

From vision to practice: adoption of artificial intelligence in libraries across ASEAN

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ABSTRACT

This study examines the use of artificial intelligence (AI) in libraries across ASEAN countries, focusing on national strategic support, AI implementation, and key challenges and opportunities in the regional context. Using a content analysis approach based on the Technology Organisation Environment (TOE) framework, 115 official documents including national AI strategies, policy reports, and statements were analysed. AI applications were reviewed at the institutional level by selecting the top five universities in the QS World University Rankings in each ASEAN country. Singapore and Malaysia show strong support for AI policies, while Indonesia, the Philippines, Thailand, and Vietnam show moderate commitment with established national policies. Brunei, Cambodia, Laos, and Myanmar exhibit emerging support, with AI mentioned only within a broader digital agenda. In practice, libraries in Singapore, Malaysia, Indonesia, Thailand, the Philippines, and Vietnam have adopted AI technologies or developed AI-enabled services for research and patron engagement, supported by training and investment in infrastructure. The introduction of AI is limited or undocumented in Brunei, Laos, Cambodia, and Myanmar. Major challenges include uneven technical resources, data quality issues, lack of governance, talent shortages, and inadequate ethical guidelines. Opportunities exist in local innovation, regional collaboration, policy advocacy, and training to accelerate AI adoption. This is the first region-wide analysis linking ASEAN national AI policies to AI implementation in libraries. It provides cross-country insights and practical cases for policymakers, library professionals, and regional bodies, and serves as a strategic reference to drive AI integration across the region.

Keywords: Artificial Intelligence; Libraries; ASEAN; TOE Framework; National AI Strategy; AI Adoption.

INTRODUCTION

The digital age has profoundly transformed libraries into dynamic centres for knowledge management and information services. Artificial Intelligence (AI), with its advanced capabilities in data processing, pattern recognition, and intelligent decision-making, is widely recognised as a transformative force that can redefine library and information services, improve operational efficiency, and increase user engagement (Cox, 2021). From intelligent recommender systems and automated cataloguing to virtual reference chatbots and advanced knowledge discovery tools, AI is steadily permeating many aspects of library

operations, marking the advent of the "intelligent library" era (Cox, Pinfield, & Rutter, 2019; Asemi, Ko, & Nowkarizi, 2021). In this study, we use the term "AI technologies" to refer specifically to applications and systems that incorporate artificial intelligence techniques such as machine learning (ML), natural language processing (NLP), and computer vision (CV). The term "digital technologies" is used only when referring more broadly to information and communication technologies (ICTs) that may or may not include AI components.

In advanced economies, libraries are piloting AI-driven personalised services and automated subject indexing (Ikwuanusi, Adepoju, & Odionu, 2023; Suominen, Inkinen, & Lehtinen, 2022; Golub et al., 2024), supported by governments that increasingly regard AI as a strategic priority (Keith, 2024). Libraries therefore play an important role in AI-driven transformation. In the Association of Southeast Asian Nations (ASEAN), however, adoption is more uneven. Member states differ widely in economic development, infrastructure, cultural context, and policy-making capacity (Lu, 2024), shaping how AI is perceived, planned, and implemented. Understanding these disparities is essential for fostering collaborative growth and intelligent transformation across the ASEAN library ecosystem.

At the same time, such diversity presents unique opportunities. ASEAN countries are rich in cultural, linguistic, and artistic traditions, contributing to a broad spectrum of intangible heritage (The ASEAN, 2023, December 19). Libraries are central to these efforts, with professionals guiding the integration of AI to align technologies with institutional goals and user needs. Yet implementation remains inconsistent, often revealing a disconnect between ambitious national visions and practical realities (Isono & Prilliadi, 2023). Policies may articulate advanced plans, but concrete initiatives in libraries are scarce, and institutions face challenges including weak infrastructure, limited expertise, and cultural or ethical constraints.

While there is a relatively rich academic literature on AI applications in libraries in Western countries, in-depth research addressing the unique and diverse context of the ASEAN region remains significantly lacking. Few studies provide a systematic analysis linking policy strategies to concrete library practices, leaving progress and obstacles unclear. In particular, the Technology Organization Environment (TOE) framework has rarely been used to examine how national strategies translate into institutional adoption in the library sector. This study aims to address several significant gaps in the current literature. First, there is a lack of integrated investigations into AI applications in libraries across ASEAN countries. Most existing studies focus on individual countries or specific technologies, offering limited insight into regional commonalities and differences. Second, the relationship between national AI strategies and sector-specific implementation remains underexplored. While the literature often highlights what AI "can do" or "has done," it seldom examines how official visions are articulated, how they translate into library practices, or what barriers impede them. Finally, the unique challenges and opportunities shaping AI adoption in ASEAN libraries have not been adequately identified. Given the region's diversity in education, technology, and culture, these factors cannot simply be inferred from Western experiences. A deeper understanding of these barriers and growth pathways is essential for promoting collaborative development and sustainable transformation.

Accordingly, this study investigates the current state, challenges, and opportunities related to the application of AI in libraries across ASEAN countries. Specifically, it analyses national AI strategies and official reports to uncover policy intentions and strategic visions and examines practical cases of AI integration in libraries to illustrate domains of adoption. To this end, the study addresses the following two core research questions:

- 1) How do ASEAN countries demonstrate policy support and articulate development visions in their national AI strategies?
- 2) What are the specific domains and practical instances of AI adoption in libraries across ASEAN countries?

These questions align with the TOE framework: the first relates to the environmental dimension, assessing national policy contexts, while the second addresses the technological and organisational dimensions, examining deployed technologies and institutional capacities such as training, collaboration, and human resources. Building on these, the discussion considers key challenges and opportunities shaping AI adoption in the region's libraries.

LITERATURE REVIEW

Key applications of AI in library services

AI has become increasingly integral to modern library services, enhancing various operational and user-focused functions (Cox, 2022, 2025; Lund & Wang, 2023). Key applications include chatbots and virtual assistants, which provide real-time guidance and personalised recommendations while reducing staff workload (Panda & Chakravarty, 2022). Automated cataloguing and classification use machine learning to streamline metadata generation and improve retrieval accuracy (Mahmud, 2024). Recommender systems further enhance discovery by analysing user behaviour and suggesting relevant resources (Verma & Patnaik, 2024).

