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Project Report

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A Blended Learning Course Design in Fit for Purposes' Cadastral Survey

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Executive Summary

Fit For Purpose (FFP) Land Administration has been tested and implemented world wide. Although there has been a comprehensive implementing guidelines available (Enemark, McLaren and Lemmen, 2015), finding the really fit land registration method suitable for a country context is not easy. Managing the financial, political, legal and administrative risks associated with large-scale registration campaigns are crucial. Indonesia's current progress on land registration program provides a good context to try out how quality, cost, and speed of land administration services should be accelerated extending stakeholder interaction. Under the current legal and institutional framework, systematic land titling activities from village to village are impossible without a complete cadastral map and same time-same place participation from communities and government officers. A combination of modern survey techniques and community participation applying Fit for Purposes (FFP) Land Administration principles will accelerate and assure the quality of the land registration.

Unfortunately, a capacity building to shift the paradigm from a top-down traditional cadastral survey and mapping into a bottom-up modern cadastral survey for accelerated land registration lacks in the country. The project developed a set of learning materials applying blended learning practices in FFP Cadastral Survey (FFP-CS) for both in-house students, surveyors and para surveyors (i.e. local representatives in the community) across the country. The project developed course objectives, student outcomes and teaching materials of FFP-CS. The training module has been developd accordingly with the focus on the cadastral data quality improvements. The publications have been successfully produced with the full support from the grant. The author as the grantee would like to thank for the Aubrey barker Fund and FIG support.

Foreword

This report provides summary, background, implementation and evaluation results as well as lessons learnt in regard to implementation of Aubrey Barker Fund/FIG Course Development Project. The report was created by the grantee, Trias Aditya from UGM that has been granted by FIG/The Aubrey barker Foundation to run the project. Right after the initial grant disburesements, the global pandemi was disrupting the field activities and travel plan. As national and local governments restrict face-to-face meeting and traveling, the crisis affected the project implementation and delayed outputs. From 2020 till 2022, despite there were so many uncertainties in regard to this project, some project activities including the literature study, survey & field visit, teaching material development and preparation of a publication have been done successfully. In responding to the grant situation, some adaptation strategies in conducting assessments and collecting feedback were done. Finally, the project has produced two types of outputs: training materials (book and videos) and publication papers (FIG working week papers, book chapter, magazine article). As the grantee, I thank Aubrey Barker for their financial support for this research project. I would like to express my sincere gratitude to Louise Friis-Hansen from FIG for her great help in bridging the grantee with the Foundation and for her full support during the project. I would also like to thank colleagues from Land offices of Surabaya, Pontianak, Jakarta and Denpasar for their support during this project. Many thanks also go to my colleagues Purnama Budi Santosa, Nurrochmat Widjajanti, Yulaikhah and Dedi Atunggal as well as our assistants: Miranty, Ali and Febriyan, who have contributed to the development of training materials. I hope the report will give benefits to acceleration of fit for purposes land registration processes and showcases.

August 2024,

Trias Aditya

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Chapter 1 A Blended Practices of Fit for Purpose Cadastral Survey

1.1. Introduction

Spatial and non-spatial data collection for systematic land titling projects are often considered challenging tasks. It is not easy for local land offices to collect the required documents and to verify the registration documents in the field. Under the current legal and institutional framework, systematic land titling activities are procedurally demanding and rigid, requiring active participation from communities, village and government officers. Actually, such a challenge also has been critical to many countries wish to complete theor first land titling. That situation is owing to an uncoordinated and sporadic registration system activities in the past. In Indonesia, since 2017, a new land policy has been implemented under a project to completely and systematically register land titles across villages in the country. This new policy has increased the production of land titles by seven times. However, the approach remains focused on increasing quantity rather than improving quality. Fit for Purposes Land Administration (FFP LA) principles aim to accelerate land registration activities applying spatial, institutional and legal frameworks, and also call for incremental improvement (FIG, 2014). FFP best practices have been tested, if not implemented, world-wide (Enemark, McLaren, & Lemmen, 2015) see also (Barry 2018).

FFP has been tested and implemented world wide. Although there has been a comprehensive implementing guidelines available (Enemark, McLaren and Lemmen, 2015), finding the really fit land registration method suitable for a country context is not easy. Managing the financial, political, legal and administrative risks associated with large-scale registration campaigns are crucial. A standardised planning and monitoring framework for registration and maintenance cost, time and quality indicators is needed. Such a standardised planning and monitoring framework would also allow comparative studies to be made. However, such a framework does not yet exist (Persha *et al.*, 2017).

