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Protecting Student Privacy in Digital Education: A Systematic Review of Wearable Technology Policies in Southeast Asia

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ABSTRACT. This paper seeks to review the current policies related to the application of wearable devices in education in Southeast Asia, focusing on privacy protection and compliance issues. A Systematic Literature Review (SLR) was performed according to PRISMA guidelines, considering the PICOS components. Relevant articles were searched in Scopus, Web of Science, IEEE Xplore, PubMed, and regional databases from 2015 to 2025. Results show significant differences in policy formulation and implementation among ASEAN member states, of which only 32% of the surveyed institutions have a full-fledged policy covering wearable technology. Significant challenges include divergent approaches to data protection, varying levels of institutional capacity, and limited awareness of privacy rights amongst privacy stakeholders. The study finds that the current frameworks must be better integrated to ensure that advancing technological innovation is balanced with solid privacy protection. These results have theoretical implications for educational digital rights and practical implications for policymakers, educators, and technology developers to promote ethical technology use and security.

Keywords: *Digital education; Data protection; Policy frameworks; Wearable technology; Student privacy.*

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INTRODUCTION

The digitization of education has seen significant growth in recent years, especially after the global pandemic that forced remote learning alternatives to be deployed. As part of the larger digital transformation, wearable technology is one of the most influential technologies in educational settings that may be used for a variety of purposes, including health monitoring and biometric data acquisition, as well as the development of learning analytics and customized educational experiences (Drummond et al., 2022; Ferrier et al., 2022). Protection of student privacy in this space is critical, as wearable devices capture highly sensitive personally identifiable information, such as physiological measures, behavioral trends, location data, and measures of cognitive function. Student privacy is a fundamental right that conflicts with educational goals, technological development, and regulatory requirements. With respect to wearable technology, the stakes are exceptionally high, as such devices typically gather continuous, real-time information on users' physical and cognitive states, which can be used to assemble detailed profiles of users that may be abused without sufficient protections (Jordan et al., 2022; Van Dijk et al., 2018; Williamson, 2015). Safeguarding such

information is not just a technical concern, but an education in ethics, student rights, and institutional duties. The implementation of these technologies has been spurred by several factors, such as government policies encouraging digital literacy, collaboration between the private sector and educational institutions, and the increasing awareness of the need to develop students as whole individuals, both academically and physically.

The Southeast Asia educational wearables market is growing wonderfully, with a CAGR of 18.7% expected from 2023 to 2028 (Düking et al., 2020; Walkington et al., 2024). The falling hardware costs, rising internet penetration, and burgeoning digital infrastructure in the region enable this increase. However, the pace of technological change in this area has far outrun the ability of government regulators to keep up, resulting in gaping voids in privacy protection regimes. The widespread use of wearable technology in schools has produced a challenging privacy environment marked by weak regulatory oversight, divergent policies at the institutional level, and diminished stakeholder awareness related to the consequences of sustained data collection for student privacy (Prinsloo & Kaliisa, 2022; Prinsloo & Slade, 2015). However, the issue is more pressing in Southeast Asia, with regulatory models varying widely from country to country and education providers frequently lacking the technical means and financial resources needed to apply stringent data protection. (1) Amount of Data Being Collected: In the educational context, wearable technologies gather an unprecedented level and variety of personal information, including biometric, behavioral, and location data, with few limits on the scope or length of data collection. (2) Informed Consent Concerns: The capacity of students (especially minors) to give meaningful informed consent for data collection is uncertain due to the complexity of data use terms and the power relations embedded in educational institutions. (3) Vulnerabilities to Data Security: Schools and universities do not usually have the advanced cybersecurity systems to adequately secure the sensitive information collected by wearables, leading to potential risks of having data accessed unlawfully, breached, or misused. (4) Sharing Data with Third Parties: Numerous providers of wearable technologies are involved in data sharing with third parties for commercial activities, and, in many instances, the schools or parents are not even made aware of the data collection, let alone with whom it is shared. (5) Data Implications for the Long Term: The aggregating effect of harvesting data continuously across a student's educational path can generate extensive digital dossiers that may be used to influence access to future educational and employment opportunities.

There is a lacuna of inquiry on the governance of SEAs and KTECs in the policy context, despite the increasing popularity of wearable technology in Southeast Asian education and worries about student privacy. It can be seen that the trend of existing research about policy implications has focused on the technological potential, pedagogical applications, or general issues of data privacy, overlooking the particular challenges provoked by the use of wearable devices in patent educational settings (Liang et al., 2023; Mengiste et al., 2023). Particularly identified gaps in the literature are as follows: (1) Domestic Policy Review: There is no concerted systematic review that analyses the national policies regarding wearable technologies in the context of education in Southeast Asia as a whole, which will facilitate understanding of the best practices across the region and what areas could be improved upon. (2) Efficacy of Implementation: There is a paucity of research on how well such policies actually work in practice, and when faced with institutional challenges in carrying out measures to protect privacy, how this translates into protecting student privacy. (3) Stakeholder issues – From the literature examined so far, much work will be done to investigate how stakeholders (students, parents, teachers, administrators, technology providers) understand privacy threats and policy demands in educational wearables. (4) Cultural/Contextual considerations: The effect of cultural, social, and economic contexts on policy formation and implementation in Southeast Asia has not been adequately considered in this region, known for its diversity. (5) Policy Evolution over Time: There is a need for research investigating how policies for wearable technology have evolved in response to technological innovations, as well as privacy concerns over time.

The need to consider student privacy in the context of digital education is increasingly supported by research that points to potential risks and challenges relating to collecting educational data. Research has demonstrated that students are a vulnerable population for privacy violations, as they are believed to have a low awareness of their data rights and are forced to participate in the educational system (Jones et al., 2020; Stoilova et al., 2020). Studies carried out in different educational contexts reveal data abuse, data breaches, and unethical commercial use of student data gathered through digital tools.

Evidence from regulatory frameworks such as the General Data Protection Regulation (GDPR) in Europe and the Personal Data Protection Act (PDPA) in Singapore demonstrates the growing recognition of the need for specialized protections for children's data in educational contexts (GDPR, 2016). However, applying these frameworks to wearable technology in education remains inconsistent and often inadequate, as evidenced by case studies of policy implementation failures and privacy violations (Momen et al., 2019; Murdoch et al., 2023). The Southeast Asian context presents unique challenges and opportunities for addressing student privacy in wearable technology adoption. The region comprises diverse countries with varying levels of economic development, regulatory maturity, technological infrastructure, and cultural approaches to privacy and education (Javed et al., 2020; Lysaght et al., n.d.). Countries like Singapore have established comprehensive data protection regimes, while others are still developing basic privacy legislation. This regulatory diversity challenges technology providers operating across multiple jurisdictions and educational institutions seeking to implement consistent privacy standards.

Cultural factors also play a significant role in shaping privacy perceptions and policy approaches in Southeast Asia. Collectivist values in many countries may influence attitudes toward data sharing and individual privacy rights, while varying levels of digital literacy affect stakeholders' ability to understand and advocate for privacy protections (Seto et al., 2021; White et al., 2021). Additionally, the rapid pace of technological adoption in the region often outstrips the development of corresponding regulatory frameworks, creating implementation gaps and enforcement challenges.

This systematic review aims to address the identified research gaps and comprehensively analyze wearable technology policies in Southeast Asian education. The specific objectives are: (1) to identify and catalog existing policy frameworks, regulations, and guidelines governing the use of wearable technology in educational settings across Southeast Asian countries. (2) To analyze and compare the approaches taken by different countries in addressing student privacy concerns related to wearable technology, including regulatory scope, enforcement mechanisms, and stakeholder responsibilities. (3) To evaluate the effectiveness of existing policies in protecting student privacy, based on documented implementation experiences, case studies, and stakeholder feedback. (4) To identify key challenges and barriers to effective policy implementation, including technical, institutional, resource-related, and cultural factors. (5) To develop evidence-based recommendations for policymakers, educational institutions, technology providers, and other stakeholders to enhance student privacy protection in the context of wearable technology adoption. This research addresses these objectives and contributes to the theoretical understanding of digital rights in educational contexts. It provides practical guidance for balancing technological innovation with privacy protection in Southeast Asia and beyond.

METHOD

Research Design

This systematic review employed a comprehensive research design following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure methodological rigor, transparency, and reproducibility (Moher et al., 2009; Page et al., 2021; Petticrew & Roberts, 2006). The review addressed the complex and multidimensional nature of wearable technology policies in educational settings, incorporating quantitative and qualitative

evidence to provide a holistic understanding of the research landscape. The research design was structured around the PICOS framework (Population, Intervention, Comparison, Outcome, Study type) to guide the systematic identification, screening, and analysis of relevant literature (Booth et al., 2021; Hott et al., 2024). This approach ensured that the review remained focused on the specific research question while allowing for the inclusion of diverse evidence types that could contribute to a comprehensive understanding of the policy landscape.

