

Article

Forensic Cadastre Approach in Resolving Land Disputes: Majalengka Regency as Case Study

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Abstract: Forensic cadastre is the application of forensic science in land dispute resolution to enhance the accuracy of analysis and the precision of recommendations. This study applied forensic science stages—recognition, identification, individualization, and evidence evaluation—to a land overlap dispute between state-owned land and privately owned parcels belonging to three individuals in Buntu Village, Ligung District, Majalengka Regency, West Java. Method validation was conducted through expert judgment using a questionnaire to assess its alignment with scientific and professional dispute resolution principles. The reliability test resulted in a Cronbach's Alpha value of 0.855 for 10 questionnaire items, indicating a high level of internal consistency, while the validity reached 80%. These findings confirm that forensic cadastre has a strong conceptual validity and good reliability, making it an objective and transparent strategy for resolving land disputes that cannot be settled through traditional methods such as mediation.



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Keywords: forensic science; forensic cadastre; land dispute

1. Introduction

Land administration encompasses the following four main interrelated aspects: land tenure, land valuation, land use, and land development. Secure land tenure is essential to provide landowners with legal security, enable them to defend their rights, and facilitate land transactions [1–3]. Secure land tenure can also increase agricultural productivity, enhance urban land values, and improve human welfare [4]. On the other hand, land valuation plays an important role in determining the economic value of land, which affects investment decisions and financial services [5]. Methods such as market price comparison and income capitalization can accurately estimate the value of land, thereby supporting national income growth and economic development [1,6]. In addition to land ownership and valuation, effective land use is essential to ensure that land resources are used efficiently and sustainably [7,8]. Appropriate land use planning regulations can help to address the challenges of rapid urbanization and maintain environmental balance [8,9]. The last aspect, land development, is crucial to optimize land use for public

benefit, including housing, infrastructure, and commercial areas [6,10]. To ensure equitable and sustainable development, coordination among different stakeholders is necessary to improve the efficiency of the land development process. With a structured and integrated approach, land management can maximize the benefits for development and community welfare [9].

While effective land governance can enhance tenure security, increase land value, optimize land use, and support development, challenges remain, particularly with respect to land conflicts. These conflicts can occur at different levels, from global to national. At the global level, land grabbing in the Global South often triggers conflicts, especially in plantation and agricultural projects. Despite mediation efforts, political and institutional factors often impede resolution [11]. Land disputes also occur at the regional level. In Northeast Asia, nationalism and public perception influence conflicts such as the Senkaku/Diaoyu dispute between Japan and China and the Takeshima/Dokdo dispute between Japan and South Korea [12–14]. In Southeast Asia, the South China Sea is a focal point of conflict, with many countries interested in maritime boundaries and resource exploitation, with China playing a dominant role. In addition, border disputes such as Ambalat and Sipadan–Ligitan between Indonesia and Malaysia demonstrate the complexity of international arbitration and the importance of diplomacy in achieving a peaceful resolution [15–17]. At the domestic level, Indonesia still faces ongoing conflicts due to overlapping claims and governance issues. Clear examples include the dispute over the Reducing Emissions from Deforestation and Forest Degradation (REDD) initiative in West Kalimantan [18], the protracted land tenure conflict in Rempek village, Lombok [19], and the economic, environmental, and indigenous rights issues surrounding PT Freeport Indonesia [20].

In general, land disputes can arise from technical and legal factors. From a technical perspective, inaccurate or incomplete land data are often the main cause of disputes, leading to uncertainty about land boundaries and ownership [21,22]. In addition, the existence of conflicting land titles creates legal uncertainty and complicates the settlement process, as multiple parties may claim rights to the same land [23]. Another contributing factor is the inefficiency of the land administration and titling system, which fails to provide clear and reliable documentation of land ownership [22,24]. From a legal perspective, dualism in agrarian law is a major cause of land disputes, as different interpretations and applications of the legal framework can lead to overlapping claims to the same land [21]. Legal ambiguity and the lack of a clear regulatory framework exacerbate conflicts and make dispute resolution difficult [23,25]. In addition, illegal activities by the land mafia, such as fraudulent land registration, complicate the legal process and undermine public confidence in the legal system [21,24].

To address the challenges in the land sector, it is critical to implement a reliable cadastral system to resolve land disputes and improve the efficiency of land administration. This system should integrate spatial and legal information for each parcel of land, and its success depends on the accuracy, reliability, and timely updating of data [26–33]. One of the main functions of a cadastre is the accurate determination and recording of land boundaries. Unclear boundaries, especially in areas of high land pressure, often lead to conflicts. To avoid overlapping ownership, the system needs to be developed in a sustainable manner. As the cadastral system evolves, its legal and administrative aspects will be further strengthened by providing official records that are accessible to all stakeholders, thus helping to reduce uncertainty and facilitate dispute resolution [31–33]. In addition, the implementation of a cadastral system will also contribute to spatial planning, land management, and fiscal optimization [22–25,27,34].

One approach that can improve the reliability and effectiveness of a cadastral system in resolving land disputes is the application of forensic science. This discipline combines

scientific methods to reconstruct events based on physical evidence through processes of investigation, analysis, and evaluation. Forensic science also considers the interaction between people, materials, and other objects [35,36]. When cadastral information is used in a legal context or for dispute resolution, this information becomes part of a forensic practice known as forensic cadastre. This approach aims to ensure the accurate identification of land boundaries, provide evidence that is acceptable in court, and analyze cases such as land encroachment or illegal land use [37–39].

In land administration, forensic cadastre plays an important role in resolving disputes over ownership status, unauthorized construction, and claims of co-ownership. In addition to facilitating a more objective resolution process, forensic cadastre also contributes to increased transparency in land administration [39,40].

Although it holds significant promise for tackling land-related challenges, the execution of forensic cadastre continues to encounter numerous obstacles, especially the absence of a uniform methodology [40–42]. Earlier investigations revealed that the use of forensic cadastre was confined to field identification and data verification, lacking a thorough framework for assessing evidence [40,41]. Meanwhile, other research has provided a wide range of methods, such as document reviews, field inspections, and the creation of conflict resolution suggestions [39]. However, these processes do not fully conform to the core tenets of forensic science, which are identification, recognition, individualization, and interpretation. Furthermore, to ensure procedural accuracy and the importance of recommended actions, each stage of the forensic cadastre process must be validated by experts in the cadastral field.

This study addresses existing gaps by proposing a novel methodology for the application of forensic cadastre. It emphasizes the integration of the foundational principles of forensic science and the inclusion of expert validation throughout each phase of the process. This method aims to improve the efficiency, impartiality, and clarity of land dispute resolution, offering a practical alternative for cases that remain unresolved through traditional approaches like mediation.

2. Material and Methodology

2.1. Material

2.1.1. Study Area

The research area is located in Majalengka Regency, West Java Province, Indonesia, as shown in Figure 1. As an archipelago, Indonesia has an island called Java, which consists of several provinces. Majalengka is one of the regencies in West Java Province that has a high agricultural potential supported by marginal land. The land conditions in Majalengka Regency mainly consist of agricultural land, plantations, and urban areas. However, Majalengka Regency is facing increasing land disputes, rapid urbanization, and economic development. These disputes are often reported by individuals who feel aggrieved by overlapping land ownership, unclear land boundaries, and non-transparent land use changes.

Land administration in Majalengka District is managed by the local office of the National Land Agency (BPN), which is responsible for land registration, issuing certificates, and resolving ownership disputes. However, challenges such as inaccurate property data, incomplete digital mapping, and missing ownership documents make land disputes increasingly complex and challenging.

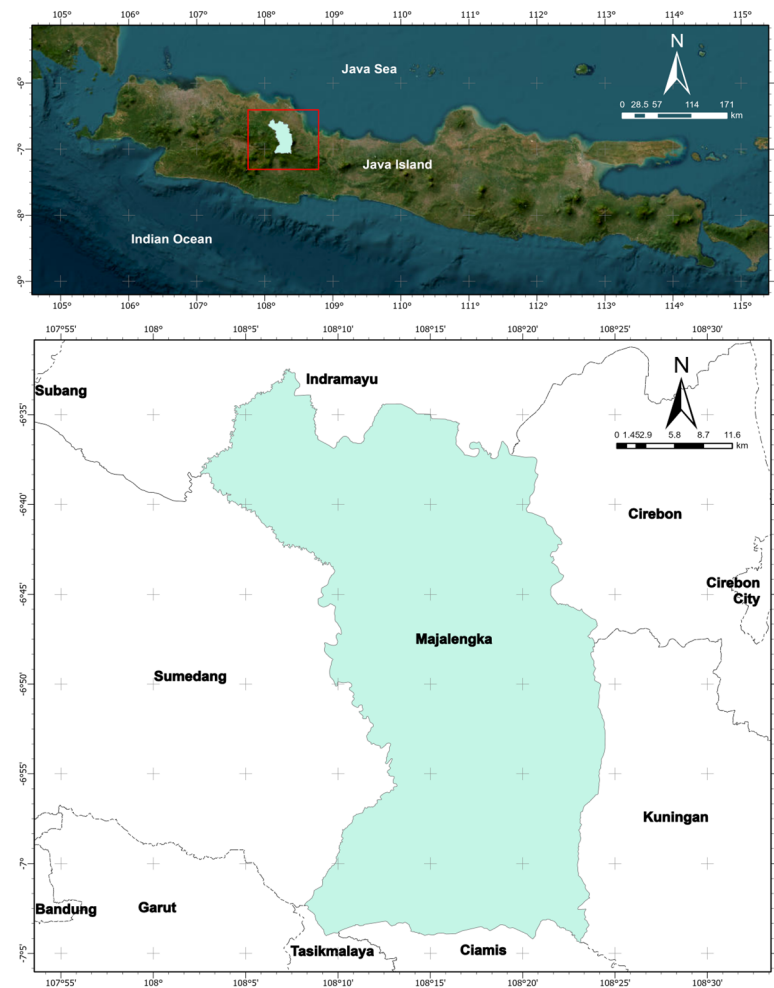


Figure 1. Map of Majalengka Regency.

