Visualizing Title Uncertainty and Quality Issues in the Digital Era of Land Administration

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Key words: land title, unmapped certificates, quality, accuracy, uncertainty, visualization

SUMMARY

Digitalization in Land Administration requires analogue-digital data conversion and digital transformations of business operations. For a country in transition, the complexity of unleashing digital land administration services might be caused by heterogeneity in cadastral data quality due to various methods, measurements, materials, manpower, management and machines (6M) adopted or applied over the decades. A fundamental step to embark on digital land services will be first to deal with quality improvements of land records. This paper presents some lessons learnt from quality investigations in Indonesia, especially the cases of unmapped titles found in eight cities and rural areas. The unmapped titles amounted to over 15 million out of more than 90 million valid certificates in 2023. Indonesia is the country where the digital transformation process in land administration is underway, where, at the moment, both paper outputs and digital processes are used in its daily operations. Quality problems can be classified into spatial inaccuracies, legal/attribute inaccuracies, temporal accuracy and digital incompleteness and inconsistency, leading to uncertainty of land titles. This paper will focus on the visualization of title uncertainty to assist decision-making in resolving quality issues of mapped and unmapped certificates. For indicating inaccuracy and overlapping spatial boundaries, different types of error plots, precision plots, and heatmaps have been used to represent levels of validity and displacements found in the underlying cadastral map. For indicating multi attribute inaccuracies that reflect title uncertainty, different visual variables (i.e., sizes and values) can be applied to differentiate the levels of uncertainty. Meanwhile, for investigating logical attribute consistencies between paper and digital data, Parallel Coordinate Plots (PCP) can be used to ease evaluations. The paper will draw opportunities to convert these visual displays into decision-support tools for accelerating quality improvement progress.

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1. INTRODUCTION

Certainty and reliability are primary measures that assure the people's trust in land administration, including land registration services. Land registration services require unifying past and present cadastral surveys and maps. In addition to accelerating the formal registration and recognition of the ownership and or use of land parcels by parties (i.e., persons or legal entities), a systematic land registration aims at speeding up the unification of past and present cadastral surveys. In Indonesia, although the systematic land registration campaign has successfully accelerated the number of titles from 40 million to 90 million and more within only five years, from 2017 to 2022, the quality of land titles remains challenging. The unmapped titles totalled over 15 million out of over 90 million valid certificates in 2023. Besides the unmapped titles, which amounted to 15 million out of 90 million and more titles, a big issue has been the quality validation of registered land parcels. This condition can be seen as a consequence of the implementation of the sporadic registration approach in decades, undertaken by the government using different surveying methods, funding sources and regulatory frameworks.

In a land registration system (LAS), the quality evaluation would include validating three fundamental elements or at least three sets of documents representing three LAS elements: parties (persons or entities), land, and its ownership or use by parties. Although it is based on the deed/notary system for a right transfer, the ultimate output of each parcel's registration in Indonesia is a title, known as a land certificate given to owners. For owners, the land certificate is the strongest proof of ownership in the land market and before the court. A land certificate can be seen as a copy of its corresponding land book and letter measurement stored in the land office. The underlying documents for issuing land certificates include cadastral maps, administrative forms/archives, field sketches, measurement letters, decision letters and the land books representing the validity of the three fundamental elements: parties, land and their unique relationship. The overall recordation and documentation for each registered parcel have been in digital formats since 1997, but the output (field sketches, measurement letters, land books and land certificates) are printed.

Digitalization in land administration requires digitization of paper-based underlying documents and digital transformations of business operations. In addition to sporadic adjudication done in past decades, the digitization of underlying documents has also created problems. Digitization has been applied to sporadically convert paper-based letter measurements, land books, and field sketches into digital formats. As a result, digitization has created incompleteness of digital

document sources regarding area coverage (e.g., incomplete conversion of wards/villages within the same sub-district impacted by region proliferation/expansion) and digital-paper linkages. Besides the consistency correctness between the digital and paper data issue, the accuracy and completeness in representing spatial units of land parcels are also quality problems (Aditya et al., 2021a).

