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Digital Transformation in the Validation of Land Tax Block Maps and Land Parcel Maps in Kedaton Village, Kapas District, Bojonegoro Regency

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Abstract: The digital era has brought significant changes across various sectors, including the management of Land and Building Tax (PBB) in Indonesia, which serves as one of the country's main revenue sources and contributes substantially to regional income for public service provision. However, technical issues persist in the spatial aspect of PBB management, particularly concerning the consistency between Land and Building Tax Block Maps (peta blok PBB) and Cadastral Parcel Maps (Peta Bidang Tanah, PBT). Discrepancies in boundary delineation, parcel area, and ownership identity often lead to inaccuracies that may undermine fairness, compliance, and revenue optimization. This study aims to evaluate and analyze the consistency between PBB and PBT data in Kedaton Village, Kapas District, Bojonegoro Regency. A quantitative method with a spatial analysis approach was employed, using Geographic Information System (GIS) tools and three evaluation parameters: Polygon Area, Polygon Near Distance, and Polygon Circularity Ratio. The results indicate that 48% of parcels showed area discrepancies beyond the tolerance limit, only 30% had matching taxpayer and landowner names, and 52% of parcels were categorized as accurate based on spatial evaluation. The findings highlight the urgency of strengthening PBB–PBT integration through harmonized mapping standards, centralized geospatial databases, systematic validation procedures, and digital platforms to enhance accuracy, efficiency, and sustainability in land taxation management.

Keywords: Digital Era, Land and Building Tax Map, Land Parcel Map Integration, Spatial Data Quality.

INTRODUCTION

In the digital era, land administration and taxation systems are increasingly modernized to improve accuracy, efficiency, and transparency. A critical component in this transformation is the management of Land and Building Tax (Pajak Bumi dan Bangunan, PBB), which plays a significant role in Indonesia's fiscal system. According to Law No. 12 of 1994 (Pemerintah Republik Indonesia, 1994), PBB is a state tax, of which a considerable portion is allocated as regional revenue to support public services provided by both central and local governments. Thus, PBB is not only a vital revenue source but also a tool for sustainable regional development and spatial equity (Purnamasari, 2024).

The key determinant of PBB valuation is the Tax Object Sales Value (Nilai Jual Objek Pajak, NJOP), which is influenced by factors such as land size, location, and building characteristics. The accuracy of land area data directly affects NJOP and, consequently, the tax payable. Previous research has indicated that land area, building size, and land layout significantly impact PBB revenue (Mampow, 2020). Errors in land area records affect not only fiscal aspects but also legal dimensions. From a fiscal perspective, discrepancies in parcel size may lead to overestimation or underestimation of tax liabilities, potentially causing revenue losses for the government and dissatisfaction among taxpayers. From a legal standpoint, land area is a crucial element of land tenure security and the legal basis for tax assessment (Chairunisa, 2017). Inconsistencies between Cadastral Parcel Maps (PBT) and Land and Building Tax Block Maps (PBB) can trigger boundary disputes, overlapping claims, and even legal objections or lawsuits related to tax determinations (Selawati, 2022)

At the technical level, land measurement in Indonesia often still relies on simple tools such as measuring tapes, where distances are used as the basis for area calculation (Pebriadi & Rudianto, 2018). The resulting land parcel information is then recorded in cadastral maps, which play an essential role in land administration (Budisusanto & Zaenuri ,2018). However, harmonizing land tax block maps with cadastral parcel maps requires systematic integration of tax administration systems and land information systems to avoid data conflicts and improve public service efficiency (Lemmen, 2012).

To address these challenges, the Indonesian government has implemented the Complete Systematic Land Registration program (Pendaftaran Tanah Sistematis Lengkap, PTSL), as regulated by the Minister of Agrarian Affairs Regulation No. 6 of 2018. PTSL is a nationwide program aimed at registering all land parcels within a specific administrative boundary, collecting both physical and legal data to provide certainty for landowners while reducing land conflicts and disputes (Firdaus , 2021). This presents an excellent opportunity to evaluate the consistency between tax block maps (Peta Blok PBB) and cadastral maps (Peta Bidang Tanah, PBT)(Sitorus, 2016). Peta blok itself is a cartographic product that represents a group of taxable objects within a geographic zone and serves as a spatial database for PBB management (Genengan et al., 2024).

The integration of PBB and PBT datasets is crucial for ensuring accuracy in land tax records, particularly in terms of geometry, position, and area. Discrepancies between these maps can significantly affect tax calculations and lead to legal or administrative complications. According to (Putra, 2023) assessing area differences and identifying mismatches between taxpayer data (in PBB) and landowner records (in PBT) is essential for transparent and effective land governance (Santoso, 2017). In addition, standardization of zoning and numbering systems—such as those adapted from the Universal Transverse Mercator projection—has been applied in PBB mapping to ensure consistency across regions (Wahyono & Nugroho, 2019).

