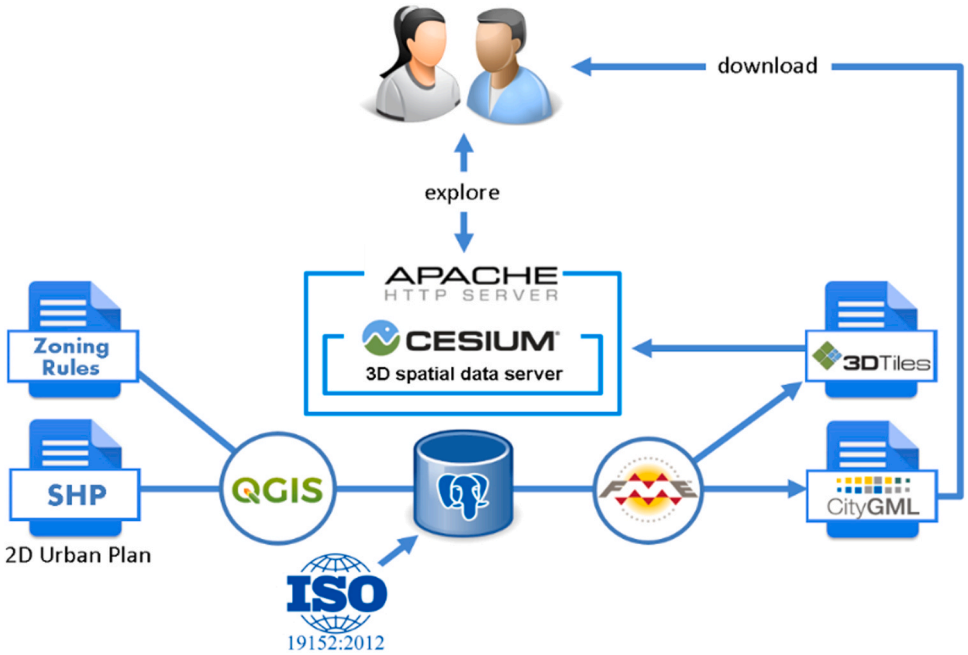
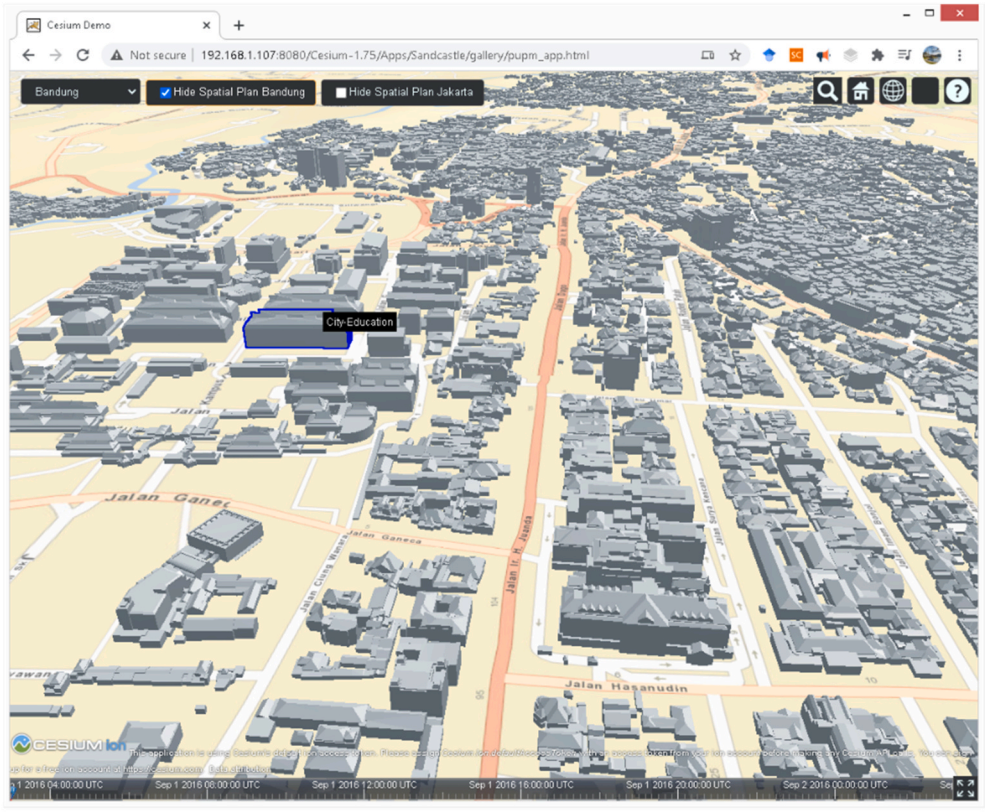
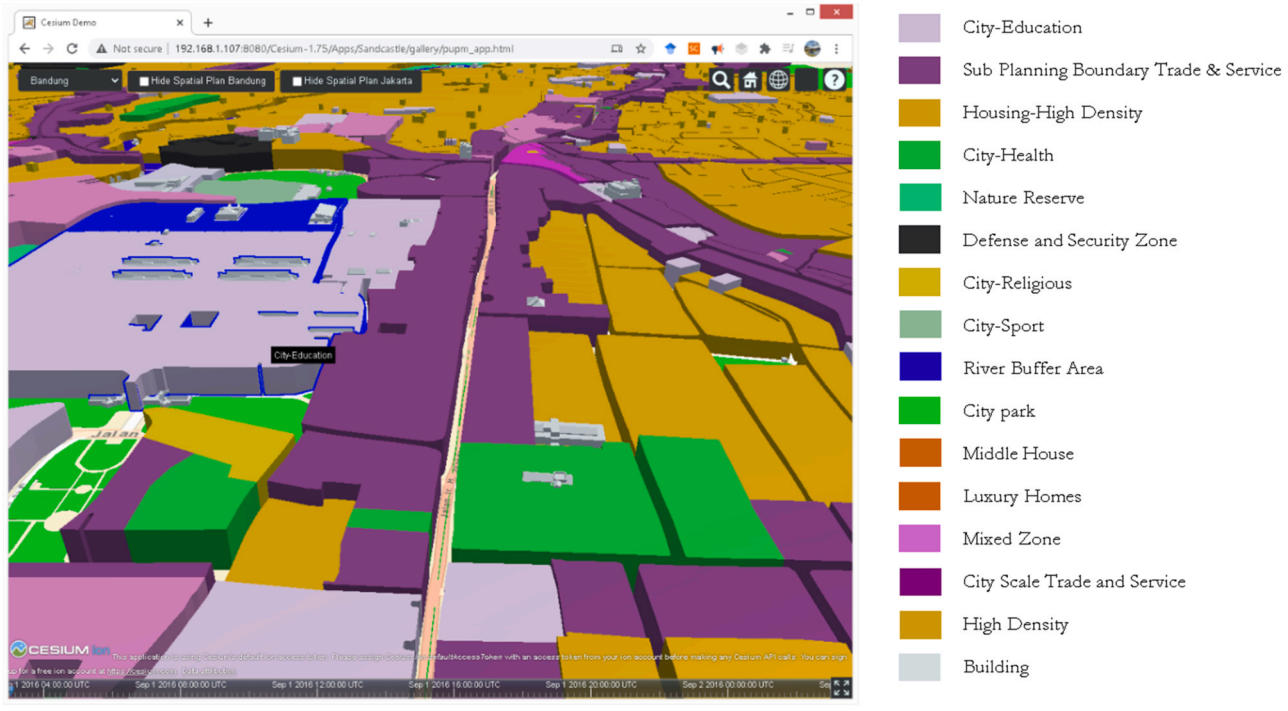