Indonesia is the country where the digital transformation process in land administration is underway, where, at the moment, both paper outputs and digital processes are used in its daily operations. For a country in transition, the complexity of unleashing digital land registration services might be caused by heterogeneity in cadastral data quality due to various quality methods, measurements, materials, manpower, management and machines (6M) in implementing land registration for decades (Aditya et al., 2021a). Quality assessment practices are a fundamental step to embarking on digital land services by dealing with quality improvements of land records in the first place. Visualizing title uncertainty is chosen as the term rather than visualizing the title accuracy. Quality of land titles can be measured based upon its spatial accuracy (its accurate representation to the real world in terms of area and position), attribute accuracy (its accurate documentation to the underlying deeds or letters of ownership, information of boundary parcels, neighbourhood and boundary markers involved in determining boundary parcels), and temporal accuracy (the accuracy of the title to the present ownership and whether the title has been validated recently or not validated, for example).

This paper presents some lessons learnt from quality investigations in Indonesia, especially the unmapped titles found in eight cities and rural areas. The paper summarizes visual approaches implemented to quickly identify quality issues or defined as uncertainty as a collective representation of spatial cadastre accuracy, digital incompleteness and legal cadastre accuracy. Further explanation about title uncertainty will be given in the next section, followed by presenting results and discussions.

2. VISUALIZING UNCERTAINTY OF CADASTRAL DATA

Quality problems in a land registration system can be classified into spatial inaccuracies, legal/attribute inaccuracies (that include temporal accuracy) and digital incompleteness and inconsistency. These three quality factors contribute to title uncertainty that reflect the confidence level of governments to provide further mitigation and actions related to handling mapped and unmapped land certificates. In this paper, a certainty of land title can be determined as a highly accurate land title if: (1) the spatial accuracy fits the requirement and represents the actual spatial boundary of ownerships, (2) the attributes of legal and administrative data are correctly and consistently representing the legal situation of owners and their relationship with the land (known as or right-restrictions-responsibilities or RRR but in this context is only the right), (3) the temporal data correctly representing the update-ness of ownership information. In addition to that, the highly accurate land title can have imprecise data (of spatial location/address, deeds or underlying documents, timestamp of ownership and transfers). Thus, the title certainty can be seen as a highly accurate and precise representation of spatial, attribute

and temporal data presented in a title. It represents the relationship between owners and their land parcels supported by their valid underlying documents. This concept is illustrated in Figure 1 (see Fig 1). Previous works on visualization of spatial data quality of spatial phenomenon have been interests of cartographers and geospatial researchers since the 1990s, e.g., (MacEachren, 1992), (Mason et al., 2017), (Kinkeldey et al., 2017), (Witt et al., 2021), while visualization of cadastral data quality can be found in the literature for example work done by Smida & Bajtala (2019) and also previous works on cadastral data quality improvements in Indonesia (Aditya et al., 2021a) and (Yulaikhah et al., 2023).

