Explaining healthcare AI adoption: A decade review of the ASEAN research landscape

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Abstract

Artificial intelligence (AI) is revolutionizing the world we live in. It holds significant promise for improving performance across various sectors. Researchers worldwide have been working on developing solutions that leverage this technology for application by diverse user groups. A key category of AI is healthcare AI; smart solutions designed to address the needs of various stakeholders in the sector, from medical practitioners to patients. Crucial for any AI deployment are good adoption rates from the intended users and support from key stakeholders. Therefore, understanding the factors that influence its adoption is essential. This paper aims to provide insights through a systematic literature review of research related to healthcare AI adoption. Specifically, it reports on research works from ASEAN countries published over the past decade, between 2014 and 2024, identified through a systematic search of the Lens.org database. The search string focused on terms such as "Artificial Intelligence," "Medical," "Healthcare," "Explainable," "Transparency," "Trust," and "Adoption." The motivation for this search stems from developments in Explainable Artificial Intelligence (XAI). XAI is vital for fostering trust and facilitating the widespread adoption of AI-driven clinical decision support systems (CDSS) in healthcare. While AI has the potential to augment clinical decision-making, the lack of transparency in traditional "black box" models can undermine trust and hinder adoption. XAI techniques aim to make AI systems more interpretable by providing explanations and visualizations of the decision-making process. This transparency is essential for overcoming skepticism and encouraging the adoption of CDSS in clinical practice. The findings of this review will offer insights into the current research landscape in the region and inform future research on the adoption and use of healthcare AI. These issues are particularly relevant in the ASEAN context, where varying levels of digital literacy and healthcare infrastructure necessitate explainable and transparent AI to build user trust and support effective integration.

Keywords: Adoption, Artificial Intelligence, Explainable, Healthcare, Medical, Transparency, Trust.

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1. Introduction

The advent of Artificial Intelligence (AI) heralds a transformative era for healthcare. This technological leap offers unprecedented opportunities to refine patient care, enhance diagnostic accuracy, and improve treatment outcomes. As AI integrates into clinical workflows, it promises to redefine healthcare, but not without raising ethical, transparency, and acceptance considerations among healthcare professionals and patients alike. On the other hand, the successful integration of AI into healthcare will drive adoption and, subsequently, widespread acceptance among stakeholders [1, 2]. The complexity of clinical environments and the sensitivity of health data underscore the necessity for Explainable AI (XAI), which provides interpretable outputs to medical professionals and supports ethical decision-making.

This study focuses specifically on the ASEAN region, driven by its unique socioeconomic and healthcare challenges. ASEAN countries represent a diverse mix of economies with varying levels of technological adoption and healthcare infrastructure. This diversity provides a rich landscape for studying AI adoption, highlighting both common and country-specific barriers and opportunities. Understanding AI adoption in this region can provide valuable insights into how developing and emerging economies can leverage AI to improve healthcare outcomes. The swift embrace of AI, particularly during global health crises like the COVID-19 pandemic, reveals the nuanced dynamics of technology acceptance within healthcare settings [3].

Amidst this backdrop, AI's niche in digital health research underscores the importance of ethical considerations. These are crucial for aligning AI deployments with the healthcare sector's framework and ensuring equitable distribution of AI solutions across diverse populations and regions. Ethical AI in healthcare transcends regulatory compliance, aiming to instill trustworthiness, accountability, and fairness at the core of AI development and implementation processes. As emphasized in recent studies, ethical AI is not merely an option but a necessity for responsible and sustainable AI integration in healthcare [4].

Through a meticulous literature review, this paper aims to dissect the complexities of integrating AI into healthcare within the ASEAN context. It examines ethical imperatives, pathways to fostering an environment conducive to AI acceptance, and factors influencing its adoption. This study envisions a future where AI and healthcare synergize harmoniously, propelling the industry towards unprecedented efficiency and effectiveness. It also seeks to contribute to the growing body of knowledge on AI adoption in healthcare, particularly within the context of developing and emerging economies, as exemplified by the ASEAN region.

By focusing on ASEAN countries, this review aims to provide actionable insights for policymakers, practitioners, and researchers to facilitate the seamless integration of AI into healthcare systems across the region. The findings will inform future research and policy development, ensuring that AI's benefits are realized equitably and effectively.