Beyond front-end services, AI supports predictive analytics to anticipate user needs and guide collection development (Ikwuanusi, Adepoju, & Odionu, 2023). It also enables digitisation and preservation of archival materials using image recognition and NLP, ensuring long-term accessibility and conservation of historical documents (Barlindhaug, 2022). AI also advances accessibility through speech recognition and text-to-speech technologies, broadening participation for users with disabilities (Raffoul & Jaber, 2023). These applications collectively contribute to the modernisation and increased efficiency of library operations.

Global trends in AI adoption in libraries

The past decade has seen significant growth in AI research and deployment in libraries worldwide. Islam et al. (2025) report a sharp increase in AI-related studies between 2010 and 2023, with China, the United States, and India among the most active contributors. Core applications include predictive analytics, NLP, and personalised recommendation systems (Balnaves et al., 2025), reflecting a global emphasis on improving discovery and user experience.

Emerging economies are increasingly adopting AI in libraries to bridge information access gaps and support educational development. Samuel, Vidza, and Addo (2025) highlight the role of AI in enhancing library services in universities across Africa, emphasising applications such as automated cataloguing and virtual reference services. Similarly, Barsha and Munshi (2024) indicate a growing trend of AI adoption in libraries within developing countries, driven by the need to improve service efficiency and user engagement.

Despite these advancements, global AI adoption in libraries faces challenges. Limited technical expertise among staff, concerns about data privacy and ethics, and high implementation costs remain common obstacles (Molaudzi & Ngulube, 2025).

Infrastructural disparities also lead to uneven adoption across regions. Addressing these issues requires international collaboration and knowledge sharing through conferences, cross-border projects, and open-access initiatives, which can accelerate capacity building in AI competencies.

AI-related research on libraries in the ASEAN region

The adoption of AI in libraries across Southeast Asia is progressing, though at varying rates among member countries. Xu and Loo (2025) note that chatbots, virtual assistants, and recommender systems are being introduced to improve user satisfaction and service efficiency. At the professional level, research identifies significant gaps in AI literacy. Subaveerapandiyan, Paladhi, and Maruthaveeran (2024) found that while LIS researchers in ASEAN demonstrate competence in some areas, weaknesses persist in ethical awareness, conceptual understanding, and programming skills. Barriers include limited resources and the lack of AI-focused curricula.

Country-level studies reveal diverse perspectives. In Indonesia, library leaders and practitioners express cautious optimism, citing the need for adequate infrastructure and training (Harisanty et al., 2024). A comparative study of librarians in Malaysia and Indonesia indicates that AI can support personalised learning and user engagement, with librarians in both countries reporting positive impacts of AI on tailoring education to individual needs, enhancing patrons' engagement with learning materials, and improving their understanding of concepts through AI-driven feedback mechanisms (Mutia et al., 2024). Collectively, these findings highlight both the promise of AI and the need for greater investment in literacy, infrastructure, and evaluation to ensure effective integration in ASEAN libraries.

The TOE framework and its application in the library context

The TOE framework, originally developed by Tornatzky and Fleischer (1990), explains how internal and external factors influence technology adoption. It identifies three dimensions: i) technological (advantages, compatibility, complexity); ii) organisational (resources, leadership, readiness); and iii) environmental (industry trends, regulation, competition). Building on this foundational model, Baker (2011) elaborated on the TOE framework's adaptability and relevance within information systems, demonstrating how the framework can be tailored to different technologies and sectors. This flexibility makes TOE a useful lens for analysing AI adoption in the library context.

Recent studies confirm its relevance. Technologically, Pinto et al. (2024) showed that compatibility and relative advantage strongly encourage AI adoption, while complexity has less influence. Organisationally, Molaudzi and Ngulube (2025) emphasised that strong leadership commitment and adequate resources are vital for AI adoption. Similarly, Jan, Khan, and Khan (2024) highlighted the importance of organisational readiness, indicating that libraries with supportive cultures and sufficient infrastructure are better positioned to implement AI technologies effectively. Environmentally, Pinto et al. (2024) found that government support, competitive pressure, and vendor partnerships have a strong and positive impact on AI adoption. By integrating these dimensions, the TOE framework provides a systematic lens to analyse how technological attributes, institutional capacities, and policy environments interact in shaping AI adoption, offering a robust foundation for investigating both the drivers and constraints of AI adoption in libraries.

METHODS

This study uses content analysis as its primary methodological approach to examine policy documents, official reports, and public statements, capturing both explicit content and underlying meanings (Drisko & Maschi, 2016). This method provides a coherent account of AI adoption by tracing the progression from policy development to practical implementation and its associated issues. To guide interpretation, the study adopts the TOE framework (Tornatzky & Fleischer, 1990), which offers a structured lens to categorise policy intentions and practices, and to identify key challenges and opportunities. Combining content analysis with the TOE framework enhances the explanatory power of the study, enabling a comprehensive understanding of the factors shaping AI adoption in libraries.

Data collection and selection

This study relies primarily on publicly accessible official documents, carefully selected through a rigorous sampling strategy. In this context, “official” refers to documents formally released by national government bodies, ministries, or recognised regional institutions, available on their official websites or through government open-data portals. Sources included ministry websites, ASEAN official archives, and verified policy repositories. Only the most recent and complete AI-related policy documents for each country were included; where multiple documents existed, all relevant ones were reviewed, and where no AI-specific document was available, the closest national digital or ICT strategy was included. The deliberate focus on official policy documents and public reports reflects the study’s emphasis on exploring established AI strategic visions, government-supported applications, and the associated challenges and opportunities, rather than relying on subjective perceptions or unpublished internal data.

Given the diverse information landscapes across ASEAN member states, a multi-pronged sampling approach was used to ensure both representativeness and data accessibility. First, the study adopted a systematic filtering workflow inspired by the PRISMA framework. Using the search terms “AI + Strategy + Country name,” relevant national AI strategies and supporting documents were retrieved via Google.com and Bing.com. The initial search yielded 210 documents relating to national AI strategies and related policy documents. Second, the collected documents were screened based on the following exclusion criteria: (i) documents not officially published by national governments or regional institutions; (ii) blog posts, news articles, or informal publications that do not represent official positions or records; and (iii) outdated documents published before 2016. After applying these criteria, 64 reports were excluded. The content of the remaining reports was then further examined to assess their relevance to the research objectives. Documents that discussed technology only in general terms without specific reference to AI or its subfields were excluded. Additionally, as not all ASEAN countries publish their AI-related reports in English, translation software was used to process non-English materials. However, reports found to be incomplete or inconsistent after translation were also excluded (n=31). After this final screening, 115 documents were selected as the primary data corpus for this study. Figure 1 provides a visual representation of the data collection and selection workflow described above.

