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ANALYSIS TREN PENELITIAN SMART LEARNING ENVIRONMENT FRAMEWORK

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ABSTRACT

The integration of technology into education has transformed learning environments, giving rise to Smart Learning Environments (SLE) that utilize AI, IoT, cloud computing, and adaptive systems. However, despite widespread interest, there is a lack of standardized frameworks and measurement models guiding the development and evaluation of SLE across diverse educational contexts. This study aims to explore research trends related to SLE frameworks by conducting a Systematic Literature Review (SLR) based on Kitchenham's method, covering 21 qualified articles published between 2019 and 2023. The analysis investigates core components, implementation contexts, research focus, and gaps in existing models. Results reveal that most SLE research is concentrated at the university level, focusing heavily on performance evaluation and system design. Yet, critical shortcomings remain, including insufficient integration of emerging technologies such as AI and blockchain, lack of measurable indicators, and minimal consideration of teacher perspectives. These findings suggest a need for more comprehensive, inclusive, and measurable frameworks to ensure relevant and effective SLE implementation. This study offers insights for researchers and policymakers to refine future SLE research and design strategies aligned with the evolving demands of digital education.

KEYWORDS Smart Learning Environment, Trend, Framework

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INTRODUCTION

Technology has become a major driver of global transformation in various areas of life. From the era of the industrial revolution to the current digital era, technology continues to experience rapid developments that affect the way humans work, communicate, and live their daily lives. Innovations such as artificial intelligence, the Internet of Things (IoT), and blockchain technology have opened the door to a new era. In addition, the development of communication technologies

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such as 5G has accelerated the exchange of information and enabled faster connectivity in various sectors around the world (Deev & Finogeev, 2023a).

Technology has had a significant impact on the field of education. The integration of technology in education not only expands access to learning resources but also changes the way of learning and teaching. Online learning platforms, educational applications, and e-learning solutions have become part of the educational component (García-Tudela et al., 2023). Teachers and students can easily access online learning resources, learning videos, and interactive materials. Technology also plays a role in distance learning, allowing students to access learning easily. The use of learning tools and devices such as computers allows for personalized learning, where learners can learn according to their level of understanding and learning speed. Technological developments in education bring great potential to improve the quality and accessibility of education worldwide (T. Chen & Liu, 2024).

Technology in education includes online learning resources and involves the concept of Smart Learning Environment (SLE). The SLE concept of the learning environment combines technology with physical and virtual environments to optimize learning activities. SLE emphasizes the use of technologies such as virtual reality, robotics, learning analytics, artificial intelligence, and sensors to support the implementation of the Internet of Things (IoT). SLE also emphasizes the need for an open and flexible learning environment, allowing learning anywhere and anytime (Rosmansyah et al., 2023a). The SLE concept also emphasizes the use of technology to automate educational processes and increased attention to diversity and personalization of learning. The technology in SLE is used to carry out connectivity, presence, and personalization. In addition, SLE also emphasizes the importance of using adaptive technology, personalized learning paths, and other learning technologies that support a tailored learning experience (Tabuenca et al., 2023a).

The technology used in SLE can be live simulation, laboratory equipment, and communication equipment. The main goal of SLE is to create an effective, efficient, and engaging learning environment for learners. SLE also aims to support the development of skills that can be applied in real life. The technology used in SLE includes hands-on simulations that allow learners to conduct formative and summative assessments (Akhrif et al., 2020). In addition, technology can also be in the form of laboratory equipment that affects students' learning experience. The use of technology in SLE can be in the form of various tools and applications that support learning, such as simulations, laboratory equipment, and communication equipment (Thomas et al., 2019a).

SLE is integrated with advanced technologies, such as artificial intelligence, data analysis, and algorithms to provide a more dynamic and adaptive learning experience. In SLE, the system can automatically monitor learning progress, identify needs, and adjust learning materials for learners (Real-Fernández et al., 2021). The implementation of SLE provides independent learning services and creates a motivating and interactive environment. SLE is an innovative step in supporting educational effectiveness, allowing teachers and students to be more involved in the learning process relevant to their needs and development. Through a combination of technological developments and the concept of SLE, education can continue to develop in a more inclusive, adaptive, and relevant direction to meet the demands of the modern world (Li, 2021).

SLE in education is increasingly influential, along with the evolution of modern learning needs. SLE is not only a technological innovation but also a solution to overcome educational challenges. SLE can help address disparities in learners' abilities and learning styles, ensuring that each individual can develop their potential optimally (García-Tudela et al., 2021). SLE improves teacher engagement by providing more accurate and in-depth information about student progress so that teachers can provide more timely support. The integration of SLE is not only a technology support, but a foundation to create inclusive, innovative, and relevant education to global demands in the digital era (Al Faruqi & Harso Supangkat, 2020).