A combination of modern survey technology and community participation will accelerate and assure the quality of the progress. Unfortunately, a capacity building to shift paradigm and practices from a top-down traditional cadastral survey and mapping into a bottom-up modern mobile cadastral survey for an accelerated land registration has not been developed well in the country. The Department of Geodetic Engineering of Universitas Gadjah Mada (UGM) that has been internationally accredited by Engineering Accreditation Commission (EAC) of ABET can play a critical role to fill the gap.

The conventional approaches in land registration encompassing mandatory delimitation, demarcation and registration of land boundaries are still expensive and difficult to complete due to either ownership disputes or low owner participation. As seen in the case of Indonesia land registration: under President Joko Widodo administration, it is targeted that

more than 50 million parcels are yet to be registered before 2025. The current results still expose inefficient boundary demarcations, leading to undertitling and over demarcation (Arruñada, 2018). To overcome this, the National Land Office launched com-munity-based land registration projects that aim at optimizing the role of para surveyors to help the local land office collect legal and boundary data; a method refers to Fit for Purpose (FFP) principles (Enemark et al., 2015). Unfortunately, ownership disputes are still high, and landowner participation is low. This work enhances the FFP LA principles with the use of AR and VR devices to leverage a collaborative environment for land registration practices.

An FFP principle that suggests “aerial imageries rather than field surveys” seem facing rejections by many village landowners. As landowners feel more secure with agreed visible boundaries, this research sees a mix of AR and VR as a promising collaborative survey tool to help para-surveyors collaborate with local offices to accelerate the demarcation of disputed land boundaries. As envisioned by (Enemark et al., 2015), a FFP Land Administration would accommodates affordable modern technologies, and this research would provide initial findings in utilizing the technologies for FFP-LA use cases. In this regard, utilization of state-of-the-art technologies for such purposes is spearheading smarter land administration as shown in some previous use cases (De Vries et al., 2020).

This project aims to develop a possible solution for surveyors and government officers to work with geovisualization systems with digital environment and map-based displays to facilitate different-time different-place interactions for enabling land registration services beyond conventional same-time same-place interactions currently run by land offices. The work aims to provide safe interactions and to support field workers and decision-making groups to reach fast and effective collaborative decisions on boundary mapping.

AR/VR devices on top of a game engine are frontiers in building construction (Edwards et al., 2015; Natephra et al., 2017), urban planning (Alatalo et al., 2017) and archaeology reconstruction (Rua & Alvito, 2011). This research uses Unity3D game engine for creating a multi-platform 3D map visualizations from mix sources of OpenStreetMap (OSM) and cadastral maps. This research will connect the apps build by the game engine with a GPS antenna to enable accurate field positioning. Mapbox for Unity is used to provide supports on georeferencing 3D objects and to provide AR functions to create Mixed Reality experiences. The research will develop two case studies of land demarcation in urban wards. A usability test on the 3D visualization and interactions will be conducted to assess usability acceptances of boundary demarcations in a rural and urban setting using a game engine as a platform.

Section 2 will describe the background theory and methods implemented to develop the application. Section 3 will present the results of a mixed reality environment where para-surveyors and adjacent landowners work from the field, landowners from their private places and government surveyors work from the office. It will evaluate and assess how an effective and efficient AR/VR technology for supporting boundary de-marcation and adjudication will increase the quality and completeness of land regis-tration. Additional information (3D

models and relevant information visualization on land values, zones and other related restrictions and responsibilities) will also be added to complete a comprehensive boundary survey and mapping, sought to be validated by landowners and related stakeholders. Section 4 discusses the findings, and Section 5 draws conclusions.

1.2. Objective

The project will design and implement a blended learning course in the area of modern cadastral survey and mapping, designed for undergraduate students and para surveyors (local representatives in the community) in remote villages who are involved by local land offices in participatory data collection for fit for purposes Land Administration projects in the country.

1.3. Background

1.3.1. PTSL Successes and Challenges

PTSL (*Pendaftaran Tanah Sistematis Lengkap*) is a government program dealing with systematic land title registration to all unregistered land parcels in a village in Indonesia. The land registration activities cover survey, mapping, registration and certification of all land parcels in a village. As in one village there can be lands that have been certified previously, the mapping should also deal with boundaries of registered land parcels in order to create a complete representation of land ownership boundaries in the village. It was officially laundged by the government in 2017.