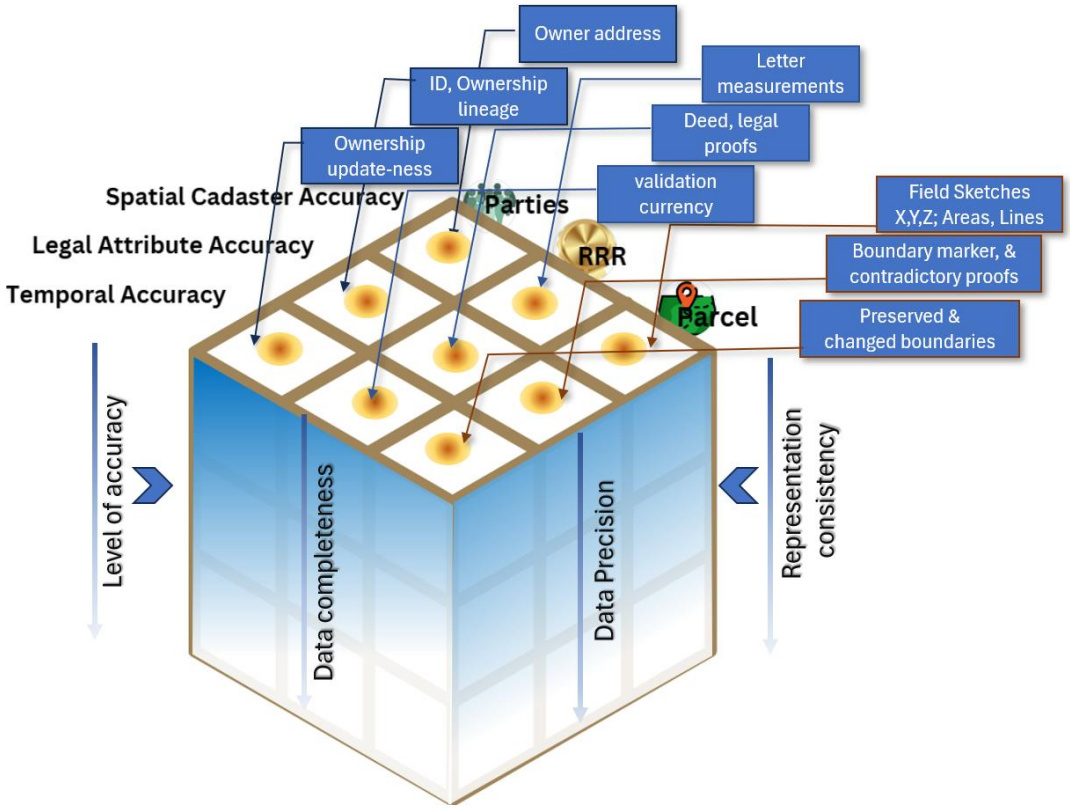


Fig 1. The concept of title uncertainty as a composite of location, attribute and temporal accuracy from multidimensional data related to owner/parties, the association between owner and parcel (right-restrictions-responsibilities), and the parcel by which the level of precision, completeness, and representation consistency of data can vary from one title to another title (source: own analysis).

This paper will focus on the visualization of data inaccuracy and inconsistency as a tool to assist decision-making in resolving quality issues of mapped and unmapped land certificates. The work presented here proposes a new decision-support in the form of a more visual cadastral map, useful to accelerate the quality improvement process and strengthen the confidence level on legal certainty of titles. In order to communicate spatial and legal inaccuracies in the

cadastral maps, Bertin's graphic variables of size and values (Kraak & Ormeling, 2013) are used to differentiate the numerical and ordinal levels of uncertainty. In addition to size and values as the most logical variables to present uncertainty, MacEachren (1992) also explained: "*...while color (hue), shape, and perhaps orientation can be used for uncertainty in nominal information. Texture, although it has an order, might work best in a binary classification of 'certain enough' and 'not certain enough' that could be used for either nominal or numerical data*". MacEachren (1992) also adds that saturation and symbol focus manipulation (e.g., contour crispness, fill clarity, fog/transparency and resolution) can appropriately present uncertainty. Meanwhile, digital completeness and inconsistency for all unmapped certificates, as these are primarily multidimensional data, will be summarised as lines of quality on a visual display called Parallel Coordinate Plots (PCP) (Guo et al. 2005).

Although the quality evaluation has been done by UGM in collaboration with ATR/BPN from 2015 to 2022 in eight cities and districts (Aditya et al., 2015), (Aditya et al., 2017), (Aditya et al., 2018), (Aditya et al., 2019), (Aditya et al., 2020), (Aditya et al., 2021b), (Yulaikhah et al., 2021), (Aditya et al., 2022a), and (Aditya, et al., 2022b), the paper will only provide an overview about how a visual cadastral map for quality assurance purpose can be produced for accelerating improvements. For that purpose, the data will be taken from a campaign survey and document investigations in Jakarta land offices and cases of Surabaya II land office.