To address the second research question, the study also examined institutional-level applications of AI by selecting the top five universities in each ASEAN country according to the QS World University Rankings. Where fewer than five universities were listed, or where a country did not participate in the QS rankings, nationally recognised rankings were used. This criterion ensured the inclusion of academic institutions likely to be at the forefront of

technological adoption. To further enrich the dataset and mitigate potential information asymmetries, a supplementary keyword-based search strategy was implemented, targeting AI applications in libraries across the ASEAN region. This involved the strategic use of English search terms such as “AI,” “artificial intelligence,” “machine learning,” “natural language processing,” “recommender system,” “chatbot,” “smart,” and “intelligent,” in combination with “library” and specific country names (e.g., “AI + library + Singapore”). This supplementary search helped to identify additional cases, especially from public libraries, and thus provided a broader understanding of the current state and diversity of AI adoption in the region.

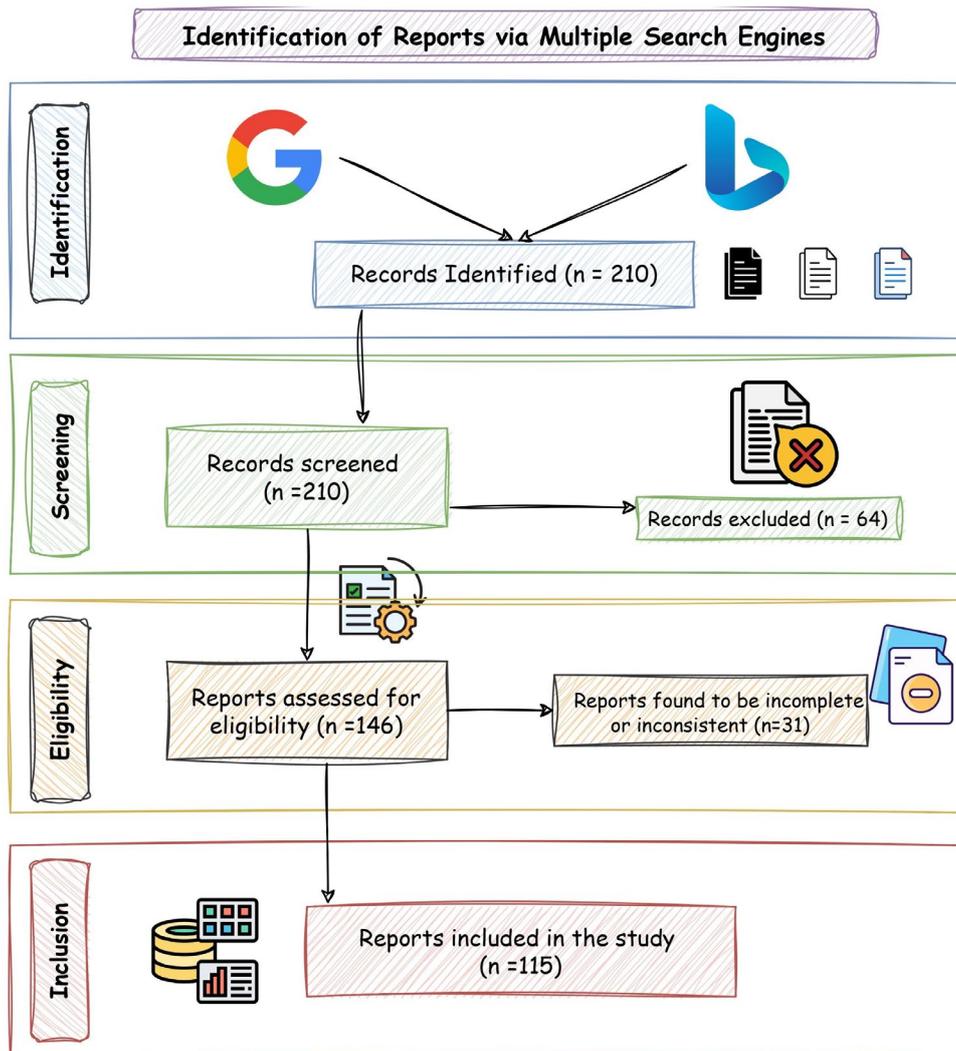


Figure 1: Workflow for data collection and selection

Data analysis

The analysis used a straightforward content analysis approach, guided by categories from the TOE framework and the specific focus of each research question. A deductive content analysis was conducted, with the three main TOE categories - Technological, Organisational, and Environmental - serving as predefined coding dimensions. Within each category, sub-themes were identified inductively to capture recurring patterns and country-specific nuances. Two researchers independently reviewed and coded all 115 documents. Any coding discrepancies were discussed and resolved by consensus to ensure interpretive

consistency. Although no formal statistical measure of inter-coder reliability was calculated, this collaborative review process helped maintain transparency and minimise subjective bias.

For Research Question 1, the analysis identified and categorised official policy documents and public reports collected from ASEAN member states. Based on the publication of AI strategies, supporting frameworks, and regulatory documents, countries were grouped into three categories of policy support: high-support environments, medium-support environments, and emerging-support environments. Within each group, national strategy documents were analysed collectively. To complement this content interpretation, keyword frequency analysis was conducted, and word clouds were generated to visualise the core thematic focuses of AI strategies, while also reflecting differing AI development priorities across varying levels of environmental support.

For Research Question 2, the aim was to identify concrete cases of AI implementation in libraries. This required a detailed examination of descriptions in the collected documents concerning real-world AI projects, pilot programmes, or integrated AI-enabled services. Each identified case was systematically recorded, including the specific AI technology deployed, the targeted area of library operations, and any reported outcomes or perceived benefits. This stage of analysis is directly linked to the technological and organisational dimensions of the TOE framework, deepening our understanding of AI implementation in practice and providing the basis for subsequent discussion of potential challenges and opportunities.

Throughout the analytical process, we maintained a strict focus on the explicit language used in the documents to ensure that all interpretations remained grounded in both the source material and the theoretical framework. This approach enhanced the overall reliability and validity of the findings. For tools, we used Python for text processing and visualisation. Specifically, we used libraries such as NLTK, Pandas, NumPy, PyMuPDF, and Scikit-learn for data preprocessing and textual analysis, including n-gram modelling. For data visualisation, we used matplotlib, plotly, and seaborn to generate graphical representations such as word clouds, radar charts, and peak distribution graphs. Figure 2 shows the steps involved in text preprocessing and subsequent visualisation generation.