Some of the main factors leading to the high number of land disputes in Majalengka Regency include the following:

- Overlapping ownership—Errors in land records or land use without clear certification often result in multiple parties claiming the same land.
- Unclear land boundaries—Inaccurate mapping results in unclear ownership boundaries, leading to conflicts between landowners.
- Incomplete ownership documents—Many parcels of land lack official certification, so their ownership status is often disputed.
- Unregulated land use changes—Infrastructure and housing development without clear regulations lead to land use change disputes between landowners and developers.

Given the increasing number and complexity of land disputes, a more comprehensive approach is needed. One possible solution is forensic cadastre, an evidence-based investigative method to identify the root causes of land disputes. This approach enables more accurate ownership verification and facilitates a fairer and more transparent resolution process.

2.1.2. Data

The data used in this study include the following:

- Land Ownership Documents: Proof of Ownership (Deed of Sale/Grant, Girik/Letter C/Petok, Court Decision, Other Proof of Ownership) and Statement of Physical Land Possession (SPLP).

- Identity and Administrative Documents: Identity Card (IC), Family Card (FC), and Land Book.
- Land Measurement and Mapping Documents: Measurement Letter (ML), Measurement Drawing (MD), and Land Parcel Map (LPM).
- Taxation and Legal Documents: Land and Building Tax (LBT) and Tax Due Notification Letter (TDNL of LBT).
- Supporting Documents for Land Measurement and Verification: Boundary Determining Authority, Witness, Documentation, and Satellite Imagery.

2.2. Methodology

According to the book *Principle of Forensic Science*, forensic science comprises the following four main processes: recognition, identification, individualization, and evaluation of physical evidence [41]. Recognition is the initial stage, focusing on the early detection of an incident or event that appears unusual, serving as the foundation for further analysis [36,43]. Next, the identification stage involves collecting and verifying evidence and relevant data for case analysis. At this stage, a deep understanding of the characteristics of the evidence is crucial to ensure accurate identification and authenticity [44–46]. Following this, the individualization stage aims to link the evidence to a specific source or group through an analysis of its characteristics and comparison with relevant databases. This process determines the specific aspects that need to be analyzed based on the evidence collected in the previous stage [47,48]. Finally, the evaluation stage assesses the significance of the evidence in the investigation process. The collected evidence is analyzed and interpreted to support the case investigation. Key considerations in this stage include the reliability of the evidence, the conditions under which it was found, and its impact on the investigation process [36,49].

In forensic cadastre, which is the application of forensic science in the cadastral field, the process follows the basic stages of forensic science by adapting a more specific methodology to resolve land disputes. The process starts with an introduction stage, where the need for forensic analysis is identified in various land dispute cases, such as ownership conflicts, boundary inconsistencies, unauthorized development, or other cases reported by the public. At this stage, disputes are classified based on spatial and cadastral evidence to understand the nature of the problem [39]. Next, the identification stage involves collecting and analyzing all relevant data that can be used as evidence in dispute resolution. The objective of this stage is to gain a comprehensive understanding of the characteristics of the available evidence, ensuring that legitimate ownership claims can be distinguished from potential boundary violations, land encroachment, or other violations [40,50]. Thereafter, the individualization stage focuses on analyzing the unique characteristics of each dispute based on the evidence collected. This process allows for the categorization of cases based on their specific features, allowing for more accurate and tailored dispute resolution [39]. After classification, the evidence evaluation stage is conducted to investigate each case according to its characteristics using all the evidence that has been collected. This process includes testing and verification to ensure that the evidence complies with legal standards. Overall, the stages in forensic cadastre highlight the important role of forensic cadastre in resolving land disputes through a proper scientific approach, ultimately resulting in an objective and justifiable decision [39,51].

To ensure the reliability of forensic cadastre in resolving land disputes, a validation process must be carried out after completing the stages of forensic cadastre [39].

Furthermore, the application of forensic cadastre in land dispute resolution in this study follows the flowchart presented in Figure 2, with each stage described as follows:

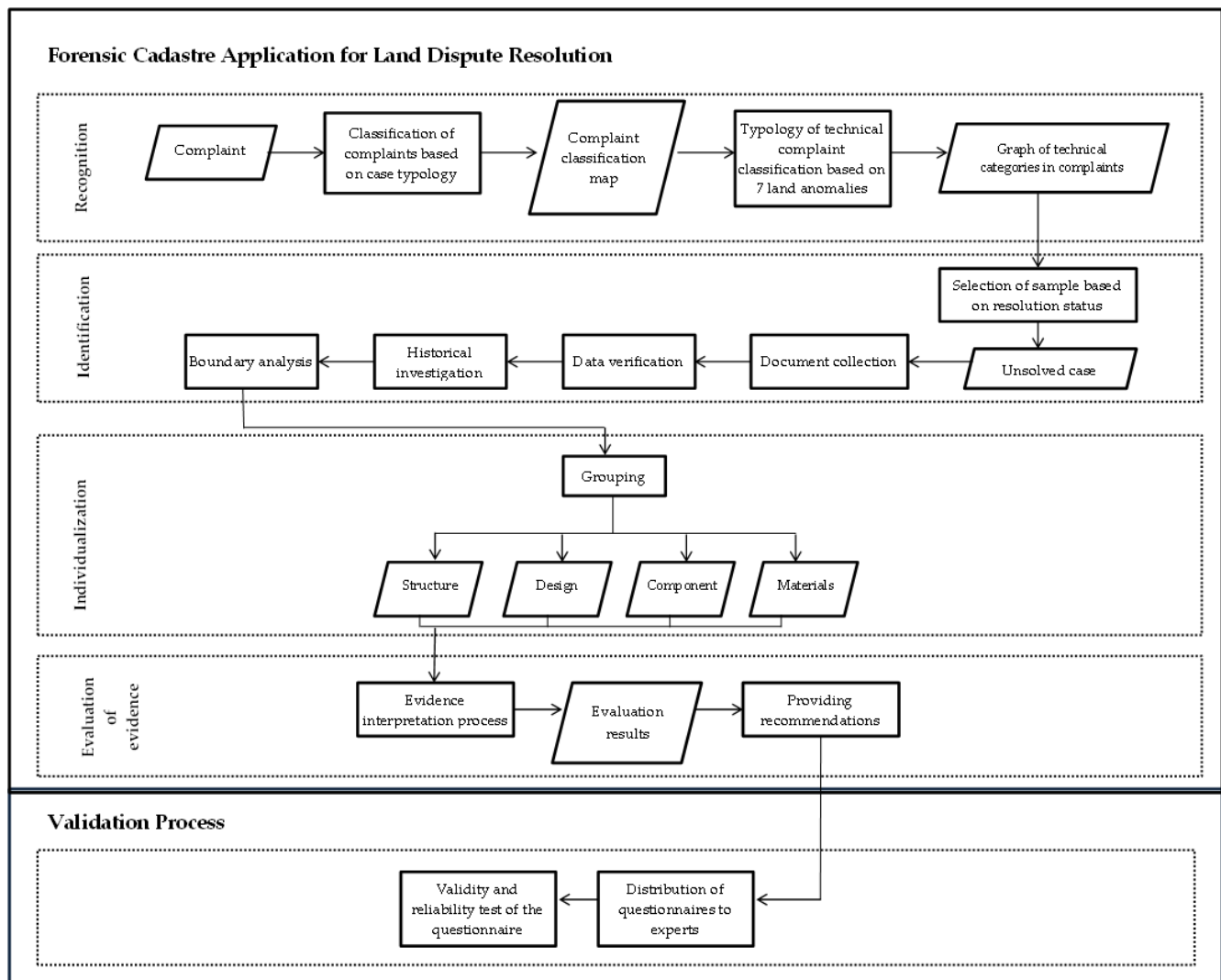


Figure 2. Research flowchart.

2.2.1. Recognition

The recognition process in forensic cadastre starts with the filing of a complaint. A complaint is a formal objection or claim relating to land ownership rights, land use, administrative decisions, or other related matters. Complaints arise when a party feels that their rights have been violated or when there is a dispute related to land ownership or use [52–54]. In addition, according to the Regulation of the Minister of Agrarian and Spatial Planning/Head of the National Land Agency of the Republic of Indonesia No. 8/2018, complaints are also defined as complaints filed against services that are not in accordance with established standards, negligence in fulfilling obligations, or alleged violations of regulations by service providers [55].

The complaints received are then classified into the following two main categories: technical and juridical. This classification aims to understand the nature of the reported problem, resolve it effectively, and provide the most appropriate solution [56,57].

Based on complaint data from the 2021–2024 period, there were 19 land-related cases in Majalengka Regency categorized as juridical and technical complaints. Juridical complaints generally focus on the legal and administrative aspects of land, while technical complaints usually involve issues related to the measurement, mapping, and physical characteristics of land [56,57]. Based on this classification, Table 1 presents the typology of cases in

the technical and juridical categories in the complaint data for the 2021–2024 period in Majalengka District.

