

# An Innovative Mathematical Approach to Implementing Cloud-Based IT Infrastructure

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Received: 06 Sep. 2025, Revised: 23 Nov. 2025, Accepted: 12 Jan. 2026

Published online: 01 Mar. 2026

**Abstract:** The Administration of IT and communication networks has been an altar-way since the inception of cloud computing technology. The term cloud computing, being an abbreviation, stands for a new kind of management information system (MIS) where the emphasis is on supplying a plethora of computer services via a public network, most commonly the Internet. Cloud computing issues include the deployment of resource sharing environments, trust in third parties, and issues of confidentiality and privacy. The prime intent of this study is to develop a framework that considers those cloud computing adoption factors that hold the utmost importance in the eyes of developing countries higher education institutions (JHEIs), having as a final goal to help the institutions in making worthy decisions regarding cloud computing. In this research, DOI, TAM, and TOE theories have been explored in the development of a model for the diffusion of cloud computing into junior and senior high school institutions (JHEIs). Based on the above underlying theories and models, the authors developed a framework named Technology- Organization-Environment-Quality of Cloud Computing Adoption (TOEQCC) that would help them attain better knowledge about factors influencing cloud computing adoption in the JHEIs context. The study incorporated eleven developing countries organizations, including government and private companies. NVivo was put to use to quicken the process of the study, present the data more clearly, and ascertain the correctness of our findings. Statistical and frequency data were presented using tables, pies, bars, and columns. Business Intelligence and Visio tools from Microsoft were used, as well.

**Keywords:** Cloud computing, Novel framework, Information technology, NVivo

## 1 Introduction

For a very long time, scientists have been questioning how ICT should benefit educational institutions. But unfortunately, there has been very little work done on how cloud computing, an aspect of information and communications technology, can be applied to institutions in less developed countries such as Developing countries. The main aim of this research is to shed away some of the impediments blocking wide acceptance of cloud computing in Developing countries higher education

institution (JHEIs). Using a conceptual framework linking theory and practice made this undertaking quite attainable. Another key thing to investigate in studying the major variables affecting cloud computing adoption in JHEIs is to develop a conceptual framework based on those variables using a quality emphasis. Hopefully, this will, in some way, assist us in working out the strategic best use of cloud computing for Developing countries' educational institutions (JHEIs). This study was intended to determine the possible advantages cloud computing may provide to institutions, including universities, of

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education. The examination covers the trend toward cloud-based systems and the role of technology in facilitating educational achievements. It is the central objective in this research to establish how modern types of ICT, particularly the applications of cloud computing, impact educational methods in Developing countries schools. Indicators abound showing inefficiency in the higher education system in Developing countries [1,2], e.g., a high rate of unemployment for college graduates and a low return on investment. Developing countries' higher education system, in one instance, is inefficacious. Unwillingness to accept and deploy cutting-edge information technologies in the classroom happens to be just one of many causes to these deficiencies in the academic establishment.

## 2 The Challenges That Research Involves

Higher education is a must if a nation has even a remote chance of successfully aligning itself with different economic and social conditions [3,4,5,6,7]. Some industry experts, however, are putting the country's universities in question as to their capabilities of providing education matching international standards [8, 9,10,11,12]. This situation extorts the country's saving from the emergence in the global knowledge economy and further from meeting the nation's social and developmental needs. Yet Developing countries colleges keep using all orthodox methods of instruction. While junior colleges have not exercised cloud computing, bullying will begin sometime. More exploration of acceptance factors would pave the way for their being considered in the acceptance of there, innovative technologies at junior and senior high educational institutions. The cloud computing architecture would aid the selection of the best medium through which Developing countries higher education institutions (JHEIs) might embrace cloud computing.

