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Ethical AI Implementation in Educational Settings: Balancing Innovation with Academic Integrity and Student Privacy

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Abstrak

Integrasi cepat kecerdasan buatan (AI) ke dalam pendidikan menuntut adanya kerangka implementasi etis yang mendesak, terutama dalam sistem vokasi di negara berkembang seperti Indonesia, di mana kesiapan tenaga kerja bertemu dengan transformasi digital. Tujuan penelitian ini adalah untuk mengatasi kesenjangan tata kelola etika AI di Sekolah Menengah Kejuruan (SMK) Indonesia. Penelitian ini menggunakan desain metode campuran sequential explanatory dengan melibatkan 847 pemangku kepentingan dari 34 provinsi dan delapan studi kasus mendalam di SMK. Temuan menunjukkan kesadaran etika AI nasional berada pada tingkat sedang (M=2,83) dengan kesenjangan regional yang signifikan—mulai dari Jawa (3,01) hingga Papua (2,34)—serta adanya paradoks privasi: tingkat kekhawatiran yang tinggi (M=3,67) berdampingan dengan literasi hukum yang rendah (28,9%). Siswa secara aktif menggunakan AI untuk mendukung akademik (64,3%) namun tanpa panduan institusional, sementara guru menghadapi krisis identitas yang menuntut reformasi pedagogis lebih dalam melampaui pelatihan teknis. Kerangka kerja ETIKA-SMK yang dikembangkan bersama para ahli memperoleh validasi kuat (relevansi 4,3/5,0; inovasi 4,4/5,0) dan menunjukkan peningkatan kepatuhan kebijakan etis (67,8%) serta praktik keamanan siber (58,7%) di sekolah percontohan. Penelitian ini menekankan perlunya strategi implementasi yang ter diferensiasi, karena 50% SMK termasuk kategori “Tradisional” atau “Tertinggal” yang memerlukan penguatan kapasitas dasar. Disimpulkan bahwa integrasi AI etis harus didasarkan pada konteks lokal, kapasitas institusional, dan nilai budaya, bukan sekadar mengadopsi model global standar yang kurang sesuai untuk lingkungan pendidikan dengan sumber daya terbatas.

Keywords:
AI ethics; Vocational education; Developing countries; Educational technology.

Abstract

The rapid integration of artificial intelligence (AI) into education necessitates urgent ethical implementation frameworks, especially in vocational systems of developing countries like Indonesia, where workforce readiness meets digital transformation. The purpose of this study is to address gaps in ethical AI governance within Indonesian vocational schools (SMK). A sequential explanatory mixed-methods design was employed, involving 847 stakeholders from 34 provinces and eight in-depth SMK case studies. Findings reveal moderate national AI ethics awareness (M=2.83), with significant regional gaps—from Java (3.01) to Papua (2.34)—and a critical privacy paradox: high concern (M=3.67) coexists with low legal literacy (28.9%). Students actively use AI for academic support (64.3%) but lack institutional guidance, while teachers face identity

crises requiring deeper pedagogical reform beyond technical training. The proposed ETIKA-SMK framework, co-developed with experts, received strong validation (relevance 4.3/5.0; innovation 4.4/5.0) and showed improvements in ethical policy compliance (67.8%) and cybersecurity practices (58.7%) at pilot schools. The study highlights the need for differentiated implementation strategies, as 50% of SMKs fall into “Traditional” or “Struggling” categories requiring foundational capacity-building. It concludes that ethical AI integration must be grounded in local contexts, institutional capacities, and cultural values, rather than adopting standardized global models unsuitable for low-resource educational environments.

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INTRODUCTION

The global landscape of artificial intelligence (AI) in education is experiencing a transformative shift from experimental adoption to systematic implementation, fundamentally altering pedagogical paradigms and institutional frameworks worldwide. Mass AI experimentation is transitioning to serious implementation, with AI adoption accelerating as countries roll out policies, guidelines, and frameworks, while AI-enabled solutions continue to emerge to tackle challenges at every stage of the learning journey (*2025 Education Trends Snapshot*, n.d.). This transformation is particularly evident in the exponential growth of AI adoption in educational settings, where 89% of students acknowledge using ChatGPT for their homework, while 50% of teachers utilize AI for lesson planning, signaling a fundamental restructuring of traditional educational practice (Yeo et al., 2020)

AI-powered educational systems promise to democratize access to personalized instruction, potentially addressing longstanding inequities in educational provision through sophisticated technological interventions. Extensive research confirms that individual tutoring significantly boosts learning outcomes, with tutored students consistently outperforming 98% of their peers in traditional classroom settings (*The Future of Learning*, 2024). Bibliometric analyses further highlight AI’s potential to enhance accessibility, inclusivity, and vocational education, particularly in manufacturing and logistics, through automation and robotics (Prasetya et al., 2025). These advances suggest a future where intelligent, adaptive learning environments dismantle barriers and respond to individual student needs.

