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MINIMUM WAGE DIFFERENCES AND ECONOMIC INEQUALITY IN INDONESIA: A MIXED-METHODS ANALYSIS INTEGRATING MACHINE LEARNING

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Abstract

Economic inequality remains a persistent challenge in Indonesia, as reflected in disparities in income distribution across provinces. This study aims to analyze the effect of minimum wage differences on economic inequality by incorporating poverty as a supporting variable using a mixed-method approach. The quantitative analysis utilizes provincial-level data obtained from the Badan Pusat Statistik, including minimum wage, poverty rate, and Gini Ratio, which is classified into high and low inequality categories. The data are processed using Orange Data Mining by applying Logistic Regression, Decision Tree, and Random Forest models, with performance evaluated using AUC, accuracy, precision, recall, and F1-score. The results show that Logistic Regression achieves the best overall performance, indicating that the relationship between minimum wage, poverty, and inequality can be effectively captured through a relatively stable model, while feature importance analysis reveals that minimum wage has a more dominant influence compared to poverty. The qualitative findings based on the PRISMA framework indicate that the impact of minimum wage policies on inequality is conditional and varies across regions, particularly depending on labor market structures and the prevalence of informal employment. The integration of findings suggests that economic inequality is shaped by complex interactions between wage policy, poverty, and regional conditions, implying that minimum wage policy alone is insufficient and should be complemented by broader socio-economic strategie.

Keywords: Minimum Wage, Economic Inequality, Gini Ratio, Poverty, Machine Learning

Abstrak

Ketimpangan ekonomi masih menjadi tantangan yang berkelanjutan di Indonesia, yang tercermin dari disparitas distribusi pendapatan antarprovinsi. Penelitian ini bertujuan untuk menganalisis pengaruh perbedaan upah minimum terhadap ketimpangan ekonomi dengan memasukkan kemiskinan sebagai variabel pendukung menggunakan pendekatan mixed-method. Analisis kuantitatif menggunakan data tingkat provinsi yang diperoleh dari Badan Pusat Statistik, meliputi upah minimum, tingkat kemiskinan, dan Rasio Gini yang diklasifikasikan ke dalam kategori ketimpangan tinggi dan rendah. Data diolah menggunakan Orange Data Mining dengan menerapkan model Logistic Regression, Decision Tree, dan Random Forest, yang dievaluasi menggunakan metrik AUC, akurasi, presisi, recall, dan F1-score. Hasil penelitian menunjukkan bahwa Logistic Regression memiliki kinerja terbaik, yang mengindikasikan bahwa hubungan antara upah minimum, kemiskinan, dan ketimpangan dapat dijelaskan melalui pola yang relatif stabil, sementara analisis feature importance menunjukkan bahwa upah

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minimum memiliki pengaruh yang lebih dominan dibandingkan kemiskinan. Temuan kualitatif berbasis kerangka PRISMA menunjukkan bahwa dampak kebijakan upah minimum terhadap ketimpangan bersifat kondisional dan bervariasi antar wilayah, terutama dipengaruhi oleh struktur pasar tenaga kerja dan dominasi sektor informal. Integrasi hasil menunjukkan bahwa ketimpangan ekonomi dipengaruhi oleh interaksi kompleks antara kebijakan upah, kemiskinan, dan kondisi regional, sehingga kebijakan upah minimum saja tidak cukup dan perlu didukung oleh strategi sosial-ekonomi yang lebih komprehensif.

***Kata kunci**: Upah Minimum, Ketimpangan Ekonomi, Gini Ratio, Kemiskinan, Machine Learning, PRISMA*

Introduction

Economic development in Indonesia has shown significant progress over the past decades, marked by steady economic growth, expanding infrastructure, and increasing integration into the global economy. However, these achievements have not been accompanied by an equal distribution of welfare across regions and population groups. Disparities in income, access to resources, and economic opportunities remain evident, indicating that growth has been uneven and, in many cases, exclusionary. Understanding the underlying structure of these disparities is essential for formulating effective policies aimed at achieving inclusive and equitable development. In this context, examining the patterns and drivers of inequality across regions provides a critical foundation for analyzing broader socio-economic dynamics in Indonesia.

Economic Inequality and Regional Disparities in Indonesia

Economic inequality remains one of the most persistent and complex challenges in Indonesia's development trajectory. Despite achieving relatively stable economic growth over the past decades, the distribution of income and welfare across regions and population groups remains uneven. This condition indicates that economic expansion has not been fully inclusive, as the benefits of growth are disproportionately concentrated in certain regions, particularly urban and industrial centers. Data published by the Badan Pusat Statistik show that the Gini Ratio, as a key indicator of inequality, continues to fluctuate, reflecting ongoing disparities in income distribution at both national and regional levels (BPS, 2025).

Regional disparities in Indonesia are deeply rooted in structural differences across provinces, including variations in economic structure, infrastructure development, human capital, and access to public services. Provinces located in western Indonesia, such as those in Java and Sumatra, generally exhibit higher levels of economic activity due to better infrastructure, industrial concentration, and access to markets. In contrast, eastern regions often face limitations in connectivity, investment, and industrial diversification, which constrain economic growth and income generation. These structural imbalances create a dualistic economic pattern, where advanced regions continue to grow rapidly while lagging regions struggle to catch up (Wibawa et al., 2023).

In addition, differences in labor market conditions contribute significantly to regional inequality. Variations in employment opportunities, productivity levels, and wage structures result in unequal income distribution across provinces (Dwiputrianti et al., 2025). The implementation of Provincial Minimum Wages (Upah Minimum Provinsi/UMP) further reflects these disparities, as wage levels are determined based on regional economic capacity, cost of living, and policy considerations. While this decentralized approach allows for flexibility, it also

leads to significant wage gaps between provinces, which in turn influence household income and consumption capacity. Regions with higher minimum wages tend to experience stronger purchasing power and economic dynamism, whereas lower-wage regions often remain trapped in low-income equilibria (Merdikawati & Izzati, 2025).