Table 1. The PICOS Explanations

Components	Explanations
Population	The review focused on policies, regulations, and guidelines applicable to wearable technology use in educational settings involving students at all levels (primary, secondary, and tertiary education) in Southeast Asian countries (ASEAN member states: Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam).
Intervention	The interventions of interest were policy frameworks, regulatory approaches, guidelines, and implementation mechanisms related to privacy protection in the use of wearable technology in educational contexts. This included formal legislation, institutional policies, industry standards, and best practice guidelines.
Comparison	Where available, the review compared different policy approaches across countries, institutional types, and time periods to identify variations in regulatory scope, implementation effectiveness, and privacy protection outcomes.
Outcomes	Primary outcomes included the identification of policy elements, implementation mechanisms, enforcement approaches, and documented effectiveness in protecting student privacy. Secondary outcomes included identification of challenges, barriers, success factors, and stakeholder perspectives on policy development and implementation.
Study type	The review included peer-reviewed academic articles, policy documents, government reports, case studies, and grey literature published between January 2015 and December 2025. This timeframe was selected to capture the emergence and evolution of wearable technology policies in education during the period of significant technological adoption.

A comprehensive search strategy was developed to identify relevant literature across multiple databases and sources. The search process was conducted in three phases to ensure thorough coverage of the research landscape.

Resources and Query Methodologies

Systematic searches were performed across the following electronic databases: (1) Academic Databases: Scopus, Web of Science, ERIC (Education Resources Information Center), PubMed, IEEE Xplore, ACM Digital Library; (2) Regional Databases: ASEAN Citation Index, Southeast Asian Academic Information Network; and (3) Legal and Policy Databases: LexisNexis, Westlaw, UNESCO Digital Library, World Bank Open Knowledge Repository.

The search strategy employed a combination of controlled vocabulary (MeSH terms, subject headings) and free-text terms related to the key concepts of the review. Each database's search string was adapted to account for differences in indexing and search functionality. The core search terms included: ("wearable technology" OR "wearable devices" OR "smartwatch" OR "fitness tracker" OR "biometric devices" OR "body-worn devices") AND ("education" OR "school" OR "university" OR "student" OR "academic" OR "learning") AND ("privacy" OR "data protection" OR "personal data" OR "information privacy" OR "data security" OR "confidentiality") AND ("policy" OR "policies" OR "regulation" OR "legislation" OR "guidelines" OR "framework") AND ("Southeast Asia" OR "ASEAN" OR "Brunei" OR "Cambodia" OR "Indonesia" OR "Laos" OR "Malaysia" OR "Myanmar" OR "Philippines" OR "Singapore" OR "Thailand" OR "Vietnam").

To capture policy documents, government reports, and other grey literature not indexed in academic databases, targeted searches were conducted using: (1) Government Websites: Official portals of education ministries and data protection authorities in ASEAN countries; (2) International Organization Websites: UNESCO, UNICEF, OECD, World Bank; (3) Professional Organizations: International Association of Privacy Professionals, EDUCAUSE; (4) Google Advanced Search:

Using domain filters (.gov, .edu, .org) and file type filters (PDF, DOC). Forward and backward citation tracking was performed on all included studies to identify additional relevant literature. It involved examining reference lists of included articles and conducting citation searches to identify more recent works that had cited the included studies.

Inclusion and Exclusion Criteria

The inclusion and exclusion criteria were developed to ensure a rigorous yet contextually grounded review process (Andrabi et al., 2012; Martin, 2025; Torgerson, 2003). Studies published in English or with English translations between 2015 and 2025 were included if they examined wearable technology policies in educational contexts within Southeast Asia. Eligible sources addressed privacy protection issues, data governance, or regulatory frameworks and demonstrated methodological transparency across various document types, including peer-reviewed articles, policy reports, and case studies. Studies were excluded if they focused on non-educational contexts, lacked specific references to wearable devices, or provided only opinion-based discussions without substantive content. Duplicate or insufficiently detailed documents were also omitted.

Data Analysis Procedure

The data analysis process in this study followed the principles of the Systematic Literature Review (SLR) methodology as outlined by Kitchenham (2007), emphasizing thematic synthesis and quality assessment to generate valid and scientifically credible insights (Lucchetti & Renzi, 2025; Staffs, 2007). Two independent reviewers conducted the study selection through a structured three-stage process to ensure reliability and minimize bias. During the initial screening, titles and abstracts were evaluated against predefined inclusion and exclusion criteria, and any inconsistencies were resolved through discussion or consultation with a third reviewer. Subsequently, full-text assessments were carried out using a standardized eligibility form to record study characteristics, policy focus, geographic scope, and relevance to the review objectives, with transparent documentation of exclusion reasons. In the final consensus stage, reviewers compared evaluations and reached agreement through dialogue, while a third reviewer independently adjudicated unresolved cases.

Data Extraction

A standardized data extraction form was developed and piloted to ensure accuracy, consistency, and comprehensiveness throughout the review process. The form systematically captured key information from each included study, encompassing basic study details (authors, publication year, document type, country coverage, and funding sources), policy characteristics (type, scope, provisions, stakeholder roles, enforcement mechanisms, and data protection measures), implementation details (status, responsible institutions, resource allocations, and monitoring systems), and documented outcomes (policy effectiveness, impacts on student privacy, stakeholder perspectives, and best practices). This structured approach enabled a holistic understanding of how wearable technology policies are designed and operationalized across diverse educational contexts in Southeast Asia. To uphold methodological rigor, two independent reviewers extracted data using the standardized form, and any discrepancies were resolved through collaborative discussion or consultation with a third reviewer when necessary.

The methodological quality of the included studies was evaluated using rigorously selected tools appropriate to each study type, ensuring both analytical precision and fairness in interpretation. For peer-reviewed academic articles, the Joanna Briggs Institute (JBI) critical appraisal tools were applied, with specific instruments tailored to the study design—such as the JBI Checklist for Analytical Cross-Sectional Studies and the JBI Checklist for Qualitative Research (Munn et al., 2023; Wu et al., 2022). The evaluation emphasized the clarity of research objectives, appropriateness of methodology, rigor of data collection and analysis, transparency in reporting, attention to ethical considerations, and relevance to policy and practice. A customized quality assessment framework

was developed for policy documents and institutional reports based on established policy analysis standards (Heise et al., 2022; Whiting et al., 2017), focusing on policy objectives, evidence bases, stakeholder engagement, implementation feasibility, monitoring mechanisms, and transparency. Two reviewers independently assessed each study, and disagreements were resolved through discussion or, when necessary, by a third reviewer.

Data Synthesis and Analysis

The data synthesis employed a mixed-methods approach that integrated narrative synthesis with thematic and comparative analyses, allowing for a nuanced understanding of the diverse evidence base. The process began with a descriptive analysis to map publication trends, geographic distribution, document types, and policy orientations, thereby revealing patterns, research gaps, and the overall landscape of wearable technology policies in education. It was followed by a thematic analysis (Hee et al., 2019), in which the extracted data were iteratively reviewed, coded, and organized into coherent themes and subthemes that reflected the underlying meanings and relationships within the studies. Through familiarization, systematic coding, and refinement, key themes were defined and supported by empirical evidence, ensuring both analytical depth and interpretive transparency. Subsequently, a comparative analysis explored variations and commonalities in policy approaches across countries, institutional contexts, and temporal frameworks, highlighting best practices and areas requiring greater alignment. The final synthesis integrated insights from all analytical stages to construct a comprehensive and balanced portrayal of the wearable technology policy landscape in Southeast Asian education—illuminating emerging challenges, promising innovations, and actionable implications for policymakers, educators, and technology developers committed to ethical and practical digital transformation.

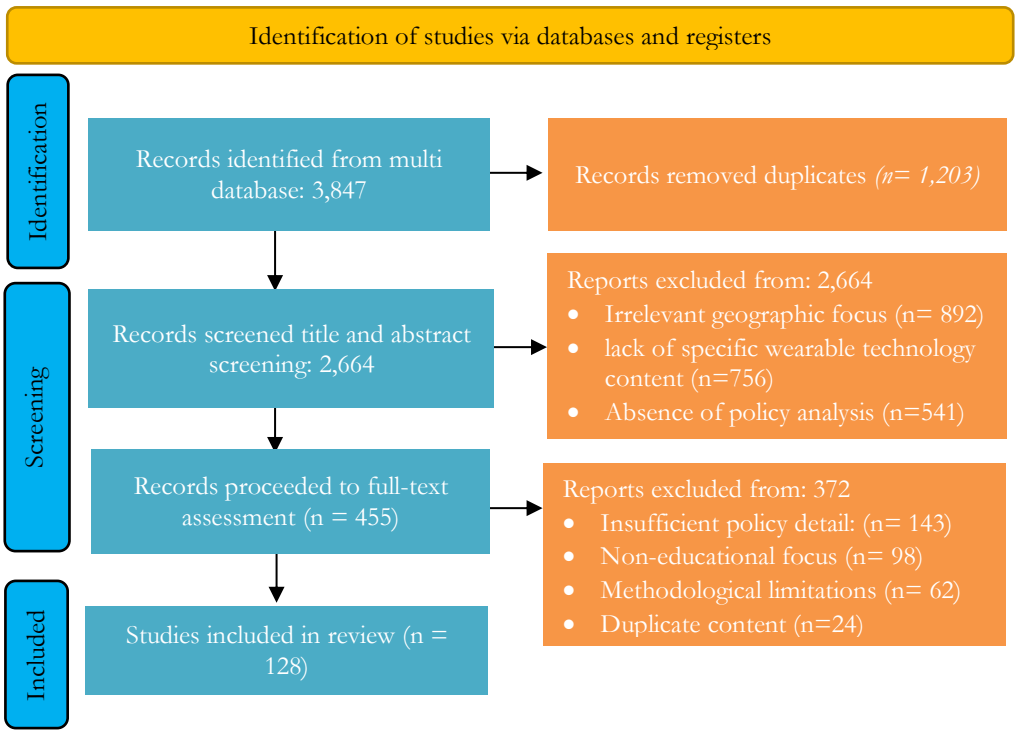

Figure 1. PRISMA Flow diagram of the systematic review process from initial identification of records through final inclusion

Ethical Considerations

This systematic review fully adhered to established ethical research principles, ensuring transparency, integrity, and respect for intellectual contributions throughout the process (Raciti et al., 2021). Ethical rigor was maintained through secure data management practices, with all extracted materials stored confidentially and accessed only by authorized research team members.