CCEA became the study's main focus because the researcher was already aware of the limitations and possibilities of cloud computing in education applications. Because of the inhibitions put on JHEI vis-à-vis cloud computing, the following secondary research questions arise:

## 3 How May Cloud Computing be Advantageous for Educational Institutions in Developing Countries?

Due to the many benefits that might be attained from their utilization, cloud services are used by quite a number of JHEIs. Lastly, what really are the advantages of cloud computing with regard to JHEIs, and what are some of the disadvantages that they have to confront in the implementation process? For instance, what are the big

processes being used to implement JHEI's cloud-computing technology across the whole organization? Below is the study proposal that has given birth to after settling down on a main research question and studying previous work related to the topic: A paradigm shift which takes into account the most important aspects of heavy cloud computing adoption may prove to be useful for Developing countries a colleges with the use of applications and services offered by cloud computing, one may store, share, and control information on computers located far off. Cloud computing, on the other hand, allows for numerous forms of computing, including massively expedited processing, huge amounts of storage, distributed computing, and grid computing. There is even discussion about limitations placed on the magnitude of computer resources and storage [13,14]. A mixture of hardware, software, networking, and storage in a distributed computer system configures the system to be provided with services and applications over the internet [15,16]. Being a relatively new concept, cloud computing has enough potential to provide easy-to-use services, reliable software, and extremely quick data processing. The basic thought behind cloud computing is that users would always pick an option based on which one is easier and faster.

At the broadest level, we have to understand that cloud implementations consist of public, private, shared, and hybrid kinds. Chou [17] informs us that the most usual implementation of cloud is through public cloud services which maybe free or offered on a very nominal charge by companies such as Google, Amazon, and IBM. It is said that this is the most common method; sadly, for bad publicity and insecurity doubt on their part, these public cloud services have retained low status in the public eyes despite their lowest cost and maximum convenience [14]. If no payments are made by the users in a premium promotion, then physical capacity gets limited as well as processing speed in this shared pool of resources, regardless of whether users do pay for the promotion or not [18]. Customers of a public cloud provider cannot obtain direct control of the underlying hardware [18]. Therefore, for companies that share the same physical servers with other companies, a breach of privacy may arise with respect to their own customers' private information [18]. Private cloud installations present an option to lease or own the hardware where they do give their clients more direct control over the hardware than do the public cloud types.

The sheer number of advantages that private cloud users enjoy coupled to the disapproval loaded in the attitudes towards the adoption of public topologies is often deemed as an increased exploit edges and generally more edge information. At the con, providers' services are handed over to them for management on a per-client basis [19]. Thus, private cloud services end up being more costly monthly to the end user than public services. In addition, it is practically possible to utilize a hybrid cloud model, thus enabling to avoid the associated drawbacks,

by utilizing both the off-the-shelf and the bespoke functionalities. Integration of hybrid cloud environments [14]. Finally, in community cloud architecture there is matching of companies with similar requirements, objectives, and regulations in terms of cloud pooling. How nice this sounds and would relieve so many stresses area taken. It is synonymous with SaaS in a cloud model “Software as a Service” paradigm. Cloud Computing is classified into various services such as Hardware as a Service, Software as a Service, Platform as a Service, and Infrastructure as a Service (IaaS). Alas, firms or institutions have already lapsed in utilizing cloud technologies hence the coinage of the term “late adopters” is common due to their use of cloud computing in less proportionate terms compared to others [20]. There appears to be an increased rate of cloud adoption in the health sector than in any other sector, and the public sector is along the lines that there are moderate improvements made. This is evidenced by the very low penetrations of cloud computing in some of the organizations.