Moreover, inequality in Indonesia is not limited to income differences but also encompasses disparities in access to essential services such as education, healthcare, and social protection. Limited access to quality education reduces opportunities for skill development, thereby affecting productivity and income potential. Similarly, unequal access to healthcare services can lead to differences in human capital outcomes, further reinforcing socio-economic disparities. These factors collectively contribute to a cycle of inequality, where disadvantaged regions face persistent barriers to development (Dwiputrianti et al., 2025).

Another important dimension of regional inequality is the uneven distribution of economic opportunities driven by urbanization and agglomeration effects. Major metropolitan areas, such as Jakarta, attract investment, skilled labor, and technological innovation, creating economic clusters that generate higher productivity and income levels. However, this concentration of resources also leads to widening gaps between urban and rural areas, as peripheral regions experience outmigration of labor and limited economic diversification. Consequently, regional inequality becomes self-reinforcing, as economic activities continue to concentrate in already developed areas (Mardhiyah & Fitrawaty, 2025).

Furthermore, the persistence of inequality is closely linked to the interaction between structural economic factors and policy frameworks. Fiscal decentralization, while intended to promote regional autonomy, has produced mixed outcomes in reducing disparities. Some regions have successfully leveraged local resources and governance capacity to stimulate growth, while others remain dependent on central government transfers. This uneven capacity in policy implementation contributes to variations in development outcomes across provinces (Azies & Herowati, 2023).

In this context, understanding economic inequality in Indonesia requires a multidimensional perspective that integrates regional, structural, and policy-related factors. The interplay between wage differentials, labor market conditions, and access to resources highlights the complexity of inequality dynamics. Therefore, analyzing regional disparities through both quantitative and qualitative approaches is essential to capture the full scope of socio-economic inequality. Such an approach enables a more comprehensive understanding of how structural constraints and regional characteristics shape the distribution of income and welfare across Indonesia.

Minimum Wage Policy and Its Role in Shaping Inequality

Minimum wage policy represents one of the most critical instruments in labor market regulation, particularly in developing economies such as Indonesia. The primary objective of minimum wage implementation is to ensure that workers receive a basic standard of living that is sufficient to meet essential needs. However, beyond its normative role as a social protection mechanism, minimum wage policy also plays a significant role in shaping income distribution and influencing broader patterns of economic inequality.

In Indonesia, the determination of the Provincial Minimum Wage (Upah Minimum Provinsi/UMP) is carried out through a decentralized framework that considers regional economic conditions, including inflation rates, economic growth, and the cost of living. This process, coordinated through national guidelines and implemented by regional governments, reflects an attempt to balance economic efficiency with social equity. Nevertheless, variations in economic capacity across provinces result in substantial differences in minimum wage levels,

which in turn contribute to disparities in income and consumption across regions (Panggabean, 2025).

From a theoretical standpoint, the relationship between minimum wages and inequality is inherently complex and often debated in economic literature. On one hand, higher minimum wages can reduce income inequality by increasing earnings among low-wage workers, thereby narrowing the income gap between lower and higher income groups (Azies & Herowati, 2023). This perspective aligns with equity-oriented economic policies that emphasize redistribution and social welfare. On the other hand, critics argue that excessively high minimum wages may lead to unintended consequences, such as reduced employment opportunities, particularly for low-skilled workers. In such cases, firms may respond by reducing labor demand, increasing automation, or shifting to informal employment arrangements, which can ultimately exacerbate inequality rather than reduce it (Merdikawati & Izzati, 2025).

In the Indonesian context, this dual effect is particularly relevant due to the significant size of the informal sector. A large proportion of the workforce operates outside formal labor regulations, meaning that minimum wage policies may not fully reach or benefit all workers. As a result, the effectiveness of minimum wage increases in reducing inequality is often contingent upon the structure of the labor market and the extent of formal employment within each region. Provinces with higher levels of industrialization and formal sector employment are more likely to experience the positive effects of minimum wage policies, whereas regions dominated by informal activities may see limited impact (Fiyantika et al., 2025).

Moreover, minimum wage differentials across provinces contribute to spatial economic dynamics, including labor mobility and regional competitiveness. Higher wages in economically advanced regions tend to attract workers from less developed areas, leading to internal migration flows that can intensify regional disparities. While such migration may improve individual welfare for some workers, it can also create imbalances in labor supply, urban congestion, and pressure on public services in receiving regions. At the same time, regions with lower wage levels may face challenges in retaining skilled labor, which can hinder local economic development and perpetuate inequality (Nabiel et al., 2025).

Another important dimension of minimum wage policy is its interaction with productivity and business performance. In theory, higher wages can incentivize firms to improve efficiency and invest in human capital, leading to productivity gains. However, in practice, the ability of firms to adjust to wage increases varies depending on their size, sector, and access to resources. Small and medium enterprises, which constitute a significant portion of Indonesia’s economy, may face greater constraints in adapting to higher wage requirements, potentially affecting employment levels and income distribution (Pamula et al., 2023). Furthermore, minimum wage policy cannot be analyzed in isolation, as its impact on inequality is closely linked to other socio-economic variables, particularly poverty. Wage increases may improve income levels for employed workers, but they do not necessarily address the conditions of unemployed or underemployed individuals. Therefore, the role of minimum wage in reducing inequality must be understood within a broader framework that includes labor market dynamics, social protection systems, and economic structure (Rozi & Atmanti, 2024).

In this context, analyzing the role of minimum wage policy in shaping inequality requires an integrated approach that considers both its direct and indirect effects. Directly, minimum wages influence earnings and household income. Indirectly, they affect employment, labor mobility, and regional economic dynamics. The complexity of these interactions underscores the need for advanced analytical tools, such as machine learning, to capture non-linear relationships and provide deeper insights into how wage policies contribute to economic inequality in Indonesia.

Poverty as a Supporting Variable in Economic Inequality

Poverty plays a crucial role in shaping the structure of economic inequality. While inequality measures the distribution of income across populations, poverty reflects the inability of individuals or households to meet basic needs. In Indonesia, poverty is unevenly distributed across regions, with higher concentrations in rural and less developed provinces. This uneven distribution reinforces inequality, as poorer regions face structural barriers that limit economic participation. The relationship between poverty and inequality is complex and mutually reinforcing. High levels of inequality can limit access to opportunities for low-income groups, thereby sustaining poverty. At the same time, persistent poverty can widen inequality by concentrating resources among higher-income groups. In this context, minimum wage policies may serve as a mechanism to alleviate poverty, but their effectiveness depends on labor market conditions and regional economic structures (Kunarti et al., 2025).