2. Literature Review

2.1. Integration in Clinical Workflow

The integration of Artificial Intelligence (AI) into clinical workflows represents a crucial factor in healthcare delivery, aiming to enhance decision-making processes and overall patient outcomes. This integration addresses the significant challenge of adopting genomic medicine advancements and AI technologies within healthcare settings, facilitating the practical application of these discoveries to improve patient care [5]. Phenome-wide association studies (PheWAS) and validated electronic medical record-based phenotyping algorithms are instrumental in driving genomic research by accurately defining phenotypes from clinical data, underscoring the importance of precise phenotyping in genomic research [5]. The sharing of data plays a vital role in advancing precision medicine and fostering research collaborations, necessitating open data policies to ensure transparency and enhance healthcare outcomes [5]. Artificial Intelligence and machine learning technologies, at this point, are increasingly recognized for their potential to support digital health research, offering significant improvements in the accessibility, affordability, and quality of healthcare services, including in ophthalmology [6, 7].

The COVID-19 pandemic has accelerated the adoption of AI technologies, emphasizing the need for AI tools that reduce non-essential contact between healthcare providers and patients [6]. This is a prime example of a clear integration of AI into clinical workflows that necessitates the collaboration of healthcare stakeholders, clinical experts, AI researchers, and patient advocacy groups to identify and address clinical challenges through effective AI-based solutions. Studies such as those by Gunasekeran et al. [6] on the automated diagnosis of plus disease in retinopathy of prematurity using deep learning models illustrate the transformative impact AI can have on specialties like ophthalmology. These advancements highlight the potential of AI to significantly enhance preventive care by integrating deep learning models for predictive analyses, such as cardiovascular risk factors from retinal fundus photographs, into clinical workflows [8-10].

The seamless integration of AI into clinical workflows not only promises to revolutionize healthcare delivery and patient care but also poses challenges that require careful consideration, including the need for operationalization, performance monitoring, and quality control to ensure the effective and ethical use of AI in healthcare [11]. While the technological integration of AI into clinical workflows is progressing, its success ultimately hinges on ethical standards and user trust, as discussed in the next section.

2.2. Ethical and Transparency in AI

Ethical considerations in AI play a pivotal role in ensuring that technological advances do not come at the cost of violating human rights or exacerbating biases arising from health data. Transparency and explainability stand out as critical quality requirements for AI systems, necessitating a focus on ethical guidelines to address potential bias and privacy concerns effectively. In the context of ASEAN, AI adoption is rather slow as ethical considerations and transparency have

emerged as foundational elements for trustworthy AI deployment [2, 5, 6]. Ethical AI is essential for aligning complex AI models with clinical standards and practices, ensuring they address decision-makers' concerns and facilitate the correction of any undesirable behaviors.

Recent literature underscores the criticality of ethical AI in fostering decision-making processes that are fair, transparent, and aligned with societal values [12]. The tension between risks and concerns versus potential and opportunity drives the need for policies in AI to align with safety, efficacy, and clinical standards, ensuring algorithms are interpretable and decisions are traceable [13]. Effective governance of AI in healthcare necessitates cross-disciplinary collaboration. By engaging a wide array of experts, it is possible to cultivate AI systems that not only adhere to ethical standards but also promote fairness across the board, ensuring that AI benefits are equitably distributed [4, 14].

Moreover, the development of AI must be governed by policy frameworks that guarantee alignment with ethical obligations, thereby protecting patient information and ensuring that healthcare AI solutions are consistent with international conventions [11]. Explainable AI models represent a significant step toward enhancing the interface between AI systems and human users. By making AI decisions more transparent and understandable, these models help build trust and ensure that AI applications are closely aligned with human values and expertise. This approach is crucial in fostering AI adoption while leveraging human expertise in the decision-making process, further embedding ethical considerations into the fabric of AI development [12]. In addition to ethical frameworks and explainability, privacy protection and the use of privacy-enhancing technologies are indispensable in AI development. These measures are vital for preventing privacy violations and ensuring the security of data within AI systems.

Furthermore, open data policies and collaborative efforts among stakeholders are essential for advancing transparency and ethical considerations in AI applications, creating an ecosystem where AI can thrive responsibly and beneficially for all involved [15]. Establishing ethical and transparent frameworks is a prerequisite for AI acceptance, yet real-world adoption depends significantly on user perception, trust, and willingness, among the issues we are going to explore in the next section.