For surveying and mapping land parcels, a special task force consisting government surveyors or licensed surveyors are mandated to collect boundary data. In paralel to that team, a juridicial team is deployed to collect and verify the legal data concerning landowner identity and underlying ownership data from landowners. Juridical teams are land office employee assigned by the head of land office. The standards and procedures in relation to technical implementation and budget have been officially assigned by Ministry of ATR/BPN. PTSL can be seen as a government initiated national land certification program. The steps that form PTSL activities in every village can be structured as: determination of PTSL location, boundary data and legal data collection, data processing that include legal data verification and validation and certification.

Based on the government data, it is claimed that PTSL has been a massive success. In 2016 when the project has not been started, there was 86 million out of in total 126 million land parcels that are not registered or titled. In 2024 it is reported that more than 110 million parcels have been mapped and titled. The government also acknowledges that there are still big challenges in plotting valid certificates that are not with maps or unknown their locations. In total there are more than 15 million certificates that are still yet to be mapped. Along with data maintenances (e.g. land transfers, subdivisions, mortgage application), these floating titles could be solved when land owners or their descendants visit local land offices to apply for land administration services. However, these can also

be seen as the gap to assure title certainties to all land parcels. Data quality improvements through Kota Lengkap (Complete City) program have been implemented to strategically handle the issue.

The current advancements in land registration in Indonesia is the implementation of Sertel (electronic certificates) which transform new registration and maintenances of land parcels into digital certificates not as paper certificates anyomore. The policy has been implemented nationally starting from December 2023. For realizing the potential values of completeness of land registration, the blended survey and mapping activities for supporting land administration services for new titiling and services (subdivision, right transfers) are seen as critical strategies to improve efficiency and effectiveness for users in land administration services. The blended survey activities are done using online and extended reality tools for AR and VR.

1.3.2. Blended Learning and Practices for Survey and Mapping in Land Registration Services

This project aims to develop a learning platform applying blended learning practices (Amanda G. Madden, Lauren Margulieux, 2019). It will facilitate both ‘same-time different-place’ and ‘different-time different-place’ types of interactions for both in-house students and para surveyors across the country enrolled in the program of Fit for Purposes Cadastral Survey (FFP-CS). In the first year, the project will compile best practices of implementing cadastral survey and mapping in villages to define user requirements, course objectives and student outcomes of a new course, FFP-CS. The design will utilize existing course objectives and outcomes, including: Cadastral Survey, Data Quality Improvements, Design and Management of Land Information, Land & Property Information Systems. The development of student outcomes and teaching activity plan will involve The National Land Agency as the main collaborator. In the second year, the project will finalize teaching materials, a collaborative course and assessment together with The National Land Agency and the Indonesia Surveyor Association (ISI).

Chapter 2 Implementation

From the planned of 20,000 UK Poundsterling (according to the grant call back in 2019), the grant disbursements were received by the grantee of 15,000 EUR into two batches (Batch I : 2020 of 5,000 EUR and batch II: 2022 of 10,000 EUR). The pandemic crisis of COVID-19 started right after the Grant announcement in late 2019. That condition made national and local governments restricted face-to-face meeting. Thus, it was in fact affected the project implementation and outputs. The implementation can be divided into three main activities: Field Observation and Visit,

2.1. Field Observation & Visit

The land offices chosen are: Denpasar & Bangli, Surabaya, Batam and Jakarta. Only Bangli is rural city, whereas the other offices located in urban areas. The selection is merely based upon the completeness of land registration progresses in the areas.
The stakeholders involved in the project can be seen in **Figure 2. 1.** The grant impe

