



# Determinants of Cloud Computing Adoption and Usage in Nigerian Universities

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**Abstract:** Cloud computing has attracted numerous organizations to take advantage of this technology to support teaching, learning, and research. It is seen as being able to support institutions in managing and storing information in a more flexible, cost-effective, and scalable manner. However, there are many challenges faced by cloud computing, such as data security, higher costs, developing the cloud model, and reliance on cloud providers. In addition to these issues, several studies have applied different theories to examine the implementation of cloud computing in the higher educational environment. Therefore, this paper examines the adoption of cloud computing in universities using combined theories of technology organization and environment as well as diffusion of innovation. The study examines twelve variables and their impact on the level and pace of adoption. These factors include relative advantage, compatibility, complexity, security, privacy, management support, innovativeness, technology readiness, the size of the institution, reliability, competitive pressure, and regulations. The findings of this study provide a model and insights for the decision-making process of higher education institutions regarding cloud computing adoption and informed policy development related to the implementation and management of cloud-based systems in the education sector.

**Keywords:** Cloud Computing, Adoption of Technology, Diffusion of Innovation, Technology Organization and Environment, Higher Educational Institutions

## INTRODUCTION

Cloud computing is an innovative technology that organizations should use to give themselves a technological foundation to deliver their programs (Krelja *et al.*, 2018). Cloud computing can offer better scalability as well as portability when applied to learning programs by making a wide range of cloud-based apps available to prospective clients, like teachers and students, who can help them with their academic objectives (Alharthi *et al.*, 2015; Stergiou *et al.*, 2018).

Cloud computing could be thought of as a large collection of resources that have been virtualized and managed to grow dynamically by a demand-utilized pay-per-resources pricing model (Sultan, 2010). Computing resources can be accessed using cloud technology that institutions are gradually adopting along with services based on those that may be accessed via the internet, the resources also comprise software and hardware from distant data centers (Pearson and Benameur, 2010). Rohani *et al.*, (2015) claim that when adopting emerging innovations, organizations improve their competitiveness and additionally improve the effectiveness and productivity of the services with limited resources that have overloaded educational institutions (Abdollahzadehgan *et al.*, 2013). Effective utilization of resources, elasticity, pay-per-use, and multi-tenancy are emphasized in cloud computing (Agarwal, 2011). Both potential advantages and challenges come with the implementation of cloud computing, the key issues with cloud computing adoption in an organization are weak system monitoring, reliable identity management, ease of access, and secure data control (Cartes, 2014).

Transferring traditional class delivery to an online system is a huge transition that needs a lot of planning and preparation (Bao *et al.*, 2020). This is true because converting to a virtual learning program would necessitate workable equipment for online learning and an appropriate cloud service model to offer teachers and students high-quality services (Almaiah *et al.*, 2020). Higher education institutions are moving forward with Internet usage by embracing cloud computing. This is due to its ability to share IT-related services in the cloud and provide students and faculty personnel with crucial tools (M. A. Islam, et al 2019). Many institutions are trying their best to keep up with the rapid growth of technological advancements, which is seen in all areas of human activity, the use of emerging innovations is now seen as a need in the Information and Communication Technology (ICT) era, as they may quickly enhance the majority of organizational activities (Alhelou *et al.*, 2021). As a result of intense competition and shifting corporate environments, organizations continuously strive to upgrade their advertising content by implementing new technology, and CC is no different. It is an easy technique of computing services provided over the internet. Udenor *et al.*, (2018) claim that ICT improvements have consistently had a major impact on educational systems resources are spread among educational institutions, they can focus more on fundamental academic tasks like research. Universities in particular have viewed cloud computing as a revolutionary technical advancement in higher education institutions as well as an innovation in which internet technologies provide IT-driven skills that are flexible and accessible (Sultan, 2010). Since CC allows for the rapid adoption of IT resources, particularly for research, which surpasses conventional software platforms. Additionally, socially progressive learning theories and collaborative learning can be implemented and utilize cloud CC systems. Using centralized data storage, and virtualization, including all capabilities, the resources of the cloud can be used to create e-learning environments, technology, as well as educational facilities. In light of all these reasons, cloud computing is crucial for several higher education institutions. Several organizations depend on technology to cut costs, maintain competitiveness, to attend to students' and teachers' needs (Garcia-Penalvo *et al.*, 2014). Higher education institutions can take advantage of existing knowledge to their mutual advantage due to the availability and openness of CC services. For the client, using applications through cloud computing is more affordable and flexible.