Reliable and valid spatial data in PBB maps is also urgently needed by local governments to formulate fair, data-driven tax policies. Spatial data quality directly affects the validity of tax assessment, especially when calculating NJOP. (Nugraha & Santosa, 2020) identify three key components for spatial validity in land tax data: land area, position, and shape. Evaluating these parameters is vital for improving spatial accuracy. Georeferencing techniques, which link non-referenced spatial data into a coordinate system, are often applied to align legacy maps with GIS databases (Longley, 2015). Accuracy of such transformations can be tested using Root Mean Square (RMS) error as a statistical indicator (Lillesand , 2015)

Recent advances in Geographic Information Systems (GIS) and digital mapping technologies enable more efficient integration of spatial data. (Zhang, 2024)demonstrated that GIS applications in land taxation enhance spatial alignment, accelerate data processing, and reduce manual errors. Nevertheless, image processing and digitizing steps such as resampling using Nearest Neighbour or on-screen digitization through ArcGIS/AutoCAD are still prone to technical limitations like pixelation or human error (Olivier & Hanqiang, 2012); (Jain, 1989); (Luthfina et al., 2019); (Prabawati, 2018). However, harmonizing legacy analog maps with newly digitized datasets remains a challenge. (Rendra, 2023) highlighted that outdated and non-standardized spatial data across systems often leads to inconsistencies in land tax records. Building upon previous studies, such as (Budiyono & Aditya, 2022), (Dita Ghairini, 2017) who used 2003 PBB maps and 2017 PBT data, this research introduces more recent datasets, employing 2022 PBB maps and 2023 PBT data from Kedaton Village.

METHODS

This research applies georeferencing—a digital method that transforms analog maps into digital formats aligned with real-world coordinates. Through this method, scanned physical maps are digitized using specialized software to create accurate polygon, point, and line representations. Georeferencing is widely used in environmental modeling, spatial analysis, and cadastral modernization. The case study for this research is located in Kedaton Village, Kapas District, Bojonegoro Regency, East Java Province. Geographically, Kedaton Village lies between 111°55'14" E – 111°56'7" E and 7°11'44" S – 7°12'32" S, as well as 111°54'29" E – 111°54'57" E and 7°12'19" S – 7°12'51" S, covering an approximate area of 180 hectares, as shown in Figure 1.

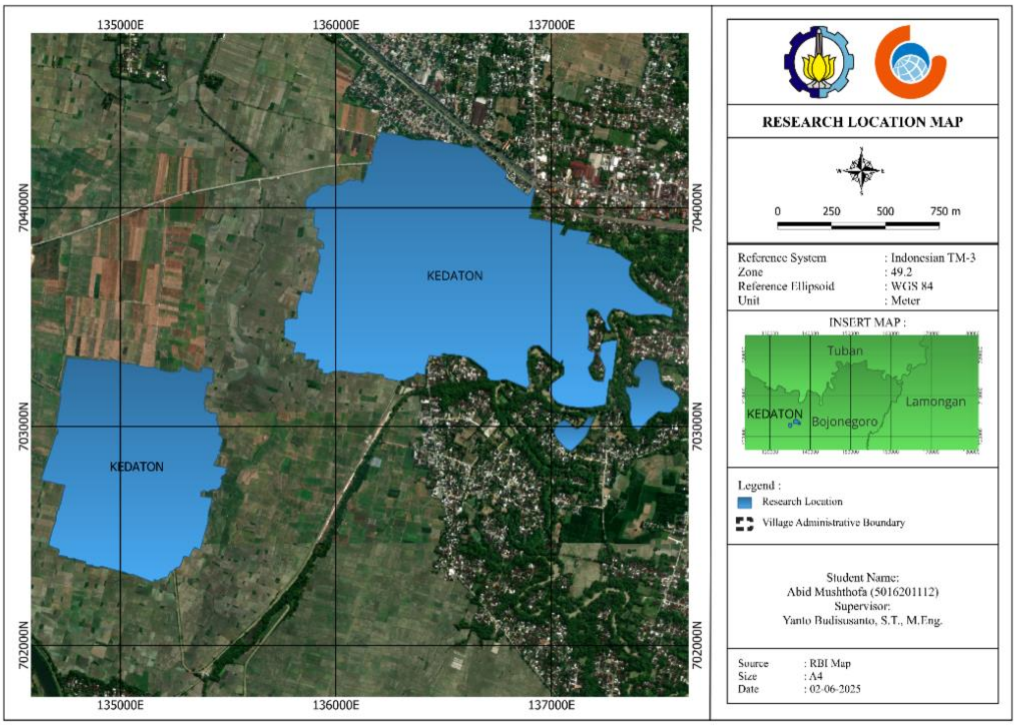

Figure 1. Research Location Map
Source: Data Processing, 2025.

The administrative boundaries of Kedaton Village are as follows:
North : Kapas Village
East : Kabunan Village
South : Sidodadi Village and Ngadiluhur Village
West : Plesungan Village

The method used in this study involves overlaying PBT (Land Parcel Map) data with PBB (Land and Building Tax) maps, followed by an interpretation of their spatial consistency. The research process begins with converting the PBB raster map into vector data. To assign a coordinate system (geometric correction) to the raster data, ground control points (GCPs) are selected as reference points. The geometric accuracy of the vectorized PBB map is assessed using independent control points (ICPs). The results of the geometric correction and its accuracy testing are represented by the root mean square error (RMSE) value. According to Indonesia's Geospatial Information Agency (BIG) Technical Standard No. 15 of 2014, positional accuracy testing refers to the coordinate difference (X, Y) between test points on the map and the reference data. The RMSE is calculated using the following formula:

$$RMSE = \sqrt{\left(\Sigma((x_i - x_i')^2 + (y_i - y_i')^2) / n \right)}$$

Where:

x_i, y_i = Coordinates from the measurement

x_i', y_i' = Coordinates from the reference map n = Number of control points

The next step involves interpreting the consistency between the PBB map and PBT data visually by identifying land parcel shapes that closely resemble one another. The Nomor Induk Bidang (NIB, or Parcel Identification Number) and Nomor Objek Pajak (NOP, or Tax Object Number) of each corresponding land parcel are recorded. These NIB and NOP identifiers serve as the basis for integrating the nominative data from PBT with the Daftar Himpunan Ketetapan Pajak (DHKP, or Tax Determination List), along with the associated land parcels. Subsequently, an evaluation is conducted on the consistency of ownership data, including the names of landowners, taxpayers, and the number of parcels, between the two datasets used in this study.