2.3. Widespread Acceptance

The adoption of AI in healthcare sectors such as gastroenterology and eye care is significantly influenced by collective attitudes, expectations, trust, and overall perception towards AI technologies [2, 6]. A notable concern among professionals is the skepticism towards AI's 'black-box' nature, particularly in diagnostic processes, indicating a critical need for enhanced trust and transparency [6]. Ensuring AI systems are developed and deployed ethically, with a strong emphasis on transparency and accountability, is paramount [1]. These ethical considerations are not just nice-to-haves, but they are foundational elements that guarantee a smooth AI integration into clinical workflows [2]. Furthermore, the fostering of open data policies, along with the encouragement of data sharing and stakeholder collaboration, plays a vital role in enhancing AI's transparency and ethicality, thereby bolstering its acceptance and trustworthiness within healthcare communities [7]. The use of machine learning (ML) algorithms during the COVID-19 pandemic to estimate infection probabilities exemplifies AI's potential when ethical guidelines are adhered to; however, ML algorithms should not replace physicians but complement them [16]. Addressing interpretability concerns through proposed frameworks is essential for AI's wider acceptance, particularly in applications where decision-making processes are critical [17]. However, challenges such as lack of expertise, funding, and recognition significantly impede AI's translation into practical healthcare solutions [18-20].

Establishing robust policy frameworks is crucial to ensure healthcare AI solutions are ethically aligned, safeguard patient information, and promote equitable benefits across diverse regions [7]. Moreover, cross-disciplinary collaboration and expert engagement are fundamental to effective AI governance and the amplification of ethical considerations in healthcare AI applications [7].

2.4. Conceptual Lens: Trust, Transparency and Explainability

The successful adoption of AI in healthcare is not solely a technological or infrastructural challenge but it is deeply rooted in the sociotechnical dynamics of trust, transparency, and explainability. These three interrelated constructs form the conceptual backbone of this study and guide the thematic synthesis of the literature reviewed. In the context of clinical decision support systems (CDSS), the ability of AI models to offer intelligible and justifiable recommendations plays a pivotal role in securing the confidence of both healthcare providers and patients [2, 12].

Trust is widely recognized as a critical determinant of AI adoption. In healthcare, where decisions carry life-altering consequences, users must feel confident that AI systems are reliable, fair, and ethically aligned. However, achieving trust requires more than high performance; it also hinges on transparency and a clear understanding of how decisions are made. Studies show that perceived trustworthiness strongly influences healthcare professionals' and patients' willingness to adopt AI tools [2, 6].

Transparency in algorithmic design and data usage is essential to foster accountability and mitigate concerns over bias, fairness, and privacy. The "black-box" nature of many AI models creates significant resistance, particularly in clinical environments that demand auditability and evidence-based reasoning [13, 14]. Without transparency, potential biases and errors remain hidden, eroding confidence in AI-driven interventions [11].

Explainability, operationalized through Explainable Artificial Intelligence (XAI), provides a pathway to address these concerns. XAI aims to make AI outputs interpretable and meaningful to end-users, offering insight into the underlying decision logic [12]. This is particularly crucial in clinical settings, where AI must complement and not replace human expertise. Explainable models can improve clinician confidence, facilitate regulatory oversight, and support collaborative

decision-making with patients [16, 17].

Incorporating these concepts into the present review was essential for framing the search strategy and analysis. The inclusion of keywords such as "explainable," "transparency," and "trust" reflects this paper's commitment to identifying research that addresses not only the technical deployment of AI in healthcare but also its human-centered adoption factors, especially within the culturally and infrastructurally diverse ASEAN context [2, 4, 6].

3. Methodology

This study adopts the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework to ensure a robust and transparent approach to conducting a systematic literature review. The PRISMA framework, a widely acknowledged guideline, facilitates the clear reporting of review findings and the process undertaken to achieve them.

The adoption and understanding of AI in healthcare have been marked by significant geographical disparities. Research indicates that some countries have demonstrated higher levels of AI adoption and understanding, attributing these variances to several factors, including economic disparities [1, 6]. Particularly, resource-abundant countries are shown to have a higher comprehension of AI technologies than resource-constrained areas, suggesting that income level significantly influences AI acceptance [1, 6].