Table 1. Case typology.

Technical Complaints	Juridical Complaints
• Boundary/Parcel Location Determination (2 cases) • Overlapping Land Parcels (1 case)	• Issues with the Procedure for Land Rights (6 cases) Determination and Registration • Registration of Land Rights Transfer (2 cases) • Land Rights Determination and Registration (1 case) • Land Ownership and Possession (7 cases)

The classification results are presented in the form of maps created using the ArcGIS software (Personal Use Term License Subscription, Ref ID: 634933227225) to illustrate the distribution of subdistricts with land problems of both a legal and technical nature.

Although Table 1 shows more juridical complaint typologies, this study will explicitly focus on technical complaints, as juridical complaints are generally handled by legal teams in accordance with applicable regulations [58,59].

To gain a deeper understanding of technical complaints, this category is further classified based on the seven land anomalies outlined in the Technical Guidelines for Improving the Land Data Quality on Land Issues. These guidelines were developed by the Ministry of Agrarian Affairs and Spatial Planning in collaboration with the World Bank in 2023–2024 [60]. Table 2 lists the seven categories of land anomalies and describes each category.

Table 2. Seven land anomalies for technical complaints.

Anomaly Id.	Seven Land Anomaly Classifications	Description
01	Overlapping land parcels identified	Land parcels are in their actual positions but still overlap, have gaps, or slivers (very small overlaps/gaps) with other parcels. This analysis results from topology error detection using the rules “must not overlap” and “must not have gaps”.
02	Land parcel not in the correct position	Land parcels are not in their actual positions but can still be directly identified based on their correct location. Identification is conducted by observing block pattern formations and imagery patterns on maps or High-Resolution Satellite Imagery (HRSI).
03	Land parcel suspected to be in an incorrect position	Land parcels are not in their actual positions, and after identification through block pattern observations and imagery patterns on maps or HRSI, their actual positions cannot be determined.
04	Land parcel area does not match the survey document	Identification is based on a comparison between textual land area values and the mapped area, as well as differences between the survey document and the mapped parcel.
05	Indication of uniform land parcels inconsistent with actual field conditions	Uniform parcel shapes that do not match the topographical conditions or actual field conditions are identified through observations of parcel shape patterns and imagery patterns on maps or HRSI.
06	Land parcel has an unrealistic area	National Identification System parcel shapes that do not match the imagery on HRSI require further refinement to obtain a more realistic parcel shape.
07	Land parcel located outside village boundaries	Parcels identified as being outside the administrative boundaries of a village. Analysis is conducted by overlaying parcel data with predefined administrative boundary data.

Once the technical complaints have been grouped into these seven land anomalies, the classification results will be presented in the form of a graph that visualizes the distribution of cases for each of the seven anomalies. This graph will highlight which categories occur most frequently, as well as categories that rarely appear or are not even registered among the complaints in Majalengka District during the 2021–2024 period.

2.2.2. Identification

The previously identified technical complaints were then selected through a sampling process to determine which issues would be further analyzed using forensic cadastre. The purpose of this process was to filter out cases that were eligible for in-depth investigation [39]. The selection was based on the resolution status of the cases, where the selected cases could not be resolved through mediation, had been taken to court, and were still unresolved at the Administrative Court.

After selecting case studies, further identification steps were carried out as follows:

- Data compilation

The initial stage begins with gathering relevant data, such as a land book, measurement letter, land parcel map, measurement drawing, identity card, family card, proof of ownership, statement of physical land possession, and land and building tax. This step ensures that all necessary evidence is available for a comprehensive analysis [39,61,62].

- Data verification

The collected data are carefully examined to ensure compliance. This process aims to prevent errors or manipulation that could affect the results of the forensic cadastre investigation [39,61,62].

- Historical investigation

Land ownership and use history is reviewed to understand the origins of rights, boundary changes, and land use patterns. This involves examining proof of ownership, transfer of rights, tax due notification letters, and statements of physical land possession to accurately reconstruct evidence and reduce information asymmetries between disputing parties [63,64].

- Boundary analysis

The technical evaluation of land boundaries is based on measurement letters, measurement drawings, statements of physical land possession, boundary-determining parties, witnesses, documentation, and satellite imagery. The accurate analysis of these boundaries is essential to determine the location, configuration, and area of disputed land, and it plays a key role in ensuring an objective and legal resolution for land disputes [39,62].

2.2.3. Individualization

After identification, each piece of evidence collected is used to analyze the following four main aspects: structure, design, components, and materials, following forensic engineering principles. Structure refers to an arrangement or system consisting of interconnected elements that support and maintain the stability of the overall system. Design involves planning and technical processes to ensure that the structure functions properly and meets applicable standards. Components are the individual parts within a structure that make up or support the system as a whole. Meanwhile, materials are the substances used to build each structural element [65].

Based on the analogy above, each aspect of the individualization process can be explained as follows:

- Structure refers to a systematically organized framework that involves various important stakeholders to ensure stability and efficiency in resolving land disputes. The framework is based on the Minister of Agrarian and Spatial Planning/Head of the National Land Agency Regulation No. 6/2018 on Complete Systematic Land Registration and Minister of Agrarian and Spatial Planning/Head of the National Land Agency Regulation No. 18-2021 on Procedures for Establishing Management Rights and Land Rights [66,67].

There are five main components involved, as follows:

- The parties in the transaction: This includes sellers, buyers, heirs, and applicants, both individuals and government agencies.
 - Entities responsible for issuing or validating land ownership documents: This includes the Land Deed Official, the Ministry of Environment and Forestry (MoEF), the courts, and the Land Procurement Implementation Committee.
 - Witnesses and local government officials: This group consists of at least two witnesses, the village head, subdistrict head, or equivalent official.
 - Authorities that issue permits: This includes the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency, the Regional Revenue Agency, and the Population and Civil Registration Office.
 - Parties responsible for land measurement and data validation: This includes surveyors, the Head of Complete Systematic Land Registration (PTSL in Indonesia), the Physical Task Force, the Head of PTSL Determination, the Head of Survey and Measurement Section, and the Head of the Land Office or authorized official.
- Design encompasses the systematic planning and development of solutions for resolving land disputes, including regulations on land certificate issuance, as outlined in Government Regulation No. 24 of 1997 [68]. This regulation establishes technical standards for land measurement and mapping, as well as administrative procedures, from collecting physical documents during the application process to issuing certificates, ensuring legal certainty.
 - Components comprise various elements that play roles in building and supporting an integrated framework for resolving land disputes [69]. These elements include human resources (such as survey officers, witnesses, boundary guides, village officials, and decision makers), technology, data processing, and data collection methods.
 - Materials refer to elements that directly contribute to land management and certificate issuance. These include land certificates in analog and electronic formats, each with distinct characteristics and roles in land administration. According to Ministerial Regulation Number 3 of 2023 on Electronic Document Issuance in Land Registration, an electronic certificate is a digital document stored within the electronic land book (LB-el) containing physical and juridical data. The electronic system provided by the Ministry of Agrarian Affairs and Spatial Planning/National Land Agency facilitates data processing, storage, dissemination, and management for land registration [69].

This four-aspect approach provides a structured analytical framework to better understand and effectively resolve land disputes.

2.2.4. Evaluation of Evidence

The evidence obtained during the identification stage will then be interpreted based on the aspects in the individualization stage. This approach allows for a more systematic analysis to identify the sources of non-conformities that lead to land disputes [70,71].

By conducting a systematic interpretation process, inconsistencies can be detected more precisely, whether they stem from one particular aspect or from the interaction of

multiple aspects. In addition, this approach is expected to provide more comprehensive, solution-focused, and objective results, ensuring more accurate recommendations for resolving land disputes effectively and based on solid evidence [39,63].

2.2.5. Validations

This study uses expert judgment as a validation method, given that the complexity of land disputes in forensic cadastre cannot be fully addressed with empirical data or mathematical approaches. The views of experts are important to provide a comprehensive and contextualized analysis of the issues [36,39,72].

Expert judgment is based on a series of questions in the form of a questionnaire, with structured evaluation methods to ensure its validity and reliability. Statistical validation techniques, such as Pearson correlation, were used to analyze the relationship between each questionnaire item and the overall construct, thus guaranteeing the significant contribution of each item in the evaluation [73,74]. In addition, the Cronbach's Alpha value measured the internal consistency of the questionnaire, ensuring that the items assessed the same aspect of forensic cadastre. A high Cronbach's Alpha value (≥ 0.7) indicates a strong reliability, supporting the robustness of expert judgment in handling land disputes [73–76].

3. Result and Analysis

3.1. Complaint Distribution Map and Graph of Technical Land Dispute Complaints

Based on the collection of data regarding land disputes in Majalengka from 2021 to 2024, a map displaying the distribution of complaints is created, as shown in Figure 3. This map illustrates the location and frequency of complaints, making it easier to identify areas with a high concentration of land disputes. Of all the complaints received, approximately 84% fall into the category of legal complaints, although this aspect is not the main focus of this study. In addition, technical complaints related to the physical and spatial aspects of land also arise, including issues of boundary determination and land plot location, as well as cases of overlapping land plots.