Generally, standards and guidelines applied by local agencies for evaluating the quality of PBB-P2 spatial data are based on the technical guidelines (Juknis) outlined in the Circular Letter of the Directorate General of Taxes No. SE-19/PJ.6/2003 (Ministry of Finance of the Republic of Indonesia). This regulation states that the absolute area difference between the PBB-P2 land parcel and the reference land parcel area must not exceed a 10% tolerance threshold.

$$S = |\Delta L / LS| \times 100\%$$

Where:

S = Percentage difference in land parcel area

ΔL = Area difference between the parcels

Ls = Reference land parcel area

Spatial data evaluation is conducted to measure the geometric quality and conformity between the Land and Building Tax (PBB) block map and the land parcel map using a quantitative approach. The methods used to evaluate spatial data include the Tolerance Test of Area Difference, Polygon Area, Polygon Near Distance, and Polygon Circularity Ratio. The following is a detailed explanation of the results obtained through each of these methods. Polygon Area is primarily used to test area accuracy by calculating the difference in area between two polygon features. The assumption is that a smaller area difference (ΔL) or polygon area value between the test data and the reference data indicates higher spatial accuracy.

$$\Delta L = |Luji - Lref|$$

Where:

Luji = Area of the test object

Lref = Area of the reference object

Polygon Near Distance assesses positional accuracy by calculating the distance between the centroids of two polygons. The assumption is that the smaller the polygon near distance (d) between the centroid coordinates of the test object and the reference object, the higher the positional accuracy of the spatial object (Nugraha & Santosa, 2020).

$$d = \sqrt{(Xtest - Xref)^2 + (Ytest - Yref)^2}$$

Where:

(Xtest,Ytest) = Centroid coordinates of the test object

(Xref,Yref) = Centroid coordinates of the reference object

Polygon Circularity Ratio calculates the boundary complexity of a polygon, considering both its area and perimeter. The assumption is that the smaller the Circularity Ratio difference (ΔCR) between the test and reference objects, the higher the spatial data quality (Nugraha & Santosa, 2020)

$$\Delta CR = |CRtest - CRref|$$

Where:

CRtest = Circularity Ratio of the test object

CRref = Circularity Ratio of the reference object

The Natural Breaks (Jenks Natural Breaks Classification) method is a data classification technique that groups data values into classes based on natural gaps in the data distribution. The method aims to maximize differences between classes while minimizing variation within each class (Jenks, 1967). Classes are determined by identifying breakpoints that yield the smallest within-class variance and the largest between-class variance. This method is most effective when the dataset has uneven or clustered distributions(Slocum, 2009).

RESULTS AND DISCUSSION

Integration of PBB and PBT Maps

During the geometric correction process of the PBB block maps across nine blocks, the resulting spatial accuracy was found to generally comply with the technical standards (BIG Technical Standards No. 15 of 2014). Block 6 had the lowest RMSE at 0.038 meters, and Block 2 had the highest at 0.078 meters. As shown in Table 1, all RMSE values fall within the tolerance limit for 1:1000 scale maps, which is a maximum of 0.5 meters. Table 2 shows that the lowest RMSE value for ICPs was 1.8721 meters in Block 7 and the highest was 4.078 meters in Block 8. With an average RMSE of approximately 3 meters and a higher number of ICPs compared to GCPs, the resulting map can still be classified under Class 1 based on BIG Technical Standards No. 15 of 2014 for large-scale maps (e.g., 1:25,000 or 1:10,000). However, the analysis also indicates that the geometrically corrected PBB maps are not recommended for use as cadastral maps.

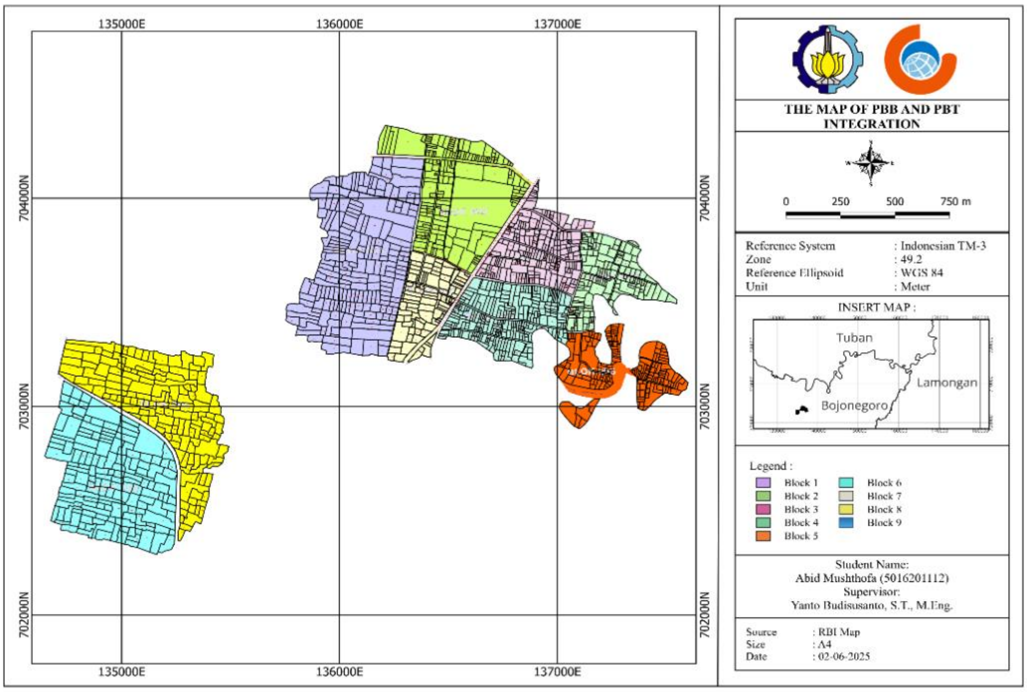

Figure 2. Visualization of Vector Conversion Results for Blocks 1 to 9
Source: Data Processing, 2025