Moreover, poverty influences household behavior, particularly in terms of consumption patterns. Households with limited income tend to prioritize basic needs, such as food and housing, while reducing expenditures on education and health. This pattern can hinder human capital development and perpetuate intergenerational inequality (Panggabean, 2025). Therefore, analyzing the interaction between minimum wages, poverty, and inequality is essential for understanding the broader socio-economic dynamics in Indonesia. Traditional econometric approaches have long been used to analyze the determinants of economic inequality. However, these methods often rely on linear assumptions and may fail to capture complex, non-linear relationships between variables. In recent years, machine learning techniques have emerged as powerful tools for analyzing socio-economic data, offering greater flexibility and predictive accuracy (Pamula et al., 2023).

Machine learning models, such as Logistic Regression, Decision Trees, and Random Forest, are particularly useful in classification problems where the objective is to categorize observations into distinct groups. In the context of this study, these models are employed to classify provinces into high and low levels of economic inequality based on indicators such as minimum wage and poverty rate. The use of Orange Data Mining provides an accessible platform for implementing these algorithms and visualizing model performance. One of the key advantages of machine learning is its ability to identify patterns and interactions that may not be evident through traditional statistical methods (Azies & Herowati, 2023). For example, Random Forest models can capture complex relationships between variables and provide insights into feature importance, highlighting which factors have the most significant influence on inequality. This capability is particularly relevant in analyzing socio-economic phenomena, where multiple variables interact in dynamic and often non-linear ways (Harwanti et al., 2024).

Although numerous studies have examined economic inequality, minimum wage policies, and poverty in Indonesia, there remains a gap in integrating these perspectives within a unified analytical framework. Most existing research focuses either on econometric analysis of inequality or on qualitative assessments of social conditions, with limited integration between quantitative and qualitative approaches. Furthermore, the application of machine learning in analyzing economic inequality in Indonesia is still relatively limited. While some studies have explored the use of data mining techniques, there is a lack of research that combines machine learning with systematic literature review methods to provide a comprehensive understanding of inequality dynamics.

This study addresses these gaps by employing a mixed-method approach that integrates machine learning analysis with a systematic literature review based on the PRISMA framework. By combining quantitative data analysis with theoretical synthesis, this research aims to provide a more holistic understanding of the relationship between minimum wage differences and economic inequality in Indonesia.

Research Method

Research Design

This study adopts a mixed-methods research design that integrates quantitative analysis with a systematic literature review to examine the relationship between minimum wage differences and economic inequality in Indonesia. The use of a mixed-methods approach is motivated by the need to capture both empirical patterns and theoretical explanations underlying inequality. Economic inequality is a multidimensional phenomenon that cannot be fully understood through a single methodological perspective. Therefore, combining quantitative and qualitative approaches enables a more comprehensive and nuanced analysis (Pamula et al., 2023).

The quantitative component focuses on identifying statistical relationships between minimum wage, poverty, and inequality using machine learning techniques. This approach allows the study to uncover patterns and predictive relationships that may not be easily detected through conventional econometric methods. Meanwhile, the qualitative component, conducted through a systematic literature review, aims to synthesize existing theoretical and empirical findings related to inequality, wage policy, and poverty. By integrating these two approaches, the study achieves methodological triangulation, enhancing both internal validity and analytical depth.

Furthermore, this research design allows for the interpretation of quantitative findings within a broader socio-economic context. While machine learning provides strong predictive capability, it does not inherently explain causal mechanisms. The inclusion of a systematic literature review addresses this limitation by providing conceptual frameworks that help interpret the observed relationships. As a result, the study is able to bridge the gap between data-driven analysis and theoretical understanding, offering a more holistic perspective on economic inequality in Indonesia.

Data Source and Variables

The quantitative data used in this study are derived from secondary sources obtained from the Badan Pusat Statistik, which provides comprehensive and reliable socio-economic data at the provincial level. The use of official statistical data ensures a high degree of accuracy and consistency, as the data are collected through standardized national surveys. Provincial-level data are particularly relevant for this study, as they allow for the analysis of regional disparities and the identification of differences in economic conditions across Indonesia (Azies & Herowati, 2023).

The dataset includes key variables that are closely related to the study of economic inequality. The Provincial Minimum Wage (Upah Minimum Provinsi/UMP) is used as the primary independent variable, representing differences in wage policy across regions. This variable captures variations in labor market conditions and regional economic capacity, which are central to understanding income distribution. In addition, the poverty rate is included as a supporting variable to reflect socio-economic vulnerability and structural inequality. Poverty serves as an important contextual factor that influences how income disparities are experienced at the household level (Pamula et al., 2023).

The dependent variable in this study is the Gini Ratio, which is widely used as a measure of income inequality. To facilitate the application of classification-based machine learning models, the Gini Ratio is transformed into a categorical variable. This transformation involves dividing the data into two categories, namely high inequality and low inequality, based on a defined threshold such as the mean or median value. This categorization allows the study to

focus on classification accuracy and predictive performance, rather than solely on numerical estimation. The selection of these variables reflects the theoretical framework of the study, which emphasizes the interaction between wage policy, poverty, and inequality. By combining these indicators, the analysis captures both structural and socio-economic dimensions of inequality, providing a more comprehensive understanding of the factors that drive disparities across regions.

Data Analysis Using Machine Learning

The quantitative analysis in this study is conducted using Orange Data Mining, a visual-based data mining platform that facilitates the implementation of machine learning algorithms. The choice of this software is based on its flexibility, user-friendly interface, and ability to integrate data preprocessing, model training, and evaluation within a single analytical environment. This allows for a systematic and transparent analytical process.

