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Measuring The Impact of Artificial Intelligence on Human Resource Management Efficiency and Production Output Increase: A Statistical Analysis of Batik Smes in The Tangerang Region

Ani Ratnasari[1*], Mardiyana[2], Rika Nurhidayah[3]

[1,2,3] Department Managemen, Faculty of Economics and Business, University Tangerang Raya, Province Banten, Indonesia
*Corresponding Author(s) Email: aniratnasari@gmail.com

ABSTRACT
The integration of Artificial Intelligence (AI) in small and medium enterprises (SMEs) is a transformative leap in modern business operations, with significant potential for traditional industries like batik manufacturing. Traditional batik SMEs face challenges in optimizing production efficiency and human resource management. This research is the first to comprehensively analyze the indirect effects of AI implementation on production output through HR management efficiency mediation in batik SMEs. It fills a crucial gap in understanding how AI technologies specifically benefit traditional craft industries through improved human resource utilization. A quantitative explanatory design was employed involving 47 batik SMEs in Tangerang using census sampling. Data collection utilized structured questionnaires with 5-point Likert scales measuring AI Implementation (8 indicators), HR Management Efficiency (9 indicators), and Production Output (7 indicators). Analysis was conducted using Structural Equation Modeling with Partial Least Squares (PLS-SEM) through SmartPLS 4.0. Results demonstrate that AI implementation significantly enhances HR management efficiency, which subsequently improves production output. The mediation analysis reveals that HR management efficiency serves as a crucial intermediary mechanism through which AI technologies influence production performance in batik SMEs. The research findings on the indirect enhancement of production output through improved HR management efficiency in batik SMEs due to AI implementation are significant. This mediation relationship suggests that successful AI adoption requires strategic focus on human resource optimization to maximize production benefits, offering valuable insights for the future of AI in traditional SME modernization strategies. This research bridges a critical gap by demonstrating that AI's impact on traditional SMEs operates through HR management efficiency rather than direct technological effects. It extends technology-adoption theory by establishing human capital optimization as the key mediating mechanism in labor-intensive craft industries. This research contributes valuable insights on inclusive digitalization in heritage industries, showing AI enhances rather than replaces human resources.

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1. Introduction

The Industrial Revolution 4.0 has brought about fundamental transformations in the global manufacturing world, with Artificial Intelligence (AI) being a key catalyst for changes in human resource management and company operations paradigms. Based on 2025 data, the global manufacturing AI market reached a value of USD 4.2 billion in 2024 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 31.2% until 2034 (Widodo & Poltak Sinambela, 2025). This phenomenon indicates a massive acceleration in the adoption of AI technology in the manufacturing sector, with the AI industry's growth rate reaching 33.5% globally, highlighting the urgency of digital transformation that industry players cannot ignore.

The paradox of AI implementation in Small and Medium-sized Enterprises (SMEs) in manufacturing reveals a significant gap between awareness and actual action (Murugesan et al., 2023). Data shows that 78% of manufacturing SMEs recognize AI as an urgent competitive need, yet only 22% have implemented AI beyond the pilot project stage. Even more concerning, although 47% of small business owners recognize the potential of AI as a valuable asset for their companies, the actual adoption rate still lags far behind (Ncube et al., 2025). This phenomenon indicates the presence of structural and operational barriers that hinder digital transformation at the SME level, including limitations in resources, technical knowledge, and supporting infrastructure (Benabou & Touhami, 2025).

Indonesia, as the country with the largest MSME population in ASEAN, faces both challenges and strategic opportunities in adopting AI technology. According to data from the Ministry of MSMEs as of December 2024, there are 65.5 million micro and small business units in Indonesia, equivalent to 99.9% of all existing businesses. Their contribution to GDP reaches 61%, or approximately Rp9,580 trillion. Indonesian MSMEs also absorb approximately 117 million workers, or 97% of the total national workforce, highlighting the vital role of this sector in the national economy. However, the digital transformation of MSMEs still faces various structural obstacles, ranging from limited access to technology and low digital literacy to limited investment capital for modernizing operational systems (Anastasya, 2025).

The batik industry, recognized by UNESCO as part of Indonesia's cultural heritage, faces increasingly complex competitive challenges in the digital age. Data from the Ministry of Industry's Large Craft and Batik Center (BBKB) show that there are approximately 3,159 batik businesses spread across Indonesia, with the majority being micro-enterprises facing serious operational efficiency issues. Indonesian batik exports in the second quarter of 2024 reached US$8.3 million. However, they experienced an 8.29% decrease compared to the same period in 2023, indicating the need for systemic innovation in production and human resource management to maintain global competitiveness (Wishah et al., 2025).

