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REVIEW

Impact of Cloud Computing on Higher Education Institutions: A Comprehensive Systematic Review

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ABSTRACT

In higher education institutions (HEIs), Cloud Computing has facilitated remote access to teaching and administrative resources, reducing costs and enhancing collaboration, although it requires robust connectivity infrastructure and rigorous management of security and privacy. The purpose of this study is to systematically evaluate both the positive and negative impacts of Cloud Computing on HEIs through an exhaustive search across multiple databases, integrating developments, applications, and authors' perspectives on this technology. A total of 65 papers from major digital libraries—IEEE Xplore, Scopus, Springer Link, Semantic Scholar, and ResearchGate—were analyzed, applying a systematic review focused on Cloud Computing in HEIs. The analysis covered the period 2018–2024, exclusively using open-access sources, with the aim of identifying developments, applications, and authors' perspectives on this technology. A total of 66 papers were obtained, and the results show that most publications on this topic appear in IEEE Xplore. Moreover, these papers predominantly originate from Malaysia and China. It is suggested to explore the identified gaps through new research questions, focusing on understudied regions. Additionally, it is important to systematize the use of technological tools and evaluate their impact across different educational contexts.

KEYWORDS

cloud computing, cloud, cloud service, higher education institutions (HEIs), university, systematic and bibliometric review

1 INTRODUCTION

Cloud computing has established itself as a strategic technology for transforming and optimizing the management of technological resources in higher education institutions (HEIs). Its implementation has not only enhanced digital infrastructure but has also facilitated academic collaboration and access to virtual learning environments. Currently, this technology is no longer a future promise but a tangible reality: universities and educational centers are already using it to develop

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virtual classrooms, efficiently manage large volumes of data, and offer personalized educational services to both students and faculty. This study proposes a framework for the adoption of cloud computing in HEIs in Jordan, utilizing theories such as DOI, TAM, and TOE. Data were collected from 11 universities and analyzed using NVivo, Microsoft Visio, and Business Intelligence to improve the understanding and adoption of this technology [1]. This study evaluates the technological and organizational readiness of Saudi universities to migrate to cloud-based educational services through the Cloud Migration Readiness Assessment (CMRA) instrument. Its usefulness and practicality were validated through questionnaires and interviews with specialists across three case studies [2]. This paper reviews the current state of the use of deep learning and machine learning in cloud computing security, highlighting trends such as anomaly detection and security automation. It identifies challenges like data privacy and scalability and suggests future research directions [3]. The pandemic accelerated digitalization in higher education. A study in Malaysia, using TAM and TRI models, found that ease of use and perceived usefulness are key factors for accepting cloud computing, with optimism and innovativeness as positive influences [4]. Another paper analyzes the integration of sustainability into ICT. Students improve in environmental awareness but are dissatisfied with the university's level of commitment [5]. A study evaluated the use of cloud computing applications in distance education at King Faisal University, highlighting its importance for educational quality and sustainable development. It identified challenges and proposed improvements to optimize its implementation in Saudi Arabian educational institutions [6]. Another study develops a practical framework for simulated business management in universities, using a combined weighting method based on cloud models. It evaluates five key business aspects and provides a comprehensive assessment and early warning system through a digital "cockpit," optimizing operational strategies and budget allocation [7]. In 2022, the Ministry of Education of China published a standard for teachers' digital literacy. Researchers assessed the digital literacy of English as a Foreign Language (EFL) teachers using a Likert-scale questionnaire administered to 92 instructors. The proposed model was validated, and recommendations were made to enhance teachers' digital literacy [8]. Research determined that the architecture of digital technologies significantly impacts university teacher training, showing a 22.88% increase in digital skills. A quantitative, pre-experimental design with 269 teachers was used. Results were statistically significant ($P = 0.000$), confirming the proposed hypothesis [9]. This study proposes a conceptual model for cloud computing adoption in HEIs in Yemen, considering technological, organizational, and environmental (TOE) factors. Using a quantitative approach, advantages, reliability, compatibility, and managerial support were identified as positive factors, while tribal culture was found to have a negative moderating effect [10]. Another study presents an online platform implemented in 12 Turkish universities in 2020, meeting educational and data requirements [11]. The COVID-19 pandemic accelerated digitalization in higher education through cloud computing adoption. This study examines user acceptance and readiness in Malaysian HEIs, utilizing TAM, TRI, and SEM models. Ease of use and perceived usefulness positively influence adoption [12]. This study investigates how gamification in active learning impacts the development of labor market skills, academic standards, and student satisfaction. Results show that co-creative playful experiences enhance learning without compromising academic performance, developing key skills for 21st-century professionals [13]. HEIs in Malaysia are adopting cloud computing, with a continuation intention explained 85.2% by TOE factors, according to a quantitative study with SEM-PLS [14]. Another study investigates the factors influencing the continued use of cloud computing in HEIs, utilizing the IS continuance model and the TOE framework. Preliminary results suggest that the proposed model is reliable and valid, paving the way for future research [15]. A paper reviews the adoption of cloud computing in HEIs, developing a taxonomy that identifies opportunities and challenges and offers an outlook for future research [67]. Another study analyzes the integration of e-learning and cloud computing, highlighting impacts on architecture, software, and security, examining models such as SaaS, PaaS, and IaaS, with emphasis on public clouds [68]. A paper reviews studies on cloud computing adoption in HEIs, highlighting the need for more research on socio-technical concerns [69]. Another review analyzes 20 studies on cloud computing adoption in universities, showing a high success rate but also identifying a lack of empirical studies in the field [70]. A separate paper reviews 27 studies on cloud computing adoption in universities, showing interest in its use and application of various cloud service models, also identifying a lack of empirical studies [71]. Another review focuses on cloud computing adoption in Saudi universities between 2018 and 2023, highlighting its impact on teaching, learning, and institutional efficiency, and offering recommendations for future research [72]. A comprehensive review analyzes key factors influencing cloud computing adoption in education and organizations, offering strategies for effective implementation [73]. A paper highlights the potential of cloud computing to enhance distance learning [74]. Another review analyzes the potential and barriers of cloud-based teaching in schools, highlighting five key categories: globalization, educational and administrative benefits, barriers, and implementation factors [75]. A study identifies key factors for cloud computing adoption in university libraries and proposes a framework to facilitate its implementation [76].

The exhaustive review of the literature reveals growing attention to the qualitative aspects shaping the impact of Cloud Computing on HEIs. This technology not only optimizes institutional management by improving operational efficiency and reducing costs but also facilitates the adoption of advanced technological tools aimed at teaching and academic administration. In this context, it is essential to conduct a systematic and updated analysis of how cloud computing is transforming these environments from both organizational and pedagogical perspectives. This study is justified by the need to consolidate existing findings, identify current gaps, and project future lines of action to guide a more effective and sustainable adoption of these technologies in higher education. Consequently, the objective of this paper is to analyze the current relevance of Cloud Computing in HEIs through a systematic review of the available scientific literature, aiming to understand its impact on both academic and administrative domains. Therefore, this paper presents the systematic review as follows: Section 2 develops the theoretical background; Section 3 describes the methodology used; Section 4 presents the main findings and their discussion; and finally, Section 5 offers conclusions and recommendations for future research directions.

2 THEORETICAL BACKGROUND

In light of the sustained advancement of cloud computing within the higher education environment, it becomes essential to understand the fundamental concepts underpinning this technology before examining the emerging trends that shape its adoption and application in this context.

2.1 Cloud computing

Cloud computing has become a central focus of multiple research efforts aimed at addressing challenges in teaching and learning environments [2]. This technology enables the delivery of storage and applications over the Internet to institutional devices and systems, facilitating remote access to digital resources [6]. It is understood as a set of attributes shared across various cloud services, including collaborative applications and access to servers hosting common data [28]. From a more structural perspective, it is conceived as a network-based infrastructure capable of supplying resources on demand to its users [48], allowing for greater operational flexibility in educational institutions [71].

