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Transforming Educational Operations Exploring the Impact of Cloud Computing Adoption in Two Pakistan Institutions

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This research aimed to investigate the impact of cloud computing on operations in the education sector in Pakistan. The study focused on the adoption of cloud computing applications as the dependent variable and assessed cost-effectiveness, data security, flexibility, availability, student outcomes, institutional outcomes, communication, and collaboration as independent variables. A quantitative approach was adopted for the research, and data was collected using a survey questionnaire. The sample size for this study was capped at 173 participants. This choice was made based on the practical and technical issues that arise during the data collection process. Participants were selected for this study based on the designations. The population targeted included teachers, students, and IT professionals of an education institution in Lahore, Pakistan. The findings revealed that cloud computing adoption was positively associated with all independent variables except data security, which was found to have a negative relationship. The study recommended that educational institutions should have focused on addressing data security concerns while adopting cloud computing applications to leverage the benefits it offered. This study contributed to the limited research in the field of cloud computing in the education sector and provided insights for educational institutions to make informed decisions when adopting cloud computing applications.

Introduction

Cloud computing has emerged as a disruptive technology with significant implications for many industries, including education. Users do not need to manage the networked pieces that supply services individually. Instead, the entire provider-managed hardware and software package might be considered an amorphous cloud. There are four types of cloud computing, and they are private clouds, public clouds, hybrid clouds and multi-clouds (Islam *et al*., 2023). In the future, most educational services will be stored in the cloud, eliminating the need for pricey hardware, power bills, staff salaries, and underutilized computing resources. Remote

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data centers, pooling of resources, infinite scalability, pay per use and self-service are some of the characteristics of cloud computing (Nofan, 2015).

In recent years, educational institutions have increasingly used cloud computing to improve their operations and educational offerings (Bulla et al., 2016). The cloud is analogous to the web and aims to provide customization and client-centered interaction (Ishaq et al., 2019). Educational institutions started adopting cloud computing applications in the early 2000s (Sultan, 2010). Initially, universities and colleges mainly used cloud computing for storage purposes (Alhomdy et al., 2021). This move has been inspired by the multiple advantages that cloud computing provides, such as enhanced efficiency, cooperation, flexibility, and cost savings (Sultan, 2010). Educational institutions can streamline data management, improve teaching and learning experiences, and optimize overall operations by leveraging cloud services such as Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) (Kale and Mente, 2017). Web technology has led to three emerging trends: mobile learning, massive open online courses (MOOCs), and online language learning (Nofan, 2015). Students and employees at educational institutions can access free services like email, contact lists, calendars, document storage, document creation and sharing, and website development using modern "cloud" platforms like "Microsoft" and "Google" (Sclater, 2009).

The growing popularity of cloud computing in education has been accompanied by an emerging body of research into its impact and possibilities. Researchers have looked into several areas of cloud computing use in educational institutions, such as deployment methods, service frameworks, and adoption techniques (Qasem et al., 2019). Cloud computing has been studied for its benefits, including attaining economies of scale, enabling on-demand self-service, and offering ubiquitous access to resources (Rawajbeh et al., 2019). Furthermore, cloud computing has been found to improve distant learning initiatives by allowing students and teachers to access educational information and services remotely (Khalid et al., 2021).

Despite the numerous benefits of cloud computing, its implementation in the education sector is not without challenges or issues (Singh and Mansotra, 2019). Potential challenges to adoption include data security, privacy, reliability, and vendor lock-in (Ashtari and Eydgahi, 2015). Educational institutions must properly manage these issues to take advantage of the full benefits of cloud computing while minimizing associated hazards (Riahi, 2015). Furthermore, more research is needed to identify best practices and methods for efficient cloud computing adoption and utilization in educational contexts (Ahmad et al., 2020).

Regarding the previous studies on cloud computing in education, a cloud-based architecture designed for wide area, high-performance networks and supporting essential data mining applications was created by Grossman et al. (2009). Cloud computing infrastructures allowed schools to access its resources and facilities whenever they needed them, and they sped up the adoption of many technological breakthroughs in academia. Praveena and Betsy (2009) gave a thorough overview of cloud computing's use in higher education. Delic & Riley (2009) evaluated the state of enterprise knowledge management today and how cloud computing, a more reliable, efficient, and worldwide infrastructure, would develop from it. They talked about architectural technologies and their uses. Mitchell (2008) gave a summary of current learning architectures and posed queries on the way in which academic institutions are handling their cloud computing resources. Additionally, he provided logical justifications for the difficulty of indexing web materials for the best possible discoverability by educators and students.