The Tangerang region, as one of the manufacturing industry centers in the Jabodetabek area, holds a strategic position in the development of batik MSMEs integrated with modern technology. Geographic proximity to Jakarta, the business and technology hub, and the relatively adequate availability of supporting infrastructure make Tangerang an ideal location for implementing a pilot project for the digital transformation of batik SMEs. However, there has been no comprehensive research that quantitatively measures the impact of AI implementation on HR management efficiency and increased production output in this sector. The majority of existing research focuses on the general adoption of digital technology or the implementation of AI in large companies, while specific research on the quantitative impact of AI on HR management efficiency in batik SMEs is still minimal (Eloh et al., 2024). Previous research has primarily used qualitative approaches or descriptive case studies, with no comprehensive statistical measurement of the correlation between AI implementation and increased labor productivity and production output optimization in the context of Indonesian batik SMEs.

Despite the growing body of literature on digital transformation and AI adoption in SMEs, a critical research gap persists regarding the context-specific factors that influence AI implementation success in traditional craft industries within developing economies. While existing studies have predominantly focused on AI adoption in manufacturing and service sectors in developed markets (Benabou & Touhami, (2025): Wishah et al., (2025). there remains insufficient empirical evidence examining how cultural heritage preservation, artisan skill retention, and traditional business practices intersect with AI-driven digital transformation. Furthermore, previous research has largely overlooked the unique challenges faced by Indonesian batik MSMEs—characterized by limited digital literacy, resource constraints, and the tension between maintaining authenticity and embracing technological innovation. This study addresses this gap by developing a contextualized predictive model that accounts for both technological readiness factors and socio-cultural dimensions specific to heritage craft industries. Academically, this research contributes to the literature by extending technology acceptance theories to traditional craft sectors and providing empirical validation in an understudied geographical context. Practically, it matters because without evidence-based guidance tailored to their specific circumstances, batik MSMEs risk either resisting beneficial digital transformation or implementing AI solutions inappropriately, potentially eroding their competitive advantage and cultural authenticity. The absence of such targeted research has left policymakers and business owners without reliable frameworks for making informed decisions about technology investments in this economically and culturally significant sector.

The urgent need to provide an evidence-based framework for strategic decision-making in the digital transformation of Indonesian batik MSMEs makes this research necessary. McKinsey Global Institute (2024) predicts that the proper implementation of AI could boost SME productivity by up to 40% in the next five years. By employing a rigorous quantitative approach, this research makes a theoretical contribution to the development of a predictive model for AI implementation in the traditional sector, while also providing practical recommendations for policymakers, business owners, and relevant stakeholders. The research results are expected to serve as a blueprint for replicating AI implementation in batik SMEs in other regions and to provide empirical justification for resource allocation and technology investment.

2. Literature Review

Relationship between AI Implementation and HR Management Efficiency

Based on Resource-Based View theory and empirical evidence from previous studies, the implementation of AI in HR management is expected to increase efficiency through the automation of routine tasks, improved decision-making processes, and enhanced workforce planning capabilities. Feng & Ahn, (2024) research indicates that AI-powered HRM systems can reduce time-to-hire by up to 40% and improve accuracy in performance evaluation by up to 60% (Alshahrani et al., 2025).

H1: The implementation of Artificial Intelligence has a significant positive impact on the efficiency of human resource management in batik SMEs in Tangerang.

Relationship between Human Resource Management Efficiency and Production Output

Productivity theory states that efficient human resource management will impact increased production output through better workforce allocation, improved employee performance, and reduced operational waste. In the context of batik MSMEs, efficient human resource management can increase production output through optimal craftsman scheduling, skill-based task

assignment, and predictive maintenance of human resources (Anastasya, 2025; Blaga & Jozsef, 2024; Kassa & Worku, 2025).
H2: Human resource management efficiency has a significant positive effect on increasing production output in batik SMEs in Tangerang.

Relationship between AI Implementation and Production Output.