#### 4 Establishing a Theoretical and Mathematical Basis

The study sought to determine the factors that influence the changeover to cloud computing the most, as well as propose a framework for its application in Developing countries institutions. With this purpose, the research may aid the diffuse acceptance of cloud computing in Developing countries institutions. The framework developed henceforth combined the two theories with an already existing framework. The study sought to identify the most influencing factors towards the adoption process of cloud computing as well as to create an implementation framework tailored for Developing countries institutions. The objective of the study was to ease the diffusion of cloud computing among Developing countries institutions. The framework was customized for this study by combining two theories and an existing framework. Examples of such models include TAM [21, 22, 23], T-O-E framework [24], and the DOI model [21, 22, 23, 24, 25]. By undertaking a review of the literature, the researcher was trying to deepen the understanding of the challenges that higher education institutions face while integrating ICT, as well as the dominant approaches and frameworks used to actualize that goal. In consideration of method(s), this section specifies how data shall be gathered, and thereafter, analyzed. The researcher accepted not only to limit himself to DOI, TAM, and TOE hypotheses but considered alternative propositions prior to dismissing them. Introduced by Fishbein and Ajzen in 1975, the Theory of Reasoned Action (TRA) investigates how people adjust to the introduction of a new kind of technology. This theory fails to explain irrational behavior by some people or the fast

adoption of new technologies. Since cloud computing is a quite new type of technology, some people joining higher education institutions in Developing countries might have unwarranted fears about the impact of this technology on privacy and security. Unlike cloud computing, conventional IT architecture is deficient in that the client’s data and processes are housed by the service provider rather than on workstations of the customers. This study does not consider the TRA hypothesis since the authors wanted to evaluate adoption behavior that is both logical and irrational in relation to cloud computing. TAM is an extension to convert the insufficiencies of TRA into explanation of people’s different activities when it comes to the adoption of new technology and is actually climbing out of the Theory of Planned Behavior. Another model that will be reviewed, refuted, and rejected in this study is the Web Adoption Hypothesis [?], which pertains to the adoption of institutional websites. Four phases characterize the adoption process. Class 0 establishments utilize email but do not have any sites. The websites of Level 1 institutions are developed whilst still being utilized. The companies at Level 2 announce current events, groundbreaking innovations, and other important occurrences. At Level 3, Business Integration converts banks into a digital couple with a client base. The companies at Level 2 announce current events, groundbreaking innovations, and other important occurrences. At Level 3, Business Integration converts banks into a digital couple with a client base. However, the Web Adoption Model does not take into account the technical infrastructure of higher education institutions, for example, server, network, and storage device.

The Web Adoption Theory’s sole focus on the evaluation of its websites may not be ready for junior-high and possibly even some senior colleges and universities. This study aimed to offer recommendations to junior and senior high educational institutions as they are making their transition to cloud computing. The Web Adoption Hypothesis is false as it does not consider critical elements of cloud computing (cost, compatibility, security, privacy, and scalability). The research methodology and our outcomes. We used an interpretive paradigm and triangulation approaches to conduct 31 semi-structured interviews with key members from Developing countries institutions. These participants included professors of cloud computing and IT, vice chancellors, IT managers, department heads, and deans. The researcher, in addition to three focus groups held in Developing countries, also distributed 100 questionnaires to students of Developing countries. The Developing countries Accreditation Commission for Universities and the Developing countries Ministry of Higher Education (JHEAC) provided data. An analysis, called a three-step process [26], comprising data reduction, data display, and conclusion drawing and verification, was conducted using NVivo. Excel was used to make any frequency or statistical presentations by way of tables, pie charts, bar charts, and column charts. The suggestion was to include

quality as one component along with knowledge exchange.

#### 4.1 quad Statistics and Probability Equations for Cloud-Based IT Infrastructure Adoption

The adoption of cloud-based IT infrastructure in developing countries' educational institutions is inherently influenced by uncertainty, variability, and complex decision-making factors. Statistics and probability provide the mathematical foundation to quantify these uncertainties, evaluate risks, and estimate the likelihood of successful adoption. By applying statistical models and probabilistic equations, institutions can objectively assess benefits, costs, and security threats, while also forecasting adoption outcomes under different scenarios. The following equations integrate probability theory, risk analysis, and statistical inference to support the Technology-Organization-Environment-Quality of Cloud Computing Adoption (TOEQCC) framework, offering a rigorous approach for decision-making in cloud computing implementation.

