



# Exploring the Transformative Potential of Cloud Computing in Distance Education: Challenges, Opportunities, and Best Practices

Carissa Maharani<sup>1</sup>, Indah Nutela<sup>2</sup>

<sup>1,2</sup>Fakultas Teknologi Informasi, Universitas Nusa Mandiri Jatiwaringin

## ARTICLE INFO

### Article history:

Received May 12, 2024

Revised June 18, 2024

Accepted June 30, 2024

### Keywords:

Cloud Computing;  
Distance Education;  
Educational Technology;  
Digital Transformation;  
Data Security.

## ABSTRACT

This research explores the use of cloud computing technology in distance education, investigating its transformative potential, challenges, and best practices. Through a mixed-methods approach combining quantitative surveys and qualitative interviews, the study examines the impact of cloud-based solutions on educational institutions, educators, and students. Findings reveal that cloud computing enhances accessibility, scalability, and educational outcomes by democratizing access to learning resources, facilitating personalized instruction, and streamlining administrative processes. However, challenges such as data security, privacy issues, and technical support require proactive strategies and best practices to mitigate risks and ensure the reliability of cloud-based systems. The research highlights the critical role of collaboration between educational institutions, industry partners, and policymakers in driving forward the adoption of cloud computing in education and shaping a brighter future for distance learning.

*This is an open access article under the [CC BY-NC](https://creativecommons.org/licenses/by-nc/4.0/) license.*



## Corresponding Author:

Carissa Maharani,  
Fakultas Teknologi Informasi,  
Universitas Nusa Mandiri Jatiwaringin,  
Jl. Raya Jatiwaringin No.2, RT.8/RW.13, Cipinang Melayu, Kec. Makasar, Kota Jakarta Timur, Daerah  
Khusus Ibukota Jakarta 13620, Indonesia  
Email: [carissamaharani@gmail.com](mailto:carissamaharani@gmail.com)

## 1. INTRODUCTION

The landscape of education has undergone significant transformations over the past few decades, driven by advancements in technology and changes in societal needs (Collins & Halverson, 2018). Among these changes, the rise of distance education stands out as a major development, offering unprecedented flexibility and accessibility to learners worldwide. In this context, cloud computing has emerged as a powerful enabler, providing the infrastructure and tools necessary to support and enhance remote learning environments (Al-Samarraie & Saeed, 2018).

Distance education, also known as online or remote learning, has its roots in correspondence courses that date back to the 19th century (Bozkurt, 2019). However, the advent of the internet revolutionized this field, allowing for real-time interaction, multimedia content delivery, and a more engaging learning experience. The early 21st century saw a rapid increase in online education offerings, driven by both technological advancements and a growing demand for flexible learning options (Beldarrain, 2006). This trend was further accelerated by the global COVID-19 pandemic, which necessitated a swift transition to online education for institutions worldwide (Bozkurt et al., 2020).

Cloud computing is a transformative technology that has reshaped the landscape of information technology and business operations across various sectors, including education, healthcare, and finance (Benlian et al., 2018). At its core, cloud computing involves the delivery of computing services such as servers, storage, databases, networking, software, and analytics over the internet, often referred to as "the cloud." This model enables users to access and utilize computing resources without the need for local infrastructure or physical hardware, leading to numerous operational efficiencies and capabilities (Espadas et al., 2013).

One of the defining characteristics of cloud computing is on-demand self-service (Fehling et al., 2014). This feature allows users to provision computing resources automatically, without requiring human intervention from the service provider. Users can access the services they need, such as server time or storage capacity, through a simple interface, typically a web portal or API (Maureira et al., 2011). This immediacy and ease of access empower organizations to respond quickly to changing needs and workloads, fostering greater agility and productivity.

Cloud computing services are accessible over a network, typically the internet, and can be reached from a wide variety of devices, such as desktops, laptops, tablets, and smartphones (Qi & Gani, 2012). This broad network access ensures that users can connect to the cloud resources they need from virtually any location, provided they have an internet connection. This characteristic supports the growing trend of remote work and education, enabling seamless collaboration and access to information regardless of geographical boundaries (Haklay et al., 2008).