The challenge to realize SLE as a whole is that there is no standard reference for measuring the impact and success of technology applications in the educational environment. Currently, there is still no data on standards detailing the use of technology in the world of education. Although technology integration continues to evolve, there is no consistent standard to measure the impact and success of technology implementation in various educational settings (Molnár et al., 2022). Some educational institutions may use technology with different standards, making comparing and evaluating their effectiveness difficult. In addition, the measure of success in the use of technology can vary between institutions, hindering efforts to develop standards that can be applied (Dai et al., 2023).

The research conducted by Mikhail Deeva and Alexey Finogeev only discusses the definition and implementation of a convergent educational environment, but has not touched on how ready an institution is in adopting the educational environment (Deev & Finogeev, 2023a). In addition, another study conducted by Taifeng Chen & Chunbo Liu discusses the definition and implementation of Smart Grid (SG) technology and fault detection in SG using data monitoring and classification with fuzzy machine learning models. However, the research has not touched on the readiness of an institution or educational institution to adopt SLE. The research focuses more on the development of error detection technologies and methods in SG than on the readiness aspect of educational institutions (T. Chen & Liu, 2024).

According to Romansyah, there is still little research on SLE that can be used as a guideline to develop further research and as material for evaluating and improving the quality of existing SLE research. The research shows a need for more research that focuses on the development of simple SLE models and evaluation tools, such as the SLE Maturity Model (SLEMM), to help improve the quality of the electronic learning environment. Thus, further research can expand knowledge about SLE models and the development of instruments that will be very beneficial for the application of technology-based education (Rosmansyah et al., 2023a).

The research that will be conducted focuses on the exploration of frameworks in the Smart Learning Environment (SLE). Until now, not many studies have discussed in depth how we should evaluate the success of SLE implementation in the educational environment. Existing research has not been able to answer the question of what kind of framework is required to implement SLE in an educational institution. The research will examine the trends in applying the SLE framework more deeply, which will provide recommendations for the next research.

Although numerous studies have introduced various frameworks and models for Smart Learning Environments (SLE), there remains a significant lack of standardization in how these frameworks are evaluated and implemented across different educational contexts. Many existing works focus narrowly on technical implementation or theoretical development without providing integrated performance measurements or considering institutional readiness. Additionally, most studies are concentrated at the university level, with limited attention to diverse educational settings and perspectives, such as those of educators. This gap reveals the need for comprehensive research that identifies dominant SLE components and evaluates their practical applicability and relevance in a broader, more inclusive educational spectrum.

This study uniquely employs a Systematic Literature Review (SLR) approach based on Kitchenham's methodology to map trends in SLE framework research. Unlike prior works that primarily develop models or assess system performance, this research critically analyzes the presence of conceptual frameworks and the extent to which these frameworks are paired with measurable indicators. It also highlights the underrepresentation of modern technologies in existing frameworks, such as AI, cloud computing, and blockchain. By exposing these thematic and technological gaps, the study offers new insights to guide future framework development in aligning with current digital education demands.

This independent study aims to analyze aspects related to the implementation of the SLE framework. This research will identify the extent of the application of the SLE framework or model and whether it is more dominant in the school or higher education environment. The study also aims to analyze the main focus of the SLE framework or model through literature by examining whether it is more focused on technical implementation, institutional readiness, or evaluation of SLE effectiveness. In addition, the study identifies and analyzes the shortcomings of the framework or model in SLE research.

The benefit of this independent study is to provide an overview and information to determine the research domain. The results are expected to contribute to understanding SLE's application in education, enrich the literature, and provide useful guidance for the development of technology-based educational policies and practices.

RESEARCH METHOD

The method used in this independent study was an SLR method adapted from Kitchenham versions 1.0 and 2.3 (Kitchenham, 2004) (Kitchenham, B., & Charters, 2007). There are three stages according to Kitchenham, which are carried out in this independent study, namely planning, implementation, and reporting as seen in Figure 1.

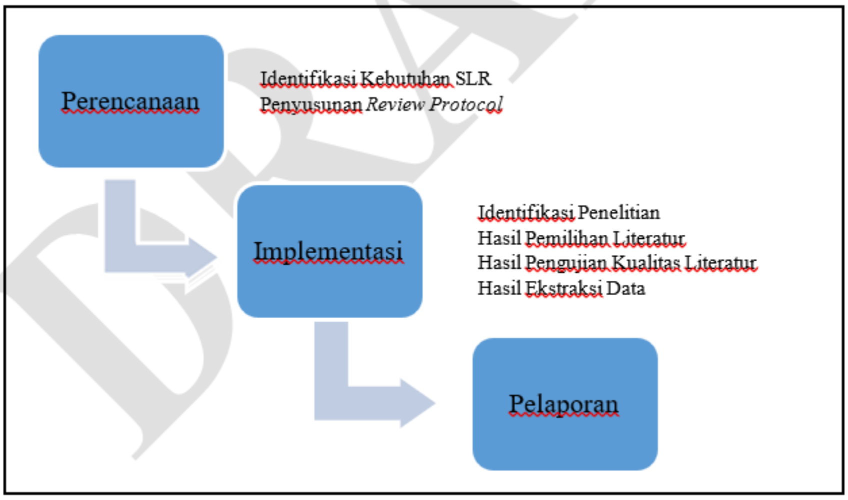

Figure 1. SLR Methodology (Kitchenham, 2004)