Independent review procedures and comprehensive search strategies were implemented to minimize potential biases—such as selection, detection, and reporting bias—promoting objectivity and methodological fairness. Every stage of the review process was carefully documented to enhance transparency and reproducibility, allowing future researchers to trace and validate the analytical pathway. Potential conflicts of interest were openly disclosed and managed according to institutional and publication ethics guidelines. Furthermore, all intellectual property and copyright standards were strictly observed, ensuring proper acknowledgment of original authors and the ethical use of scholarly materials. The study selection process was documented using a PRISMA flow diagram to provide a transparent account of the number of records identified, screened, assessed for eligibility, and included in the review, along with reasons for exclusion at each stage.

RESULT AND DISCUSSION

Result

The systematic search across multiple databases and sources identified 3,847 potentially relevant records. After removing duplicates (n = 1,203), 2,644 unique records underwent title and abstract screening. Of these, 2,189 records were excluded because they did not meet the inclusion criteria, primarily due to irrelevant geographic focus (n = 892), lack of specific wearable technology content (n = 756), or absence of policy analysis (n = 541). The remaining 455 records proceeded to full-text assessment, during which an additional 327 records were excluded for the following reasons: insufficient policy detail (n = 143), non-educational focus (n = 98), methodological limitations (n = 62), and duplicate content (n = 24). This process resulted in the final inclusion of 128 studies and documents for analysis.

The characteristics of the included studies demonstrate a wide variety of document types and extensive geographic coverage. The analyzed studies consisted of 67 peer-reviewed journal articles (52.3%), 28 government policy documents (21.9%), 18 institutional guidelines (14.1%), 9 case studies (7.0%), and six evaluation reports (4.7%). In terms of geographic distribution, the studies covered the Southeast Asian region with the highest representation coming from Singapore, accounting for 34 studies (26.6%), followed by Malaysia with 27 studies (21.1%), Thailand with 19 studies (14.8%), the Philippines with 15 studies (11.7%), Indonesia with 13 studies (10.2%), Vietnam with nine studies (7.0%), multinational studies numbering 7 (5.5%), and other ASEAN countries with four studies (3.1%). This data reflects the diversity of sources and regional coverage that supports a broad range of perspectives within this research.

Table 2. Policy Development Status by Country

Country	Comprehensive Framework	Partial Coverage	Limited Development	Policy Year Introduced
Singapore	✓			2019
Malaysia	✓			2020
Thailand	✓			2021
Philippines		✓		2020
Indonesia		✓		2022
Vietnam		✓		2021
Brunei		✓		2022
Cambodia			✓	
Laos			✓	
Myanmar			✓	

The analysis revealed a significant increase in publications on wearable technology policies in education over the review period, with 78% of included studies published since 2020, reflecting growing attention to this issue in response to accelerated technology adoption during and after the COVID-19 pandemic. The systematic review identified substantial variation in the development

and implementation of wearable technology policies across Southeast Asian countries. Key findings from the policy landscape analysis include: (1) Comprehensive Frameworks: Only three countries (Singapore, Malaysia, and Thailand) have developed comprehensive policy frameworks specifically addressing wearable technology in educational settings. (2) Partial Coverage: 4 countries (Philippines, Indonesia, Vietnam, and Brunei) have policies that partially address wearable technology within broader educational technology or data protection frameworks. (3) Limited Development: 3 countries (Cambodia, Laos, and Myanmar) have minimal policy development specific to wearable technology in education, relying on general data protection provisions.

The analysis identified four main types of policy documents governing wearable technology in educational settings: (1) Legislative Frameworks: Formal laws enacted by national legislatures (n = 12). (2) Regulatory Instruments: Rules and regulations issued by executive agencies or regulatory bodies (n = 31). (3) Institutional Policies: Policies developed by individual educational institutions (n = 48). (4) Guidelines and Best Practices: Non-binding guidance documents (n = 37). The sources of policy development varied significantly across countries, with Singapore and Malaysia demonstrating the most coordinated approaches involving multiple government agencies, educational institutions, and industry stakeholders. In contrast, countries with limited policy development tended to rely on individual institutional initiatives without national coordination.

The thematic analysis of policy content identified seven core elements consistently addressed across the included documents, though with varying levels of detail and emphasis. Scope and Limitations: 89% of comprehensive policies defined specific types of data that could be collected through wearable devices, commonly including: (1) Physiological data (heart rate, sleep patterns, activity levels); (2) Location data (for safety and attendance monitoring); (3) Behavioral data (attention levels, engagement metrics); and (4) Academic performance data (test scores, completion rates). Purpose Specification: 76% of policies required explicit specification of data collection purposes, with limitations on secondary use. Common legitimate purposes identified: health monitoring, safety assurance, personalized learning, and administrative efficiency. Data Minimization: 68% of comprehensive policies incorporated data minimization principles, requiring only the collection of necessary information. Significant variation in implementation approaches, with Singaporean policies demonstrating the most detailed specifications.

The policies regarding consent and participation for wearable technology use in educational settings predominantly address informed consent requirements, with 92% of the policies incorporating these provisions. Among these policies, there is notable variation in the approach taken: parental consent is uniformly mandated for minors in all comprehensive policies, while student assent is required in 78% of the policies for age-appropriate students. Additionally, 64% of comprehensive policies offer opt-out provisions to participants. However, the complexity of consent forms presents significant challenges; analysis reveals an average readability level corresponding to grade 14.2, which exceeds the comprehension abilities of most students and many parents. Moreover, only 23% of the policies include requirements to tailor the consent process according to the age and developmental level of the students. It suggests that while consent is widely recognized as important, substantial gaps remain in making the consent process accessible and appropriate for all stakeholders.

Table 3. Consent Requirements across Policy Types

Policy Type	Parental Consent Required	Student Assent Required	Opt-out Available	Age-Appropriate Process
Legislative (n=12)	12 (100%)	9 (75%)	8 (67%)	2 (17%)
Regulatory (n=31)	31 (100%)	25 (81%)	21 (68%)	6 (19%)
Institutional (n=48)	48 (100%)	36 (75%)	29 (60%)	9 (19%)
Guidelines (n=37)	32 (86%)	28 (76%)	22 (59%)	12 (32%)

Data Security and Storage

Data security requirements form a cornerstone of educational data protection policies across Southeast Asia. Research indicates that 84% of comprehensive policies in the region include specific data security requirements, reflecting a growing recognition of the importance of safeguarding student information. Among these requirements, encryption is the most prevalent measure, implemented in 92% of policies with security provisions. Access controls follow closely at 87%, while audit trails are included in 76% of policies. Though less universal, regular security assessments are still mandated in 68% of comprehensive policies, demonstrating a commitment to ongoing vigilance in data protection.

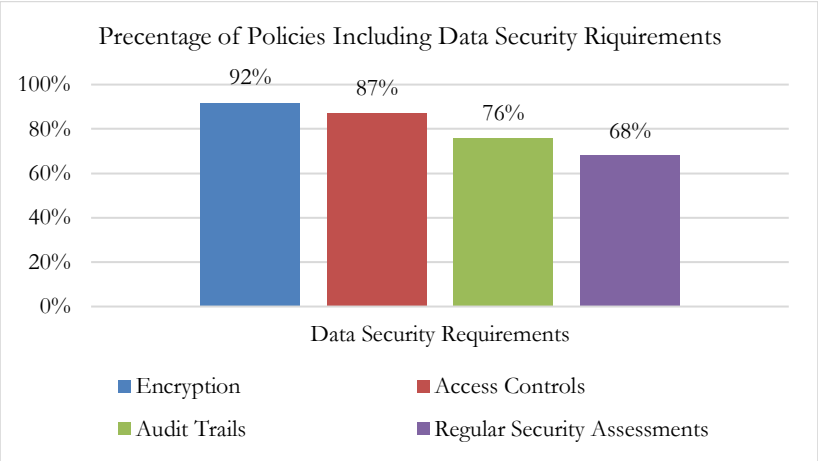

Figure 2. Percentages of Policies Including Data Security Requirements

A bar chart showing the percentage of policies including various data security requirements: encryption (92%), access controls (87%), audit trails (76%), and regular security assessments (68%). Data localization represents another critical aspect of storage policies, with 58% of regional policies addressing the physical location of data storage. The approaches to data localization vary significantly across jurisdictions. Singapore and Malaysia have implemented mandatory local storage requirements for student data, reflecting a strict approach to data sovereignty. In contrast, Thailand and the Philippines have adopted a more flexible stance, preferring local storage but not making it compulsory. Notably, countries with limited policy development typically lack specific requirements regarding data storage location, potentially creating vulnerabilities in cross-border data flows.