Fig. 8. The architecture of the prototype of the 3D Land-use plan. (The prototype is available to the public through http://pakhuis.tudelft.nl:8080/edu/cesium74/Apps/pupm2/).

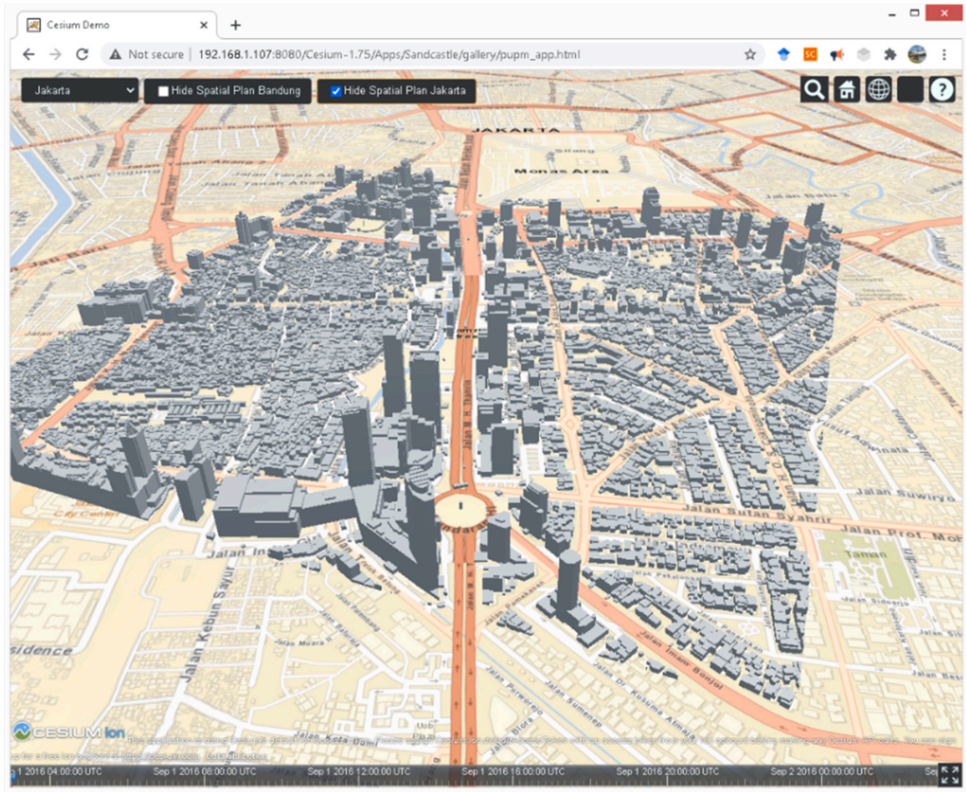


(a) 3D City model of Bandung City (Data provided by the City of Bandung)

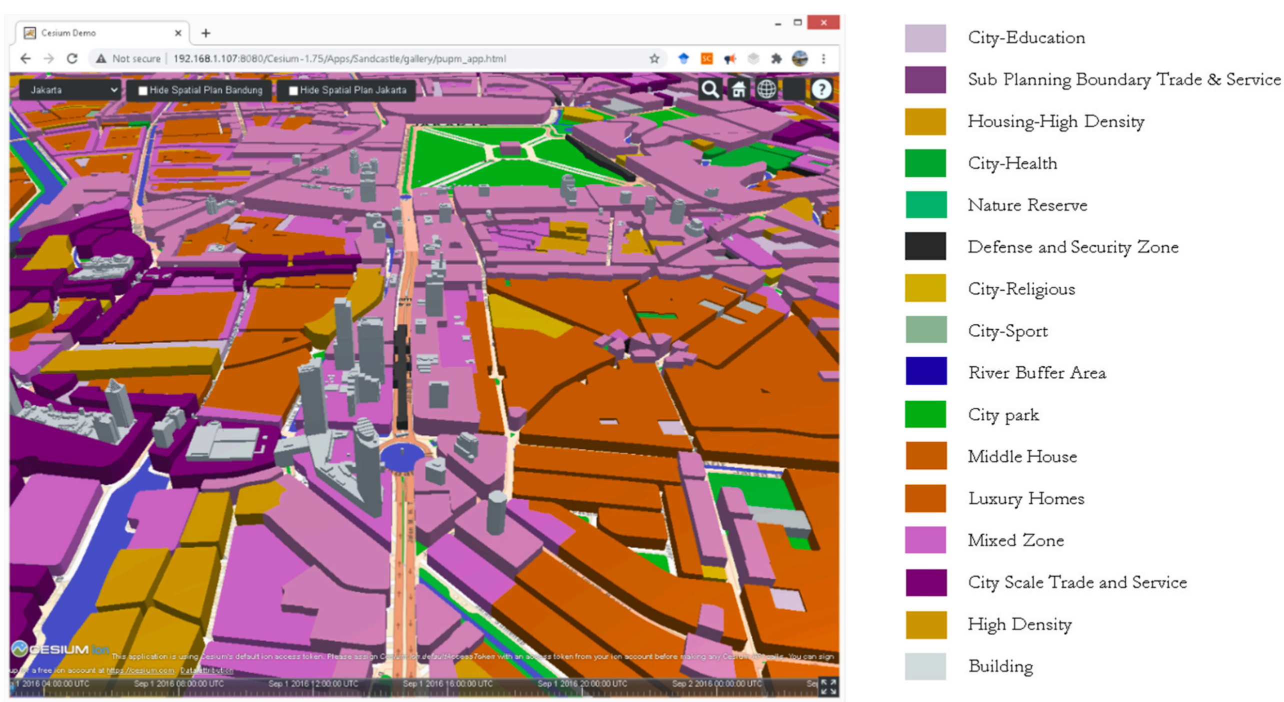


(b). 3D Land-use plan of Bandung City

Fig. 9. Visualization of 3D representation of RRRs of Bandung, City (near to Institute Technology of Bandung Campus) using SP Package from the updated LADM Country Profile of Indonesia. Note: some buildings exceeding the height limit governed in the urban plan.