Figure 2 presents the visualization of raster-to-vector data conversion, integrating Blocks 1 through 9. Each block number represents a specific group of areas that were processed and converted into vector format, facilitating further spatial analysis, management, and map data manipulation. This conversion process is essential for transforming image (raster) data into polygon-based vector format, which is compatible with GIS software. The vector visualization of the blocks aids in identifying spatial distribution patterns, mapping zones with similar characteristics, and supporting the quality assessment and integration of land parcel data more effectively.

Attribute Conformity of Names and PBB Objects to PBT Data

This analysis was conducted to evaluate the relationship between the number of PBB objects and PBT objects in relation to the conformity of name attributes. The purpose is to identify whether the land ownership name in the PBT data matches the taxpayer name in the PBB data within the same land parcel. Based on the analysis shown in Figure 3, green indicates parcels where the owner's name matches the taxpayer's name, totaling 570 parcels. Red indicates parcels where the owner's name does not match the taxpayer's name, totaling 437 parcels. Dark and light blue indicate parcels requiring adjustment or subdivision due to inconsistencies between PBT data (from the Land Office) and PBB data (from the Regional Revenue Agency). There are 896 such parcels: 76 parcels (dark blue) represent cases where a single land parcel is associated with multiple taxpayers, and 820 parcels (light blue) represent tax objects that contain multiple landowners.

Figure 3 shows that parcels with matching names are fewer in number than those with mismatched names. To ensure proper land administration, it is recommended that the names listed on land ownership documents (e.g., land certificates) match the names listed on tax documents (e.g., SPPT). This can help minimize land disputes and clarify ownership rights. Furthermore, for parcels with multiple taxpayers, land subdivision and certification should be processed through the Land Office, while parcels with multiple landowners under one tax object should be processed through the Regional Revenue Agency to separate taxpayer records accordingly.

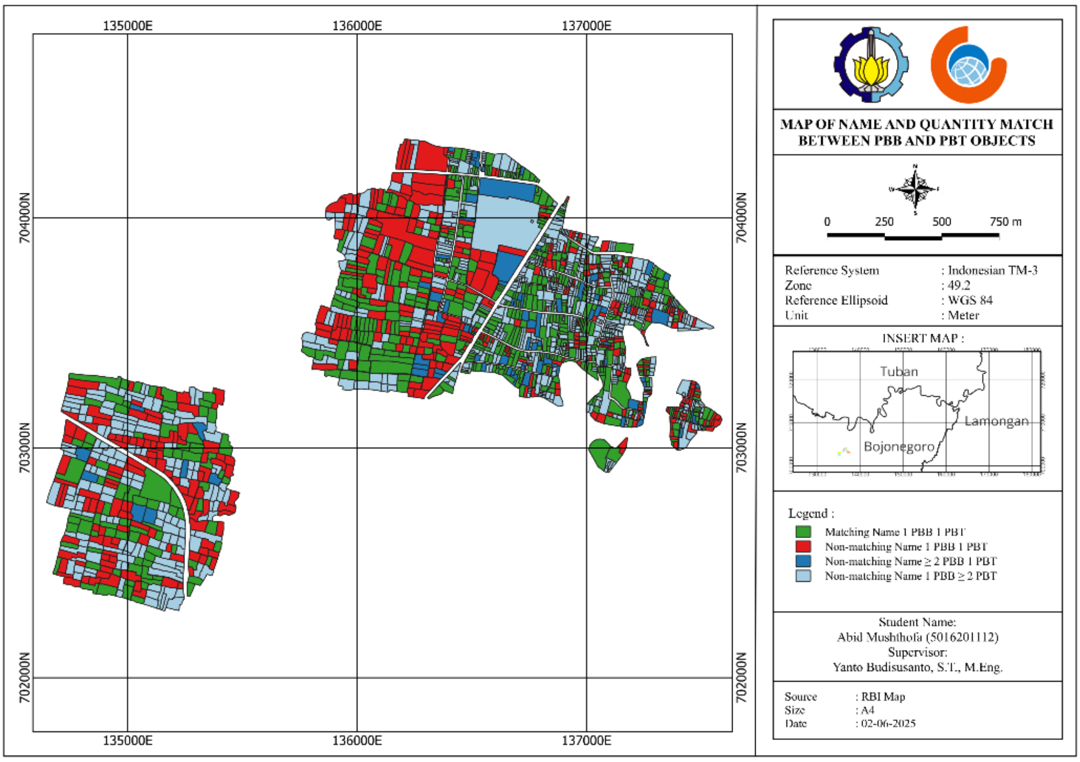

Figure 3. Visualization of Ownership and Usage Identity Conformity
Source: Data Processing, 2025

Based on the analysis above, if the grouping of name conformity between landowners and taxpayers for each land parcel is simplified into two categories, the results can be seen in Figure 4. The light blue objects represent land parcels where the landowner's identity (from PBT data) matches the taxpayer's identity (from the PBB map), totaling 570 parcels. In contrast, the light purple objects represent land parcels where there is a discrepancy between the landowner's identity and the taxpayer's identity, totaling 1,333 parcels (as shown in Figure 4). The large number of light purple parcels indicates that, to ensure the integrity of land administration data, regular and periodic data updates are essential.