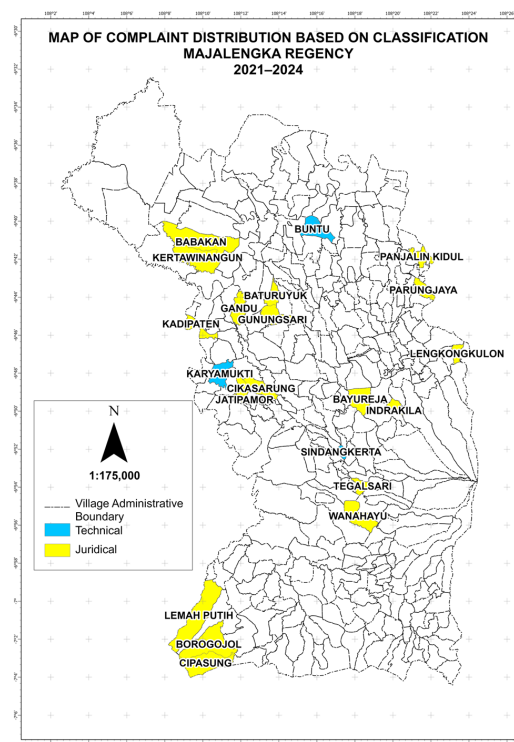


Figure 3. Complaint distribution map.

Based on the typology of the seven land anomalies, Boundary/Parcel Location Determination is classified as “Land parcel, not in the correct position”, with one reported case in Buntu Village, Ligung District. Meanwhile, Overlapping Land Parcels fall under the category of “Overlapping land parcels identified”, with two reported cases in Indangkerta Village, Maja District, and Karyamukti Village, Panyingkiran District. The distribution of these technical complaints can be further observed in the graph presented in Figure 4.

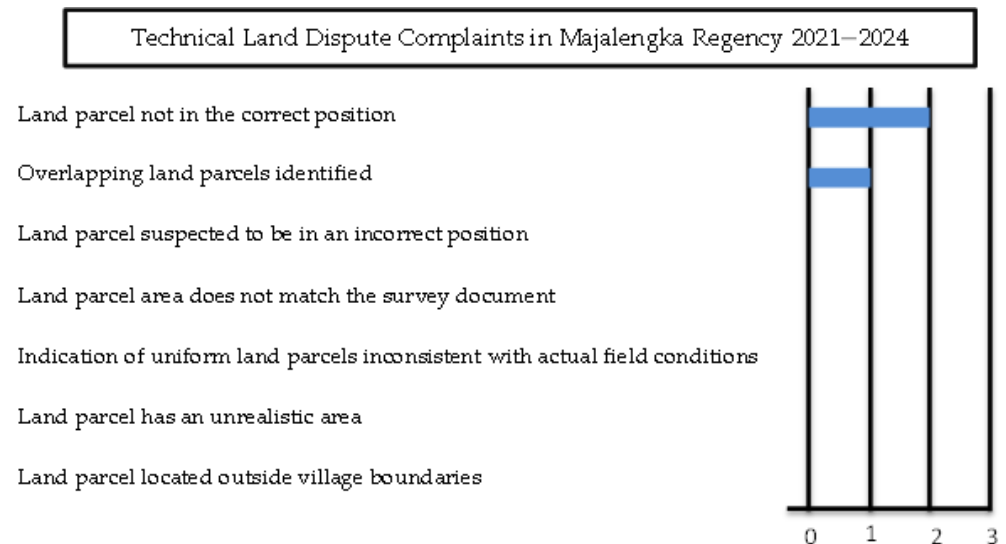


Figure 4. Technical land dispute complaints.

3.2. Unresolved Case Selected

Out of three technical land dispute complaints, two cases were successfully resolved through mediation in 2021 and 2023. Both cases had similar issues, namely, the applicants claimed that the boundary of the respondent’s land violated their land boundary, based on the land plot map accessed through the Bumi ATR/BPN website (<https://bhumi.atrbpn.go.id/> accessed on 10 March 2021). This dispute was relatively easy to resolve because it only involved two parties (the applicant and the respondent) and did not involve state-owned land. The issue was caused by a graphic mapping error that did not affect the area of land owned by the parties or the neighboring lands. Through the mediation process, it was agreed that the land boundaries would be determined according to each party’s certificate, without any change in area, only positional adjustments. With this agreement, both parties felt that they were not at a disadvantage. Illustrations of the land boundary conditions before and after mediation are shown in Figure 5.

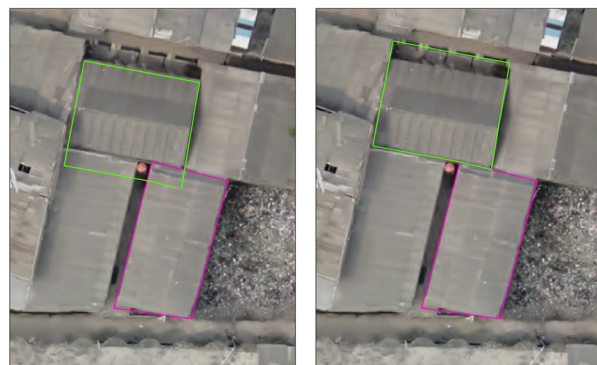


Figure 5. Illustration of ‘land parcel not in the correct position’: before (left) and after (right) the mediation process. Green represents applicant’s land; red represents respondent’s land.

Meanwhile, the unresolved case involved state-owned land and three private lands. This case was raised in 2023 and was caused by overlapping land parcels. As shown in Figure 6, land plots A, B, and C overlap, affecting nearly half of their total area. This case cannot be resolved through mediation, because if one party wins, the other party will suffer significant losses. Although three stages of mediation efforts have been carried out, no solution acceptable to both parties has been achieved. Therefore, this case was chosen as the focus of this study.

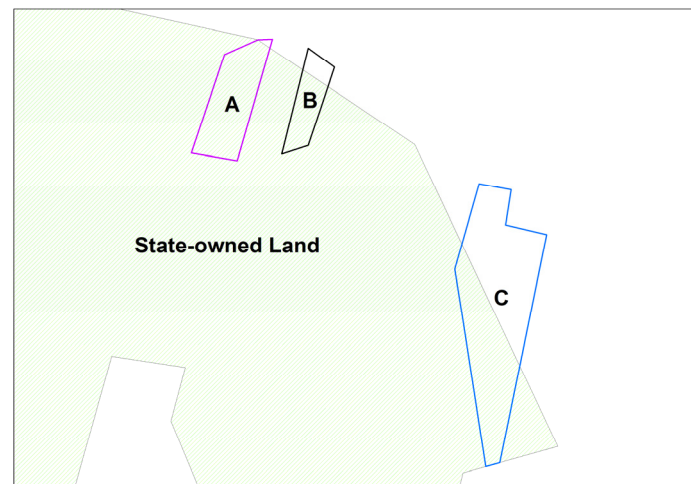


Figure 6. Overlap between state-owned land and parcels owned by A, B, and C.

3.3. Results of Document Collection and Verification

After the case study was selected, a document collection and verification process was carried out. Table 3 lists the details of the documents collected and verified for each involved party.

Table 3. Document Collection and Verification.

Parcel	Land Book	ML	LPM	MD	IC	FC	Proof of Ownership	SPLP	LBT
State-Owned Land	✓	✓	✓	✓	✓	✓	✓	✓	✓
Owner A (Ownership Rights)	✓	✓	✓	✓	✓	✓	✓	✓	✓
Owner B (Ownership Rights)	✓	✓	✓	✓	✓	✓	✓	✓	✓
Owner C (Ownership Rights)	✓	✓							

✓ Indicates document compliance for collection and verification by all parties.

The verification results show that Owner C only has two out of the nine collected documents. This indicates that Owner C has incomplete documentation and records, as the other parties have all seven documents.

3.4. Result of Historical Investigation and Boundary Analysis

The collected and verified documents were then used for a historical investigation to trace land ownership, track changes in land status over time, and prevent encroachment or document forgery. The results of this historical investigation are presented in Table 4, with a detailed description in Table 5.

Table 4. Results of historical investigation.

Parcel	Proof of Ownership				Transfer of Rights	Tax Due Notification Letter	SPLP
	Deed of Sale/Grant	Girik/Letter C/Petok D	Court Decision	Other Proof of Ownership			
Applicant: State-Owned Land (Right of Use)			✓		✓	✓	✓
Owner A (Ownership Right)				✓ (Orally)	✓ (Orally)	✓	✓
Owner B (Ownership Right)	✓				✓	✓	✓
Owner C (Ownership Right)							

✓ indicates compliant documents from each party during historical investigation.

Description: Girik, Letter C, and Petok D were documents used as proof of land tax payments in the past, but do not serve as legal proof of ownership based on the Supreme Court of the Republic of Indonesia Decision No. 34/K/Sip/1960, dated 19 February 1960 [77].

Table 5. Description of the historical investigation results.

Components of Historical Investigation	Description
Proof of ownership	- Owner A - Statement of Sale and Purchase Agreement between Owner A and X made orally in 1996 for land previously registered under kohir (a colonial-era land tax record as proof of payment)/C/TDNL No.—Parcel xxx Type/Class xxx ± 450 m², located on Jalan/BLOK PARANGGONG, Buntu Village/Subdistrict. - Excerpt from Village C Book of Buntu, Parcel xxx, Class xxx. - Certificate of Former Customary Land No. xxx/xxx/Des/2018. - Owner B - Statement of Acceptance of Gift for land previously registered under kohir (a colonial-era land tax record as proof of payment)/C/TDNL No—Parcel xxx Type/Class xxx ± 285 m², recorded under the name B, located on Jalan/Blok PARANGKONG II, Buntu Village/Subdistrict. - Certificate of Former Customary Land No. xxx/xxx/Des/2018. - Owner C - No basis of rights available. - State-Owned Land - Governor's Decree No. xxx.xx/S.K.xxx/DITAG/1986 dated October 1986.