The study employs several supervised learning algorithms to classify levels of economic inequality, including Logistic Regression, Decision Tree, and Random Forest. These models are selected based on their complementary strengths in handling classification problems. Logistic Regression is used as a baseline model due to its simplicity and interpretability, providing a reference point for evaluating more complex models. Decision Tree is employed for its ability to generate rule-based classifications that are easily interpretable, allowing for the identification of threshold values and decision patterns within the data. Random Forest, as an ensemble learning method, is used to improve predictive accuracy by combining multiple decision trees and reducing the risk of overfitting. The application of these models enables the study to capture both linear and non-linear relationships between variables. This is particularly important in the context of socio-economic analysis, where interactions between variables are often complex and multidimensional. Machine learning models are capable of identifying hidden patterns and interactions that may not be evident through traditional statistical methods, thereby providing deeper insights into the determinants of inequality (Pamula et al., 2023).

Model performance is evaluated using several statistical metrics, including accuracy, precision, recall, F1-score, and Area Under the Curve (AUC). These metrics provide a comprehensive assessment of the model's predictive capability, taking into account both correct classifications and errors. In addition to performance evaluation, feature importance analysis is conducted to determine the relative contribution of each variable in predicting inequality. This analysis is particularly useful for identifying whether minimum wage or poverty plays a more dominant role in shaping inequality patterns. Overall, the use of machine learning in this study enhances the analytical rigor by enabling data-driven insights and improving the ability to model complex socio-economic relationships.

Systematic Literature Review (PRISMA Approach)

The qualitative component of this study is conducted through a systematic literature review based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework. The PRISMA approach is widely recognized as a standard method for conducting systematic reviews, as it ensures transparency, consistency, and reproducibility in the selection and evaluation of literature.

The literature search process is conducted using academic databases such as Google Scholar, focusing on studies related to economic inequality, minimum wage policy, poverty, and machine learning applications in socio-economic research. Relevant keywords are used to identify studies that align with the research objectives. The search process is designed to capture both theoretical and empirical studies, ensuring a comprehensive coverage of the topic (Pamula et al., 2023).

Following the identification stage, the screening process involves removing duplicate records and evaluating titles and abstracts to determine their relevance. Studies that do not align with the research focus are excluded at this stage. The remaining articles are then assessed in the eligibility stage through full-text review, where inclusion and exclusion criteria are applied. These criteria include relevance to the research topic, publication within a specified time range, availability of full-text access, and academic credibility.

The final selection of studies is included in the synthesis phase, where key findings, methodologies, and theoretical perspectives are analyzed and compared. This synthesis process allows the study to identify common themes, research gaps, and contrasting findings in the literature. The use of PRISMA ensures that the review process is systematic and unbiased, providing a strong theoretical foundation for the study.

Data Integration and Analysis Strategy

The final stage of the methodology involves integrating the results of the quantitative and qualitative analyses to provide a comprehensive understanding of the relationship between minimum wage differences and economic inequality in Indonesia. This integration is essential in a mixed-methods framework, as it allows empirical findings to be interpreted within a broader theoretical and contextual perspective.

The results obtained from the machine learning models are analyzed in conjunction with the findings from the systematic literature review. This process enables the study to connect statistical patterns with established theories and prior empirical evidence. For instance, the identification of minimum wage as a significant predictor of inequality can be interpreted through labor market theories that emphasize wage regulation as a tool for income redistribution. Similarly, the role of poverty in influencing inequality can be understood in relation to structural economic constraints and limited access to resources. By combining these two analytical approaches, the study enhances the depth and coherence of its findings. The quantitative analysis provides objective and data-driven insights, while the qualitative synthesis offers explanatory power and theoretical grounding. This integration not only strengthens the interpretation of results but also ensures that the conclusions drawn are contextually relevant and academically robust.

In addition, the use of official secondary data from the Badan Pusat Statistik, along with the application of standardized machine learning evaluation metrics, contributes to the consistency and credibility of the analysis. The systematic literature review further supports the robustness of the study by ensuring that the findings are aligned with established research and current academic discourse.

Results and Discussion

Machine Learning Visualization and Interpretation

To complement the quantitative findings, a series of visualizations are generated using Orange Data Mining in order to provide a more comprehensive understanding of the patterns and relationships underlying economic inequality in Indonesia. These visualizations not only support the statistical results obtained from the classification models, but also offer intuitive insights into how minimum wage and poverty interact in shaping inequality across provinces.

The distribution of the Gini Ratio reveals a noticeable distinction between provinces classified as having low and high levels of inequality. Provinces within the high-inequality category tend to exhibit consistently higher Gini values, indicating a greater concentration of income among certain groups. However, the presence of overlapping ranges between the two categories suggests that inequality is not strictly dichotomous, but rather exists along a

spectrum. This overlap reflects transitional conditions in which certain provinces may shift between inequality levels depending on economic dynamics, such as changes in wage structure or poverty conditions. The distribution pattern also indicates that the classification approach, while effective for modeling purposes, simplifies a complex socio-economic phenomenon that is inherently continuous in nature.

Table 1. Evaluation of the Prediction Matrix for Low and High-Level Deviations

Model	AUC	CA	F1	Prec	Recall	MCC
Logistic Regression	0.600	0.711	0.707	0.714	0.711	0.420
Random Forest	0.626	0.553	0.548	0.550	0.553	0.096
Tree	0.472	0.447	0.446	0.446	0.447	-0.112

The results in Table 1 indicate that Logistic Regression outperforms the other models in terms of overall performance, particularly in accuracy, F1-score, and MCC. This finding suggests that the relationship between the independent variables and economic inequality is relatively structured and can be effectively captured through a linear decision boundary. Unlike more complex models, Logistic Regression assumes a probabilistic relationship between predictors and outcomes, which appears to align well with the characteristics of the dataset used in this study. This implies that variations in minimum wage and poverty levels contribute to inequality in a consistent and predictable manner across provinces.

In contrast, the Decision Tree model shows the weakest performance, indicating limitations in its ability to generalize from the data. Decision Trees tend to partition the data into rigid, rule-based segments, which may lead to overfitting, especially when the dataset is relatively small or contains overlapping patterns between classes. The low AUC and negative MCC values observed in this study suggest that the Decision Tree fails to capture meaningful patterns and may be sensitive to noise in the data. This highlights the limitation of using single-tree models in analyzing complex socio-economic phenomena, where relationships between variables are rarely strictly hierarchical or rule-based.