Furthermore, there is a lot of interest in cloud computing from both academia and business, and the paradigm is still developing. Nigeria is one of the world's developing nations. So, without a significant investment, cloud computing provides access to highly modern technology and accompanying infrastructure. Cloud computing adoption in Nigerian universities gives access to modern technology with a small investment and technical knowledge (Udenor, 2018). Cloud computing is expected to replace obsolete conventional computational models inspired by the construction of data centers and internal management of the infrastructure. Lowering costs and being responsive to business requirements are linked to relative advantage.

### A. The Cloud Computing Concept

The National Institute of Standards and Technology (NIST) describes cloud computing as a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with very little management effort or service provider interaction (Mell and Grance, 2011). E-Learning will be encouraged, moved, and integrated via cloud computing, universities, and colleges must possess the necessary technological resources and digital infrastructure (Al-Masri *et al.*, 2019). It would not be until then that cloud computing will be effective for e-Learning. According to Sharma *et al.*, (2014), who recognize the application of technology tools to enhance the integrity of the information supplied, this is in keeping with their findings. By linking more users to a virtual learning environment, a broader group of students across institutes of learning, and community is maximized (Alqahtani and Rajkhan, 2020). Government-imposed hygienic regulations have made cloud-based e-Learning systems increasingly necessary for educational institutions, businesses, and individuals. Quick access, no cost or low cost, quality, security, and storage alternatives are addressed as the main justifications. According to Alhelou *et al.*, (2021), cloud platforms allow many users to join across many data sources simultaneously, are user-friendly, and only need a fundamental understanding of ICT. For instance, allowing different students to contact one another promotes more student interaction, communication, and knowledge exchange. According to additional data, it has been found that throughout the pandemic, the zoom platform was one of the leading cloud services for e-Learning (Bhardwaj *et al.*, 2020).

The powerful tool known as cloud computing, which provides great scalability and flexibility, enables students, staff, instructors, directors, and available university users to view file storage, databases, as well as other university programs from different locations within the campus (Jain and Pandey, 2013). Few studies expressly discuss the advantages of implementing cloud computing in colleges and its difficulties, particularly in universities. The only areas are cloud computing frameworks, security, and implementation which are currently the subject of research on their use in education (Hussein *et al.*, 2015; Mokhtar *et al.*, 2016; Scholten, 2017). Universities worldwide, notably some in advanced nations, are pressured to stay current with important IT trends like CC in the field of education since technology is expanding at an unmatched rate. The price of acquiring and sustaining ICT equipment, as well as the issue of the country's insufficient power supply, are two major reasons why the usage of ICT is growing very slowly in some developing nations, like Nigerian institutions. CC remains in its early stages (Ume *et al.*, 2012). Cloud computing innovation despite reducing costs but also saves electricity because it allows multiple stakeholders to use infrastructure simultaneously for the intent of teaching, learning, and research. But higher education institutions face a direct demand to decide how cloud computing may be successfully applied and how to offer cloud-based education (Qasem *et al.*, 2019). In the past, numerous kinds of research on the efficient use of CC there been reliable, adopted as well as validated, particularly in underdeveloped countries, studies on cloud computing in higher education institutions are scarce, especially in contexts of universities in underdeveloped countries (Njenga *et al.*, 2019). There needs to be equipment like computers, servers, software, and an internet network. To ensure that the configuration is suitable for the database, security, and usability before it to function effectively, the online experience must be of good quality, and specialists or technical ICT staff are required (Agrawal *et al.*, 2021). Then, sufficient training must be provided to teachers or tutors to learn new skills related to online course delivery, student interaction, and tracking and giving feedback on students' progress. End users who are students and learners must receive a prior presentation on how to use cloud services and deliver tasks.

Therefore, an appropriate academic program must be created due to e-Learning purposes; otherwise, engaging visually online will be difficult for both students and students. Any educational resources, including e-books and PDFs for teaching and learning, must be entered into the cloud database.

In both rich and developing nations, CC becomes a potent platform for teaching and learning activities (Massadeh *et al.*, 2013) recommended that Jordanian colleges may likely implement cloud computing as a solution to address expanding demand for IT services and address the constrained budget due to the government's extremely inefficient support financially. Because Jordanian universities are unable to handle the necessary IT support for advancement, educational, and research studies that need to be offered in such an excellent teaching and learning environment, (Suryawanshi and Narkehde 2012) give way for implementing the transition from a traditional IT platform towards the cloud for tertiary level. The scientists claim that employing cloud computing is an ideal method for giving excellent pricing models for those institutions. In their proposal, a committee to oversee the deployment procedures is proposed to gather knowledge by attending conferences and seminars on cloud computing and speaking with cloud service providers.