##### A. Probability of Adoption (Logistic Model)

$$P(\text{Adopt} = 1 | \mathbf{X}) = \frac{1}{1 + \exp[-(\beta_0 + \sum_{i=1}^k \beta_i X_i)]} \quad (1)$$

- $X_i$ : predictors (e.g., cost, trust, compatibility, infrastructure readiness, quality of service).
- $\beta_i$ : estimated coefficients.
- Application: Probability that a JHEI adopts cloud-based IT given organizational, technological, and environmental predictors.

##### B. Expected Value of Benefits

$$\mathbb{E}[B] = \sum_{j=1}^m p_j b_j \quad (2)$$

- $p_j$ : probability of benefit  $j$  (e.g., scalability, cost-saving, accessibility).
- $b_j$ : monetary or utility value of benefit  $j$ .
- Application: Quantifies expected gain from adoption under uncertainty.

##### C. Risk Function (Confidentiality, Integrity, Availability)

$$R = \sum_{n=1}^N P(T_n) \times I(T_n) \quad (3)$$

- $P(T_n)$ : probability of threat  $n$  (e.g., data breach, downtime).
- $I(T_n)$ : impact severity score of threat  $n$ .
- Application: Probability-weighted risk analysis for cloud security.

##### D. TOEQCC Weighted Index (Composite Score)

$$\text{TOEQCC}_{\text{score}} = \sum_{d=1}^D w_d f_d \quad (4)$$

- $f_d$ : normalized factor (Technology, Organization, Environment, Quality).
- $w_d$ : assigned weight (from expert input or AHP method).
- Application: Provides a measurable adoption readiness score for JHEIs.

##### E. Bayesian Updating of Adoption Belief

$$P(A | E) = \frac{P(E | A)P(A)}{P(E)} \quad (5)$$

- $A$ : event of cloud adoption.
- $E$ : evidence (survey responses, trial outcomes).
- Application: Updates prior belief in adoption likelihood after new data is observed.

##### F. Hypothesis Testing for Adoption Factors

$$H_0: \mu_{\text{adopters}} = \mu_{\text{non-adopters}} \quad \text{vs.} \quad H_1: \mu_{\text{adopters}} \neq \mu_{\text{non-adopters}} \quad (6)$$

Test statistic (two-sample t-test):

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \quad (6)$$

Application: Examines whether adoption factors (e.g., cost perception, security concern) differ significantly between adopter and non-adopter institutions.

##### G. Decision-Making under Uncertainty (Expected Utility)

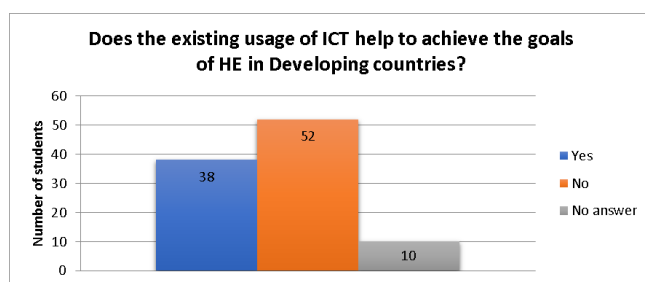
$$EU = \sum_{s=1}^S P(s) \times U(s) \quad (7)$$

- $P(s)$ : probability of scenario  $ss$ .
- $U(s)$ : utility of scenario  $ss$  (adoption vs. rejection).
- Application: Helps JHEIs select adoption strategy with maximum expected utility.