2.2 Higher education institutions

Higher education institutions have significantly benefited from cloud computing by accessing a variety of technological services through new computing paradigms that are transforming their digital infrastructure [29]. This technology has been widely adopted in key processes such as admissions, teaching, collaboration, and learning, promoting the digitalization of numerous academic activities [42]. Its implementation has proven valuable across various educational aspects by providing tools that enhance the learning experience [54]. Indeed, cloud-based solutions have contributed to strengthening socially and collaboratively oriented pedagogical approaches, such as cooperative learning [58]. In this sense, educational institutions foster a culture of active collaboration driven by the strategic use of cloud technologies [65].

2.3 Tools used

During the development of this systematic review, the fundamental role of Mendeley Desktop as a reference manager for efficiently organizing and managing academic sources was highlighted. In addition, the graphs included in the results and discussion section were generated using artificial intelligence tools, together with the research assistant RAj, an advanced computational solution developed by Dr. Javier Gamboa-Cruzado, specifically designed to support analysis processes in scientific research.

3 REVIEW METHOD

A Systematic Literature Review (SLR) approach was adopted following the methodological guidelines proposed by B. Kitchenham [66], with the purpose of conducting a rigorous analysis of the impact of Cloud Computing on HEIs. This approach allowed for a structured examination of the research questions (RQs) posed (see Figure 1).

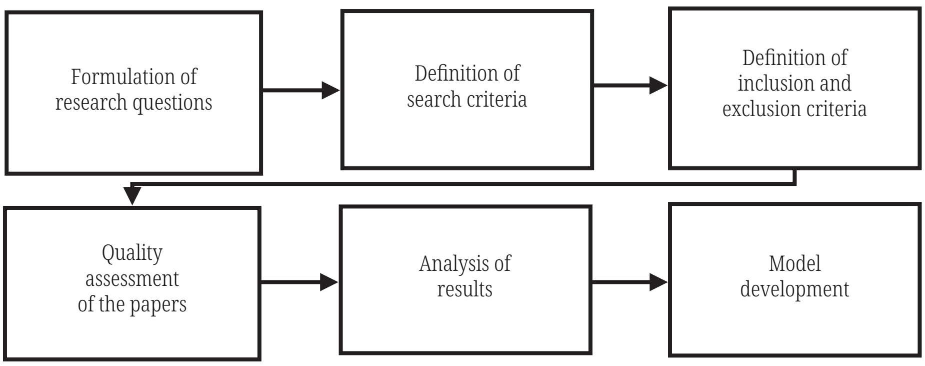

Fig. 1. SLR stages

3.1 Research problems

Given the importance of studying the impact of Cloud Computing on HEIs, it was essential to establish an effective search strategy to optimally collect information for a rigorous analysis. In this regard, RQs were formulated, forming the central axis of this paper. Five RQs were defined to guide the development of this study.

RQ1: What indicators are used to evaluate the effectiveness of Cloud Computing implementation?
RQ2: In which quartile levels are the scientific journals that have published studies on the impact of Cloud Computing in higher education institutions?
RQ3: What keywords show the greatest co-occurrence in research related to the impact of Cloud Computing in higher education institutions?
RQ4: Which named entities—such as persons, organizations, geographic locations, temporal, and quantitative references—are most frequently mentioned in the conclusions of studies on Cloud Computing in the university environment?
RQ5: What are the main thematic categories addressed in scientific literature regarding the impact of Cloud Computing on higher education institutions?

3.2 Information sources and search strategies

To identify relevant studies for this review, the most recognized scientific databases were consulted: IEEE Xplore, Scopus, Springer Link, Semantic Scholar, and ResearchGate. Additionally, the following key descriptors were defined to ensure the relevance and accuracy in the selection of academic documents.

- cloud computing/iCloud/cloud service
- higher education institutions/university/higher education

The search process was carried out using a set of key terms designed to optimize the identification and understanding of relevant information. This combination of terms, referred to as the search equation, was adapted according to the characteristics of each consulted database (refer to Table 1).

Table 1. Information sources and search equations

Source	Search Equation
IEEE Xplore	((“Publication Title”: “cloud computing” OR “Publication Title”: iCloud OR “Publication Title”: “cloud service”) AND (“Publication Title”: “higher education institutions” OR “Publication Title”: “university OR “Publication Title”: “higher education”)) OR ((“Abstract”: “cloud computing” OR “Abstract”: iCloud OR “Abstract”: “cloud service”) AND (“Abstract”: “higher education institutions” OR “Abstract”: “university OR “Abstract”: “higher education”))
Scopus	TITLE-ABS-KEY ((“cloud computing” OR iCloud OR “cloud service”) AND (“higher education institutions” OR university OR “higher education”))
Springer Link	(“cloud computing” OR iCloud OR “cloud service”) AND (“higher education institutions” OR university OR “higher education”)
Semantic Scholar	title-abstract-keywords ((“cloud computing” OR iCloud OR “cloud service”) AND (“higher education institutions” OR university OR “higher education”))
ResearchGate	(“cloud computing” OR iCloud OR “cloud service” AND “higher education institutions” OR university OR “higher education”)

3.3 Identified studies

Once the search process across the various information sources was completed, a representative set of relevant studies and research was compiled for the analysis (see Figure 2).

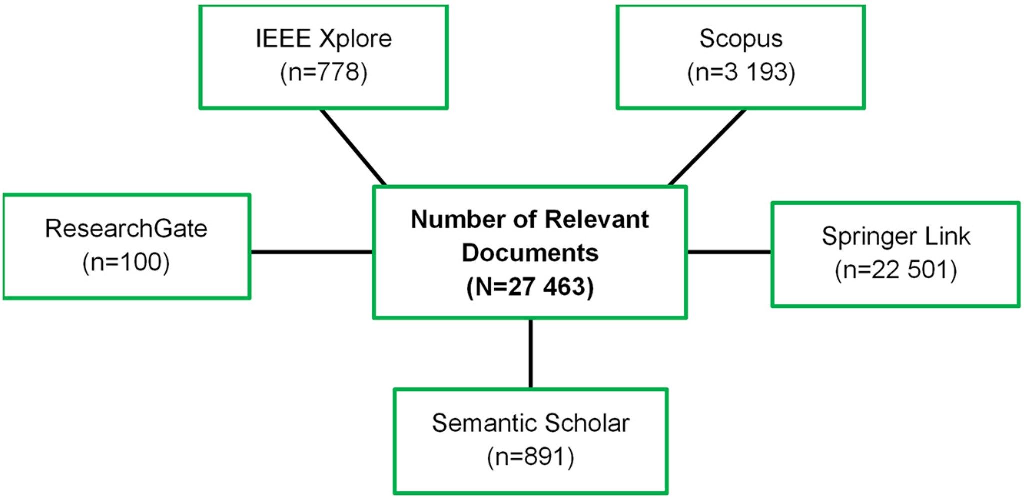

Fig. 2. Number of relevant documents

3.4 Exclusion criteria

To ensure the methodological rigor of the review, six exclusion criteria (EC) were established, aligned with the recommendations of the most cited SLR guidelines in Software Engineering and Computer Science – Kitchenham [66] and Petersen et al. [83].

EC1: Publications older than seven years. Kitchenham [66] recommends limiting the time frame when the domain evolves rapidly; in Cloud Computing, technologies change in cycles shorter than five years, so a seven-year threshold maintains relevance without losing a critical mass of recent studies.

EC2: Papers not written in English. Several systematic reviews (e.g., Petersen et al. [83]) recommend restricting the language to avoid translation bias and ensure comparability of technical terms, especially when the predominant literature is published in English.

EC3: Works not published in peer-reviewed journals or conferences. Excluding gray literature minimizes risks related to quality and publication bias [66]; only studies with a formal academic review process are retained.

EC4: Studies that are systematic or bibliometric reviews. This section distinguishes between primary and secondary studies; for this phase, primary empirical evidence on the adoption of Cloud Computing in HEIs is required.

EC5: Titles or keywords not related to the topic. Kitchenham [66] recommends filtering for thematic relevance based on title, abstract, and keywords to optimize the precision of the corpus before full-text screening.

EC6: Lack of access to the full text. Full access is a necessary condition to evaluate internal validity and extract data [83]; records without a PDF or a verifiable institutional link are excluded.