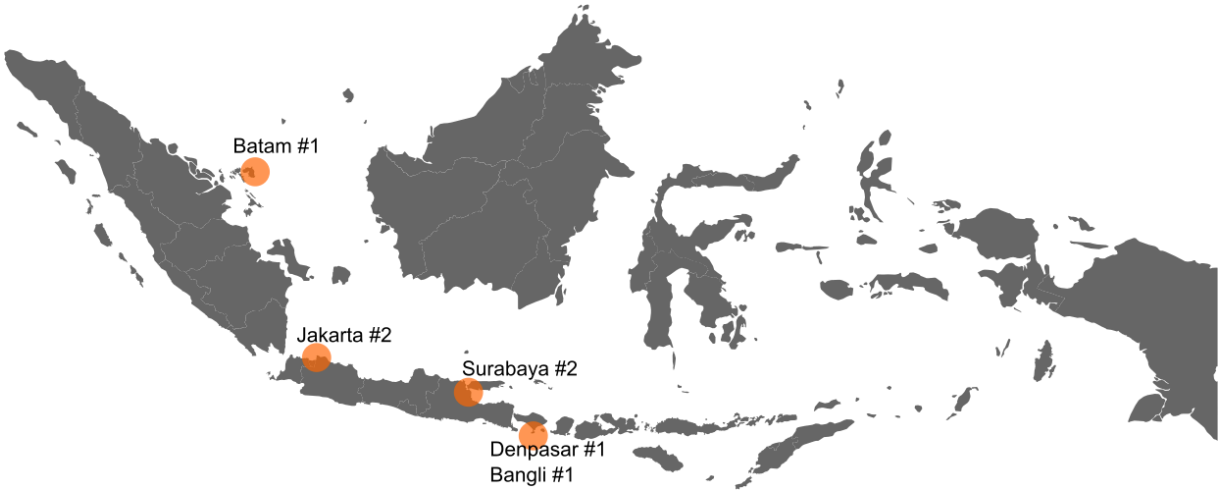

Figure 2. 1. The field visit and stakeholders involved in the project for Batch I (2020-2022) and Batch II (2022-2023)

The field observation and visit in study areas are specified in a matrix **Table 2. 1** as a follow.

Table 2. 1. Field visit scope

Where	Topics of Survey & Mapping in LAS	Learning Needs for LAS	Materials to adapt LAS
Denpasar (2019) and Bangli (2020)	Community-based Land Registration Committee (CLRC) as Facilitator in Participatory Land Registration	Training sessions in Socialization, community mapping in Legal/Boundary Data Collection, field mapping activities in	Participatory Land Registration

Where	Topics of Survey & Mapping in LAS	Learning Needs for LAS	Materials to adapt LAS
		Boundary Data Collection and Data Processing	
Batam (2020), Surabaya (2022), Jakarta (2022-2023)	Cadastral quality improvements: Forensic Cadastre and Block Adjustments		Cadastral data quality improvements
Jakarta (2022)	Same Time – Different Place Stakeholder's interaction with AR/VR for improved land registration services		Advancing the Survey and Mapping Practices for Land Registration

In regard to Systematic and Complete Land Regsitrtation (PTSL) and Participatory Land Registration observation and course developments, the workflow adapted from earlier in the project the PaLaR (2018) done by Kadaster NL and ATR/BPN is presented in The Figure 2.2.