2.1 Spatial cadastre inaccuracy

From spatial quality perspectives, gaps and overlapping boundaries in the cadastral map should be checked. The use of colour transparencies has been sufficient to indicate the overlapping spatial boundaries of land parcels (Fig. 2). After the cadastral redrawing (using corresponding field sketches and letter of measurements from the area), the map will be adjusted with results of field surveys. This remeasurement, or cadastral adjustments or block adjustments (Aditya et al., 2022c), will increase the spatial accuracy and minimize the distortion to a certain acceptance degree. In this case, the acceptance degree can be its point boundary accuracy (in terms of precision vectors) or the fitness to area tolerance (in percentages). Error plots with different levels of gradations are used to represent precision vectors (Fig. 3). The different values for each land parcel are used to represent the different levels of fitness to area tolerance (Fig. 4). The area tolerance is calculated by comparing the difference value between textual and spatial parcel areas against a certain tolerance threshold (e.g., 5%, 0.5 square the difference or other threshold). The visual approach is developed based on previous works in eight projects.

2.2 Legal cadastre incompleteness

For indicating attribute inaccuracy that reflects title uncertainty, different values can be applied to differentiate the aggregation of the problems. On top of spatial inaccuracy, the legal cadastre incompleteness is shown (Fig. 5). The legal cadastre inaccuracy levels show the textual completeness related to the location of reference points, existences of boundary markers and boundary metadata like agreement between adjoining landowners and the persons involved in

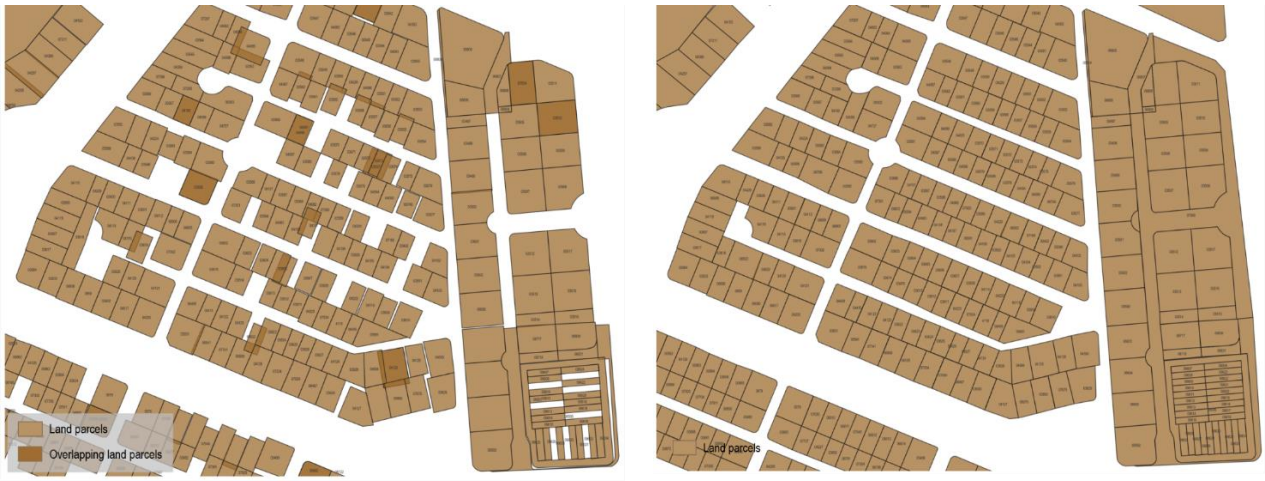
the contradictory delimitation activity. This concept formulation was taken from previous works by Martono et al. (2021) and Hanus et al. (2020).