RESULT AND DISCUSSION

1. Final paper

At the closing stage of this research, we have 21 final papers that have gone through a series of strict stages, ranging from selection to quality tests. A careful selection process and quality tests have ensured that each paper meets the pre-determined quality criteria. This collection of final papers results from the careful collection, evaluation, and screening process throughout the research.

Table 4.1 provides detailed information related to this final paper. It is a visual representation of the literature collection that will be the main basis of this research. The table includes details that reflect the diversity of the selected literature, creating a comprehensive picture of each paper's contribution in the context of our research. With this final paper, this research is increasingly directed towards in-depth analysis and data synthesis, allowing us to detail the findings and answer research questions precisely and in detail.

Table 1. Comparison of Performance of Algorithms

Code	Heading	Writer	Research Objectives
A1	*A theoretical framework for designing smart and ubiquitous learning environments for outdoor cultural heritage*	(Alkhafaji et al., 2020)	• Introduce the theoretical framework and create a service design of the intelligent learning environment
A2	*Towards Personalized Feedback in a Smart Learning Environment for Teaching Conceptual Modelling*	(Bogdanova, 2019)	• Develop an intelligent learning environment, feedback architecture, and create a conceptual modeling learning ontology
A3	*An artificial intelligence-based efficient smart learning framework for an education platform*	(Cao et al., 2020)	• Developing an Artificial Intelligence-based Intelligent Learning Framework (AI-ESLF)
A4	*Construction of the Evaluation Index System for Smart Learning Environment in Colleges and*	(Dai & Hey, 2020)	• Establish an evaluation index system for the smart learning environment and reflect the construction of the smart learning environment objectively/

	Universities Based on Multi-Space Integration		
A5	*Assessment of Smart Learning Environments in Higher Educational Institutions: A Study Using AHP-FCE and GA-BP Methods*	(Dai et al., 2021)	• Developing two evaluation systems for a smart learning environment • Identifying shortcomings in the construction of the Smart Learning Environment • Providing suggestions for improvements to the Smart Learning Environment
A6	*Application of the convergent education model in the development of a smart learning environment*	(Sex & Finogeev, 2023b)	• Integration of educational programs with the suitability of learning content • Development and implementation of convergent learning
A7	*Smart education framework*	(Iron, 2021)	• Discuss the smart learning framework • Comparing different educational frameworks and smart learning • Designing learning with an intelligent educational design approach
A8	*Towards a Conceptual Model for a Smart Open learning environment based on Computational Thinking*	(Frady & Cheniti-Belkadhi, 2022)	• Developing a Smart Open Learning Environment • Developing Computational Thinking (CT) through Pedagogy
A9	*New Development and Evaluation Model for Self-Regulated Smart Learning Environment in Higher Education*	(Gambo & Shakir, 2019)	• Identify educational requirements for developing and evaluating intelligent learning environments. • Propose a model for developing and evaluating a self-regulating intelligent learning environment. • Implementing a learning management system model.
A10	*Smart learning environments: a fundamental research towards the definition of a practical model*	(García-Tudela et al., 2021)	• Providing a new definition of a smart learning environment • Designing an innovative model for SLE called SLE-5
A11	*Theoretical Framework Design for Measuring Students' Preference towards Smart Learning Class*	(Kaniaswari & Suzianti, 2020)	• Developing a theoretical framework to measure students' preferences for intelligent learning • Identify factors that affect intelligent learning
A12	*A simple model of a smart learning environment*	(Rosmansyah et al., 2023)	• Developing a simple SLE model
A13	*Smart learning environment, measure online student satisfaction: a case study in the context*	(Safsouf et al., 2020)	• Identify factors that explain student satisfaction in online learning • Reviewing theories and models