## 5 Developing countries' public and private schools make use of information and communication technology

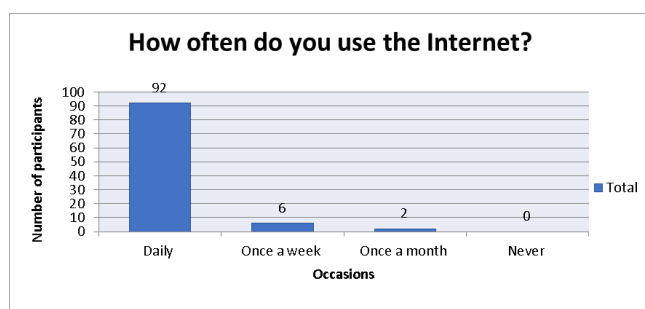
A 52% proportion of participants' descriptive reviews showed that ICT lacked extent in Developing countries Higher Education Institutions; hence, the existing state of ICT in Developing countries Higher Education

Institutions could not fulfill the current educational objectives. This is shown in Figure 1. A 52% proportion of participants' comments descriptive reviews showed that ICT lacked extent in Developing countries Higher Education Institutions; hence, the existing state of ICT in Developing countries Higher Education Institutions could not fulfill the current educational objectives. Figure 1 presents these views.



**Fig. 1:** ICT usage at Developing countries' universities

Yet it was also shown that students engage heavily with the internet. Hence, these students are in a position to utilize cloud services that are appointed via the acquiring of an online connection as is the case with many other software. Figure 2 also portrays the discrepancy between the usage of cloud computing and the usage of the internet by especially students when more than 92% of the interviewees used the Internet daily. No one in our focus groups has ever been a Web user.



**Fig. 2:** The internet usage level

### 5.1 Spoon-feeding

Assuming the role of spoon-feeding, which is an approach to education normally argued as a one-dimensional perspective which does not in any way promote the intellectual growth that children possess and should be inculcated in them so as to be able to tap materials from various sources. Such theories are put in

the context of the education and research agenda in higher education institutions such as JHEIs [28]. Somehow students believe that everything they need will be provided by the teacher [29]. As a result, in this perspective, they dissuade students from using ICT in the process of searching for new knowledge [30,31,32]. As mentioned by the former minister of higher education, DM8, students do not encourage self-learning because the answers to all their questions are always given to them.

It is high time we reconsider the classical university teacher-payment relationships and suggest reforms. To be specific, the researchers have recently attended several meetings and face-to-face discussions where these issues have been addressed, including the one where the head of one of the universities was present. The generation of students of our period has no thinking or creative development in class since they are always taught to seek help instead. Some students apparently look like robots doing their teacher-pleasing deeds. The former minister of higher Education in Developing countries pointed to the increased need for inquiry and team-based learning opportunities in JHEIs. (P14) demonstrated the harmful effects of spoon-feeding on Developing countries students, advocating the increased use of ICT to fuel students' innate curiosities. Nonetheless, according to the report of the student focus groups, JHEIs are facing troubles due to a lack of ICT resources. Soon, Developing countries universities and schools might be renting virtual servers and storage through cloud computing, providing students with almost unlimited resources and services. Students stand to gain a lot in their learning if they are encouraged to pursue independent study using various online resources [5]. Overall, this is expected to enhance the HE outcomes in Developing countries through increased student collaboration, communication, and exchange of information.

## 6 Conclusion

The proposed research was the development of the awareness of the JHEIs on cloud computing. The appropriateness to use, usability, among other factors of cloud computing, was investigated, then introduced which elements are to be adopted. There were five parameters introduced upon the establishment of the research design of the Historical Social Research. Eleven Developing countries universities, both public and private, were included in the analysis. The survey was conducted with thirty-one JHEIs' leaders. The research used three focus groups for interviews, one hundred student questionnaires, and instant observation. Our analysis identified several factors that are known to be important for the successful use of cloud computing in JHEIs. These dimensions impact how these determinants are linked.