### B. The Relevant Cloud Computing Adoption Framework

The DOI model created by Rohani *et al.*, (2015) and the TOE model developed by (Alharthi *et al.*, 2012) are the two models for new technology adoption in an organization that is most frequently employed. Universities' adoption of cloud applications is mostly based on these theories, some authors choose to analyze the use of technology using the TOE framework, likewise, others opted to do so using the DOI model; however, some scholars have advised combining the two models to do so, as well as to evaluate the model's suitability. The study decides to move on to decide and understand several topics previously examined regarding cloud computing adoption in universities. Many researchers on the technical features of cloud computing have developed (Sultan, 2010, Hussein *et al.*, 2015; Mokhtar *et al.*, 2016). Understanding the variables that influence the uptake of cloud computing at universities is essential according to the two models that have previously been created and have substantial support, the DOI and TOE framework, in light of this gap in the literature. Table-1 below shows cloud computing adoption according to the two models.

Table-1 The constructs utilized in the TOE and the DOI model

Author and Year	Theory	Construct
Oliveira <i>et al.</i> , 2014	DOI and TOE	Complexity, Relative advantage, Technology readiness, Firm size, and Top management support.
Lian <i>et al.</i> , 2014	TOE	Cost, Security, Top management support, and Complexity.
Sabi <i>et al.</i> , 2016	DOI	Complexity, Technology readiness, Firm size, and Top management support.
Salim <i>et al.</i> , 2016; Low <i>et al.</i> , 2011	TOE and DOI	Relative advantage, Data privacy, Complexity, Security, Top management support, Innovativeness, Competitive pressure, Regulatory Policy, firm size, and External support.
Tashkandi <i>et al.</i> , 2015; Gupta <i>et al.</i> , 2013	TOE	Relative advantage, IT Experiences, Data privacy, Complexity, Security, Top management support, Innovativeness, Competitive pressure, Regulatory Policy, External support, and Reliability.

### C. Research Model and Hypothesis

The paradigm for cloud computing adoption that universities in Nigeria have provided is based on TOE and DOI; even though they can be used to categorize all adoption factors, this theory is much more applicable. The diffusion innovation theory (DOI) model and TOE have been used in this study to explore the advantages and difficulties associated with adopting and using cloud computing. Therefore, the DOI and TOE models were enhanced in this research on cloud computing adoption by Nigerian universities by 12 additional variables, which are listed below: relative benefit, compatibility, complexity, technology readiness, security, privacy, and support from top management, size of the institution, innovativeness, reliability, regulatory, and competitive evidence demonstrating the influence of all mentioned constructs over the purpose of cloud adoption. Since the initial DOI applications to this study and the concept is used and changed across various areas. The suggested model for this research is shown below in Fig. 1.