3.1. Meta-Analysis of Included Studies

This section provides a meta-analysis of the 20 articles included in this systematic literature review. The analysis primarily focuses on the distribution of publication years and the geographical locations of the studies. This overview aims to offer a comprehensive understanding of the research landscape concerning healthcare AI adoption in the ASEAN region.

3.2. Distribution of Publication Years

The 20 articles included in this review span a period of 10 years, from 2014 to 2023. The distribution of publications across these years shows a clear trend of increasing research interest in healthcare AI adoption within the ASEAN region. While the earlier years (2014-2018) witnessed a relatively lower number of publications, the subsequent years (2019-2023) saw a substantial surge in research output. This trend likely reflects the growing recognition of AI's potential in transforming healthcare delivery and outcomes, coupled with advancements in AI technologies and their increasing accessibility.
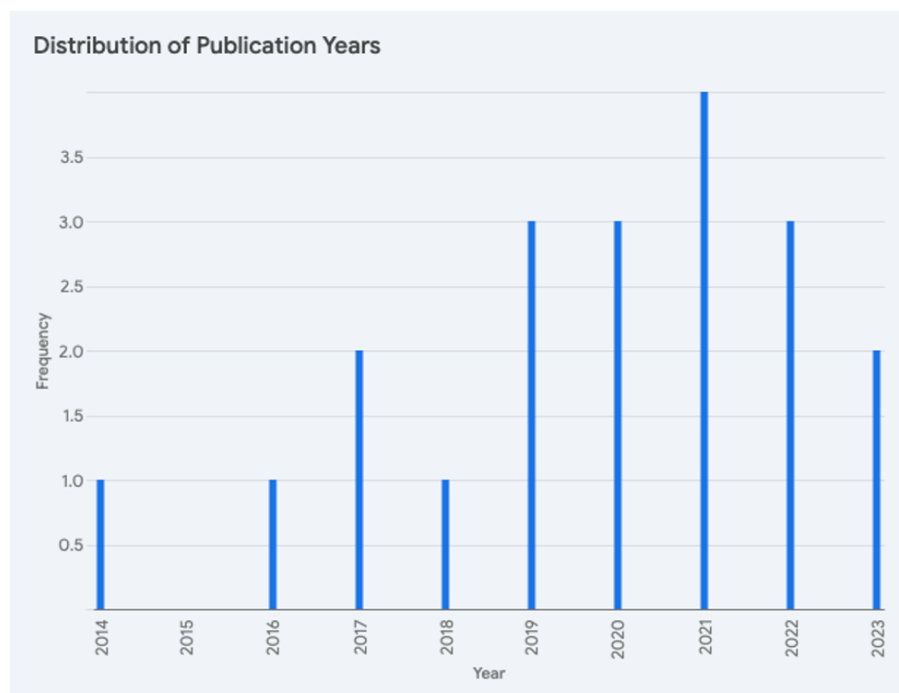

Figure 1.
Distribution of Publication Years.

3.3. Geographical Locations of Studies

The 20 articles encompass research conducted across various ASEAN countries, showcasing regional diversity in healthcare AI adoption research. The distribution of studies by country is as follows:

Table 1.
Geographical location of studies.

Country	Frequency
Singapore	7
Malaysia	4
Thailand	3
Vietnam	2
Indonesia	2
Philippines	1
Myanmar	1

3.4. Database and Search Strategy

The lens.org database served as the primary source for retrieving research articles due to its comprehensive repository of academic publications. A focused search (https://link.lens.org/XQ7l50ed8qc) was conducted using the date range from 2014 to 2024 to encompass the latest decade of advancements within the specified fields.

The geographical scope was limited to ASEAN countries to explore regional contributions towards AI, healthcare, social sciences, management, and human-computer interaction. The search was restricted to journal documents to maintain a high standard of scholarly rigor.

3.5. Selection Criteria and Process

Initially, a total of 1087 documents were identified through the Lens.org database using predetermined keywords related to AI, social science, management, and human-computer interaction. The keywords included "Artificial Intelligence," "Medical," "Healthcare," "Explainable," "Transparency," "Trust," and "Adoption." Following this, filters were applied to narrow down the publications by country within the ASEAN region, resulting in 38 papers. These papers were further assessed for relevance, language, and accessibility of full text, which refined the selection to 20 papers.