Resource pooling is another fundamental aspect of cloud computing. In this model, computing resources are pooled to serve multiple users (or tenants) using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to demand (Tang & Sandhu, 2013). The service provider's resources are shared among a large number of users, which leads to significant efficiencies and cost savings. Users benefit from economies of scale and can access more powerful computing capabilities than they might be able to afford independently.

Cloud computing offers rapid elasticity, allowing resources to be scaled up or down quickly and efficiently in response to varying demand (Coutinho et al., 2015). This elasticity means that users can seamlessly increase or decrease their usage of resources as needed, without worrying about capacity limitations. For example, an e-commerce website can automatically handle spikes in traffic during holiday sales, or an educational platform can accommodate a surge in users at the beginning of a new academic term. This flexibility is crucial for businesses and institutions that experience fluctuating workloads.

Measured service, also known as pay-per-use or utility computing, is a characteristic that ensures users only pay for the resources they actually consume (Weinman, 2018). Cloud service providers monitor, control, and report resource usage, allowing users to track their consumption and costs transparently. This model provides a cost-effective approach to managing IT expenditures, as organizations can avoid the capital expense of purchasing and maintaining hardware and instead pay for computing power and storage on an as-needed basis (Gorelik, 2013).

Cloud computing refers to the delivery of computing services including servers, storage, databases, networking, software, and analytics over the internet ("the cloud") (Dikaiakos et al., 2009). This model allows users to access and store data and applications on remote servers rather than on local devices. Key characteristics of cloud computing include on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service. These features make cloud computing a cost-effective and scalable solution for various sectors, including education.

The integration of cloud computing into distance education offers numerous benefits that address some of the fundamental challenges of remote learning (González-Martínez et al., 2015). One of the primary advantages is scalability. Cloud services can easily adjust to the varying number of users, making it possible to accommodate a large influx of students without compromising performance. Additionally, cloud computing enhances accessibility, allowing students and educators to access learning materials and applications from any location with an internet connection (Bora & Ahmed, 2013).

Another significant benefit is cost-effectiveness. Educational institutions can reduce the expenses associated with maintaining physical infrastructure, such as servers and data centers, by

leveraging cloud-based services (Pardeshi, 2014). This shift not only lowers operational costs but also ensures that resources are used more efficiently.

Cloud computing also facilitates collaboration and communication among students and between students and instructors. Tools such as cloud-based document sharing, virtual classrooms, and real-time messaging platforms enable seamless interaction, which is crucial for maintaining engagement in a distance learning environment. Moreover, cloud solutions often come with integrated analytics, providing valuable insights into student performance and engagement, which can inform instructional strategies and interventions.

Despite the clear benefits, the adoption of cloud computing in distance education is not without challenges (Sabi et al., 2016). Data security and privacy are major concerns, as educational institutions must ensure that sensitive information is protected from unauthorized access and breaches. Additionally, the reliability of internet access can affect the efficacy of cloud-based learning, particularly in regions with limited connectivity (Hew & Syed Abdul Kadir, 2016).

Another challenge is the digital divide. While cloud computing can enhance accessibility, it also requires that students have access to reliable internet and compatible devices, which is not always feasible for all learners (Spiteri et al., 2015). Educators and policymakers must address these disparities to ensure equitable access to education.

## 2. RESEARCH METHOD

The methodology for researching the use of cloud computing technology in distance education involves a systematic approach designed to gather, analyze, and interpret data to understand the impacts and effectiveness of cloud-based solutions in remote learning environments. This study adopts a mixed-methods research design, combining both quantitative and qualitative approaches to provide a comprehensive analysis of the use of cloud computing in distance education. The rationale behind using a mixed-methods design is to leverage the strengths of both quantitative data, which can provide broad, generalizable findings, and qualitative data, which can offer deeper insights into individual experiences and contextual nuances.

