Cloud Computing in Ecuadorian Higher Education: A Case Study on Use, Benefits, and Challenges at UTEQ

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***Abstract*—** Digital transformation continues to reshape higher education, with cloud computing emerging as a key enabler of enhanced accessibility, collaboration, and academic management. This study investigates the use of cloud computing in Ecuadorian universities by identifying its benefits, barriers, and opportunities through a survey of key stakeholders in the education system. A quantitative approach was employed using a structured questionnaire to collect data on participants' knowledge levels, tools used, perceived advantages, challenges, and expectations. The main benefit identified was accessibility from any location (92%), followed by enhanced collaboration (73%) and the modernization of educational practices (43%). The primary challenges included lack of training (67%), limited connectivity (58%), associated costs (46%), and concerns about data security and privacy (34%). These findings underscore the need to strengthen technological infrastructure and provide targeted training to optimize the effective use of cloud computing. Regarding future perspectives, 71% of respondents advocated for greater integration into teaching and learning, while 64% suggested expanding its use across academic and administrative domains. Cloud computing represents a strategic asset for Ecuadorian higher education. However, its full adoption requires addressing infrastructure and capacity-building challenges through policies that promote collaboration, innovation, and the efficient management of institutional resources.

***Keywords*—** *Cloud computing, higher education, digital transformation, educational innovation*

I. Introduction

Cloud computing represents a key enabler of digital transformation across multiple sectors, notably in education [1]. This technological model facilitates remote access to data storage, processing power, and software applications via the Internet, thereby reducing dependence on complex and costly physical infrastructure [2], [3]. In the field of higher education, its implementation promises to significantly enhance learning quality, facilitate collaborative research, and optimize administrative processes [4].

In Ecuador, universities face the challenge of adapting to a globalized environment in which digital technologies are essential to ensure quality education aligned with labor market demands [5], [6]. Cloud computing, with its scalability and accessibility, offers a promising solution to these needs. However, adopting this technology is not without challenges, such as limited connectivity in certain regions, insufficient technological training for teaching and administrative staff, and concerns regarding data security and privacy [7].

Previous studies have explored the benefits of cloud computing in education, emphasizing its ability to scale resources, reduce operational costs, and promote collaboration [8]. However, research such as [9] highlights significant limitations, including uneven connectivity in developing countries and user resistance to change. Other studies, such as [10], have identified gaps in the technological training of educational staff, hindering full adoption of this technology. These limitations underscore the need to tailor implementation strategies to the specific context of each institution, taking into account cultural, economic, and technological factors [11].

This context highlights the importance of conducting research that evaluates the real impact of cloud computing in Ecuadorian higher education. Understanding how this technology is currently being used, what benefits it brings, and what barriers institutions face is crucial for designing effective implementation strategies. Furthermore, this information is essential for aligning public education policies with the technological needs of universities, enabling them to bridge digital gaps and promote inclusive, forward-looking education.

This study seeks to provide insight into the use, benefits, and challenges of cloud computing in Ecuadorian universities. Through an analysis based on empirical data, the goal is to identify patterns and trends that reflect the current situation and offer practical recommendations to optimize the use of this technology in the education sector. Unlike previous research that focuses on global or generalized contexts, this study emphasizes the particularities of an education system operating under limited connectivity and restricted financial resources. This approach makes it possible to identify region-specific opportunities, representing a valuable contribution to closing digital divides and strengthening the technological capacity of Ecuadorian universities.

By examining cloud computing as a strategic enabler in higher education, this study contributes to the global discourse on the digital transformation of educational systems, with a particular emphasis on Latin America and other emerging economies [12], [13]. This study is guided by the following research question:

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How does cloud computing impact educational and administrative processes in Ecuadorian universities?

Answering this question will help assess the current state of technological adoption and propose practical strategies to enhance its implementation and harness its transformative potential. This document is structured as follows: after this introduction, we describe the proposed solution, followed by the methodology, results, and discussion. Finally, the paper presents the conclusions.