Table 5. Cont.

Components of Historical Investigation	Description
Transfer of Rights	• Owner A ○ Statement of Sale and Purchase Agreement between A and X made orally in 1996 and registered through the PTSL Program in 2018. • Owner B ○ Statement of Acceptance of Gift and registered through the PTSL Program in 2021. • Owner C ○ No supporting documents for transfer of rights. • State-Owned Land ○ Governor's Decree No. xxx.xx/S.K.xxx/DIRECTORATE OF AGRARIAN ARRANGEMENT/1986 dated October 1986, followed by the granting of rights.
Land and Building Tax Notification Letter (SPPT)	• Owner A ○ Photocopy of TDNL for 2017, NOP: 32.xx.xxx.xxx.xxx-xxxx.0 in the name of X, covering $\pm 450 \text{ m}^2$. • Owner B ○ Original TDNL, NOP: 32.xx.xxx.xxx.xxx-xxxx.0 in the name of X, covering $\pm 285 \text{ m}^2$. • Owner C ○ No TDNL available. • State-Owned Land ○ Photocopy of Tax Payment Receipt, based on the Minister of Home Affairs Regulation No. x/19xx.
Statement of Physical Land Possession	• Owner A ○ Statement of Physical Land Possession dated 9 September 20xx, made by X (Respondent) and acknowledged by the Head of Buntu Village. • Owner B ○ Statement of Physical Land Possession dated 9 February 20xx, made by X (Respondent) and acknowledged by the Head of Buntu Village. • Owner C ○ No Statement of Physical Land Possession available. • State-Owned Land ○ Statement of Physical Land Possession based on the Governor's Decree.

Among the four components of this historical investigation, the most crucial is proof of ownership, as this serves as the legal basis for the issuance of ownership rights. Proof of ownership documentation may take various forms, as outlined in the categories presented in Table 4. Based on this consideration, the following irregularity was identified: Owner A provided proof of ownership and the transfer of rights only orally, which is legally weak and not recognized as valid evidence [78]. In contrast, the owner of Parcel C failed to submit any supporting documents, including proof of ownership, which is the most fundamental requirement in land rights verification.

The following process involved boundary analysis. This step is crucial, especially since overlapping land parcels caused the case. The results of each component used for the

boundary analysis are presented in Table 6, with a visualization of the overlapping areas based on satellite imagery shown in Figure 7.

Table 6. Results of boundary analysis.

Parcel	ML	MD	SPLP	Boundary Determining Authority	Wit- ness	Documentation	Satellite Imagery	Boundary Document Compliance	
								Yes	No
State-Owned Land	✓	✓	✓	✓	✓	✓	✓	✓	
Owner A	✓	✓	✓	✓	✓	✓	✓	✓	
Owner B	✓	✓	✓	✓	✓	✓	✓	✓	
Owner C	✓	✓		✓			✓		

✓ indicates compliant documents from each party during boundary analysis.



Figure 7. Satellite imagery of Parcels A, B, C, and state-owned land.

Each document listed in Table 6 plays an equally important role in boundary analysis, as boundary determination requires not only quantitative data, but also visual evidence and the involvement of authorized parties to define and verify boundaries. Based on the evidence review, the boundary accuracy of Owner C's land cannot be confirmed and is considered weak due to the absence of complete supporting documents.

3.5. Structure, Design, Components, and Materials Analysis

The next step is to identify and analyze potential errors in structure, design, components, and materials based on the evidence collected.

Regarding structure, which includes the parties involved in land certificate issuance, the analysis of Parcels A, B, and C refers to the Minister of Agrarian Affairs and Spatial Planning/Head of the National Land Agency Regulation No. 6 of 2018 on Systematic Complete Land Registration. Meanwhile, the structural analysis of state-owned land refers to the Minister of Agrarian Affairs and Spatial Planning/Head of the National Land Agency Regulation No. 18 of 2021 on Procedures for Determining Management Rights and Land Rights [66,67].

The parties involved in issuing certificates for disputed land complied with the established standards, with details presented in Tables 7 and 8.

Table 7. Results of structure analysis for Parcels A, B, and C.

No	Structure	Parcel A	Parcel B	Parcel C
		Compliance		
1	Basis of Rights Includes:			
	a. Written statement of verbal sale and purchase signed by witnesses and acknowledged by the village head.	✓		
	b. The deed of sale and purchase was signed by both parties, two witnesses, and the village head and legalized by the land deed official.			
	c. Two witnesses and the village head acknowledged the statement of grant.		✓	
	d. The inheritance statement was acknowledged by other heirs, two witnesses, and the village head.			
2	Statement of Physical Land Possession acknowledged by two witnesses and signed on stamp duty by the owner.	✓	✓	
3	Photocopy of Identity Card and Family Card issued by the Civil Registry Office.	✓	✓	
4	Photocopy of the latest Land and Building Tax Notification Letter issued by the Regional Revenue Agency	✓	✓	
5	Research report on juridical data legalized by the Head of PTSL Determination	✓	✓	
6	Land parcel measurement conducted by a surveyor.	✓	✓	✓
7	LPM, MD, and ML were examined and legalized by the head of the PTSL Physical Task Force.	✓	✓	✓
8	The land book was reviewed and authorized by the Head of PTSL Determination	✓	✓	✓
9	The land certificate is validated by the head of the land office or an authorized official (Head of PTSL Determination).	✓	✓	✓

✓ indicates the completion of each structural analysis stage for land parcels A, B, and C.

Table 8. Results of structure analysis for state-owned land.

State-Owned Land		
No	Structure	Compliance
1	The applicant's identity (government agency) or the applicant's identity and their representative (photocopy of the representative's ID card) along with a power of attorney, if authorized.	✓
2	Basis of Land Ownership:	
	Certificate, deed of rights transfer, deed/document of relinquishment of rights, land allocation or purchase letter, decision on forest area release from the authorized institution (MoEF), auction minutes, court ruling, or other proof of land acquisition.	✓
	In the case of land acquisition for public interest development, the proof of land acquisition is in the form of a handover report following applicable laws and regulations (issued by the Land Procurement Implementation Committee, usually under the coordination of the Ministry of Agrarian Affairs and Spatial Planning/Head of the National Land Agency or the Regional Government).	
	If the proof of land acquisition as mentioned above is entirely unavailable:	
	(1) Physical possession of the land must be stated in a declaration of physical land possession, witnessed by at least two local witnesses familiar with the land's history, have no family relation, and acknowledged by the village head/sub-district head or an equivalent authority.	
	(2) Accompanied by an asset possession declaration letter.	

Table 8. Cont.

State-Owned Land		
No	Structure	Compliance
3	Legislation on institutional formation.	✓
4	Permit documents include: KKPR is issued by the Central Government (Ministry of Agrarian Affairs and Spatial Planning/Head of the National Land Agency).	✓
	Location determination for land acquisition in public interest development. Business licensing issued by the Central Government (Ministry of Agrarian Affairs and Spatial Planning/Head of the National Land Agency) for reclamation execution if the requested land is reclaimed land.	
5	Land parcel measurement conducted by a surveyor.	✓
6	LPM, MD, and ML have been examined and approved by the Head of the Survey and Measurement Section or the authorized official.	✓
7	The Land Book has been reviewed and authorized by the Head of the Land Office or an authorized official.	✓
8	The Land Certificate has been validated by the Head of the Land Office or an authorized official.	✓

✓ indicates the completion of each structural analysis stage for stated-owned land.

After analyzing the structural aspects of the land certificate issuance process, the next step is to examine the design aspects related to the certificate issuance mechanism. Since all the land certificates in this case study were issued before the regulations on electronic certificates under Law No. 1 of 2021 came into effect, the process followed the implementation stages outlined in Government Regulation No. 24 of 1997, as shown in Table 9 [68].

Table 9. Results of design analysis.

No.	Stage	Owner A	Owner B	Owner C	State-Owned Land
Compliance					
1	Collection and processing of physical data				
	a. Creation of the base map for registration.	✓	✓	✓	✓
	b. Determination of land parcel boundaries.	✓	✓	✓	✓
	c. Measure and map land parcels and create the registration map.	✓	✓	✓	✓
	d. Preparation of the land register.	✓	✓	✓	✓
	e. Preparation of the measurement certificate.	✓	✓	✓	✓
2	Proof of rights and registration.	✓	✓	✓	✓
3	Issuance of the certificate.	✓	✓	✓	✓
4	Presentation of physical and legal data.	✓	✓	✓	✓
5	Storage of the general register and documents.	✓	✓	✓	✓

✓ indicates the completion of each design analysis stage by all parties.

Based on Table 9, the issuance processes for the Owner A, Owner B, Owner C, and state-owned land certificates complied with the requirements set forth in the applicable regulations. For individual land rights holders, in this case, a certificate can be issued if no objections are raised within one month. Meanwhile, for state-owned land, the issuance process does not require a public announcement but is carried out through a decree issued by the Head of the Land Office or the Regional Office. During the designated one-month

objection period, no objections or disputes were raised regarding the Owner A, Owner B, Owner C, or state-owned land certificates.

After reviewing the design aspects of the land certificate issuance mechanism, the next step is to analyze the components involved in resolving the land issues between Owner A, Owner B, Owner C, and the state-owned land. These components include human resources, decision makers from relevant organizations, the technology used, and the data collection process in the field, as presented in Table 10.