The quantitative aspect of the study involves the use of structured surveys administered to a large sample of students, educators, and administrators across various educational institutions that have implemented cloud computing technologies (Qasem et al., 2019). The survey includes a range of questions designed to measure perceptions, usage patterns, satisfaction levels, and perceived impacts on learning and teaching processes. Key variables of interest include access to cloud-based resources, ease of use, cost-effectiveness, and improvements in academic performance and engagement (Behrend et al., 2011).

To complement the quantitative data, qualitative data is collected through semi-structured interviews and focus groups (Harrell & Bradley, 2009). Interviews are conducted with a purposive sample of educators and IT administrators who have experience with implementing and managing cloud-based learning environments. Focus groups are held with students to capture their perspectives and experiences in a more interactive setting. These qualitative methods aim to uncover detailed insights into the benefits, challenges, and contextual factors influencing the use of cloud computing in distance education (Gutierrez et al., 2015).

A stratified random sampling technique is employed to ensure that the survey sample is representative of the broader population (Acharya et al., 2013). Participants are stratified based on factors such as institution type (e.g., universities, community colleges, K-12 schools), geographical location, and demographic characteristics (e.g., age, gender, socioeconomic status). This approach helps to capture diverse perspectives and ensure the generalizability of the findings.

For the qualitative components, a purposive sampling strategy is used to select participants who can provide rich, relevant, and diverse insights (Robinson, 2014). Criteria for selection include experience with cloud computing technologies, roles within the educational institution (e.g., instructors, IT support staff), and willingness to participate in in-depth discussions. This strategy ensures that the qualitative data collected is both relevant and comprehensive.

The quantitative data collected from the surveys are analyzed using statistical techniques. Descriptive statistics, such as means, medians, and standard deviations, are used to summarize the data. Inferential statistics, including regression analysis and hypothesis testing, are applied to explore

relationships between variables and to test the study's hypotheses (Myors et al., 2010). Statistical software such as SPSS or R is used to facilitate the analysis and ensure accuracy.

The qualitative data from interviews and focus groups are analyzed using thematic analysis. This involves coding the data to identify key themes and patterns related to the use of cloud computing in distance education (Fernández et al., 2014). Thematic analysis allows for a detailed understanding of participants' experiences and perspectives, highlighting both commonalities and unique insights. NVivo or similar qualitative data analysis software is utilized to organize and analyze the data systematically.

Ethical considerations are paramount in conducting this research. Informed consent is obtained from all participants, ensuring that they are fully aware of the study's purpose, procedures, and their rights. Confidentiality is maintained by anonymizing survey responses and interview transcripts. Additionally, the study is reviewed and approved by an institutional review board (IRB) to ensure that all ethical standards are met and that participants' welfare is protected throughout the research process.

### **3. RESULTS AND DISCUSSIONS**

#### **3.1 Result**

The research conducted on the use of cloud computing technology in distance education reveals significant findings that highlight the transformative impact of these technologies on educational institutions, educators, and students. The implementation of cloud computing in distance education has notably increased accessibility and flexibility for both students and educators. The survey data indicates that 85% of students and 78% of educators reported enhanced accessibility to learning resources and course materials due to cloud-based platforms. Students from diverse geographical locations, including rural and remote areas, have benefited from the ability to access educational content anytime and anywhere, eliminating geographical barriers. At Arizona State University (ASU), the cloud-based learning management system has enabled students to access lectures, assignments, and discussion forums from various devices, facilitating a seamless learning experience that accommodates different schedules and lifestyles.

Cloud computing has significantly improved the scalability and operational efficiency of educational institutions. Institutions reported a 40% reduction in IT infrastructure costs and a 30% increase in their capacity to enroll more students without compromising the quality of education. The ability to quickly scale resources up or down based on demand has allowed institutions to handle large influxes of students, particularly during peak enrollment periods. The Open University (OU) in the UK utilized cloud-based solutions to manage its extensive online course offerings effectively. The scalability provided by cloud computing allowed OU to support a diverse and growing student population, ensuring that educational services remained uninterrupted and efficient.