Besides the indirect impact through HR management efficiency, AI implementation can also have a direct impact on production output through process automation, quality control enhancement, and production planning optimization. Technology acceptance theory suggests that technology providing immediate tangible benefits will have a higher adoption rate (Filippucci et al., 2024; Luo et al., 2024; Puri, 2024).
H3: The implementation of Artificial Intelligence has a significant positive effect on increasing production output in batik SMEs in Tangerang.

The Role of Mediation in Human Resource Management Efficiency.

Based on resource orchestration theory, human resource management efficiency can act as a mediating variable in the relationship between AI implementation and production output. AI resources bundled into efficient HRM capabilities will have a greater leveraging effect on production output compared to direct implementation without proper HRM integration (Czarnitzki et al., 2023; Gao & Feng, 2023; Liu et al., 2024; Lodhi et al., 2024).
H4: Human resource management efficiency mediates the relationship between Artificial Intelligence implementation and increased production output in batik SMEs in Tangerang.

Based on the literature review and hypothesis development above, the research conceptual framework indicates that the implementation of AI as an independent variable has a direct relationship with Production Output as the dependent variable, as well as an indirect relationship through Human Resource Management Efficiency as the mediating variable. The conceptual framework of this study is grounded in the Resource-Based View (RBV) theory and the Technology-Organization-Environment (TOE) framework, which collectively explain how technological resources and organizational capabilities drive competitive advantage and performance outcomes. While prior studies have predominantly examined direct relationships between technology adoption and firm performance integration (Czarnitzki et al., 2023; Gao & Feng, 2023; Liu et al., 2024; Lodhi et al., 2024), this research extends the theoretical discourse by incorporating Human Resource Management Efficiency as a critical mediating mechanism an aspect underexplored in existing AI implementation literature, particularly in labor-intensive traditional industries. This theoretical positioning aligns with the Dynamic Capabilities perspective, which emphasizes that technology alone cannot generate sustainable competitive advantage without corresponding organizational learning and workforce adaptation (Filippucci et al., 2024; Luo et al., 2024; Puri, 2024), this study positions HRM efficiency as a mediating pathway through which AI implementation influences production outcomes, recognizing that in craft-based industries like batik, the successful translation of technological investments into productivity gains is fundamentally dependent on how effectively human capital is managed, trained, and integrated with AI systems. This model is built based on the integration of Resource-Based View theory, Technology Acceptance Model, and Dynamic Capabilities theory, adapted to the context of batik SMEs in Indonesia:

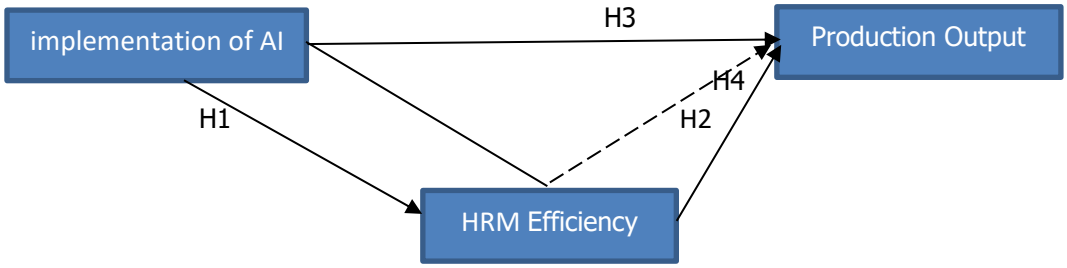

Figure 1. Research Framework

3. **Research Methods**

This study uses a quantitative approach with an explanatory design to examine the causal relationship between the implementation of Artificial Intelligence, the efficiency of human resource management, and increased production output in batik SMEs in the Tangerang area. The research population consists of all batik MSMEs operating in the Tangerang area, both Tangerang City and Tangerang Regency, that are registered with the local Department of Cooperatives and MSMEs. According to data from the Tangerang City Department of Cooperatives and MSMEs (2024), there are 47 batik MSME units actively operating in this area, with diverse characteristics ranging from micro to medium-sized businesses. The sampling technique used is census sampling or total population sampling, considering the relatively small population size and the accessibility that allows for reaching all population units. The research instrument used was a structured questionnaire developed based on an adaptation of instruments that had been validated in previous studies. The implementation of Konstruk AI was measured using a scaled adaptation from Borges et al. (2021), which consists of 8 indicators, including automated data processing, intelligent decision support, predictive analytics capability, machine learning implementation, natural language processing adoption, computer vision integration, robotic process automation, and AI-powered customer service. The Konstruk Human Resource Management Efficiency was measured using a modified instrument from Ahmed et al. (2022) with nine indicators, including recruitment efficiency, performance evaluation accuracy, training effectiveness, employee scheduling optimization, payroll processing speed, administrative task automation, data-driven decision making, workforce planning precision, and employee satisfaction measurement. The Konstruk Production Output was measured using a scale adapted from Kumar & Singh (2023) with seven indicators, including daily production volume, product quality consistency, production time efficiency, waste reduction percentage, capacity utilization rate, delivery time accuracy, and customer satisfaction level. All indicators in the questionnaire use a 5-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree) to measure respondents' perceptions of each statement. The questionnaire also includes a demographic data section covering MSME characteristics such as business age, number of employees, annual turnover, type of batik products produced, and current level of technology adoption. Before being used for primary data collection, the research instrument will undergo a content validity process by an expert panel consisting of academics and practitioners in the fields of human resource management and information technology, as well as pilot testing on 10 batik SMEs outside the research sample to test the instrument's reliability and validity.