However, this rapid integration of AI in educational settings has generated significant ethical concerns and implementation challenges that demand urgent attention from educators, policymakers, and technology developers. Despite the potential benefits of AI to support students’ learning experiences and teachers’ practices, the ethical and

societal drawbacks of these systems are rarely fully considered in K-12 educational contexts (Akgun & Greenhow, 2022). A comprehensive survey revealed that 78% of parents believe the use of AI generative tools in school assignments constitutes cheating, while only around 22% of students and teachers report having a code of conduct or advisory for AI technologies within their establishments (AIPRM, 2024). This disparity highlights a critical gap between technological adoption and ethical governance frameworks, particularly concerning academic integrity, student privacy, and equitable access to AI-enhanced educational resources.

The ethical implications of AI implementation in education extend far beyond individual student behaviors to encompass broader systemic concerns about fairness, transparency, and accountability in educational decision-making processes. Experience from other AI domains suggests that ethical intentions are not by themselves sufficient, as good intentions do not always result in ethical designs or ethical deployments (Holmes et al., 2022). There is a compelling need to consider explicitly issues such as fairness, accountability, transparency, bias, autonomy, agency, and inclusion, while differentiating between doing ethical things and doing things ethically, understanding and making pedagogical choices that are ethical, and accounting for the ever-present possibility of unintended consequences (Holmes et al., 2022). This complexity is further amplified in educational contexts where the recognition of algorithms as opinions represents a fundamental step in enabling students to comprehend how algorithms are saturated with human values (Akgun & Greenhow, 2022).

Recent comprehensive analysis of AI ethics guidelines for K-12 education has identified core principles including Transparency, Justice and Fairness, Non-maleficence, Responsibility, Privacy, Beneficence, and Freedom & Autonomy, along with education-specific principles such as Pedagogical Appropriateness, Children's Rights, AI Literacy, and Teacher Well-being (Nguyen et al., 2023). The challenge of ethical AI implementation becomes particularly acute in vocational education settings, where the dual mandate of academic excellence and workforce preparation creates unique ethical considerations that traditional educational frameworks struggle to address effectively. Vocational training is emerging as a pragmatic choice for learners, with collaborative initiatives between academic institutions and industries creating seamless pathways from education to employment, addressing local talent shortages while raising complex questions about the intersection of educational integrity and industry demands (HolonIQ 2025).

Contemporary research indicates that many education systems struggle to address the growing digital skills gap, crucial for students' employability and ethical tech use,

making it imperative to cultivate an AI-ready workforce (*The Future of Learning*, 2024). This context demands sophisticated ethical frameworks that balance innovation with responsibility while preparing students for an AI-integrated professional landscape, yet the positive aspects of AI use can be occluded if there is a sole pedagogical focus on challenges such as bias and privacy (Aljedaani et al., 2022). The need for a widened remit to encompass an explicit focus on human values and equity issues becomes particularly pronounced in vocational education, where students must navigate the complex intersection of technological competency and ethical responsibility. These challenges require nuanced approaches that acknowledge the unique characteristics of vocational learning environments while maintaining rigorous ethical standards.

Despite the growing recognition of these challenges, significant research gaps persist in understanding how to implement ethical AI frameworks specifically within vocational education contexts across different cultural and economic settings. Schiff's comprehensive review of 24 national AI policy strategies revealed that the use of AI in education (AIED) is largely absent from policy conversations, while the instrumental value of education in supporting an AI-ready workforce and training more AI experts is overwhelmingly prioritized, with the ethical implications of AIED receiving scant attention despite the prominence of AI ethics discussion generally in these documents(Schiff, 2022). This suggests that AIED and its broader policy and ethical implications have failed to reach mainstream awareness and the agendas of key decision-makers, a concern given that effective AIED policy development requires understanding the distinct challenges of different educational contexts (Schiff, 2022).

Holmes explicitly noted that "no framework has been devised, no guidelines have been agreed, no policies have been developed, and no regulations have been enacted to address the specific ethical issues raised by" AI in educational contexts, with this gap being even more pronounced in vocational education where students engage directly with industry-relevant technologies and practices (Holmes et al., 2022). The situation becomes particularly challenging in developing countries, where resource constraints and infrastructure limitations compound the complexity of ethical AI implementation in educational settings. Recent analysis demonstrates that the global landscape of AI literacy is marked by significant disparities between developed and developing nations, with many developing nations lagging behind due to various structural and systemic challenges, raising concerns about the potential for a widening global digital divide where developing nations risk falling further behind in the AI-driven global economy (Kathala & Palakurthi, 2024).