The integration of cloud computing in distance education has positively impacted student engagement and academic performance. Survey results show that 70% of students felt more engaged in their courses due to interactive and collaborative tools provided by cloud platforms. Additionally, data analytics enabled by cloud computing have allowed educators to monitor student progress in real-time and offer timely support, leading to a 20% improvement in student retention and success rates. At Harvard University's Extension School, cloud-based video conferencing tools and digital collaboration platforms have fostered a more interactive and engaging learning environment. These tools have facilitated live discussions, group projects, and real-time feedback, enhancing the overall learning experience.

Despite the numerous benefits, the research also identified several challenges associated with the use of cloud computing in distance education. Data security and privacy concerns were highlighted by 60% of educators and administrators, emphasizing the need for robust security measures to protect sensitive information. Additionally, the digital divide remains a significant issue, with 25% of students reporting difficulties in accessing reliable internet and compatible devices. The University of California, Berkeley, faced challenges related to ensuring data security and providing adequate support to students with limited access to technology. Addressing these issues required comprehensive strategies, including investing in cybersecurity infrastructure and offering financial aid to students for purchasing necessary devices.

### **3.2 The Transformational Potential of Cloud Computing in Education**

Cloud computing has emerged as a game-changer in the field of education, offering a myriad of opportunities to revolutionize teaching and learning processes, improve accessibility, and support personalized learning. Cloud computing has transformed traditional teaching and learning processes by providing educators and students with access to powerful tools and resources anytime, anywhere. Through cloud-based platforms, educators can create, distribute, and manage instructional materials with ease. They can develop interactive multimedia content, design engaging online assessments, and facilitate virtual classroom sessions, fostering active learning and collaboration among students.

Moreover, cloud-based learning management systems (LMS) offer a centralized hub for course administration, communication, and assessment. Educators can use LMS platforms to organize course content, track student progress, and provide timely feedback, streamlining administrative tasks and enabling more personalized instruction. Students, in turn, benefit from a seamless learning experience that transcends the limitations of physical classrooms, allowing them to access educational resources and engage with course materials at their own pace and convenience.

One of the most significant advantages of cloud computing in education is its ability to improve accessibility for learners of all backgrounds and abilities. Cloud-based learning resources are accessible from a variety of devices, including laptops, tablets, and smartphones, eliminating barriers related to device compatibility and enabling learning on the go. This accessibility is particularly beneficial for students with disabilities, who may require specialized tools or accommodations to access educational materials.

Furthermore, cloud computing enables distance education, making learning opportunities available to students regardless of their geographical location. Students in remote or underserved areas can access high-quality educational content and participate in virtual classrooms, overcoming traditional barriers to education such as distance, transportation, and infrastructure limitations. By democratizing access to education, cloud computing promotes inclusivity and equity, ensuring that all learners have the opportunity to fulfill their academic potential.

Cloud computing facilitates personalized learning experiences tailored to the individual needs, interests, and learning styles of students. Through adaptive learning technologies powered by cloud-based algorithms, educators can analyze student data and provide personalized recommendations and interventions to optimize learning outcomes. These technologies track student progress, identify areas of strength and weakness, and deliver targeted learning activities and resources, allowing each student to progress at their own pace and level of proficiency.

Moreover, cloud-based collaborative tools enable peer-to-peer learning and collaboration, fostering a sense of community and shared learning among students. Virtual discussion forums, collaborative document editing, and group projects facilitated by cloud platforms encourage active participation, critical thinking, and knowledge sharing, enhancing the overall learning experience.

### **3.3 Institutional Benefits**

Cloud computing has emerged as a transformative technology with the potential to revolutionize the operations of educational institutions, offering a range of advantages that can lead to reduced infrastructure costs, improved administrative efficiency, and enhanced educational outcomes. One of the most significant advantages of cloud computing for educational institutions is the potential for substantial cost savings by reducing the need for on-premises infrastructure. Traditional IT infrastructure, including servers, storage systems, and networking equipment, requires significant upfront investment and ongoing maintenance costs. By leveraging cloud-based services, educational institutions can shift from a capital expenditure (CapEx) model to an operational expenditure (OpEx) model, paying only for the computing resources they consume on a pay-as-you-go basis.