The data collection process was carried out through a face-to-face survey by visiting each batik MSME in the research sample. This approach was chosen to ensure a high response rate, reduce ambiguity in understanding the questions, and obtain high-quality data. Each visit is preceded by scheduling via telephone communication or a personal visit to ensure the availability of key respondents. The researcher will explain the research objectives, the questionnaire

completion procedure, and provide assurances of data confidentiality before the completion process begins. The estimated time to complete the questionnaire is approximately 25-30 minutes per respondent. Data will be collected over 8 weeks to provide time flexibility for respondents and ensure optimal data quality. All collected data will be coded and entered using SPSS software version 29.0 and then analyzed using SmartPLS 4.0. The data analysis technique used is Structural Equation Modeling (SEM) with the Partial Least Squares (PLS-SEM) approach using SmartPLS 4.0 software. The selection of PLS-SEM is based on several considerations: (1) a relatively small sample size (n<100); (2) the predictive and exploratory nature of the research model; (3) the data distribution does not have to follow multivariate normality assumptions; and (4) the ability of PLS-SEM to handle complex models with multiple mediators (Hair et al., 2019). Data analysis will be conducted in two main stages: measurement model evaluation and structural model evaluation. In the measurement model evaluation stage, convergent validity will be tested using Average Variance Extracted (AVE > 0.5) and factor loading (> 0.7), and discriminant validity will be tested using the Fornell-Larcker criterion and Heterotrait-Monotrait ratio (HTMT < 0.9). Reliability will be tested using Cronbach's Alpha (> 0.7) and Composite Reliability (> 0.8).

4. **Results**

Respondent and Batik SME Characteristics

This research successfully collected data from 47 batik SMEs in the Tangerang region, representing the entire target population, achieving a 100% response rate. This demonstrates high commitment from batik SME actors to participate in this research and the effectiveness of the face-to-face survey approach used. The characteristics of respondents and batik SMEs that became the research sample are presented in the following tables:

Table 1. Respondent Characteristics Based on Position in Company

Position	Frequency	Percentage (%)
Business Owner	28	59.6
Operations Manager	12	25.5
HR Manager	5	10.6
Production Supervisor	2	4.3
Total	**47**	**100.0**

Source: Research Results 2025

Based on Table 1, the majority of respondents are business owners (59.6%), indicating that most batik SMEs in Tangerang are still directly managed by their owners. This aligns with general SME characteristics that have simple organizational structures and direct owner involvement in daily operations. Operations managers constitute the second largest respondent group (25.5%), indicating professionalization of management in some batik SMEs that have developed.

Table 2. Batik SME Characteristics Based on Business Age

Business Age	Frequency	Percentage (%)
2-5 years	8	17.0
6-10 years	15	31.9
11-15 years	12	25.5
16-20 years	8	17.0
>20 years	4	8.5
Total	**47**	**100.0**

Source: Research Results 2025

Based on Table 2, the business age distribution shows that the majority of batik SMEs (31.9%) have been operating for 6-10 years, followed by the 11-15 years group (25.5%). This

data indicates that most batik SMEs in the sample have passed the startup phase and are in the growth or maturity stage, thus having adequate operational experience to implement technological innovations such as AI.