The Random Forest model, which is an ensemble extension of Decision Trees, demonstrates improved performance compared to the single Decision Tree but still does not outperform Logistic Regression. Random Forest is designed to reduce overfitting by combining multiple trees and introducing randomness in feature selection and data sampling. While this approach generally enhances model robustness, the results in this study indicate that the added complexity does not necessarily translate into better predictive performance. This may be due to the relatively simple structure of the dataset, where the relationships between variables do not exhibit strong non-linear interactions that require ensemble learning techniques.

From a model development perspective, these findings suggest that increasing model complexity does not always improve performance, particularly when the underlying data structure is relatively linear. The effectiveness of Logistic Regression indicates that the key variables—minimum wage and poverty—have a direct and interpretable relationship with economic inequality. This is further supported by the feature importance analysis, which identifies minimum wage as the most influential predictor. The dominance of this variable suggests that regional wage differences play a central role in determining inequality patterns, reinforcing the theoretical expectation that wage policy is a key driver of income distribution (Harwanti et al., 2024).

In addition, the relatively lower contribution of poverty in the feature importance ranking does not imply that poverty is insignificant, but rather that its effect may be indirect or mediated through other variables. Poverty may influence inequality through mechanisms such as limited access to employment, education, and economic opportunities, which are not fully

captured in the model. This highlights a limitation of the current modeling approach and suggests the potential benefit of incorporating additional variables in future research (Rozi & Atmanti, 2024).

The evaluation metrics used in this study also provide important insights into model performance. While AUC is commonly used to assess classification models, it is important to consider other metrics such as F1-score and MCC, particularly when dealing with imbalanced or complex datasets. The relatively high MCC value for Logistic Regression indicates a strong correlation between predicted and actual classifications, further confirming its reliability. In contrast, the low MCC values for Decision Tree and Random Forest suggest weaker predictive consistency.

Overall, the model development process in this study demonstrates that simpler and more interpretable models can outperform more complex algorithms when the data structure supports linear relationships. This finding has important implications for the application of machine learning in socio-economic research, where model interpretability is often as important as predictive accuracy. By selecting an appropriate model that balances performance and interpretability, this study provides a more reliable and meaningful analysis of economic inequality in Indonesia.

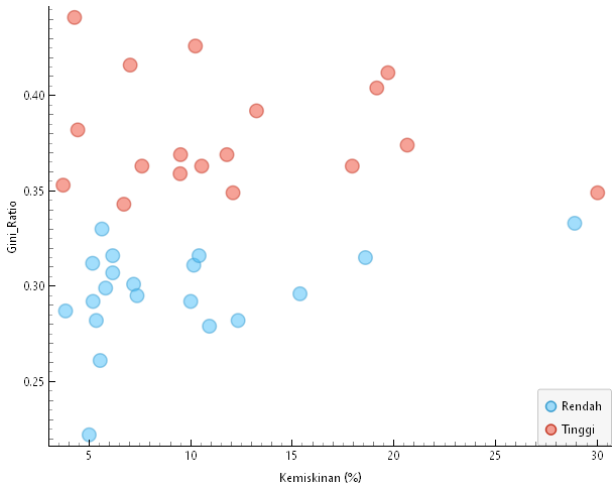


Figure 1. Scatter Plot of Relationship Between Poverty and Economic Inequality

The relationship between poverty and economic inequality further illustrates the multidimensional nature of inequality. The scatter plot shows a general tendency for provinces with higher poverty rates to also experience higher levels of inequality, suggesting a positive association between the two variables. This pattern indicates that poverty contributes to unequal income distribution by limiting access to economic opportunities and resources among lower-income groups. However, the dispersion of data points also reveals that the relationship is not perfectly linear. Some provinces with relatively moderate poverty levels still exhibit high inequality, while others with higher poverty rates show lower inequality levels. This variation suggests that poverty alone is insufficient to explain inequality, and that other structural factors, such as labor market composition, education levels, and regional economic development, play significant roles in shaping income distribution (Haerunisa & Nabila, 2025).

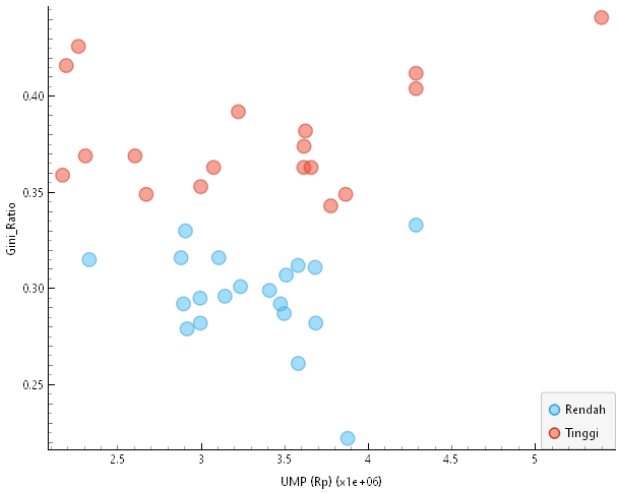


Figure 2. Scatter Plot of Relationship Between Provincial Minimum Wage (UMP) and Inequality

In contrast to poverty, the relationship between Provincial Minimum Wage (UMP) and inequality appears to be more complex and less predictable. The scatter plot indicates that higher minimum wages do not consistently correspond to lower levels of inequality. In some provinces, higher wages are associated with reduced inequality, suggesting that wage increases improve income distribution among workers. However, in other regions, high minimum wages coexist with high levels of inequality, indicating that wage increases may benefit only certain segments of the population, particularly those employed in the formal sector. This inconsistency highlights the context-dependent nature of minimum wage policy, where its effectiveness is influenced by regional economic structures, labor market conditions, and the proportion of informal employment. In regions with a large informal sector, minimum wage policies may have limited reach, thereby reducing their effectiveness in addressing inequality (Rinaldi et al., 2025).