Table 10. Results of component analysis.

Parcel	Human Resources				
	Survey Officer	Witness	Boundary Guide	Village Officials	Decision Maker
Owner A	✓	✓	✓	✓	✓
Owner B	✓	✓	✓	✓	✓
Owner C	✓	✓	✓	✓	✓
State-Owned Land	✓	✓	✓	✓	✓
Parcel	Technology		Data Processing		Data Collection
	Tools	Method	Computer	Manual	Satellite Imagery / Aerial Photography
Owner A	GNSS Receiver	GPS	✓	-	✓
Owner B	GNSS Receiver	GPS	✓	-	✓
Owner C	GNSS Receiver	GPS	✓	-	✓
State-Owned Land	Measuring Tape	-	-	✓	✓

✓ indicates the completion of each aspect within the analysis components by all parties.

As the final stage in the individualization process, the material aspect becomes the focus of analysis in resolving the land issues in this case study. All the examined land parcels use analog certificates and have fulfilled the certificate components, including the land register, measurement letter, land parcel map, and survey drawing. However, one parcel, namely Parcel C, lacks the *warkah* document, even though this document serves as the primary basis for issuing land certificates.

Among the four aspects analyzed during the individualization stage, structure and design are the most critical, as they play key roles in identifying the relevant parties and determining the procedural mechanisms for land certificate issuance. The land certificate itself serves as the primary legal instrument that establishes the legitimacy of land ownership.

3.6. Interpretation Results in Evaluation

After completing the analysis in the individualization stage, the next step is to proceed to the evaluation stage. In this phase, the evidence gathered during the identification process is analyzed in greater depth to examine each aspect of the individualization process. Through this evaluation, the evidence is further scrutinized to identify the key factors contributing to the underlying issues, with the mapping of potential failures presented in Table 11.

Based on Table 11, it was identified that the primary sources of issues or non-compliance with the applicable regulations stemmed from Owner C, followed by Owner A. Meanwhile, the review of Owner B's ownership and state-owned land showed no issues. Therefore, the following recommendations are proposed:

Table 11. Interpretation result.

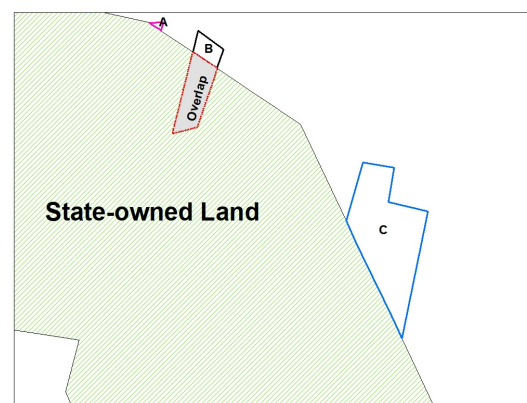
	Stages	Potential Failures or Sources of Issues			
		State-Owned Land	Owner A	Owner B	Owner C
Identification	Collection and verification of documents				
	Historical investigation				
	Boundary analysis				
Individualization	Structure				
	Design				
	Component				
	Material				

Red color highlights potential failures or sources of issues for each landowner.

The certificates of Owner A and Owner C should be reassessed, and if significant discrepancies are found, the certificates may be canceled. If Owners A and C cannot prove the validity of their land ownership, their claims will be considered void, and the land overlapping with state-owned land should be transferred to state ownership.

Owner B and the authorities managing the state-owned land should clarify the land boundaries to ensure legal certainty regarding land ownership. Since the documents held by both parties have equal legal weight, the policies that can be implemented include discussions for land area division. If the state refuses to divide the land, the state should consider purchasing the land from Owner B that overlaps with the state-owned land.

As an illustration, the visualization of the recommendations for each land parcel can be seen in Figure 8.

**Figure 8.** Recommendations for land dispute case.

The application of forensic cadastre enables a comprehensive examination of the evidence presented by each disputing party, thereby facilitating objective and well-informed recommendations. This methodological approach is expected to be applicable in other land dispute cases to support fair, transparent, and effective resolution processes.

3.7. Validations Result

The validation process of this study involved 43 respondents consisting of practitioners in the field of cadastre and decision makers. The main objective was to ensure that each stage based on forensic science and engineering can be applied in the cadastral forensic process. Validation was conducted through Google Forms with a rating scale from one to four, where a score of one indicated incompatibility and a score of four reflected a high level of suitability. Thus, this validation aimed to ensure that the stages of forensic science and forensic engineering are relevant in the context of cadastre to address land dispute issues. The questions posed are as follows:

The suitability of complaint classification based on case typology for effectively grouping complaints (Q1).

The accuracy of technical complaint typology based on the seven land anomalies in identifying technical issues (Q2).

The appropriateness of sample selection based on resolution status for determining cases for further analysis (Q3).

The relevance of document collection as a step in identifying complaint cases (Q4).

The necessity of data verification to ensure the accuracy of information in resolving complaints (Q5).

The role of historical investigation in gaining a deeper understanding of complaint contexts (Q6).

The suitability of boundary analysis in determining the legal aspects of complaint cases (Q7).

The accuracy of the individualization process, which categorizes evidence analysis into four categories (structure, design, components, and materials) to identify errors in unresolved cases (Q8).

Forensic cadastre procedures are necessary even when previous steps have followed standard protocols (Q9).

The accuracy of the research validation for applying forensic cadastre in land dispute resolution (Q10).

The detailed responses from the experts are presented in Table A1. The validity and reliability tests of the questionnaire used for the validation process were conducted using IBM SPSS Statistics version 23.0 Desktop. The results of the validity test showed that 80% of the total correlations had a p -value below 0.05, indicating a good internal validity and the ability of the items to consistently measure the intended construct. Although 20% of those correlations were invalid, the proportion that was valid was much higher, indicating that this questionnaire still had a high level of reliability in evaluating each stage of cadastral forensics to resolve land disputes. The detected invalidity may have been caused by weak relationships between some of the questioned variables, differences in respondents' interpretations, or external factors influencing the answers. This phenomenon is common in questionnaires, especially those involving complex variables.

In addition to validity, the reliability of the questionnaire was also tested, with a Cronbach's Alpha result of 0.855 for 10 items. A value above 0.8 indicates a high internal consistency, so the instrument can be considered as reliable for assessing the forensic cadastre methodology.

4. Conclusions

Based on the research conducted, it was found that the forensic cadastre approach, which integrates forensic science and forensic engineering steps, can more effectively, thoroughly, and systematically resolve land disputes that have not been settled by traditional methods such as mediation. Validation was conducted by distributing questionnaires to experts in the field of cadastre and policymakers. This instrument was tested for validity and reliability, with a validity result above 80% and a Cronbach's Alpha value of 0.855. This indicates that the questionnaire can consistently measure the intended construct and has a high internal consistency.

Although the forensic cadastre approach in this study showed positive results, reinforcement is needed to enhance their reliability. The evaluation of human resources involved in the creation of land certificates is very important, considering that land certificates are key documents in proving the legal status of a piece of land. With an objective and measurable assessment system, the certification process can run more efficiently and in

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The following abbreviations are used in this manuscript:

Appendix A

Table A1. Results of the expert judgment questionnaire.

[illegible]

Table A1. Cont.

Current Position	Location	Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	Q.8	Q.9	Q.10
Head of Cadastral Measurement Section, Kantah Kab. Sukabumi	Sukabumi District Land Office	3	3	3	4	4	3	3	3	3	4
Mapping Analysis	Majalengka District Land Office	4	4	4	4	4	4	4	3	4	4
General Administration Assistant	Majalengka District Land Office	3	3	3	3	3	3	3	3	3	3
Mapping Analysis	Majalengka District Land Office	4	4	4	4	4	3	4	4	4	4
Measurement Officer	Majalengka District Land Office	4	4	4	4	4	4	4	4	4	4
Survey, Measurement, and Mapping Analyst	Majalengka District Land Office	3	4	3	3	4	4	3	3	3	3
Head of Sub Directorate	Badan Pengembangan Sumber Daya Manusia	4	3	4	4	4	4	3	4	3	4