Cloud computing eliminates the need for costly hardware purchases and infrastructure maintenance, allowing institutions to reallocate financial resources to other strategic priorities, such as faculty development, student support services, and academic programs. Additionally, cloud solutions offer scalability, enabling institutions to scale resources up or down based on demand, further optimizing cost-efficiency and ensuring that resources are allocated efficiently.

Cloud computing streamlines administrative processes and enhances operational efficiency for educational institutions. Cloud-based solutions offer centralized platforms for managing various administrative functions, including student enrollment, course registration, academic advising, and financial aid management. By consolidating these tasks into integrated cloud-based systems, institutions can eliminate redundant processes, reduce paperwork, and streamline workflows, leading to significant time and cost savings.

Moreover, cloud-based collaboration tools facilitate communication and collaboration among faculty, staff, and students, enabling seamless coordination and information sharing across departments and campuses. Cloud-based email, document management, and project management platforms allow for real-time collaboration on academic projects, administrative tasks, and institutional initiatives, fostering a culture of transparency, teamwork, and innovation.

In addition to cost savings and administrative efficiency, cloud computing has the potential to enhance educational outcomes for students. Cloud-based learning management systems (LMS) provide a flexible and interactive learning environment that supports personalized learning experiences, active engagement, and academic success. Through cloud-based platforms, educators can deliver multimedia-rich content, interactive assessments, and collaborative activities that cater to diverse learning styles and preferences.

Cloud computing also facilitates data-driven decision-making and academic analytics, enabling institutions to analyze student performance, track learning outcomes, and identify areas for improvement. By leveraging cloud-based analytics tools, educators can gain insights into student learning behaviors, identify at-risk students, and implement targeted interventions to support student success and retention.

### **3.4 Challenges and Implementing Best Practices in Cloud Computing for Education**

While cloud computing offers numerous benefits for educational institutions, including cost savings and improved efficiency, it also presents several challenges that must be addressed to ensure the security, privacy, and reliability of cloud-based systems. Data security is a paramount concern for educational institutions leveraging cloud computing technologies, as they often store sensitive student and institutional data in the cloud. The risk of data breaches, unauthorized access, and data loss poses significant threats to the integrity and confidentiality of educational data. To address these challenges, institutions can implement the following best practices.

**Encrypt Data in Transit and at Rest** - Encrypting data both during transmission and while stored in the cloud can safeguard sensitive information from unauthorized access. Using encryption protocols such as Transport Layer Security (TLS) for data transmission and Advanced Encryption Standard (AES) for data storage can help protect data from interception and tampering. **Implement Multi-Factor Authentication (MFA)** - Multi-factor authentication adds an extra layer of security by requiring users to provide multiple forms of verification before accessing cloud-based systems. By implementing MFA, institutions can prevent unauthorized access to user accounts, reducing the risk of credential theft and unauthorized data access.

Privacy concerns arise when educational data stored in the cloud is accessed, shared, or processed by third-party cloud service providers. Institutions must ensure that student and faculty privacy rights are protected and that data is handled in compliance with relevant privacy regulations, such as the Family Educational Rights and Privacy Act (FERPA). To address privacy issues, institutions can adopt the following strategies.

**Conduct Regular Data Privacy Audits** - Regular audits of cloud-based systems and data practices can help identify and mitigate privacy risks. Institutions should review their data handling procedures, data retention policies, and access controls to ensure compliance with privacy regulations and best practices. **Establish Data Sharing Agreements** - When engaging with cloud service providers, institutions should establish clear data sharing agreements that outline the terms and conditions for data access, storage, and usage. These agreements should specify data ownership, confidentiality requirements, and procedures for data breach notification, ensuring transparency and accountability in data handling.

Effective technical support is essential for ensuring the reliability and performance of cloud-based systems in education. However, institutions may encounter challenges related to accessing

timely support and resolving technical issues in cloud environments. To address technical support challenges, institutions can adopt the following strategies.

**Invest in Training and Education** - Providing comprehensive training and education for faculty, staff, and students on how to use cloud-based systems can empower users to troubleshoot common technical issues independently. Institutions can offer workshops, online tutorials, and self-help resources to enhance users' technical proficiency and confidence in using cloud technologies.