II. Related Work

The adoption of cloud computing in higher education has been extensively examined in recent literature, particularly within the context of developing countries. In [14], the authors examined the early-stage implementation of cloud services in Ugandan universities with limited infrastructure, proposing an institutional readiness framework and highlighting the need for training and organizational support. Similarly, [15] analyzed how cloud computing influences academic performance in Indian institutions, using the Technology Acceptance Model as a guiding framework. Their findings provided empirical support for the core constructs of the model and confirmed its relevance in post-pandemic educational settings.

A qualitative approach was used by [16] to explore factors affecting mobile cloud computing adoption in Palestinian universities. Their study, based on the TOE and DOI frameworks, emphasized technological preparedness and institutional perceptions of risk as determinants of successful implementation. In a different line, [17] compared cognitive load and usability between local and cloud-based database systems, demonstrating that cloud tools reduced mental effort and improved student experience in technical tasks.

At a broader level, [18] conducted a bibliometric analysis of over 8,000 publications on smart university trends, identifying cloud computing as a foundational component within the digital transformation landscape. The study situates cloud technologies as enablers of educational innovation, particularly when integrated with artificial intelligence and the principles of Industry 5.0.

While these studies provide insights into the technical, cognitive, and institutional aspects of cloud computing adoption, they often focus on national or international frameworks. The present study contributes to this literature by offering an Ecuador-specific perspective, addressing local constraints such as limited connectivity, fragmented digital infrastructure, and the evolving digital culture in higher education institutions.

In addition to empirical studies, several theoretical models provide useful frameworks for understanding the adoption of cloud computing in educational contexts. The Technology Acceptance Model (TAM), developed by Davis, identifies perceived usefulness and ease of use as key determinants of user acceptance [19], [20]. Similarly, the Diffusion of Innovations (DOI) theory by Rogers explains how new technologies spread through a social system, identifying key factors such as relative advantage, compatibility, trialability, and complexity [21], [22]. These models are especially pertinent in developing country contexts, where technological adoption may encounter cultural and infrastructural resistance. Furthermore, Digital Transformation Frameworks for Higher Education propose that successful implementation of technologies like cloud computing requires alignment between institutional vision, leadership, digital competencies, and organizational culture [23], [24]. The inclusion of these theoretical perspectives strengthens the analytical foundation of this study and supports a deeper interpretation of its findings.

III. Methodology

The methodology adopted in this study aimed to provide a comprehensive understanding of the impact of cloud computing on Ecuadorian universities. A systematic approach was used to collect, analyze, and present empirical data that support the conclusions and recommendations. This section details the study design, population and sample, data collection instrument, and analysis procedure to ensure clarity and consistency in the results presented.

A. Study Design

This study employed a descriptive approach through a structured survey to gather data on participants' perspectives and opinions regarding the use, benefits, and challenges of cloud computing in Ecuadorian higher education. The survey was designed to capture clear and direct information, and responses were collected using Microsoft Forms.

B. Population and Sample

The survey targeted faculty, administrative staff, and students at the Technical State University of Quevedo (UTEQ), with a total of 116 respondents voluntarily participating in the study. This population provided insight from key actors involved in the adoption and use of educational technologies.

In terms of demographics, participants ranged in age from 18 to 50. Students represented different academic levels—from early-stage students to those in their final semesters—while faculty and administrative personnel came from various fields of knowledge, enabling the inclusion of both technical and humanities-based perspectives.

The sample included only participants who completed the online form voluntarily, ensuring that the opinions reflected genuine interest and engagement with the topic. Given the exploratory nature of this study and its focus on institutional-level insights, the sample size (n = 116) was considered adequate to capture relevant perceptions from key stakeholder groups within UTEQ. While not intended to support statistical generalization to the national university system, the data provide a meaningful representation of internal dynamics and adoption patterns within a mid-sized Ecuadorian public university.

