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REVIEW PAPER

Cloud Computing Adoption in Management of Educational Institutions: A Systematic Literature Review of Drivers, Implementation, Benefits, and Challenges

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Abstract

Purpose: Cloud computing has become an important component of digital transformation in educational institutions, supporting scalable digital learning environments and improved educational service delivery. However, evidence on cloud computing adoption remains fragmented across institutional contexts, theoretical perspectives, and technology applications. This systematic literature review synthesises research on cloud computing adoption by examining drivers, implementation approaches, benefits, and challenges.

Methodology: Following the PRISMA framework, a structured search was conducted across Scopus, Web of Science, IEEE Xplore Digital Library, and ERIC. From 1,001 identified records, 46 studies met the eligibility criteria after screening and full-text assessment. The included studies were analysed using thematic synthesis.

Results: Findings show that adoption is influenced by technological readiness, compatibility, security, organisational support, institutional resources, and environmental factors. Cloud computing supports learning management systems, digital learning platforms, administrative services, and smart campus initiatives. However, security, privacy, infrastructure limitations, cost, and institutional readiness remain major challenges.

Novelty and Contribution: This review provides an integrated synthesis linking adoption determinants, implementation pathways, outcomes, and barriers, addressing fragmentation in previous studies.

Social and Practical Implications: The findings highlight the need for institutions to align technological investment with governance, security, infrastructure, and user readiness to achieve sustainable cloud adoption and strengthen digital educational access.

Keywords: Cloud Computing; Management; Educational Institutions; Technology Adoption; Digital Transformation

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1 Introduction

The rapid acceleration of digital transformation in education has intensified pressure on educational institutions to develop flexible, scalable, and sustainable digital infrastructures. The expansion of digital learning environments, remote and hybrid instruction models, online assessment systems, and data-driven educational services has significantly increased institutional dependence on reliable information technology resources. Universities and other educational organisations are increasingly required to manage growing volumes of digital content, learner data, and technology-supported services while maintaining operational efficiency and controlling infrastructure costs. These pressures have encouraged institutions to explore alternative computing approaches that can provide greater flexibility, resource optimisation, and service availability compared with traditional information technology arrangements (Hussein Alghushami et al., 2020; Almaiah et al., 2021).

This transformation has contributed to a gradual shift from conventional on-premises IT infrastructures towards cloud-enabled educational ecosystems. Rather than relying exclusively on locally managed servers and physical computing resources, educational institutions are increasingly adopting cloud-based solutions, including Software as a Service (SaaS) learning platforms, Infrastructure as a Service (IaaS) hosting environments, Platform as a Service (PaaS) solutions, cloud storage systems, virtual laboratories, and cloud-supported learning management systems. These approaches allow institutions to access computing resources according to demand, support large-scale digital learning activities, and improve collaboration among students, educators, and administrative stakeholders. Existing studies demonstrate that cloud platforms have been applied across diverse educational functions, including e-learning delivery, university administration, library services, knowledge management, and smart campus development (Wu & Plakhtii, 2021; Miao, 2022; Xie, 2022).

Despite the increasing relevance of cloud computing in education, scientific investigations have demonstrated that adoption is influenced by complex and interconnected factors rather than technological availability alone. Previous studies have examined cloud adoption drivers, implementation approaches, benefits, and challenges using different theoretical perspectives and institutional contexts. The Technology Organisation Environment (TOE) framework has been widely applied to explain institutional adoption decisions, with studies identifying technological readiness, compatibility, security, organisational support, resources, government assistance, and competitive pressure as important determinants (Hussein Alghushami et al., 2020; Al-Ramahi et al., 2022). Other studies have extended adoption explanations through Technology Acceptance Model (TAM), Diffusion of Innovation (DOI), Unified Theory of Acceptance and Use of Technology (UTAUT), and integrated frameworks to examine user acceptance, behavioural intention, cultural influences, and continuance of cloud service usage (Hiran & Henten, 2020; Qasem et al., 2020; Feng & Haridas, 2025). However, evidence also indicates that adoption patterns vary according to institutional level, geographical context, technological maturity, and the specific educational application being implemented. For example, cloud adoption challenges reported in higher education institutions in developing contexts often emphasise infrastructure readiness, security, and resource limitations, whereas studies focusing on learning platforms highlight usability, perceived usefulness, and user acceptance factors (Bhardwaj et al., 2021; Dutta et al., 2021; Naveed et al., 2023).

Although the existing literature provides valuable insights into cloud computing adoption within educational environments, the evidence base remains fragmented across theoretical perspectives, geographical settings, educational levels, and technology applications. Many studies investigate individual aspects of cloud adoption, such as acceptance behaviour, institutional readiness, technical implementation, or specific cloud-based learning applications, without providing an integrated understanding of how these dimensions interact. Furthermore, while previous reviews have examined cloud computing in education broadly, there remains a need for a systematic synthesis that simultaneously considers adoption drivers, implementation approaches, institutional benefits, and barriers influencing sustainable cloud computing adoption. Addressing this fragmentation is important because educational institutions require a comprehensive understanding of not only why cloud technologies are adopted, but also how they are implemented, what outcomes they produce, and what challenges must be managed for long-term success.

Therefore, this systematic literature review aims to synthesise existing empirical and conceptual evidence on cloud computing adoption in educational institutions by examining the factors influencing adoption decisions, implementation approaches, reported benefits, and associated challenges. Specifically, this review addresses the following research questions:

RQ1: What are the drivers of cloud computing adoption in educational institutions?

RQ2: How is cloud computing implemented and integrated within educational institutions?

RQ3: What benefits and outcomes are associated with cloud computing adoption in educational institutions?

RQ4: What challenges and barriers affect cloud computing adoption and implementation in educational institutions?

2 Methodology

This systematic literature review (SLR) was conducted to synthesise existing evidence on cloud computing adoption, implementation, benefits, and challenges within educational institutions. The review followed a structured and transparent methodology guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework to ensure methodological rigour, reproducibility, and clarity throughout the review process. The methodology consisted of four main stages: search strategy development, study identification, screening and eligibility assessment, and data extraction and synthesis.

2.1 Review Design and Protocol

A systematic literature review approach was adopted because the objective of this study was to identify, evaluate, and synthesise fragmented evidence relating to cloud computing adoption in educational contexts. Unlike traditional narrative reviews, an SLR applies predefined procedures for literature identification, selection, analysis, and reporting, thereby reducing selection bias and improving transparency. The review protocol was developed before the literature search and defined the research scope, databases, search terms, inclusion and exclusion criteria, screening procedures, and data extraction strategy.

2.2 Inclusion and Exclusion Criteria

To ensure that only relevant, quality-assured, and comparable studies were incorporated into this systematic literature review, explicit inclusion and exclusion criteria were applied at the screening and eligibility stages (Table 1), consistent with standard SLR protocol (PRISMA guidance). These criteria operationalise the review's aim of identifying, classifying, and synthesising evidence on the drivers, implementation, benefits, and challenges of cloud computing adoption in educational institutions, and they were applied consistently across all candidate records retrieved from the search strategy.

Table 1 Inclusion and Exclusion Criteria

S/N	Inclusion Criterion	Exclusion Criterion	Rationale
1	Peer-reviewed journal articles	Reviews, systematic reviews, meta-analyses, Conceptual or opinion papers without empirical data. Dissertations and theses, Books and book chapters	Ensures a baseline level of methodological quality assurance through the peer-review process
2	Publication period: 2020–2026	Works outside the specified period	Cloud computing in educational contexts matured as a distinct research area from the mid-2010s onward; this window captures the field's development while excluding earlier, largely speculative or pre-adoption literature
3	Focused on educational institutions (K-12, vocational, or higher education) as the unit of analysis	Studies on cloud computing adoption in non-education sectors (healthcare, banking, government, generic SMEs)	Keeps the corpus aligned with the review's institutional focus, rather than individual learners, informal learning, or non-institutional settings
4	Empirical study addressing at least one of RQ1–RQ4	Fails to address at least one research question.	Ensures direct relevance to the review's four guiding research questions and excludes tangentially related studies

	(drivers, implementation, benefits, or challenges)		
5	Cloud computing (SaaS, PaaS, IaaS, or unspecified "cloud") is the explicit technology under study	Purely technical/architectural computer-science papers on cloud infrastructure with no educational-institution context	Ensures the technology of interest is central to the study rather than incidental or mentioned only in passing
6	Full text available	Unavailable full text	Full-text access is required to extract the study design, findings, and contextual detail needed for data extraction and synthesis
7	Published in English	Non-English	Ensures consistent interpretation and extraction accuracy across the review team without reliance on translation

2.3 Search Strategy

A comprehensive and systematic search strategy was developed to identify relevant empirical and conceptual studies examining cloud computing adoption, implementation, outcomes, and challenges within educational institutions. The search strategy was designed in accordance with the principles of systematic literature reviews and guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. The review was anchored on Scopus as the primary database due to its broad multidisciplinary coverage of information systems, computer science, and education-related research. To improve retrieval completeness and minimise database-specific coverage limitations, additional searches were conducted in Web of Science Core Collection, IEEE Xplore Digital Library, and the Education Resources Information Center (ERIC). These databases were selected because they collectively capture multidisciplinary, computing-focused, and education-specific literature relevant to cloud computing adoption in educational contexts.