The criteria for inclusion were the relevance of the study to the research questions, the quality of the research methodology, and the significance of the findings to the understanding of AI adoption in healthcare. Discrepancies in the selection process were resolved through discussions among the researchers, ensuring a consensus was reached.

3.6. Data Extraction and Analysis

Data extraction was meticulously carried out based on the PRISMA checklist, emphasizing the importance of transparency and replicability in systematic reviews. Each selected paper underwent a detailed review to extract pertinent information aligned with our research objectives. The extracted information included study design, methodologies employed, findings, and thematic elements related to AI adoption in healthcare.

3.7. Research Team Involvement and Consensus Process

The selection and evaluation of publications involved a collaborative qualitative judgment process among three researchers. Each researcher independently reviewed the initially identified papers using the predefined selection criteria, which included relevance to the research questions, quality of the research methodology, and the significance of the findings related to AI adoption in healthcare.

Following the independent reviews, the researchers engaged in discussions to resolve any discrepancies and to ensure a consistent application of the selection criteria. This consensus process was iterative and involved multiple rounds of discussion until all researchers agreed on the final set of included papers.

Prior to conducting the critical review of the final set of included studies, the researchers reached a consensus to ensure that all selected papers met the established inclusion criteria. This approach ensured that the selection process was rigorous and that the final set of papers provided a comprehensive and representative sample of relevant research in the field.

3.8. PRISMA Flow Diagram

To visually represent the search and selection process, a PRISMA flow diagram was constructed. This diagram (Figure 2) illustrates the filtering stages from the initial number of records identified through database searching to the final selection of studies included in the review.
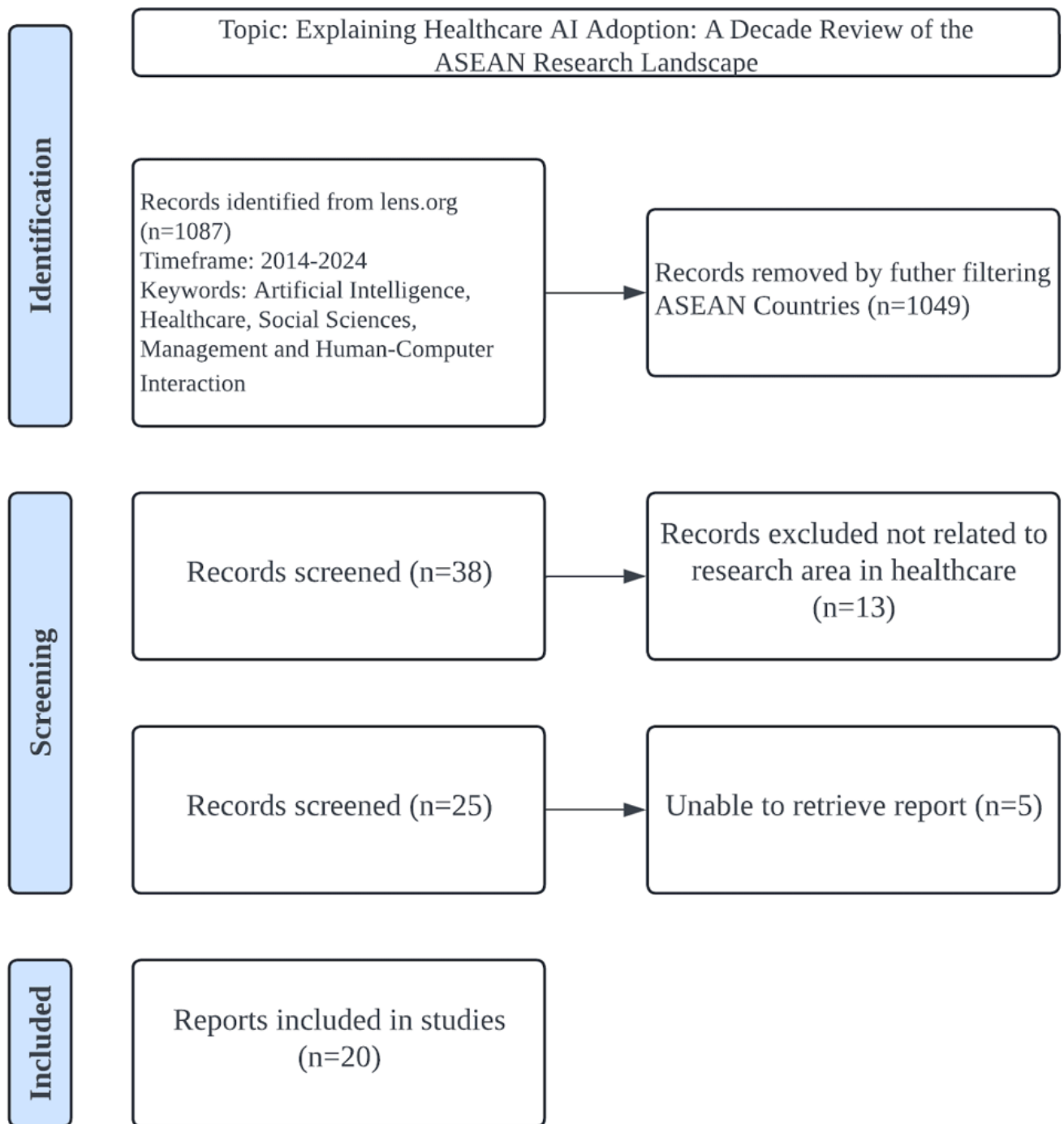
Figure 2.
PRISMA Flow Diagram.