(a) 3D City model of Jakarta City (Sample data provided by the visicomdata.com)



(b). The 3D Land-use plan of Jakarta City

Fig. 10. Visualization of 3D representation of RRRs of Jakarta, City (near to National Monument) using SP Package from the updated LADM Country Profile of Indonesia. Note: some buildings exceeding the height limit governed in the urban plan.

information within the OSS system. However, in reality, standardization of RRRs information in Indonesia is non-existing, forcing authorities to examine and interpret the documents manually, prone to human errors and moral hazards, causing information asymmetry. This situation may create challenges in the integration of the RRRs information from land registration and spatial plan. Information asymmetry may be imposed when authorities and economic actors had different access to land information or lack of information interoperability. Therefore, we implemented the proposed SP Package to ensure interoperability and pave the way to make land information understandable, meaningful, machine-readable, and machine-actionable in spatial planning processes. Zoning regulation and detailed spatial plans at map scale 1:5000 have been provided by the cities of Jakarta and Bandung City. These cities, the two biggest in Indonesia, have been selected because they regulate land and space with 3D criteria by specifying height indication, which we used to create 3D geometries.

The zoning plans (represented in the class LA_PlanningBlock, containing the LA_PlanningUnit class) and building map from these two cities are in 2D shapefile files. Bandung City has 21,429 zones, while Jakarta consists of 37,378 zones. These zoning plans consist of physical and activity criteria categorized as restrictions, including building height limits and free spaces (e.g., roads). We implement the proposed Spatial Plan Information Packages for the revised LADM (for the legal objects) and CityGML version 2 standards for developing the spatial representation of RRRs. Each zone in these cities is subject to volumetric limitations for landowners and developers in utilizing their land and spaces, including physical height restrictions and specific responsibilities (see Tables A.1–A.3 in Appendix A). Quantum GIS has been utilized to extract, transform, and load data from/to the PostgreSQL database. UML Class Diagram from LA_BoundaryFace of LADM to CityGML is available in Fig. B.1 in Appendix B. FME software was used to create the 3D spatial representation. Instead of implementing CityGML for the abstract objects: LandUseType and LandUse classes, this study follows the Ministry Regulation on Spatial Plan Database for the planned land-use code list (see Tables A.4 and A.5 in Appendix A). The RRRs information is managed in different classes but related to the spatial representation, as described in the Indonesian LADM country profile. This study develops a prototype via 3D web GIS to deliver a 3D representation of the RRRs with the system's architecture shown in Fig. 8. It is disseminated in the Batched 3D Model (b3dm) format using CesiumJS to allow interactive exploration and query by the end-users (see Figs. 9 and 10). The architecture of the prototype in Fig. 8 is expected to deliver 3D RRRs for users to explore through the Internet.

Magel and Wehrmann (2001) report that land management practices in many emerging economies are often over-centralized and lack coordination between policy-makers at the national and local governments. This situation creates inefficiencies and redundancies in the effort and utilization of human and financial resources to provide land management information. In contrast, the SII-based approach can enhance the collaborative approach in facilitating broader stakeholders in accessing and contributing land information to solve society's problems. By integrating LAS with the SII initiative, a city may transform its centralized to distributed approach with keeping information interoperability in place. This strategy is in harmony with the World Bank's EODB criteria on how a country or a city facilitating economic actors or start-ups in getting the location permits, registering land/properties creating facilities for their businesses. The integration of LAS and SII may leverage the quality of land administration services, particularly in the reliability of (information) infrastructure, geographic coverage, transparency of information, equal access to property rights, and land-related dispute resolution. The EODB determines the reliability of the (information) infrastructure index reflects the integrity of the information managed in the LAS. This index describes the use of geoinformation technology and information infrastructure (i.e., SIIs) in data sharing practices. On the other hand, the geographic coverage index represents the completeness of land information. In short, the EODB examines how the country facilitates economic actors in obtaining relevant land information and accessing the tools or services needed for starting and protecting their business.

8. Discussion

Information and technical interoperability allow for more applications utilizing land information and automation (machine-readable and machine-actionable). This section provides an assessment of the proposed SP Package for the Second Edition of the LADM standard, employing this new (proposed) package to improve Indonesia's LADM country profile. The two biggest Indonesian cities (Jakarta and Bandung) are presented in this study as showcases with a prototype of 3D visualization throughout the Internet, allowing maximum outreach for interactive exploration and querying. There are three critical areas for implementing the SP Package. Subsection 8.1 consists of the standardization of RRRs information from spatial planning processes. Subsection 8.2 discusses the institutional arrangement for implementing the proposed LADM Edition II within the Indonesian SII context (based on a new strategy of One Data Indonesia policy). Section 8.3 discusses the technical aspect of implementing an updated LADM country profile into the database and SII systems.

8.1. Standardization of RRRs information from the spatial plan

The interoperability of information is crucial in the land management paradigm, mainly to make land information accessible, understandable, and reusable for broader applications and users. As one of the end-products of land management activities, it is inevitable to standardize a spatial plan to ensure RRRs information interoperability. The emergence of the web- and mobile-based applications built on the shared digital platform needs interoperability enabling automation of public services as an online permit system or a service for land-use (urban) plan monitoring. Countries can study the proposals for revising the LADM standard for improving information interoperability of spatial plans and developing LAS. However, the ongoing LADM revision will extend to the land-use plan with the newly proposed SP Package.