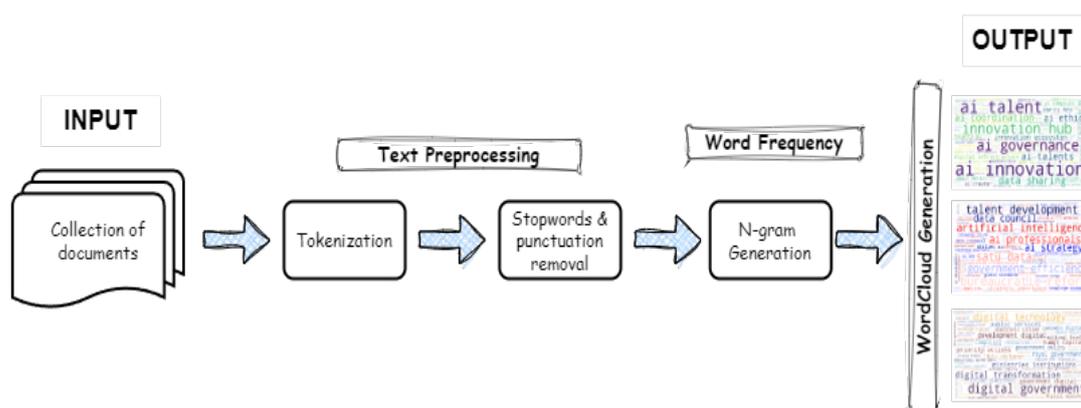


Figure 2: The process of text preprocessing and visualization generation

RESULTS

i. Policy intentions and strategic guidance for AI in ASEAN countries

This subsection addresses Research Question 1 and corresponds to the environmental dimension of the TOE framework, examining how national policy environments influence AI adoption in libraries. We analyse national AI strategies and related official documents from ASEAN member states (Appendix 1), grouping them into High-, Moderate-, and Emerging-support environments based on the extent of policy support. Figure 3 shows the number of supplementary AI-related documents in addition to the main strategies.

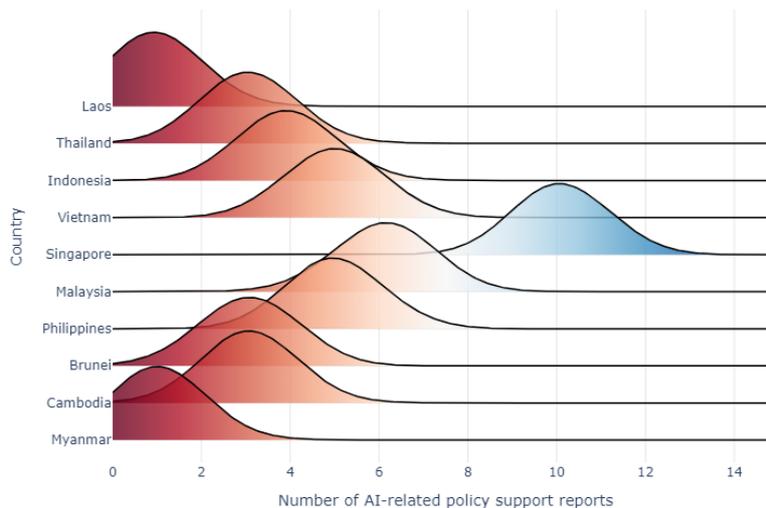


Figure 3: Ridge plot of the supplementary AI-related policy support documents

a) High-support environments: Singapore and Malaysia

Singapore and Malaysia lead the region with early strategies and comprehensive follow-up frameworks. Singapore released its first National AI Strategy (NAIS) in 2019, followed by NAIS 2.0 in 2023, and by 2024 had published more than a dozen documents covering AI ethics, governance, sectoral applications, data privacy, cybersecurity, and generative AI. Its Model AI Governance Framework (2020, updated in 2024 for GenAI) is widely recognised as a global best practice, reflecting a policy environment that balances innovation with risk management.

Malaysia's National AI Roadmap 2021–2025 is supported by several 2024 initiatives, including the National Guidelines on AI Governance and Ethics and the AI Talent Roadmap 2024–2030. These focus on workforce development, ethical principles, and public outreach (e.g., AI untuk Rakyat). The establishment of the National AI Office further consolidates governance. Although these policies are national in scope, they have implications for libraries in developing AI competencies, establishing ethical service standards, and promoting inter-institutional collaboration.

Figure 4 shows the word cloud generated from the AI strategy documents of these high-support environments, highlighting recurring keywords that reflect core priorities and strategic orientations. Notably, terms such as "AI innovation," "AI talent," "AI governance," and "data sharing" feature prominently, indicating a strong emphasis on fostering an innovation-driven ecosystem supported by skilled human capital and robust regulatory frameworks. The prominence of "innovation hub" and "digital infrastructure" further demonstrates a clear intent to position these countries as regional AI leaders through coordinated infrastructure development and cross-sectoral collaboration. The inclusion of

terms like "AI ethics" and "international partnership" also indicates a forward-looking and globally connected approach that aims to balance technological advancement with responsible governance.



Figure 4: Word cloud of high-frequency terms in AI strategy reports from high-support environments

b) Moderate-support environments: Indonesia, Philippines, Thailand, and Vietnam

Indonesia, the Philippines, Thailand, and Vietnam have all issued national AI strategies within the past five years, but with only moderate supplementary instruments. Indonesia’s Stranas KA 2020–2045 was supplemented by three major policy documents in 2023, including the MOCI AI Ethical Guidelines and a presidential regulation on digital transformation. The Philippines has published its National AI Strategy Roadmap – NAISR 1.0 (2021) and NAISR 2.0 (2024), accompanied by three policy instruments between 2023 and 2024. Thailand published its national AI strategy in 2021 and has issued two additional guidelines: one on AI ethics (2021) and another specifically for generative AI governance (2024). Vietnam’s National Strategy on AI R&D and Application to 2030 (2021) is supported by the National Digital Transformation Programme (through 2025).