3.5 Study selection

In the initial stage, 27 463 papers were identified through a search process based on key descriptors relevant to the research objective. After applying the exclusion criteria and performing a detailed relevance and quality analysis, a total of 65 papers were selected, as shown in Figure 3.

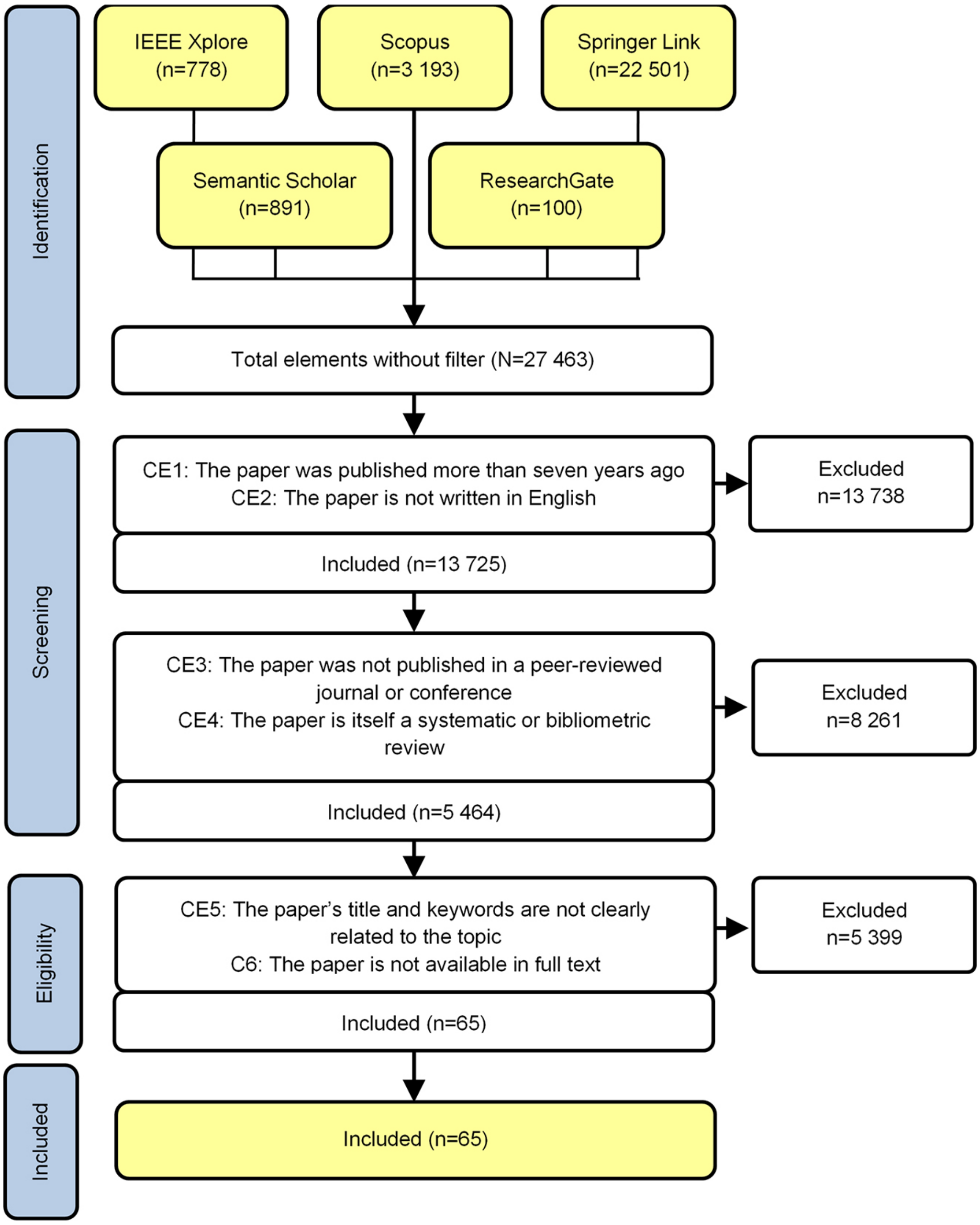

Fig. 3. PRISMA chart

3.6 Quality assessment

The selected studies originate from databases recognized for their high academic standards and were reviewed by experts in the field, belonging to indexed scientific journals and prestigious conferences. To ensure the methodological quality of each analyzed study, thirteen quality evaluation criteria were applied:

1. Are the study's objectives clearly defined?
2. Does the methodological design align with the stated objectives?
3. Are the applied techniques well-described and adequately justified?
4. Were the study indicators measured appropriately and accurately?
5. Are the data collection methods clearly explained?
6. Is the description of the collected data clear and complete?
7. Is the objective of the data analysis clearly established?
8. Are the statistical tools applied appropriate and justified?
9. Are unfavorable or negative findings included in the results?
10. Are potential limitations regarding the validity or reliability of the results discussed?
11. Are the answers to the RQs well-supported?
12. Is there a clear connection between the data, its interpretation, and the conclusions drawn?
13. Do the results come from more than one research project?

A three-level rating scale was used: 1 (poor), 2 (acceptable), and 3 (excellent). A minimum score of 23 points was established as the threshold for considering a paper eligible. After applying this evaluation to the 65 selected papers, all exceeded 11.5 points in each quality criterion (QA), which justified their final inclusion in the systematic review (refer to Table 2).

Table 2. Quality evaluation results

Reference	Type	QA1	QA2	QA3	QA4	QA5	QA6	QA7	QA8	QA9	QA10	QA11	QA12	QA13	Score
[1]	Journal	2	3	2	2	1	2	1	2	2	1	1	2	2	**23**
[2]	Journal	1	2	3	3	2	3	2	3	2	2	3	3	2	**31**
[3]	Conference	1	2	3	2	2	3	2	3	1	2	1	3	2	**27**
[4]	Journal	2	2	3	1	3	3	1	2	2	1	2	1	2	**25**
[5]	Journal	2	2	3	1	2	3	2	2	2	1	2	3	2	**27**
[6]	Conference	2	2	2	2	2	1	2	3	2	1	2	3	2	**26**
[7]	Journal	2	3	2	2	1	2	2	1	2	2	2	1	2	**24**
[8]	Journal	2	2	2	3	2	2	2	3	1	2	3	2	2	**28**
[9]	Journal	2	3	2	2	1	2	3	2	2	1	2	3	2	**27**
[10]	Journal	2	2	2	2	2	2	3	2	2	2	1	2	3	**27**
[11]	Journal	2	2	3	2	2	2	2	1	2	1	2	1	2	**24**
[12]	Journal	2	2	2	2	2	2	2	3	2	1	2	2	2	**26**
[13]	Conference	2	3	2	2	2	3	3	2	2	3	2	2	2	**30**
[14]	Journal	2	3	2	2	1	2	2	1	2	2	2	3	2	**26**
[15]	Journal	2	2	2	2	3	3	3	2	2	3	2	2	2	**30**

(Continued)