C. Data Collection Instrument

The questionnaire consisted of 15 questions—14 closed (single or multiple choice) and one open-ended question—to gather additional opinions and suggestions. The questions were organized into six thematic sections to address various aspects of cloud computing in higher education.

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- The first section, familiarity level, included two questions aimed at assessing participants' knowledge of cloud computing.
- The second section, tools and platforms used, included four questions to identify the most commonly used platforms and services in academic settings and their practical applications in educational activities.
- The third section, specific applications, comprised two questions to explore areas where cloud computing is most useful and which platforms are applied in those contexts.
- The fourth section, perceived benefits, included two questions to identify the main advantages observed in adopting cloud computing.
- The fifth section, challenges and limitations, contained two questions aimed at recognizing the main barriers that hinder effective implementation of this technology.
- The sixth section, titled "Future Outlook and Expectations," incorporated two questions—one of which was open-ended—to elicit participants' recommendations and perceptions regarding strategies to enhance the adoption of cloud-based tools in higher education.

This structure, summarized in Table 1, provided a comprehensive view of the topic, enabling both quantitative and qualitative analysis.

TABLE I. QUESTIONNAIRE STRUCTURE AND SECTION OBJECTIVES

Section	*Objective*	*Example Question*
Familiarity	Assess participants' level of knowledge about cloud computing.	Are you familiar with the concept of cloud computing?
Tools and Platforms	Identify the cloud-based services and platforms used by respondents.	Which cloud platforms or services have you used most frequently?
Specific Applications	Explore the areas where cloud computing is most useful and its application.	In which areas of higher education is cloud computing most useful?
Perceived Benefits	Understand the main advantages observed by participants.	What do you consider the main benefits of cloud computing in higher education?
Challenges Faced	Identify the main limitations and barriers to adoption.	What barriers do you face in implementing or using cloud computing?
Future Perspectives	Explore recommendations to improve cloud usage in institutions.	What cloud tools or services would you like your institution to implement?

D. Data Collection Process

The survey was distributed in digital format using Microsoft Forms and completed remotely. The questionnaire link (https://forms.office.com/r/tCpgtkQgpc) was shared via institutional email and internal communication channels at the Technical State University of Quevedo (UTEQ). This method ensured that both students and faculty at UTEQ could easily access the form from any device with internet connectivity.

UTEQ was used as a case study to assess the level of knowledge, usage, and perception of cloud computing in a representative academic environment. The questionnaire was designed to take approximately 2 to 4 minutes to complete, enabling efficient data collection and the extraction of relevant information for analyzing the role of this technology in the institution.

E. Comparative Reference and Justification

While previous studies on educational technologies have used more complex methodologies to gather qualitative and quantitative data [25], the approach adopted in this study was deliberately straightforward and focused on the relevant user base. This method was chosen to obtain a clear perspective on the needs and opinions within UTEQ's local context. Comparative studies such as [26], have shown that this approach is effective for evaluating the impact of emerging technologies when applied in specific contexts.

In this case, the use of closed-ended questions allowed for efficient structuring of responses, while the open-ended question provided the necessary flexibility to include participants' qualitative observations. This resulted in a balance between methodological rigor and the practicality needed for research in a local educational setting.

F. Data Analysis

The data were analyzed directly through the Microsoft Forms platform, using its automated tools to calculate frequencies, percentages, and generate basic charts. The open-ended responses were analyzed through a word cloud, which visually highlighted the most frequently mentioned terms and key areas of interest expressed by the respondents.

Even though the adoption of technologies such as cloud computing faces challenges—particularly in access and training—studies like this one show that simple, user-centered methodologies can be just as effective in gathering critical information in local environments [27].

This methodological approach seeks to establish a basis for assessing the current landscape of cloud computing in Ecuadorian higher education, while also generating actionable recommendations to support its effective institutional integration.