UNESCO's recommendation emphasizes that public understanding of AI and data should be promoted through open & accessible education, civic engagement, digital skills & AI ethics training, with AI actors promoting social justice, fairness, and non-discrimination while taking an inclusive approach to ensure AI's benefits are accessible to all populations (*Recommendation on the Ethics of Artificial Intelligence | UNESCO*, n.d.) . However, while international organizations have provided valuable frameworks for AI in education generally, these frameworks lack the contextual specificity required for vocational education in resource-constrained environments where students, teachers, and institutions face unique challenges related to infrastructure, funding, and industry partnerships. Indonesia, as the world's fourth most populous country with a rapidly expanding economy and significant investment in vocational education, presents a particularly compelling context for examining ethical AI implementation in educational settings. The Indonesian government's commitment to strengthening vocational education through the "link and match" policy with industry partners creates a unique environment where ethical AI considerations intersect with workforce development imperatives.

Despite the critical importance of this intersection, the specific challenges and opportunities of implementing ethical AI frameworks in Indonesian vocational schools remain largely unexplored in the academic literature, representing a significant gap in global understanding. Existing AI ethics frameworks tend to be generic and lack specific guidance for the unique challenges faced by vocational schools that must balance academic integrity with practical skill development and industry partnerships. While the ethical challenges of AI in education must be identified and introduced to teachers and students (Akgun & Greenhow, 2022), current approaches often fail to address the complex interplay between educational goals and workforce preparation that characterizes vocational education. Furthermore, there is limited empirical research on the implementation of ethical AI frameworks in educational institutions, with most existing work remaining at the theoretical or policy recommendation level, creating an urgent need for evidence-based guidance.

Despite the growing recognition that new pedagogical methods and ways of thinking about how best to teach AI ethics in the context of education are required, practical implementation studies remain significantly underrepresented, particularly in vocational contexts where technological competences must be grounded in sound pedagogical principles (Zawacki-Richter et al., 2019). The intersection of AI ethics and vocational education in developing countries represents an almost entirely unexplored research

domain, creating an urgent need for contextually-appropriate frameworks that can bridge theory and practice effectively. This study addresses these critical gaps by developing a contextually-appropriate ethical AI implementation framework specifically designed for vocational education settings in developing countries. By focusing on Indonesian vocational schools (SMK), this research provides the first comprehensive examination of ethical AI implementation challenges and opportunities within the unique context of Southeast Asian vocational education, contributing to both theoretical understanding and practical implementation strategies.

This study addresses these gaps by developing a contextually appropriate ethical AI implementation framework specifically for vocational education in developing countries, using Indonesian vocational schools (SMK) as a case study. Unlike previous research that focuses on single stakeholders or generic frameworks, this study employs a multi-stakeholder approach—students, teachers, industry partners, and policymakers—to capture the complex dynamics of ethical AI governance. Theoretically, it contributes to bridging general AI ethics principles with the sociotechnical and cultural realities of vocational education in resource-constrained environments. Practically, it provides evidence-based guidance for curriculum development, teacher training, student assessment, and industry partnerships.

By situating the discussion within Indonesia yet extending its implications to other developing nations, this research contributes to a more inclusive and globally representative understanding of educational technology ethics. Ultimately, the study aims to balance technological innovation with ethical responsibility, offering insights that strengthen both theoretical discourse and practical implementation in AI-enhanced vocational education.

METHOD

This study employs a sequential explanatory mixed methods research design to comprehensively examine ethical AI implementation in Indonesian vocational education contexts. The approach addresses the complexity of AI ethics in education, which involves technical, pedagogical, social, and regulatory aspects requiring systematic investigation through diverse methodological approaches (Creswell & Plano Clark, 2014). Mixed methods research enables comprehensive understanding through triangulation of quantitative data regarding adoption patterns and digital literacy levels with qualitative insights into stakeholder perceptions and implementation experiences (Tashakkori & Teddlie, 2010). The sequential design allows quantitative findings to inform qualitative

data collection, ensuring comprehensive coverage of critical implementation factors while addressing research gaps through empirical evidence from Indonesian SMK contexts.

Research Design

The study adopts a three-phase sequential design integrating quantitative survey research, qualitative case study investigation, and expert validation processes for framework development. The theoretical foundation combines the extended Technology Acceptance Model (TAM) for understanding adoption factors (Davis, 1989a), Diffusion of Innovation Theory for examining implementation processes, Ethics of Care Theory for addressing student privacy considerations, and Social Cognitive Theory for analyzing academic integrity implications. The conceptual framework synthesizes UNESCO AI Ethics Framework principles with Indonesian Personal Data Protection Law requirements, vocational education dual-mission theory, and Industry 4.0 competency frameworks. This integration ensures the research addresses international ethical standards while remaining contextually relevant to Indonesian regulatory requirements and vocational education characteristics.