Figure 5 highlights recurring terms such as "AI professionals," "talent development," and "AI strategy," indicating that workforce capacity-building and strategic planning remain central themes in these countries. Additionally, keywords like "bureaucratic reform," "government efficiency," and "data council" reflect efforts to align AI adoption with broader goals of administrative modernisation and digital governance. The visibility of “Satu Data” (Indonesia’s national data integration initiative), along with terms like “strategic importance” and “global standards,” demonstrates a growing emphasis on building coherent data governance frameworks, promoting standardised practices, and fostering cross-sectoral coordination as foundational elements of AI strategy. Overall, these countries emphasise foundational capacity, policy alignment, and institutional coordination as prerequisites for deeper AI integration.

ii. AI applications and implementation status in libraries across ASEAN countries

This subsection addresses Research Question 2, examining the specific AI technologies adopted in libraries across ASEAN and the institutional capacities supporting their use. Compared to the policy landscape, adoption remains uneven and largely at an early stage. Based on institutional reports, official announcements, and national developments, three main patterns emerge: early adoption in select institutions, experimental pilot projects, and limited or no systematic application in others. Table 1 summarises current initiatives.

Table 1: Current AI-related applications and implementations in libraries across ASEAN

Country	Source	Title	Release date
Singapore	National University of Singapore	AI-Driven Library Recommender System	2021
	Nanyang Technological University	TEMI - the robot	2022
	Singapore Management University	Scopus AI	2025
	Singapore Management University	Undermind.ai	2024
	National Library Board, Singapore	ChatBook	2023
	National Library Board, Singapore	StoryGen	2024
	National Library Board, Singapore	Glue: Curiosity	2024
	National Library Board, Singapore	Playbrary	2024
Malaysia	Universiti Malaya	Collaboration with Alibaba Cloud	2024
	Universiti Putra Malaysia	Scopus AI	2025
	Universiti Kebangsaan Malaysia	Scopus AI	2025
	Universiti Teknologi Malaysia	TheWhizWrite	2024
Indonesia	Universitas Indonesia	Trinka AI	2024
	Universitas Indonesia	Scopus AI	2025
	Institut Teknologi Bandung	Trinka AI	2025
	Gadjah Mada University	Scopus AI	2024
Thailand	Chulalongkorn University	Chula AIX	2024
	Mahidol University	Trinka AI	2024
	Mahidol University	Enago Report	2024
	Mahidol University	Enago Read	2024
	Thammasat University	Subscribe to AI services for 4 platforms	2024
Vietnam	Hanoi University of Science and Technology	AI4LIFE	2024
Philippines	University of the Philippines	Scopus AI	2024
	Ateneo de Manila University	Scopus AI	2024
	University of Santo Tomas	BiblioTech AI Library	2023

a) AI-supported research discovery and writing assistance

AI-driven discovery platforms and writing assistants have become a major entry point for integrating AI into academic library services across ASEAN. These tools enhance research workflows by facilitating access to scholarly literature and supporting academic writing. “Scopus AI”, developed by Elsevier, serves as a generative-AI research assistant embedded within the Scopus citation database. As of 2024, it has been adopted by seven institutions in the region, including Singapore Management University, Universitas Indonesia, Universitas Gadjah Mada, Universiti Putra Malaysia, Universiti Kebangsaan Malaysia, the University of the Philippines, and Ateneo de Manila University. Launched in January 2024, Scopus AI

assists users by summarising, contextualising, and synthesising academic content, supporting the initial phases of literature review and topic exploration. “Trinka AI” has also been implemented at Universitas Indonesia, Institut Teknologi Bandung, and Mahidol University. Designed to support academic, technical, and formal writing, Trinka AI provides assistance beyond conventional grammar and spelling checks. It enhances clarity and precision and ensures alignment with academic standards and conventions.

The SMU Library in Singapore piloted “Undermind.ai”, an AI-powered research assistant designed to help users navigate complex academic literature. Undermind employs large language models, such as GPT-4, to perform in-depth reasoning and iterative analysis across scientific databases. Its agent-based approach simulates the structured inquiry of human researchers by following citation trails and refining search strategies based on emerging findings. At Mahidol University, the library has introduced “Enago Read” and “Enago Report” to support both literature engagement and writing quality. Enago Read assists researchers by providing AI-generated summaries, highlighting key insights, and facilitating more efficient literature analysis. Enago Report offers tools to evaluate and improve academic and professional documents, focusing on language quality, content integrity, and compliance with publication standards.

In June 2024, the Universiti Teknologi Malaysia (UTM) Library launched “TheWhizWrite”, an AI-powered thesis assistance module as part of its User Education Programme. This initiative supports students throughout the thesis-writing process by offering guidance on complex writing tasks, immediate feedback on grammar and structure, and access to relevant resources. The programme aims to enhance students’ writing efficiency and improve the quality of their academic output. Together, these applications reflect a growing institutional commitment to leveraging AI technologies for research discovery and academic writing, positioning libraries as active facilitators of scholarly productivity in the digital age.

b) AI-enhanced patron services and user interaction

While academic libraries in the ASEAN region increasingly prioritise AI applications in research support, national and public libraries have also made progress in exploring generative AI interfaces, chatbots, and location-aware discovery tools to enhance engagement with broader and more diverse user groups.

AI-driven recommender system

In 2021, the National University of Singapore (NUS) Libraries launched an AI-driven recommender system integrated into its unified search portal, “FindMore”. This system uses a hybrid recommendation algorithm that draws from three core data sources: natural-language features derived from users and their queries, metadata and descriptive information of library holdings, and historical transaction records reflecting user-item interactions. In real time, the model returns a ranked list of alternative or complementary items alongside standard search results, diversifying the range of materials surfaced. In addition, a weekly email recommender generates personalised suggestions tailored to user preferences, profiles, and borrowing histories.

Smart robotic assistant

In 2022, Nanyang Technological University (NTU) Library piloted “Temi”, a smart robotic assistant capable of providing directional guidance, responding to frequently asked questions, and connecting patrons via video calls to NTU librarians. This initiative marked early experimentation with embodied AI to facilitate on-site library navigation and service access.

Generative AI-based applications

The National Library Board (NLB) of Singapore has led several generative AI projects. In 2023, NLB launched “ChatBook”, a prototype that enables patrons to converse with curated historical texts through a generative-AI interface, while “StoryGen” (released in 2024) facilitates creative storytelling with AI-generated illustrations. Meanwhile, “Glue: Curiosity” integrates geospatial data with gamified exploration of archival content, and “Playbrary” reimagines classic literature as interactive games where users shape narratives through AI-driven choices. Collectively, these projects expand how patrons interact with cultural heritage and literary resources.

Together, these initiatives illustrate how AI technologies are reshaping library-patron interaction across diverse contexts, from academic discovery to public engagement, reinforcing the evolving role of libraries as digitally augmented cultural institutions.

c) AI training, cross-institutional collaboration, infrastructure readiness

An increasing number of academic libraries have adopted a preparatory approach to AI integration by prioritising staff and student training, fostering institutional partnerships, and investing in digital infrastructure, even without fully operational AI services. These foundational efforts are essential for enabling future innovation as policy alignment and funding mechanisms develop.