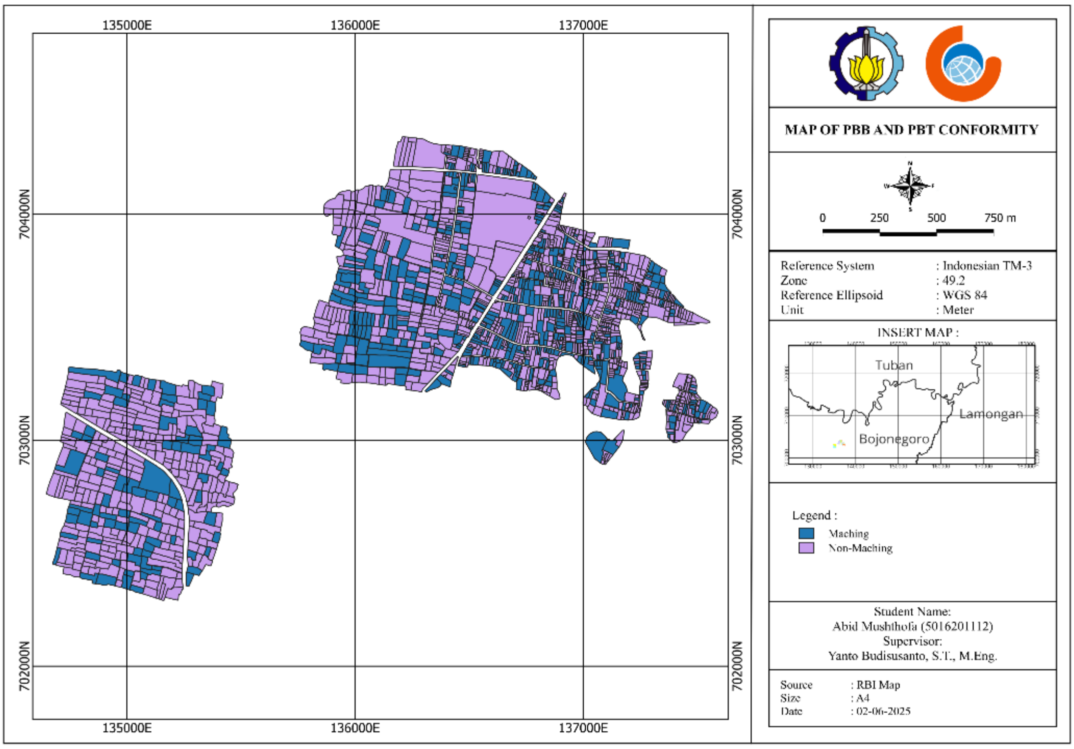

Figure 4. Visualization of Ownership and Usage Identity Conformity from the Integration of PBB and PBT Maps

Source: Data Processing, 2025

Area Tolerance Test

The results of the area tolerance test on land parcels from the PBB map compared to land parcel features in the PBT map are shown in Figure 5. Based on the test results, it was found that 996 land tax objects (shown in cream color) fall within the acceptable tolerance limit of 10 percent, as stipulated in SE-19/PJ.6/2003. Meanwhile, 907 land tax objects (shown in red) exceed the tolerance threshold, out of a total of 1,903 objects.

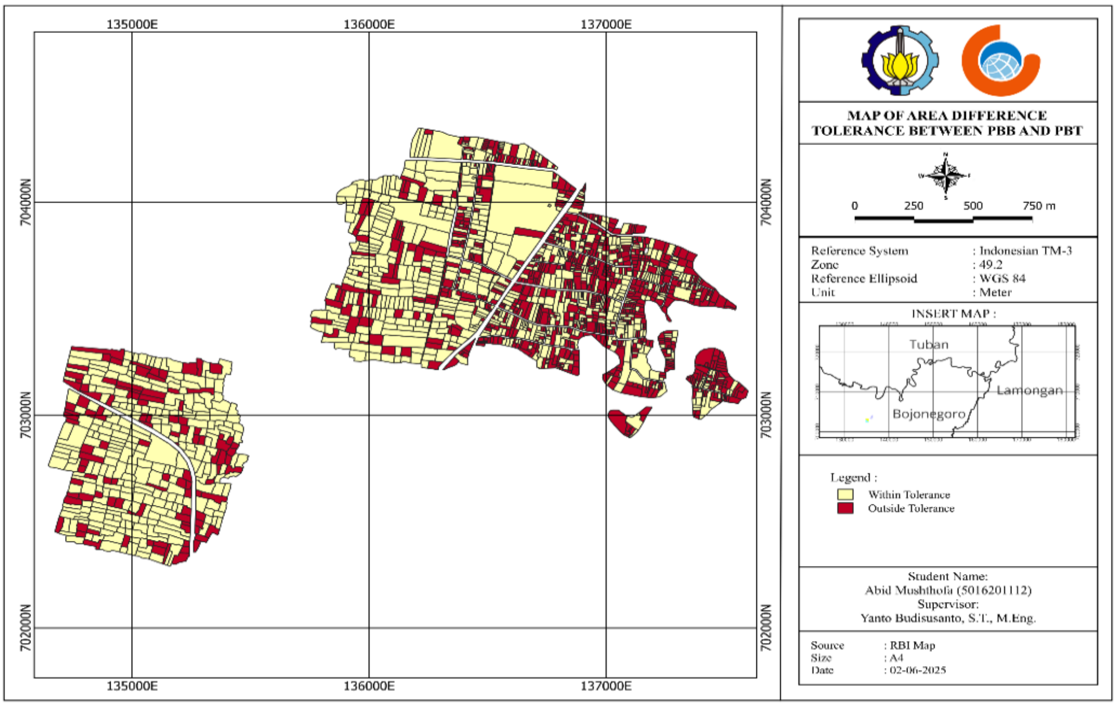

Figure 5. Visualization of Tolerance Test Results for PBB and PBT Map Integration
Source: Data Processing, 2025.