2.3 Digital incompleteness and problem-solving method

In order to start the quality improvement work, a consistency assessment must be done. The results of this work are a summary table. Based on the findings, strategies or called treatments to improve qualities (i.e., labelled as C1 up to C5 and their corresponding treatments shown in Aditya et al., 2021a) are done. After the project is finished, the table is extended to provide metadata about the solution on how each flying certificate successfully landed on the map. For this, PCP is used (Fig 6). PCP is intended to investigate logical attribute consistencies between paper and digital data. In addition, PCP can give insights into how a land office's quality management and solutions are to be done. This approach can be lessons learned for other land offices with similar mandates to improve the quality.

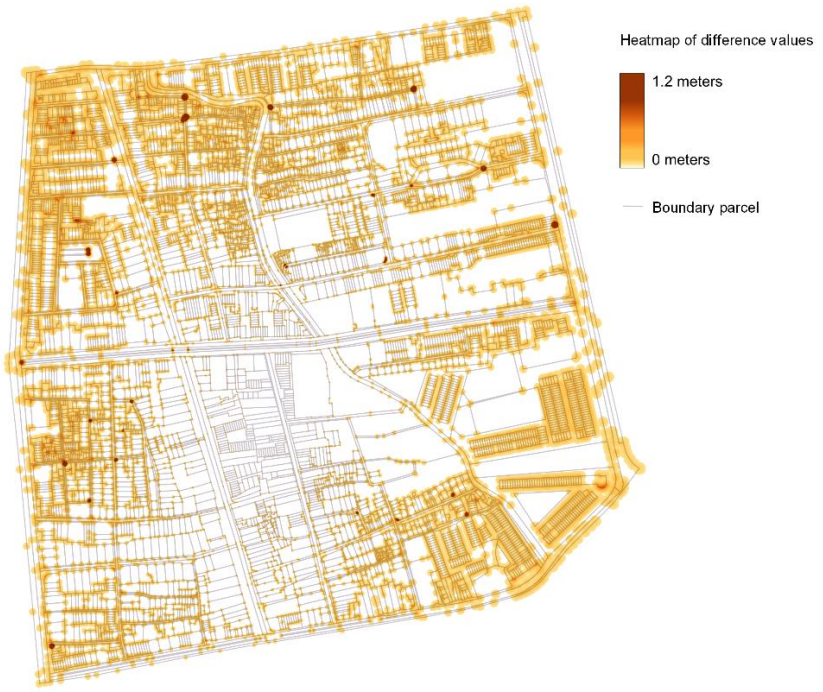
3. RESULTS AND DISCUSSIONS

The following figures illustrate the visualization of cadastral data quality, resulting from quality assessments and improvements of unmapped titles in 8 cities from 2017-2022. As stated in Section 2, three quality factors, namely spatial cadastre inaccuracy, legal data inaccuracy and data inconsistency, contribute to title uncertainty of mapped and unmapped land certificates.