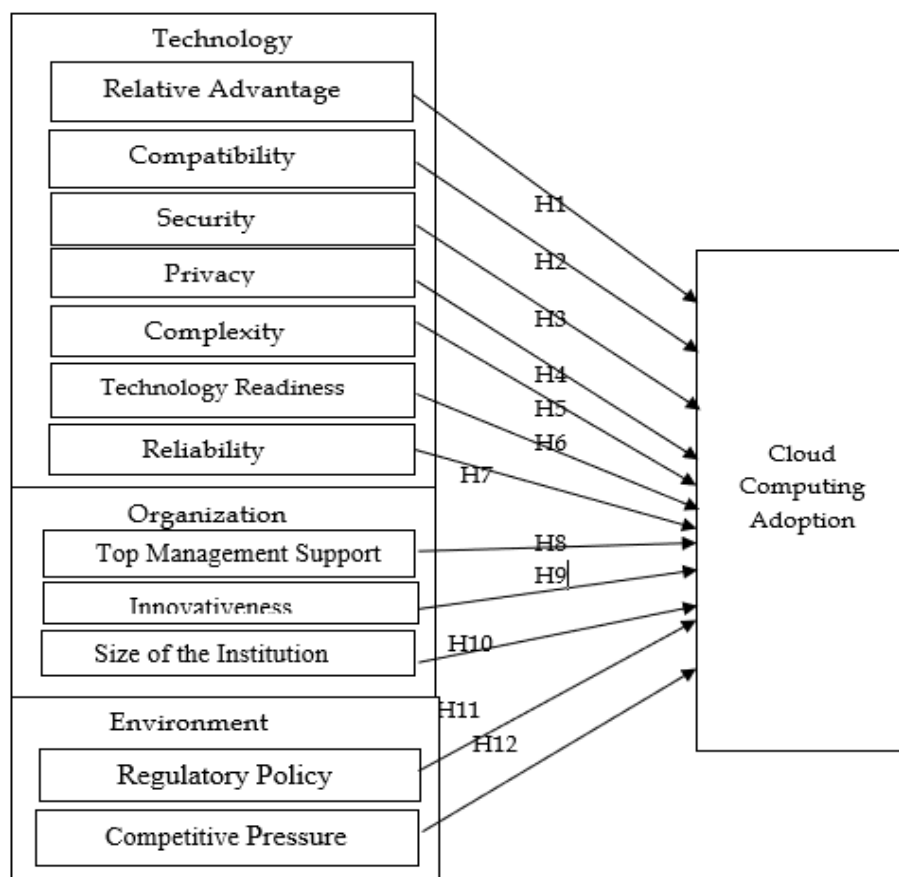


Fig. 1 The research model

### D. Technological Context

The proposed model of the research detailed the factors of the technological setting, such as relative advantage, compatibility, complexity, security, privacy, technology readiness, and reliability. Institutions embracing modern technology, however, are only relative advantages (Makoza, 2016). Additionally, it connects cost reduction to a business requirement (Tashkandi and Al-Jabri, 2015).



Furthermore, it stands to reason that organizations should research the benefits of incorporating modern technologies (Low *et al.*, 2011). On the contrary, complexity harms the adoption rate whereas relative advantage has a positive effect (Rogers, 2003; Alshamaila, 2013). On the other hand, complexity relates to the stated challenge of establishing the use of emerging innovations (Tashkandi and Al-Jabri, 2015). Due to the complexity of IT services and systems, institutions might not be willing to use an idea. In contrast, security and privacy are acknowledged as important concerns for implementing the latest technology. This problem is connected to the concern over safeguarding tools that are transmitting and keeping institutional data or information online (Lippert and Govindarajulu, 2015). Furthermore, privacy means allowed access to information, whereas security is about preventing unwanted access or preserving information against unlawful usage, the quality of cloud-based services is mostly determined by reliability (Gupta *et al.*, 2013). Institutions have substantial concerns about both security and privacy (Alshamaila, 2013). Such issues give rise to the following hypothesis:

- H1. Relative advantage has a positive impact on CC adoption.
- H2. Compatibility has a positive influence on the adoption of CC.
- H3. Security has a positive influence on CC adoption.
- H4. Privacy has a positive impact on CC adoption.
- H5. Complexity has a negative influence on CC adoption
- H6. Technology Readiness influences CC adoption
- H7: Reliability is a negative impact on adopting CC.

#### *E. Organizational Context*

The impacts on an organization's decision to adopt modern technology are another aspect of the concept. Numerous studies have pinpointed organizational barriers that are impeding the implementation of the latest technology (Lippert and Govindarajulu, 2015). Additionally, earlier studies on the adoption of innovation suggested that top management backing, innovativeness, and institutional size are important organizational elements for implementing new technologies. Additionally, upper management backing is crucial for firms to succeed in communicating the relevance of new technology to all stakeholders while also ensuring the availability of necessary services (Alshamaila, 2013). Therefore, it is anticipated that businesses with more imaginative decision-makers will adopt new technologies more frequently (Tehrani and Shirazi, 2014). Technical expertise is also necessary to operate and maintain cloud-related services and applications. If institutions have the necessary infrastructure and IT expertise, IT services can become a substantial element of their operations (Low *et al.*, 2011). Such issues give rise to the following hypothesis:

- H8: Top Management support has a positive influence on CC adoption.
- H9: Innovativeness harms adopting cloud computing.
- H10: The size of the institution influences cloud computing adoption.

#### *F. Environmental Context*

As a result, the environmental setting alludes to how businesses have changed to incorporate innovation to remain competitive (Makoza *et al.*, 2016). The competition is linked to the deployment of cloud computing and gives the institution the possibility to understand its surroundings. Additionally, institutions that rely on other businesses should take into account the prerequisites for implementing new technologies as a means of combating compression (Makoza, 2016). Additionally, earlier research suggested that external, competitive, and regulatory supports are crucial environmental factors used in implementing the latest technologies (Alshamaila, 2013; Tehrani *et al.*, 2014). As a result, the impact of additional crucial factors on the ecosystem has been investigated.