In Malaysia, the Universiti Malaya (UM) Library partnered with Alibaba Cloud through the Alibaba Cloud Academic Empowerment Program (AAEP) in 2024. The collaboration included workshops, cloud-based AI services, new curricula, and the establishment of an AI Skills Centre and internship program, enhancing digital competencies for staff and students. In Singapore, cross-institutional collaboration has also gained momentum. The NUS partnered with AI Singapore to develop applications such as an AI-driven recommender system. The NLB worked with Open Government Products (OGP) to co-develop “Glue: Curiosity” and collaborated with LePub Singapore on “Playbrary”. These collaborations exemplify how public and academic institutions can co-create user-focused AI innovations by combining domain expertise and technological capacity. In Thailand, Chulalongkorn University launched Chula AIX in 2024 as an “AI sandbox” offering tools such as ChatGPT, Claude, Gemini, QuillBot, and MidJourney via GPU-enabled cloud infrastructure. Similarly, Thammasat University Library subscribed to four AI platforms (Grammarly Pro, Gemini Advanced, Claude AI Pro, and ChatGPT-4o), available at library workstations for students and staff.

In Vietnam, the Hanoi University of Science and Technology (HUST) established the AI4LIFE Institute within the Ta Quang Buu Library. AI4LIFE is envisioned as a multidisciplinary research hub that fosters collaboration between academic institutions, government agencies, and industry partners. In the Philippines, the Miguel de Benavides Library at the University of Santo Tomas, in collaboration with the College of Information and Computing Sciences (CICS), launched BiblioTech Ai Library in 2023. This satellite library provides access to essential academic resources alongside recreational elements, encouraging both academic and leisure engagement among students. At Universitas Indonesia (UI), the library's research team has leveraged Google Lens's deep-learning Optical Character Recognition (OCR) to digitize traditional Chinese ancient manuscripts. This initiative allows for the accurate recognition and extraction of classical Chinese characters, thereby facilitating the translation and preservation of rare textual materials within the collection.

Figure 7 compares AI adoption across ASEAN libraries in the three domains. In research discovery and writing assistance, Thailand, Malaysia, and Indonesia show diverse applications, while Singapore emphasizes locally developed solutions, reflecting strong innovation capacity. In patron services, Singapore demonstrates the most comprehensive deployment, with Malaysia, Thailand, and Indonesia showing moderate progress. In training, collaboration, and infrastructure, Singapore, Malaysia, and Thailand have invested consistently in staff development, digital infrastructure, and institutional partnerships—key foundations for sustainable AI integration. Vietnam and the Philippines also show growing interest, while Indonesia performs relatively well in institutional collaboration, indicating momentum for regional partnerships.

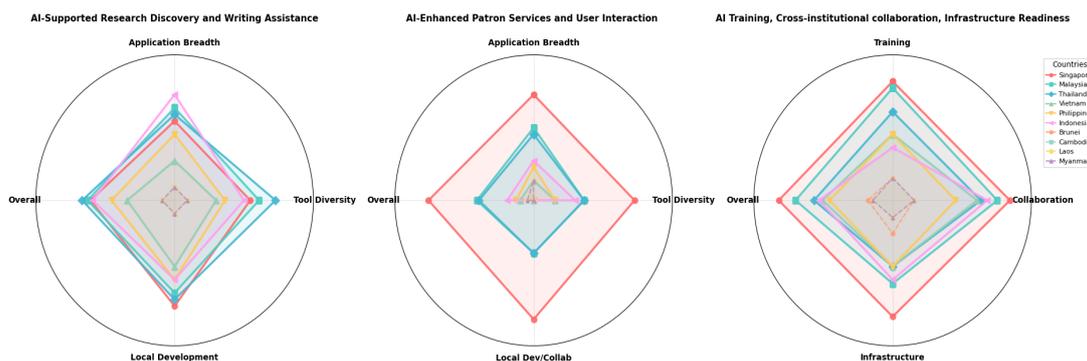


Figure 7: Comparative radar charts of AI adoption in libraries across ASEAN countries

However, a review of available official sources indicates that, as of mid-2025, Brunei, Laos, Cambodia, and Myanmar have not documented any explicit deployments of AI in their libraries. Although AI has been identified as a national strategic priority in most of these countries, its practical implementation in library contexts remains at a very early stage or is unreported.

DISCUSSIONS

This discussion extends the analysis of the research findings using the three dimensions of the TOE framework and further examines the key challenges and opportunities influencing AI adoption in libraries across the ASEAN region. Our analysis reveals significant variation across the region. Singapore and Malaysia represent high-support environments, supported by comprehensive strategies and extensive policy instruments. Indonesia, the Philippines, Thailand, and Vietnam occupy a moderate tier, having issued formal AI strategies but with limited complementary guidelines. Brunei, Cambodia, Laos, and Myanmar remain in the emerging category, with limited or no dedicated AI policies. In terms of implementation, universities in Singapore, Malaysia, Indonesia, Thailand, and the Philippines have adopted AI tools such as Scopus AI, Trinka AI, Undermind.ai, and Enago Read for research support. Public institutions such as the NLB in Singapore have pioneered user-facing generative AI applications, including ChatBook, StoryGen, Glue: Curiosity, and Playbrary, to enhance patron engagement. In other ASEAN countries, libraries are prioritising preparatory efforts in training, partnerships, and infrastructure, laying the groundwork for broader deployment.

i. Key challenges by TOE dimensions

Building on the findings, which revealed substantial variation in policy support and implementation readiness across ASEAN libraries, we discuss the underlying challenges

using the TOE framework. This approach enables us to disentangle the technological, organisational, and environmental factors that collectively shape the pace and scope of AI adoption in the region.

a) Technology

From a technological perspective, the maturity and accessibility of AI tools have driven early adoption in research-focused institutions. Commercial platforms such as Scopus AI and Trinka AI provide accessible NLP and writing support, while pilot projects like Undermind.ai and Enago Read show the potential of large language models in academic research. These tools are available via subscription or institutional licensing, reducing barriers to entry. In contrast, self-developed systems such as AI-driven recommender systems require significant computational resources, including GPUs and robust cloud services, which are unevenly distributed across the region. Data quality and standardisation remain persistent challenges. AI discovery and recommendation systems rely on structured metadata and complete user logs. Inconsistent formats across institutions hinder interoperability and reduce accuracy, necessitating continual model adjustments. OCR projects also encounter difficulties with non-standardised scripts and deteriorated materials, which require complex preprocessing and manual correction. Although algorithms are increasingly mature, broader implementation depends on improving metadata quality and infrastructure access.