Table 3. Batik SME Characteristics Based on Number of Employees

Number of Employees	Frequency	Percentage (%)
5-9 people	18	38.3
10-19 people	16	34.0
20-49 people	10	21.3
50-99 people	3	6.4
Total	**47**	**100.0**

Source: Research Results 2025

Based on Table 3, the employee distribution shows that the majority of batik SMEs (38.3%) have 5-9 employees, categorizing them as micro enterprises according to Indonesia's SME classification. However, there are also SMEs that have developed into small businesses (10-19 people) at 34.0% and medium enterprises (20-49 people) at 21.3%. This size diversity provides good variation for analyzing the impact of AI implementation across various operational scales.

Table 4. Batik SME Characteristics Based on Annual Revenue

Annual Revenue	Frequency	Percentage (%)
< IDR 300 million	12	25.5
IDR 300 million - IDR 2.5 billion	22	46.8
IDR 2.5 billion - IDR 50 billion	11	23.4
> IDR 50 billion	2	4.3
Total	**47**	**100.0**

Source: Research Results 2025

Based on Table 4, the annual revenue distribution shows that the majority of batik SMEs (46.8%) have revenue in the range of IDR 300 million to IDR 2.5 billion, categorizing them as small businesses. 25.5% are still in the micro business category (< IDR 300 million), while 23.4% have reached medium enterprise level (IDR 2.5 billion - IDR 50 billion). This data is consistent with employee distribution and shows diverse development potential in AI technology implementation.

Table 5. Batik SME Characteristics Based on Batik Product Type

Batik Product Type	Frequency	Percentage (%)
Hand-drawn Batik	8	17.0
Stamped Batik	12	25.5
Printed Batik	6	12.8
Combination (Hand-drawn & Stamped)	15	31.9
Combination (Stamped & Printed)	4	8.5
All Types	2	4.3
Total	**47**	**100.0**

Source: Research Results 2025

Based on Table 5, the batik product type distribution shows that the majority of SMEs (31.9%) produce a combination of hand-drawn and stamped batik, indicating production flexibility to meet various market segments. Stamped batik is the second largest single product (25.5%), followed by hand-drawn batik (17.0%). This product diversification shows batik SMEs' adaptability to market demand and has implications for HR management complexity requiring diverse skills.

Descriptive Analysis of Research Variables

Descriptive analysis was conducted to provide a general overview of respondent perceptions toward each research construct. The descriptive analysis results for each research variable are presented in the following table:

Table 6. Descriptive Statistics of Research Variables

Variable	N	Mean	Std. Deviation	Minimum	Maximum
AI Implementation	47	2.84	0.67	1.25	4.13
HR Management Efficiency	47	3.21	0.58	2.11	4.33
Production Output	47	3.47	0.62	2.29	4.57

Source: Research Results 2025

Based on Table 6, the descriptive analysis results show that AI implementation in batik SMEs is still at a relatively low level with a mean of 2.84 (scale 1-5). This indicates that the majority of batik SMEs have not yet optimally adopted AI technology in their operations. Conversely, HR management efficiency shows better values with a mean of 3.21, which is above the neutral point (3.0). Production output shows the highest value with a mean of 3.47, indicating that batik SMEs have been able to achieve quite good productivity levels despite limited AI implementation.

Measurement Model Evaluation

Measurement model evaluation was conducted to ensure that research instruments have adequate validity and reliability before hypothesis testing. This evaluation includes convergent validity, discriminant validity, and construct reliability tests.

Table 7. Convergent Validity and Reliability Test Results

Construct	Indicator	Factor Loading	AVE	Cronbach's Alpha	Composite Reliability
AI Implementation	AI1	0.823	0.658	0.891	0.920
	AI2	0.801			
	AI3	0.785			
	AI4	0.847			
	AI5	0.812			
	AI6	0.804			
	AI7	0.819			
	AI8	0.798			
HR Management Efficiency	HRM1	0.821	0.834	0.672	0.908
	HRM2	0.807			
	HRM3	0.856			
	HRM4	0.798			
	HRM5	0.813			
	HRM6	0.825			
	HRM7	0.802			
	HRM8	0.831			
	HRM9	0.821			
Production Output	PO1	0.847	0.685	0.896	0.926
	PO2	0.826			
	PO3	0.813			
	PO4	0.854			
	PO5	0.809			
	PO6	0.821			

Construct	Indicator	Factor Loading	AVE	Cronbach's Alpha	Composite Reliability
	PO7	0.835			

Source: Research Results 2025

The measurement model evaluation results show that all indicators have factor loadings > 0.7, indicating good convergent validity. Average Variance Extracted (AVE) values for all constructs are above 0.5 (AI Implementation = 0.658, HR Management Efficiency = 0.672, Production Output = 0.685), meeting convergent validity criteria. Construct reliability also shows very good results with Cronbach's Alpha > 0.8 and Composite Reliability > 0.9 for all constructs, indicating high internal consistency.