The SP Package will likely support the implementation of the recently enacted Job Creation Act (UU Cipta Kerja) (2020). This Act indicates that spatial planning should consider a volumetric representation due to height, depth, and distance restrictions. For this reason, we implement the SP Package as proposed for the revised LADM for a better implementation of the Indonesian LADM country profile (see Fig. 6). In Indonesia, local governments are the leading authority in (detailed) spatial planning. Planners consider land ownership and rights as a foundation and input in designing spatial plans. We found in our assessment that the proposed LADM country profile (Fig. 6) is suitable for improving land management and permit system. The CityGML framework is suitable for representing the actual buildings, as physical reference objects, in city-wide applications such as business permits.

8.2. Institutional arrangements for implementing the revised LADM in SII

Land management in today's globalized and digital era requires interoperability and a suitable environment for sharing data among economic actors worldwide. Our study is an extension of work initiated by Van Oosterom et al. (2009) that considers land information as the cornerstone of SII. This article presents the implementation of the land management paradigm and modern LASs capable of organizing land management functions (land tenure, land valuation, land-use planning, and land development). This study also provides an approach to implement the LADM in a networked system (web services) approach such as the SII, allowing government institutions and economic actors to exploit integrated land information for decision-making. In the Indonesian context, the 'One Data' Policy is suitable for supporting a modern LAS. Further, this regulation will strengthen the LAS by enforcing

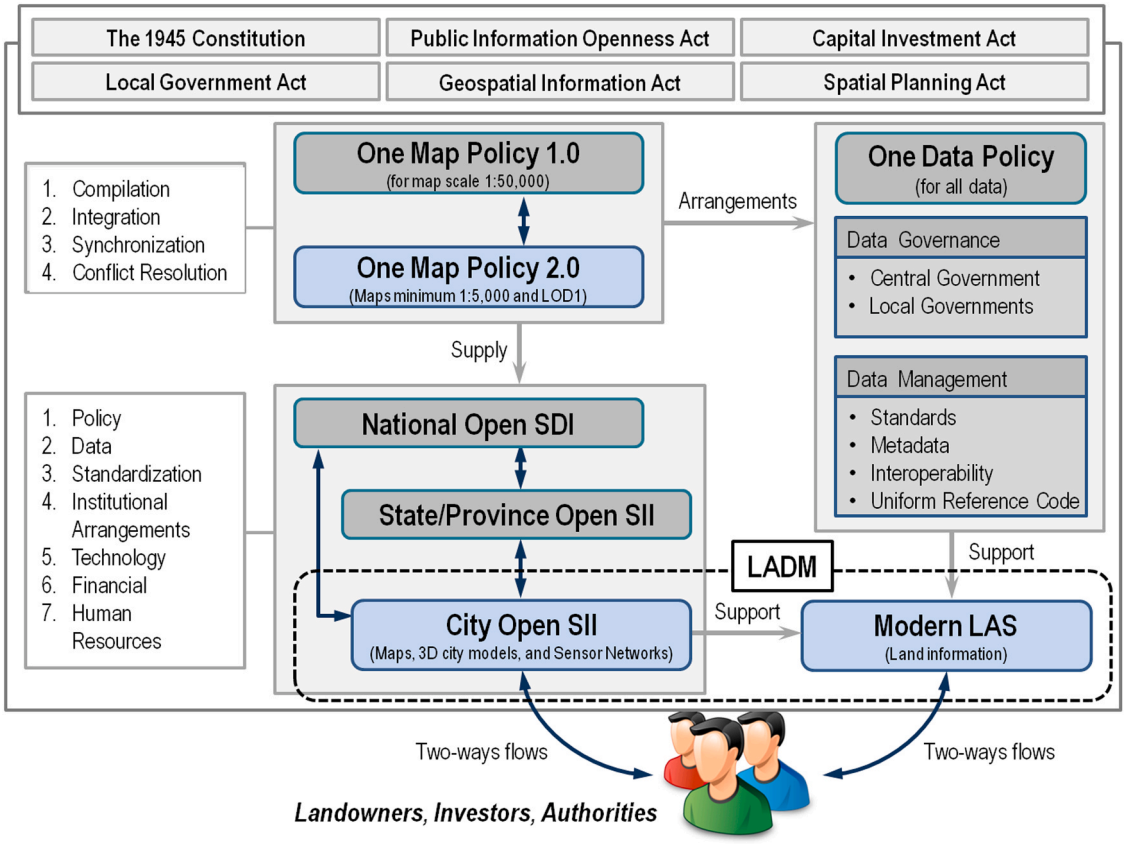


Fig. 11. Institutional rearrangement based on 'One Map' Policy and 'One Data' Policy for modernizing LAS in Indonesian cities.

participation and promotion of standardizations and institutional arrangements. On the other hand, the current 'One Map' Policy needs a realigned scope, allowing map production at a scale and Level of Detail (LOD) suitable for land management (Fig. 11). Both Jakarta and Bandung are organizing smart city projects and city level SII, facilitating a spatially enabled society to access land information that complies with open data principles. However, only the BPN Branch Offices are familiar with implementing the LADM country profiles in Jakarta and Bandung. Therefore, it is essential to extend LADM usage beyond land offices and cadastre communities, for example, to local government and planning communities. We assign three classes: LA_Right, LA_Restriction, and LA_Responsibilities, to accommodate different parties to maintain RRRs information according to their role (see Figs. 5, 7, and 11).

8.3. Technical aspect for managing and disseminating 3D spatial plan through the SII

The Spatial Planning regulation mandates Jakarta and Bandung to compile the zoning plan in 2D from the topographic map and aerial photogrammetric imagery at the scale 1:5000. However, a 2D representation is inadequate to support the OSS systems for issuing the construction permits prescribed in the Government Regulation World Bank's EODB guidance. Therefore, we propose that the zoning plan will be designed at least at a map scale of 1:1000 and LoD1 (with 3D representation) to support authorities better in issuing permits in the OSS and with the EODB's Dealing With Construction Permit. The proposals for a revised LADM standard is useful to enforce RRRs information interoperability and spatial representation. CityGML or IFC as standard for spatial data exchange is essential to be accommodated in SIIs. This study found that current geospatial technologies can provide two-way land information flows when economic actors can access and share relevant land information in land management. However, in Indonesia, regulations limit the provision of authoritative spatial information to government institutions. Therefore, non-government parties can only contribute attribute information into the database.

