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Artificial Intelligence in Aviation Vocational Training: Mapping Legal Frameworks and Institutional Readiness in Indonesia

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ABSTRACT

Artificial Intelligence (AI) has emerged as a transformative force in higher and vocational education, yet its rapid adoption often outpaces existing legal and institutional frameworks. This study investigates how Indonesia's regulatory landscape supports the integration of AI in teaching and learning at Politeknik Penerbangan Makassar (Poltekbang Makassar), and identifies the legal, ethical, and governance challenges shaping responsible innovation. Employing a qualitative descriptive approach, the research combines document analysis of key national policies (such as the National Education System Law 2003, Presidential Regulation No. 95/2018, and the National AI Strategy 2020–2045) with semi-structured interviews involving five lecturers and two academic policymakers. Data were analyzed thematically. The results reveal that while Indonesia's legal foundations implicitly support AI adoption through broader digital transformation policies, significant regulatory gaps persist, particularly concerning algorithmic transparency, accountability, and data privacy. Institutional policies at Poltekbang Makassar demonstrate readiness for technological innovation but lack comprehensive AI governance mechanisms. The study proposes a multi-level regulatory model encompassing national policy formulation, sectoral alignment within vocational standards, and internal institutional governance frameworks to ensure accountability, fairness, and compliance. These findings contribute to the development of an Institutional AI Governance Framework based on principles of accountability, transparency, and compliance with the Personal Data Protection Law, offering a practical roadmap for policymakers and educational leaders in Indonesia's vocational sector.

1. Introduction

Artificial Intelligence (AI) has become a transformative force in higher education, influencing how teachers design instruction, assess learning, and provide feedback [15], [18], [20]. AI applications in education include intelligent tutoring systems, adaptive learning platforms, automated grading, and predictive analytics to monitor student progress [16], [14], [19]. In technical institutions such as Politeknik Penerbangan Makassar (Poltekbang Mks), AI has the potential to

enhance simulation-based learning, automate student assessments, and personalize aviation training, providing both efficiency and pedagogical flexibility [16].

However, the integration of AI in educational settings introduces significant challenges. Ethical considerations, including algorithmic fairness, bias, and transparency, are critical in ensuring equitable learning opportunities. Data privacy concerns emerge from the collection and processing of sensitive learner data, which require adherence to legal frameworks such as the Personal Data Protection Law in Indonesia or GDPR analogues internationally [11], [3], [17]. Moreover, the rapid development of AI often surpasses the capacity of existing legal and institutional frameworks to regulate its use effectively [20], [15].

In Indonesia, the adoption of AI in higher education is supported by national initiatives such as the National Strategy for Artificial Intelligence 2020–2045 and Presidential Regulation No. 95/2018 on Electronic-Based Government Systems. Nevertheless, vocational and technical institutions face the challenge of limited sector-specific legal guidance for AI integration. Existing laws and regulations provide broad support for digital transformation but do not yet offer detailed operational guidelines for AI ethics, accountability, or explainability [16], [11]. This creates a research gap: how can institutions responsibly implement AI while complying with national and sectoral regulations?.

Poltekbang Makassar, under the Ministry of Transportation, is one of Indonesia's leading aviation polytechnics integrating digital technologies into teaching and learning. Its context is particularly suitable for investigating how legal regulations and institutional governance shape AI adoption in vocational education. Understanding institutional practices in a high-stakes, safety-critical environment provides novel insights into AI governance models that balance innovation with ethical and legal responsibility [13].

This study addresses this novelty by combining document analysis of national and institutional policies with empirical evidence from interviews with lecturers and academic policymakers. The research aims to answer the question: "How do existing legal regulations support the use of AI in teaching and learning at Politeknik Penerbangan Makassar?". By mapping regulatory support, analyzing institutional readiness, and proposing operational recommendations, this study provides a practical and theoretically grounded roadmap for responsible AI integration in Indonesian vocational education.

2. Method

This study employed a qualitative descriptive approach to examine the relationship between legal regulations and the implementation of artificial intelligence (AI) in education. The research combined document analysis and empirical inquiry to gain a comprehensive understanding of regulatory frameworks and institutional practices that support AI integration, particularly within the context of aviation education in Indonesia.