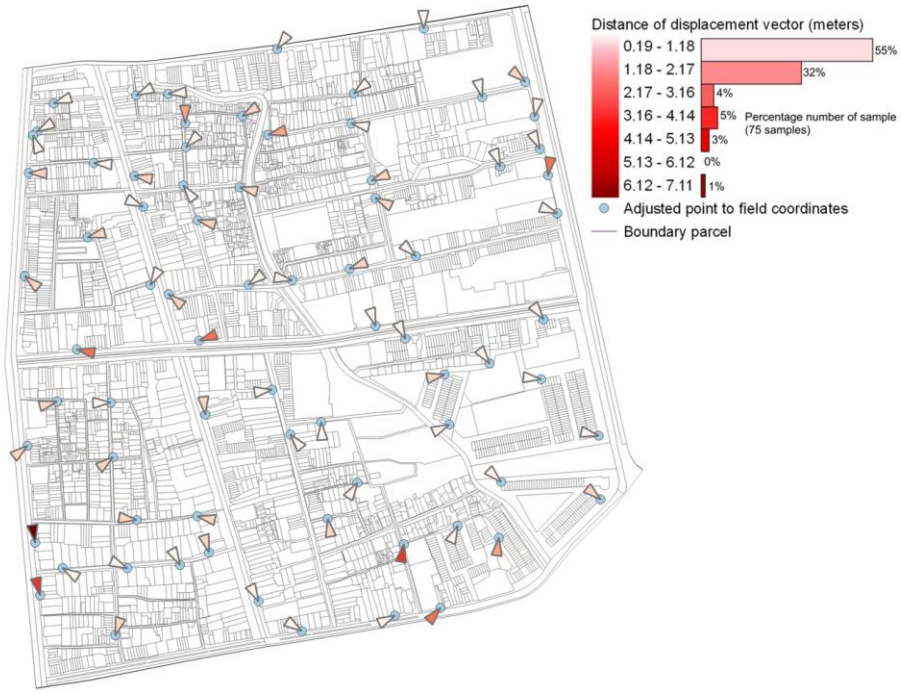


(a) (b)

Fig 2. Detection of overlapping spatial boundaries of land parcels with the of transparency of 60% (source: own analysis) in the Ward of Pradah Kalikendal, Dukuh Pakis District of Surabaya City: (a) before the quality improvement (b) after the quality improvement



(a)



(b)

Fig 3. Precision vectors as: (a) heatmap (b) error plots of samples in The Ward of Petojo Utara, Gambir District of Central Jakarta

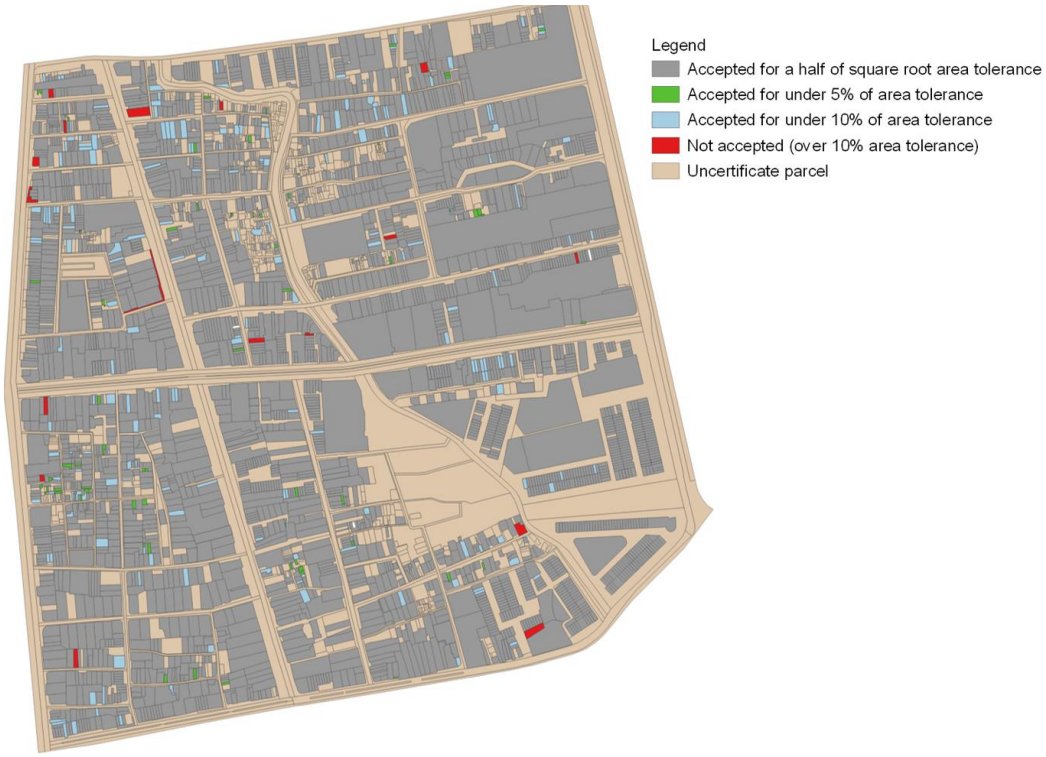


Fig 4. Level of acceptance to textual vs spatial area differences in Petojo Utara