	of higher education in Morocco		to improve student satisfaction
A14	*QLearn: Towards a framework for smart learning environments*	(Şerban et al., 2020)	• Create a new learning design based on active learning methods • Developing an e-learning platform • Integrating smart learning environments
A15	*A Blended Learning Model Based on Smart Learning Environment to Improve College Students' Information Literacy*	(Shi et al., 2022)	• Explain the elements of a smart learning environment • Introducing a blended learning model to improve information literacy for students
A16	*An Empirical Study of A Smart Education Model Enabled by the Edu-Metaverse to Enhance Better Learning Outcomes for Students*	(Shu & Gu, 2023)	• To analyze the effectiveness of smart education models in improving learning outcomes
A17	*Conceptual framework on Smart Learning Environment for the present and the new century, Indian perspective*	(Singh, 2022)	• Identify learning elements and approaches to a smart learning environment. • Provide standard development for learning and education.
A18	*Optical fog-assisted smart learning framework to enhance students' employability in engineering education*	(Sood & Singh, 2019)	• Assess students' skills using algorithms • Monitor academic/skills data to increase employability potential through e-learning
A19	*A New Smart Learning Framework using Artificial Intelligence*	(Wahyono et al., 2020)	• Developing a smart framework for online learning • Allows users to obtain learning materials that match their abilities • Classify user capabilities using artificial intelligence (AI)
A20	*Smart Learning Environments Framework for Educational Applications in IoT-Enabled Educational Ecosystems: A Review on AI-Based GUI Tools for IoT Wearables*	(Wangoo & Reddy, 2020)	• Create an IoT-enabled SLE framework
A21	*Model Construction and Empirical Research of Deep Interaction in Smart Learning Environment — Take Smart Classroom as an Example*	(Xiong & Fang, 2021)	• Establish a personalized learning model for each student.

2. Statistics of articles on SLRs

After obtaining a collection of 21 final papers, we continued with the data extraction stage based on the procedures set in the review method. This extraction process is designed to extract important information from each paper that can support comprehensive data analysis and synthesis. We pay close attention to every detail contained in the paper to ensure completeness and accuracy in the data extraction process.

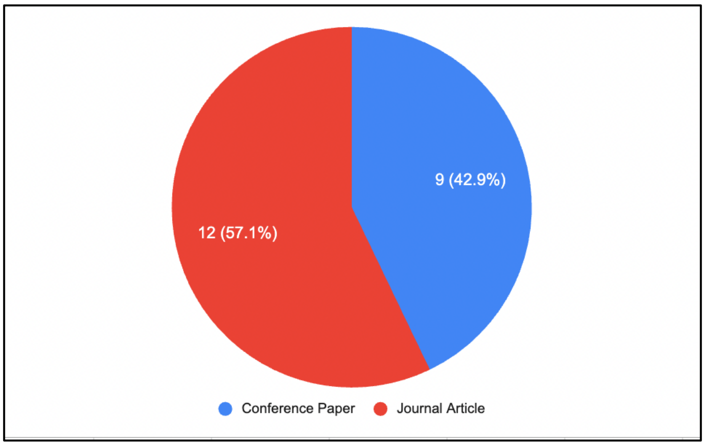

Figure 2. Distribution of paper types

The data extraction results attracted attention to the distribution of the final paper publication. As seen in Figure 2, as many as 57.1% of the papers were published in scientific journals, while the other 42.9% chose publication through scientific conferences. These findings indicate that research that explores frameworks or models tends to be discussed more often in scientific journals than in conferences. This distribution analysis provides additional insights related to publication preferences and trends in this research domain, enriching our understanding of the academic context in which frameworks or models often receive attention and validation.

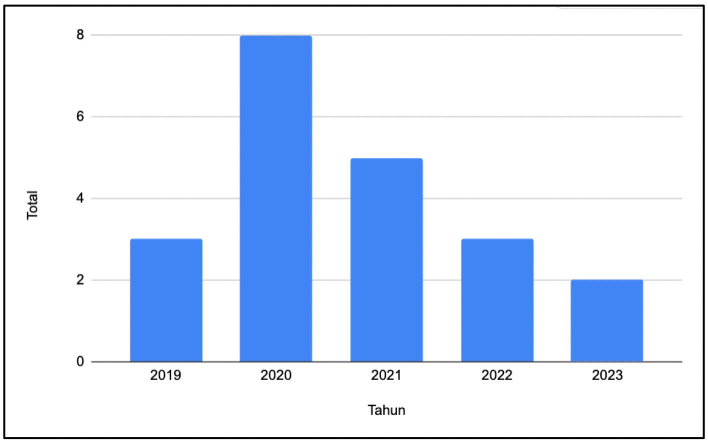

Figure 3. Distribution of articles every year

The analysis of the distribution of paper articles from 2019 to 2023 provides an interesting picture related to research trends in the Smart Learning Environment domain. There was a significant increase in 2020, which reached its peak. This may reflect increased research interest or focus during that period. This positive trend can indicate a strong push in exploration and understanding related to the Smart Learning Environment in that year.