b) Organization

Organisational readiness strongly influences adoption. Institutions with clear governance structures progress more rapidly from pilots to full deployment. For example, the NLB's collaborations with digital government agencies and private firms have enabled streamlined project management, allowing NLB to iterate quickly on projects such as ChatBook and StoryGen. Similarly, universities like SMU have established steering groups to oversee Scopus AI trials, ensuring alignment with strategic goals and user needs. In contrast, smaller libraries or those with less robust administrative structures often lack the internal expertise or clear leadership to advance AI projects beyond the conceptual stage. Staffing and governance remain persistent constraints. Most libraries have not created "AI librarian" positions or formalised AI teams. Consequently, AI projects often rely on seconded faculty or AI specialists. We observed that in institutions without a clear governance structure, initial enthusiasm for AI trials gradually dissipated, and projects stagnated without consistent leadership.

Human capital is another constraint. While some universities recruit data scientists or collaborate with computer science departments, many libraries lack staff trained in ML, data management, or ethical oversight. Initiatives such as Universiti Malaya's partnership with Alibaba Cloud help build capacity, but region-wide training remains uneven. Effective adoption requires change management, staff development, and clear communication to ensure librarians view AI as a complementary tool rather than a threat.

c) Environment

National policy environments create both opportunities and uncertainty. Many ASEAN states have issued AI ethics guidelines, but none are tailored to the library sector. The 2024 release of the ASEAN Guide on AI Governance and Ethics and its expanded Guide for Generative AI provide general principles such as fairness, transparency, and data privacy. However, the absence of sector-specific guidance leaves library practitioners uncertain about how to address critical issues such as user privacy, data ownership, and algorithmic bias.

For example, librarians face challenges in balancing open access with copyright restrictions when digitising cultural heritage materials using OCR technologies. This regulatory ambiguity can delay or halt AI projects, as institutions seek to avoid non-compliance with emerging data protection laws. Concerns about the accuracy and potential harms of AI-generated content (AIGC) further complicate implementation. In practice, libraries rely on broad ethical principles that may not fully address the nuances of library-specific scenarios, such as maintaining user anonymity in circulation records or responding to community sensitivities surrounding AIGC.

In addition, regional cooperation mechanisms remain insufficient. Although ASEAN has promoted digital integration and collaborative AI research, there is no dedicated platform or institutional mechanism focused on library-specific AI initiatives. Furthermore, the absence of a region-wide mechanism for sharing curated datasets, pre-trained models, and multilingual training resources limits collective progress. This gap is particularly evident in countries such as Cambodia, Laos, and Myanmar, where libraries often operate in isolation, lacking access to technical expertise and external partnerships. While some libraries in Singapore and Malaysia have successfully partnered with corporations and government bodies, their counterparts in less connected countries are unable to leverage their rich cultural and linguistic resources, such as ancient manuscripts, oral traditions, and indigenous knowledge, for AI research. The lack of a shared forum to connect resource-rich but under-connected institutions with better-resourced partners represents a missed opportunity to harness regional diversity for the development of culturally inclusive AI models.

These challenges must be understood within the distinctive socio-cultural and economic context of ASEAN. The region's linguistic diversity, varying levels of ICT readiness, and strong mandates for cultural heritage preservation shape both the feasibility and desirability of AI adoption in libraries. In contrast to Western contexts, where digital infrastructure and standardised metadata frameworks are more uniformly established, ASEAN libraries often present a mixed landscape in which some institutions operate advanced AI pilot projects while others continue to face significant resource constraints, making regional cooperation and the development of culturally adaptive solutions particularly critical.

ii. Opportunities, strategic recommendations, and practical implications

While the preceding discussion highlights challenges, these factors also indicate potential areas for targeted intervention and growth. A coordinated and context-sensitive approach to AI integration can help ASEAN libraries turn these challenges into opportunities for sustainable development. Below, we present strategic recommendations in four interrelated areas: local innovation, regional collaboration, policy advocacy, and organisational training.

a) Local innovation

Libraries are encouraged to invest in developing or adapting open-source AI models tailored to local languages and content. By curating corpora in Khmer, Burmese, Javanese, and other regional languages, institutions can train OCR engines and NLP tools that more accurately reflect the linguistic and cultural nuances of their heritage collections. Lightweight, on-device AI solutions, particularly those based on edge computing, can help address bandwidth and connectivity limitations, which are especially relevant for under-resourced libraries. Collaboration with computer science departments and local universities can support the creation of small-scale prototypes, such as multilingual OCR pipelines or thematic clustering tools, which can serve as foundational elements for broader services.

Crucially, these innovations should be guided by librarians and cultural experts to ensure that technology supports, rather than overrides, local knowledge structures.

b) Regional collaboration mechanisms

Given the rich cultural and linguistic diversity across ASEAN, the formation of a cross-national “Library AI Consortium” or “Shared Data Platform” would enable resource pooling and collaborative innovation. Within such a framework, technologically advanced institutions in Singapore, Malaysia, and Indonesia could contribute pretrained models and computational infrastructure, while libraries in Cambodia and Myanmar could provide digitised heritage materials and domain-specific expertise. Joint activities such as model training workshops and collaborative seminars would support the refinement of AI technologies for cultural relevance and ethical alignment. Regular “ASEAN Library AI Symposiums” could provide ongoing opportunities for librarians, technologists, and policymakers to exchange insights on best practices, data governance, and user engagement. Such institutionalised networks would not only accelerate AI adoption in emerging environments but also promote shared protocols and interoperability standards, strengthening regional trust and cohesion.

c) Policy advocacy and sector standards

To address the lack of library-specific ethical guidelines, we recommend that national libraries establish working groups comprising experts from cultural institutions, legal bodies, and academia to develop a “Library AI Ethics and Privacy Framework”. This document would adapt ASEAN’s general AI ethics guidelines to the specific needs of library contexts, clarifying issues such as anonymisation of circulation data, consent procedures for AI-driven interactions, and protocols for preserving cultural integrity in generative outputs. Advocacy should also seek formal recognition of “Library AI” within national digital strategies, unlocking funding and institutional support.

d) Organisational and training strategies

We recommend that libraries establish an AI coordination unit responsible for overseeing project scoping, vendor negotiations, and cross-departmental communication. Creating an “AI Librarian” position would help institutionalise knowledge of AI technologies and practices, ensuring continuity and internal expertise. At the same time, we encourage libraries to develop tiered training programmes that progress from basic AI awareness to advanced workshops on model evaluation and ethical considerations. Embedding these curricula into regular professional development cycles will gradually raise collective AI literacy and skills.