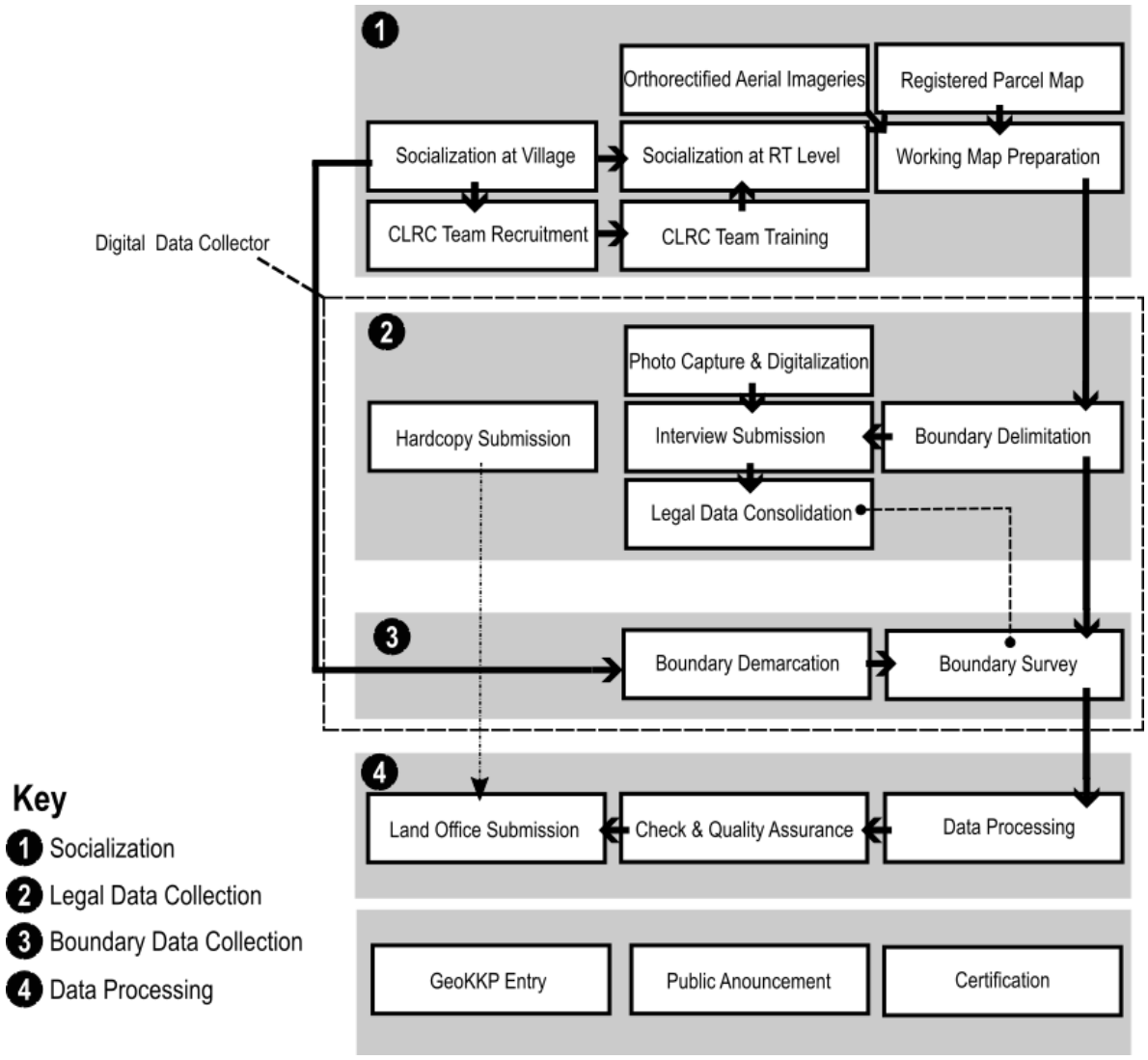

Figure 2. 2. The intended participatory land registration workflow from PaLAR project adopted into the national land registration system (PaLAR 2018 in Aditya et. al. 2020)

Socialization, spatial and administrative data collection are still important components in Land Registration. As seen in World Bank-supported PTSL implementation in 2021 till 2022, participatory land registration has been among influential factors that contribute to the successfullness of PTSL project, especially in mapping nearly all land parcels of the country. The participatory approach was firstly implemented in rural areas adjacent with forest areas in Financial Year (FY) 2021. Subsequently, the participatory approach and integrated mapping in FY 2022 and FY 2023. During the field visits especially in Denpasar and Bangli Land Offices in the Bali Province (2020-2021), the introduction of community-based land registration committee can be seen very influential for the success of land registration progresses.

During the field visits in land offices in metropolitan and urban areas (2022), the focus has been in the topic of cadastral data quality improvements. The topic of quality improvements

becoming very important along ith the significant increases of land parcels' mapping and registration in Indonesia. Approaching the completion of land mapping and registration of 126 million's land parcels, the government finds and considers that issues of data quality including floating registered/certified parcels and overlapping land parcels should be amended along with chasing the completion of first titling to all land parcels in the country. The procedure for quality improvements is presented in Figure 2.3.