Using unstandardized land-use (urban) plans is technically challenging and time-consuming, particularly for the integration of information and analysis. The revised LADM for Indonesia is an approach to standardize the land-use plan of the two biggest cities of this country. The country profile developed can be implemented as the core task for modernizing LAS in cities to reduce information asymmetry between stakeholders in land management and improve the doing of business in Indonesian cities. The 3D web GIS prototype developed in our research is a proof-of-concept implementation for the updated LADM country profile and integration into SII components. Assessment of effectiveness and efficiency in the quasi-real context is required to improve the framework and share 3D RRRs to broader society. An experimental improvement in sharing two-way information using 3D RRRs information of our implementation is planned to be completed. Usability analysis of the improved prototype is being prepared for publication. This study is the first attempt to implement the SP Package of the proposed revision of ISO 19152 using two real land-use plans data: Jakarta and Bandung. Consequently, many improvements should be made, mainly integrating 3D cadastre with the 3D land-use (urban) plan for supporting permit systems, disaster management, environmental analysis, and fiscal cadastre (taxation, valuation, and transaction) studies.

9. Conclusion and recommendations

Information and technical interoperability are essential for allowing economic actors to share, integrate, and reuse land information to support participatory spatial planning activities. Indonesia's LADM country profile has been extended and improved using the proposals for a new SP Package for inclusion in LADM Edition II, emphasizing

interoperability to RRRs information and 3D spatial information. The 3D land-use (urban) plan and 3D cadastre will represent RRRs in 3D, what will be essential in cities. The recent advancement in a 3D spatial database and 3D visualization over the Internet allows cities to maintain their land-use (urban) plan and cadastre data in 3D and disseminate them to broader society. This study shows that the proposed SP Package could be implemented in land (or cadastre) agencies and local governments in a networked environment such as the Spatial Information Infrastructure. Information from the spatial (zoning) plan combined with RRR information is essential for any permit system. It contains information that can affect financial and legal impacts for authorities, landowners, and economic actors. Therefore, it is inevitable to have a standardized spatial plan to ensure interoperability with RRRs information.

Implementation of the SP information package will support the better-protected land market in two ways: by instructing data custodians to intensify *signaling* actions and by allowing users to perform *screening*. The performance of participation by (potential) stakeholders depends on transparency. Thus, a city could harness its society to be spatially enabled - where relevant land information is published based on open data principles. All stakeholders can share land information in two-ways flows. The World Bank's EoDB is the perfect example for countries to use international standards to facilitate more stakeholders globally and autonomously. A country may adopt the FAIR Guiding principles to ensure its LAS interoperability to enable users (human and machine) to reuse land information. A contemporary Spatial Information Infrastructure (SII) is in support of the maintenance of authoritative land information. However, in the Indonesian context, the legal framework allows society to contribute land information and contribute maps to the SII initiative. The 'One Data' Indonesia' (ODI) policy supports the land management paradigm vision and the modernization of LASs through data governance and data management. The SII has long advocated for facilitating relevant stakeholders in sharing and updating land information. Information asymmetry can be reduced with well-implemented interoperability between databases and with sharply increased transparency and accessibility. International standards are essential to guide countries and industries in making land information machine-readable and machine-actionable. Therefore, it is recommended to perform further research in information interoperability and implementation of open data in land management, mainly supporting ease of doing business. This study recommends that local governments provide an accurate Digital Terrain Model for the entire urban area using advanced 3D mapping technologies (i.e., LiDAR surveying techniques). The proposal for revising the LADM contains packages that can provide standardized information about people, land, and relationships. It is critical to fasten the revision process of the LADM to help countries better-utilize land information to improve their EODB rank. However, the proposed SP Package needs to be investigated for integrating land tenure and land-use planning, making it easier to support land valuation and land development activities (for example, issuing permits). Finally, we encourage countries to improve their LADM country profile by using packages from the proposed revision of the LADM. We also recommend further research on Open SII to facilitate stakeholders to share relevant land information.

CRediT authorship contribution statement

Agung Indrajit: Conceptualization, Methodology, Formal Analysis, Investigation, Resources, Writing - original draft, Visualization. **Bastiaan Van Loenen:** Conceptualization, Validation, Investigation, Data Curation, Writing - review & editing, Supervision. **Peter Van Oosterom:** Conceptualization, Validation, Writing - review & editing, Supervision. **Hendrik Ploeger:** Methodology, Validation. **Chrit Lemmen:** Validation. **Suprajaka:** Formal Analysis. **Virgo Eresta Jaya:** Formal Analysis.

Appendix A

See Tables A.1–A.6 here.

Table A.1
Specification of database of an land-use (urban) plan based on Minister of Agrarian and Spatial Planning/Head of BPN Number 14 of 2020.

Attribute Name	Attribute Code	Content
Object Name	**NAMOBJ**	the classification of order features in the regional spatial plan. The contents of local elements and / or derived elements in the province / regency / city that are not listed in the Regulation.
Types of Spatial Structure Plans	**JNSRSR**	the types of spatial structure plans that include the arrangement of service centers and infrastructure networks at BWP in accordance with the Regulation of the Minister of Agrarian and Spatial Planning / Head of BPN Number 16 of 2018
Element Name in Order 1	**ORDE01**	the classification of derived elements of order 1 types of spatial structure plans
Element Name in Order 2	**ORDE02**	the classification of derived elements of order 2 types of spatial structure plans
Zone code	**KODZON**	the code of zone used in the spatial pattern plan
Zone name	**NAMZON**	the name of zone in the spatial pattern plan
Sub zone code	**NAMZON**	the code of sub zone used in the spatial pattern plan
Sub zone name	**NAMSZN**	the name of sub zone in the spatial pattern plan
Block Code	**KODBLK**	the code of block used for a delimited plot of land at least by obvious physical limitations.
Sub Block Code	**KODSBL**	the code of sub block used for a delimited plot of land at least by obvious physical limitations
Administrative-District	**WADMKC**	the code of district - administrative area unit where the object is located
Administrative -Village	**WADMKD**	the code of village- administrative area unit where the object is located
Planning Area Section (BWP)	**NAMBWP**	the regional units that are part of the district / city and / or district / city strategic areas for which RDTR need to be compiled.
Sub Division of Planning Area	**NASBWP**	The part of the BWP that is bounded by physical boundaries and consists of several blocks.
Special Provisions		additional rules that are overlaid over a particular zone / subzone due to special things that require separate rules, consisting of:
	KKOP_1	1. Airport, including Aviation Operation Safety Zone (KKOP), Noise Area Boundary, and Areas around airports
	LP2B_2	2. Sustainable Food Agricultural Land (LP2B)
	KRB_03	3. Disaster Prone Areas
	TOD_04	4. Transit Oriented Area (TOD)
	TEB_05	5. Disaster Evacuation Sites include temporary evacuation areas and final evacuation sites
	CAGBUD	6. Cultural or Customary Conservation
	HANKAM	7. Defense and Security (Defense)
	PUSLIT	8. Research Center includes observatories, rocket launching sites
Zoning Arrangement Techniques	**TPZ_00**	the rules to overcome the rigidity of basic rules in the implementation of development, the number of columns depends on the number of TPZ in the city concerned.
Network Status	**STSJRN**	the status of the network which consists of a new network plan or development or existing condition
Prioritized BWP	**TEMAPP**	the handling theme which is the main program of each priority BWP sub
Data source	**SBDATA**	the source of the data from and the year the data was published

Table A.2
Type of Rights on Land Parcel/Space in Indonesia.