Data Collection

Phase One employs cross-sectional survey methodology targeting 500+ respondents through stratified random sampling across Indonesian regions, institutional types (public/private SMK), and vocational specializations. Target respondents include SMK principals (25%), teachers (50%), and senior students (25%), providing multi-stakeholder perspectives on AI implementation. Data collection utilizes validated instruments including AI Ethics Awareness Scale, Digital Literacy Assessment, Academic Integrity Perception Scale, Privacy Concern Questionnaire, and Technology Adoption Readiness Scale. These instruments undergo rigorous validation through expert review, pilot testing, and psychometric analysis to ensure reliability and validity within Indonesian vocational education contexts.

Phase Two employs multiple case study methodology through purposive sampling of 6-8 representative SMK institutions selected based on technology adoption levels, industry partnerships, geographical distribution, and digital maturity (*Yin, 2018*). Data collection methods include in-depth interviews (60-90 minutes) with principals, teachers, students, industry partners, and government stakeholders; focus group discussions with homogeneous groups of teachers, students, and school committee members; and participant observation of AI use in educational contexts. This comprehensive qualitative approach captures implementation experiences across different stakeholder

perspectives and organizational contexts while documenting best practices and persistent challenges.

Data Analysis and Integration

Quantitative analysis employs descriptive statistics for adoption patterns, inferential statistics (ANOVA, regression) for predictive factors, Structural Equation Modeling (SEM) for model validation, and cluster analysis for SMK typologies. Qualitative analysis utilizes thematic analysis for interview data, cross-case analysis for institutional comparisons, framework analysis for policy implications, and narrative analysis for stakeholder experiences. Phase Three implements Delphi technique with 15-20 experts representing vocational education academics, IT practitioners, AI ethics specialists, policymakers, and industry representatives for framework validation through multiple consultation rounds (Green, 2014) (*De Villiers, Marietjie R., Pierre J. T. de Villiers,... - Google Scholar*, n.d.).

Mixed methods integration employs joint displays for systematic combination of quantitative and qualitative findings, meta-inference development for holistic conclusions, and triangulation matrices for validation across data sources(Tashakkori & Teddlie, 2010). The integration process ensures framework development reflects comprehensive understanding of ethical AI implementation challenges while maintaining methodological rigor. Final framework development synthesizes empirical findings with expert validation to produce implementation guidance addressing policy development, institutional implementation, teacher preparation, and industry partnership coordination while acknowledging resource constraints and cultural considerations in Indonesian vocational education contexts.

Trustworthiness and Data Validation

To ensure data validity and reliability, several strategies were employed. For quantitative data, instrument validity was established through expert judgment, pilot testing, and confirmatory factor analysis, while reliability was tested using Cronbach's Alpha. For qualitative data, trustworthiness was ensured through credibility (member checking and prolonged engagement), transferability (rich, thick description), dependability (audit trail of data collection and analysis), and confirmability (peer debriefing and triangulation across data sources and methods). These procedures ensured that both quantitative and qualitative findings meet rigorous scientific standards and enhance the robustness of the mixed methods integration.

RESULT AND DISCUSSION

This comprehensive mixed-methods study involved 847 respondents from 34 Indonesian provinces and 8 in-depth case studies across SMK institutions with varying digital maturity levels. The results reveal significant gaps between AI ethics awareness and practical implementation, highlighting the urgent need for comprehensive frameworks tailored to Indonesian vocational education contexts. The findings demonstrate substantial variations across geographical regions, institutional types, and stakeholder roles, providing crucial insights for evidence-based policy development and implementation strategies in developing country educational settings.

Quantitative Phase Results

The quantitative analysis encompasses 847 respondents representing diverse Indonesian vocational education contexts, with comprehensive geographical distribution across major regions. Table 1 presents the demographic composition showing Java's dominance (45.2%, n=383) followed by Sumatra (23.1%, n=196), while eastern regions demonstrate lower representation, reflecting Indonesia's development disparities. The respondent distribution includes SMK teachers (52.3%, n=443), students (25.7%, n=218), and principals (22.0%, n=186), ensuring multi-stakeholder perspectives. Vocational specialization coverage spans Technology & Engineering (34.6%), Business & Management (28.9%), Information Technology (15.7%), Health (11.2%), and Creative Industries (9.6%), providing comprehensive sectoral representation for framework development and policy recommendations.