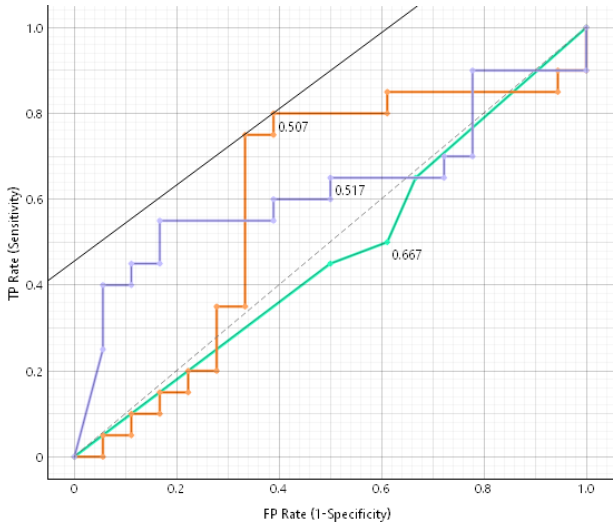
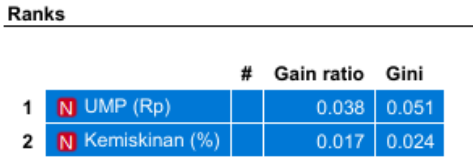


Figure 3. Scatter Plot of Relationship Between Poverty and Economic Inequality

The evaluation of model performance through ROC curve analysis provides additional insight into the ability of each model to distinguish between high and low inequality categories. The ROC curves show that Logistic Regression and Random Forest outperform the Decision Tree model, as their curves are positioned closer to the top-left corner, indicating better

classification performance. Although Random Forest achieves a slightly higher AUC value, Logistic Regression demonstrates more consistent performance across different classification thresholds. This consistency suggests that the relationship between the variables is relatively stable and can be effectively captured by a linear model. On the other hand, the weaker performance of the Decision Tree model indicates limitations in its ability to generalize patterns from the data, possibly due to overfitting or the presence of noise in the dataset (Pamula et al., 2023). These findings reinforce the earlier conclusion that Logistic Regression is the most reliable model for this analysis.


Ranks

		#	Gain ratio	Gini
1	N UMP (Rp)		0.038	0.051
2	N Kemiskinan (%)		0.017	0.024

Figure 4. Feature Importance

The feature importance analysis provides a deeper understanding of the relative contribution of each variable in predicting economic inequality. The results indicate that Provincial Minimum Wage (UMP) has a higher importance value compared to poverty, suggesting that wage differences across regions play a more dominant role in shaping inequality patterns. This finding is particularly significant, as it emphasizes the central role of wage policy in influencing income distribution. While poverty remains an important factor, its impact appears to be mediated through broader economic structures, whereas minimum wage directly affects earnings and purchasing power. The dominance of UMP in the model also supports the argument that regional wage disparities are a key driver of inequality in Indonesia (Kunarti et al., 2025).

Overall, the integration of these visualizations with machine learning results provides a more nuanced understanding of economic inequality. The findings suggest that inequality in Indonesia is influenced by a combination of structural, economic, and policy-related factors. Minimum wage emerges as a key determinant, particularly in shaping income distribution across regions, while poverty plays a complementary role in reinforcing disparities. At the same time, the non-linear and context-dependent relationships observed in the data highlight the limitations of one-dimensional policy approaches. Addressing inequality therefore requires a comprehensive strategy that considers not only wage policy, but also broader socio-economic conditions, including employment structure, regional development, and access to opportunities.

Systematic Literature Review Based on PRISMA

To complement the quantitative analysis, this study conducts a systematic literature review to synthesize existing findings on the relationship between minimum wage, poverty, and economic inequality. The review process follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to ensure a transparent and structured selection of relevant studies. The outcome of this process is summarized in the PRISMA flow diagram below, which illustrates the stages of identification, screening, eligibility, and inclusion of studies.

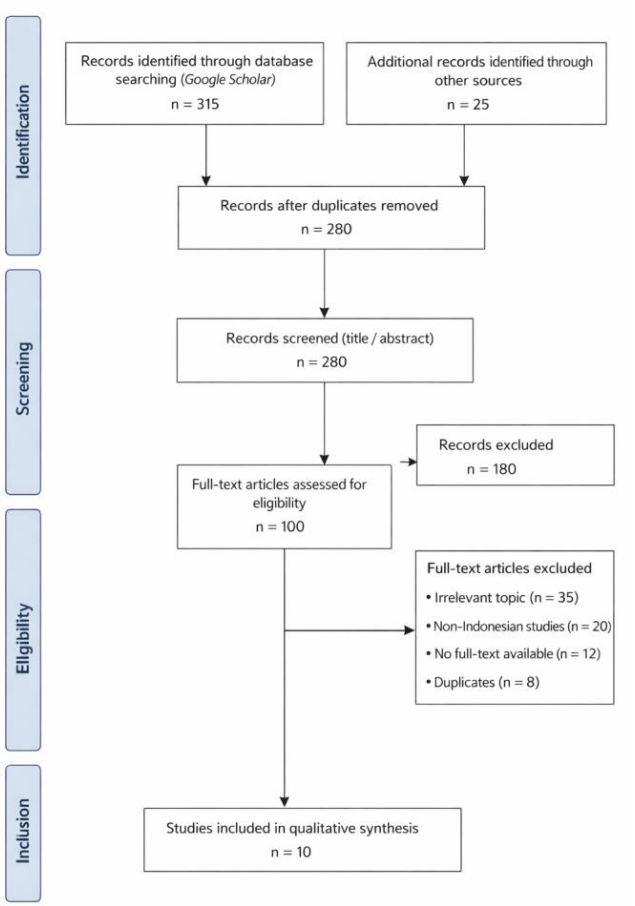


Figure 5. PRISMA Flowchart

Based on the PRISMA selection process, a total of ten studies are included in the final analysis. These studies represent a combination of quantitative, qualitative, and policy-based approaches, providing a comprehensive overview of the relationship between minimum wage policies and economic inequality in Indonesia.

