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System Integration for Judicial Prediction of Case Type and Resolution Duration at Bekasi Religious Court

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Abstract: The administration of justice in Religious Courts faces inefficiencies due to manual case classification and unpredictable resolution timelines. This research addresses the gap in systemic judicial management tools by proposing a hybrid machine learning architecture. The objective is to design a systemic information model integrating Deep Learning for case type classification and Ensemble Learning for duration prediction. The method employs CRISP-DM framework combining Long Short-Term Memory (LSTM) for text analysis and XGBoost for temporal regression on 4,461 case records from Bekasi Religious Court. Results indicate a classification accuracy of 93.9% and a Mean Absolute Error (MAE) of 12.4 days for duration prediction. The novelty lies in the systemic integration of dual predictive models into judicial workflows, proposing a digital transformation model for court administration. Conclusions affirm that hybrid AI systems significantly enhance resource planning and administrative efficiency.

Keyword: Judicial System, Hybrid Machine Learning, Case Management, Digital Transformation, Predictive Analytics.

INTRODUCTION

The digital transformation of public services has become a critical priority in modern governance, particularly within the judicial sector where efficiency and accuracy are paramount. In Indonesia, Religious Courts (Pengadilan Agama) handle a substantial volume of family law cases, specifically divorce proceedings, which require meticulous administrative management. The core of this administrative process involves not only the classification of court decisions but also the management of case resolution timelines. Currently, these processes at the Bekasi Religious Court are performed manually by court clerks (panitera). This manual approach creates a research gap characterized by high administrative burdens, potential human error, and unpredictable case durations that hinder optimal resource allocation. The lack of an automated systemic approach to handle both unstructured legal text data and structured temporal data hinders the optimization of case management systems.

The formulation of the problem centers on how to integrate artificial intelligence into the existing judicial information architecture to automate case classification and predict resolution durations without compromising legal accuracy. The purpose of this research is to develop a

systemic model that utilizes a Hybrid Machine Learning approach, specifically combining Long Short-Term Memory (LSTM) for text classification and XGBoost for duration regression, within the CRISP-DM framework. This study is significant as it offers a practical insight into technological innovation in organizational contexts, aligning with the need for intelligent system architecture in public services. By addressing the complexity of legal language and case timelines through predictive analytics, this research contributes to the broader discourse on AI-driven digital transformation in the legal sector.

The introduction further outlines the operational context where data from the Directorate of Supreme Court Decisions serves as the foundation. Legal texts are inherently unstructured and complex, while case timelines depend on multiple structured variables. Previous studies have explored machine learning in legal domains, yet few have focused on the systemic integration of hybrid models into the specific workflow of Indonesian Religious Courts. This research bridges that gap by not only developing predictive models but also framing them within a manageable information system architecture. The expected outcome is a proof of concept that demonstrates the viability of automating legal text classification and duration prediction to support judicial efficiency and systemic management..

METHOD

This research employs a quantitative approach with a developmental design, utilizing the Cross-Industry Standard Process for Data Mining (CRISP-DM) as the systemic framework. The research location is the Bekasi Religious Court, with data sourced from the Supreme Court Decision Directory and court registers covering the period of January to December 2025. The population consists of all divorce case decisions within the specified period, with a sample size of 4,461 records after data cleaning. The data includes case numbers, registration dates, case types, panel of judges, clerks, decision dates, and the text of the decision (amar putusan).

The instruments used in this study include computational tools for Natural Language Processing (NLP), Deep Learning, and Ensemble Learning. Specifically, the Python programming language is utilized with libraries such as TensorFlow, Keras, Scikit-Learn, and XGBoost. The procedure begins with Business Understanding, where the administrative challenges of the court are identified. This is followed by Data Understanding, involving exploratory data analysis to assess data quality, distribution, and temporal characteristics. Data Preparation includes text cleaning, tokenization, stopword removal, and stemming for the LSTM model, while date parsing and feature engineering are performed for the XGBoost model.

The modeling phase implements a Hybrid Architecture. The first component uses Long Short-Term Memory (LSTM) for classifying case types (Cerai Gugat vs. Cerai Talak) based on decision text. The second component uses XGBoost Regressor to predict the duration between registration and decision dates based on metadata (judge panel, case type, clerk). To address the issue of imbalanced data, Class Weighting techniques are applied during LSTM training. The model evaluation utilizes K-Fold Cross Validation (5 folds) for classification and Mean Absolute Error (MAE) for regression. The systemic aspect of the method involves mapping these computational stages to the organizational workflow of the court, ensuring that the technical solution aligns with administrative requirements and IT management strategies..