However, after peaking in 2020, the number of articles declined in the following years. This shift can be interpreted as a response to various factors, including possible shifts in research focus, project discontinuity, or changes in research priorities within the academic community. This annual article distribution analysis not only presents time trends but also provides valuable insights into the dynamics of change in Smart Learning Environment research during the observed period.

Table 2. List of article publications

Publication	Article
2019 13th International Conference on Research Challenges in Information Science (RCIS)	A2
2019 IEEE Global Engineering Education Conference (EDUCON)	A9
2020 4th International Conference on Vocational Education and Training (ICOVET)	A19
2020 IEEE 17th India Council International Conference (INDICON)	A20
2020 International Conference on Electrical and Information Technologies (ICEIT)	A13
2020 International Conference on Modern Education and Information Management (ICMEIM)	A4
2021 16th International Conference on Computer Science & Education (ICCSE)	A21
Computer Applications in Engineering Education	A18
IEEE Access	A5, A15
IEEE Global Engineering Education Conference, EDUCON	A8
Artificial intelligence	A3
Interactive Learning Environments	A12
Journal of Cultural Heritage	A1
Procedia Computer Science	A14
Proceedings of the 3rd Asia Pacific Conference on Research in Industrial and Systems Engineering	A11
Journal of Education and Law	A17
Smart Learning Environments	A7, A10
Systems	A16
Telematics and Informatics Reports	A6

In extracting information from 21 research articles, we highlight aspects related to publication. The extraction data revealed that the articles came from 19 different publishers. This analysis shows the diversity of publication sources that support the framework or model that our research focuses on. Although the number of articles produced came from several publishers, the IEEE is prominently seen as the dominant publisher.

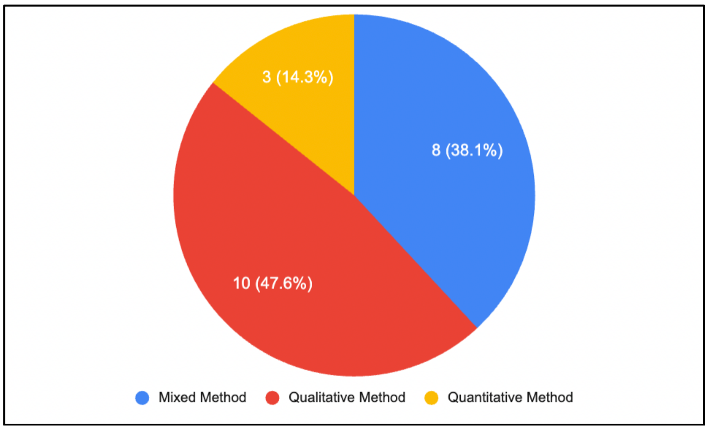

Figure 4. Distribution of research methods in articles

In looking at the diversity of research methods in the study of Smart Learning Environment, it can be seen that the dominance of qualitative methods is seen. Of the total 21 articles we reviewed, as many as 10 articles used a qualitative approach as the main methodological foundation. The Delphi method emerged as the most dominant option in the qualitative method. These results show the tendency of researchers to choose the Delphi method as an approach to get in-depth views and experts' views related to the Smart Learning Environment.

Furthermore, 8 articles apply the Mixed-Method approach, which combines qualitative and quantitative elements in research. This approach allows researchers to embrace the advantages of both methods, allowing for a more holistic and in-depth analysis of the Smart Learning Environment phenomenon.

Meanwhile, the quantitative method is used in fewer numbers, appearing in only 3 articles. This phenomenon may reflect the complexity or subjective nature of the research context regarding the Smart Learning Environment. Research in this area tends to rely more on qualitative approaches to explore and understand the aspects involving this intelligent learning context in depth. These results further understand the methodological preferences and research approaches that dominate in research related to Smart Learning Environment.

Table 3. Articles that discuss frameworks and measurements

Code	*Framework/Model*	*Measurement*
A1	*ALREADY*	*NO*
A2	*ALREADY*	*NO*
A3	*ALREADY*	*NO*
A4	*ALREADY*	*ALREADY*
A5	*NO*	*ALREADY*
A6	*ALREADY*	*NO*
A7	*ALREADY*	*NO*
A8	*ALREADY*	*NO*
A9	*NO*	*ALREADY*
A10	*ALREADY*	*NO*
A11	*ALREADY*	*ALREADY*
A12	*ALREADY*	*ALREADY*
A13	*ALREADY*	*NO*
A14	*ALREADY*	*NO*
A15	*ALREADY*	*ALREADY*

A16	*ALREADY*	*NO*
A17	*ALREADY*	*NO*
A18	*ALREADY*	*NO*
A19	*ALREADY*	*NO*
A20	*ALREADY*	*NO*
A21	*ALREADY*	*NO*

In looking at the analysis results documented in Table 3, it can be seen that there is a dominance in the discussion of frameworks or models in research articles. Most articles, marked with "YES" in the Framework/Model column, indicate that the discussion or introduction of a framework or model is the main focus or at least one of the main focuses in the research represented by the data. This finding confirms that research in the Smart Learning Environment domain tends to have a strong orientation towards developing and applying frameworks or models as a conceptual foundation.