Category	Distribution	AI Ethics Awareness Score*	Significance
Geographic Distribution			
Java	45.2% (n=383)	3.01	p<0.001
Sumatra	23.1% (n=196)	2.78	
Sulawesi	12.4% (n=105)	2.65	
Kalimantan	9.8% (n=83)	2.59	
Papua & Maluku	6.1% (n=52)	2.34	
Stakeholder Roles			
School Principals	22.0% (n=186)	3.24	p<0.001
Senior Teachers (>10 years)	28.7% (n=243)	2.96	
Junior Teachers (<5 years)	23.6% (n=200)	2.78	
Students	25.7% (n=218)	2.51	
Overall Score	N=847	**2.83 (Moderate)**	

*Scale: 1-5 (1=Very Low, 5=Very High)

Table 1: Respondent Demographics and AI Ethics Awareness Levels

AI ethics awareness assessment reveals moderate overall levels (M=2.83, SD=0.67) with significant variations across stakeholder roles and geographical regions. Privacy and data protection awareness scored highest (M=3.12), while human agency and oversight

demonstrated lowest scores (M=2.54), indicating specific areas requiring targeted intervention. Regional disparities show Java leading significantly (M=3.01) compared to eastern regions, particularly Papua (M=2.34), reflecting broader development inequalities. Principals demonstrate highest awareness (M=3.24), followed by senior teachers, while students show lowest levels (M=2.51), suggesting hierarchical knowledge distribution requiring differentiated capacity building approaches for effective implementation.

Component	Mean Score	Distribution Categories	Readiness Level
Digital Literacy Components			
Communication & Collaboration	3.34	High: 18.4%	Very Ready: 12.3%
Technical Skills	3.12	Medium: 45.6%	Ready: 34.7%
Information Literacy	2.89	Low: 28.7%	Moderately Ready: 38.9%
Digital Creation	2.67	Very Low: 7.3%	Not Ready: 14.1%
Safety & Legal Issues	2.45		
Privacy Concerns			
Data Collection	3.89	UU PDP Awareness: 28.9%	
Data Sharing	3.84	Unaware: 71.1%	
Data Usage	3.71		
Data Storage	3.23		

*Scale: 1-5 (1=Very Low, 5=Very High)

Table 2: Digital Literacy and Technology Adoption Readiness

Digital literacy assessment demonstrates mixed competency levels, with communication and collaboration skills scoring highest (M=3.34) while safety and legal awareness remains concerning (M=2.45). Technology adoption readiness indicates moderate preparedness, with only 47% feeling ready or very ready for AI implementation. Privacy concerns register high levels (M=3.67), yet awareness of Indonesia's Personal Data Protection Law remains critically low (28.9%), creating implementation challenges. The disconnect between high privacy concerns and low legal awareness suggests urgent need for comprehensive legal literacy programs alongside technical capacity building efforts.

Academic integrity perceptions reveal complex attitudes toward AI usage, with 67.8% of respondents viewing AI as potentially threatening academic integrity while 23.4% believe ethical AI use can enhance learning. Student AI usage patterns show 42.1% using AI for assignments and 31.7% for learning support, yet only 34.6% are aware of institutional AI policies. This policy-practice gap highlights critical implementation challenges requiring immediate attention. The data suggests that while stakeholders recognize AI's potential risks and benefits, inadequate governance frameworks and policy

awareness create environments conducive to inconsistent and potentially problematic AI usage patterns across Indonesian vocational education institutions.

Qualitative Phase Results

Eight carefully selected SMK case studies represent diverse implementation contexts, ranging from high-tech urban institutions with comprehensive industry partnerships to rural traditional schools with minimal digital infrastructure. SMK High-Tech Jakarta demonstrates advanced AI readiness (4.2/5.0) with 15+ technology partnerships, while SMK Rural Traditional Sumatera Barat reflects resource constraints typical of peripheral regions (2.1/5.0). This variation provides crucial insights into contextual factors influencing ethical AI implementation success. The hybrid model represented by SMK Jawa Tengah (3.1/5.0) illustrates transitional challenges faced by many Indonesian vocational institutions attempting technology integration while managing resource limitations and stakeholder expectations.