References

- Subedi, G.P. Land Administration and Its Impact on Economic Development. Ph.D. Thesis, University of Reading, Reading, UK, 2016.
- Barnes, G.; Enemark, S. Land Tenure Security: An Essential Component of Responsible Land Administration. In *FIG Working Week 2020 Smart Surveyors for Land and Water Management*; International Federation of Surveyors: Amsterdam, The Netherlands, 2020; p. 20.
- Lemmen, C.; Oosterom, P.; Bennett, R. The land administration domain model. *Land Use Policy* **2015**, *49*, 535–545. [\[CrossRef\]](#)
- Byamugisha, F.; Dubosse, N. The Investment Case for Land Tenure Security in Sub-Saharan Africa: A Cost–Benefit Analysis. *J. Benefit-Cost Anal.* **2023**, *14*, 272–300. [\[CrossRef\]](#)
- Sugito, N.; Gumilar, I.; Hendriatiningsih, S.; Leksono, B. Integration of Market Price Comparison Approach and Income Capitalization Approach in Urban Land Valuation. *IOP Conf. Ser. Earth Environ. Sci.* **2023**, *1127*, 012036. [\[CrossRef\]](#)
- Makgobi, G.; Nokulunga, M.; Didi, T.; Clinton, A. Effects of Land Administration on RDP Land and Buildings-A Case of Alexandra Township. In *The Construction Industry in the Fourth Industrial Revolution*; Springer: Berlin/Heidelberg, Germany, 2019. [\[CrossRef\]](#)
- Anim-Odame, W. *Land Administration in Ghana: The New Agenda*; African Real Estate Society: Johannesburg, Gauteng, 2018. [\[CrossRef\]](#)
- Enemark, S. Facing the Post 2015 Global Agenda: The Role of Land Governance and Land Professionals. In *Recovery from Disaster: FIG Working Week 2016*; International Federation of Surveyors: Amsterdam, The Netherlands, 2016; Available online: https://vbn.aau.dk/ws/files/233533937/Christchurch_Paper_ID_8332_Global_Agenda_Enemark.pdf (accessed on 17 March 2025).
- Bennett, R.; Oosterom, P.; Lemmen, C.; Koeva, M. Remote Sensing for Land Administration. *Remote Sens.* **2020**, *12*, 2497. [\[CrossRef\]](#)
- Rupasinghe, K. Formalizing Land Administration through E-Governance Mechanism in Sri Lanka. *Intell. Inf. Manag.* **2021**, *13*, 214–231. [\[CrossRef\]](#)
- Dhiaulhaq, A.; McCarthy, J.; Yasmi, Y. Resolving industrial plantation conflicts in Indonesia: Can mediation deliver? *For. Policy Econ.* **2017**, *91*, 64–72. [\[CrossRef\]](#)
- Lee, J.W. A study on the origins of territorial disputes in Northeast Asia and a nationalistic approach. *Korean Assoc. Area Stud.* **2021**, *39*, 149–168. [\[CrossRef\]](#)
- Bukh, A. *These Islands Are Ours*; Walter de Gruyter GmbH: Berlin, Germany, 2020. [\[CrossRef\]](#)
- Igarashi, A. Territorial Conflicts and Japanese Attitudes Towards East Asian Countries: Natural Experiments with Foreigners' Landings on Disputed Islands. *Polit. Psychol.* **2018**, *39*, 977–992. [\[CrossRef\]](#)
- Jenne, N. Managing Territorial Disputes in Southeast Asia: Is There more than the South China Sea? *J. Curr. Southeast Asian Aff.* **2017**, *36*, 35–61. [\[CrossRef\]](#)
- Mia, M.R.; Tao, J.; Anderson, C.D. The South China Sea Dispute and Regional Response. *Quest J. Manag. Soc. Sci.* **2024**, *6*, 74–86. [\[CrossRef\]](#)
- Saputra, M.R.S.K. Examining Dispute Settlement Under the Asean Charter: Analyzes Indonesia's Handling of Violations in the Ambalat Block Dispute and the Status of Sipadan and Ligitan Islands. *Probl. Huk.* **2024**, *10*, 39–54. [\[CrossRef\]](#)

18. Eilenberg, M. Shades of green and REDD: Local and global contestations over the value of forest versus plantation development on the Indonesian forest frontier. *Asia Pac. Viewp.* **2015**, *56*, 48–61. [\[CrossRef\]](#)
19. Riggs, R.; Sayer, J.; Margules, C.; Boedhihartono, A.; Langston, J.; Sutanto, H. Forest tenure and conflict in Indonesia: Contested rights in Rempuk Village, Lombok. *Land Use Policy* **2016**, *57*, 241–249. [\[CrossRef\]](#)
20. Tsaqif, A.M.; Situmorang, L.R.; Rajabi, Z.; Tarina, D.D.Y. Analysis of Land Disputes Between PT Freeport Indonesia, the Indonesian Government and the Papuan Community. *JISIP (Jurnal Ilmu Sos. Pendidikan)* **2024**, *8*, 1576–1582. [\[CrossRef\]](#)
21. Yustini, L.W. Land Dispute Arrangements in Indonesia. *J. Kepastian Huk. Keadilan* **2023**, *5*, 12–27. [\[CrossRef\]](#)
22. Zandroto, K.A.; Marsella, M.; Nasution, A.H. Tinjauan Yuridis Penyelesaian Sengketa Terhadap Alas Hak Atas Tanah (Studi Putusan Nomor: 347/PDT/2014/PT-Mdn). *JUNCTO J. Ilm. Huk.* **2021**, *3*, 156–165. [\[CrossRef\]](#)
23. Sabdaningtyas, Y.; Dewi, P.M. Legal Certainty and Procedural Justice in Land Management in Indonesia: Ensuring Rights Protection and Effective Dispute Resolution. *Mimb. Keadilan* **2024**, *17*, 210–222. [\[CrossRef\]](#)
24. Ramadhani, R. Legal Protection for Land Rights Holders Who Are Victims of the Land Mafia. *Int. J. Reglem. Soc.* **2021**, *2*, 87–95. [\[CrossRef\]](#)
25. Claudia, J. Settlement of Land Disputes with the Competence of the State Administrative Court According to the Perspective of Indonesian Law. *Asian J. Soc. Humanit.* **2023**, *1*, 399–406. [\[CrossRef\]](#)
26. Kocur-Bera, K.; Frąszczak, H. Coherence of Cadastral Data in Land Management—A Case Study of Rural Areas in Poland. *Land* **2021**, *10*, 399. [\[CrossRef\]](#)
27. Cienciała, A.; Sobolewska-Mikulska, K.; Sobura, S. Credibility of the cadastral data on land use and the methodology for their verification and update. *Land Use Policy* **2021**, *102*, 105204. [\[CrossRef\]](#)
28. Tykhenko, O.; Bavrovska, N. Cadastral data as a basis for rational use and protection of land. *Balt. Surv.* **2020**, *13*, 64–69. [\[CrossRef\]](#)
29. Fetai, B.; Tekavec, J.; Fras, M.; Lisec, A. Inconsistencies in Cadastral Boundary Data—Digitisation and Maintenance. *Land* **2022**, *11*, 2318. [\[CrossRef\]](#)
30. Yagol, P.; Dangol, S.; Joshi, P. Cadastre in Nepal: Need for 3D and Way Towards 4D. *J. Geoinform. Nepal* **2024**, *23*, 9–17. [\[CrossRef\]](#)
31. Hassanzadeh, A. 236 The role of Cadastre in consolidating ownership in the Developing country (case study: Iran). *Int. J. Res. Appl. Sci. Eng. Technol.* **2018**, *6*, 236–246. [\[CrossRef\]](#)
32. Stupen, N.; Melnyk, M. Prerequisites for the emergence of 3D-cadastre in Ukraine. *Mod. Achiev. Geod. Sci. Ind.* **2022**, *2*, 11–15. [\[CrossRef\]](#)
33. Grant, D.; Enemark, S.; Zevenbergen, J.; Mitchell, D.; McCamley, G. The Cadastral triangular model. *Land Use Policy* **2020**, *97*, 104758. [\[CrossRef\]](#)
34. Koshkalda, I.; Dombrovska, O.; Sopov, D.; Butov, A. Geoinformation Technologies in Industrial Cadastre: Directions of Development. *Ukr. J. Appl. Econ.* **2021**, *6*, 249–258. [\[CrossRef\]](#)
35. Fraser, J. 1 What is forensic science? In *Forensic Science: A Very Short Introduction*; Oxford Academic: Oxford, UK, 2020. [\[CrossRef\]](#)
36. Ahluwalia, J.K.; Sharma, R. The Role of Forensic Science in Criminal Investigation. *Int. J. Multidiscip. Res.* **2023**, *3*, 1–4. [\[CrossRef\]](#)
37. Kumar, V.; Bhalavi, K. Anugya Identification and Mapping of Encroachment at Plot Level for Delhi-Saharanpur Road Housing Scheme of Uttar Pradesh Awastha Vikas Parishad, Ghaziabad, India, using Worldview Satellite Data, GIS & GPS Techniques. *Int. J. Eng. Res. Technol.* **2015**, *4*, 124–129.
38. Eldo, J.; Ntantis, E. Satellite Mapping and Demarcation Analysis for Coastal Regulation Zones Assessment. *Environ. Res. Commun.* **2024**, *6*, 075023. [\[CrossRef\]](#)
39. Butyrin, A.; Zhukova, O.; Stativa, E. Typical Forensic Situations Arising When Considering Land Disputes. *Theory Pract. Forensic Sci.* **2020**, *14*, 19–31. [\[CrossRef\]](#)
40. Kozlova, A.; Golyakova, Y. The role of forensic examination in judicial practice. *E3S Web Conf.* **2019**, *110*, 02120. [\[CrossRef\]](#)
41. Salov, S.; Antropov, D.; Ruleva, N.; Samoilenko, D.; Smirnova, M. Forensic land surveying: Accuracy data testing through a computer-graphic model. *IOP Conf. Ser. Earth Environ. Sci.* **2021**, *867*, 012175. [\[CrossRef\]](#)
42. Xia, X.; Persello, C.; Koeva, M. Deep Fully Convolutional Networks for Cadastral Boundary Detection from UAV Images. *Remote Sens.* **2019**, *11*, 1725. [\[CrossRef\]](#)
43. Mubarik, N. Importance and Role of Physical Evidences in Forensic Science. *Acad. J. Forensic Sci.* **2019**, *02*, 18–22.
44. Sijen, T.; Harbison, S. On the Identification of Body Fluids and Tissues: A Crucial Link in the Investigation and Solution of Crime. *Genes* **2021**, *12*, 1728. [\[CrossRef\]](#)
45. Fikiet, M.; Khandasammy, S.; Mistek, E.; Ahmed, Y.; Halámková, L.; Bueno, J.; Lednev, I. Forensics: Evidence examination via Raman spectroscopy. *Phys. Sci. Rev.* **2018**, *4*, 20170049. [\[CrossRef\]](#)
46. Kumar, A.; Singh, J. Significance of Blood and its Identification: A Perspective in Forensic Investigation. *Vigyan Varta* **2020**, *1*, 5–9.
47. Biedermann, A.; Bozza, S.; Taroni, F.; Garbolino, P. A formal approach to qualifying and quantifying the ‘goodness’ of forensic identification decisions. *Law Probab. Risk* **2018**, *17*, 295–310. [\[CrossRef\]](#)
48. Cole, S. Individual and collective identification in contemporary forensics. *Biosocieties* **2018**, *15*, 350–375. [\[CrossRef\]](#)