Table 2. Quality evaluation results *(Continued)*

Reference	Type	QA1	QA2	QA3	QA4	QA5	QA6	QA7	QA8	QA9	QA10	QA11	QA12	QA13	Score
[16]	Journal	2	2	2	2	3	3	2	2	2	2	2	3	2	**29**
[17]	Journal	2	2	1	2	3	2	2	1	2	3	2	2	2	**26**
[18]	Journal	2	2	2	2	2	2	3	2	2	3	2	1	2	**27**
[19]	Journal	2	2	1	2	2	3	3	2	3	2	2	2	2	**28**
[20]	Conference	2	2	2	1	2	3	2	2	2	2	2	3	2	**27**
[21]	Conference	2	3	2	3	3	3	2	2	2	1	2	2	2	**29**
[22]	Conference	2	3	2	2	2	3	2	2	3	2	2	2	2	**29**
[23]	Conference	2	2	1	2	2	1	2	2	3	2	2	2	2	**25**
[24]	Journal	2	2	2	2	2	2	3	2	1	2	2	2	2	**26**
[25]	Conference	2	2	3	2	2	3	2	2	3	2	1	2	2	**28**
[26]	Journal	2	2	2	2	2	2	2	3	2	2	1	2	2	**26**
[27]	Conference	2	2	2	2	2	2	2	3	2	2	2	2	2	**27**
[28]	Journal	2	2	2	2	1	2	2	2	2	2	3	2	2	**26**
[29]	Journal	2	3	3	2	2	3	3	2	2	2	2	1	2	**29**
[30]	Conference	2	3	2	2	2	2	2	3	2	3	2	2	2	**29**
[31]	Journal	2	2	2	2	3	3	2	2	2	3	2	2	2	**29**
[32]	Journal	2	2	2	2	2	2	3	3	3	2	2	2	2	**29**
[33]	Journal	2	2	2	2	2	2	2	2	1	2	2	3	2	**26**
[34]	Journal	2	2	2	2	2	2	2	3	2	3	2	2	2	**28**
[35]	Journal	2	2	2	2	2	1	2	3	2	2	3	2	2	**27**
[36]	Conference	2	2	3	2	2	2	2	2	3	2	2	2	2	**28**
[37]	Journal	2	2	2	2	2	2	2	3	3	3	3	2	2	**30**
[38]	Journal	2	2	2	2	3	3	3	3	2	2	2	2	2	**30**
[39]	Journal	2	2	2	2	3	2	2	2	2	2	3	2	2	**28**
[40]	Journal	2	2	2	2	1	2	2	3	3	3	3	2	2	**29**
[41]	Journal	2	3	3	3	3	3	3	2	2	2	2	2	2	**32**
[42]	Journal	2	2	2	2	3	3	2	2	2	2	1	2	2	**27**
[43]	Conference	2	2	2	2	3	2	2	2	1	2	2	3	2	**27**
[44]	Journal	2	2	2	3	3	3	2	2	2	2	1	2	2	**28**
[45]	Journal	2	2	2	2	2	3	2	2	2	1	2	2	3	**27**
[46]	Journal	2	2	2	2	2	2	3	2	2	1	2	2	3	**27**
[47]	Journal	2	2	2	3	3	3	2	2	1	2	2	3	2	**29**
[48]	Conference	2	2	2	1	2	2	2	3	2	2	1	2	2	**25**
[49]	Journal	3	2	2	1	2	2	3	2	2	1	2	2	3	**27**

(Continued)

Table 2. Quality evaluation results *(Continued)*

Reference	Type	QA1	QA2	QA3	QA4	QA5	QA6	QA7	QA8	QA9	QA10	QA11	QA12	QA13	Score
[50]	Journal	2	2	3	2	2	3	3	3	2	2	2	2	2	**30**
[51]	Journal	2	2	2	2	2	3	3	3	2	2	2	2	2	**29**
[52]	Journal	2	2	2	3	2	2	2	1	2	2	2	3	2	**27**
[53]	Journal	2	2	2	2	2	3	3	3	2	2	2	2	2	**29**
[54]	Journal	2	2	2	2	2	2	3	3	3	2	2	2	2	**29**
[55]	Conference	2	2	2	3	2	2	2	1	2	2	2	3	2	**27**
[56]	Conference	2	2	2	3	2	2	2	1	2	2	2	2	2	**26**
[57]	Conference	2	2	2	2	3	3	2	2	2	2	2	2	2	**28**
[58]	Journal	2	1	2	2	1	2	2	1	2	2	2	2	2	**23**
[59]	Journal	2	2	2	2	3	2	2	1	2	2	2	3	2	**27**
[60]	Journal	2	2	2	2	3	2	2	2	3	3	2	2	2	**29**
[61]	Conference	2	2	2	2	2	2	3	1	2	2	3	2	2	**27**
[62]	Conference	2	2	2	2	2	3	2	2	2	2	2	3	2	**28**
[63]	Journal	2	2	2	2	2	2	2	1	2	2	2	2	2	**25**
[64]	Conference	2	2	2	2	3	3	2	2	2	3	2	2	2	**29**
[65]	Journal	2	2	2	2	3	3	3	3	2	2	2	3	2	**31**

4 RESULTS AND DISCUSSION

This section presents and examines the findings obtained, contextualizing them in relation to previous research and the objectives established in the present study.

4.1 General description of studies

The general analysis of the collected studies made it possible to identify key trends in the scientific literature related to the adoption of cloud computing in HEIs. Aspects such as the temporal distribution of publications, the most frequently used academic sources, and the evolution of research interest over time were evaluated. This description provides a quantitative and qualitative basis for understanding the current landscape, enabling a more accurate interpretation of the advances and gaps present in this field of study. Likewise, the countries with the highest volume of publications and the most prolific authors on the topic were identified, allowing for a geographical mapping of research development and the recognition of leading academic figures in the adoption of cloud computing in higher education.

Figure 4 presents a georeferenced map and a bar chart that visualize the geographical distribution of scientific publications on Cloud Computing in HEIs. The aim is to identify the leading countries in research and their relative contribution to the body of knowledge in this field.

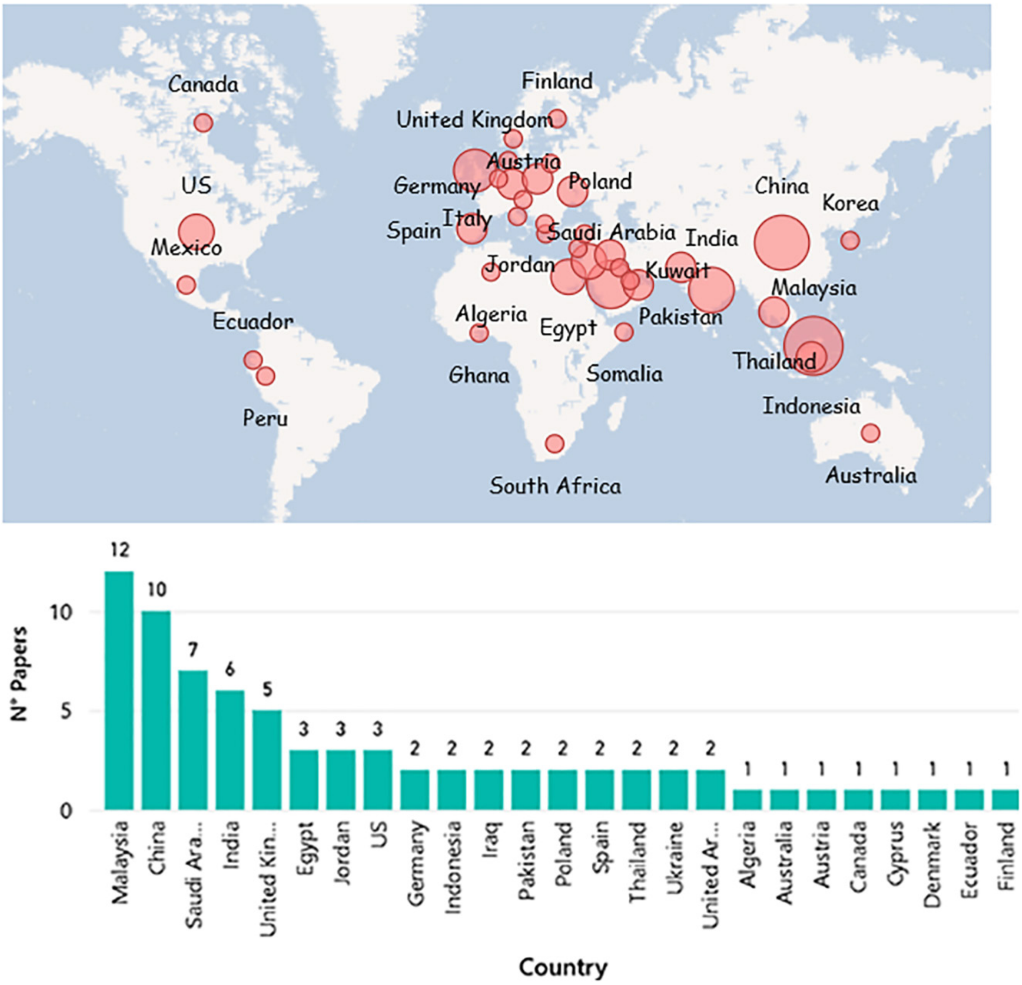

Fig. 4. Leading countries in research and their relative contribution through paper publications

Malaysia ranks as the country with the highest number of publications (12), followed by China (10), Saudi Arabia (7), India (6), and the United Kingdom (5), revealing a significant concentration of scientific production in Asia. The United States and Egypt each present three studies, while the remaining countries, such as Peru, Ecuador, Ghana, and Finland, have low representation (1 publication). This distribution suggests a strong research initiative in emerging Asian economies, where interest in advanced educational technologies has increased since the pandemic.