4. Results and Discussion

The adoption and understanding of artificial intelligence (AI) in healthcare have been marked by significant geographical disparities. The ASEAN region shows markedly different adoption patterns compared to more developed regions, revealing how structural and contextual differences such as digital infrastructure, regulatory maturity, and public trust impact the feasibility of deploying AI technologies [1, 6]. Particularly, resource-abundant regions are shown to have a higher comprehension of AI technologies than resource-constrained areas, suggesting that income level significantly influences AI acceptance [1, 6].

User perception towards AI has been varied, with a significant portion of users rating their understanding as below average or average. This suggests a substantial gap in AI literacy, underscoring the need for enhanced education and awareness about AI's capabilities and applications [1]. Concurrently, ethical considerations and the call for transparency in AI practices have emerged as critical to gaining widespread acceptance. Furthermore, the discourse around ethical AI underscores the importance of developing AI technologies that are both ethical and transparent to foster trust among stakeholders across various domains [6].

The impact of education on AI understanding cannot be overstated. Studies have found a direct correlation between education levels and AI understanding, with individuals possessing higher education levels exhibiting better comprehension and acceptance of AI technologies [2]. The role of healthcare providers has also been highlighted as pivotal in influencing AI adoption among patients. This indicates a pressing need for targeted education and training programs aimed at healthcare professionals to bridge the gap in AI adoption and acceptance [2].

Trust and reliability in AI systems have been identified as key factors influencing user acceptance. Transparent and explainable AI models are more likely to gain trust from users and stakeholders, indicating a pathway toward greater acceptance and integration of AI in healthcare [2]. This data reinforces earlier literature suggesting that XAI is not merely a technical enhancement but a fundamental requirement for overcoming hesitancy in clinical adoption, especially in lower-literacy or resource-constrained environments.

Lastly, the necessity of robust regulatory frameworks to ensure ethical AI practices, protect user privacy, and promote responsible AI deployment has been emphasized. Such frameworks are vital for navigating the complexities associated with AI integration into healthcare settings, ensuring that AI technologies are deployed in a manner that is both ethical and beneficial to society at large [14, 19].

4.1. Gaps and Limitations

In the dynamic landscape of ASEAN healthcare, AI presents a significant opportunity for transformative change. With a diverse socioeconomic backdrop, ASEAN countries are at varying stages of AI adoption, revealing numerous opportunities and challenges unique to the region. Notably, significant geographical disparities have been observed, with regions such as North America advancing more rapidly in AI adoption compared to regions like ASEAN. This uneven terrain of AI assimilation, underscored by economic disparities, suggests that the benefits of AI are not yet universally accessible or that the potential benefits of AI are not yet equally enjoyed by the global population [20].