The final search strategy was developed around three conceptual blocks: (1) cloud computing technologies, (2) adoption, implementation, drivers, outcomes, and challenges, and (3) educational institutions. The use of multiple synonymous terms and truncation operators was intended to maximise retrieval sensitivity while maintaining alignment with the review objectives. The first block captured different forms of cloud computing technologies, including cloud services, cloud-based platforms, and service delivery models such as Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). The second block incorporated terms related to technology adoption, implementation processes, institutional integration, expected benefits, determinants, and barriers. The third block focused specifically on educational settings, including higher education institutions, universities, colleges, schools, academic environments, and learning management systems.

The following database-specific search strings were applied.

Scopus Search Strategy

The Scopus database was searched using the TITLE-ABS-KEY field to identify studies containing relevant concepts within titles, abstracts, or keywords. The search string was:

TITLE-ABS-KEY (("cloud computing" OR "cloud service*" OR "cloud-based" OR "cloud technology" OR "software as a service" OR SaaS OR "platform as a service" OR PaaS OR "infrastructure as a service" OR IaaS) AND (adopt* OR implement* OR integrat* OR migrat* OR deploy* OR utilisation OR driver* OR determinant* OR benefit* OR advantage* OR challenge* OR barrier* OR risk*) AND ("higher education" OR "educational institution*" OR university OR universities OR college* OR school* OR "K-12" OR academ* OR "learning management system*"))

Web of Science Search Strategy

The Web of Science Core Collection database was searched using the Topic (TS) field, which searches titles, abstracts, author keywords, and Keywords Plus. The search string was:

TS=(("cloud computing" OR "cloud service*" OR "cloud-based" OR "cloud technology" OR "software as a service" OR SaaS OR "platform as a service" OR PaaS OR "infrastructure as a service" OR IaaS) AND (adopt* OR implement* OR

integrat* OR migrat* OR deploy* OR utiliz* OR utilis* OR driver* OR determinant* OR benefit* OR advantage* OR challenge* OR barrier* OR risk*) AND ("higher education" OR "educational institution*" OR university OR universities OR college* OR school* OR "K-12" OR academ* OR "learning management system*"))

IEEE Xplore Search Strategy

IEEE Xplore Digital Library was searched to capture computer science, information systems, and engineering-oriented studies that may not be fully represented in multidisciplinary databases. The search string was:

(("Full Text & Metadata":"cloud computing" OR "Full Text & Metadata":"cloud service" OR "Full Text & Metadata":"cloud-based" OR "Full Text & Metadata":SaaS OR "Full Text & Metadata":PaaS OR "Full Text & Metadata":IaaS) AND ("Full Text & Metadata":adoption OR "Full Text & Metadata":implementation OR "Full Text & Metadata":integration OR "Full Text & Metadata":benefits OR "Full Text & Metadata":challenges OR "Full Text & Metadata":barriers) AND ("Full Text & Metadata":"higher education" OR "Full Text & Metadata":university OR "Full Text & Metadata":school OR "Full Text & Metadata":"educational institution"))

The study selection process followed a two-stage screening procedure consistent with PRISMA recommendations. The initial database searches identified a combined total of 1,001 records across Scopus, Web of Science Core Collection, IEEE Xplore, and ERIC. All retrieved records were exported into a reference management system, where records were merged and prepared for screening.

During the first eligibility refinement stage, database filtering options were applied to remove document types that did not meet the review criteria, including theses, book chapters, and conference proceedings. Following this process, 475 journal articles remained for further assessment. A subsequent publication year filter was applied to retain studies published between 2020 and 2026, resulting in 292 records.

The remaining records were screened for duplicate publications, resulting in the removal of duplicate records and retention of 283 unique articles for title and abstract assessment. During Stage 1 screening, titles and abstracts were examined against the predefined eligibility criteria. Studies were excluded where they did not address at least one of the research questions, lacked an educational focus, examined unrelated technological contexts, or did not investigate cloud computing adoption, implementation, outcomes, or challenges within educational environments. Following abstract screening, 178 articles were considered potentially relevant and progressed to full-text assessment.

Stage 2 involved a detailed full-text eligibility assessment of the remaining manuscripts. Full-text screening focused on whether studies provided sufficient evidence related to one or more review objectives: cloud computing adoption drivers, implementation and integration approaches, benefits and outcomes, or challenges and barriers within educational institutions. Articles were excluded where cloud computing was only mentioned superficially, where the educational context was absent, where the study focused exclusively on non-educational sectors, or where insufficient methodological information was available.

Following full-text assessment, 46 studies met all eligibility criteria and were included in the final systematic literature review. The complete study identification, screening, eligibility assessment, and inclusion process is presented using a PRISMA flow diagram (Figure 1).

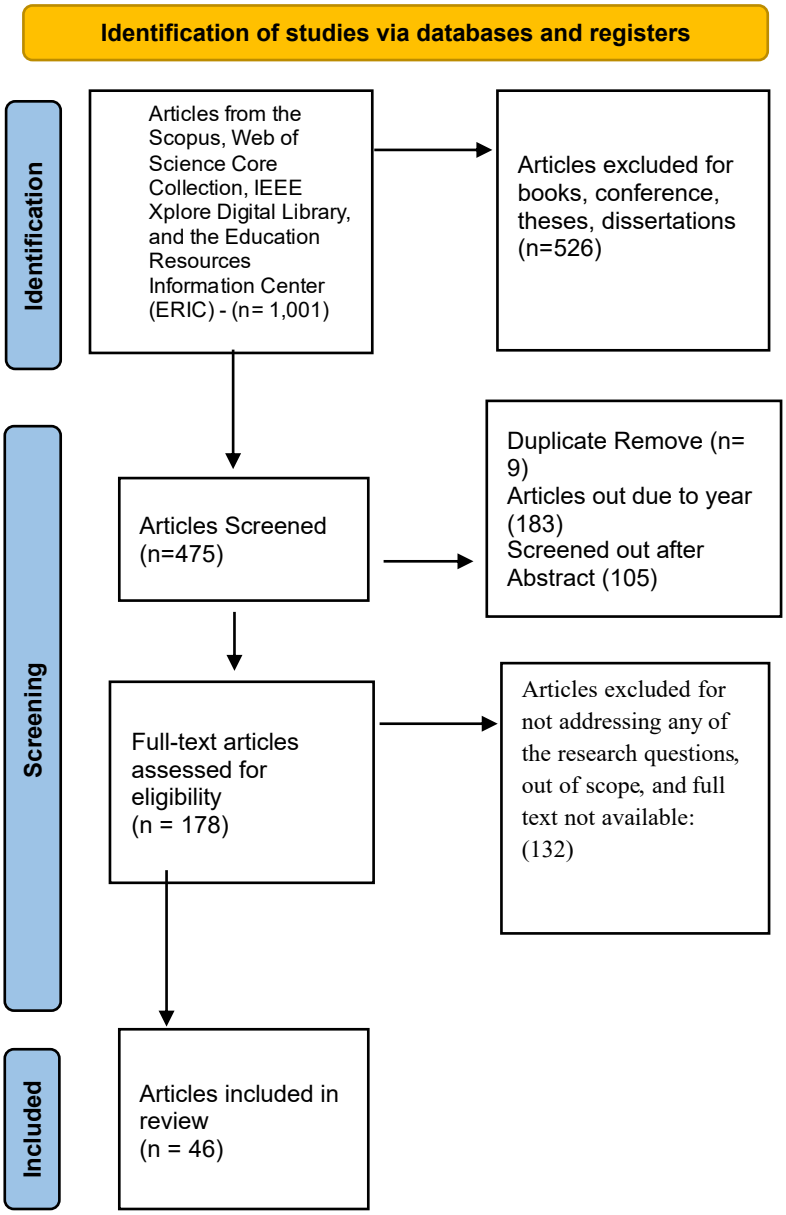


Figure 1 PRISMA flow diagram

2.4 Data Extraction and Analyses

A structured data extraction framework was applied to systematically organise and synthesise evidence from the included studies (Table 2). The extraction process captured key study characteristics, methodological approaches, theoretical foundations, and major findings relevant to cloud computing adoption and implementation in educational institutions. The following information was extracted from each study: Author Name and Year, Institution Type, Theoretical Model Used, Study Design, Authors' Main Conclusion, and Journal.