Ali [69] finds that Malaysia hosts the largest concentration of studies on this topic. The authors Ibrahim, Salleh, and Misra [71] interpret that Australia leads in publications based on the development of the topic. Conversely, the study by Thavi et al. [74] mentions that the US has the highest number of publications related to the research objective. Compared to Birk et al. [75], it is also interpreted that the US has a higher volume of papers than other countries. Finally, the authors Narkhede et al. [72] also agree that the most productive research on the topic is conducted in the United States of America.

These results open opportunities to foster international collaboration between countries with lower research output and those leading the field. It is also suggested to promote scientific networks that integrate underrepresented regions such as Latin America and Africa. Finally, future research could explore contextual barriers that limit the adoption and study of Cloud Computing in certain countries, as well as compare thematic approaches by region.

Table 3 provides a longitudinal overview of scientific production related to Cloud Computing in HEIs, classified by year and source of publication. This allows for the identification of trends in the distribution and use of digital repositories.

Table 3. Papers by year and source

Year	IEEE Xplore	Research Gate	Scopus	Semantic Scholar	Springer Link	Total
2018	5	2	0	0	0	**7**
2019	4	3	0	5	0	**12**
2020	0	3	0	6	1	**10**
2021	2	2	0	2	1	**7**
2022	0	3	0	5	0	**8**
2023	0	4	1	2	4	**11**
2024	0	2	2	1	5	**10**
Total	**11**	**19**	**3**	**21**	**11**	**65**

Semantic Scholar stands out as the most used source, with 21 papers (32.3%), followed by ResearchGate (29.2%), and both IEEE Xplore and Springer Link with 11 papers each. Despite its prestige, Scopus represents only 4.6% of the total production. We identified 2019 as the peak year, with 12 publications, while 2018 marks the start of our review period. Springer Link has increased its contribution in 2023–2024, underscoring the platform's sustained commitment to peer-reviewed research.

According to the authors Qasem et al. [67], the highest number of papers was published in 2015, with 51 papers mostly indexed in IEEE Xplore. Meanwhile, Eljak et al. [68] highlight the years 2014 and 2017 as having the highest publication rates on the topic, also emphasizing IEEE Xplore. In the comparison by Ali [69], Semantic Scholar is estimated to be the platform with the highest presence of studies. Furthermore, in the paper by Ali, Wood-Harper, and Mohamad [70], it is noted that the topic was most widely addressed in 2014. Lastly, Ibrahim, Salleh, and Misra [71] consider IEEE Xplore to be the primary database for retrieving papers relevant to the proposed research.

These findings suggest that, while open academic platforms like ResearchGate and Semantic Scholar are widely used, there remains room for improvement in publishing within indexed databases such as Scopus. Promoting access to high-quality and more visible publications is essential for increasing research impact. This analysis can be extrapolated to other disciplines and regions to strengthen scientific publishing strategies. Finally, it is recommended that early-career researchers prioritize outlets with higher indexing to strengthen their academic production.

4.2 Responses to the research questions

This section presents the responses obtained for each of the RQs formulated, integrating critical analysis, discussion of findings, and their implications for future research directions. The results derive from papers published in scientific journals and specialized conferences on the impact of cloud computing in HEIs. A total of

65 papers were analyzed, forming the empirical foundation of this review. The presentation of results follows the order of the RQs posed.

RQ1: What indicators are used to evaluate the effectiveness of Cloud Computing implementation in higher education institutions?

Table 4 and Figure 5 summarize the main criteria used to assess the effectiveness of Cloud Computing in HEIs. These criteria, extracted from the 65 reviewed studies, help identify the most valued factors in technological adoption and implementation processes within university contexts.

Table 4. Criteria for measuring effectiveness

Criterio	Reference	Qty. (%)
Scalability	[1][2][3][5][7][8][24][26][27][29][30][32][35][38][43][45][46][51][56][57][58][63][64]	23 (11)
Availability	[1][2][3][5][6][7][8][13][15][21][22][24][26][29][30][31][32][33][35][38][39][46][47][51][55][56][57][64]	28 (13)
Data Security	[1][5][8][9][16][17][24][26][29][32][35][46][51][58][65]	15 (7)
Cost	[1][2][3][4][5][6][7][8][9][10][12][13][15][16][20][22][23][24][25][26][27][28][29][30][31][32][33][34][35][36][38][39][40][41][42][43][45][46][48][49][50][51][52][54][55][56][57][58][59][60][63][64][65]	53 (25)
Flexibility	[1][5][7][10][13][15][21][22][24][32][35][42][43][45][46][51][53][54][57][64]	20 (10)
Interoperability	[3][8][34][53][65]	5 (2)
Maintenance	[1][3][6][7][13][20][24][26][27][29][32][35][38][39][40][43][45][46][49][50][52][55][57][58][59][60][65]	27 (13)
Innovation	[2][4][5][6][7][9][10][11][12][14][15][16][17][19][20][21][23][25][28][29][30][31][33][34][35][40][41][43][44][45][49][48][49][50][51][52][54][55][57][60][65]	41 (19)

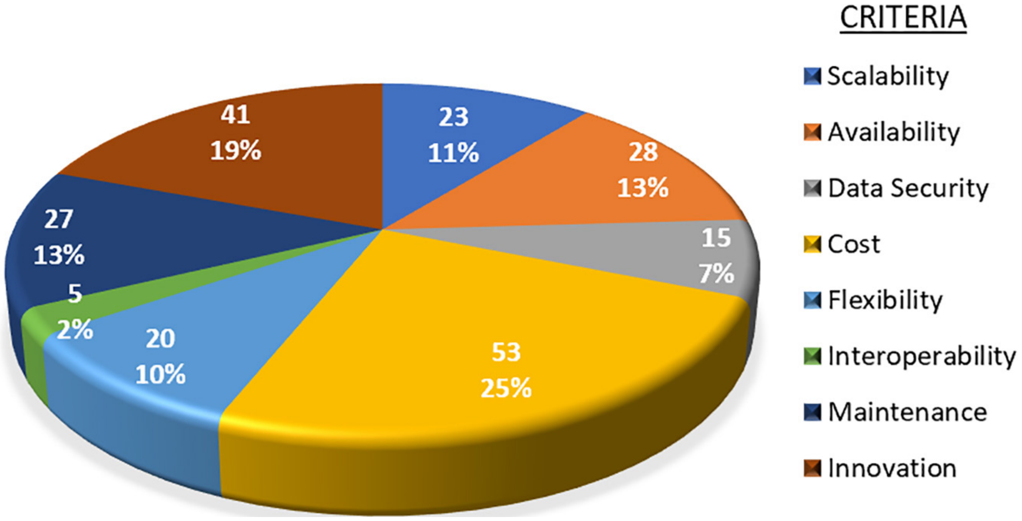

Fig. 5. Consolidated criteria for the effectiveness of Cloud Computing implementation

The results show that cost (25%) is the most frequently cited criterion, reflecting its strategic importance in institutional decision-making. It is followed by innovation (19%)

and both maintenance and availability (13% each), indicating a balanced concern for technological sustainability and operational continuity. Other factors, such as scalability (11%) and flexibility (10%), reveal the need for adaptable and dynamic infrastructure. In contrast, interoperability (2%) and data security (7%) receive less attention, despite their critical relevance in interconnected educational environments.