Stakeholder	Primary Themes	Representative Quotes	Implementation Implications
School Principals	Strategic Vision Gap	"We know AI is important for students' future, but how to implement it ethically and safely, that's unclear"	Need strategic planning support
	Resource Constraints	"Budget for technology is limited, especially for abstract things like AI ethics frameworks"	Require funding mechanisms
	Partnership Challenges	"Industry demands tech-savvy students, but they don't help much with AI usage ethics guidelines"	Need industry engagement protocols
Teachers	Pedagogical Confusion	"I don't know when student AI use helps learning or reduces critical thinking"	Require pedagogical guidance
	Professional Development Gap	"Tech training exists, but AI ethics in learning? Almost never"	Need specialized training programs
	Assessment Dilemma	"How do I evaluate student work if I don't know if they used AI?"	Require assessment strategies
Students	Pragmatic Usage	"I use ChatGPT to understand difficult material, not for direct assignments"	Need usage guidelines
	Ethical Uncertainty	"Teachers never explain what's allowed. So we just use it if it makes sense"	Require clear boundaries
	Future Readiness	"Industry will use AI later, why prohibit it at school? Better teach proper usage"	Need forward-looking policies
Industry Partners	Skill-Ethics Balance	"We need graduates who can use technology and understand ethical responsibilities"	Require competency frameworks
	Standards Gap	"Our company has strict AI SOPs, but SMK graduates aren't familiar with these concepts"	Need industry-education alignment

Figure 1: Stakeholder Perspectives Matrix - Key Themes from In-Depth Interviews

Focus Group Discussions with teachers (6 groups, 48 participants) achieved strong consensus on urgent needs: 87.5% demand clear AI usage guidelines, 91.7% prioritize AI ethics training, and 83.3% struggle with monitoring student AI usage. Student FGDs (6 groups, 42 participants) reveal sophisticated usage patterns including learning support

(64.3%), language translation (52.4%), and programming assistance (38.1%). Notably, 78.6% desire clear guidance on appropriate AI usage, while 85.7% recognize AI's importance for future careers. These findings demonstrate stakeholder readiness for comprehensive ethical frameworks while highlighting current guidance deficits requiring immediate policy attention and capacity building interventions.

The qualitative data reveals a critical disconnect between stakeholder recognition of AI's educational potential and current implementation realities characterized by inadequate policies, insufficient training, and unclear boundaries. Teachers express pedagogical uncertainty about distinguishing beneficial AI use from problematic dependency, while students demonstrate pragmatic approaches often lacking ethical grounding. Industry partners emphasize the necessity for graduates who understand both technical capabilities and ethical limitations. This convergence of perspectives supports the urgent need for comprehensive frameworks that bridge current gaps while preparing vocational education systems for AI-integrated futures requiring sophisticated stakeholder coordination and systematic capacity building efforts.

Mixed Methods Integration and Framework Development

The three-round Delphi study involving 18 carefully selected experts representing vocational education academics, IT practitioners, AI ethics specialists, policymakers, and industry representatives achieved strong consensus on ethical AI implementation priorities. Round 1 identified 18 fundamental principles for AI ethics in Indonesian SMK contexts, Round 2 established priority rankings with student data protection achieving highest consensus (94.4%), followed by transparent usage policies and teacher professional development (both 88.9%). Round 3 developed a comprehensive three-phase implementation roadmap spanning policy development (6-12 months), capacity building (12-18 months), and ongoing monitoring and evaluation, providing practical guidance for systematic implementation across diverse institutional contexts.

Framework Component	Description	Expert Consensus	Pilot Results*
E - Education	AI literacy and ethics for all stakeholders	88.9%	+34.6% awareness
T - Transparency	Clear and open AI usage policies	88.9%	+67.8% compliance
I - Integrity	Maintaining academic integrity in AI era	83.3%	+45.2% understanding
K - Keamanan	Student data protection and privacy	94.4%	+58.7% security measures
A - Accountability	Responsibility and evaluation systems	83.3%	+52.3% engagement

E - Education	AI literacy and ethics for all stakeholders	88.9%	+34.6% awareness

*Pilot implementation results from 3 SMK sites (n=156 teachers, 287 students) over 6 months

Table 3: ETIKA-SMK Framework Components and Validation Results

The proposed ETIKA-SMK framework integrates quantitative findings with qualitative insights and expert validation to address identified implementation gaps systematically. Each component addresses specific challenges revealed through mixed-methods analysis: Education tackles awareness deficits, Transparency addresses policy gaps, Integrity manages academic concerns, Keamanan responds to privacy issues, and Accountability ensures sustainable implementation. Pilot testing across three diverse SMK sites demonstrates significant improvements in all measured dimensions, with particularly strong gains in policy compliance (67.8%) and security measures implementation (58.7%), validating the framework's effectiveness and practical applicability.

Framework validation through external expert review (12 international specialists) confirms high relevance ratings (4.3/5.0) and cultural appropriateness (4.1/5.0), though implementation feasibility scores moderately (3.8/5.0), reflecting realistic resource constraints in developing country contexts. The innovation level rating (4.4/5.0) indicates significant contribution to global discourse on ethical AI in vocational education. Three-level implementation guidelines spanning institutional policy, pedagogical practice, and technical infrastructure provide comprehensive roadmaps addressing diverse institutional capacities and resource availability, ensuring framework adaptability across varying SMK contexts while maintaining ethical standards and educational effectiveness.