CONCLUSIONS

This study examined the development strategies and current state of AI adoption in libraries across ASEAN countries. Grounded in the TOE framework, it analysed national AI strategies and supporting policy documents, supplemented by institutional cases of AI deployment in academic and public libraries. The analysis focused on two key dimensions: policy support at the national level and concrete applications implemented in library settings, while also identifying challenges and opportunities shaping the trajectory of AI adoption.

Our findings reveal three tiers of policy environments: high-support countries such as Singapore and Malaysia, with comprehensive AI strategies and multiple complementary guidelines; moderate-support countries including Indonesia, the Philippines, Thailand, and

Vietnam, with formal strategies but limited supporting instruments; and emerging-support countries such as Brunei, Cambodia, Laos, and Myanmar, where AI is referenced mainly within broader digital agendas. At the implementation level, libraries in several countries have adopted AI tools for literature discovery, academic writing assistance, and patron services. Public libraries, particularly Singapore's NLB, have piloted generative AI initiatives that expand user interaction with cultural and literary resources. Other institutions have prioritised training, partnerships, and infrastructure investment, signalling preparatory efforts for wider adoption.

This research makes several contributions. Theoretically, applying the TOE framework to the library context illuminates how technological maturity, organisational capacity, and environmental support interact to influence AI adoption. Practically, the case descriptions and cross-national comparisons provide libraries and policymakers with valuable insights into the diverse trajectories of AI implementation across ASEAN. The purpose is not to rank or compare countries competitively, but to offer clear reference points for institutional learning and strategic planning. Based on these insights, we offer actionable recommendations, including fostering local innovation, creating a regional consortium for shared resources, advocating for library-specific ethical guidelines, and institutionalising AI training within professional development frameworks.

Nevertheless, this study has limitations. Relying primarily on official documents may have overlooked unpublished projects or internal initiatives, and the absence of primary data from interviews, surveys, or direct observation limits insights into the lived experiences of librarians and users. Future research should address these gaps through fieldwork and quantitative assessment of AI tool performance to capture evolving practices and impacts more comprehensively.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest related to the publication of this paper. One author is a joint editor of this journal. To prevent any potential conflict of interest, this author was not involved in the review or editorial decision-making process for this article.

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Appendix 1: Summary of national AI/ICT/digital strategy reports

Country	Official releasing body	Main strategy report	Document type	Release date	Supporting policy document
Singapore	Smart Nation and Digital Government Office (SNDGO)	National AI Strategy 1.0 (NAIS 1.0); National AI Strategy 2.0 (NAIS 2.0)	National AI Strategy	2019, 2023	Model AI Governance Framework (2020 released); Model AI Governance Framework for Generative AI (2024 released); Public Sector AI Playbook (2024 released); Responsible AI Playbook (2024 released); Guidelines and Companion Guide on Securing AI Systems (2024 released); Advisory Guidelines on use of Personal Data in AI Recommendation and Decision Systems (2024 released); Artificial Intelligence in Healthcare Guidelines (2021 released); Artificial Intelligence (AI) Model Risk Management (2024 released); Proposed Guide On Synthetic Data Generation (2024 released); AI Ethics & Governance Body of Knowledge Version 2.0 (2024 released); Cyber Security Agency of Singapore Guidelines and Companion Guide on Securing AI Systems (2024 released)
Malaysia	Ministry of Science, Technology and Innovation (MOSTI)	Malaysia National Artificial Intelligence Roadmap 2021-2025	National AI Strategy	2021	Artificial Intelligence Nexus 2024 - Malaysia Artificial Intelligence Consortium (2024 released); AI Talent Roadmap (2024-2030) (2024 released); AI untuk Rakyat (2024 released); The National Guidelines on AI Governance and Ethics (2024 released); MOCI- circular letter no. 9 of 2023 on AI Ethical Guidelines (2023 released); Financial Services Authority (OJK) Ethical Guidelines on Responsible and Trustworthy AI in the Financial Technology; Presidential Regulation No. 82/2023 on Accelerating Digital Transformation and Integration of National Digital Services;
Indonesia	National Research and Innovation Agency - Kemenristek / BRIN	National Artificial Intelligence Strategy - Stranas KA (2020-2045)	National AI Strategy	2020	Principles and guidelines for the ethical and trustworthy use of AI in the government (2024 released); DPA Digital Digest: Philippines (2024 released); Artificial Intelligence (AI) Regulation Act (HB 7913) including AI authority governance (2023 released)
Philippines	The Department of Trade and Industry (DTI)	National AI Strategy Roadmap 1.0; National AI Strategy Roadmap 2.0	National AI Strategy	2021, 2024	

From vision to practice: adoption of artificial intelligence in libraries

Thailand	Prime Minister's Cabinet Office	National AI Strategy and Action Plan (2022-2027)	National AI Strategy	2021	Digital Thailand - AI Ethics Guideline (2021 released); GenAI governance Guideline for organizations (2024 released)
Brunei	Authority for Information's Technology Industry of Brunei Darussalam	AITI Strategic Plan 2020 - 2025	National ICT Strategy	2020	Guide on AI Governance and Ethics for Brunei Darussalam (2024 released)
Vietnam	Ministry of Science and Technology - MOST	National Strategy on Artificial Intelligence R&D and Application through 2030	National AI Strategy	2021	National Digital Transformation Program until 2025, with a vision to 2030; Decision No. 749/QD-TTg 2020 national digital transformation program through 2025 (2020 released)
Cambodia	Ministry of Post and Telecommunications	Cambodia Digital Government Policy 2022-2035	Digital Government Policy	2022	AI Landscape in Cambodia: Current Status and Future Trends; Cambodia's Ethics of AI Readiness Assessment Advanced at Strategic Multi-stakeholder Consultation
Laos	Ministry of Technology and Communications	National Digital Economy Development Vision, Strategy, plan	National Digital Economy Development Strategy	2021	N/A
Myanmar	Digital Economy Development Committee	MYANMAR DIGITAL ECONOMY ROADMAP	Digital Economy Roadmap	2018	N/A