The document analysis involved reviewing key national policies and legal documents, including Law No. 20 of 2003 on the National Education System, Presidential Regulation No. 95 of 2018 on Electronic-Based Government Systems, the National AI Strategy 2020–2045 published by BRIN, and relevant regulations issued by the Ministry of Transportation concerning aviation education. Institutional policies and Standard Operating Procedures (SOPs) from Politeknik Penerbangan Makassar related to digital learning and AI integration were also examined.

Complementing this, semi-structured interviews were conducted with five lecturers actively engaged in digital learning innovations and two academic policymakers—the Head of the Education Division and the Head of the IT Unit. The collected data were analyzed using thematic analysis, which followed three stages: (1) data familiarization through an in-depth review of documents and interview transcripts; (2) coding and categorization to identify recurring themes such as policy support, ethical concerns, and institutional readiness; and (3) interpretation by relating emerging themes to the existing body of literature on AI in education and the Indonesian regulatory landscape.

3. Results and Discussion

3.1. National legal framework

The analysis reveals that Indonesia's current regulatory landscape provides indirect yet significant support for the adoption of artificial intelligence (AI) in education through broader policies on digital transformation and innovation. The National Education Law emphasizes the integration of technology in teaching and learning processes; however, it does not explicitly address the use of AI. Similarly, the National AI Strategy (2020–2045) highlights the potential of AI to enhance educational quality but lacks binding operational guidelines to ensure consistent implementation across institutions. Regulations issued by the Ministry of Transportation further encourage modernization within aviation education, though their focus remains primarily on physical infrastructure development rather than digital pedagogy. Consequently, while national-level policies foster an enabling environment for technological innovation, they have yet to establish specific legal standards governing AI ethics, data protection, and academic integrity in educational contexts.

3.2. Institutional policy and implementation

At the institutional level, Politeknik Penerbangan Makassar demonstrates a gradual yet structured approach to integrating AI into its teaching and learning processes. Institutional policies and Standard Operating Procedures (SOPs) related to digital learning emphasize the use of technology-enhanced instruction and data-driven evaluation systems. However, these documents remain general in scope and do not provide explicit provisions for AI governance, ethical use, or data security. The findings indicate that institutional initiatives are largely driven by practical needs—such as improving instructional efficiency and supporting blended learning—rather than by a formal AI adoption framework. Despite this limitation, the institution's openness to experimentation and technological innovation reflects an adaptive organizational culture that supports future AI integration once clearer regulatory standards are established.

3.3. Empirical insights from lecturers and policymakers

Interviews with lecturers and academic policymakers reveal a cautiously optimistic attitude toward the use of AI in education. Lecturers involved in digital learning innovation view AI tools as valuable for content development, student assessment, and enhancing engagement, particularly in technically complex aviation courses. Nevertheless, they express concerns about overreliance on AI, data privacy, and the potential dilution of pedagogical values. Policymakers—represented by the Head of the Education Division and the Head of the IT Unit—acknowledge these concerns but emphasize that AI integration aligns with institutional modernization goals. They also highlight the need for capacity-building programs and institutional guidelines to ensure responsible AI use.

3.4. Thematic synthesis

The thematic analysis of document reviews and interview data yields four interrelated themes: **policy support**, **regulatory gaps**, **ethical accountability**, and **institutional readiness**. Policy support emerges as a macro-level enabler that legitimizes AI adoption without prescribing its operational or ethical dimensions. Regulatory gaps highlight the absence of clarity regarding accountability, fairness, and transparency, posing potential risks to educational equity. Ethical accountability underscores the tension between innovation and compliance, particularly in managing sensitive student data. Finally, institutional readiness reflects the willingness of Poltekbang Makassar to integrate AI technologies despite limited legal and ethical frameworks.

The findings of this study highlight a complex interplay between policy intent, ethical considerations, and institutional readiness in the integration of artificial intelligence (AI) within vocational higher education in Indonesia. While national policies provide a supportive foundation for digital transformation, their lack of specificity regarding AI implementation produces interpretive ambiguity at the institutional level.

At the philosophical level, Indonesia's legal foundation—particularly Law No. 20 of 2003 on the National Education System—implicitly legitimizes the use of AI by emphasizing the right of students to develop their potential through diverse learning approaches. However, the absence of explicit reference to AI within the national legal corpus means that institutions such as Politeknik

Penerbangan Makassar must interpret broad educational mandates to justify technological adoption.