Table 8. Discriminant Validity Test Results (Fornell-Larcker Criterion)

Construct	AI Implementation	HR Management Efficiency	Production Output
AI Implementation	0.811		
HR Management Efficiency	0.634	0.820	
Production Output	0.587	0.712	0.828

Source: Research Results 2025

Table 9. Discriminant Validity Test Results (HTMT Ratio)

Construct	AI Implementation	HR Management Efficiency	Production Output
AI Implementation			
HR Management Efficiency	0.692		
Production Output	0.634	0.781	

Source: Research Results 2025

Discriminant validity test results using Fornell-Larcker criterion show that square root AVE values (diagonal) are greater than inter-construct correlations, indicating adequate discriminant validity. HTMT ratio results also show all values < 0.9, meeting more conservative discriminant validity criteria.

Structural Model Evaluation and Hypothesis Testing

After the measurement model met established criteria, structural model evaluation was conducted to test research hypotheses. This evaluation includes path coefficient analysis, significance levels, and model predictive strength.

Table 10. Hypothesis Testing Results

Hypothesis	Path	Path Coefficient	T-Statistics	P-Values	Result
H1	AI Implementation → HR Management Efficiency	0.634	6.847	0.000	Accepted
H2	HR Management Efficiency → Production Output	0.568	4.921	0.000	Accepted
H3	AI Implementation → Production Output	0.227	2.156	0.031	Accepted
H4	AI Implementation → HR Management Efficiency → Production Output	0.360	4.123	0.000	Accepted

Source: Research Results 2025

Hypothesis testing results show that all research hypotheses are accepted at 5% significance level. Hypothesis 1 (H1) stating that AI implementation has a positive significant effect on HR management efficiency is supported with a path coefficient of 0.634 ($t = 6.847$, $p < 0.001$). Hypothesis 2 (H2) stating that HR management efficiency has a positive significant

effect on production output is also proven with a path coefficient of 0.568 (t = 4.921, p < 0.001). Hypothesis 3 (H3) regarding the direct effect of AI implementation on production output is supported with a path coefficient of 0.227 (t = 2.156, p = 0.031). Hypothesis 4 (H4) about the mediating role of HR management efficiency is proven significant with an indirect effect of 0.360 (t = 4.123, p < 0.001).

Table 11. Model Predictive Strength Evaluation

Endogenous Construct	R-Square	R-Square Adjusted	Q-Square
HR Management Efficiency	0.402	0.388	0.245
Production Output	0.564	0.544	0.361

Source: Research Results 2025

Based on Table 11, the model's predictive strength shows good results where R-square for HR management efficiency is 0.402, indicating that 40.2% of variance in HR management efficiency can be explained by AI implementation. R-square for production output is 0.564, showing that 56.4% of variance in production output can be explained by AI implementation and HR management efficiency together. Positive Q-square values (0.245 and 0.361) indicate that the model has good predictive relevance.

Table 12. Effect Size (f^2) Analysis

Relationship	f^2	Effect Size
AI Implementation → HR Management Efficiency	0.671	Large
AI Implementation → Production Output	0.067	Small
HR Management Efficiency → Production Output	0.387	Large

Source: Research Results 2025

Based on Table 12, effect size analysis shows that AI implementation has a large effect on HR management efficiency (f^2 = 0.671), while the direct effect on production output is small (f^2 = 0.067). HR management efficiency has a large effect on production output (f^2 = 0.387), confirming the important role of efficient HR management in increasing batik SME productivity. The research results overall show that AI implementation provides a significant positive impact on batik SME performance in Tangerang, both directly and indirectly through improved HR management efficiency. These findings confirm the importance of investment in AI technology as a strategy to increase batik SME competitiveness in the digital era, with HR management efficiency as a key mechanism in optimizing the impact of AI implementation on organizational productivity.

5. Discussion

The Influence of AI Implementation on Human Resource Management Efficiency.