When considering recent research Ahmad et al. (2020) investigated the development of a cloud based mobile learning adoption model to support sustainable education. This study identified sixteen crucial success factors (CSF) and categorized them into four categories. The identified factors were cloud data security, availability and reliability, customizable SLA, Cloud services, network bandwidth, technological compatibility, smart device adoption, technical support, management support, human readiness, social media usage, utilization complexity, cost flexibility, ease of use, relative advantage and design of innovative services. Riahi, 2015 investigate E-learning systems based on cloud computing. In this study, the researcher observed Traditional E-learning architecture and modern E-learning architecture and their advantages and disadvantages. He compares these two architectures by using five main service models which are the acquisition model, business model, access model, technical model, and delivery model. The findings of research showed that the adoption of cloud computing using modern E-learning architectures will benefit students, teachers, and institutions in a very good manner. The focus on the students will guarantee that DevOps principles and practices are carried forward into the longer-term future. Increased adoption of cloud DevOps will result in more innovative services being offered at reduced costs and with better quality (Airaj, 2016).

The effectiveness of blackboard learns as a teaching tool and the benefits of using cloud-based e-learning at institutions of higher was studied in research and it demonstrated that a shift to cloud computing will have good impacts on training and educational material (Ali & Alourany, 2021). Foster et al. (2019) investigated a cloud computing learning community based on innovation and technology in computer science education (ITiCSE) work group. The researcher showed that "Cloud managed services" as a prospective new knowledge area that should be watched for potential addition in the future. The findings of this study showed that there is a significant impact between cloud computing learning courses and cloud job roles.

Hashem et al. (2015) showed that the data of many companies can be loaded onto a cloud platform. The algorithms also showed high accuracy. This study shows how machine learning can be used in the cloud to provide cloud computing services such as EaaS, LaaS, MaaS and examined how dynamically virtualized and scalable resources provided as a network service are changing how businesses solve problems and make decisions. Hung (2019) observed both cloud computing technology on services like Education-as-a-Service (EaaS), Logistic-as-a-Service (LaaS), and Manufacturing-as-a-Service(MaaS).

The results show that the main concerns guiding cloud computing development are automatio n and intelligence. Jiang and Sun (2022) studied the impact of deep learning and cloud computing on tennis education at colleges and Universities. This study found that the level of tennis teaching impact and personalized resource sharing was greater than the original method of teaching and that the difference between the actual and predicted effects of teaching was better. Rajbabu (2019) investigated how cloud computing has affected higher education and how the present COVID-19 pandemic scenario has contributed to an increase in cloud utilization in the higher education field. The findings of this study showed it helps higher education educational institutions all over India, specifically the student community, understand the benefits and challenges of successful cloud computing use in higher education. According to the findings in this survey, students are willing to use cloud computing for learning because of the many advantages it provides. Tariq et al. (2020) studied the factors that affect the adoption of cloud computing by higher education institutions in Punjab in Pakistan. This study found that 84.44 % of students decided to adopt cloud computing at their schools. 99% of them said the main reason was cost reduction. Yaghmaei and Binesh (2015) investigated whether cloud computing can help educational institutions deal with budget cuts. This study found that cloud computing can improve data transmission speed and quality at an affordable cost. Electricity consumption is reduced due to the use of virtualization instead of actual computers and IT devices. Colleges and other educational establishments may find this useful. Cloud computing can help universities save money and reallocate those savings to other areas.

Purpose of the study

Considering the growing interest and importance of cloud computing in education, the objective of this study was to provide an in-depth assessment of current cloud operations in the educational industry in Pakistan. Based on a thorough examination using a questionnaire it has been investigated the use of cloud computing services and applications in an educational institution in Pakistan, as well as their impact on many elements of educational operations. Furthermore, this article outlines important issues and problems connected with cloud computing adoption in education, as well as recommendations and tactics for educational institutions to effectively leverage cloud computing technology (Moloja and Ruhode, 2020).

Development of Hypothesis

Hypothesis 1:

$H1_a$: There is a positive relationship between cost-effectiveness and the adoption of cloud computing applications in education institutions.

$H1_0$: There is no positive relationship between cost-effectiveness and the adoption of cloud computing applications in education institutions.

Hypothesis 2:

$H2_a$: There is a positive relationship between data security and the adoption of cloud computing applications in education institutions.

$H2_0$: There is no positive relationship between data security and the adoption of cloud computing applications in education institutions.

Hypothesis 3:

$H3_a$: There is a positive relationship between availability and the adoption of cloud computing applications in education institutions.

$H3_0$: There is no positive relationship between availability and the adoption of cloud computing applications in education institutions.

Hypothesis 4:

$H4_a$: There is a positive relationship between flexibility and the adoption of cloud computing applications in education institutions.

$H4_0$: There is no positive relationship between flexibility and the adoption of cloud computing applications in education institutions.

Hypothesis 5:

$H5_a$: There is a positive relationship between student outcomes and the adoption of cloud computing applications in education institutions.

H5$_0$: There is no positive relationship between student outcomes and the adoption of cloud computing applications in education institutions.

Hypothesis 6:

H6$_a$: There is a positive relationship between institutional outcomes and the adoption of cloud computing applications in education institutions.