Competitiveness is the level of rivalry between businesses in the industry that the firm operates in, and it pushes businesses to innovate more to survive (Tehrani and Shirazi, 2014). Additionally, fierce rivalry forces businesses to look at the latest technology in the development of an idea (Alshamaila, 2013). Additionally, the institution's exposure to fierce competition is crucial for implementing modern technology (Low et al., 2011). Regulatory policy, on the other hand, refers to the present laws and rules that permit institutions to use cloud computing resources and services that are housed outside of their institution. In contrast, the level of external support provided by cloud service providers determines how widely cloud computing is used (Tehrani et al., 2014). Additionally, "The perceived value of support provided by cloud providers" is explained by "regulatory policy". Consequently, such issues lead to the following hypothesis:

H11: Regulatory has a positive influence on CC adoption.

H12: Competitive Pressure Harms CC adoption

### G. Cloud Computing Adoption

Using the cloud-based platforms, infrastructure, and services offered by universities, an index is created to track the use of cloud computing. A question was also put up to gauge if universities plan to use resources for using the cloud. The measure items for the proposed constructs are shown in Table-2 below based on the literature.

Table-2 The measured items used

Contexts	Constructs	Items	Sources
Technological	Relative Advantage	1. cloud computing Accelerate University processes. 2. Increase the efficiency of the University 3. Improves the quality of operational services.	Oliveira et al., 2014 Tashkandi et al., 2015 Low et al., 2011
	Compatibility	1. Cloud computing is compatible with the preferred working method of our university. 2. Our university's present hardware and software infrastructure is compatible with cloud computing. 3. The use of technologies for cloud computing fits well with the way we operate.	Lian et al., 2014 Tashkandi et al., 2015 Low et al., 2011
	Data Security	Data Security: 1. Our university is concerned about cloud computing data security. 2. Our university is concerned that internet criminals cannot alter data. 3. Cloud service providers are concerned about our university, so no official data is used for other purposes.	Sabi et al., 2016 Oliveira et al., 2014 Tashkandi et al., 2015 Lian et al., 2014
	Privacy	1. Our university is concerned about freedom and access restrictions to cloud services. 2. Our university is concerned about cloud computing privacy.	Salim et al., 2016 Tashkandi et al., 2015

	Complexity	<ol style="list-style-type: none"> <li>1. Cloud Computing requires a high level of expertise for our university to implement</li> <li>2. Using cloud computing services requires a lot of intellectual effort.</li> </ol>	<a href="#">Tashkandi et al., 2015</a> <a href="#">Low et al., 2011</a> <a href="#">Lian et al., 2014</a>
	Technology Readiness	<ol style="list-style-type: none"> <li>1. The institutional norms and principles that guide our organization encourage the use of cloud computing.</li> <li>2. The technology used in our university support for cloud computing adoption.</li> </ol>	<a href="#">Oliveira et al., 2014</a> <a href="#">Low et al., 2011</a>
	Reliability	<ol style="list-style-type: none"> <li>1. Cloud Computing requires Reliability of Information.</li> <li>2. Cloud computing requires a reliable storage alternative for our university data.</li> <li>3. Our university requires a reliable atmosphere of trust toward cloud implementation.</li> </ol>	<a href="#">Gupta et al., 2013</a>
Organization	Top management	<ol style="list-style-type: none"> <li>1. To adopt cloud computing, top management has the requisite technical and non-technical skills.</li> <li>2. Management at our university is interested in implementing cloud computing.</li> <li>3. The management of the university is prepared to accept financial risks associated with the use of cloud computing.</li> </ol>	<a href="#">Tashkandi et al., 2015</a> <a href="#">Oliveira et al., 2014</a> <a href="#">Lian et al., 2014</a> <a href="#">Low et al., 2011</a>
	Innovativeness	<ol style="list-style-type: none"> <li>1. Cloud Computing improved working collaboration remotely within and outside universities.</li> <li>2. Cloud computing enables staff and students to exploit new opportunities for teaching and research</li> <li>3. Cloud Computing Improved the level of IT professions in our university.</li> </ol>	<a href="#">Low et al., 2011</a> <a href="#">Tashkandi et al., 2015</a>
	Size	<ol style="list-style-type: none"> <li>1. Our university population encourages cloud computing adoption.</li> <li>2. Staff and students in our university encourage the adoption of cloud technologies.</li> <li>3. High level of IT expertise is required for our university to implement cloud computing.</li> </ol>	<a href="#">Low et al., 2011</a> <a href="#">Oliveira et al., 2014</a>
Environment	Regulatory Policy	<ol style="list-style-type: none"> <li>1. Current laws and regulations enable us to use cloud computing assets and services located elsewhere.</li> <li>2. Laws in Nigeria facilitate and encourage cloud computing adoption.</li> </ol>	<a href="#">Low et al., 2011</a> <a href="#">Tashkandi et al., 2015</a>
	Competitive Pressure	<ol style="list-style-type: none"> <li>1. Competition was pressuring our organization to adopt cloud computing.</li> <li>2. Our University found it difficult to switch to cloud computing services.</li> </ol>	<a href="#">Low et al., 2011</a>