Table 2. Result of Literature Review

No	Title (Authors, Year)	Research Method	Main Findings
1	Viewing The Minimum Wages and Income Inequality in Indonesia (Paramita, 2021)	This study employs a descriptive qualitative approach by analyzing minimum wage policy in Indonesia using literature review and secondary data.	The results show that minimum wage policy can reduce inequality in regions dominated by the formal sector, while its impact is relatively weak in the informal sector.
2	Does Minimum Wage Reduces Gender Inequality Long and Short Term In Indonesia? (Abdul et al., 2024)	This study uses panel data regression across provinces to analyze the effect of minimum wage on gender inequality.	The findings indicate that increases in minimum wage tend to widen gender inequality, as not all worker groups benefit equally.

3	Determination of The Gini Ratio in Indonesia in 2020-2024 : A Panel Data Study of 10 Provinces (Aprilia et al., 2026)	This study applies panel data regression using minimum wage and Gini Ratio variables to examine economic relationships.	The results reveal that minimum wage has a significant effect on the Gini Ratio, although the direction of the effect depends on regional economic conditions.
4	The Influence of Open Unemployment Rates, Inflation and Minimum Wages on Income Inequality in The North Sumatra Region (Nurdini et al., 2024)	This study uses a quantitative approach with multiple linear regression based on secondary data from Badan Pusat Statistik.	The results show that unemployment, inflation, and minimum wage significantly affect income inequality, with unemployment having the strongest positive impact.
5	Pengaruh Upah Minimum terhadap Ketimpangan dan Kemiskinan di Pulau Jawa (Haerunisa & Nabila, 2025)	This quantitative study applies linear regression using variables of poverty, minimum wage, and inequality.	The results indicate that minimum wage has not been effective in reducing inequality, as poverty remains the dominant influencing factor.
6	Upah Minimum dan Tingkat Kemiskinan: Studi Kebijakan di Indonesia (Husni et al., 2023)	This study uses quantitative regression analysis to examine the relationship between minimum wage and poverty levels in Indonesia.	The findings show that increases in minimum wage contribute to poverty reduction, but their effect on inequality is indirect.
7	Kesenjangan upah dan keadilan sosial terhadap sistem pengupahan di Indonesia (Indrayani & Muzan, 2025)	This study employs a descriptive qualitative approach to analyze wage disparities across regions.	The study finds that regional wage disparities are a major factor contributing to increased economic inequality.
8	Reformulation of Minimum Wage Policy and Its Implications Concerning Justice and Workers ' Welfare in the Context Indonesian law (Kunarti et al., 2025)	This study uses a normative legal approach to analyze minimum wage policy based on Indonesian regulations.	The findings suggest that minimum wage policy needs to be reformulated to improve fairness and enhance workers' welfare.
9	The Influence of Minimum Wages and Unemployment Rates on Poverty in	This study applies multiple linear regression using minimum wage,	The results show that minimum wage and unemployment significantly affect

	Indonesia for the Period 2015-2025 (Rinaldi et al., 2025)	unemployment, and poverty variables from 2015–2025.	poverty, which indirectly impacts inequality.
10	Heterogeneous Impact of the Minimum Wage : Implications for Changes in Between- and Within-group Inequality (Oka & Yamada, 2019)	This study uses an econometric approach to analyze wage distribution and minimum wage policy.	The findings indicate that minimum wage policies affect income distribution, but their impact on inequality is complex and varies across contexts.

Table 1 provides a comprehensive overview of the selected studies, highlighting variations in research methods and findings. The studies demonstrate that the relationship between minimum wage and economic inequality is complex and context-dependent, influenced by regional economic structures and labor market conditions.

The findings from the selected studies indicate that the impact of minimum wage on economic inequality is not uniform and tends to vary depending on regional economic structures and labor market conditions. Research conducted by Paramita (2021) shows that minimum wage policies can reduce inequality in regions where the formal sector dominates, as wage regulations are more effectively implemented. However, in regions with a large informal sector, the impact of minimum wage is relatively weak, as many workers are not covered by formal labor regulations.

Similarly, Abdul et al. (2024) highlight that increases in minimum wage may have unintended consequences, particularly in terms of gender inequality. Their findings suggest that wage increases do not benefit all groups equally, leading to a widening gap between male and female workers. This indicates that minimum wage policy alone is insufficient to address structural inequalities in the labor market.

The role of minimum wage in influencing income inequality is further supported by Raden et al. (2024), who find a significant relationship between minimum wage and the Gini Ratio. However, the direction of this relationship varies across regions, depending on economic conditions such as industrialization and labor absorption capacity. This finding is consistent with Nurdini et al. (2024) who employs multiple linear regression analysis using secondary data from Badan Pusat Statistik to examine the effects of open unemployment, inflation, and minimum wage on income inequality. The findings indicate that these variables have a significant simultaneous effect, with unemployment showing a positive relationship with inequality, while the impact of minimum wage varies depending on regional labor market conditions..

In addition, the interaction between minimum wage and poverty emerges as a key theme in the literature. Haerunisa & Nabila (2025) finds that poverty remains a dominant factor influencing inequality, suggesting that wage policies alone are not sufficient to address income disparities. This is supported by Husni et al. (2023), who show that while minimum wage increases can reduce poverty, their impact on inequality is indirect and limited. Further evidence from Indrayani & Muzan (2025) emphasizes that regional wage disparities themselves are a major driver of inequality. Differences in wage levels across provinces contribute to uneven income distribution, reinforcing regional economic gaps. This perspective is complemented by Kunarti et al. (2025), who argue that minimum wage policies need to be reformulated to better address issues of fairness and worker welfare. Moreover, Rinaldi et al. (2025) demonstrate that minimum wage and unemployment jointly influence poverty levels,

which in turn affect inequality. This finding highlights the importance of considering multiple socio-economic variables in analyzing inequality. Finally, Oka & Yamada (2019) conclude that while minimum wage policies influence income distribution, their overall impact on inequality is complex and context-dependent.