IV. RESULTS

The results obtained from this study provide a comprehensive overview of the level of knowledge, usage, benefits, challenges, and future perspectives regarding cloud computing in the context of Ecuadorian higher education, using the Technical State University of Quevedo (UTEQ) as a case study. Below are the most relevant findings derived from the analysis of the collected data, organized according to the thematic areas addressed in the questionnaire.

A. Familiarity with Cloud Computing

Among participants, 27% reported being "fully familiar" with cloud computing, while 25% stated they were "quite familiar." Another 45% indicated being "somewhat familiar," 13% said they were "slightly familiar," and 6% admitted to having no familiarity at all. These results show that, although a significant portion of respondents are knowledgeable about cloud computing, there remains a gap in understanding its capabilities and applications.

B. Use of Tools and Platforms

Cloud computing tools were used "occasionally" by 57% of participants and "frequently" by 30%. In terms of platforms, Google Workspace was the most used (82%), followed by Microsoft Azure (30%), Moodle Cloud (11%), and AWS Educate (9%). For storage services, Google Drive

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stood out with 110 mentions, followed by Microsoft OneDrive (66) and GitHub (26). These preferences reflect a tendency to favor platforms offering accessibility and easy integration into academic environments.

To further explore this trend, a correlation analysis was conducted between the level of knowledge about cloud computing and the frequency of tool usage. This analysis was based on the codified survey responses, reflecting the reported proportions: 27% of participants indicated being fully familiar with cloud computing, while 30% stated they use these tools frequently.

Using the Spearman correlation coefficient, a moderate positive correlation was found ($\rho = 0.41$, $p < 0.001$). This suggests that although greater familiarity tends to increase the use of cloud-based tools, the relationship is neither strictly linear nor uniform. Instances were observed where participants had a high level of knowledge but reported low frequency of use, and vice versa.

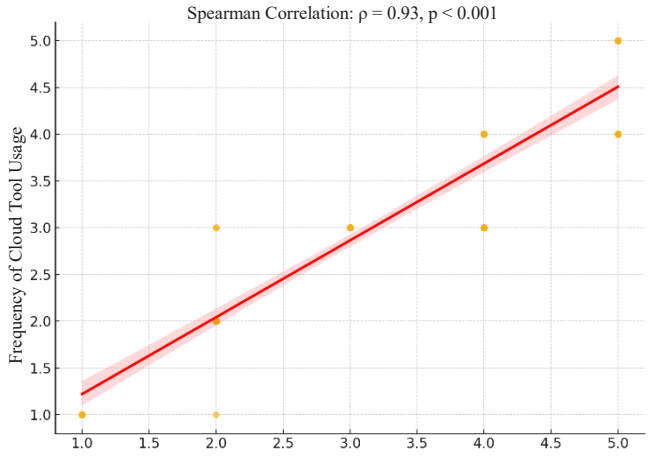

Fig. 1. Correlation between level of knowledge and frequency of cloud computing tool usage

Fig. 1 illustrates this relationship through a scatter plot, showing a higher concentration of responses in the mid-to-high ranges of both knowledge and usage. The dispersion of data points indicates that other factors—such as training, connectivity access, and institutional digital culture—also play a significant role in the effective adoption of cloud technologies.

C. Specific Applications

Regarding application areas, research and collaborative projects were selected by 78% of respondents, while academic management—including enrollment and records—was chosen by 70%. Online learning was highlighted by 66%, and areas such as virtual laboratories and simulations were mentioned by 48%. These findings underscore the broad applicability of cloud computing in addressing a variety of academic needs.

D. Perceived Benefits

Anywhere accessibility was identified as the main benefit by 92% of participants. Ease of collaboration followed with 73%, and modernization of teaching methods was recognized by 43%. Additional benefits such as reduced physical infrastructure costs and scalability were mentioned by 25% and 45% of respondents, respectively. These findings underscore the potential of cloud computing to drive operational efficiency and institutional adaptability within higher education environments.