Table 2 Data extraction table

S/N	Author Name & Year	Institution Type	Theoretical Model Used	Study Design	Authors' Main Conclusion	Journal
1	Tella et al. (2020)	Academic libraries in Nigerian universities	Unified Theory of Acceptance and Use of Technology (UTAUT) and Technology Acceptance Model (TAM)	Quantitative	The authors concluded that the investigated factors were significant determinants of cloud computing adoption for web-based services in academic libraries. The study reported that perceived security and perceived reliability had the strongest influence among the examined factors.	The Journal of Academic Librarianship
2	Hussein Alghushami et al. (2020)	Higher Education Institutions (HEIs) in Yemen	Technology-Organization-Environment (TOE) framework with tribalism culture as a moderating factor	Quantitative	The authors concluded that relative advantage, reliability, compatibility, security, technology readiness, top management support, regulatory policy, and competitive pressure significantly influenced cloud computing adoption in Yemen HEIs. The study also found that tribalism culture had a negative significant effect and moderated some relationships within the adoption model.	Applied Sciences
3	Bhardwaj et al. (2021)	Indian public universities	Technology-Organization-Environment (TOE) framework	Quantitative	The authors concluded that successful cloud computing adoption for e-learning in Indian public universities depends on institutional and technological factors. The study reported that institutional infrastructure and compatibility significantly influenced e-learning adoption.	Computers, Materials & Continua
4	Carreón (2025)	University undergraduate students enrolled in a Database Systems course	Cognitive Load Theory and usability measurement approach	Quantitative	The authors concluded that cloud services provided a viable environment for supporting database learning activities. The study reported that students were able to remotely manage database systems using cloud services and evaluated the learning experience through usability and cognitive load measures.	Journal of Information Technology Education: Innovations in Practice
5	Althani (2025)	Higher education institutions, specifically five Saudi	Socio-technical perspective	Mixed-Method	The author concluded that migrating legacy software to cloud environments in higher education involves interconnected technical, organizational, and human challenges. The study developed an understanding of migration obstacles affecting	Cogent Business & Management

		Arabian universities			higher education institutions during cloud transition.	
6	Ahmed et al. (2025)	Higher education institution, involving students enrolled in an Object-Oriented Programming course	No model adoption	Mixed-Method	The authors concluded that the gamified mobile cloud-based LMS improved student engagement and academic achievement compared with conventional learning approaches. The study reported that integrating cloud-based learning environments with gamification features created a more interactive learning experience.	International Journal of Educational Technology in Higher Education
7	Al-Ramahi et al. (2022)	Jordanian higher education institutions, including governmental and private universities	Modified Technology-Organization-Environment (TOE) framework integrated with Diffusion of Innovation (DOI) theory and Technology Acceptance Model (TAM). The authors proposed the TOEQCC framework.	Qualitative	The authors concluded that cloud computing adoption in Jordanian higher education institutions is influenced by technological, organisational, environmental, and quality-related factors. The study proposed the TOEQCC framework as a roadmap for understanding and supporting sustainable cloud computing adoption.	Sustainability
8	Qasem et al. (2021)	Higher education institutions in Malaysia	Integrated Information Systems (IS) Success Model and IS Discontinuance Model through the Technology-Organization-Environment (TOE) framework	Quantitative	The authors concluded that cloud computing continuance intention in HEIs can be explained through technological, organisational, environmental, and contextual factors. The proposed model explained a substantial proportion of variance in continuance intention.	Sustainability
9	Aldahwan and Ramzan (2022)	Higher education institutions in Saudi Arabia	Quadruple-theory-based framework incorporating Technology Acceptance Model (TAM), Technology-	Quantitative	The authors concluded that multiple technological, organisational, environmental, and institutional factors influence community cloud computing adoption in Saudi HEIs. The study developed and	BioMed Research International

			Organization-Environment (TOE), Diffusion of Innovation (DOI), and Institutional Theory		empirically tested a framework explaining adoption relationships.	
10	Spirin et al. (2022)	Educational institutions	No model adopted	Quantitative	The authors concluded that selecting a cloud-based LMS requires consideration of specific evaluation criteria related to system functionality, educational requirements, and institutional needs.	Information Technologies and Learning Tools
11	Sharma et al. (2025)	Higher education institutions	Knowledge management perspective integrated with cloud computing adoption and innovation framework	Quantitative	The authors concluded that cloud computing adoption contributes to innovation in higher education institutions, and innovation subsequently improves academic performance. The study reported that knowledge management mechanisms help explain the relationship between cloud adoption and academic outcomes.	International Journal of Human–Computer Interaction
12	Naveed et al. (2021)	Higher education institutions	Information Systems Success Model (IS Success Model) and service quality perspective	Quantitative	The authors concluded that service quality factors influence users' perceptions and continued usage of cloud e-learning systems. The study identified determinants affecting effective use of cloud-based e-learning services.	Applied Sciences
13	Amira (2026)	Higher education institution, involving students enrolled in BAIS courses	Technology Acceptance Model (TAM) concepts discussed; data-driven digital learning framework	Quantitative	The author concluded that data-driven factors, digital learning features, perceived usefulness, ease of use, and engagement-related factors influence student learning experiences and academic performance in digital learning environments.	Frontiers in Education
14	Badshah et al. (2023)	Educational institutions	No model adopted	Qualitative	The authors concluded that combining IoT, fog computing, and cloud computing can address limitations of traditional educational systems and support improved educational services, learning environments, and administrative processes.	Future Internet
15	Feng and Haridas (2025)	Jordanian higher education institutions	Extended Unified Theory of Acceptance and Use of Technology (UTAUT) integrated	Quantitative	The authors concluded that the extended UTAUT model improved explanation of behavioural intention to adopt cloud-based collaborative platforms. The study reported that behavioural	Scientific Reports

			with Object-Oriented approaches		control, effort expectancy, and social influence significantly affected attitudes toward using cloud services.	
16	El Koshiry et al. (2024)	Higher education institution, involving blind graduate students	No model adoption	Qualitative	The authors concluded that the cloud-based LMS was effective in developing digital transformation skills among blind graduate students. The study reported improvements after using the cloud learning environment.	Societies
17	Matar et al. (2022)	Universities in Jordan	Technology Acceptance Model (TAM) related constructs	Quantitative	The authors concluded that factors affecting behavioural intention to use mobile cloud computing differed between faculty members and administrative staff. The study identified relationships between technology acceptance factors and intention to use mobile cloud computing in Jordanian universities.	International Arab Journal of Information Technology
18	Younas et al. (2022)	Higher education institution, specifically a public university in Saudi Arabia	No model adopted	Qualitative	The authors concluded that the proposed cloud-based knowledge management framework can support administrative decision-making by providing consolidated information extraction, reporting, and knowledge-sharing capabilities within higher education institutions.	Intelligent Automation & Soft Computing
19	Hiran and Henten (2020)	Higher education institutions in Ethiopia	Integrated Technology–Organization–Environment (TOE) framework and Diffusion of Innovation (DoI) theory	Quantitative	The authors concluded that the integrated TOE–DoI framework provides a suitable approach for explaining cloud computing adoption in Ethiopian higher education. The study validated the measurement of the identified adoption factors.	International Journal of System Assurance Engineering and Management
20	Veljić et al. (2025)	Higher education institutions	Analytic Hierarchy Process (AHP) and Normalized Weighted Aggregated (NWA) decision-making framework	Quantitative	The authors concluded that a structured decision-making framework can support higher education institutions in evaluating and selecting suitable LMS solutions according to institutional sustainability and performance criteria.	Sustainability