The synthesis of the literature reveals several important insights into the relationship between minimum wage and economic inequality in Indonesia. First, the impact of minimum wage is highly conditional, depending on the structure of the labor market and the level of economic development in each region. In areas with a strong formal sector, minimum wage policies are more likely to reduce inequality by increasing the income of low-wage workers. However, in regions dominated by informal employment, the effectiveness of such policies is significantly reduced. Second, the findings highlight the importance of poverty as a mediating variable in the relationship between minimum wage and inequality. While minimum wage increases can improve income levels for certain groups, they do not necessarily address the structural causes of poverty. As a result, inequality may persist even when poverty levels decline. Third, the literature suggests that minimum wage policies may produce unintended effects, such as increased unemployment or widening gender disparities. These outcomes underscore the need for a more comprehensive policy approach that integrates wage regulation with broader socio-economic strategies, including job creation, education, and social protection.

Overall, the results of the systematic literature review indicate that minimum wage policy alone is not sufficient to address economic inequality. Instead, its effectiveness depends on the interaction with other factors, including poverty, labor market conditions, and regional economic structures. These findings provide an important foundation for interpreting the results of the quantitative analysis presented in the next section. The qualitative analysis of the selected studies reveals several recurring themes regarding the relationship between minimum wage and economic inequality in Indonesia. These themes provide a deeper understanding of the mechanisms through which wage policy influences inequality and highlight the contextual factors that shape its effectiveness.

One of the main themes identified is the conditional impact of minimum wage on inequality. Several studies indicate that minimum wage policies are more effective in reducing inequality in regions with a strong formal labor market. In such contexts, wage regulations are more likely to be enforced, allowing workers to benefit directly from policy interventions. However, in regions dominated by informal employment, the impact of minimum wage tends to be limited, as a large portion of workers are not covered by formal regulations. This finding suggests that the effectiveness of wage policy is highly dependent on labor market structure.

Another important theme is the role of poverty as a mediating factor. The literature consistently shows that poverty remains a dominant determinant of inequality, often outweighing the direct effect of minimum wage. While increases in minimum wage may improve income levels for certain groups, they do not necessarily address the underlying structural causes of poverty. As a result, inequality may persist even when wage levels increase, indicating the need for more comprehensive socio-economic policies. The analysis also highlights the presence of unequal distribution of policy benefits. Some studies suggest that minimum wage increases may disproportionately benefit specific groups, such as formal sector workers, while leaving others behind. This uneven distribution can lead to unintended consequences, including widening inequality across different demographic or regional groups. For example, disparities in gender or employment status may be exacerbated when policy benefits are not evenly distributed.

Furthermore, regional wage disparities emerge as a key driver of inequality. Differences in minimum wage levels across provinces contribute to uneven income distribution and

reinforce economic gaps between regions. This finding is consistent with the quantitative results, which identify minimum wage as a dominant variable in predicting inequality. The alignment between qualitative and quantitative findings strengthens the overall validity of the study.

Finally, the literature suggests that the relationship between minimum wage and inequality is complex and context-dependent. Rather than having a uniform effect, minimum wage policies interact with various economic and social factors, including labor market conditions, regional development, and institutional capacity. This complexity underscores the importance of adopting an integrated analytical approach, such as the mixed-method design used in this study.

Conclusion

This study aims to analyze the relationship between minimum wage differences and economic inequality in Indonesia by integrating machine learning analysis with a systematic literature review. The findings reveal that economic inequality in Indonesia is influenced by multiple interrelated factors, with minimum wage and poverty playing significant but distinct roles in shaping income distribution across regions.

From the quantitative analysis, the results indicate that Logistic Regression is the most effective model in predicting economic inequality compared to Decision Tree and Random Forest. The superior performance of this model suggests that the relationship between minimum wage, poverty, and inequality follows a relatively stable and interpretable pattern. Furthermore, feature importance analysis shows that Provincial Minimum Wage (UMP) has a more dominant influence on inequality compared to poverty. This finding highlights the critical role of wage policy in determining income distribution, particularly in the context of regional disparities. However, the visualization results also demonstrate that the relationship between minimum wage and inequality is not strictly linear. In several provinces, higher minimum wages do not necessarily correspond to lower inequality levels, indicating that the impact of wage policy is highly dependent on regional economic structures. Similarly, while poverty shows a positive association with inequality, it does not fully explain variations in inequality across provinces, suggesting the presence of additional structural factors such as labor market composition and regional development.

The qualitative findings derived from the PRISMA-based literature review further reinforce these results. The synthesis of selected studies reveals that the effectiveness of minimum wage policies in reducing inequality is conditional and context-dependent. In regions with a strong formal labor market, minimum wage policies tend to have a more direct and positive impact on reducing inequality. In contrast, in regions dominated by informal employment, the impact is limited, as a large portion of workers are not covered by formal wage regulations. In addition, poverty is consistently identified as a key factor influencing inequality, although its role is often indirect and mediated through broader socio-economic conditions. The integration of quantitative and qualitative findings highlights that minimum wage policy alone is insufficient to address economic inequality in Indonesia. Instead, its effectiveness depends on its interaction with other factors, including poverty, employment structure, and regional economic conditions. This confirms that inequality is a complex and multidimensional phenomenon that requires a comprehensive and integrated policy approach.

Based on these findings, this study contributes to the literature by demonstrating the usefulness of combining machine learning and systematic literature review in analyzing socio-economic issues. The mixed-method approach allows for both empirical validation and theoretical interpretation, providing a more holistic understanding of inequality dynamics.

From a policy perspective, the results suggest that efforts to reduce economic inequality should not rely solely on minimum wage adjustments. Policymakers need to consider complementary strategies, such as strengthening the formal labor sector, reducing regional disparities, and improving access to education and employment opportunities. In addition, targeted interventions are needed to address the structural causes of poverty, which continue to play a significant role in shaping inequality.

In conclusion, economic inequality in Indonesia is shaped by a complex interaction between wage policy, poverty, and regional economic structures. While minimum wage differences are shown to be a significant determinant, their impact is not uniform across regions. Therefore, a multidimensional and context-sensitive policy approach is essential to achieve more inclusive and equitable economic development.

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