The results of this review are consistent with the findings reported by Singun [77], who identifies technological scalability, flexibility, and institutional innovation as key enablers of digital transformation in higher education—elements that also appear among the main evaluation criteria for Cloud Computing. Similarly, Farias-Gaytan et al. [79] propose cost-efficiency, scalability, availability, interoperability, and security as key indicators of effectiveness, closely aligning with the most frequently cited factors in the studies analyzed. Likewise, Arviansyah et al. [80] highlight cost, scalability, operational efficiency, and reliability as decisive aspects in the adoption of cloud services, in line with the results of this review. Finally, Aldahwan and Ramzan [81] identify cost reduction, accessibility, educational innovation, and sustainable maintenance as central benefits, reinforcing the presence of these same criteria in the reviewed literature. Moreover, both [80] and [81] recognize interoperability as an emerging but underdeveloped aspect, consistent with its low frequency in this review.

These findings suggest that the evaluation of Cloud Computing could also be adapted to other sectors such as healthcare, manufacturing, or government, where cost and innovation are equally decisive. In different geographical contexts—especially in developing regions—these criteria can help guide more sustainable technology policies. Furthermore, in future timeframes, flexibility and interoperability may become increasingly relevant as digital transformation advances.

RQ2: In which quartile levels are the scientific journals that have published studies on the impact of Cloud Computing in higher education institutions?

Table 5 and Figure 6 show the temporal evolution of the reviewed papers based on the quartiles (Q1–Q4) of the journals in which they were published, in addition to studies published in non-quartile (SQ) journals. This analysis provides insight into the quality of the scientific sources that disseminate research on Cloud Computing in higher education.

Table 5. Quartile distribution by year

Quartile	2018	2019	2020	2021	2022	2023	2024	Total
SQ	7	11	5	4	5	6	3	41
Q1	0	0	0	2	1	3	5	11
Q2	0	0	4	1	1	1	1	8
Q3	0	0	1	0	1	0	1	3
Q4	0	1	0	0	0	1	0	2
Total	**7**	**12**	**10**	**7**	**8**	**11**	**10**	**65**

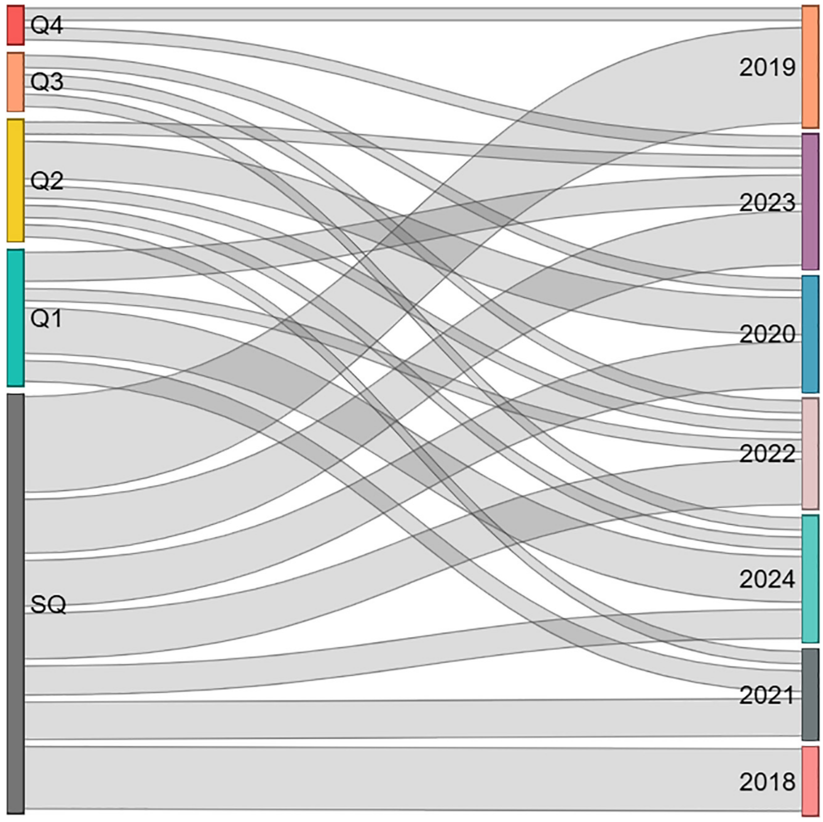

Fig. 6. Quartiles by year of publication

The largest volume of studies is concentrated in non-quartile (SQ) journals, representing 63.1% (41 out of 65 papers), which may indicate an emerging stage of development or a practical orientation of this study. However, there is a clear upward trend toward publication in high-impact journals, with Q1 journals accounting for 11 papers (16.9%), particularly during the 2021–2024 period. Q2 and Q3 journals include 8 (12.3%) and 3 (4.6%) papers, respectively, while Q4 journals account for only 2 papers (3.1%), showing low representation. This evolution suggests a progressive improvement in the quality and visibility of scientific research in this field.

No previous systematic reviews were found that analyze the quartile levels of journals where research on Cloud Computing in higher education is published. This lack of evidence prevents direct comparisons as part of the discussion. Nevertheless, it highlights a gap in the literature that this study helps to address.

The results suggest that the impact of Cloud Computing in higher education is reaching academic maturity, with a growing presence in Q1 journals in recent years. This pattern may be replicated in other regions where digital educational transformation is expanding. Likewise, the rise in high-quartile publications signals the prospect of more rigorous research in the future.

RQ3: What keywords show the greatest co-occurrence in research related to the impact of Cloud Computing in higher education institutions?

Figure 7 and Table 6 represent the keyword co-occurrence network in the analyzed studies, allowing the identification of terms most frequently associated with "cloud computing" in research on higher education. This analysis helps to map the most recurrent thematic areas.

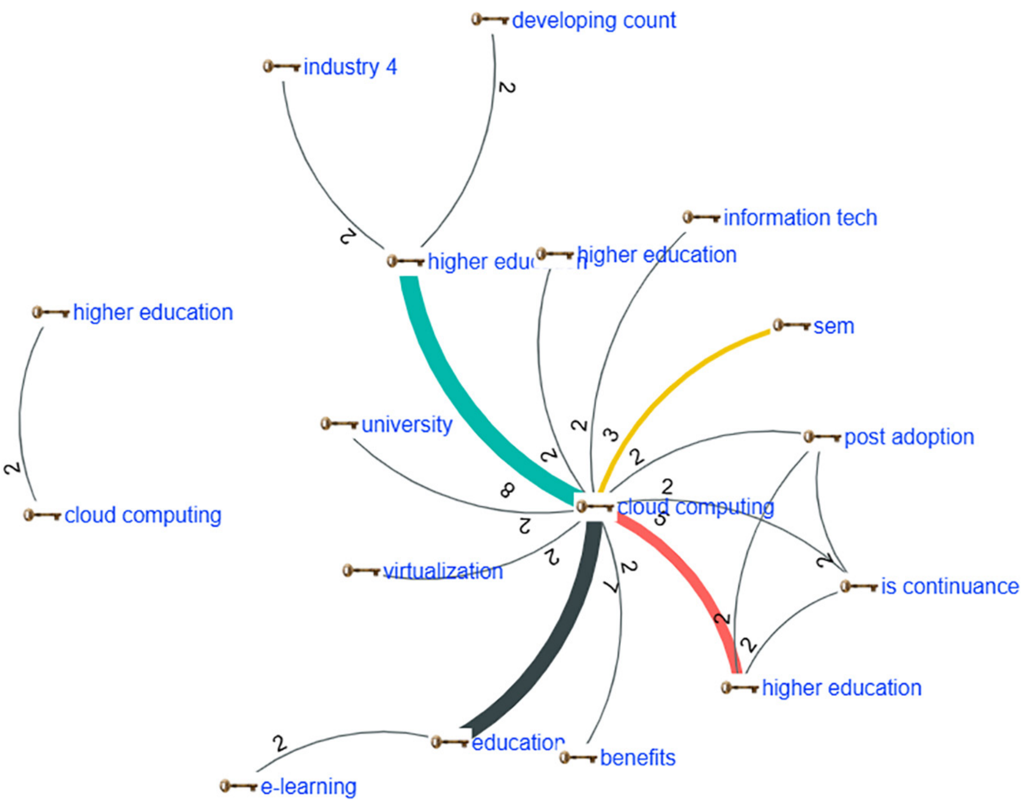

Fig. 7. Bibliometric network of keywords

Table 6. Keyword co-occurrence

Keyword1	Keyword2	Weight
cloud computing	higher education	8
cloud computing	education	7
cloud computing	higher education institutions	5
cloud computing	sem	3
cloud computing	benefits	2
cloud computing	higher education institution	2
cloud computing	information technology	2
cloud computing	is continuance	2
cloud computing	post adoption	2
cloud computing	university	2
cloud computing	virtualization	2
cloud computing	higher education institutions (heis)	2

The keywords that show the highest co-occurrence with "cloud computing" are "higher education" (weight 8), "education" (7), and "higher education institutions" (5), reflecting the literature's predominant focus on the institutional educational environment. Also noteworthy are concepts related to evaluation ("SEM," "benefits"), implementation ("post adoption," "IS continuance"), and infrastructure ("virtualization," "information technology"), indicating a comprehensive view of the technological adoption process. The term "university" appears less frequently but remains relevant within the terminological ecosystem.