Interestingly, articles that list the existence of both, namely frameworks/models and measurements, make a more comprehensive contribution to research. The presence of measurement elements in addition to the discussion of the framework or model can be interpreted as an effort to provide empirical and in-depth validation of the effectiveness or implementation of the proposed framework or model. Thus, the integration between theoretical and empirical aspects in these articles indicates a holistic approach in facing the challenges and complexities of the Smart Learning Environment. These results reinforce our understanding of the nuances of research focused on concept development and practical applications, thus providing a more substantial and testable framework.

3. RQ1: SLE Components

In the analysis of Table 3, it can be observed that the table maps the content of the components of the research framework that have been studied. The structure of this table illustrates the existence of two levels, namely the main component and the sub-component. At this level, some of the entries in the table show blanks, which indicates that the related article only describes the main components without providing details about the sub-components that support them.

Several shortcomings need to be considered in the framework proposed by previous research. Articles A6, A18, A19, and A21, for example, do not provide a sufficiently specific explanation of the dimensions or components contained in the framework. This creates a shortage in understanding and implementation of the framework.

In addition, it should be noted that several articles, such as A1, A3, A8, A11, and A14, tend to focus their dimensions on pedagogical or learning aspects, while the lack of exploration of the dominance of emerging technologies, such as the presence of artificial intelligence (AI), blockchain technology, and cloud computing. This limitation causes incompleteness of understanding when associated with Learning Environment Standards (SLE).

On the other hand, the incompatibility of technological trends is also an important note in the research literature. Today, technology has developed rapidly, including various innovations such as artificial intelligence, blockchain technology, and cloud computing. However, it is unfortunate that articles A4 and A17 do not detail or discuss these advances, leaving a significant information gap in the understanding of recent developments in the world of educational technology. Therefore, this study aims to fill this gap and present a more comprehensive perspective on the integration of technology in the learning framework.

Article	Level 1	Level 2
A1	*Learner*	*Learners perform and conceive learning differently*
	Content	*Useful information*
	Learning design	*Experiential, social, collaborative, situated, and conversational learning*
	Interaction design	*use different resources and tools to acquire information*
	Contexts	*People visit sites individually and in groups; being with a group might bring different experiences than on their own*
	Challenges and obstacles	*technology, confidentiality, financial issues, and people's preferences*
A2	*Theoretical artefact*	*Domain ontology exercise, ontology error, ontology*
	(Iterative) case study via the concrete course	*Domain knowledge exercise set common error set*
	Input from a knowledge base	*Literature*
A3	*Learner's feedback*	-
	Learner's performance assessment	-
	Knowledge base	*learner profile learner contextual data*
A4	*Physical space*	*Designability, Structural, Comprehensive, Practicability, Diversity, Intelligence, Perception, Humanization, Accessibility*
	Resource space	*Technical architecture, Compatibility, Functionality, Safety, Operability, Stability, Connectivity, Magnanimity, Scientific, Oneness, Plurality*
	Social space	*Expressing ability, Teaching methods, Teaching quality, Technical mastery, Interaction ability, Willingness to learn, Classroom performance, Cognitive load*
A5	*Physical space*	*Designability, Structural, Comprehensive, Practicability, Diversity, Intelligence, Perception, Humanization, Accessibility*
	Resource space	*Technical architecture, Compatibility, Functionality, Safety, Operability, Stability, Connectivity, Magnanimity, Scientific, Oneness, Plurality*
	Social space	*Expressing ability, Teaching methods, Teaching quality, Technical mastery, Interaction ability, Willingness to learn, Classroom performance, Cognitive load*
A7	*Learner*	-
	Educator	-
	Educational technology	-
	New or Improved Learning and Teaching Approaches	-
A8	*Learner's information*	-
	CT skill level	-
	Oer	-
	Open practice	-

	Open assessment	-
	Open learner model	-
	Instructional design model	-
	Learning theory	-
	Learning interactions	-
A9	*Learning Technology Qualities*	-
	Educational curriculum	-
	Enriched methodologies and strategies	-
	Enriched assessment	-
	Educational roles	-
A10	*Smart technology*	-
	Attitude towards Behavior	-
	Subjective norm	-
	Perceived behavioral control	-
	Behavioral intention	-
	Behavior	-
	Student negotiation	-
	Inquiry learning	-
	Reflective thinking	-
	Ease of Use	-
	Perceived usefulness	-
	Multiple sources	-
	Functional design	-
A11	*Connectedness*	-
	Standard, policy, and curriculum	-
	Learner module	-
	Domain module	-
	Pedagogy module	-
	Interface module	-
A12	*Supporting resources*	-
	Learner dimension	-
	Instructor dimension	-
	System dimension	-
	Course dimension	-
A13	*Social dimension*	-
	Task support	-
	Adaptive and instant learning support	-
	Tracking the learning progress for students	-
A14	*Connecting the learning community*	-