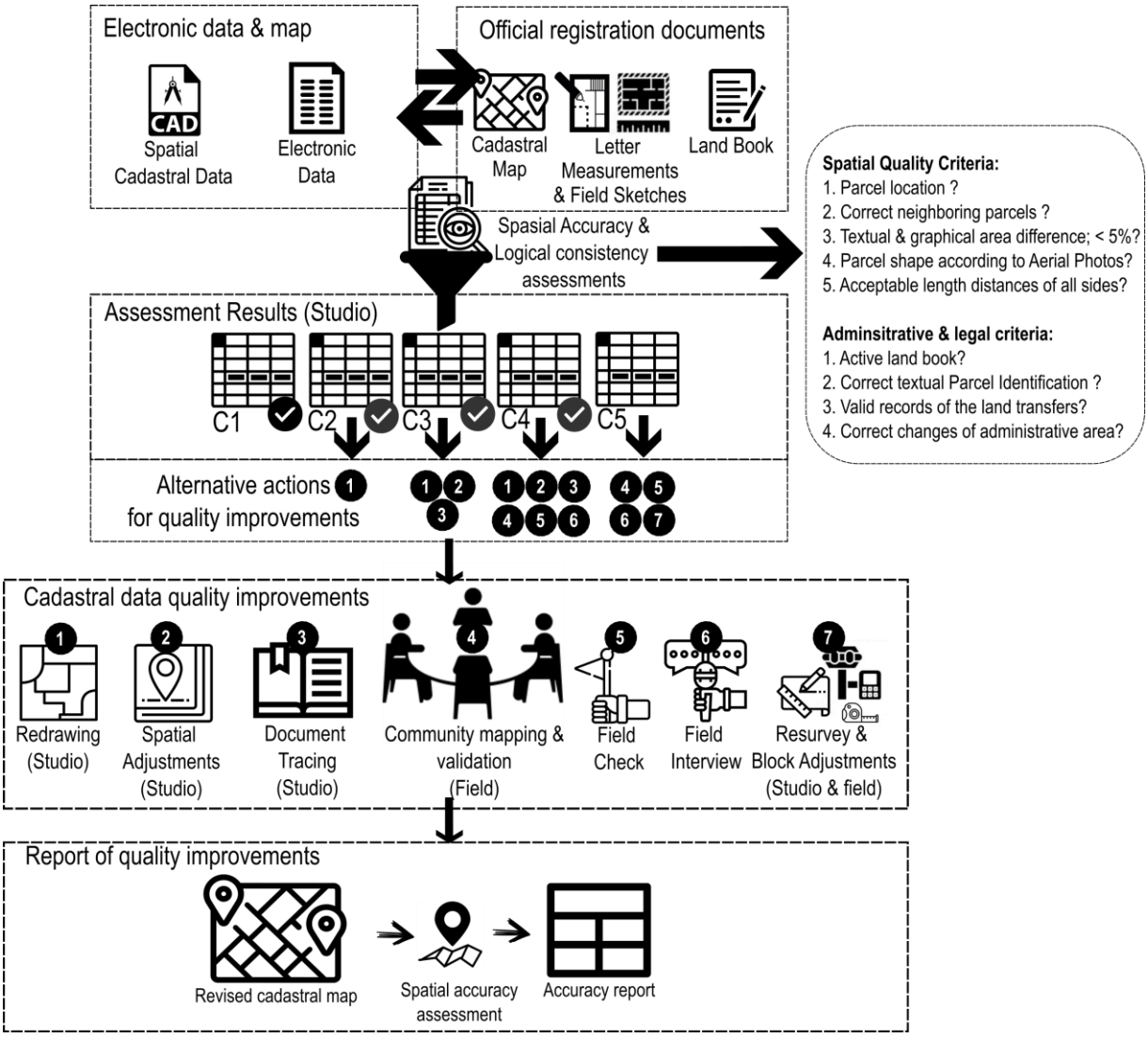

Figure 2. 3. The workflow of data quality improvements (modified from Aditya et. al. 2021) which is adopted by The Ministry in their PTSL Technical Guidance.

The workflow is made based upon the existing procedure produced by the Ministry of ATR/BPN and improvised from the on going research results done by the author. At the same time, during the FY 2021 and 2022 where the field visits were dupoorted by the grant, the author was asked to be the resource person for providing insights and comments to the development of the PTSL's technical guidance. In fact, many materials used in the PTSL

guidance were adopted from technical reports related to quality improvements by the author and the colleagues from the Department of Geodetic Engineering UGM.

2.2. Research & Data Processing

2.2.1. Data Quality Implementation

The observations and research activities of data quality improvements were done in order to be able to develop training materials about cadastral data improvements.

2.2.2. Block Adjustments

Special attention has been given to the development concept of Forensic Cadastre for tracing and tracking past and present transactions, documents, maps in order to plot flying or floating land parcels. IN addition to that, together with the colleagues in Surveying Lab, the author developed a plugin software with QGIS to help field survey data and existing cadastral map to be integrated for an improved cadastral map. The common quality profile of land offices in Indonesia is Level 0 (Island or sporadic mapping) and Level 1 (Rubbersheeting). This rubbersheeted level has been common to local land offices after the implementation of PTSL (The national's systematic land registration project since 2017).