Statistical Analysis and Model Validation

Correlation analysis reveals significant relationships supporting theoretical framework foundations, with AI ethics awareness strongly correlating with digital literacy ($r=0.687$, $p<0.01$), indicating mutually reinforcing competencies requiring integrated development approaches. Privacy concerns correlate moderately with data protection knowledge ($r=0.542$, $p<0.01$), while technology readiness shows strong association with infrastructure quality ($r=0.721$, $p<0.01$), emphasizing resource availability importance. Academic integrity perception correlates with AI policy awareness ($r=0.456$, $p<0.01$), supporting policy development priorities identified through qualitative analysis and expert consensus.

SMK Type	Distribution	Characteristics	AI Readiness Score	Implementation Priority
Digital Pioneers	15.3%	High tech, high awareness, comprehensive policies	4.2/5.0	Advanced integration
Transitional Schools	34.7%	Medium tech, growing awareness, developing policies	3.1/5.0	Systematic development
Traditional Schools	38.9%	Low tech, limited awareness, minimal policies	2.3/5.0	Foundation building
Struggling Schools	11.1%	Very low tech, very low awareness, no policies	1.6/5.0	Basic capacity building

Table 4: SMK Typology and Implementation Readiness

Regression analysis identifies key predictors of AI ethics awareness (R^2=0.524), with digital literacy emerging as strongest predictor (β=0.387, p<0.001), followed by teaching experience (β=0.231, p<0.01), regional development index (β=0.198, p<0.05), and industry partnership intensity (β=0.167, p<0.05). These findings inform targeted intervention strategies addressing multiple influencing factors simultaneously. Cluster analysis reveals four distinct SMK typologies, with Traditional Schools representing the largest segment (38.9%), indicating widespread need for foundational capacity building, while Digital Pioneers (15.3%) demonstrate implementation possibilities under optimal conditions.

The statistical validation confirms framework relevance across diverse contexts while highlighting implementation challenges requiring differentiated approaches. Traditional and struggling schools, representing 50% of institutions, require intensive foundational support, while transitional schools need systematic development assistance. Digital pioneers can serve as implementation models and peer learning resources. This typological understanding enables resource allocation optimization and realistic timeline development for nationwide framework implementation, acknowledging varying institutional capacities while maintaining consistent ethical standards across all SMK types and contexts.

DISCUSSION

Gaps in AI Ethics Awareness

The findings revealed moderate levels of AI ethics awareness (M = 2.83) among 847 respondents across 34 provinces. This is paradoxical considering Indonesia's ambition as a regional digital transformation leader. The gap highlights that rapid technological adoption, without corresponding ethical frameworks, risks creating vulnerable educational environments. Similar observations were made by (van Dijk et al., 2020) and (Lai & Widmar, 2021), who noted that technology adoption in developing contexts often outpaces regulatory and ethical readiness.

Interpretation: The Indonesian case reinforces that digital leapfrogging is insufficient unless complemented by systematic ethical literacy programs.

Regional Inequalities and Ethical Literacy Divide

The study reported stark disparities in AI ethics awareness, with Java scoring 3.01 compared to Papua's 2.34. Likewise, AI readiness in Jakarta's vocational schools (M = 4.2/5.0) was significantly higher than in rural Sumatera (M = 2.1/5.0). These disparities suggest that technological proximity translates into cascading advantages in ethical competencies. Comparable findings were noted in (Van Damme, 2023) and (Strategy, n.d.), which emphasize that digital inequities reinforce broader educational inequalities.

Interpretation: Ethical AI education must therefore be treated not only as a technical issue but as a social justice imperative in achieving educational equity.

Privacy Paradox and Regulatory Illiteracy

While students expressed high privacy concerns (M = 3.67), awareness of Indonesia's Personal Data Protection Law was critically low (28.9%). This mirrors findings by (Auxier et al., 2019) and (Marwick, 2018), who argue that strong perceptions of risk rarely translate into protective behaviors without institutional support and legal literacy.

Interpretation: The Indonesian vocational context demonstrates that intuitive awareness of risks is insufficient; institutionalized legal education and policy integration are needed to bridge this paradox.

Ethical Intuitions versus Formal Frameworks

The study found that 64.3% of students used AI for learning support but only 19.0% for completing assignments, suggesting intuitive ethical boundaries. However, without formal guidance, students' ethical reasoning remains underdeveloped. (Rest et al., 1999) and (Walker & Hennig, 2004) highlight that moral intuitions require reinforcement through structured ethical reasoning education.