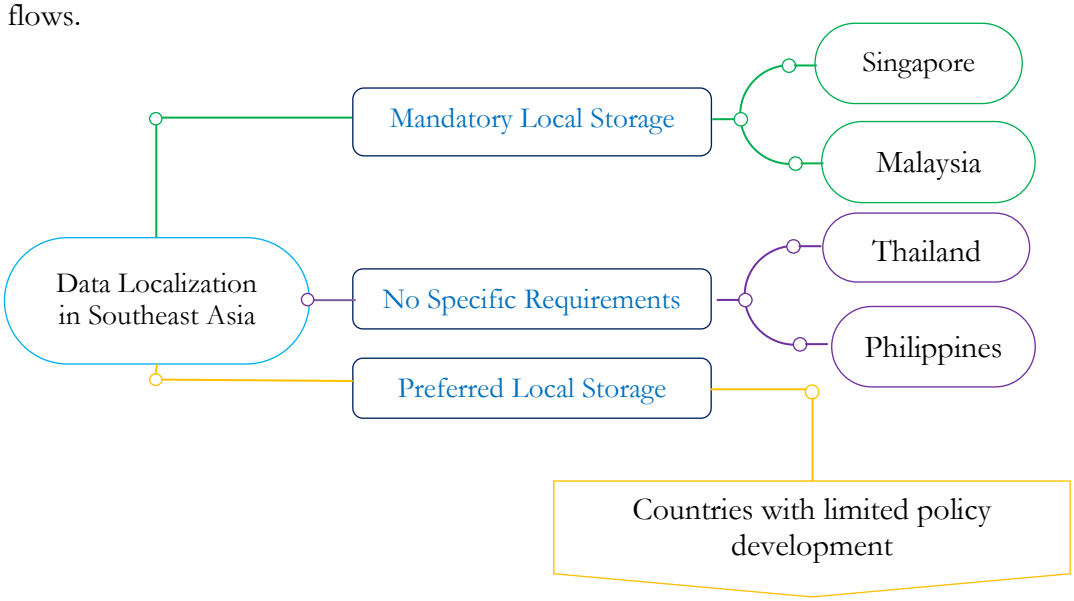

Figure 3. A map Diagram of Data Localization in Southeast Asia

A map diagram illustrating different approaches to data localization across Southeast Asian countries: mandatory local storage (Singapore, Malaysia), preferred local storage (Thailand, Philippines), and no specific requirements (countries with limited policy development). Retention periods for educational data are specified in 72% of policies, with considerable variation in duration ranging from 30 days to 7 years. This variation largely depends on data type, with physiological data generally subject to shorter retention periods than academic data. This distinction reflects an understanding of the different risk profiles associated with various categories of student information, with more sensitive personal data being retained for shorter periods to minimize exposure.

Access and Sharing

Access rights to personal data are addressed in 81% of Southeast Asian policies, indicating widespread recognition of individuals' rights to access their own information. Among these policies, 67% specify detailed procedures for students and parents to access their data, establishing formal mechanisms for exercising these rights. However, implementation challenges are documented in 43% of cases, with technical capacity limitations and extended response times emerging as significant barriers to effective access. These challenges highlight the gap between policy formulation and practical implementation, particularly in resource-constrained environments.

Third-party data sharing is addressed in 76% of policies, with substantial variation in restrictions. A complete prohibition on commercial sharing is found in 28% of policies, representing the most restrictive approach. Most policies (52%) adopt a conditional sharing model, allowing data sharing with third parties only with explicit consent and specific safeguards. The remaining 20% of policies impose limited restrictions, primarily in countries with limited policy development. This spectrum of approaches reflects differing regional perspectives on data commercialization and the balance between educational innovation and privacy protection.

Institutional Responsibilities

The designation of data protection officers is required in 67% of comprehensive policies, establishing formal accountability for data protection within educational institutions. However, implementation rates vary dramatically across the region, with Singapore achieving 92% compliance compared to 34% in countries with limited policy development. This disparity underscores the influence of regulatory maturity and institutional capacity on effectively implementing data protection measures. Training requirements for staff and administrators are included in 73% of policies, reflecting an understanding of the human element in data security. However, only 38% of policies extend training requirements to students, despite their role as data subjects and potential data handlers. Evaluation studies document training gaps in 58% of cases, indicating that they may not be adequately implemented or evaluated even where training requirements exist. This finding suggests a need for more robust training frameworks and assessment mechanisms to ensure all stakeholders possess the necessary knowledge and skills to protect student data effectively.

Incident response requirements are included in 82% of comprehensive policies, establishing protocols for data breach notification and response. The average notification time requirements are 72 hours for severe breaches and 7 days for minor breaches, aligning with international best practices. However, significant variation in implementation capacity exists across institutions, with many lacking the technical infrastructure and expertise to meet these timelines. This gap between policy requirements and operational capabilities represents a critical vulnerability in the region's data protection landscape.

Enforcement and Compliance

Monitoring mechanisms for compliance are included in 64% of policies, employing diverse approaches to oversight. Formal audits represent the most rigorous approach, utilized in 32% of policies with monitoring provisions. Self-assessment mechanisms are more common in 45% of policies, while complaint-driven investigations are used in 23% of cases. This variety of approaches reflects different regulatory philosophies and resource constraints across jurisdictions, with some emphasizing external validation and others relying on internal compliance mechanisms. Penalties for non-compliance are specified in 58% of policies, establishing consequences for violations of data protection requirements. The range of penalties includes administrative fines, with Singapore imposing fines of up to $500,000 for serious violations, institutional sanctions, and individual liability. Despite these provisions, documented enforcement actions remain limited across the region, suggesting penalties may serve more as deterrents than regularly applied sanctions. This limited enforcement may stem from capacity constraints in regulatory bodies or challenges in detecting and proving violations.

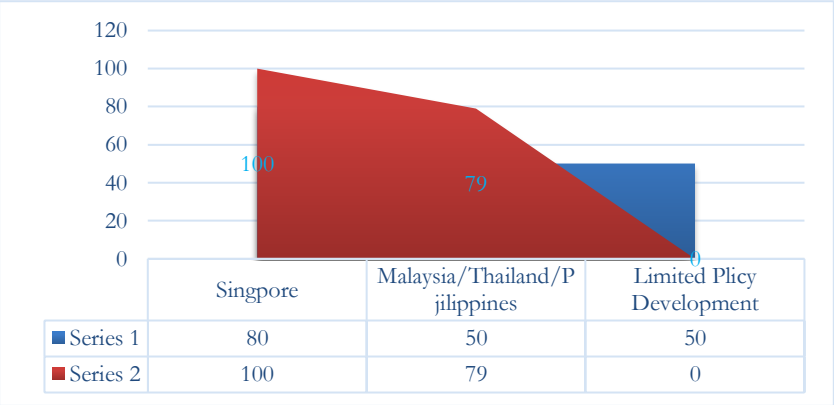

Figure 4. A comparative chart of compliance rates across Southeast Asian countries

Compliance rates vary significantly across Southeast Asia, with available data revealing a clear correlation between policy maturity and compliance levels. High compliance rates (80-100%) are primarily observed in Singapore and among large institutions with robust resources. Moderate compliance (50-79%) is standard in Malaysia, Thailand, and the Philippines, reflecting developing regulatory frameworks and implementation capacity. Low compliance (<50%) is prevalent in countries with limited policy development and smaller institutions, highlighting the challenges faced by resource-constrained environments in meeting data protection requirements. A comparative chart showing compliance rates across Southeast Asian countries: Singapore (80-100%), Malaysia/Thailand/Philippines (50-79%), and countries with limited policy development (<50%).

Stakeholder Engagement

Stakeholder consultation during policy development is documented in 71% of comprehensive policies, indicating a commitment to inclusive policy formation. The most commonly consulted stakeholders are parents (92%), teachers (87%), students (63%), technology providers (58%), and privacy experts (52%). This broad consultation approach recognizes the multifaceted nature of educational data protection and the importance of incorporating diverse perspectives into policy development.

A flow diagram showing the stakeholder engagement process in policy development, with input from parents (92%), teachers (87%), students (63%), technology providers (58%), and privacy experts (52%). Ongoing stakeholder engagement is included in 56% of policies, establishing mechanisms for continuous dialogue beyond the initial policy development phase. Advisory committees are the most formal approach in 38% of policies with engagement provisions. Regular

consultations are included in 42% of policies, while feedback mechanisms are the most common approach in 67% of policies. These ongoing engagement mechanisms recognize the evolving nature of data protection challenges and the need for policies to adapt to changing technologies and threats.