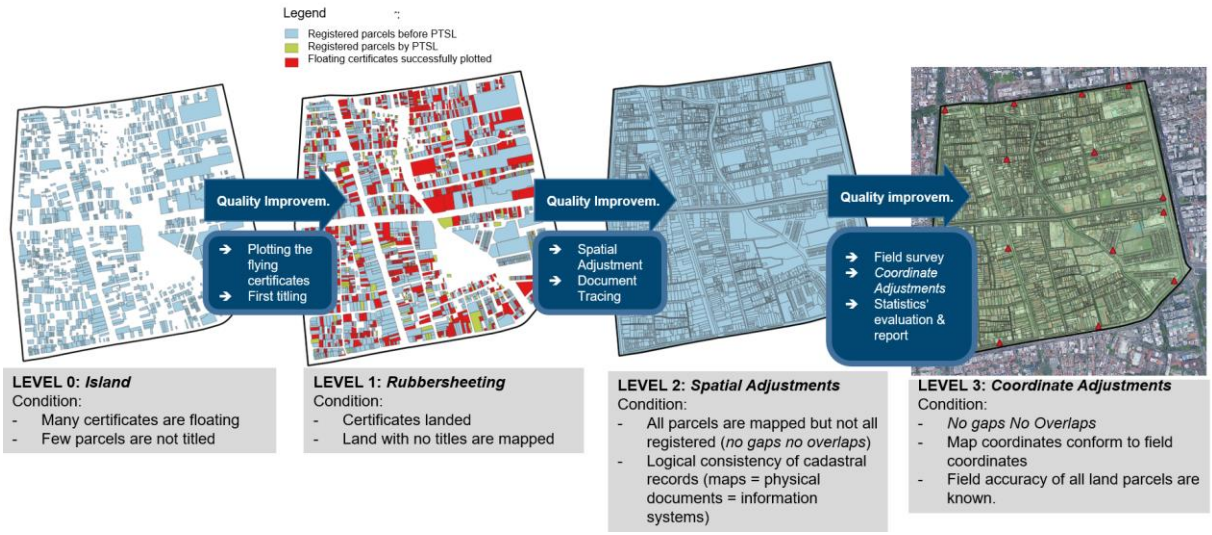

Figure 2. 3. Ladders of quality levels in cadastral data (from sporadic cadastral mapping of level 0 till systematic and accurate cadastral mapping of level 4)

2.2.3. Field Visits and AR/VR Exploration

Boundary data collection is mandatory done by same-palce same-time interactions in the current land registration services. Here, each landowner was asked to show their corresponding land parcels by drawing the land boundaries on the tablet (Figure 2.5). Each landowner showed point boundaries that have been marked with pillars adjacing to neighbouring land parcels. This requirement is applied mostly for fiert titling but also to

data maintenance (e.g., transfers because of sell-buy reason, subdivision) and also quality improvements (boundary resurvey, field interview). The advantages of Virtual Reality (VR) to bridge same time – different places interactions has also been thought by the government.

Figure 2. 4. Boundary point measurement with GPS by CLRC Team

Joint activity of field survey of point boundaries was done together with landowners, RT / RW representatives, CLRC members, and local officersor private surveyors assigned by the local land office.

Field visits and observations as well meetings with stakeholders are shown in **Figure 2. 5.**. The feedback and discussions gathered from the activity including the potential uses of AR/VR for land registration are still evaluated.

Visit to Bangli, Bali

Visit to Batam City, Riau Islands

A typical archive room in a land office

A storage archive for physical land books and letters of measurements in Surabaya

A typical land measurement with using the current procedures

An exploration with the use of VR

A group meeting with Surabaya land office

An interview with Jakarta land office

Figure 2. 5. Field visits and interactions to many stakeholders (land officers and surevyors)

2.2.4. Development of research papers and training materials

Data processing and field activities were done in order to produce the expected outcomes. The activities include: module development, video material development and writing the publication materials.

Chapter 3 Results

The interview/study areas were done in: Bangli local land offices (for rural areas) and Batam local land offices (for urban area) in December and November 2020 (these field assessments were delayed in November – December 2020 as from May to December 2020 the Covid cases in Indonesia were very high, thus travel restriction and human movements/gatherings were applied nationally. Entering 2021, the focus was still on content development and discussions with Ministry of Agrarian and Spatial Planning for content adoption. As the case getting worse since May till August 2021 (getting better since September and October), the field test has not been planned and done. From 2022 till 2023 despite unclear communication and support from the grant provider, the progress is still achieved.