The regulatory gaps identified in this study—particularly those related to algorithmic transparency, accountability, and fairness—reflect broader global debates about the governance of AI systems in education. The resulting legal "grey zone" places vocational institutions in a precarious position: they are encouraged to innovate but must do so without clear procedural safeguards.

Ethical and data privacy concerns further complicate this situation. Although the Personal Data Protection (PDP) Law represents a significant legislative step, its application in educational AI remains insufficiently defined. The case of Poltekbang Makassar illustrates how sensitive learning data—such as student performance in flight simulations—can be both a valuable pedagogical resource and a potential vulnerability.

Institutional governance emerges as a critical mediating factor. Establishing internal frameworks for algorithmic audits, data consent, and human oversight ("human-in-the-loop") would not only enhance institutional accountability but also create a model for responsible innovation within vocational education.

1) Improving algorithmic accountability to reduce the risk of regulatory lag

Makassar State Polytechnic (Poltekbang) may be vulnerable to legal disputes due to the lack of national regulations. The institution must immediately internalize the principles of Algorithmic Accountability to avoid regulatory delays.

- Accountability Challenge: If Poltekbang's AI system is involved in determining critical skills, the institution must establish a clear policy on legal liability. A legal vacuum can arise if vendors, schools, or institutions fail to define responsibility.
- Explanation Obligation: Institutions must shift from "AI as a black box" to "AI as explainable". Makassar State Polytechnic must implement the "Right to Explanation" principle for students who fail algorithmic assessments.

2) Evaluation of the data protection impact assessment law for data governance as a basis for ethics and compliance

The implementation of the Data Protection Impact Assessment Law in the AI ecosystem is a crucial ethical compliance check. Sensitive data, such as learning patterns, simulation recordings, and technical performance data, must be managed in a manner that goes beyond general compliance.

- Implementation of DPIA as Best Practice: Poltekbang Makassar should establish a DPIA (Data Protection Impact Assessment) as a mandatory procedure for every launch or modification of an AI system. This is a proactive measure to identify and mitigate privacy risks before they occur.
- Layered Consent Principle: To prevent unintentional bias and ensure AI systems are designed with privacy-by-design principles, students must provide explicit and specific consent for the collection, processing, and storage of their data used by AI algorithms.

4. Conclusion

Although regulatory gaps continue to present significant challenges to the implementation of artificial intelligence (AI) in vocational higher education, this study finds that the use of AI in learning at Politeknik Penerbangan Makassar (Poltekbang Makassar) is grounded in a strong philosophical and legal foundation. National education policies—including the National Education System Law (Law No. 20 of 2003), the Ministerial Regulation No. 3 of 2020, and the National AI Strategy 2020–2045—demonstrate the Indonesian government's commitment to digital transformation and educational innovation.

However, these policies have not yet been translated into operational guidelines that are specific to the aviation education sector. The absence of clear regulations concerning algorithmic accountability, data protection, and ethical oversight creates legal and operational uncertainty. To

address this issue, the development of a comprehensive Institutional AI Governance Framework is crucial.

To bridge the divide where technological advancement outpaces legal adaptation, a multi-level governance approach is required:

- Macro Level: The national government should formulate detailed and enforceable regulations on AI ethics, data protection, and accountability mechanisms in education.
- Meso Level: Sectoral ministries, particularly the Ministry of Transportation, should integrate AI-related competencies into accreditation systems, curriculum standards, and professional licensing requirements.
- Micro Level: Vocational institutions should adopt internal policies ensuring algorithmic transparency, human oversight, and ethical data management in all AI-assisted learning environments.

Based on the study's analysis, the following structured recommendations are proposed to strengthen AI governance and implementation:

1. Organizational Policy Recommendations (Poltekbang Makassar):
    - Establishment of an AI Ethics and Governance Committee.
    - Standardization of AI Assessment Procedures, clarifying the role of the Human-in-the-Loop Lecturer.
    - Compliance Policy for the AI-PDP Law, developing strict operational guidelines regarding data minimization and security.
2. Recommendations for Sectoral Regulatory Advocacy:
    - Initiate Sectoral Political Negotiations between relevant ministries to formulate Technical Instructions (Juknis) or Ministerial Regulations governing AI explanation standards and legal liability schemes.
3. Improving Human Resource Capacity:
    - Establish an AI-Ethics Literacy Certification Program for lecturers and educational staff to ensure they can manage AI systems professionally and responsibly.

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