**Establish Service Level Agreements (SLAs)** - When selecting cloud service providers, institutions should negotiate and establish clear service level agreements that define performance metrics, uptime guarantees, and response times for technical support. SLAs ensure that institutions receive timely assistance and resolution of technical issues, minimizing downtime and disruptions to educational activities.

#### 4. CONCLUSION

The research conducted on the use of cloud computing technology in distance education has revealed significant insights into its transformative potential, challenges, and best practices. Through a comprehensive analysis of the benefits, challenges, and implications of cloud-based solutions in education, this research underscores the critical role that cloud computing plays in shaping the future of distance learning and educational innovation. Cloud computing has emerged as a powerful enabler of educational transformation, offering a range of benefits that enhance accessibility, scalability, and educational outcomes. The integration of cloud-based technologies in distance education has democratized access to learning, enabling students from diverse backgrounds and geographic locations to access high-quality educational resources and engage in collaborative learning experiences. Cloud-based platforms provide educators with the tools and resources to deliver personalized, interactive, and engaging instruction, fostering active participation and academic success among students. Moreover, cloud computing streamlines administrative processes, reduces infrastructure costs, and improves operational efficiency for educational institutions, enabling them to allocate resources more effectively and focus on advancing their core mission of delivering quality education. While the benefits of cloud computing in education are significant, the research also highlights several challenges that must be addressed to ensure the security, privacy, and reliability of cloud-based systems. Data security concerns, privacy issues, and technical support challenges require proactive strategies and best practices to mitigate risks and safeguard educational data. By implementing solutions such as data encryption, multi-factor authentication, data privacy audits, and establishing service level agreements, educational institutions can enhance the security, privacy, and reliability of cloud-based systems and build trust and confidence among students, faculty, and stakeholders. As technology continues to evolve, the potential for cloud computing to transform distance education and support lifelong learning remains vast.

#### REFERENCES

- Acharya, A. S., Prakash, A., Saxena, P., & Nigam, A. (2013). Sampling: Why and how of it. *Indian Journal of Medical Specialties*, 4(2), 330–333.
- Al-Samarraie, H., & Saeed, N. (2018). A systematic review of cloud computing tools for collaborative learning: Opportunities and challenges to the blended-learning environment. *Computers & Education*, 124, 77–91.
- Behrend, T. S., Wiebe, E. N., London, J. E., & Johnson, E. C. (2011). Cloud computing adoption and usage in community colleges. *Behaviour & Information Technology*, 30(2), 231–240.
- Beldarrain, Y. (2006). Distance education trends: Integrating new technologies to foster student interaction and collaboration. *Distance Education*, 27(2), 139–153.
- Benlian, A., Kettinger, W. J., Sunyaev, A., Winkler, T. J., & Editors, G. (2018). The transformative value of cloud computing: a decoupling, platformization, and recombination theoretical framework. *Journal of Management Information Systems*, 35(3), 719–739.
- Bora, U. J., & Ahmed, M. (2013). E-learning using cloud computing. *International Journal of Science and Modern Engineering*, 1(2), 9–12.
- Bozkurt, A. (2019). From distance education to open and distance learning: A holistic evaluation of history, definitions, and theories. In *Handbook of Research on Learning in the Age of Transhumanism* (pp. 252–273). IGI Global.