In addition, a weighted co-occurrence graph was constructed, and the metrics degree, strength, betweenness, and local clustering coefficient were calculated using NetworkX 3.2, following the formulation proposed by Barrat et al. [82] (see Table 7).

$$s_i = \sum_{j \in \Gamma(i)} w_{ij} \tag{1}$$

where:
s_i: Strength
$\Gamma(i)$: set of neighbors of node i
w_{ij}: weight of the edge between nodes i and j

$$C_i^w = \frac{1}{ki(ki-1)} \sum_{j,h \in \Gamma(i)} (W_{ij} W_{ih} W_{jh})^{1/3} \tag{2}$$

where:
C_i^w: weighted clustering coefficient (ClustCoeff)
$\Gamma(i)$: set of neighbors of node i
ki: number of adjacent nodes to node i
w_{ij}: weight of the edge between nodes i and j

Table 7. Keyword co-occurrence metrics in the bibliometric network

Keyword	Degree	Strength	ClustCoeff	Betweenness
cloud computing	0.688	37	0.017	0.700
higher education	0.188	12	0.000	0.208
higher education institutions	0.188	9	0.310	0.000
education	0.125	9	0.000	0.108
is continuance	0.188	6	0.280	0.050
post-adoption	0.188	6	0.280	0.050
sem	0.063	3	0.000	0.000
university	0.063	2	0.000	0.000
e-learning	0.063	2	0.000	0.000
developing countries	0.063	2	0.000	0.000
cloud computing adoption	0.063	2	0.000	0.000
higher education institutions	0.063	2	0.000	0.000
benefits	0.063	2	0.000	0.000
industry 4	0.063	2	0.000	0.000
virtualization	0.063	2	0.000	0.000
information technology	0.063	2	0.000	0.000
higher education institution	0.063	2	0.000	0.000

The **Degree** metric shows that "cloud computing" (0.688) acts as a dominant node, connecting with most concepts; its **Strength** (37) confirms that it concentrates the highest intensity of links. The **Betweenness** value of 0.700 indicates that it functions as a semantic bridge between subtopics, demonstrating its articulating role in the academic agenda. Terms such as "higher education," "IS continuance," and "post adoption" display intermediate degree and betweenness values, suggesting that the literature has progressed beyond initial adoption toward continuity and consolidation phases. In contrast, keywords such as "SEM" or "virtualization" exhibit low betweenness, indicating specialized but still peripheral niches. The high **ClustCoeff** of "higher education institutions" (0.310) reveals internal clustering: studies addressing this term tend to cite each other, forming a cohesive subfield.

The keyword co-occurrence analysis developed in this review shows a strong methodological correspondence with the study by Shi and Wan [78], who also used co-occurrence maps and thematic clustering through CiteSpace. In their research, they highlight terms such as "digital transformation," "online learning," "cloud computing," and "artificial intelligence" as central nodes, especially in the context of educational digitalization in China. The presence of "cloud computing" as a recurrent term in both studies confirms its transversal role in recent academic agendas. Although [78] is limited to a specific geographic and temporal context, a notable semantic convergence can be observed around technological infrastructure, educational innovation, and digital learning environments. Complementarily, the study by Aldahwan and Ramzan [81] presents a structured review of the key factors and dimensions involved in the implementation of Cloud Computing in higher education, identifying recurrent terms related to technological adoption, service quality, and user experience. These concepts align with several of the terms with the highest co-occurrence strength in the present review, such as "IS continuance," "post adoption," and "benefits."

The predominance of educational terms suggests that the impact of Cloud Computing in higher education is well-defined, though it could be explored more deeply in contexts such as technical education, continuing education, or rural education. This co-occurrence can also serve as a foundation for studies in sectors such as healthcare, justice, or digital government. Likewise, it can guide research in regions with low digitalization, where Cloud adoption is still in its early stages.

RQ4: Which named entities—such as persons, organizations, geographic locations, temporal, and quantitative references—are most frequently mentioned in the conclusions of studies on Cloud Computing in the university context?

Figure 8, which presents a pie chart and a word cloud, clearly visualizes the most frequently mentioned named entities (Named Entities Recognition–NER) extracted from the conclusions of the analyzed papers. This semantic analysis helps identify the predominant focuses and research priorities in the use of Cloud Computing in higher education institutions.

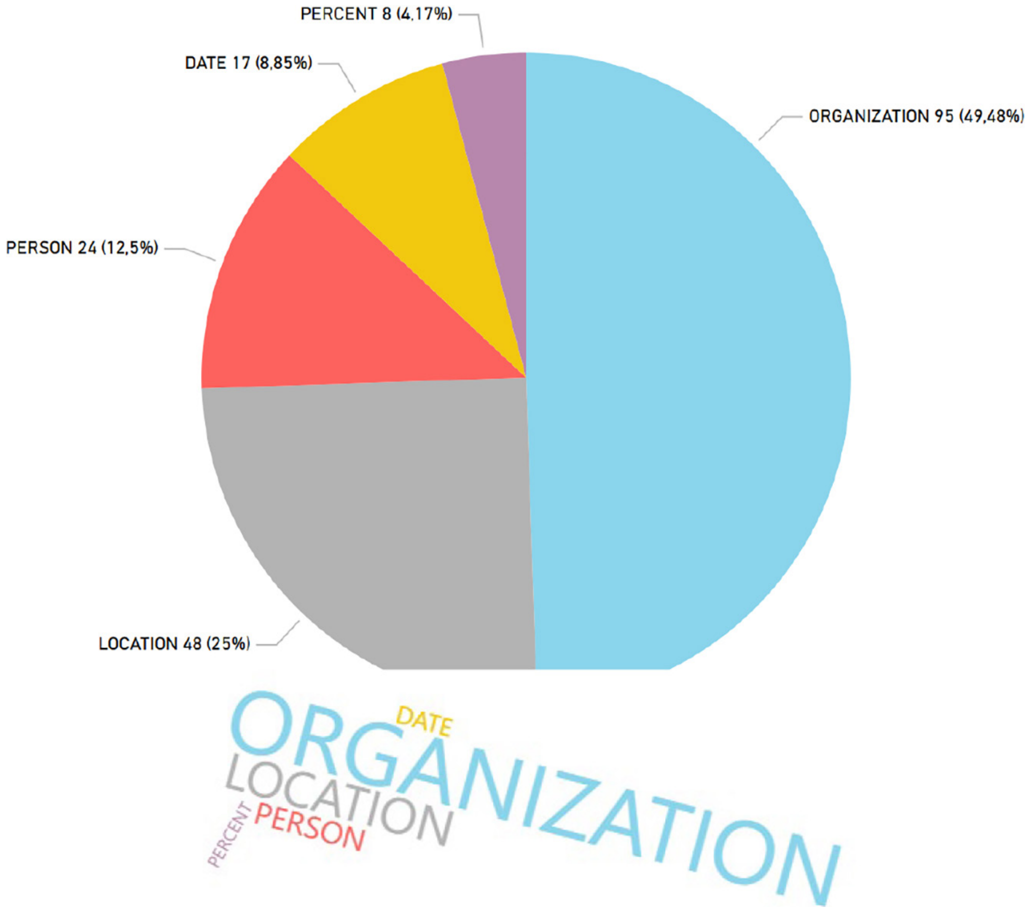

Fig. 8. Frequency of NER types in conclusions

The term "big data" holds a central position, underscoring its role as the primary focus in these studies. Its co-occurrence with terms such as "healthcare," "big data analytics," and "covid-19" highlights the importance of these concepts in the context of healthcare. Other significant connections include "big data" and "IoT," emphasizing interest in emerging technologies applied to health data analysis. The presence of terms such as "digital transformation" and "deep learning" reflects the relevance of technological innovation in advancing this field, revealing a multidisciplinary and technological focus.