49. Johnson, J.; Chitra, R. Survey on the investigation of forensic crime scene evidence. *Int. J. Model. Simul. Sci. Comput.* **2022**, *13*, 2250047. [[CrossRef](#)]
50. Trifonova, Z. Establishment of Forensic Land Surveying in the System of Forensic Science Organizations of the Russian Ministry of Justice. *Theory Pract. Forensic Sci.* **2018**, *13*, 43–49. [[CrossRef](#)]
51. Tretiak, M. Modern Institutional Problems of Forensic Land-Technical Examination. *Forensic Sci. Forensic Exam.* **2020**, 519–524. [[CrossRef](#)]
52. Phuong, N.T.; Van, T.T.T.; Huyen, D.T.N.; Khoe, T.T. Law on Complaints Related to the Land Field: A Qualitative Study in Vietnam. *Trans. Chinese Soc. Agric. Mach.* **2024**, *55*. [[CrossRef](#)]
53. Thaariq, Y.A.; Saputra, M. Penyelesaian Sengketa Tanah di Desa Bitahan Baru Kabupaten Tapin Melalui Mediasi oleh Kepala Desa. *J. Penegakan Huk. Indones.* **2023**, *4*, 1–13. [[CrossRef](#)]
54. Rembang, P.; Lasut, J.J.; Kandowangko, N. Peranan Tokoh Masyarakat Dalam Penanganan Masalah Sengketa Tanah Di Desa Sulu Kecamatan Tatapaan Kabupaten Minahasa Selatan. *Holistik* **2018**, 1–18.
55. Kementerian Agraria dan Tata Ruang. *Peraturan Menteri Agraria Dan Tata Ruang/Kepala Badan Pertanahan Nasional Republik Indonesia Nomor 8 Tahun 2018 Tentang Pengelolaan Pengaduan di Lingkungan Kementerian Agraria Dan Tata Ruang/Badan Pertanahan Nasional*; Kementerian Agraria dan Tata Ruang: Jakarta, Indonesia, 2018.
56. Alekseeva, N.; Syrykh, E.; Panchenko, V.; Vlasenko, V.; Makarchuk, I. The Application of Classification of Land Disputes in Judicial Practice. In *XIV European-Asian Law Congress “The Value of Law” (EAC-LAW 2020)*; Atlantis Press: Paris, France, 2020; pp. 228–232. [[CrossRef](#)]
57. Chudyk-Bilousova, N.; Taranenko, L. The Essence and Methods of Resolving Land Disputes. *Univ. Sci. Notes* **2020**, 257–273. [[CrossRef](#)]
58. Tyska, M.; Smoliński, T. Sposób ukształtowania obligatoryjnych elementów skargi o stwierdzenie niezgodności z prawem prawomocnego orzeczenia a jego wpływ na skuteczność dochodzenia roszczeń odszkodowawczych od Skarbu Państwa. *Kortowski Przegląd Praw.* **2021**, 77–92. [[CrossRef](#)]
59. Darmawan, M.I.; Suryawati, N. Analisa Yuridis Tentang Legalitas Alat Pembuktian Dalam Pembatalan Sertifikat Hak Milik Dan Kewenangan Badan Peradilan (Studi Kasus Putusan PN Surabaya Nomor 810/Pdt.G/2014/PN.Sby). *Wajah Huk.* **2024**, *8*, 74–83. [[CrossRef](#)]
60. Kementerian Agraria dan Tata Ruang/Badan Pertanahan Nasional. *Petunjuk Teknis Peningkatan Kualitas Data Spasial Bidang Tanah*; Kementerian Agraria dan Tata Ruang/Badan Pertanahan Nasional: Jakarta, Indonesia, 2023.
61. Badera, V.; Dolmatova, O.; Tsyplenkova, I.; Kuryachaya, E. Experience of Land Disputes’ Resolution in the Omsk Region. In *Proceedings of the International Scientific Conference The Fifth Technological Order: Prospects for the Development and Modernization of the Russian Agro-Industrial Sector (TFTS 2019)*, Omsk, Russia, 15 October 2020; pp. 173–175. [[CrossRef](#)]
62. Odintsov, S.; Loshakov, A.; Kipa, L.; Melnik, M.; Kasmynina, M. Digital technologies and geodetic measurements in land management expertise. *IOP Conf. Ser. Earth Environ. Sci.* **2022**, *1076*, 012052. [[CrossRef](#)]
63. Li, L.; Gao, H.; Song, B.; Cui, C. How to Use Evidence Rules Reasonably to Resolve Land Disputes: Analysis of Typical Land Dispute Cases from China. *Land* **2024**, *13*, 1187. [[CrossRef](#)]
64. Mamontova, S.; Parkina, D.O.; Kolpakova, O.; Kobanenko, T. The problem of conceptual apparatus of land surveying expertise. *Financ. Manag.* **2020**, *2*, 45–54. [[CrossRef](#)]
65. Hainsworth, S.V.; Fitzpatrick, M.E. Forensic engineering: Applying materials and mechanics principles to the investigation of product failures. *Forensic Sci. Med. Pathol.* **2007**, *3*, 81–92. [[CrossRef](#)]
66. Kementerian Agraria dan Tata Ruang. *Peraturan Menteri Agraria Dan Tata Ruang/Kepala Badan Pertanahan Nasional Republik Indonesia Nomor 6 Tahun 2018 Tentang Pendaftaran Tanah Sistematis Lengkap*; Kementerian Agraria dan Tata Ruang: Jakarta, Indonesia, 2018.
67. Kementerian Agraria dan Tata Ruang. *Badan Pertanahan Nasional Peraturan Menteri Agraria dan Tata Ruang/Kepala Badan Pertanahan Nasional Republik Indonesia Nomor 18 Tahun 2021 Tentang Tata Cara Penetapan Hak Pengelolaan dan Hak Atas Tanah*; Kementerian Agraria dan Tata Ruang: Jakarta, Indonesia, 2021.
68. Republik Indonesia. *Peraturan Pemerintah (PP) Nomor 24 Tahun 1997 Tentang Pendaftaran Tanah*; Republik Indonesia: Jakarta, Indonesia, 1997.
69. Kementerian Agraria dan Tata Ruang. *Peraturan Menteri Nomor 3 Tahun 2023 tentang Penerbitan Dokumen Elektronik dalam Pendaftaran Tanah*; Kementerian Agraria dan Tata Ruang: Jakarta, Indonesia, 2023.
70. Bunga, M.; Amu, R.W.; Nurmala, L. Certificate of Land Property Rights as an Evidence in Land Dispute Settlement. *IJRAEL Int. J. Relig. Educ. Law* **2023**, *2*, 5–12. [[CrossRef](#)]
71. Yasinok, M.; Khominich, M. Features of evidentiary information in civil proceedings regarding land property disputes, the object of which is agricultural land. *Anal. Comp. Jurisprud.* **2023**, *1*, 217–223. [[CrossRef](#)]
72. Butyrin, A.; Zhukova, O.; Stativa, E. The Main Tasks of Forensic Research Conducted in Trials on Land Disputes. *Theory Pract. Forensic Sci.* **2020**, *15*, 94–108. [[CrossRef](#)]

73. Marisya, F.; Hatidah, H.; Wuryanti, L.; Iqbal, M.; Indriani, R.A.R.F.; Polytechnic, D. Palembang Analysis Of Level Understanding of the Accounting Students Towards the Management Accounting Course. *Int. J. Econ. Manag. Res.* **2023**, *2*, 01–09. [[CrossRef](#)]
74. Said, H.S.; Khotimah, C.; Ardiansyah, D.; Khadrinur, H. Uji Validitas dan Reliabilitas: Pemahaman Mahasiswa Akuntansi Terhadap Matakuliah Accounting for Business atau Pengantar Akuntansi. *J. Publ. Ekon. Akunt.* **2023**, *3*, 249–259. [[CrossRef](#)]
75. Grivas, T.; Dadakaridou, D.; Fokidi, S.; Kastrinis, A.; Kosti, M.; Mihas, C.; Oikonomaki, M.; Theodosopoulos, E.; Griva, A. A Questionnaire of Physiotherapeutic Specific Exercises of Scoliosis—QPSSE. *J. Clin. Med.* **2024**, *13*, 318. [[CrossRef](#)]
76. Christmann, A.; Aelst, S. Robust estimation of Cronbach's alpha. *J. Multivar. Anal.* **2006**, *97*, 1660–1674. [[CrossRef](#)]
77. MAR Indonesia. *Putusan Mahkamah Agung Nomor 34 K/SIP/1960*; MAR Indonesia: Jakarta, Indonesia, 1960.
78. Putri, D.A.M.; Silviana, A. The Transfer of Land Rights through Oral Grants: A Case Studies of Court Decision. *SIGn J. Huk.* **2022**, *4*, 99–112. [[CrossRef](#)]

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