Moreover, the variance in user perception towards AI, where a substantial portion of users report below-average understanding, signals a substantial gap in AI literacy [6]. This variance in AI literacy, particularly among end users and healthcare professionals, not only contributes to slower adoption but also highlights a missed opportunity for XAI to function as both a technical and educational tool, enabling users to understand and trust AI systems more effectively. Good AI literacy is crucial to drive AI development, deployment, and adoption at the users' end. While education has been identified as a key lever for improving AI understanding, the existing educational initiatives appear insufficient for bridging the knowledge gap among healthcare providers.

Ethical considerations and the call for transparency further compound these challenges, emphasizing the necessity for AI technologies to align with not just clinical standards but also healthcare's moral compass [4, 11]. Trust and reliability also emerge as pivotal concerns, suggesting that transparent and explainable AI models are crucial for fostering acceptance. Thus, this signals the potential of explainable AI innovations in general and for healthcare purposes specifically. Explainability would promote trust in the technology, and in designing explainability, the resulting reliability of AI innovations would also improve.

Finally, the review also pointed out that the current research landscape reveals a pressing need for robust regulatory frameworks. Currently, there is still a limited regulatory framework in place designed to enable practitioners to navigate the ethical complexities of AI integration into healthcare settings, ensuring that AI's deployment is both beneficial and equitable. Furthermore, the various intricate rights, such as the patient-doctor relationship etc., need to be clearly guided when adding AI to the equation.

4.2. Future Direction

Looking forward, addressing these gaps necessitates a multifaceted approach. Firstly, in-depth regional studies are essential for unraveling the specific barriers to AI adoption, thereby facilitating more equitable access to AI technologies across diverse geographical landscapes.

Economic analysis will play a crucial role in understanding the nuanced impact of AI on healthcare, including its potential to alleviate costs and improve outcomes. Expanding research to include a broader spectrum of healthcare users will offer a more comprehensive view of AI's acceptance and utility, guiding the development of user-centered AI solutions.

The operationalization of ethical AI principles is paramount; future efforts must focus on creating actionable frameworks that integrate these principles into all stages of AI development and deployment. Such frameworks should be absorbed into policy frameworks designed to drive the AI sector, with more detailed adaptations incorporated into sector-specific initiatives, including the healthcare sector.

Lastly, innovative educational programs designed to enhance AI literacy among healthcare professionals will be critical for bridging the existing knowledge gap. These programs should not only focus on technical AI competencies but also encompass ethical considerations, preparing healthcare providers for the complexities of an AI-enhanced healthcare landscape. By addressing these gaps and limitations, the path towards a future where AI and healthcare converge in harmony becomes clearer, promising improved patient care and outcomes.

5. Conclusion

In conclusion, this systematic literature review has shed light on the multifaceted landscape of AI adoption within the healthcare sector across the ASEAN region over the past decade. The examination has revealed significant geographical disparities in AI adoption, with economic factors and income levels playing a pivotal role in regional acceptance and

understanding of AI technologies. Furthermore, user perception and education levels have been identified as critical elements influencing AI comprehension and acceptance, highlighting the urgent need for enhanced educational initiatives and awareness programs to bridge the existing knowledge gap.

The discourse around ethical AI practices and transparency has emerged as a cornerstone for building trust and gaining widespread acceptance among various stakeholders. Trust and reliability, underpinned by transparent and explainable AI models, have been pinpointed as essential for fostering user acceptance. Moreover, the role of healthcare providers has been accentuated, underscoring the importance of targeted education and training programs to equip them with the necessary skills to navigate the evolving AI landscape in healthcare.

Lastly, the necessity for robust regulatory frameworks has been underscored, emphasizing the need for policies that ensure ethical AI practices, protect user privacy, and promote responsible AI deployment. The adoption of AI in healthcare presents a promising avenue for enhancing healthcare delivery and outcomes. However, it necessitates a concerted effort from all stakeholders to address the identified challenges and harness the full potential of AI technologies in a manner that is ethical, transparent, and equitable.

By synthesizing insights from the integration, ethical considerations, and user acceptance of AI systems, this review offers a holistic understanding of healthcare AI adoption in ASEAN. This review thus calls for a continued exploration of the factors influencing AI adoption in healthcare, aiming to provide actionable insights for policymakers, practitioners, and researchers to facilitate the seamless integration of AI into healthcare systems across the ASEAN region and beyond.

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