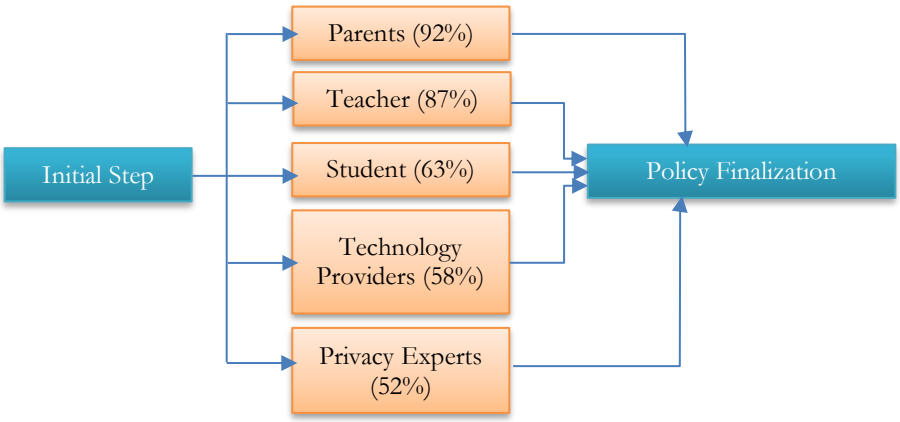

Figure 5. A flow diagram of the stakeholder engagement process in policy development

Table 4. Stakeholder Engagement in Policy Development

Stakeholder Group	Consulted During Development	Included in Ongoing Engagement	Formal Role in Implementation
Parents	92%	78%	45%
Teachers	87%	82%	67%
Students	63%	58%	23%
Technology Providers	58%	52%	38%
Privacy Experts	52%	48%	29%
Government Agencies	87%	76%	82%

The implementation of wearable technology policies in Southeast Asian educational institutions faces significant technical and infrastructure hurdles that substantially affect adoption rates and effectiveness. Evaluation studies indicate that 68% of identified limited technical capacity is a significant implementation barrier, highlighting a fundamental challenge permeating the region. These technical limitations manifest in various forms, with inadequate data storage infrastructure being the most prevalent issue, affecting 72% of institutions attempting to implement wearable technology solutions. The inability to properly store and manage the vast amounts of data generated by wearable devices creates a bottleneck that undermines the entire implementation process.

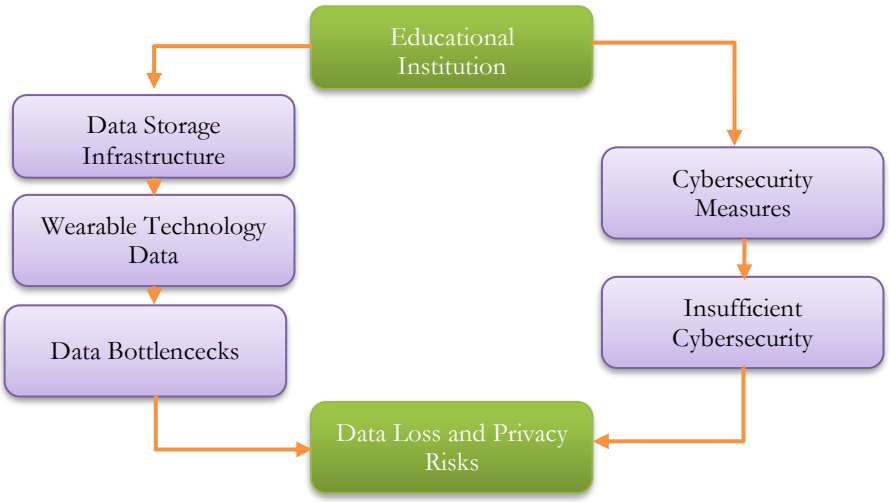

Figure 6. A diagram of technical infrastructure challenges in educational institutions

A diagram showing technical infrastructure challenges in educational institutions. Compounding the storage challenges are insufficient cybersecurity measures, which were identified as problematic in 68% of evaluation studies. As wearable devices collect increasingly sensitive student data, including biometric information, location tracking, and behavioral patterns, the absence of robust cybersecurity protocols exposes educational institutions to significant risks. The lack of adequate protection mechanisms threatens data integrity and erodes stakeholder confidence in wearable technology initiatives. Perhaps most concerning is the widespread lack of data management expertise, reported in 81% of evaluation studies. This skills gap extends beyond technical staff to include administrators and policymakers who may lack the foundational knowledge necessary to develop and implement effective data governance frameworks. The shortage of qualified personnel capable of managing complex data ecosystems represents a critical human capital challenge that must be addressed to enable successful wearable technology integration.

Integration complexity presents another formidable technical challenge, with 57% of studies documenting difficulties connecting wearable technology data with existing educational information systems. The compatibility issues between different wearable platforms and institutional systems create significant interoperability challenges, often requiring custom integration solutions that exceed the technical capacity of many educational institutions. These integration barriers increase implementation costs and extend deployment timelines, potentially delaying the realization of educational benefits. Financial limitations are predominant constraints affecting wearable technology implementation across Southeast Asian educational institutions. A comprehensive analysis of case studies reveals that 76% identified financial constraints as significant barriers to policy implementation. The economic burden of adopting wearable technology varies considerably based on institution size and policy scope, with implementation costs ranging from $45,000 to $250,000 per institution. This substantial financial commitment represents a significant investment for many educational institutions, particularly in developing economies with strained budgets.

The diversity of funding sources reflects the varied approaches to financing wearable technology initiatives across the region. Government grants constitute the primary funding mechanism, supporting 42% of implementations, while institutional budgets account for 35% of funding sources. Technology provider partnerships represent a smaller but significant portion, contributing to 23% of implementations. This funding distribution highlights the collaborative nature of wearable technology adoption, with multiple stakeholders sharing the financial burden and potential benefits. Human resource constraints present an equally critical challenge, with 82% of evaluation studies reporting insufficient personnel for effective policy implementation. The human resource gaps extend across multiple domains, with the most severe shortage being in data protection specialists, identified as lacking in 87% of institutions. This shortage is particularly concerning given the sensitive nature of data collected by wearable devices and the increasing regulatory requirements for data protection in many Southeast Asian countries.

IT support staff shortages were documented in 76% of evaluation studies, limiting the technical capacity necessary for maintaining wearable technology infrastructure and troubleshooting integration issues. Additionally, limited administrative capacity, reported in 68% of studies, affects the ability of educational institutions to develop and implement comprehensive policies governing wearable technology use. These human resource constraints collectively create a significant implementation barrier beyond mere technical challenges to encompass institutional capacity limitations. Stakeholder awareness regarding wearable technology policies varies dramatically across different groups within the educational ecosystem, creating significant implementation challenges. Survey data reveal that 73% of assessments identified limited awareness among stakeholders about wearable technology policies, highlighting a fundamental communication and engagement challenge. The awareness disparities are particularly pronounced

when examining different stakeholder groups, with administrators demonstrating the highest awareness at 68%, followed by teachers at 42%, parents at 27%, and students at merely 18%.

This awareness gradient creates a complex implementation environment where policy development and enforcement must contend with varying levels of understanding across stakeholder groups. The relatively low awareness among teachers, who are often responsible for implementing wearable technology in classroom settings, represents a particularly concerning gap that may affect technology adoption and effective utilization. Similarly, the minimal awareness among parents and students raises questions about informed consent and the ability of these groups to make educated decisions about participation in wearable technology initiatives. Privacy literacy emerges as an even more significant challenge, with 81% of studies identifying low privacy literacy as a substantial barrier to effective policy implementation. This concern is particularly acute when considering students' ability to understand privacy implications, which was documented as problematic in 89% of student-focused studies. The complexity of data collection practices and the sophisticated nature of modern data analytics create a significant comprehension gap that undermines meaningful consent and informed participation.

The privacy literacy challenge extends beyond students to include teachers, administrators, and parents, who may lack the foundational knowledge necessary to evaluate the privacy implications of wearable technology adoption. This widespread privacy illiteracy creates an environment where policies may be implemented without genuine stakeholder understanding, potentially undermining wearable technology initiatives' effectiveness and ethical integrity. Cultural variations in privacy perceptions significantly influence the acceptance and implementation of wearable technology policies across Southeast Asia. Qualitative studies reveal that 67% identified cultural differences as affecting policy acceptance, highlighting the importance of contextual understanding in policy development. In collectivist cultures prevalent throughout Southeast Asia, attitudes toward data sharing and individual privacy rights often differ substantially from Western individualistic frameworks, creating unique policy challenges and opportunities. These cultural variations manifest in different expectations about data ownership, sharing practices, and the appropriate balance between individual privacy and collective benefits. For instance, in contexts where communal decision-making and shared resources are valued, policies that emphasize individual data rights may face resistance or require adaptation to align with local cultural norms. Conversely, in more individualistic contexts within the region, policies emphasizing data sharing for collective benefits may encounter skepticism regarding privacy protections.