## MATERIALS AND METHODS

Concerning this study, a survey instrument should be created based on the suggested measure items a pilot study is made here to improve the present variable available. To test the proposed model, the theoretical approach developed in this research should be put into practice and tested at a variety of universities around the nation. Universities can therefore take advantage of the discoveries or outcomes. To variety the connection between the constructs, empirical tests must be done in conjunction with implementing the model. This method was seen to be especially appropriate when it was necessary to look into the actual setting or source that was investigated (Kawalek, 2007).

## RESULTS AND DISCUSSION

This research looks at the determinants of cloud computing adoption at universities in Nigeria, according to previous studies, there has been little prior research to examine the determinants impacting cloud computing adoption in universities, therefore this study has major significance for cloud computing studies.

The determinants of innovative characteristics and organizational and environmental context that are important to cloud computing adoption in universities are included in this research. This research should pave the way for features on the determinants that encourage or advocate against using cloud computing, particularly in universities. To make an informed choice before using cloud-based services, university decision-makers can use this study as a basis for thinking about whether to implement cloud computing in their institutions by comparing their experience with the study's objectives that has to do with challenges that may be the main factor in the academic institutions' potential failure to perform well in instruction showcase competition. The results satisfy the investigation's goal with the studies and in the perspective of the conceptual research model and were interpreted. Finally, management appears to be an exceedingly important task for universities as it relates to the findings of the inquiry that support the hypothesis on internal and external factors that tendency. In contrary towards this study's findings, the adoption of CC will force management decisions regarding how to manage teaching and learning.

## CONTRIBUTION TO KNOWLEDGE

Cloud computing represents a significant change in information technology as well as in the context of higher education. The deployment of cloud computing in Nigerian higher education environments, particularly in universities, using combined theories of technology adoption was successful by exploring the factors that influence adoption among universities. Therefore, this paper bridges the research gap caused by the lack of studies that highlight other factors that emphasize the adoption and usage of cloud-based systems and can also benefit decision-makers in organizations that intend to adopt cloud computing in their respective institutions.

## CONCLUSION

In conclusion, this research paper has shed light on the adoption of cloud computing in higher education institutions by employing a comprehensive framework encompassing theories of technology organization and environment, as well as diffusion of innovation.

By analyzing twelve key variables, such as relative advantage, compatibility, complexity, security, privacy, management support, innovativeness, technology readiness, size of the institution, reliability, competitive pressure, and regulations, the study has investigated their influence on the level and pace of cloud computing adoption. The findings of this study hold significant implications for higher education institutions, as they provide valuable insights into the decision-making process surrounding the adoption of cloud computing. By understanding the various factors that impact adoption, institutions can make informed choices about implementing cloud-based systems and overcome potential barriers. Moreover, the research outcomes can inform policy development aimed at facilitating the effective implementation and management of cloud-based technologies within the education sector. By bridging the gap between theoretical frameworks and practical considerations, this study contributes to the existing body of knowledge in the field of cloud computing adoption in higher education. The comprehensive analysis of multiple variables expands our understanding of the complex dynamics involved in this process, offering a nuanced perspective on the challenges and opportunities associated with cloud computing adoption. Overall, this research contributes to the ongoing dialogue on cloud computing adoption in higher education and provides a foundation for future studies in this domain. The outcomes of this research can guide institutions in making informed decisions, foster innovation, and ultimately enhance the quality of education through the effective implementation and management of cloud-based systems.

## CONFLICT OF INTEREST

The authors declare no conflict of interest in the outcome of this research.

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