E. Barriers and Challenges

The main challenges identified were lack of training (67%) and connectivity limitations (58%). Associated costs were cited by 46%, while security and privacy concerns were mentioned by 34%. Resistance to technological change was also noted by 25% of respondents. These results emphasize the need to address such obstacles through targeted strategies in training and infrastructure development.

F. Future Perspectives

Regarding the future use of cloud computing, 64% suggested expanding its application across all academic and administrative areas, while 71% emphasized the importance of greater integration into teaching and learning. About 52% indicated it should primarily be used for data storage and backup, and 54% highlighted the need to promote cloud-based collaborative research projects. In contrast, only 4% stated that increasing its use is unnecessary. These responses reflect a clear interest in maximizing the impact of this technology within higher education.

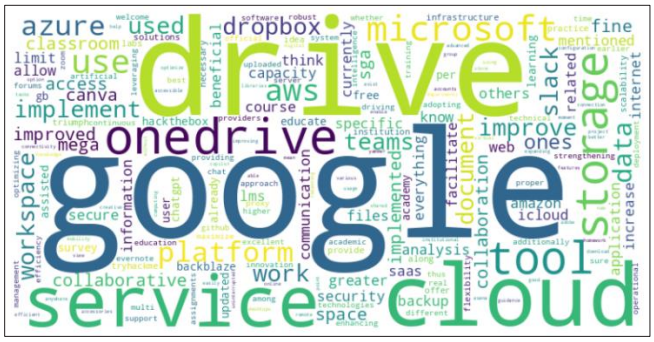

Fig. 2. Word cloud generated from open-ended responses on cloud tools and services

In Fig. 2, the word cloud generated from the open-ended responses of survey participants illustrates the cloud tools and services they consider relevant or would like to implement or improve in their institution. Terms such as Google, Drive, OneDrive, Microsoft, and service stand out, indicating a strong preference for well-known storage platforms and services. Additionally, frequent mentions of words like tool, cloud, collaboration, platform, AWS, and Azure reflect interest in technological solutions that facilitate academic and administrative work.

Specific tools like Slack, Canvas, and GitHub were also mentioned, pointing to a need for platforms that support collaboration and technological development. Words like storage, capacity, and security underscore the importance of expanding workspace capacity, improving information safeguarding, and taking advantage of the flexibility that these technologies offer. The diversity of terms—from artificial intelligence applications and data analysis to educational and collaborative platforms—highlights the growing interest in implementing services that optimize teaching, research, and institutional management.

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Overall, four main thematic areas were identified: collaboration, storage, technical capabilities, and training. Several participants emphasized the importance of tools that support collaborative work, particularly in academic and research contexts. Platforms such as Slack and Microsoft Teams were mentioned as useful solutions for task coordination in virtual environments.

In terms of storage, respondents noted the need to expand institutional capacity and ensure permanent access to files. While services like Google Drive and OneDrive were positively assessed, concerns were raised regarding backup systems and data security. Some comments highlighted the relevance of integrating more advanced tools, including virtual labs or simulation environments, which would extend the application of cloud services to research activities. These reflections point to a demand for stronger technological support in scientific work.

A recurring concern was the lack of user training. Several respondents indicated that access to tools alone does not guarantee effective use without proper training processes tailored to the diverse profiles within the academic community. Together, these qualitative insights reinforce the quantitative findings and underscore critical dimensions that should be addressed in future implementation strategies.

V. Discussion

The results of this study demonstrate that cloud computing has a significant impact on the modernization of educational processes, particularly in terms of accessibility and collaboration, as previously highlighted in studies on the scalability and flexibility of this technology [28]. However, the findings also reveal notable gaps in knowledge and technological infrastructure that hinder its adoption—an observation consistent with research emphasizing limited connectivity and training as critical factors for effective implementation [29].