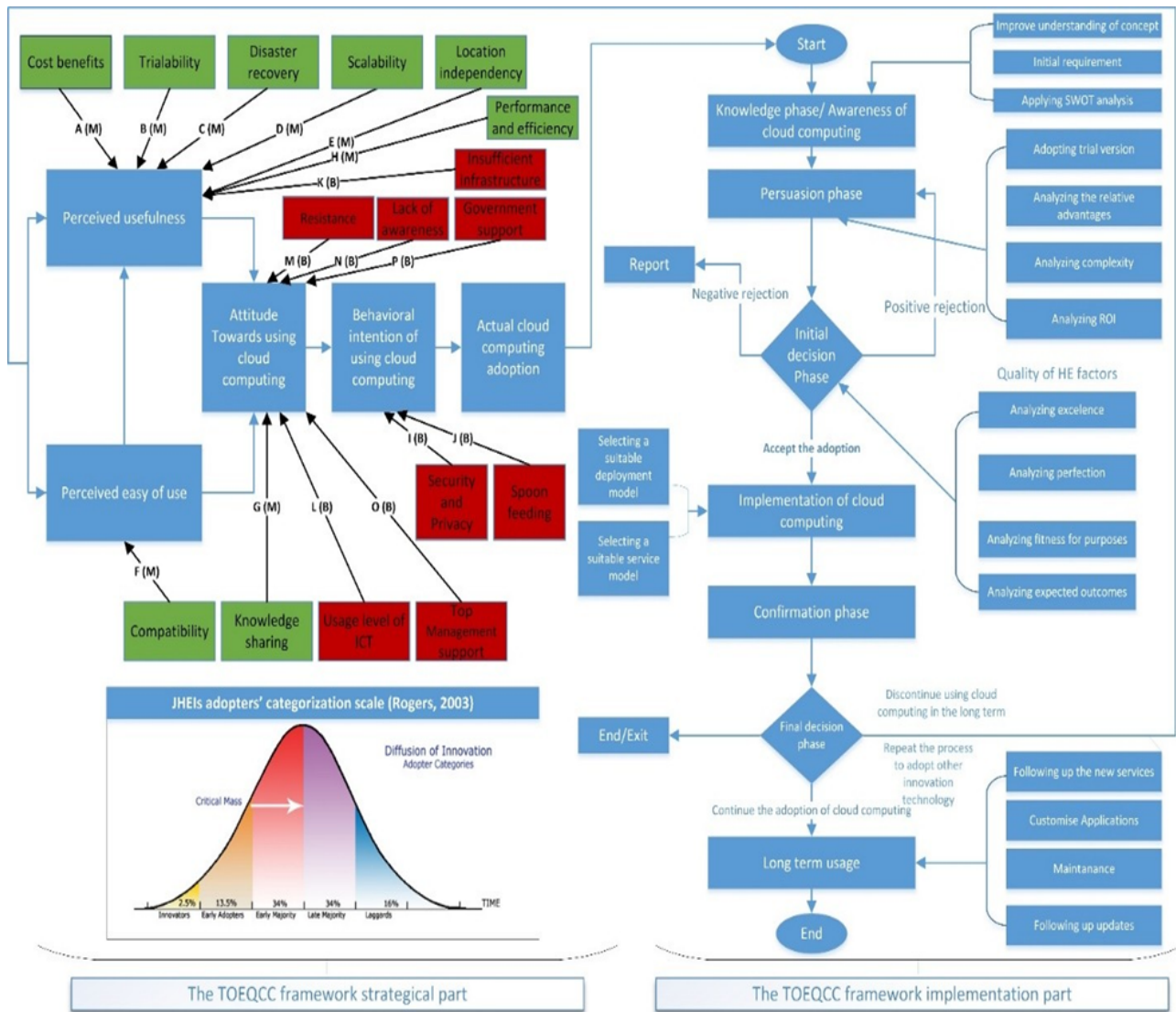


Fig. 3: TOEQCC sustainable framework in order to integrate cloud computing in JHEIs

## Acknowledgement

This research was partially funded by Zarqa University.

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