	Conceptual level	*Visual literacy, Media literacy, scientific literacy, Data literacy, Network literacy*
	Intelligence level	*Internet of things: multimedia technology, etc. Education cloud: data statistics, etc. Big data: data analysis, etc. Artificial intelligence: retrieval technology, etc. Blockchain: personal portfolio, etc.*
	Action level	*Acquisition and processing, Analysis and mining, Dissemination and Application, Screening evaluation*
A15	*Process level*	*Adaptability, Triggering Immersion, Inducibility, Individualization*
	Freedom for resource sharing and creation	-
	Multimodal interaction	-
A16	*Highly realistic teaching scenarios*	-
	Smart Stack Holder	-
	Smart technology	-
A17	*Smart pedagogy*	-
	IoT-enabled classroom boards	-
	IoT-enabled attendance monitoring systems	-
	IoT-enabled mobile learning	-
	IoT-enabled virtual worlds	-
	Smart schools and smart buildings	-
	Smart personalized learning systems	-
	Smart e-learning systems	-
	Smart IoT-enabled assessment systems	-
	Smart IoT-enabled analytical systems for educational ecosystems	-
	Smart children tracking systems for the parents	-
	Smart school and university security systems	-
A20	*Smart IoT-enabled teaching systems*	-

4. RQ2: Studi kasus penelitian Smart Learning Environment

Table 3 in the Smart Learning Environment research presents the distribution of case studies, providing an interesting overview of the various educational institutions that are the subject of the research. Case studies are conducted in various institutions, including universities, schools, and other educational institutions. The diversity of these institutions is an important point, showing that SLE research is not only focused on one type of institution but rather involves a broad spectrum of educational contexts.

Table 4. Case studies on SLE research

Research case studies	Article	Total
Central China Normal University	A5	1
Chinese University	A15	1
Education Platform	A3	1
Educational Institutions	A20	1
ITB and UPI	A12	1
Mid-Western University.	A18	1
Schools and Universities	A11, A13, A21	3
Universitas	A4, A17, A19	3
University Education	A2	1
University of Portsmouth	A1	1
Zhejiang Open University.	A16	1
Not mentioned	A6, A7, A8, A9, A10, A14	6

Interestingly, the case studies in this study are dominated by the university level. This shows that SLE research tends to focus more on the higher education environment as a center for exploring and implementing the Smart Learning Environment. An in-depth understanding of these smart learning technologies at the university level can provide specific insights useful in the context of further education.

Regarding the number of case study articles associated with a single institution, most institutions have one relevant article. This can indicate that each institution has a specific focus or aspect in developing or implementing a Smart Learning Environment, which is described in detail in a single article. These findings further explain the diversity of institutional focus and emphasis in implementing and developing Smart Learning Environments.

Table 5. Distribution of SLE research by Country

Country	Article	Total
United States	A18	1
China	A5, A15, A16	3
India	A17	1
Indonesia	A12	1
English	A1	1
Morocco	A13	1
Not mentioned	A2, A3, A4, A6, A7, A8, A9, A10, A11, A14, A19, A20, A21	13

The results of the analysis reflected in Table 5 show that research related to Smart Learning Environments is dominated by China. Each country has one or more research articles that cover the concept. This dominance may reflect the high interest and focus of research in the country related to the development and implementation of SLE.

5. RQ3: The main focus of the SLE framework or model in the literature

From the description shown by Table 4.6, it can be seen that there is a striking diversity in the research objectives in the Smart Learning Environment framework literature. These studies have varied objectives, which include system development, performance evaluation, motivation improvement, and measurement of student preferences, among others. This diversity of goals reflects the complexity and multi-dimensionality of the research approach to the Smart Learning Environment.

In some cases, research objectives are focused on developing innovative systems, emphasizing the development of technologies that support intelligent learning. Meanwhile, other research is more oriented towards evaluating the performance of existing system implementations, leading to a deeper understanding of the effectiveness and efficiency of the Smart Learning Environment.

In addition, the research objectives also involve students' psychological and motivational aspects, creating space for in-depth research related to the factors that affect the learning process. One of the interesting focuses is measuring student preferences, demonstrating the importance of understanding students' preferences and needs in the development of a smart learning environment. Overall, the diversity of this study's objectives creates a rich and varied foundation for further understanding related to the implementation and development of the Smart Learning Environment.