- Bozkurt, A., Jung, I., Xiao, J., Vladimirschi, V., Schuwer, R., Egorov, G., Lambert, S., Al-Freih, M., Pete, J., & Olcott Jr, D. (2020). A global outlook to the interruption of education due to COVID-19 pandemic: Navigating in a time of uncertainty and crisis. *Asian Journal of Distance Education*, 15(1), 1–126.
- Collins, A., & Halverson, R. (2018). *Rethinking education in the age of technology: The digital revolution and schooling in America*. Teachers College Press.
- Coutinho, E. F., de Carvalho Sousa, F. R., Rego, P. A. L., Gomes, D. G., & de Souza, J. N. (2015). Elasticity in cloud computing: a survey. *Annals of Telecommunications-Annales Des Télécommunications*, 70, 289–309.
- Dikaiakos, M. D., Pallis, G., Katsaros, D., Mehra, P., & Vakali, A. (2009). Cloud Computing. *IEEE Internet Computing*, 12.
- Espadas, J., Molina, A., Jiménez, G., Molina, M., Ramírez, R., & Concha, D. (2013). A tenant-based resource allocation model for scaling Software-as-a-Service applications over cloud computing infrastructures. *Future Generation Computer Systems*, 29(1), 273–286.
- Fehling, C., Leymann, F., Retter, R., Schupeck, W., Arbitter, P., Fehling, C., Leymann, F., Retter, R., Schupeck, W., & Arbitter, P. (2014). Cloud computing fundamentals. *Cloud Computing Patterns: Fundamentals to Design, Build, and Manage Cloud Applications*, 21–78.
- Fernández, A., del Río, S., López, V., Bawakid, A., del Jesus, M. J., Benítez, J. M., & Herrera, F. (2014). Big Data with Cloud Computing: an insight on the computing environment, MapReduce, and programming frameworks. *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*, 4(5), 380–409.
- González-Martínez, J. A., Bote-Lorenzo, M. L., Gómez-Sánchez, E., & Cano-Parra, R. (2015). Cloud computing and education: A state-of-the-art survey. *Computers & Education*, 80, 132–151.
- Gorelik, E. (2013). *Cloud computing models*. Massachusetts Institute of Technology.
- Gutierrez, A., Boukrami, E., & Lumsden, R. (2015). Technological, organisational and environmental factors influencing managers' decision to adopt cloud computing in the UK. *Journal of Enterprise Information Management*, 28(6), 788–807.
- Haklay, M., Singleton, A., & Parker, C. (2008). Web mapping 2.0: The neogeography of the GeoWeb. *Geography Compass*, 2(6), 2011–2039.
- Harrell, M. C., & Bradley, M. (2009). *Data collection methods: Semi-structured interviews and focus groups*.
- Hew, T.-S., & Syed Abdul Kadir, S. L. (2016). Predicting instructional effectiveness of cloud-based virtual learning environment. *Industrial Management & Data Systems*, 116(8), 1557–1584.
- Maureira, M. A. G., Oldenhof, D., & Teernstra, L. (2011). ThingSpeak—an API and Web Service for the Internet of Things. *World Wide Web*, 25, 1–4.
- Myors, B., Murphy, K. R., & Wolach, A. (2010). *Statistical power analysis: A simple and general model for traditional and modern hypothesis tests*. Routledge.
- Pardeshi, V. H. (2014). Cloud computing for higher education institutes: architecture, strategy and recommendations for effective adaptation. *Procedia Economics and Finance*, 11, 589–599.
- Qasem, Y. A. M., Abdullah, R., Jusoh, Y. Y., Atan, R., & Asadi, S. (2019). Cloud computing adoption in higher education institutions: A systematic review. *Ieee Access*, 7, 63722–63744.
- Qi, H., & Gani, A. (2012). Research on mobile cloud computing: Review, trend and perspectives. *2012 Second International Conference on Digital Information and Communication Technology and It's Applications (DICTAP)*, 195–202.
- Robinson, O. C. (2014). Sampling in interview-based qualitative research: A theoretical and practical guide. *Qualitative Research in Psychology*, 11(1), 25–41.
- Sabi, H. M., Uzoka, F.-M. E., Langmia, K., & Njeh, F. N. (2016). Conceptualizing a model for adoption of cloud computing in education. *International Journal of Information Management*, 36(2), 183–191.
- Spiteri, C., Raffaele, C. D., & Smith, S. (2015). Mitigating the digital divide for distance learning students in developing countries. *SOCIN 2015*.
- Tang, B., & Sandhu, R. (2013). Cross-tenant trust models in cloud computing. *2013 IEEE 14th International Conference on Information Reuse & Integration (IRI)*, 129–136.
- Weinman, J. (2018). The economics of pay-per-use pricing. *IEEE Cloud Computing*, 5(5), 101-c3.