21	Moeti (2024)	South African universities	Transaction Cost Theory (TCT) and Diffusion of Innovation (DOI) theory	Qualitative	The author concluded that IaaS adoption in South African universities requires consideration of technological, organisational, and contextual factors. The study developed the Infrastructure as a Service Adoption Model (ISAM) and identified trust, security, and attitude as important factors requiring attention during adoption decisions.	South African Journal of Information Management
22	Alvindra et al. (2026)	Higher education institutions	No model adopted	Quantitative	The authors concluded that cloud-based learning analytics tools influence student engagement and adoption behaviour in higher education. The study reported that factors related to usability and perceived value affect students' willingness to engage with cloud-based LAT systems.	International Journal of Learning Technology
23	Qasem et al. (2020)	Higher education institutions	Integrated Information Systems Success Model and Technology-Organization-Environment (TOE) framework	Qualitative	The authors concluded that continued cloud computing use in HEIs requires consideration of technological, organisational, environmental, and information-system success factors. The proposed model provides a basis for examining post-adoption cloud computing behaviour.	Applied Sciences
24	Yadegaridehkordi et al. (2020)	Malaysian universities	Extended technology acceptance/adoption model incorporating task-technology fit, performance expectancy, effort expectancy, social influence, self-efficacy, and collaboration technology experience	Quantitative	The authors concluded that several behavioural, technological, and social factors significantly predicted students' intention to adopt SaaS-based collaboration services in higher education.	Education and Information Technologies
25	Ali (2020)	Higher educational institutions in Saudi Arabia	No model adopted	Qualitative	The author concluded that cloud computing offers significant opportunities for higher education institutions by supporting improved educational services, resource utilisation, and sustainable development. The study identified important considerations affecting adoption decisions in Saudi HEIs.	International Journal of Computer Applications

26	Ayouni et al. (2021)	Higher education institutions in Saudi Arabia	IS/IEC 9126 software quality framework and Fuzzy VIKOR multi-criteria decision-making method	Quantitative	The authors concluded that a structured quality-based evaluation framework can support higher education institutions in selecting suitable LMS solutions. The study found that LMS evaluation requires consideration of multiple quality criteria when making institutional decisions.	International Journal of Information and Communication Technology Education
27	Almufarreh et al. (2026)	Smart learning environments in educational institutions	No model adopted	Qualitative	The authors concluded that machine learning-based anomaly detection can support the protection of smart learning environments. Random Forest achieved the strongest detection performance among the evaluated models, providing practical guidance for selecting intrusion detection approaches in educational network infrastructures.	Computers, Materials & Continua
28	Amo et al. (2021)	Higher education institutions	No model adopted	Qualitative	The authors concluded that a modular private cloud-based educational warehouse can support learning analytics activities while addressing privacy, security, scalability, and data management requirements in educational environments.	Applied Sciences
29	Okai-Ugbaje et al. (2020)	Higher education institution in Nigeria	Social Constructivism and Flow Theory	Qualitative	The authors concluded that cloud-based m-learning provided a practical approach for addressing infrastructure limitations and supported gradual introduction of student-centred learning practices in resource-constrained higher education environments.	Education and Information Technologies
30	Kavitha (2021)	Educational institutions	No model adopted	Qualitative	The author concluded that the proposed cloud computing-based classification approach can support teacher performance evaluation and recruitment decisions by improving prediction accuracy, protecting user queries, and reducing processing challenges associated with large educational datasets.	Wireless Personal Communications
31	Aydin (2021)	Universities in Turkey	No model adopted	Qualitative	The author concluded that universities face challenges related to cloud computing adoption and proposed an abstract hybrid cloud framework as a guideline to support universities during cloud migration.	SAGE Open

32	Corbi et al. (2023)	Educational institutions	No model adopted	Qualitative	The authors concluded that cloud computing can support educational systems by improving access to resources, supporting e-learning, reducing infrastructure requirements, and enhancing educational service delivery. They also highlighted security and privacy considerations associated with cloud adoption.	IEEE Transactions on Learning Technologies
33	Vakaliuk et al. (2021)	Educational institutions and learning environments	No model adopted	Qualitative	The authors concluded that cloud education environments enable flexible, distributed, and interoperable educational ecosystems by combining cloud services, learning resources, and educational applications.	Educational Technology Quarterly
34	Engelberger et al. (2021)	Educational institutions and learning environments	No model adopted	Qualitative	The authors concluded that cloud education environments enable flexible, distributed, and interoperable educational ecosystems by combining cloud services, learning resources, and educational applications.	Journal of Chemical Education
35	Ramya and Rajeswari (2024)	Teacher education institution / higher education	Technology acceptance-related model incorporating perceived usefulness, perceived ease of use, perceived security, frequency of usage, and behavioural intention	Quantitative	The authors concluded that usability-related factors, perceived usefulness, perceived ease of use, perceived security, frequency of use, and behavioural intention are relevant factors in understanding pre-service teachers' inclination toward cloud-based technology utilisation.	International Journal of Instruction
36	Aldoayan et al. (2021)	Higher education institutions	No model	Qualitative	The authors concluded that cloud-based collaborative online courses provide opportunities for flexible learning and improved collaboration, but successful implementation requires addressing educational, operational, quality, legal, and security issues.	International Journal of Learning Technology
37	Verma et al. (2021)	Educational institutions	No mode	Qualitative	The authors concluded that the proposed IFC framework can support Education 4.0 through real-time monitoring, irregularity detection, prediction, and reporting within educational environments. The simulation results showed improved	IEEE Access

					performance in delay efficiency, data classification, irregularity prediction, and system stability.	
38	Miao (2022)	Universities and colleges	No model	Quantitative	The author concluded that the proposed cloud computing-based educational administration platform improved system performance, including CPU and memory utilisation and response speed.	Mathematical Problems in Engineering
39	Xie (2022)	University library	No model	Quantitative	The author concluded that a cloud-based reading service platform can support university library digital services by improving resource management, personalised information services, and reading promotion activities.	Mathematical Problems in Engineering
40	Zhang (2022)	College/higher education institution	No model	Qualitative	The author concluded that introducing cloud computing technology into college English teaching can support improved teaching processes, resource sharing, and personalised learning services.	Mathematical Problems in Engineering
41	Zhang and Liu (2022)	Universities / smart campus environment	No model	Qualitative	The author concluded that integrating cloud computing and IoT technologies into smart campus one-card management can improve campus service management, information sharing, and intelligent decision support.	Mathematical Problems in Engineering
42	Wang and Wang (2023)	Colleges and universities	No model	Qualitative	The authors concluded that intelligent edge-cloud computing improved the management, sharing, and utilisation of college physical education teaching resources.	Journal of Cloud Computing
43	Tian and Li (2025	Universities / smart campus environments	No model	Qualitative	The authors concluded that the proposed fog computing framework can reduce computational burdens and improve cost efficiency in university governance environments by optimising resource allocation and processing strategies.	Scientific Reports
44	Hong (2021)	Colleges and universities	No model	Mixed-Method	The author concluded that integrating cloud computing and wireless communication technologies can provide new approaches for improving ideological and political education in colleges and universities by supporting information management, communication, and educational innovation.	Scientific Programming,

45	Dutta et al. (2021)	Educational institutions / e-learning users	Technology Acceptance Model (TAM) extended with usability-related factors	Quantitative	The authors concluded that usability-related factors significantly influence sustainable adoption of cloud-based e-learning systems. The study highlighted the importance of designing cloud-based learning systems that are useful, easy to use, and aligned with learner needs.	Sustainability
46	Naveed et al. (2023)	Higher education institutions	Extended Technology Acceptance Model (TAM) / sustainability adoption framework	Quantitative	The authors concluded that successful sustainable adoption of cloud-based mobile learning depends on multiple technological, educational, and user-related factors. The study highlighted that perceived usefulness, usability, system quality, and other adoption-related factors influence continued use of cloud-based mobile learning systems.	Sustainability

3 Discussion of Findings

This section synthesises the findings extracted from the 46 primary studies included in this systematic literature review (SLR) on cloud computing adoption in educational institutions. Rather than restating the extraction table on a study-by-study basis, the discussion draws the individual findings together into an integrated, thematic account of what the literature collectively says about the drivers, implementation patterns, benefits, and challenges of cloud computing adoption in education. Consistent with established SLR reporting conventions, the synthesis identifies points of convergence and divergence across studies, notes the theoretical frameworks that recur across the corpus, situates findings within their geographic and institutional contexts, and highlights gaps that emerge only when the studies are read together rather than in isolation. The discussion is organised around the four research questions guiding this review.