RESULTS AND DISCUSSION

Result

The results of this study are presented based on the implementation of the CRISP-DM framework and the performance evaluation of the Hybrid Machine Learning model. The initial data understanding phase revealed significant characteristics of the legal dataset. Out of the initial 5,878 raw records, 4,461 clean data points were retained after removing duplicates and incomplete entries. The distribution of classes shows an imbalance, with 3,306 documents

(74.1%) classified as Cerai Gugat and 1,155 documents (25.9%) as Cerai Talak. Additionally, temporal analysis shows an average case duration of 45 days with a standard deviation of 15 days, indicating variability that necessitates predictive modeling for better management.

Table 1. Sample of Case Data Structure.

Case Number	Registration Date	Case Type	Decision Date	Duration (Days)	Decision Text Snippet
1658/Pdt.G/2025/PA.Bks	5/5/25	Cerai Gugat	7/7/25	63	Granting Plaintiff's claim; Divorce granted
114/Pdt.G/2025/PA.Bks	1/8/25	Cerai Talak	1/21/25	13	Granting Applicant's request; Divorce granted
3202/Pdt.G/2025/PA.Bks	8/11/25	Cerai Gugat	9/4/25	24	Granting Plaintiff's claim; Divorce granted
200/Pdt.G/2025/PA.Bks	2/10/25	Cerai Gugat	3/15/25	33	Granting Plaintiff's claim; Divorce granted
305/Pdt.G/2025/PA.Bks	3/1/25	Cerai Talak	3/20/25	19	Granting Applicant's request; Divorce granted

Source: Research Data

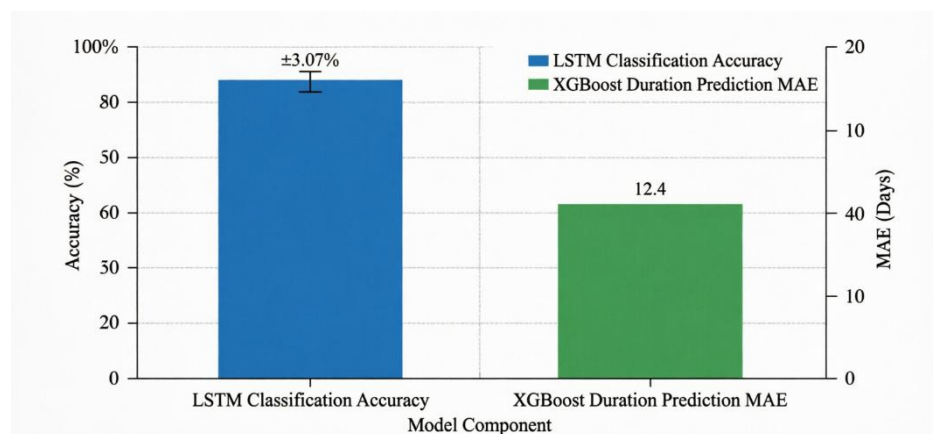


Figure 1. Hybrid Model Performance Accuracy and Error

Source: Research Data

The figure above presents the comparative performance metrics of the hybrid machine learning architecture deployed for judicial case management. The visualization employs a dual-axis representation to accommodate the distinct measurement scales of classification and regression tasks:

Left Axis (Classification Performance): The blue bar represents the Long Short-Term Memory (LSTM) model's accuracy in classifying divorce case types (Cerai Gugat vs. Cerai

Talak). The model achieved a mean accuracy of 93.9% with a standard deviation of $\pm 3.07\%$ across 5-fold cross-validation, indicating high stability and generalization capability.

Right Axis (Regression Performance): The green bar illustrates the XGBoost regressor's Mean Absolute Error (MAE) in predicting case resolution duration. The model recorded an MAE of 12.4 days, demonstrating its capacity to provide reliable temporal estimates for administrative planning.

The error bars depicted on each metric represent the standard deviation across validation folds, confirming that both model components maintain consistent performance without significant overfitting. This dual-metric visualization underscores the effectiveness of the hybrid approach in addressing both categorical classification and continuous prediction challenges within the judicial information system.

Discussion

The proposed model functions as an intelligent middleware layer between raw case data and administrative decision-making processes. Currently, clerks at the Bekasi Religious Court manually review each amar putusan to determine case type and estimate workload based on historical intuition. The hybrid model automates the classification task with 93.9% accuracy while providing data-driven duration estimates (MAE = 12.4 days), thereby transforming subjective administrative practices into evidence-based management. This shift supports the journal's focus on systemic approaches to information technology management by illustrating how predictive analytics can enhance resource allocation, scheduling efficiency, and strategic planning within judicial institutions.