Spatial Data Quality Scoring Results

Based on the results of the polygon area test, polygon near distance, and polygon circularity ratio. The classification technique used in this study is the natural breaks method, since the data tends to have a high degree of variation, as indicated by the large standard deviation values, which means the data is not evenly distributed and tends to form natural groupings based on similar values.

The classification process of the polygon area, polygon near distance, and polygon circularity ratio using the natural breaks method produced break values, which were then used to form class intervals. This classification process also yielded goodness of variance fit (GVF) values calculated, with very good results, namely 0.923 for polygon area, 0.997 for polygon near distance, and 0.894 for polygon circularity ratio. The scoring process in this study was conducted by summing the scores from the polygon area, polygon near distance, and polygon circularity ratio tests for each tax object sample. This procedure identifies the spatial data quality category for each test object. Tax objects with the highest total scores represent those with the best spatial data quality (Figure 6).

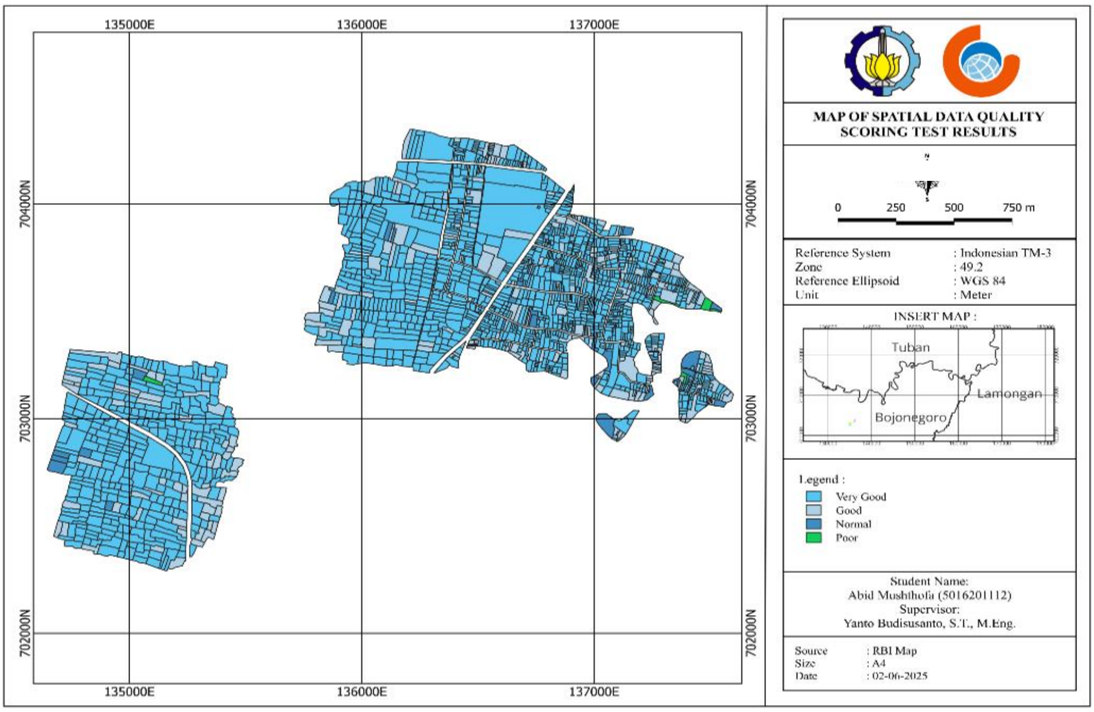

Figure 6. Spatial Data Quality Scoring Visualization
Source: Data Processing, 2025

Spatial Data Quality Assessment Results

After a series of tests on tax objects were carried out to evaluate the spatial data quality in the evaluation of PBB maps against PBT, the results are shown in Figure 7 below.

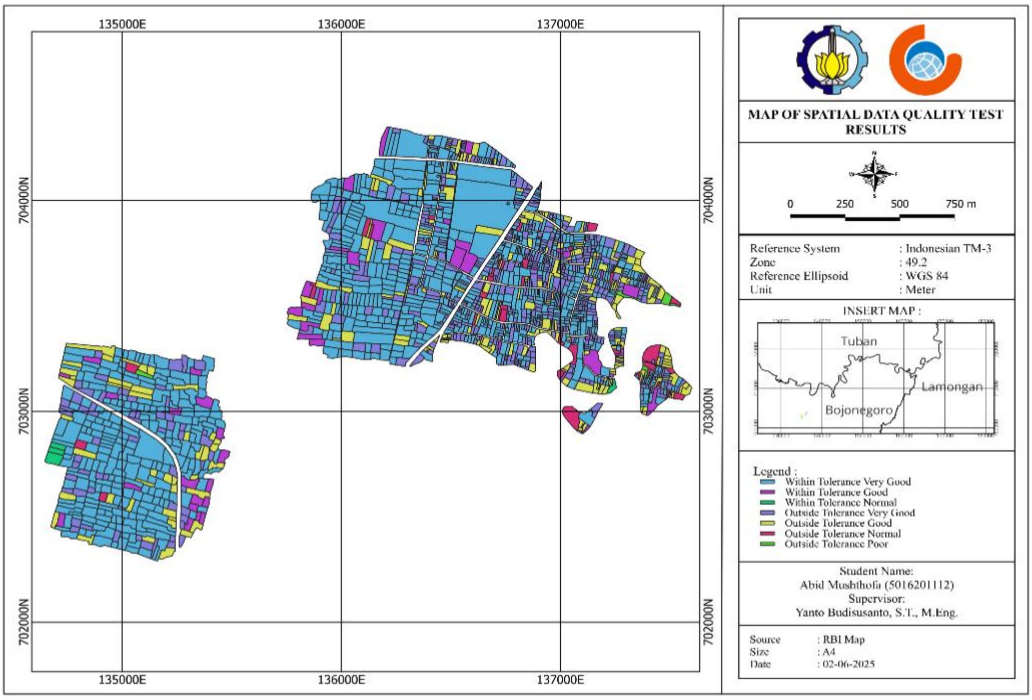

Figure 7. Spatial Data Quality Assessment Result Visualization
Source: Data Processing, 2025