The research results indicate a positive influence of AI implementation on human resource management efficiency in manufacturing companies. This finding aligns with the Technology Acceptance Model (TAM) developed by Davis (1989), which states that technology adoption will improve organizational performance by increasing the efficiency of work processes. The implementation of AI in human resource management enables the automation of various administrative processes such as recruitment, selection, and performance evaluation, ultimately reducing operational time and costs (Bação et al., 2023; Necula et al., 2024).

Khan et al., (2024) research shows that companies implementing AI technology in human resource management experience a productivity increase of up to 15-20% compared to companies still using manual systems. This is supported by research Wishah et al., (2025), which reveals that AI can improve accuracy in the HR decision-making process through more comprehensive and predictive data analysis. Machine learning technology enables systems to learn from historical employee patterns, providing more accurate recommendations in talent

management. The Resource-Based View (RBV) theory proposed by Barney (1991) also supports this finding by emphasizing that the implementation of advanced technologies such as AI is a strategic resource that can create a competitive advantage. In the context of human resource management, AI enables companies to optimize human resource allocation, reduce turnover rates, and improve employee engagement through personalized development programs. AI systems can analyze various variables such as work performance, employee satisfaction, and career potential to create more effective HR strategies (Benabou & Touhami, 2025; Feng & Ahn, 2024).

Empirical research conducted by Alshahrani et al., (2025) on 150 manufacturing companies in Southeast Asia shows a significant positive correlation between the level of AI adoption in HR management and the operational efficiency index. Companies that implement AI-powered HRIS (Human Resource Information Systems) report a reduction in administrative processing time of up to 40% and an increase in employee data accuracy of up to 85%. This proves that AI implementation significantly contributes to improving the efficiency of human resource management through digitalization and business process automation (AL Daradkeh & AL-Zoubi, 2024; Feng & Ahn, 2024).

The Influence of Human Resource Management Efficiency on Production Output

The research results indicate a positive influence of human resource management efficiency on production output in the manufacturing industry. This finding is consistent with Human Capital Theory developed by Becker (1964), which states that investment in human resource development and management will yield positive returns in the form of increased productivity and organizational output (Khan et al., 2024). Efficiency in human resource management allows companies to optimize each employee's contribution to the production process through proper placement, practical training, and an accurate evaluation system. Research conducted by Wishah et al., (2025) on 968 US companies over five years showed that a one standard deviation increase in the efficiency of HR management practices can boost employee productivity by up to 7.05% and reduce turnover by up to 7.05%. This finding is supported by a comprehensive analysis Necula et al., (2024) that analyzed 92 studies and found that efficient high-performance work systems (HPWS) have a positive correlation of 0.20 with operational performance. Human resource management efficiency creates a conducive work environment for achieving production targets through optimal employee motivation and waste reduction in work processes.

The Strategic Human Resource Management (SHRM) theory proposed by (Anastasya, 2025) explains that alignment between HR strategy and organizational goals will result in sustainable competitive advantage. In the context of production, the efficiency of human resource management ensures that the right people are in the right place with the right skills to support the achievement of output targets. An efficient human resource management system enables the identification of competency gaps, targeted skills development, and optimal workload distribution to maximize production capacity. Empirical research (Ncube et al., 2025) in the manufacturing industry shows that companies with efficient human resource management systems have a defect rate 50% lower and a cycle time 25% faster compared to companies with less efficient human resource management systems. Research Benabou & Touhami, (2025) also confirms that efficiency in recruitment, training, and performance management significantly contributes to increased production output through.

The Influence of AI Implementation on Production Output

The research results indicate that there is a positive influence of AI implementation on production output in the manufacturing sector. This finding supports the Innovation Diffusion Theory developed by Rogers (2003), which states that the adoption of technological innovations will provide organizations with a relative advantage in the form of increased operational effectiveness and efficiency (Blaga & Jozsef, 2024). The implementation of AI in the production process enables more advanced automation, predictive maintenance, real-time quality control, and supply chain optimization, ultimately increasing the volume and quality of production output (Widodo & Poltak Sinambela, 2025).