Trust in educational institutions represents another critical contextual factor affecting wearable technology policy implementation, with 58% of studies identifying trust issues as significant barriers. The varying levels of trust in educational institutions' ability to protect student data across different contexts create a complex implementation landscape where policy effectiveness may depend more on institutional credibility than technical specifications. In contexts where historical experiences or current conditions have eroded trust in institutional data management practices, even well-designed policies may face implementation challenges due to stakeholder skepticism. The analysis of policy effectiveness reveals mixed outcomes across different dimensions, reflecting the complex interplay between technical capabilities, policy frameworks, and implementation contexts. Privacy protection outcomes demonstrate both successes and areas for improvement, with documented data breaches involving wearable technology in educational settings remaining relatively low at 23 reported incidents across the region during the review period. However, this relatively low number of reported incidents must be interpreted cautiously, as underreporting was identified as a significant concern, with estimated actual incidents potentially 3-5 times higher than reported figures.

Privacy violations present a more nuanced picture, with 34% of evaluation studies documenting various forms of non-compliance with established policies. The most common violation type was unauthorized data access, accounting for 42% of documented violations,

followed by excessive data collection at 31% and inadequate consent processes at 27%. This distribution suggests that while technical safeguards may be relatively adequate, human factors and procedural compliance remain significant challenges in privacy protection. Student perceptions reveal a concerning disconnect between privacy concerns and protective actions. Surveys indicate that 67% of students express concern about wearable technology data collection, demonstrating a reasonable awareness of privacy risks. However, only 23% report specific actions to protect their privacy, highlighting a significant awareness-action gap that undermines personal data protection efforts. This discrepancy suggests that privacy concerns alone are insufficient to drive protective behaviors, indicating a need for more effective privacy education and user-friendly protection mechanisms.

Educational Benefits

Despite the challenges, wearable technology implementation has demonstrated significant educational benefits across multiple dimensions. Empirical studies report positive educational outcomes in 58% of cases, with documented benefits including personalized learning interventions (72%), improved health monitoring (68%), and enhanced student engagement (54%). These benefits illustrate the potential of wearable technology to transform educational experiences by providing real-time data that can inform personalized learning approaches and support student well-being. Administrative efficiency represents another significant benefit, with 76% of institutional case studies reporting improvements in operational processes. The most common efficiency gains include automated attendance tracking (87%), streamlined health monitoring (72%), and improved data-driven decision making (64%). These administrative benefits reduce the bureaucratic burden on educational institutions and enable more responsive and evidence-based educational practices.

Comparative Analysis across Countries

The comparative analysis reveals significant variations in policy approaches and implementation effectiveness across Southeast Asian countries, reflecting different levels of technological maturity, regulatory development, and resource availability. These variations create a complex regional landscape where wearable technology policy implementation ranges from highly sophisticated and effective to minimal and struggling.

Leading Countries: Singapore and Malaysia

Singapore and Malaysia are regional leaders in wearable technology policy development and implementation, demonstrating the most comprehensive and mature policy frameworks. Singapore's Personal Data Protection Act (PDPA) and Malaysia's Personal Data Protection Act 2010 provide strong regulatory foundations that specifically address the challenges of wearable technology in educational contexts. These comprehensive frameworks establish clear data collection, storage, and usage guidelines, creating environments where wearable technology can be implemented with appropriate privacy protections. Implementation effectiveness in these leading countries is notably high, with documented compliance rates ranging from 80% to 100%. This high compliance reflects both the strength of the regulatory frameworks and the capacity of educational institutions to implement requirements effectively. Strong institutional capacity and government support have been identified as key success factors, enabling the development of technical infrastructure and human resources necessary for successful implementation.

The advanced technical infrastructure in Singapore and Malaysia supports policy implementation through robust data storage capabilities, cybersecurity measures, and integration systems. This infrastructure foundation enables educational institutions to collect, manage, and analyze wearable technology data while complying with privacy regulations. Combining comprehensive policy frameworks and advanced technical infrastructure creates an environment where wearable technology can deliver educational benefits while protecting student privacy.

Developing Countries: Thailand, Philippines, Indonesia

Thailand, the Philippines, and Indonesia represent a middle tier of development in wearable technology policy, characterized by emerging frameworks with varying levels of comprehensiveness and implementation. Thailand demonstrates the most progress among this group, having established comprehensive guidelines specifically addressing wearable technology in education issued in 2021. These guidelines provide a foundation for implementation that, while not as mature as those in Singapore and Malaysia, represents significant progress in policy development.

Implementation effectiveness in these developing countries shows moderate compliance rates ranging from 50-79%, with significant variation across institutions. This variation reflects differences in institutional capacity, resource availability, and commitment to policy implementation. Resource constraints and capacity gaps have been identified as significant barriers to more effective implementation, limiting the ability of many institutions to fully comply with policy requirements despite the presence of regulatory frameworks. Despite these challenges, there is evidence of growing awareness and political will to address privacy concerns related to wearable technology in education. This increasing attention suggests potential for continued policy development and improved implementation effectiveness in the coming years. The trajectory of policy evolution in these countries indicates a recognition of both the benefits and risks of wearable technology in educational settings.

Countries with Limited Development: Cambodia, Laos, Myanmar

Cambodia, Laos, and Myanmar represent the third tier of development in wearable technology policy, characterized by minimal specific policy development for wearable technology in education. In these countries, wearable technology implementation relies on general data protection provisions that may not adequately address the specific educational context and unique challenges of wearable devices. This policy gap creates an environment where wearable technology adoption may occur without appropriate regulatory guidance or privacy protections.

Implementation challenges in these countries are substantial, with low compliance rates below 50% and limited institutional capacity to address even basic data protection requirements. Significant resource constraints and competing development priorities limit the ability of educational institutions to invest in the technical infrastructure and human resources necessary for effective wearable technology implementation. These constraints are compounded by limited technical expertise and awareness of privacy issues among stakeholders. Despite these limitations, there is evidence of growing technology adoption without corresponding policy frameworks, creating a potentially risky environment where student data may be collected without adequate protections. The disconnect between technological adoption and policy development represents a significant concern that may require regional cooperation and support to address effectively.

Discussion

The systematic review reveals a complex and evolving landscape of wearable technology policies in Southeast Asian education, characterized by significant variation across countries, institutions, and policy types. The findings highlight several critical dimensions that warrant deeper discussion and interpretation. The substantial disparities in policy development across Southeast Asian countries reflect broader differences in regulatory maturity, technological adoption rates, and resource availability. Singapore and Malaysia have established comprehensive frameworks that balance innovation with privacy protection, while other countries struggle with basic policy development. This variation creates an uneven playing field for students across the region, with countries with robust policies enjoying greater privacy protections than those in countries with limited frameworks (Cheung et al., 2022; Lwin et al., 2023). These disparities are particularly concerning given the borderless nature of digital technology and data flows. Students in countries

with weak privacy protections may find their data collected and transferred to jurisdictions with stronger protections, creating complex governance challenges and potential exploitation opportunities. The regional approach to harmonization, as seen in ASEAN initiatives, appears insufficient to address these disparities effectively.

The review identified a significant gap between policy development and implementation effectiveness. Even in countries with comprehensive policies, implementation challenges persist due to technical, resource, and capacity constraints. This implementation gap suggests that policy development alone is insufficient to protect student privacy; concurrent investment in institutional capacity, technical infrastructure, and stakeholder awareness is essential (Oh et al., 2021). The implementation gap is particularly pronounced in smaller institutions and those with limited resources, creating equity concerns within and between countries. Policy frameworks must be designed with scalability and resource constraints in mind, providing tiered approaches that allow institutions with varying capacities to implement appropriate protections.

The analysis reveals significant variations in stakeholder engagement across the policy lifecycle. While most comprehensive policies document consultation during development, ongoing engagement mechanisms are less common. It suggests a tendency toward static policy development rather than dynamic, adaptive governance approaches that can evolve with technological change and stakeholder needs. The limited engagement of students in policy development and implementation is particularly concerning, given that they are the primary stakeholders affected by these policies. This exclusion may reflect broader patterns of marginalization of young people in governance processes. However, it also represents a missed opportunity to develop more relevant and effective policies that reflect student needs and perspectives (Stockemer & Sundström, 2025; Watson et al., 2023).

The findings highlight the ongoing challenge of balancing privacy protection with educational innovation and benefit. While privacy concerns are significant, the documented educational benefits of wearable technology cannot be dismissed. The most effective policies appear to acknowledge this tension and seek to optimize both objectives rather than treating them as mutually exclusive (Sobko & Brown, 2019). This balance requires nuanced approaches considering context-specific factors, including educational objectives, student needs, institutional capacity, and cultural values. The one-size-fits-all approach in some policies may be less practical than contextually sensitive frameworks that allow for appropriate variation while maintaining core privacy protections.

The findings contribute to several theoretical discussions in education policy, privacy studies, and technology governance. The review extends theoretical understanding of educational governance by examining how traditional educational institutions adapt to digital transformation. The findings suggest that educational governance is becoming increasingly hybrid, combining traditional hierarchical approaches with networked governance involving multiple stakeholders, including technology providers, regulatory bodies, and international organizations (Mohamed Hashim et al., 2022; Turnbull et al., 2021). This hybrid governance model creates new challenges for accountability and coordination, as traditional educational authorities must collaborate with actors outside the education sector who may have different priorities, values, and operational approaches. The theoretical implications of this shift warrant further exploration, particularly regarding how power dynamics are reshaped in this new governance landscape.