Table 6. The main focus of SLE framework research

The main focus of SLE framework/model research	**Article**
SLE Design	A10
Learning evaluation	A16
Evaluasi *smart learning environment*	A5
The framework focuses on the use of GUIs on IoT devices in SLE	A20
The Framework focuses on educational requirements in developing and evaluating self-governing, intelligent learning environments.	A9
Framework in the form of system development (online learning materials that are in accordance with the user's ability)	A19
Interaction with SLE	A21
User satisfaction	A13
Frameworks/models focus on improving student motivation, efficiency, and better learning outcomes, and between humans, technology, and forms of learning	A8
SLE conceptual framework	A17
Maturity	A12
Measuring students' preferences for *smart learning*	A11
Development of an evaluation index system for the *smart learning environment*	A4
Performance improvement in smart learning environments	A3
Training programs	A6
Elements and characteristics in *a smart learning environment*	A7

6. RQ4: Shortcomings of frameworks or models in SLE research

Table 7. Disadvantages of SLE framework research

Weaknesses/limitations of the Framework	**Article**
Some experts argue that evaluation indicators are not representative	A4
No standardization checks the fundamental criteria of intelligent learning	A3
• Difficulty giving feedback • Lack of a universal educational framework for conceptual modeling • Unavailability of learning ontology • Unclear type and timing of feedback • The need for additional empirical studies to determine the effectiveness of feedback	A2
• Research is limited to British culture	A1

• Technical aspects are not included in the study	
There is no personalization of the learning process	A6
Focus only on the theoretical framework of the SLE application	A17
Focusing only on technical errors	A16
Focus only on maturity	A12
• The framework only focuses on the design and analysis of *smart learning environments* • Framework emphasizes the importance of ergonomics and learning analysis in SLE	A10
Focus only on app development	A14
Inadequate number of indicators to assess the *Smart Learning Environment*	A5
Lack of clear educational requirements for the implementation of self-regulated smart learning environments	A9
The research focuses only on development and focuses on the capabilities and classification of system use	A19
Research focuses only on students	A18
The research only focuses on SLE development tools using GUIs	A20
No information shows the teacher's perspective on intelligent learning	A11
Not considering the impact of diversity in assessments	A13

A critical analysis of some articles, such as A4, reveals shortcomings in evaluating the Smart Learning Environment. Some experts argue that the evaluation indicators used are not representative, raising concerns about the validity and representativeness of the metrics used in assessing the quality of SLE. This shortcoming highlights the importance of detailing appropriate and relevant evaluation indicators to ensure accurate measurements of the effectiveness and success of SLE.

However, several articles, such as A17, A16, and A12, describe research focuses that may be too specific or too general. Some only focus on certain aspects, such as the theoretical framework for implementing SLE, technical errors, and maturity. This indicates that some studies may be able to increase their relevance and generalization power by adjusting their focus to be more balanced and comprehensive.

Finally, article A11 highlights the lack of teacher perspective in the research literature. This raises questions about the relevance and completeness of the views of those directly involved in the teaching process. Given their central role in implementing this smart learning technology, this shortcoming calls for more inclusion of teachers' views and experiences in research on SLE. By responding to these findings, future research can be more in-depth and holistic in exploring and measuring the effectiveness of SLE.

CONCLUSION

Based on the explanation in the previous chapters, it can be concluded that: This study focuses on studying trends about the Smart Learning Environment (SLE) framework with a systematic literature review approach. SLR uses the Kitchenham method with 3 stages of planning, implementation, and reporting. 27 final papers will be extracted and synthesized from the data. The findings of RQ 1 show that several dimensions focus on the pedagogy aspect learning of technological dominance are still lacking, so it can be said that it is incomplete when discussed with the concept of SLE. On the other hand, technology trends are still lagging; nowadays, technology has developed, such as AI, blockchain, and cloud computing. However, the A4 and A17 papers do not mention this. The results of the extraction answered that RQ 2 was the most widely applied at the university level. Besides, research on the SLE framework was found in China, while in Indonesia, there were still few, with only 1 research found. Answering RQ 3 about the main focus of SLE framework research. The research discusses the performance evaluation of the implementation of existing systems. In RQ 4, it was concluded that in some studies, such as A4, some experts argue that the evaluation indicators used are not representative, raising concerns about the validity and representativeness of the metrics used in assessing the quality of SLE. Next are several articles, such as A17, A16, and A12, describing research focuses that may be too specific or general. Some only focus on certain aspects, such as the theoretical framework for implementing SLE, technical errors, and maturity. Finally, article A11 states that no information shows the teacher's perspective on intelligent learning. This can be interpreted as a deficiency in considering the views and experiences of those directly involved in the teaching process.

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