According to [69], the terms "big data" and "healthcare" are the most co-occurring keywords in the selected research articles, emphasizing their relevance in the topics addressed. Similarly, [71] highlights the frequency of their joint appearance, underscoring their importance in the current scientific literature. Furthermore, [82] reinforces this observation, noting that the combination of "big data" and "healthcare" is essential for data analysis in the health sector.

The prominence of concepts like "big data" and "covid-19" indicates opportunities to explore how these technologies can enhance healthcare during critical public health situations. Additionally, connections with "IoT" and "deep learning" suggest promising areas for future interdisciplinary research. These findings are also applicable in sectors such as digital health and crisis management, fostering data-driven strategies.

RQ5: What are the main thematic categories addressed in scientific literature on the impact of Cloud Computing in higher education institutions?

Figure 9 and Table 8 provide a visualization of the thematic distribution of scientific studies on Cloud Computing in HEIs, using thematic map analysis. These topics are positioned along two axes: centrality (relevance) and density (development level), which allows for their classification into motor themes, niche themes, basic themes, or emerging/marginal themes.

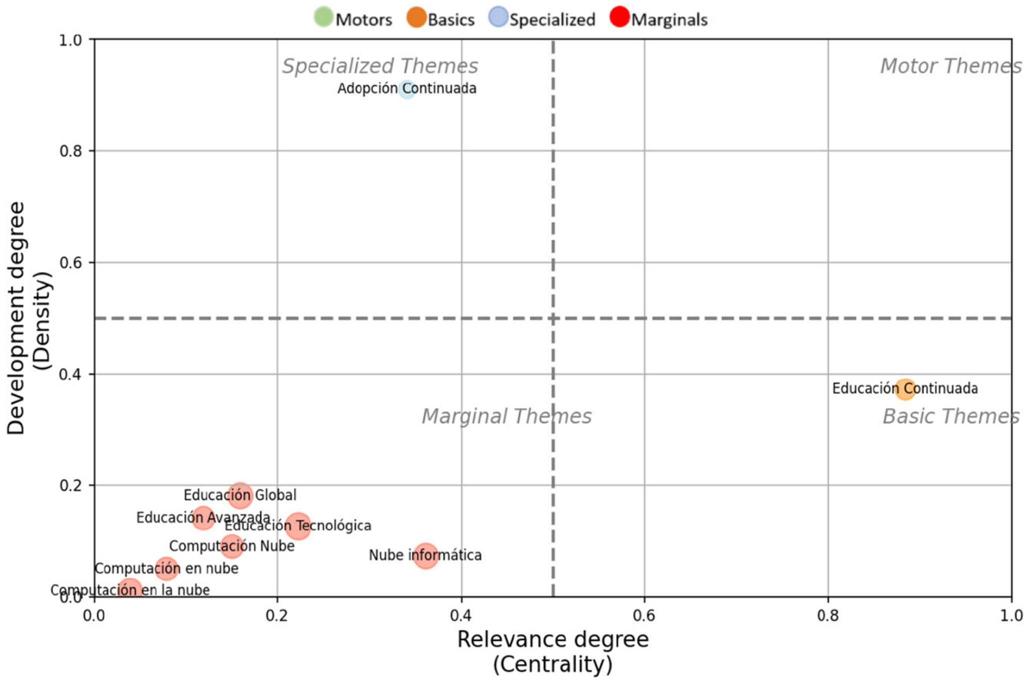

Fig. 9. Thematic categories

Table 8. Details of thematic categories

Topic	Density	Centrality	Total Citations	Total Documents	Category
Continued Adoption	0.91	0.34	72	6	Specialized
Continuing Education	0.37	0.88	115	8	Basic
Global Education	0.18	0.16	170	26	Marginal
Advanced Education	0.14	0.12	145	25	Marginal
Technological Education	0.13	0.22	194	26	Marginal
Cloud Computing	0.09	0.15	141	18	Marginal
Cloud Informatics	0.07	0.36	165	20	Marginal
Computing in the Cloud	0.05	0.08	141	18	Marginal
Cloud-Based Computing	0.01	0.04	165	20	Marginal

Notes: ● Motors ● Basics ● Specialized ● Marginals.

We observe that "Continuing Education" is the sole category positioned in the basic-theme quadrant; it exhibits high centrality (0.88) and moderate density (0.37), indicating that it is still consolidating as a structural axis. "Continued Adoption", situated in the niche theme quadrant, shows the highest density (0.91), reflecting a strong internal focus but moderate external relevance. Most themes—such as "Global Education," "Technological Education," and various forms of "Cloud Computing"—are located in the marginal zone, revealing a wide range of topics with low integration and limited thematic consolidation.

The thematic classification identified in this review finds points of convergence with the analysis conducted by Singun [77], who examines the use of emerging educational technologies in higher education, emphasizing components such as digital innovation, instructional design, and learning assessment. These dimensions align with categories identified in this study, such as "Continued Adoption" and "Technological Education," suggesting that Cloud Computing is part of a broader technological ecosystem driving educational transformation. Complementarily, Aldahwan and Ramzan [81] group the literature on Cloud Computing around dimensions such as adoption, intention to use, service quality, user experience, and educational impact, which are closely related to the categories "Continued Adoption" and "Continuing Education" identified in this review as specialized and basic, respectively. Although the methodological approach of [81] differs, both studies acknowledge the current thematic dispersion and the need to consolidate research lines around the impact of Cloud Computing in educational contexts.

These results suggest the need to strengthen research in areas with high relevance but low development, especially in emerging contexts such as Latin America and Africa. Consolidating niche themes could benefit sectors such as healthcare, justice, and public administration. Moreover, thematic analysis could be adapted to other disruptive technologies in education—such as artificial intelligence or blockchain—to anticipate their future evolution.

5 CONCLUSION AND FUTURE RESEARCH

The findings of this systematic review reveal that the most commonly used criteria to measure the effectiveness of Cloud Computing in HEIs (RQ1) are led by indicators such as cost, innovation, availability, and maintenance. This focus indicates an institutional orientation toward operational efficiency and technological sustainability, both of which are critical in digitalized educational environments. The prevalence of the "cost" criterion in over 25% of the analyzed studies suggests that economic feasibility remains the central axis for technological adoption, without displacing the relevance of data security, flexibility, and scalability as strategic attributes.

Regarding the quality of academic sources (RQ2), the analysis of journal quartile levels shows that, although a substantial portion of papers originates from Q1 and Q2 journals, there is still a strong presence of literature indexed as Non-Quartile (SQ). This pattern reflects both an increasing openness to academic debate and the need to strengthen the presence of rigorous empirical studies in high-impact journals in order to consolidate a validated body of knowledge in this field.

In terms of keyword co-occurrence (RQ3), the term "cloud computing" is systematically associated with expressions such as "higher education," "education," and "higher education institutions." This semantic alignment reflects a thematic consolidation around the role of Cloud Computing as a structural support in academic processes and suggests a conceptual standardization that can inform future analytical frameworks and research taxonomies.

Finally, regarding the thematic categories addressed in the literature (RQ5), "Continuing Education" stands out as a basic theme, while domains such as "Continued

Adoption" are positioned as niche themes, and most other topics—including "Global Education" and "Informatics Cloud"—are classified as marginal. This configuration reveals opportunities for further exploration in still nascent topics, especially those with high density but limited centrality, which could represent focal points of innovation in the digital transformation of education.

It is recommended to conduct longitudinal analyses of the marginal thematic categories to identify emerging trends and to consolidate sustained lines of research. Additionally, it is relevant to explore advanced impact metrics of Cloud Computing in areas such as university administration, digital inclusion, and institutional sustainability.

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