The analysis supports the theoretical perspective that privacy is not a universal concept but a contextual construct shaped by cultural, social, and institutional factors (Polin et al., 2023; Truong & Diep, 2023). The variation in policy approaches across Southeast Asian countries reflects different cultural understandings of privacy, different institutional priorities, and different approaches to balancing individual rights with collective interests. This contextual understanding of privacy has important implications for policy development, suggesting that effective privacy

frameworks must be sensitive to local contexts rather than imported from other jurisdictions. However, it also raises challenges for regional harmonization and global technology governance.

The findings contribute to theories of technology adoption and institutional adaptation by examining how educational institutions respond to the challenges posed by wearable technology. The variation in implementation effectiveness across institutions suggests that organizational capacity, leadership commitment, and institutional culture play significant roles in determining how successfully institutions can adapt to new technologies while protecting student interests(Ali et al., 2023; Mirata et al., 2020). This perspective challenges deterministic views of technology adoption, emphasizing instead the active role of institutions in shaping how technologies are implemented and governed. The theoretical implications of this agentic view of institutional adaptation merit further investigation.

The findings have significant practical implications for various stakeholders involved in wearable technology adoption in educational settings: (1) Harmonization Frameworks: The disparities in policy development across Southeast Asia suggest the need for regional harmonization frameworks that establish minimum standards while allowing for contextual adaptation. ASEAN could be key in facilitating this harmonization process through regional guidelines and capacity-building initiatives. (2) Capacity Building: The implementation gaps identified highlight the need for concurrent investment in institutional capacity, technical infrastructure, and human resources. Policymakers should consider multi-year capacity-building programs addressing technical and non-technical aspects of policy implementation. (3) Stakeholder Engagement: Effective policy development requires meaningful engagement with all stakeholders, particularly students and parents. Policymakers should establish structured consultation processes and ongoing engagement mechanisms to incorporate diverse perspectives into policy development and implementation.

This systematic review has several limitations that should be considered when interpreting the findings: The review focused specifically on wearable technology policies in educational settings within Southeast Asia. While appropriate for addressing the specific research question, this geographic and technological focus limits the generalizability of findings to other regions or other types of educational technology. Comparative studies across different regions and technology types would be valuable for a broader understanding.

The review included only documents published in English or with available English translations. This limitation may have excluded relevant policy documents and studies published in local languages, potentially biasing the findings toward countries and institutions with greater English-language capacity. The review identified significant gaps in implementation data, particularly regarding compliance rates, effectiveness outcomes, and long-term impacts. These data limitations reflect the early policy development and implementation stage in many contexts and highlight the need for more robust monitoring and evaluation systems. The rapid evolution of both wearable technology and privacy policy means that some findings may become outdated quickly. The dynamic nature of this field suggests the need for regular updates to systematic reviews and ongoing monitoring of policy developments.

The findings suggest several promising directions for future research: There is a need for longitudinal studies that track policy implementation over time, examining how policies evolve in response to technological change, stakeholder feedback, and implementation experiences. These studies could provide valuable insights into policy adaptation and learning processes. Comparative studies across regions (e.g., Southeast Asia vs. Europe vs. North America) could help identify cultural, institutional, and regulatory factors influencing policy effectiveness. These comparisons could inform more contextually sensitive approaches to policy development. Research centered on student perspectives and experiences is needed to better understand how wearable technology

policies affect students' privacy, autonomy, and educational experiences. This research should include diverse student populations and consider age-appropriate approaches to privacy protection.

The development of robust methodologies for assessing wearable technology policies' impact on privacy protection and educational outcomes would be valuable. These methodologies could help policymakers and institutions make more informed decisions about technology adoption and policy development. Research examining how emerging wearable technologies (e.g., brain-computer interfaces, advanced biometric sensors) challenge existing policy frameworks would be valuable. This forward-looking research could help anticipate privacy challenges and inform proactive policy development.

CONCLUSION

This systematic review comprehensively analyzes wearable technology policies in Southeast Asian education, revealing a complex landscape characterized by significant variation in policy development, implementation effectiveness, and stakeholder engagement. The findings highlight progress and challenges in protecting student privacy while harnessing the educational benefits of wearable technology. The disparities in policy development across countries and the implementation gaps within countries suggest the need for more coordinated approaches to policy development and implementation. Regional harmonization initiatives, capacity-building programs, and stakeholder engagement mechanisms could help address these challenges and ensure that all Southeast Asian students benefit from appropriate privacy protections. The balance between privacy protection and educational innovation remains a central challenge, requiring nuanced approaches considering context-specific factors and evolving technological capabilities. The most effective policies adopt privacy by design approaches, engage stakeholders meaningfully, and provide for ongoing adaptation and learning. As wearable technology continues to evolve and become more integrated into educational settings, the importance of robust privacy frameworks will only grow. This review provides a foundation for understanding the current policy landscape and identifies directions for future policy development, research, and practice. By addressing the challenges identified and building on the successes documented, Southeast Asian countries can create educational environments that harness the benefits of wearable technology while protecting student privacy and rights.

BIBLIOGRAPHY

Ali, J., Madni, S. H. H., Jahangeer, M. S. I., & Danish, M. A. A. (2023). IoT Adoption Model for E-Learning in Higher Education Institutes: A Case Study in Saudi Arabia. *Sustainability*, *15*(12), 9748. https://doi.org/10.3390/su15129748

Al-Momani, A., Kargl, F., Schmidt, R., Kung, A., & Bosch, C. (2019). A Privacy-Aware V-Model for Software Development. *2019 IEEE Security and Privacy Workshops (SPW)*, 100–104. https://doi.org/10.1109/SPW.2019.00028

Andrabi, T., Das, J., & Khwaja, A. I. (2012). What did you do all day? Maternal education and child outcomes. *Journal of Human Resources*, *47*(4), 873–912. https://doi.org/10.3368/jhr.47.4.873

Booth, A., Sutton, A., Clowes, M., & James, M. M.-S. (2021). *Systematic Approaches to a Successful Literature Review*. SAGE.

Cheung, R., Jolly, S., Vimal, M., Kim, H. L., & McGonigle, I. (2022). Who's afraid of genetic tests?: An assessment of Singapore's public attitudes and changes in attitudes after taking a genetic test. *BMC Medical Ethics*, *23*(1), 5. https://doi.org/10.1186/s12910-022-00744-5

Dini Kounoudes, A., Kapitsaki, G. M., & Katakis, I. (2023). Enhancing user awareness on inferences obtained from fitness trackers data. *User Modeling and User-Adapted Interaction*, *33*(4), 967–1014. https://doi.org/10.1007/s11257-022-09353-8

Drummond, C. K., Lewandowski, B., & Massaroni, C. (2022). Editorial: Wearable Technology for Human Performance. *Frontiers in Physiology*, *13*, 871159. https://doi.org/10.3389/fphys.2022.871159

Düking, P., Tafler, M., Wallmann-Sperlich, B., Sperlich, B., & Kleih, S. (2020). Behavior Change Techniques in Wrist-Worn Wearables to Promote Physical Activity: Content Analysis. *JMIR mHealth and uHealth*, *8*(11), e20820. https://doi.org/10.2196/20820

Ferrier, B., Lee, J., Mbuli, A., & James, D. A. (2022). Translational Applications of Wearable Sensors in Education: Implementation and Efficacy. *Sensors*, *22*(4), 1675. https://doi.org/10.3390/s22041675

GDPR (2016). https://gdpr-info.eu/

Hee, J. M., Yap, H. W., Ong, Z. X., Quek, S. Q. M., Toh, Y. P., Mason, S., & Krishna, L. K. R. (2019). Understanding the Mentoring Environment Through Thematic Analysis of the Learning Environment in Medical Education: A Systematic Review. *Journal of General Internal Medicine*, *34*(10), 2190–2199. https://doi.org/10.1007/s11606-019-05000-y

Heise, T. L., Seidler, A., Girbig, M., Freiberg, A., Alayli, A., Fischer, M., Haß, W., & Zeeb, H. (2022). CAT HPPR: A critical appraisal tool to assess the quality of systematic, rapid, and scoping reviews investigating interventions in health promotion and prevention. *BMC Medical Research Methodology*, *22*(1), 334. https://doi.org/10.1186/s12874-022-01821-4

Hott, B., Brigham, F., & Peltier, C. (2024). *Research Methods in Special Education*. Taylor & Francis.