3.1 RQ1: Drivers of Cloud Computing Adoption in Educational Institutions

Technological, Organisational and Environmental (TOE) Drivers

A significant number of the analyzed studies utilized the Technology-Organisation-Environment (TOE) framework, or its adaptations, to elucidate adoption choices, indicating a notable alignment in the theoretical perspective employed for institutional-level adoption decisions across various national settings. Hussein Alghushami et al. (2020) examined higher education institutions (HEIs) in Yemen and discovered that relative advantage, reliability, compatibility, security, technology readiness, support from top management, regulatory policy, and competitive pressure had substantial positive impacts on adoption, with all three TOE dimensions concurrently represented. Al-Ramahi et al. (2022) expanded this perspective within the Jordanian framework by introducing a TOEQCC model that incorporated quality and cultural elements alongside traditional TOE dimensions, identifying technological factors (infrastructure availability, awareness, trialability, data security, data privacy, backup and recovery), organizational factors (resources, budget, institutional size, readiness), and environmental factors (government assistance, external conditions) as collectively impactful. Bhardwaj et al. (2021) similarly identified institutional infrastructure and compatibility as critical factors in the adoption of cloud-based e-learning in Indian public universities during the COVID-19 pandemic, whereas Hiran and Henten (2020) introduced an additional socio-cultural aspect into a comprehensive TOE-DoI model for Ethiopian higher education institutions, emphasizing that technological readiness is inadequately effective across diverse cultural settings without the integration of socio-cultural factors. Qasem et al. (2021) and Qasem et al. (2020) utilized constructs derived from the TOE framework not for initial adoption but for continuance, merging the IS Success Model and IS Discontinuance Model to demonstrate that technological, organizational, environmental, and perceived-outcome factors influence whether institutions maintain cloud usage after adoption, thereby extending TOE-based reasoning into the post-adoption phase, a focus often overlooked by other TOE-oriented studies in this review.

When examined collectively, these TOE-focused studies highlight infrastructure preparedness, executive endorsement, compatibility, and security/privacy as consistent technological and organizational factors. They differ, nonetheless, regarding environmental factors, which seem significantly more reliant on context: governmental support is a key aspect in the Jordanian results of Al-Ramahi et al. (2022), whereas competitive dynamics and regulatory frameworks prevail in the Yemeni results of Hussein Alghushami et al. (2020). This discrepancy indicates that environmental factors influencing adoption are less universally applicable across different settings compared to technological or organizational factors, a subtlety that is often overlooked when the TOE framework is seen as a consistent, transferable explanatory model.

Behavioural and Technology-Acceptance-Based Drivers

A second and equally notable set of studies draws upon individual-level theories of technology acceptance, most notably UTAUT, TAM, and DOI, to account for adoption at the level of the user rather than the institution. The UTAUT and TAM constructs were used to significantly predict the adoption of cloud-based online services by librarians based on perceived security, perceived reliability, enabling conditions, simplicity of use, flexibility and productivity gains (Tella et al., 2020). Aldahwan and Ramzan (2022) combined TAM, TOE, DOI and Institutional Theory in their study of community cloud adoption in Saudi HEIs, identifying perceived usefulness, ease of use, relative advantage, compatibility, complexity, security, trust, organizational readiness and institutional influence as significant factors, thus effectively linking the individual-level and institutional-level drivers identified elsewhere in the corpus. Studies have shown that academics' attitudes toward adopting cloud-based collaborative platforms are influenced by behavioral control, effort

expectancy, and social influence, as derived from an extended UTAUT model (Feng and Haridas, 2025). Multi-group structural equation modeling has been used to show that the behavioral intention to use mobile cloud computing differs between faculty members and administrative staff (Matar et al., 2022). This methodological contribution reveals within-institution heterogeneity that aggregate TOE-level analyzes tend to mask. Yadegaridehkordi et al. (2020) identified task-technology fit, performance expectancy, effort expectancy, social influence, self-efficacy, collaboration technology experience and peer and superior influence as predictors of students' intention to adopt SaaS-based collaboration services. Ramya and Rajeswari (2024) reported similar acceptance-based predictors, perceived usefulness, ease of use, perceived security and frequency of usage, specifically among pre-service teachers, extending the acceptance literature to a teacher-training population rarely addressed elsewhere in the reviewed corpus. Dutta et al. (2021) and Naveed et al. (2023) studied usability as a driver of sustained adoption of cloud-based e-learning and mobile learning systems, respectively, not just the initial adoption. This confirms that acceptance-based drivers are relevant throughout the technology's institutional lifecycle, not just upon first adoption. Alvindra et al. (2026) similarly observed that usability and perceived utility drove students' desire to adopt cloud-based Learning Analytics Tools.

Considered jointly, this cluster confirms that individual perceptions, usefulness, ease of use, and social influence in particular, recur as adoption predictors regardless of the specific cloud application (learning management, mobile learning, collaboration, or analytics tools) or user group (students, faculty, administrative staff, or pre-service teachers). This consistency shows that these constructs serve as near-universal micro-level drivers that complement, rather than compete with, the institutional-level TOE drivers outlined in the previous paragraph.

Institutional, Contextual and Emerging Drivers

A smaller group of studies addressed drivers that sit outside the dominant TOE and acceptance paradigms. Moeti (2024) identified trust, security, and attitude as significant issues for South African university administrators deciding on Infrastructure-as-a-Service migration, foregrounding managerial risk perception as a driver different from either technology preparedness or individual acceptability. Sharma et al. (2025) approached drivers from an organisational-innovation angle, examining cloud computing adoption as a factor that supports knowledge management and innovation processes, a framing not replicated elsewhere in the reviewed literature and pointing to an under-examined driver category in which adoption is motivated by innovation strategy rather than operational necessity. Naveed et al. (2021) examined drivers from a service-quality viewpoint, reporting that system quality, information quality, and service quality influenced users' perceptions of, and usage behavior toward, cloud e-learning systems. Ali (2020) and Aydin (2021) discussed drivers at a more descriptive, institutional-capability level, technological capability, institutional requirements, and existing ICT environments, reflecting the exploratory, qualitative character of these two studies relative to the hypothesis-driven quantitative studies discussed above.

Taken as a whole, the RQ1 data converges most strongly on infrastructure and technology preparedness, top management and organisational support, security and privacy, and compatibility as consistently major determinants, cutting across both institutional and individual levels of analysis. Divergence is greatest around environmental and cultural factors, which some studies (notably Hussein Alghushami et al., 2020, and Hiran and Henten, 2020) suggest can act as negative moderators, such as tribalism culture, rather than simple facilitators, a nuance that a purely technology-centric account of adoption drivers would overlook.

3.2 RQ2: Implementation and Integration of Cloud Computing in Educational Institutions

Structured Frameworks for Adoption and Migration

Several studies proposed structured frameworks intended to guide institutions through cloud adoption or migration rather than describing an already-completed implementation. Al-Ramahi et al. (2022) proposed the TOEQCC framework as a structured approach through which Jordanian HEIs could plan cloud adoption around infrastructure availability, access to digital resources, backup and recovery mechanisms, and institutional preparedness. Moeti (2024) developed the ISAM framework to guide South African university managers through the transition from traditional on-premises infrastructure to Infrastructure-as-a-Service environments, while Aydin (2021) proposed an abstract hybrid cloud framework intended to guide university migration by combining institutional requirements with cloud service adoption approaches, having first examined existing conditions and difficulties associated with university cloud adoption. Althani (2025) examined the migration of legacy software systems to cloud environments more directly, reporting that migration involves both technical processes, such as adapting existing systems and addressing integration issues, and

organisational processes associated with managing the transition from legacy to cloud-based platforms. Taken together, these four studies indicate that implementation in the higher education context is rarely treated as a single technical event; rather, it is consistently framed as a staged, planned process requiring dedicated frameworks that combine technological, organisational, and often financial considerations.

Selection and Evaluation of Cloud-Based Learning Management Systems

A distinct implementation-related theme concerns how institutions select and evaluate Learning Management System (LMS) options once the decision to adopt cloud computing has been made. Spirin et al. (2022) examined criteria for selecting cloud-based LMS platforms, focusing on characteristics and requirements institutions should weigh when implementing cloud-based LMS solutions. Ayouni et al. (2021) extended this line of enquiry by comparing proprietary, open-source, and cloud-based LMS alternatives and developing a quality framework to assist decision-makers, while Veljić et al. (2025) provided a structured, multi-criteria approach for assessing LMS alternatives to support institutional technology decisions. The convergence across these three studies suggests that LMS selection has emerged as its own implementation sub-problem within cloud adoption, distinct from broader infrastructure migration, and one for which the literature has already generated multiple, largely compatible, decision-support frameworks.