3.1. Publications

The publications resulted from this grant is as a follow:

- **Aditya, T.** (2021). A Blended Learning for Realizing Mix Reality of Cadastral Surveying Projects. FIG Working Week 2021: Smart Surveyors for Water and land Management, A New Reality, e-presentation at FFP Best Practices & Concepts. 24th June 2021. Link: https://fig.net/resources/proceedings/fig_proceedings/fig2021/papers/ws_09.1/WS_09.1_please_insert_11242_abs.pdf
- **Aditya, T.** (2022). Cadastre forensics, para surveyor and mobile app for land registration, Coordinates, October ed. (https://mycoordinates.org/cadastre-forensics-para-surveyor-and-mobile-app-for-land-registration/)
- **Aditya, T.** (2023). Quality Improvement with Block Adjustment for Land Administration in GEO-LAND-SEA (South East Asia Workshop on Geodetic Sciences, Land Administration an Geoinformatics): a regional Workshop collaboration between TUM (Technical University of Munich and Geodetic Engineering UGM, my campus) presented in : Proceeding of Geo-Land-SEA 2023 – Departemen Teknik Geodesi – Fakultas Teknik UGM
- **Aditya, T.** (2023). Visualizing Title Uncertainty and Quality Issues in the Digital Era of Land Administration. Article presented for FIG Commission 7 & 2 Annual Meeting 2023 2-4 October 2023 in Deventer, The Netherlands **(**fig.net/resources/proceedings/fig_proceedings/7_2023/papers/se02/SE02_aditya_12363.pdf)

3.2. Training Modul

3.2.1. Training Book

- Training module solely supported by this grant is written in Bahasa Indonesia dedicated for students and surveyors (both private and government surveyors) dealing with cadastral surveying and mapping activities.
  The title of the manual/reference book is: "*Pengukuran dan Pemetaan berbasis Masyarakat untuk Pendaftaran Tanah Sistematik Lengkap"* (**Community-based Survey and Mapping for Complete & Systematic Land Registration**)

  The link of the module can be download here:
  https://drive.google.com/file/d/1lncQs6_ckzYGv65relW2LnrwF0KCv5Em/view?usp=sharing

- Training module relevant with the grant in which the grantee is one of the initiators for the development of plugin of QGIS software ("*Teori dan Praktek Hitung Perataan Koordinat Blok Persil dengan Software PEREKAT* – **Theory & Practice for Block Adjustments with PEREKAT QGIS Plug-in**) can be found in this following folder:

  https://drive.google.com/drive/folders/11OU7mrMArlSZ7MNVJM9JEz0h_fPzZPXZ?usp=sharing

3.2.2. Videos

Learning materials produced and supported by the grant is the following:

https://youtu.be/DMBToR4vW6Y?si=uh8rwoDnoG2aQ9fc

Chapter 4 Concluding Remarks

The grantee would like to acknowledge the support and funding from Aubrey barker Foundation. Also, the FIG's consistent support during the implementation of the grant is greatly appreciated.
The following are conculiding remarkes regarding conculisons and recommendation sfrom the implementation of the grant.

4.1. Conclusion

The grant has allowed the grantee to publish the results from literature review and field visits related to the topic of data quality improvements, spatial data adjustments and advancing the cadastral survey and mapping with AR/VR. The grant has allowed me to develop the training materials in regard to survey and mapping with participatory and collaborative approach for complete land registration. Some notable remarks that must be mentioned are:

1. The involvement of the grantee using the support from Aubrey Barker Grant (ABG) helps have helped the national government in developing some regulations (technical guidelines and ministry regulation) in regard to data quality improvements and participatory approaches as well as AR/VR adoption to the national land registration program.
2. The development of the consept of Forensic Cadastre as the publication and as the training material has been possible with this grant support. In addition to that the research and development on the topic of cadastral data quality improvements were made possible with the funding from the ABG.
3. The modules have been developed considering the most relevant competencies required by the system and the development of modules has been fully supported by the grant.
4. The implementation and testing of the training materials related to data quality improvements can be done partly by the grant ans also supported by the Surveyor Association of Indonesia and the Department of ggeodetic Engineering.

4.2. Recommendation

Some important reccommendations from this ABG-FIG Grant are:

1. Despite the implementation of the grant faced uncertainties in terms of financial supports and follow-ups due to COVID-19 global pandemi, the received grant has been very useful to allow field visits and interactions with relevant parties and stakeholders.
2. The module has not been covered the AR/VR training due to time and technical limitation. Further elaboration on the modul regarding the implementation of AR/VR applications in Land Administration to comprehend types of same time-different place and different different time-same place interactions need still to be done.
3. As currently the Indonesia land registration services had been in digital, the confromances with newest standards need to be checked and improved in the current module. Plus the multimedia modules could also be improved.

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