Javed, Y., Salehin, K. M., & Shehab, M. (2020). A Study of South Asian Websites on Privacy Compliance. *IEEE Access*, *8*, 156067–156083. https://doi.org/10.1109/ACCESS.2020.3019334

Jones, K. M. L., Rubel, A., & LeClere, E. (2020). A matter of trust: Higher education institutions as information fiduciaries in an age of educational data mining and learning analytics. *Journal of the Association for Information Science and Technology*, *71*(10), 1227–1241. https://doi.org/10.1002/asi.24327

Jordan, S., Fontaine, C., & Hendricks-Sturrup, R. (2022). Selecting Privacy-Enhancing Technologies for Managing Health Data Use. *Frontiers in Public Health*, *10*, 814163. https://doi.org/10.3389/fpubh.2022.814163

Liang, M., Lim, C. P., Park, J., & Mendoza, N. B. (2023). A review of ICT-enabled learning for schoolgirls in Asia and its impacts on education equity. *Educational Technology Research and Development*, *71*(2), 267–293. https://doi.org/10.1007/s11423-022-10178-w

Lucchetti, M. C., & Renzi, M. F. (2025). *Qualità, Innovazione e Sostenibilità nella filiera agro-alimentare: Il contributo delle Scienze Merceologiche*. Roma TrE-Press.

Lwin, H. N. N., Punnakitikashem, P., & Thananusak, T. (2023). E-Health Research in Southeast Asia: A Bibliometric Review. *Sustainability*, *15*(3), 2559. https://doi.org/10.3390/su15032559

Lysaght, T., Ballantyne, A., Ballantyne, A., Xafis, V., Ong, S., Schaefer, G. O., Ling, J. M. T., Newson, A. J., Khor, I. W., & Tai, E. S. (n.d.). *'Who is watching the watchdog?': Ethical perspectives of sharing health-related data for precision medicine in Singapore.*

Martin, F. (2025). *Systematic Reviews in Educational Research: A Practical Guide for Research Synthesis*. SAGE Publications.

Mengiste, S. A., Antypas, K., Johannessen, M. R., Klein, J., & Kazemi, G. (2023). eHealth policy framework in Low and Lower Middle-Income Countries; a PRISMA systematic review and analysis. *BMC Health Services Research*, *23*(1), 328. https://doi.org/10.1186/s12913-023-09325-7

Mirata, V., Hirt, F., Bergamin, P., & Van Der Westhuizen, C. (2020). Challenges and contexts in establishing adaptive learning in higher education: Findings from a Delphi study. *International Journal of Educational Technology in Higher Education*, *17*(1), 32. https://doi.org/10.1186/s41239-020-00209-y

Mohamed Hashim, M. A., Tlemsani, I., & Duncan Matthews, R. (2022). A sustainable University: Digital Transformation and Beyond. *Education and Information Technologies*, *27*(7), 8961–8996. https://doi.org/10.1007/s10639-022-10968-y

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA Statement. *Open Medicine*.

Momen, N., Hatamian, M., & Fritsch, L. (2019). Did App Privacy Improve After the GDPR? *IEEE Security & Privacy*, *17*(6), 10–20. https://doi.org/10.1109/MSEC.2019.2938445

Munn, Z., Stone, J. C., Aromataris, E., Klugar, M., Sears, K., Leonardi-Bee, J., & Barker, T. H. (2023). Assessing the risk of bias of quantitative analytical studies: Introducing the vision for critical appraisal within JBI systematic reviews. *JBI Evidence Synthesis*, *21*(3), 467–471. https://doi.org/10.11124/JBIES-22-00224

Murdoch, B., Jandura, A., & Caulfield, T. (2023). Reconsenting paediatric research participants for use of identifying data. *Journal of Medical Ethics*, *49*(2), 106–109. https://doi.org/10.1136/medethics-2021-107958

Oh, A., Abazeed, A., & Chambers, D. A. (2021). Policy Implementation Science to Advance Population Health: The Potential for Learning Health Policy Systems. *Frontiers in Public Health*, *9*, 681602. https://doi.org/10.3389/fpubh.2021.681602

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, n71. https://doi.org/10.1136/bmj.n71

Petticrew, M., & Roberts, H. (2006). *Systematic Reviews in the Social Sciences: A Practical Guide* (1st edn). Wiley. https://doi.org/10.1002/9780470754887

Polin, K., Yigitcanlar, T., Limb, M., & Washington, T. (2023). The Making of Smart Campus: A Review and Conceptual Framework. *Buildings*, *13*(4), 891. https://doi.org/10.3390/buildings13040891

Powell, D., & Godfrey, A. (2023). Considerations for integrating wearables into the everyday healthcare practice. *Npj Digital Medicine*, *6*(1), 70, s41746-023-00820-z. https://doi.org/10.1038/s41746-023-00820-z

Prinsloo, P., & Kaliisa, R. (2022). Data privacy on the African continent: Opportunities, challenges and implications for learning analytics. *British Journal of Educational Technology*, *53*(4), 894–913. https://doi.org/10.1111/bjet.13226

Prinsloo, P., & Slade, S. (2015). Student privacy self-management: Implications for learning analytics. *Proceedings of the Fifth International Conference on Learning Analytics And Knowledge*, 83–92. https://doi.org/10.1145/2723576.2723585

Raciti, C. G., Enane, L. A., MacDonald, K. R., Whipple, E. C., Ott, M. A., & McHenry, M. S. (2021). Ethical considerations for research involving pregnant women living with HIV and their young children: A systematic review of the empiric literature and discussion. *BMC Medical Ethics*, *22*(1), 38. https://doi.org/10.1186/s12910-021-00601-x

Ruotsalainen, P., & Blobel, B. (2022). Transformed Health Ecosystems—Challenges for Security, Privacy, and Trust. *Frontiers in Medicine*, *9*, 827253. https://doi.org/10.3389/fmed.2022.827253

Seto, E., Challa, P., & Ware, P. (2021). Adoption of COVID-19 Contact Tracing Apps: A Balance Between Privacy and Effectiveness. *Journal of Medical Internet Research*, *23*(3), e25726. https://doi.org/10.2196/25726

Sobko, T., & Brown, G. (2019). Reflecting on personal data in a health course: Integrating wearable technology and ePortfolio for eHealth. *Australasian Journal of Educational Technology*, *35*(3). https://doi.org/10.14742/ajet.4027

Staffs, K. (2007). Guidelines for performing systematic literature reviews in software engineering. *Technical Report, Ver. 2.3 EBSE Technical Report. EBSE*, *January 2007*, 1–57.

Stockemer, D., & Sundström, A. (2025). Age Inequalities in Political Representation: A Review Article. *Government and Opposition*, *60*(1), 271–288. https://doi.org/10.1017/gov.2023.11

Stoilova, M., Livingstone, S., & Nandagiri, R. (2020). Digital by Default: Children's Capacity to Understand and Manage Online Data and Privacy. *Media and Communication*, *8*(4), 197–207. https://doi.org/10.17645/mac.v8i4.3407

Torgerson, C. (2003). *Systematic Reviews*. Bloomsbury Publishing.

Truong, T.-C., & Diep, Q. B. (2023). Technological Spotlights of Digital Transformation in Tertiary Education. *IEEE Access*, *11*, 40954–40966. https://doi.org/10.1109/ACCESS.2023.3270340

Turnbull, D., Chugh, R., & Luck, J. (2021). Transitioning to E-Learning during the COVID-19 pandemic: How have Higher Education Institutions responded to the challenge? *Education and Information Technologies*, *26*(5), 6401–6419. https://doi.org/10.1007/s10639-021-10633-w

Van Dijk, N., Tanas, A., Rommetveit, K., & Raab, C. (2018). Right engineering? The redesign of privacy and personal data protection. *International Review of Law, Computers & Technology*, *32*(2–3), 230–256. https://doi.org/10.1080/13600869.2018.1457002

Walkington, C., Nathan, M. J., Huang, W., Hunnicutt, J., & Washington, J. (2024). Multimodal analysis of interaction data from embodied education technologies. *Educational Technology Research and Development*, *72*(5), 2565–2584. https://doi.org/10.1007/s11423-023-10254-9

Watson, D., Mhlaba, M., Molelekeng, G., Chauke, T. A., Simao, S. C., Jenner, S., Ware, L. J., & Barker, M. (2023). How do we best engage young people in decision-making about their health? A scoping review of deliberative priority setting methods. *International Journal for Equity in Health*, *22*(1), 17. https://doi.org/10.1186/s12939-022-01794-2

White, J. P., Dennis, S., Tomko, M., Bell, J., & Winter, S. (2021). Paths to social licence for tracking-data analytics in university research and services. *PLOS ONE*, *16*(5), e0251964. https://doi.org/10.1371/journal.pone.0251964

Whiting, P., Wolff, R., Mallett, S., Simera, I., & Savović, J. (2017). A proposed framework for developing quality assessment tools. *Systematic Reviews*, *6*(1), 204. https://doi.org/10.1186/s13643-017-0604-6

Williamson, B. (2015). Algorithmic skin: Health-tracking technologies, personal analytics and the biopedagogies of digitized health and physical education. *Sport, Education and Society*, *20*(1), 133–151. https://doi.org/10.1080/13573322.2014.962494

Wu, J., Zhang, Q., Chung, L. Y. F., Wu, X., Jiao, R., Chen, Y., & Wang, Y. (2022). Healthcare provider's experiences of supporting breastfeeding: Protocol for a systematic review of qualitative evidence. *BMJ Open*, *12*(4), e056001. https://doi.org/10.1136/bmjopen-2021-056001