No.	Type	Definition
1	Ownership Rights (*Eigendomrechts*) *	Rights of ownership are hereditary rights and are the strongest, and the fullest right one can have on land that may be possessed by an Indonesian citizen. This right may go over to and transferred to another party.
2	Exploitation Rights (*Erpachtrechts*) *	Rights to cultivate the land which is directly controlled by the State for a period of time. This right is typical in farming, plantations, fishing, or cattle-raising, which may go over and be transferred to another party. The validity of the exploitation rights is for periods of 25 or 35 years and can be further extended for another 25 years based on the formal assessment.
3	Building Rights *	Rights to construct and to own buildings on the land, which is not one's property for a period of not longer than 30 years.
4	Rights of Use *	Rights to use and collect the product from land is directly controlled by the State or land owned by other persons who give the privileges and obligations designated in the decision upon granting this right by the authority, or in the agreement to work the land,
5	Rights to lease *	Rights to lease land with lawful payment.
6	Rights of opening-up land of collecting forest product *	Rights opening-up land and of collecting forest products by Indonesian Citizens or Government Regulation.
7	Rights of using water, for breeding and catching fish.	Rights to obtain water for a specific purpose and to flow it over another person's land.
8	Rights of using air space *	Rights of using air space authorize the utilization of energy and elements in the air space to maintain the developing the fertility of the earth, water, and natural resources contained therein and other matters relating to it
9	Rights on land for religious and social purposes *	Rights of ownership on the land of religious and social institutions for social and religious purposes.
10	Pawn Rights	Rights of control and exploit land belonging to another person, who has received a mortgage until the mortgage is returned.
11	Rights of Profit-Sharing *	Rights to profit-sharing on land owned by another person based on an agreement between parties.
12	Rights of lodging (*Opstalrechts*) *	A type of right to authorize a person to establish or occupy a building or land owned by another person based on trust or an unwritten agreement.
13	Strata title **	The ownership rights of an apartment unit include joint ownership of public space in a building complex. The strata title concept separates rights from several strata or levels, namely the rights to the land surface, the earth below the ground, and the air above it.
14	Easement Rights ***	Rights are benefiting property or a piece of land that is enjoyed over another piece of land owned by somebody else.
15	Rights of way ***	Rights to pass along the way over property owned by another party.
16	Rights to propose ***	Rights to propose consideration on determining the direction of development;
17	Rights to clarify ***	Rights to identify the potentials and impacts from development, including rights to clarify access and benefiting from land, space, and spatial planning
18	Rights to object ***	Rights to spatial object plan and the implementation of the spatial plan

Table A.3
Type of Restrictions on Land Parcel/Space in Indonesia.

No.	Type	Definition
1	Building Boundary Line (*GarisSempadanBangunan*/GSB) ***	A line that limits the minimum clearances from the outermost side of a building mass to the boundary of the controlled land. The building boundary line is functioned as a space divider, or the minimum clearances from the outermost plane of a building mass to the land parcel, river or beach boundary, between the mass of another building or channel plan, high voltage electricity network, gas pipeline network, and so forth.
2	Building Floor Coefficient (*KoefisienLantaiBangunan*/KLB) ***	The basic ratio criteria between the total floor area of the building and the area of land parcel allowed to be built.
3	Building Base Coefficient (*KoefisienDasarBangunan*/ KDB) ***	The percentage ratio between the total area of the ground floor of a building and the area of land parcel allowed to be built
4	Green Base Coefficient (*KoefisienDasarHijau*/ KDH) ***	The percentage ratio between the total area of open space outside the building intended for landscaping /greening and a land parcel by the spatial plan and building and neighborhood plans.
5	Basement Site Coefficient (*KoefisienTapakBasement*/ KTB) ***	The ratio (percentage) between the basement and land plot/planning area (regulated by the spatial plan and building and neighborhood plans).
6	Built-up Area Coefficient (*Koefisien Wilayah Terbangun*/KWT) ***	The ratio (percentage) between the area of built-up blocks (allotment) with the total unconstructed allotment within the planned area.
7	Building Density (*KepadatanBangunan*) ***	The percentage ratio between the area of built-up blocks (allotment) with the total planned area.
8	Zoning regulations ***	The provisions governing the use of space and control mechanisms for each zone by the detailed spatial plan.

Table A.4
Type of Responsibilities on Land Parcel/Space in Indonesia.

No.	Type	Definition
1	Protect the environment and ecosystem[a]	To maintain the preservation of environmental functions and to prevent and overcome pollution and destruction.
2	Provide information about environmental management[a]	To provide correct and accurate information regarding environmental management performed in specific land owned or controlled.
3	To utilize land parcel within schedule prescribed in the zoning regulation[b]	To utilize or perform an activity on a land parcel or space according to zoning regulation
4	Compliance with permitting[b]	To utilize or perform an activity on a land parcel or space according to permit.
5	Maintain and improve the quality of land or space[a]	To perform a necessary activity in maintaining or improving the quality of land or space owned or controlled and public space.

*Basic Agrarian Principle Law (1960); **) Apartment Law (1985);
[a] Environmental Management Law (1997)
[b] Spatial Planning Law (2006); and

Table A.5
Zoning class in Bandung City (Bandung City Regulation on Detailed Spatial Plan and Zonation 2014).