Purpose-Built and Domain-Specific Cloud Systems

The largest and most heterogeneous implementation theme comprises studies that reported the design, development, or deployment of purpose-built cloud-based systems for specific institutional functions. In the teaching and learning domain, Ahmed et al. (2025) implemented a Gamified Mobile Cloud-Based Learning Management System (GMCLMS) integrating mobile technologies, cloud computing, and gamification for an Object-Oriented Programming course; El Koshiry et al. (2024) implemented a cloud-based LMS specifically to support digital transformation skills among blind graduate students; Zhang (2022) constructed a cloud-based English teaching platform to support teaching resource management and teacher-student interaction; and Wang and Wang (2023) developed an intelligent edge-cloud framework integrating cloud computing, edge computing, and virtualisation to manage college physical education teaching resources. In parallel, several studies addressed administrative and campus-management functions: Miao (2022) developed a distributed real-time cloud computing platform for university educational administration; Xie (2022) constructed a university library reading-service platform on a cloud computing base incorporating virtualisation and distributed data storage; Zhang and Liu (2022) developed a smart-campus one-card management system integrating cloud computing, big data, and the Internet of Things; and Tian and Li (2025) proposed a fog-computing-based architecture for university governance intended to reduce dependence on centralised cloud processing. Hong (2021) reported the integration of cloud computing and wireless communication technologies into college ideological and political education processes, extending purpose-built implementation into a non-STEM administrative domain rarely addressed elsewhere in the corpus.

A further sub-set of studies combined cloud computing with adjacent technologies, particularly the Internet of Things (IoT) and fog computing, to address data-intensive or infrastructure-constrained educational problems. Badshah et al. (2023) discussed the integration of cloud computing with IoT and fog computing infrastructures to support smart educational environments; Verma et al. (2021) proposed an IoT-Fog-Cloud framework that collects real-time data, processes it through fog-cloud nodes, and applies machine learning for irregularity prediction; Amo et al. (2021) proposed a modular private cloud-based educational data warehouse architecture supporting learning-analytics activities while addressing privacy and security requirements; Kavitha (2021) implemented a cloud computing-based teacher-performance evaluation framework using K-means clustering and K-nearest-neighbour classification on multidimensional educational datasets; and Almufarreh et al. (2026) examined smart learning environments relying on cloud-based learning management systems, virtual classrooms, and machine learning-based intrusion detection. Younas et al. (2022) implemented and evaluated, at a public Saudi university, a cloud-based knowledge-management framework supporting institutional decision-making, an implementation notable for targeting managerial rather than pedagogical processes.

Implementation of Cloud-Enabled Learning Environments and Practical Use Cases

A final implementation theme concerns the practical, often blended, deployment of cloud computing to support specific learning activities rather than the construction of a bespoke platform. Carreón (2025) implemented cloud services within a Database Systems course, allowing undergraduate students to remotely access and manage database systems as an alternative to a physical laboratory. Okai-Ugbaje et al. (2020) implemented a cloud-based m-learning model in a

Nigerian university as a blended approach that complemented, rather than replaced, traditional teaching. Vakaliuk et al. (2021) developed and implemented a cloud-based learning environment, together with a methodological system of forms, methods, and tools, for computer science bachelor training. Corbi et al. (2023) described cloud computing's use within educational systems through cloud-supported e-learning environments, online storage, and shared computing resources; Engelberger et al. (2021) described cloud education environments as distributed educational ecosystems integrating multiple cloud services, learning platforms, and analytics tools; and Aldoayan et al. (2021) examined how cloud-based environments support the delivery of collaborative online courses through shared resources and online collaboration. Amira (2026) examined the implementation of digital learning technologies within higher education courses more broadly, while Alvindra et al. (2026) reported the implementation of cloud-based Learning Analytics Tools to monitor and analyse student learning behaviour. Bhardwaj et al. (2021) reported the use of cloud computing to support e-learning activities during the COVID-19 outbreak, and Ali (2020) reported that cloud computing adoption in Saudi HEIs involved the use of cloud-based services to support both academic and administrative activities. Dutta et al. (2021) examined cloud-based e-learning systems as integrated platforms supporting course creation, delivery, and learning management, while Naveed et al. (2023) described cloud-based mobile learning implementation as combining cloud infrastructure with mobile access to learning materials and flexible content delivery.

Considered as a whole, the RQ2 findings show that implementation in educational institutions spans a spectrum from high-level strategic frameworks (Al-Ramahi et al., 2022; Moeti, 2024; Aydin, 2021; Althani, 2025), through decision-support tools for selecting existing cloud products (Spirin et al., 2022; Ayouni et al., 2021; Veljić et al., 2025), to the bespoke design of purpose-built systems addressing narrow institutional problems (Ahmed et al., 2025; El Koshiry et al., 2024; Miao, 2022; Xie, 2022; Zhang, 2022; Zhang and Liu, 2022; Wang and Wang, 2023; Tian and Li, 2025; Hong, 2021; Badshah et al., 2023; Verma et al., 2021; Amo et al., 2021; Kavitha, 2021; Almufarreh et al., 2026; Younas et al., 2022), and finally to the practical, classroom-level deployment of cloud services in specific courses or programmes (Carreón, 2025; Okai-Ugbaje et al., 2020; Vakaliuk et al., 2021; Corbi et al., 2023; Engelberger et al., 2021; Aldoayan et al., 2021; Amira, 2026; Alvindra et al., 2026; Bhardwaj et al., 2021; Ali, 2020; Dutta et al., 2021; Naveed et al., 2023). A notable pattern is the concentration of purpose-built system studies from Chinese university contexts (Miao, 2022; Xie, 2022; Zhang, 2022; Zhang and Liu, 2022; Wang and Wang, 2023; Tian and Li, 2025; Hong, 2021), each addressing a discrete administrative or teaching function, suggesting a distinct implementation tradition oriented toward integrated, institution-specific platforms rather than adoption of generic third-party cloud products.

3.3 RQ3: Benefits and Outcomes of Cloud Computing Adoption in Educational Institutions

Continuity, Access and Crisis Response

The clearest and most immediately evident benefit reported across the literature concerns educational continuity during disruption. Bhardwaj et al. (2021) reported that cloud computing adoption supported e-learning continuity and remote educational delivery during COVID-19, enabling Indian public universities to sustain academic activity when face-to-face teaching was disrupted. Matar et al. (2022) similarly examined mobile cloud computing as a mechanism supporting Jordanian university activities under remote-education conditions during the pandemic. Together, these two-studies position cloud computing as a resilience-enabling technology whose value became most visible under conditions of institutional disruption rather than under normal operating conditions.

Learning, Engagement and Academic Outcomes

A second cluster of studies reported benefits at the level of individual learning outcomes. Ahmed et al. (2025) found, using a quasi-experimental design, that the GMCLMS approach improved student engagement and academic achievement relative to conventional learning management approaches. El Koshiry et al. (2024) found that the cloud-based LMS contributed to improved digital transformation skills among blind graduate students, evaluated through pre- and post-implementation skill measurement. Vakaliuk et al. (2021) found that implementing the methodological system for cloud-based learning environments increased digital competence among computer science bachelor students, evaluated against defined criteria and levels. Okai-Ugbaje et al. (2020) reported a positive self-reported impact of the cloud-based m-learning approach on students' learning experiences, while Amira (2026) reported that digital learning factors positively influenced student engagement and academic performance. Carreón (2025) evaluated benefits from the students' perspective specifically, using usability and cognitive load measures, and found that cloud services supported remote database learning activities outside the traditional laboratory. Ramya and Rajeswari (2024) and Yadegaridehkordi et al. (2020), although framed primarily as adoption studies, also implicitly supported this benefit

theme by demonstrating that pre-service teachers and students, respectively, regarded cloud technologies as facilitating access to digital learning resources and collaborative activity.

Institutional Efficiency and Operational Performance

A third cluster of benefits concerns measurable improvements to institutional operations. Younas et al. (2022) reported that their cloud-based knowledge-management framework improved access to consolidated information, supported more efficient decision-making, and enhanced knowledge sharing between institutional units, with the evaluated prototype demonstrating improved effectiveness and efficiency. Miao (2022) reported measurable improvements in CPU and memory utilisation and faster system response times for the developed educational administration platform compared with the traditional approach. Xie (2022) reported that the cloud-based library platform supported improved digital reading services through large-scale data storage, personalised information services, and big data analysis. Zhang and Liu (2022) reported that the smart-campus one-card management approach improved campus management efficiency, information sharing, and service intelligence. Tian and Li (2025) reported improved cost optimisation and resource-management efficiency, with reduced computational burden supporting sustainable smart-campus operations. Kavitha (2021) reported that the cloud-based teacher-performance evaluation model improved processing speed and consistency in recruitment and evaluation decisions, and Verma et al. (2021) reported, via simulation, improved prediction efficiency, classification accuracy, delay efficiency, and system stability for the proposed IoT-Fog-Cloud framework.