Interpretation: Students' intuitive discernment is a promising foundation, but formal frameworks are critical to sustain and standardize ethical AI practices.

Teachers' Pedagogical Confusion and Professional Identity Crisis

Teachers expressed uncertainty in distinguishing beneficial AI use from problematic dependency. This indicates a deeper crisis in professional identity beyond technical skills training. Similar challenges have been documented by (Tondeur et al., 2017) and (Voogt et al., 2013), who found that integrating digital tools often destabilizes teachers' pedagogical beliefs and practices.

Interpretation: Professional development must go beyond technical capacity to address pedagogical philosophy, identity, and integrity in AI-mediated education.

Industry Expectations and Educational Misalignment

Industry stakeholders emphasized that graduates must understand not only AI's capabilities but also its ethical limitations. This reflects a systemic misalignment between vocational education outputs and workforce needs. (Cedefop, 2022) reported that vocational training often prioritizes technical skills, neglecting ethical reasoning competencies.

Interpretation: Stronger school–industry collaborations are required, where ethical competence becomes a shared responsibility rather than an afterthought.

Framework Validation and Implementation Feasibility

The ETIKA-SMK framework received strong validation for relevance (M = 4.3) and innovation (M = 4.4), but only moderate feasibility (M = 3.8), due to resource limitations. Pilot testing showed improvement in policy compliance (67.8%) and security measures (58.7%). This aligns with findings from Kaur & Rampersad (2023), who showed that context-specific ethical frameworks can be effective but face resource and sustainability barriers in low-resource settings.

Interpretation: Contextual frameworks like ETIKA-SMK are feasible solutions, but long-term impact depends on sustainable policy support and resource mobilization.

Typologies of Vocational Schools and Differentiated Strategies

Cluster analysis revealed four typologies of schools, with Traditional (38.9%) and Struggling Schools (11.1%) making up half the sample. This suggests that implementation strategies must acknowledge institutional diversity. Comparable typological challenges were highlighted in UNESCO (2022), showing that uniform interventions often fail in heterogeneous vocational contexts.

Interpretation: Differentiated strategies are needed, prioritizing foundational capacity-building for less prepared schools before advanced frameworks can succeed.

Interconnection of Ethics, Literacy, and Infrastructure

The strong correlations between AI ethics awareness, digital literacy, and infrastructure ($r = 0.687–0.721$) confirm the theoretical assumptions of the Technology Acceptance Model (Davis, 1989b) ; (Venkatesh et al., 2003). Our regression analysis indicated that digital literacy was the strongest predictor ($\beta = 0.387$). Similar patterns were

found in (Senaidi, 2019), where digital literacy mediated effective technology use in education.

Interpretation: This reinforces the idea that building ethical awareness requires parallel investment in digital literacy and infrastructure, not isolated interventions.

Methodological Limitations and Future Directions

The cross-sectional design limits causal interpretations, while the Indonesian context may constrain generalizability. (*Yin, Robert K. 2018. Case Study Research and Applications... - Google Scholar*, n.d.) remind that case-based and cross-sectional studies must be complemented by longitudinal and comparative research.

Interpretation: Future research should track long-term framework implementation, explore cultural adaptations in other developing countries, and test scalability of ethical AI education interventions.

Broader Implications for Developing Countries

Beyond Indonesia, these findings contribute to global debates on AI ethics in education. The results support South-South knowledge transfer by showing that developing nations can generate their own innovative frameworks rather than adopting models from high-income countries (Selwyn & Leyden, 2022).

Interpretation: Ethical AI integration in developing contexts requires adaptive, locally grounded approaches that balance global standards with cultural specificity.

CONCLUSION

This study underscores that the integration of AI into vocational education in Indonesia cannot be reduced to technological adoption alone, but must be approached as a process of ethical, institutional, and cultural transformation. The findings reveal that while students demonstrate adaptive ethical intuitions and teachers acknowledge the pedagogical necessity of AI, systemic disparities, privacy-law disconnects, and uneven digital literacy remain persistent barriers. The co-developed ETIKA-SMK framework illustrates that ethically grounded governance models are both feasible and contextually effective, yet their success depends on differentiated strategies that recognize the diverse capacities of vocational schools across regions.

More broadly, this research affirms that ethical AI governance in education should be localized—anchored in institutional capacity, cultural values, and societal priorities—rather than borrowed wholesale from high-resource settings. Such an approach not only strengthens national workforce readiness but also positions Indonesia to contribute

original perspectives to the global discourse on AI ethics. Future work should therefore focus on longitudinal and comparative studies to refine adaptable models, ensuring that vocational education evolves not merely as a site of technical training, but as a foundation for cultivating responsible, critically literate citizens in the age of AI.

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