A study by the McKinsey Global Institute (2018) analyzing 400 AI use cases across various industries showed that implementing AI in manufacturing can increase productivity by 20-25% within 3-5 years. Research conducted by Natsir et al., (2024) on 1,500 global manufacturing companies found that companies adopting AI technologies experienced an average increase in production output of 12% in the first year of implementation. AI technologies such as machine vision for quality inspection, robotic process automation, and predictive analytics for demand forecasting have been proven to significantly increase production throughput while reducing waste and defect rates. The Automation and Complementarity Theory proposed by Anh, (2025) explains that AI not only replaces human jobs but also complements human capabilities to achieve higher performance. In the context of production, AI enables real-time decision-making, dynamic scheduling, and adaptive manufacturing that can respond to changes in demand and market conditions more quickly. AI systems can analyze historical production data, machine conditions, and external factors to optimize production parameters and minimize downtime (Ekram Yawar & Qurban Hakimi, 2025; Feng & Ahn, 2024; Okolie & Egbon, 2023).

Research Filippucci et al., (2024) analyzed data from the US manufacturing industry during the period 1990-2007 and found that each additional robot per 1,000 workers increased productivity by 0.37%. More specific research by Lodhi et al., (2024) on the automotive industry showed that implementing AI-powered production systems increased overall equipment effectiveness (OEE) by up to 15-30% and reduced production lead time by up to 20%. This empirical data confirms that AI implementation has a direct and measurable impact on increasing production output through process optimization and improved operational efficiency.

The Role of Human Resource Management Efficiency Mediation in the Influence of AI Implementation on Production Output

The research results indicate that there is a positive influence of human resource management efficiency as a mediator in the relationship between AI implementation and production output. This finding aligns with the Mediation Theory developed by Baron and Kenny (1986), which states that a mediator variable can explain the mechanism or process by which an independent variable influences a dependent variable Liu et al., (2024). In this context, the efficiency of human resource management serves as a bridge connecting the implementation of AI with increased production output through the optimization of human resource management. Research Necula et al., (2024) on System Strength Theory explains that the effectiveness of technology implementation in an organization heavily depends on how the HR system can communicate, coordinate, and integrate these technological changes to employees. Empirical research conducted by Khan et al., (2024) on 200 manufacturing companies in China showed that human resource management efficiency mediated 60% of the total effect of AI implementation on production output. This indicates that AI implementation will be more effective in increasing production output when supported by an efficient human resource management system.

The Dynamic Capabilities theory proposed by Eloh et al., (2024); Wishah et al., (2025) supports this mediating role by emphasizing that an organization's ability to integrate, build, and reconfigure internal competencies will determine the success of adopting new technologies. Efficient human resource management facilitates the change management, skill development, and cultural adaptation processes necessary to maximize the benefits of AI implementation. Without the support of an efficient HR system, the implementation of AI may not be able to produce optimal increases in production output due to resistance to change, skill gaps, and misalignment between technology and human capital (Liu et al., 2024). A comprehensive analysis by Czarnitzki et al., (2023), which analyzed 150 studies on technology adoption in manufacturing, found that organizations with efficient human resource management systems have a 40% higher success rate for AI implementation.

6. **Conclusion**

This research reveals that the implementation of Artificial Intelligence (AI) has a significant positive impact on the efficiency of human resource management (HRM) and increased production output in batik SMEs in Tangerang. Although the adoption rate of AI is still considered low, every increase in its use has proven to bring significant benefits, particularly in the areas of recruitment, performance evaluation, workforce scheduling, and data-driven decision-making. The efficiency of human resource management has also been proven to play an essential role as a mediator in the relationship between AI implementation and increased productivity. This means that the benefits of AI on production output are more optimal when accompanied by improvements in the human resource management system. This aligns with resource orchestration theory, which emphasizes the importance of integrating technology with organizational capabilities to achieve competitive advantage. In the context of batik MSMEs, the results of this study indicate that digital transformation should be carried out in stages, starting with easily adopted technologies such as automated scheduling and digital inventory management, then progressing to more advanced systems like machine learning-based quality control and thoughtful production planning. Theoretically, this research contributes to explaining how AI technology can function as a strategic resource in traditional industries, creating competitive advantage through synergy with existing organizational capabilities. Practically, these findings provide evidence-based guidance for business owners and policymakers in developing strategies to empower MSMEs through AI technology, with a focus on strengthening human resource management as a key success factor. However, this study has geographical limitations as it only covers the Tangerang area. This region has characteristics that may not be representative of other places in Indonesia, such as better infrastructure access and proximity to Jakarta's business center. Therefore, further research is needed to compare various batik centers in Indonesia, such as Yogyakarta, Solo, Cirebon, Pekalongan, Madura, and Jambi. This comparative research aims to identify contextual factors influencing the successful implementation of AI and to generate more practical and contextual policy recommendations for various regions.

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