Resource Access, Flexibility and Scalability

A fourth, broader cluster of studies reported benefits framed in terms of resource access, flexibility, and scalability rather than specific performance metrics. Ali (2020) reported that cloud adoption could improve access to resources, enhance educational service delivery, provide scalability, and support sustainable development objectives. Corbi et al. (2023) reported that cloud computing can improve accessibility of learning resources, enable flexible learning environments, and reduce dependence on physical infrastructure. Engelberger et al. (2021) reported that cloud education environments support innovation, flexibility, accessibility, and reuse of educational resources by allowing institutions to combine cloud services according to need. Aydin (2021) reported that cloud computing can help universities address budget constraints and hardware and software management difficulties while providing more flexible services to students, instructors, researchers, and administrators. Moeti (2024) and Althani (2025) both reported that cloud migration and IaaS adoption provide potential advantages including scalability, flexibility, accessibility, and enhanced security capabilities, although Althani (2025) noted that its own study focused primarily on migration challenges rather than measured post-migration outcomes. Aldoayan et al. (2021) identified improved flexibility, easier access to learning resources, and enhanced collaboration among learners as opportunities associated with cloud-based collaborative online courses; Wang and Wang (2023) found that cloud-based resource management increased sharing and utilisation of teaching equipment, courses, sports venues, and educational media resources; Naveed et al. (2023) reported that cloud-based mobile learning improved accessibility, flexibility, and availability of learning resources while providing an economical alternative to traditional e-learning; and Dutta et al. (2021) reported that sustainable cloud-based e-learning systems support course delivery, learning management, and continuous learning access. Qasem et al. (2021) and Qasem et al. (2020) reported, at the organisational level, that institutions consider cloud computing valuable primarily for resource optimisation and improved delivery of IT services, framing perceived value as central to continuance decisions. Al-Ramahi et al. (2022) reported that stakeholders perceived cloud computing as having the potential to improve educational quality, knowledge sharing, collaboration, and institutional performance, while Aldahwan and Ramzan (2022) incorporated perceived usefulness and expected advantages of community cloud computing directly into their adoption framework. Spirin et al. (2022) and Veljić et al. (2025) reported that appropriate LMS selection and structured evaluation, respectively, can support sustainability, efficiency, and improved educational management, and Ayouni et al. (2021) reported that evaluating LMS quality can support improved learning outcomes and teaching strategies. Naveed et al. (2021) reported that improved cloud e-learning service quality contributes to active system usage, Badshah et al. (2023) reported that cloud, fog, and IoT-based educational environments can support improved accessibility and administrative efficiency, Feng and Haridas (2025) reported that cloud-platform adoption can support sustainable educational practices through improved collaboration and resource optimisation, and Alvindra et al. (2026) reported that cloud-based Learning Analytics Tools support improved understanding of student engagement.

Innovation, Security Monitoring and Specialised Outcomes

A final, smaller theme concerns benefits tied to innovation and to the improved management of educational data and networks. Sharma et al. (2025) found that cloud computing adoption positively influenced innovation, which in turn improved academic performance, when integrated with knowledge-management practices, while Hong (2021) reported that combining cloud computing with wireless communication technologies improved the efficiency and innovation of ideological and political education activities. Almufarreh et al. (2026) reported that machine learning-based anomaly detection improved the resilience and security-monitoring capability of smart learning environments, with a Random Forest model achieving high detection performance for abnormal network traffic, and Amo et al. (2021) reported that its proposed educational data-warehouse architecture supported improved educational data management and institutional decision-making while offering scalability and flexibility through cloud resources. Zhang (2022) reported that the cloud-based English teaching platform supported personalised learning, improved resource access, and enhanced teacher-student interaction.

The RQ3 findings show substantial convergence around four recurring benefit categories: continuity of educational delivery, improved learning and engagement outcomes, institutional operational efficiency, and expanded access, flexibility, and scalability, with a smaller but consistent thread of studies additionally reporting innovation and security-related gains. Notably, the benefits reported in quantitatively evaluated studies (Miao, 2022; Verma et al., 2021; Ahmed et al., 2025; Almufarreh et al., 2026) tend to be expressed as measured performance improvements, whereas benefits reported in conceptual or framework-oriented studies (for example, Ali, 2020; Corbi et al., 2023; Engelberger et al., 2021) tend to be expressed as anticipated or perceived advantages rather than empirically demonstrated outcomes. This distinction is an important qualifier on the overall strength of the benefits evidence base.

3.4 RQ4: Challenges and Barriers to Cloud Computing Adoption, Implementation and Use

Security, Privacy and Trust-Related Barriers

Security and privacy concerns constitute the most frequently reported barrier category across the reviewed literature, cutting across geographic contexts and institutional types. Hussein Alghushami et al. (2020) reported that security concerns, privacy concerns, lack of trust, cultural attitudes, limited digital experience, and insufficient technical knowledge were contextual barriers affecting cloud computing adoption in Yemen HEIs, with tribalism culture additionally exerting a negative moderating influence. Al-Ramahi et al. (2022) identified security and privacy concerns, trust in cloud service providers, insufficient ICT resources, and infrastructure limitations as barriers in the Jordanian context, while Aldahwan and Ramzan (2022) reported that security concerns, trust issues, complexity, and institutional conditions affected acceptance of community cloud computing in Saudi HEIs. Badshah et al. (2023) and Almufarreh et al. (2026) both discussed security and privacy as central concerns within smart educational technology and smart learning environments respectively, while Amo et al. (2021) and Kavitha (2021) each identified the protection of learner and educational data, and the control of access patterns within cloud-based data-mining approaches, as persistent difficulties. Younas et al. (2022) discussed cloud data security and cost considerations together, noting that selective use of cloud services can help manage both risks simultaneously, and Ali (2020) and Corbi et al. (2023) each identified security, privacy, and institutional readiness, or dependence on internet connectivity, as recurring concerns requiring institutional attention. Aldoayan et al. (2021) and Verma et al. (2021) identified security issues as part of a broader set of challenges affecting, respectively, cloud-based collaborative online course provision and IoT-enabled smart educational environments.

Infrastructure and Technical Limitations

A second cluster of barriers relates to inadequate or incompatible technical infrastructure. Bhardwaj et al. (2021) discussed institutional infrastructure requirements and compatibility considerations as conditions affecting successful cloud-based e-learning adoption, and Al-Ramahi et al. (2022) similarly identified infrastructure limitations and insufficient ICT resources as adoption barriers. Okai-Ugbaje et al. (2020) identified inadequate IT infrastructure as a contextual challenge affecting higher education learning environments more broadly, framing cloud-based m-learning as a response to, rather than a solution independent of, this constraint. Verma et al. (2021) additionally noted the need for appropriate IoT infrastructure as a precondition for implementing smart educational environments, and Aydin (2021) identified problems affecting cloud computing use in universities related to existing ICT environments prior to developing its migration guideline.

Trust, Cultural and Institutional Barriers

Beyond security-specific trust concerns, several studies identified broader cultural and institutional barriers to adoption. Hussein Alghushami et al. (2020) found that tribalism culture exerted a distinct negative significant effect on adoption in the Yemeni context, moderating other adoption relationships. Hiran and Henten (2020) examined environmental and socio-cultural factors affecting cloud adoption in Ethiopian HEIs as dimensions requiring explicit consideration alongside technological and organisational conditions, reinforcing that culturally specific barriers are not confined to a single national context but recur, in different forms, across multiple developing-country settings represented in this review.

Behavioural and Acceptance-Related Barriers

A further set of studies located barriers at the level of individual user behaviour rather than institutional infrastructure or culture. Feng and Haridas (2025) discussed users' expectations, behavioural control, effort required to use the technology, and social influence as conditions affecting successful cloud adoption and acceptance behaviour. Matar et al. (2022) found that user characteristics and acceptance conditions differed between university user groups, indicating that behavioural intention to use mobile cloud computing is not uniform across staff categories, and Naveed et al. (2021) considered system performance, service delivery, and quality perceptions as conditions affecting user experience and, by extension, continued acceptance of cloud e-learning systems.

Migration, Cost and Continuance-Related Barriers

Several studies identified barriers specific to the process of migrating to, or continuing to use, cloud services once initial adoption has occurred. Althani (2025) identified the most extensive set of migration-specific barriers in the corpus, including technical difficulties in migrating legacy software, compatibility and integration problems, vendor lock-in concerns, financial implications of migration, ongoing maintenance costs, budget allocation challenges, and organisational and stakeholder-related issues. Qasem et al. (2021) reported that continued cloud computing use involves organisational uncertainty regarding whether to maintain or discontinue services, the possibility of switching vendors, and the need for ongoing evaluation of service value, situating continuance decisions themselves as a distinct source of institutional risk. Tian and Li (2025) implicitly reinforced this theme by identifying high computational demands, inefficient resource utilisation, and increased operational costs as the specific weaknesses of the centralised computing approaches that its proposed framework was designed to address.