Code	Zoning name (Indonesia)	Zoning name (English)
LB	Zona Perlindungan Kawasan Bawahannya	Zone Protected Subordinate Area
PS	Zona Perlindungan Setempat;	Zone Local Protection
PS.1	Sub Zona Sempadan Tol	Zone Toll Road Border
PS.2	Sub Zona Sempadan Jaringan Jalan	Sub Zone Road Network Borders
PS.3	Sub Zona Sempadan Rel Kereta Api	Sub Zone Railroad Border
PS.4	Sub Zona Sempadan Sungai	Sub Zone River Border
PS.5	Sub Zona Sempadan Jaringan SUTT/SUTET;	Sub Zone High Voltage Border
PS.6	Sub Zona Sempadan Sekitar Danau Buatan;	Sub Zone Artificial Lake
PS.7	Sub Zona Sempadan Bandara.	Sub Zone Airport
RTH	Zona Lindung Alami	Sub Zone Natural Protection
RTH.1	Sub Zona Ruang Terbuka Hijau (RTH) Publik	Sub Zone Open Green Public
RTH.1.1	Sub-sub Zona RTH Taman Unit Lingkungan	Sub Zone Neighborhood Public
RTH.1.2	Sub-sub Zona RTH Pemakaman	Sub Zone Cemetery
RTH.1.3	Sub-sub Zona RTH Hutan Kota;	Sub Zone Urban Forest
RTH.1.4	Sub-sub Zona RTH Pelestarian Alam	Sub Zone Natural Conservation
RTH.1.5	Sub-sub Zona RTH Perlindungan Plasma Nutfah	Sub Zone Germplasm Protection
RTH.2	Sub Zona RTH Privat;	Sub Zone Open Green Private
BCN	Zona Rawan Bencana	Zone Disaster Risk
R	Zona Perumahan;	Zone Residential
R.1	Sub Zona Perumahan Kepadatan Tinggi	Sub Zone Residential - High
R.2	Sub Zona Perumahan Kepadatan Sedang	Sub Zone Residential - Medium
R.3	Sub Zona Perumahan Kepadatan Rendah	Sub Zone Residential - Low
K	Zona Perdagangan dan Jasa	Zone Commercial and Service
K.1	Sub Zona Perdagangan Pasar Tradisional;	Sub Zone Traditional Market
K.2	Sub Zona Pusat Perdagangan dan Jasa;	Sub Zone Central Commercial and Service
K.3	Sub Zona Perdagangan dan Jasa Linier	Sub Zone Commercial and Service Linier
C	Zona Campuran;	Zone Mixed
C.1	Sub Campuran Tinggi	Sub Zone Mixed - High
C.2	Sub Campuran Sedang	Sub Zone Mixed - Medium
KT	Zona Kantor Pemerintahan;	Zone Government
I	Zona Industri dan Pergudangan;	Zone Government
W	Zona Wisata	Zone Tourism
SPU	Zona Sarana Pelayanan Umum (SPU)	Zone Public Service and Facility
SPU.1	Sub Zona SPU Pendidikan	Sub Zone Public Facility - Education
SPU.2	Sub Zona SPU Kesehatan	Sub Zone Public Facility - Health
SPU.3	Sub Zona SPU Peribadatan	Sub Zone Public Facility - Religious
SPU.4	Sub Zona SPU Olahraga	Sub Zone Public Facility - Sport
SPU.5	Sub Zona SPU Transportasi	Sub Zone Public Facility - Transportation
SPU.6	Sub Zona SPU Sosial Budaya	Sub Zone Public Facility - Cultural
HK	Zona Pertahanan dan Keamanan	Zone Military and Security
PL	Zona Pertanian	Zone Farming
KH	Zona Khusus	Zone Special
KH.1	Instalasi Pengolahan Air Limbah	Sub Zone Special - Waste Water Processing
KH.2	Pengolahan Sampah	Sub Zone Special - Solid Waste Processing

Table A.6
LandUse class in Jakarta (Jakarta Regulation on Detailed Spatial Plan and Zonation 2014).

Code	Zoning name (Indonesia)	Zoning name (English)
L1-L3	Zona Lindung	Zone Protection
H1	Zona Hutan Kota	Zone Urban forest
H2	Zona Taman Kota/Lingkungan	Zone Park
H3	Zona Pemakaman	Zone Cemetery
H4-H6	Zona Jalur Hijau	Zone Green corridor
H7	Zona Hijau Rekreasi	Zone Green and Recreation
H8	Zona Terbuka Hijau Budidaya di Wilayah Pulau	Zone Open Green Cultivation
P1	Zona Pemerintahan Nasional	Zone Government - national
P2	Zona Pemerintahan Negara Asing	Diplomatic zone
P3	Zona Pemerintahan Daerah	Government - local
R1	Zona Perumahan Kampung	Residential - kampoong
R2-R6	Zona Perumahan Koefisien Dasar Bangunan (KDB) Sedang-Tinggi	Residential - vertical medium density
R7-R8	Zona Perumahan Vertical	Residential - vertical
R9	Zona Perumahan KDB Rendah	Residential - low density
R10	Zona Perumahan Vertical KDB Rendah	Residential - vertical low density
R11	Zona Perumahan di Wilayah Pulau	Residential on Island
K1-K2	Zona Perkantoran, Perdagangan, dan Jasa	Business, commercials and services
K3-K4	Zona Perkantoran, Perdagangan, dan Jasa KDB Rendah	Business, commercials and services - Low density
K5	Zona Perkantoran dan Jasa di Wilayah Pulau	Business and services on Island
C1	Zona Campuran	Zone Mixed
S1-S7	Zona Pelayanan Umum dan Sosial	Public and social services
I1,G1	Zona Industri	Industry
B1	Zona Terbuka biru	Open space blue
PP1	Zona Konservasi perairan	Reclamation zone
PP2	Zona Pemanfaatan umum perairan	Open space blue

Appendix B

See Fig. B.1 and Table B.1 here.