The predominant use of tools such as Google Workspace and Microsoft OneDrive highlights a preference for intuitive and easily accessible platforms. This suggests that technological solutions should prioritize simplicity and functionality, as proposed in user-centered design approaches aimed at encouraging technology adoption [30]. Similar patterns have been observed in other developing countries such as India and Uganda, where adoption is often driven by availability and familiarity rather than strategic planning [15] [14].

On the other hand, the lack of training—identified as the main barrier in this study—aligns with findings that stress the need for technological training programs within educational institutions to maximize the use of digital tools [31]. In addition, challenges related to limited connectivity and data security underscore the importance of strengthening technological infrastructure and ensuring compliance with security and privacy regulations, as discussed in research on the risks associated with cloud computing [32].

Although respondents recognized the benefits of cloud computing, their open-ended suggestions indicated that its use should be expanded into critical areas such as collaborative research and administrative management. This supports the idea that cloud computing is not only a technological tool, but also a strategic catalyst for enhancing the efficiency and competitiveness of universities, as emphasized in studies on digital transformation in higher education [33].

Since the study presents relevant trends in the use of cloud computing in higher education, it is important to acknowledge that the results derive from a case study conducted at a single institution (UTEQ). Therefore, the findings should be interpreted as exploratory and may not fully reflect the situation of the national university system. Nevertheless, the patterns identified—particularly those related to training deficits, tool usage, and infrastructure barriers—may serve as valuable input for policymakers and institutional leaders. These insights could inform the design of targeted strategies at the national level, fostering equitable digital transformation across Ecuadorian universities and serving as a foundation for broader multi-institutional research efforts.

VI. Conclusions

Cloud computing represents a key technological solution for modernizing Ecuadorian higher education, providing accessibility, scalability, and collaboration across academic and administrative processes. However, its adoption faces significant challenges, including insufficient training and limited connectivity, which must be addressed through institutional policies and strategies.

Among the most relevant findings of this study is the preference for tools such as Google Workspace and Microsoft OneDrive, reflecting a clear inclination toward versatile and collaborative platforms. Additionally, the need to improve technological infrastructure and ensure data security highlights the importance of a comprehensive approach to cloud adoption.

Educational institutions must implement technological training programs, invest in network infrastructure, and establish clear strategies to promote cloud computing in key areas such as research, distance education, and administrative management.

This study was conducted exclusively at the Technical State University of Quevedo. As a result, its findings reflect a localized perspective and are not intended to represent the entire Ecuadorian higher education system. Nonetheless, the results provide a relevant baseline for future comparative studies involving other institutions, and they contribute to the broader understanding of digital transformation in similar educational environments.

VII. Future Work

Based on the findings of this study, several lines of action are identified for future research to strengthen the integration of cloud computing in Ecuadorian higher education. First, it is recommended to conduct comparative analyses across various universities in the country—both public and private—to identify common patterns, best practices, and challenges that differ according to geographic location, institutional size, and level of technological development. Moreover, longitudinal studies should be developed to evaluate the sustained impact of cloud-based platforms on educational quality, student academic performance, and administrative efficiency. These studies must integrate both qualitative and quantitative indicators to provide robust evidence for the design of institutional policies.

Another important area for future work is the design and implementation of continuous training programs aimed at faculty, administrative staff, and students. Future research could focus on assessing the effectiveness of these training initiatives and identifying pedagogical methodologies that facilitate the critical and creative appropriation of cloud technologies. In addition, cybersecurity and data protection in cloud-based educational environments should be prioritized. Given the concerns expressed by a significant portion of

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respondents regarding privacy and information integrity, it is essential to explore regulatory and technological solutions that ensure user trust.

Finally, interdisciplinary projects should be encouraged that link cloud computing with emerging fields such as artificial intelligence, educational data analytics (learning analytics), and the automation of academic processes. These synergies can drive comprehensive transformation in university management, teaching, and research, thereby consolidating a model of higher education that is more resilient, inclusive, and responsive to the challenges of the 21st century.

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