Limitations of Traditional and Legacy Systems as Underlying Drivers of Challenge

A distinctive pattern within the RQ4 evidence, concentrated among the Chinese university-context studies, is that several papers framed the challenge motivating cloud adoption not as a property of cloud computing itself but as a limitation of the traditional, pre-cloud system it was designed to replace. Miao (2022) discussed difficulties caused by increasing university scale, growing numbers of students and departments, and the need for improved administrative management efficiency under traditional systems. Xie (2022) identified challenges associated with traditional digital library systems, including difficulties managing large information volumes and limited resource sharing between libraries. Zhang (2022) discussed limitations of traditional English teaching approaches, including restricted resource sharing and limited integration of digital learning resources, while Zhang and Liu (2022) discussed challenges associated with traditional campus management, including fragmented information systems and limited resource sharing. Wang and Wang (2023) identified limitations in traditional teaching resource management, including poor sharing, fragmentation, and inefficient utilisation, and Hong (2021) discussed limitations of traditional ideological and political education approaches, including restricted communication channels and limited information sharing. This pattern indicates that, within this sub-set of the literature, cloud computing challenges and cloud computing drivers are, in effect, two sides of the same argument: the deficiencies of the legacy system function simultaneously as the justification for adoption and as the baseline against which post-adoption benefits are subsequently measured.

Interoperability, Data Management and Sustainability-Related Challenges

A final cluster of studies identified more technical or design-level challenges. Engelberger et al. (2021) discussed challenges related to interoperability, the organisation of multiple cloud services, and the management of distributed educational environments. Kavitha (2021) and Verma et al. (2021) both identified the difficulty of managing and securing multidimensional or large-scale educational datasets as a persistent technical challenge, and Dutta et al. (2021) and Naveed et al. (2023) each examined factors affecting the sustainable, continued adoption of cloud-based

e-learning and mobile-learning systems respectively, identifying usability limitations and inadequate alignment between system design and user requirements as risks to sustained use beyond initial adoption.

Considered together, the RQ4 findings show that security and privacy concerns represent the single most consistently reported barrier across the corpus, appearing in studies from Yemen, Jordan, Saudi Arabia, China, and multiple other contexts alike, suggesting this is close to a universal barrier rather than a context-specific one. Infrastructure limitations, trust and cultural barriers, and behavioural acceptance barriers each recur with somewhat greater context-sensitivity, appearing predominantly in studies from developing-country and resource-constrained settings (Hussein Alghushami et al., 2020; Al-Ramahi et al., 2022; Hiran and Henten, 2020; Okai-Ugbaje et al., 2020). Migration-specific and cost-related barriers, by contrast, recur mainly in studies explicitly examining transition processes (Althani, 2025; Aydin, 2021; Qasem et al., 2021), and legacy-system limitations recur almost exclusively within the cluster of Chinese institution-specific implementation studies, suggesting that the framing of "challenge" in the literature is itself shaped by whether a study is examining pre-adoption conditions, the transition process, or post-implementation sustainability.

4 Conclusion

This review sets out to identify, classify, and synthesise evidence on the drivers, implementation, benefits, and challenges of cloud computing adoption in educational institutions, and the synthesis above supports four substantive conclusions.

First, the principal drivers of adoption are technological and organisational rather than purely environmental. Infrastructure readiness, compatibility, security and privacy assurance, and top-management support recur as significant determinants regardless of institutional setting, and these institutional-level TOE drivers operate alongside individual-level acceptance constructs — perceived usefulness, ease of use, and social influence — that shape adoption at the user level. Environmental drivers, by contrast, prove considerably more context-bound: government assistance, competitive pressure, and regulatory policy carry different weight in different national systems, indicating that environmental factors do not travel across contexts as reliably as technological or organisational ones.

Second, the most consistent evidence concerns implementation through learning management systems and structured migration frameworks, and benefits tied to educational continuity, access, and resource flexibility. These findings recur across quantitative, design-oriented, and qualitative studies alike, and this methodological convergence strengthens confidence in their generalisability.

Third, the evidence on challenges is markedly weaker and more context-dependent. Security and privacy concerns are reported almost universally, but trust, cultural, and legacy-system barriers cluster unevenly by region and institutional tradition, and several studies conflate the deficiencies of pre-cloud systems with challenges of cloud computing itself.

5 Study Implications

The findings of this review carry implications for theory, practice, and policy in the domain of cloud computing adoption in educational institutions.

5.1 Theoretical Implications

The review reinforces the continued relevance of the TOE framework as a base model for institutional-level adoption research, but it also demonstrates that TOE alone does not adequately capture adoption behaviour in educational settings. The recurring integration of TOE with individual-level acceptance theories (TAM, UTAUT, DOI) across the reviewed studies suggests that adoption in educational institutions is not a single organisational decision but a two-level process in which institutional readiness and individual user acceptance operate simultaneously and interact. This points to an opportunity to develop, and empirically test, integrated multi-level frameworks purpose-built for the education sector, rather than continuing to import frameworks from general organisational or e-commerce contexts. The review also surfaces socio-cultural and contextual moderators, tribalism culture, government assistance, regulatory environment, that existing TOE and acceptance models treat inconsistently or omit altogether, indicating a theoretical gap around how contextual and cultural variables should be formally incorporated into adoption models rather than treated as post hoc explanatory add-ons.

5.2 Practical and Managerial Implications

For institutional leaders and IT decision-makers, the review indicates that successful adoption depends less on the intrinsic properties of cloud technology than on deliberate organisational preparation: securing top-management support, auditing infrastructure readiness, and addressing compatibility with existing systems before migration begins. Because security and privacy concerns emerge as the most consistently reported barrier across contexts, institutions should treat security assurance and transparent data-governance communication as a precondition for adoption rather than a downstream implementation task. The concentration of measurable, benefit-generating implementations among purpose-built systems designed around a specific institutional function suggests that institutions are likely to realise more demonstrable value from targeted, needs-driven cloud deployments than from generic, one-size-fits-all cloud migration. Where cultural or trust-related resistance is anticipated, particularly in developing-country and resource-constrained contexts, the review implies that change-management and stakeholder-engagement processes deserve equal weight alongside technical planning.

5.3 Policy Implications

At the sector and government level, the concentration of environmental adoption barriers in specific national contexts implies that regulatory clarity, data-protection guidance, and, where relevant, direct government support for infrastructure can meaningfully lower institutional adoption costs. Because much of the existing evidence originates from higher education institutions, policymakers responsible for basic and vocational education systems have comparatively little context-specific evidence to draw on, and the review implies a need for policy-level investment in piloting and evaluating cloud adoption within these under-represented sub-sectors before broader mandates or funding decisions are made.

6 Study Limitations

This systematic literature review has numerous limitations that should be acknowledged. First, the review was confined to papers published in the English language. Although this approach improves consistency in analysis and enables broader accessibility of the reviewed evidence, it may have resulted in the exclusion of relevant studies published in other languages, particularly from countries where cloud computing adoption in educational institutions has been actively investigated. Consequently, the findings may not fully represent regional perspectives, contextual experiences, or implementation techniques stated in non-English academic literature. Future evaluations could solve this restriction by incorporating multilingual search tactics and including papers published in major regional languages to provide a more comprehensive global picture of cloud computing uptake in education.

Second, the review has limitations related with the features and distribution of the available evidence. The included studies were largely focused on higher education institutions, with very minimal representation of K–12 schools, vocational education, and other educational settings. The review also discovered diversity in theoretical models, research methodologies, and outcome assessments among studies, which hampered direct comparison and prevented quantitative meta-analysis. Furthermore, many research addressed initial adoption goals or technological implementation processes rather than long-term continuity, sustainability, and post-adoption results. Future research should therefore incorporate more longitudinal studies, various educational levels, and broader geographical contexts to better knowledge of sustained cloud computing uptake in educational institutions.

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Data Availability

As this study is a systematic literature review, the data analyzed consists entirely of previously published peer-reviewed articles, and they are all referenced in the reference list.

Conflict of Interest

The authors declare no conflicts of interest should be included if there is no conflict of interest.

Declaration of Use of Generative AI

During the preparation of this work, the authors used generative AI tools solely to enhance the grammatical quality and formatting of the manuscript. These tools were not used to conduct literature searches, data extraction, analysis, or interpretation. The authors reviewed and edited the output as needed and take full responsibility for the content of the publication.

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