Figure 7 illustrates the results of the spatial data quality evaluation between PBB and PBT. The evaluation is divided into several categories based on the level of conformity to established standards, visualized using different colors. The best category is marked in blue, indicating very good spatial data quality and within tolerance, accounting for 49% of the total. Additionally, the light purple category indicates "Good" and within tolerance (4%), and green represents "Normal," which is still considered acceptable. Meanwhile, colors such as light green, yellow, and dark purple indicate non-compliance with tolerance regulations and require improvement.

This map provides a clear visual depiction of how accurate the integration between PBB and PBT is based on the established tolerance standards. Areas in dark purple, yellow, red, and light green represent more significant mismatches and need correction, while areas in blue, purple, and dark green show higher levels of conformity and meet regulatory standards.

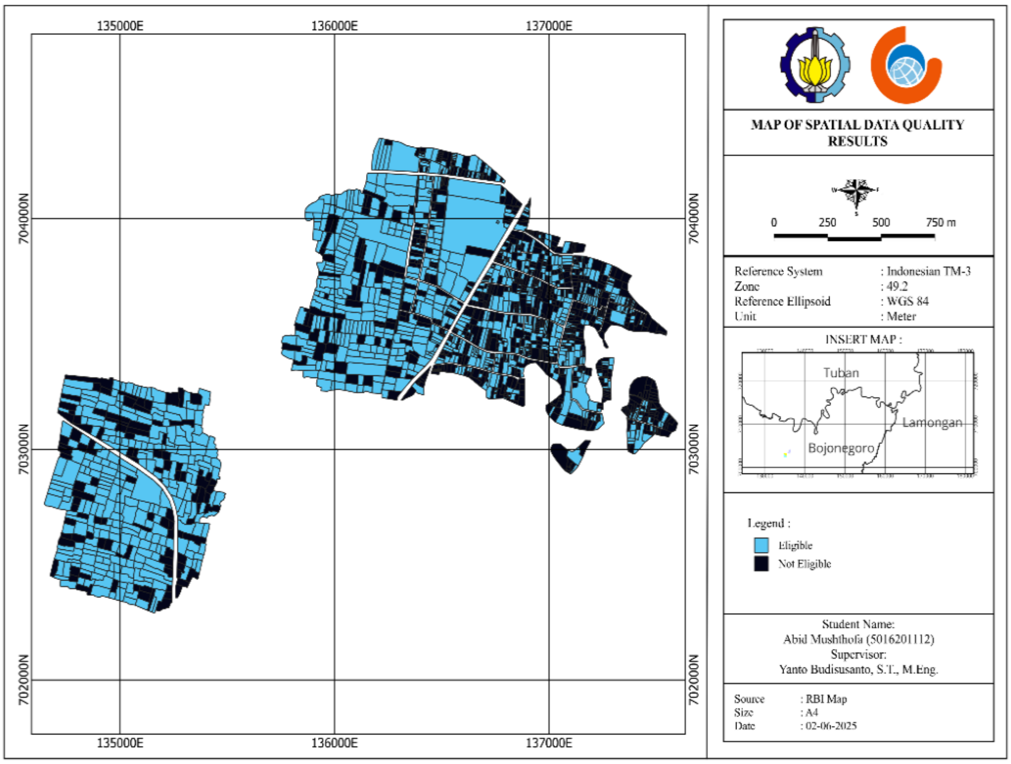

Figure 8. Spatial Data Quality Evaluation Results
Source: Data Processing, 2025.

Figure 8 presents the evaluation results of spatial data quality based on the eligibility status of the integration between PBB (land and building tax) and PBT (land parcel map). The light blue color represents areas that meet tolerance standards and are categorized as eligible, totaling 998 objects, while black represents areas outside the tolerance and categorized as ineligible, with 905 objects. The eligible areas are further divided into levels of data conformity. The Very Good, Good, and Normal categories represent data that complies with the set tolerance thresholds. The Very Good category shows the highest level of conformity, while Good and Normal indicate minor mismatches that are still acceptable. On the other hand, the ineligible areas indicate larger mismatches between PBB and PBT.

This map offers a clear visual insight into the quality and validity of the spatial data integration based on eligibility categories. The eligible areas indicate that the data meets the established standards, while the ineligible ones indicate the need for further evaluation or correction. Thus, this map helps to assess and ensure the geospatial data being used is accurate and meets the required criteria.

Map of PBB Evaluation Results Through PBT Integration

Figure 9 shows the results of the PBB evaluation through PBT integration, reflecting the validity of the resulting data. The area marked in blue (Valid), accounting for 16.67%, indicates that the integration result meets the tolerance standards and matches the set criteria in terms of land area, name, and number of attributes. This validity includes results categorized as Very Good, Good, and Normal, which respectively reflect highly accurate, reasonably accurate, and still acceptable levels of conformity.