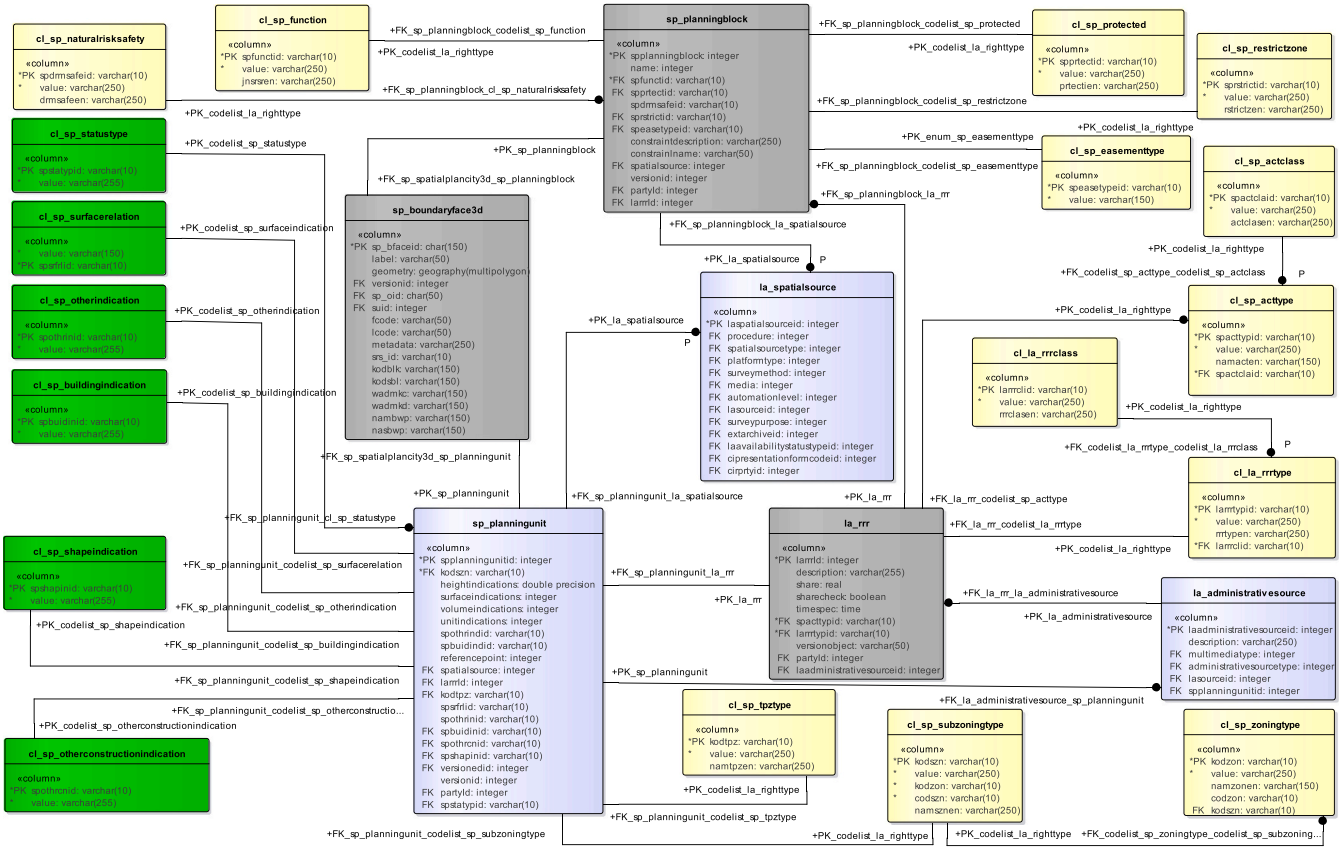


Fig. B.1. Entity Relationship Diagram of Spatial Plan Information Package within ISO 19152:2012.

Table B.1
Sample of allowable activities as Restriction based on Ministry of Spatial Planning Regulation (2020).

ACTTYPID	NAMACT	NAMACTEN
1.1	Rumah tunggal	Single house
1.2	Rumah kopel	Pair housing
1.3	Rumah deret	Row housings
1.4	Townhouse	Townhouse
1.5	Rumah susun kepadatan rendah	Low density vertical housing
1.6	Rumah susun kepadatan sedang	Medium density vertcial housing
1.7	Rumah susun kepadatan tinggi (Apartemen)	High density housing (Apartment)
1.8	Asrama	Dormitory
1.9	Wisma	Executive guesthouse
1.1	Rumah kost	Boarding house
1.11	Panti jompo	Nursing home
1.12	Panti asuhan dan yatim piatu	Orphanage
1.13	Guesthouse	Guesthouse
1.14	Apartemen rakyat	People apartment
1.15	Rumah dinas	Official residence
1.16	Pusat rehabilitasi	Rehabilitation centes
1.17	Rumah Sangat Kecil	Very small house
1.18	Rumah Kecil	Very house
1.19	Rumah Sedang	Medium house
1.2	Rumah Besar	Large house
1.21	Rumah Flat	Flat
1.22	Rumah Susun Umum	Vertical housing
1.24	Paviliun	Pavilion

Table B.1 (*continued*)

ACTTYPID	NAMACT	NAMACTEN
2.1	Warung	Shop
2.2	Toko	Store
2.3	Pertokoan	Shoping center
2.4	Pasar tradisional	Traditional market
2.5	Pasar lingkungan	Local market
2.6	Penyaluran grosir	Wholesale Distribution
2.7	Pusat Perbelanjaan atau Mall atau Plaza	Shopping Center or mall or plaza
2.8	Hypermarket atau Pasar Modern	Hypermarkets or modern markets
2.9	Minimarket	Minimarket
2.1	Toserba	Department store
2.11	Supermarket	Supermarket
2.12	Pedagang kaki lima	Street vendors
2.13	Jasa bangunan	Building contractors
2.14	Lembaga keuangan	Financial institutions
2.15	Jasa komunikasi	Communication Services
2.16	Jasa pemakaman	Funeral Services
2.17	Perawatan atau perbaikan atau renovasi barang	Maintenance servicesor repairers or renovators
2.18	Bengkel	Workshop
2.19	SPBU dan SPBG	Gas stations and natural gas stations
2.2	Penyediaan ruang pertemuan	Provision of meeting rooms
2.21	Kantin	Canteen
2.22		Food and beverages or catering

(*continued on next page*)

Table B.1 (*continued*)

ACTTYPID	NAMACT	NAMACTEN
	Penyediaan makanan dan minuman atau katering	
2.23	Travel dan Pengiriman Barang	Travel and logistics services
2.24	Pemasaran Properti	Property marketing
2.25	Biro Perjalanan Wisata	Travel bureau
2.26	Ekspedisi dan pengiriman barang	Expedition and logistics
2.27	Warnet dan game center	Internet cafe and game center
2.28	Penginapan hotel	Hotel
2.29	Penginapan losmen	Inns
2.3	Penginapan homestay	Homestay
2.31	Pangkas rambut atau salon atau salon kecantikan	Barbershop or salon or beauty salon
2.32	Laundry	Laundry
2.33	Tukang jahit	Tailor
2.34	Penitipan hewan	Animal care

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