(a)

(b)

(c)

Fig 5. Legal cadastre completeness in Petojo Utara: (a) document completeness (b) boundary marker and metadata completeness (c) overlay of document dan metadata completeness

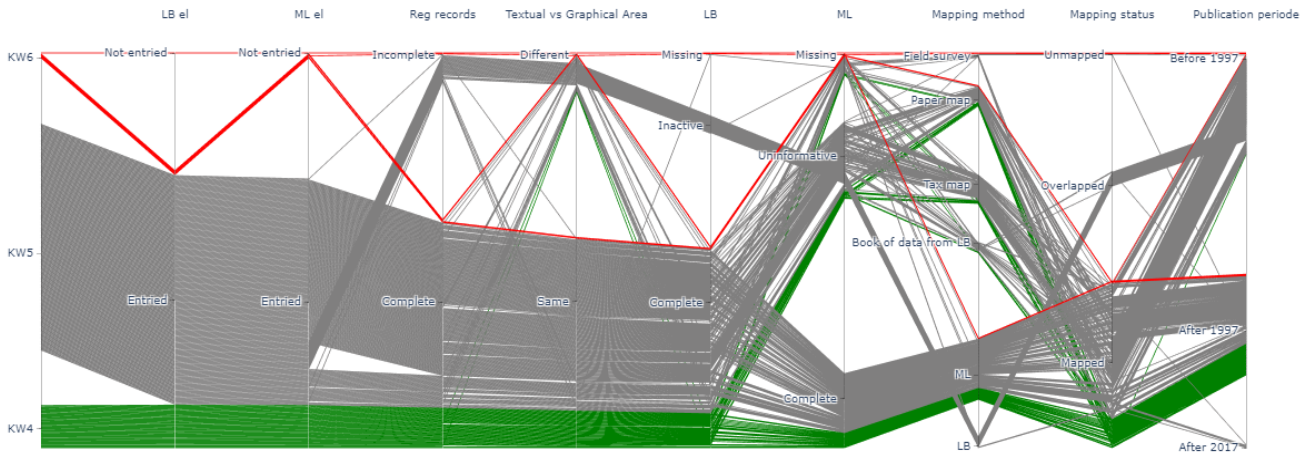


Fig 6. PCP of unmapped titles sources of problems related to inconsistencies and incompleteness of document sources and possible solutions of 282 unmapped titles in Benowo District, Surabaya.

For starting the task of quality improvements by correcting spatial data inaccuracy and legal data inaccuracy, Fig. 6 can be used as a principal interface to begin the process of validating the document sources and the links. The parallel coordinates consist of types of unmapped titles labelled by the system (KW4, KW5 and KW6), digital entry and consistency of electronic land book (LB), electronic letter of measurements (ML), electronic records completeness, digital

map area, physical land book, physical letter of measurements, plotting solutions, overlapping condition on the map, the year of certificate publication.

Later, the work can be divided into two processes: first is related to spatial inaccuracy improvement and legal data inaccuracy correction. For spatial inaccuracy improvement, maps like those presented in Fig. 2 and Fig. 4 can deal with improving spatial unit representations. For legal data accuracy correction, Fig. 5 can be used as a canvas to monitor the quality improvement progress. Once the correction or improvements of spatial inaccuracy and legal data inaccuracy of all land parcels have been made, the spatial adjustments can be executed for the whole area, and the report can be plotted as the one in Fig 3. Although it needs more verification and testing, designing a more visual cadastral map should help accelerate the enormous task of title validation faced by Indonesian land offices. A more visual cadastral map is necessary for increasing confidence levels related to the quality and use of cadastral maps both for the public and the government. Further research on this topic is planned to provide interactive visual decision support to present the uncertainty of land titles and to accelerate quality improvements.

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BIOGRAPHICAL NOTES

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