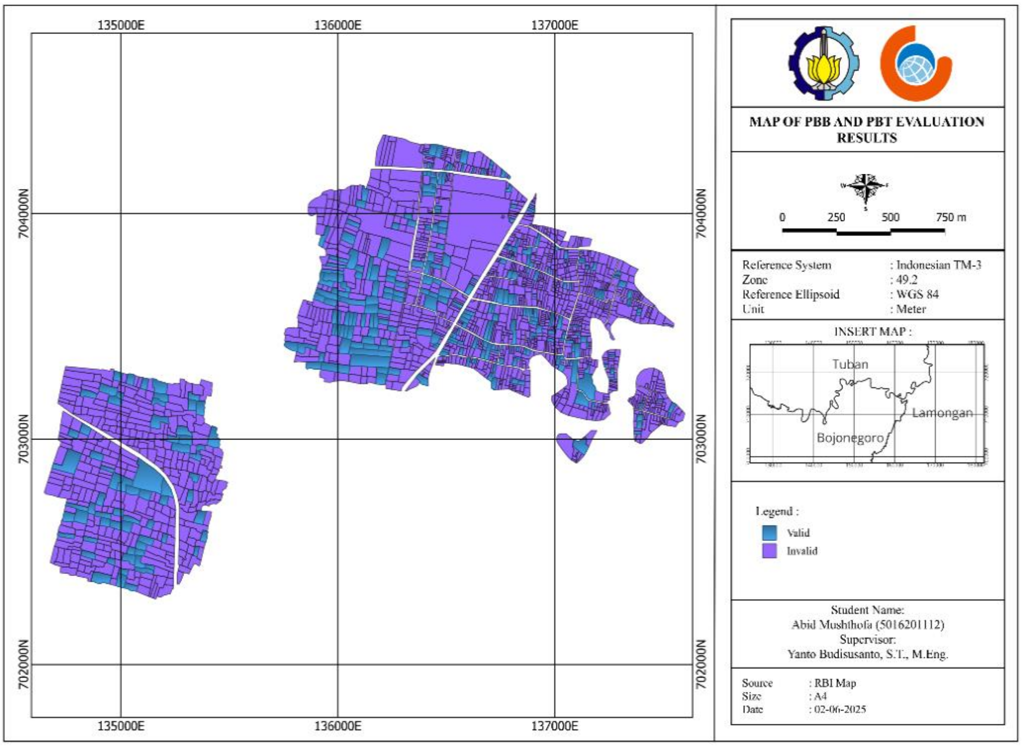

Figure 9. Number of PBB Map Evaluation Results Through PBT Integration
Source: Data Processing, 2025

Conversely, areas marked in purple (Invalid), totaling 83.33%, indicate non-compliance with tolerance standards. These mismatches may involve discrepancies in land area recorded in PBB and PBT or inconsistencies in names or counts compared to expectations. These errors highlight the need for further evaluation and improvement to achieve better accuracy.

CONCLUSIONS

Based on the research results and evaluations conducted, several conclusions can be drawn as follows: 1). The findings directly address the core problem of spatial inconsistency between the PBB and PBT datasets, particularly in terms of land parcel areas. The fact that nearly half of the parcels (48%) exceed the tolerance limit stipulated in SE-19/PJ.6/2003 reflects a critical issue of geometric inaccuracy that undermines the reliability of taxation data. This discrepancy highlights the technical challenge of ensuring consistency in land area records, which is fundamental for fair tax calculation, legal certainty, and effective land administration. Therefore, the statement specifically responds to the problem of inaccurate spatial data, emphasizing the urgent need for systematic validation and integration between the PBB and PBT maps. 2) The low consistency between taxpayer names in the PBB map and landowner names in the PBT data has several implications. First, it may result in tax bills being issued to the wrong individuals, leading to unfair taxation and administrative inefficiencies. Second, discrepancies in ownership records weaken the reliability of the tax database, which undermines its function as a foundation for regional revenue planning. Third, such inconsistencies can trigger legal disputes over land ownership, especially when cadastral records serve as formal evidence in land administration. Furthermore, mismatched data may reduce public trust and tax compliance, as taxpayers are less likely to fulfill their obligations when records are inaccurate. Ultimately, these issues highlight the urgent need for systematic improvements in data integration to ensure fairness, legal certainty, and the sustainability of land-based taxation. 3) The fact that 52% of land parcels in the PBB map are classified as Very Good, Good, or Fair indicates that more than half of the dataset can already serve as a reliable basis for taxation and land administration. This level of correspondence demonstrates that the existing PBB map has a usable degree of accuracy, reflecting a moderate alignment with cadastral records. However, the remaining 48% of parcels that do not meet the required standards highlight the persistence of data inconsistencies that may compromise fairness, compliance, and revenue optimization. Therefore, while the current condition provides a starting point for strengthening digital-based tax management, systematic validation and integration with PBT data remain essential to ensure that the entire dataset achieves a higher and more uniform standard of spatial quality. 4). The results indicate that the overall validity of the integrated PBB and PBT datasets is still far from ideal, as only 16.67% of parcels meet the tolerance standards, while 83.33% exhibit notable inconsistencies. This imbalance reflects a fundamental weakness in both spatial and administrative integration, suggesting that the taxation and cadastral systems remain poorly synchronized. Such discrepancies not only undermine the accuracy of tax calculations but also pose risks of fiscal loss, unfair tax burdens, and potential land disputes. Furthermore, the low validity level highlights the urgency of implementing systematic data correction, routine updates, and digital-based harmonization strategies to strengthen spatial accuracy and administrative reliability. Ultimately, these findings emphasize the critical need for integrated and high-quality datasets to support fair taxation, legal certainty, and public trust in land and tax administration.

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