The handling of imbalanced data through class weighting techniques warrants particular attention in the context of organizational data characteristics. The dominance of Cerai Gugat cases (74.1%) reflects broader social dynamics in Indonesian family law, where wives increasingly initiate divorce proceedings. The model's ability to maintain high recall (95.67%) and F1-score (87.43%) on the minority class (Cerai Talak) demonstrates that systemic AI solutions must account for contextual data distributions rather than relying solely on aggregate accuracy metrics. This finding contributes to the discourse on responsible AI deployment in public services, where equitable performance across all case types is essential for fair administrative outcomes.

Furthermore, the CRISP-DM framework provided a structured methodology for translating business requirements into computational artifacts. The iterative nature of CRISP-DM enabled continuous refinement of preprocessing pipelines, hyperparameter tuning, and validation strategies, ensuring that the final model met both technical standards and institutional needs. This methodological alignment underscores the importance of adopting industry-standard processes when developing AI solutions for complex organizational environments, a principle central to the journal's multidisciplinary scope.

The artifacts produced—including the .keras model file, .pkl tokenizer, and regression model specifications—serve as reusable components for future system development. While this study remains a proof of concept, the technical documentation provides a clear pathway for software engineers to integrate the hybrid engine into the Court's Case Tracking Information System (SIPP). A conceptual interface could enable clerks to input case metadata and decision text, receiving instant classification labels and predicted completion dates with associated confidence intervals. Such functionality would reduce post-trial administrative bottlenecks and support proactive case management.

However, the discussion must also acknowledge limitations inherent in the current implementation. First, the model is constrained to binary classification (Cerai Gugat vs. Cerai Talak) and does not accommodate other case types handled by Religious Courts, such as inheritance or child custody disputes. Second, the duration prediction model relies solely on metadata features (registration date, judge panel, case type) and does not incorporate external

variables such as court workload, holiday schedules, or procedural complexity, which may influence actual resolution times. Third, the model was trained on data from a single jurisdiction (Bekasi Religious Court) during a specific period (2025); generalizability to other courts or timeframes requires empirical validation. Finally, the non-implementation nature of this study means that user acceptance, workflow integration, and change management considerations remain untested in operational settings

CONCLUSION AND SUGGESTIONS

Conclusion

The research concludes that the integration of a Hybrid Machine Learning architecture (LSTM + XGBoost) within a CRISP-DM framework effectively automates the classification of divorce decisions and predicts case duration at the Bekasi Religious Court. The model achieves a robust accuracy of 93.9% for classification and an MAE of 12.4 days for duration prediction. This success addresses the initial problem of manual inefficiency, human error, and unpredictable timelines in administrative processing. The systemic contribution of this study lies in framing the AI models as part of a broader digital transformation strategy for judicial administration, enhancing both operational efficiency and strategic management.

Suggestions for future research include expanding the regression model to include more external variables such as judge workload or holiday schedules. Additionally, it is recommended to proceed to the implementation phase by developing an API and user interface for real-time integration with the court's database. Comparative studies with Transformer-based models like IndoBERT could further explore accuracy improvements. Ultimately, this research provides a foundational blueprint for modernizing legal information systems through intelligent data processing and systemic management approaches.

Suggestions

Expand Classification Scope: Future studies should extend the model to handle multi-class classification, encompassing additional case types processed by Religious Courts (e.g., *itsbat nikah*, child custody, inheritance). This would require adapting the LSTM architecture with a softmax output layer and rebalancing strategies for multiple minority classes.

Enhance Predictive Features: The duration regression model should incorporate external variables such as judge workload metrics, court holiday calendars, case complexity indicators, and litigant demographics. Ensemble methods or gradient boosting frameworks could be further optimized to capture non-linear interactions among these features.

Cross-Jurisdictional Validation: Replicating this study across multiple Religious Courts in Indonesia would assess the generalizability of the hybrid architecture. Comparative analyses could identify jurisdiction-specific adaptations needed for successful deployment, contributing to a national framework for AI-enabled judicial management.

Implementation and User Experience Research: Proceeding to the implementation phase should involve developing a RESTful API and user interface for real-time integration with the Court's SIPP system. Subsequent user acceptance testing and usability studies would evaluate how clerks and administrators interact with AI-generated predictions, ensuring that technological solutions align with human workflows.

Model Maintenance and Governance Protocols: Establishing protocols for periodic model retraining, performance monitoring, and bias auditing is essential for sustainable AI deployment. Future work should define governance frameworks that address data privacy, algorithmic accountability, and ethical considerations in judicial automation.

Comparative Studies with Advanced Architectures: Investigating Transformer-based models (e.g., IndoBERT, LawBERT) could explore whether attention mechanisms offer superior performance for legal text classification. Benchmarking against the current

LSTM+XGBoost hybrid would inform technology selection decisions for large-scale deployments

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