H6$_0$: There is no positive relationship between institutional outcomes and the adoption of cloud computing applications in education institutions.

Hypothesis 7:

H7$_a$: There is a positive relationship between communication and collaboration and the adoption of cloud computing applications in education institutions.

H7$_0$: There is no positive relationship between communication and collaboration and the adoption of cloud computing applications in education institutions.

Methodology

Study Location

The study was conducted for "The City School" and "The Smart school" at The City school Head Office, 31, Gurumangat Road, Industrial Area, Gulberg III, Lahore, Pakistan.

Types of cloud-based applications used

Learning Management System (LMS) and cloud-based productivity tools like Google drive, office 365, virtual desktops, Dropbox and OneDrive were the cloud computing applications used.

Conceptual Framework of the Research

Background information, previous research, reliable data sources, objectives of the study and questions serve as the foundation of the conceptual framework. Previous investigations were used to build a conceptual framework based on the important variables revealed in the study. Independent variables are factors that may influence the adoption of cloud computing applications in education. Dependent variable is the adoption of cloud computing applications, which is the outcome variable that needs to study.

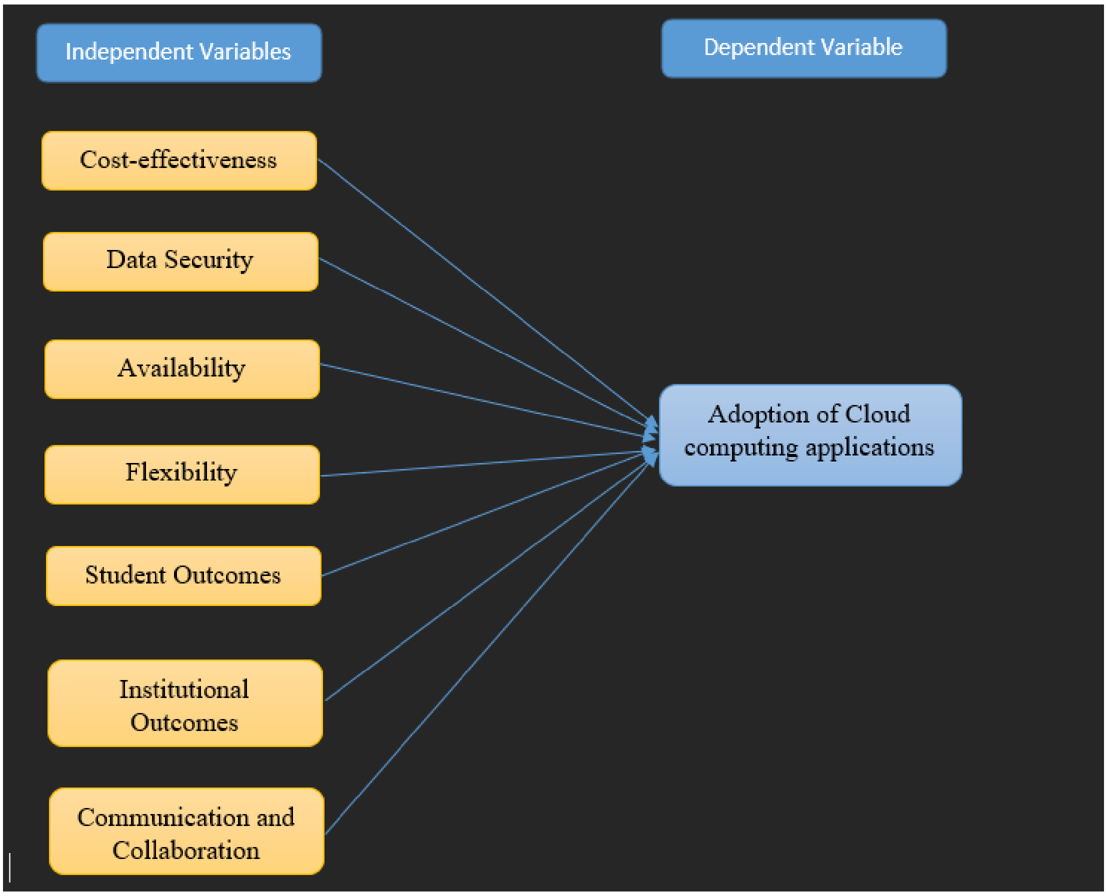

Figure 1. Conceptual framework of the study

Operationalization of the Study

Table 1 displays the variables, indicators, and measurement scales used in the investigation. The demographics include age, gender, and category. The dependent variable is adoption of cloud computing applications, which is measured using a Likert scale with questions such as usage (Q4, Q5) and implementation (Q6). The independent variables include cost-effectiveness, data security, availability, flexibility, student and institutional outcomes, as well as communication and collaboration. Each of these principles is split down into indicators such as affordability, savings, privacy, protection, uptime, reliability, adaptability, versatility, achievement, learning, performance, reputation, cooperation, and coordination, and they have been measured using related questions (Q7-Q21).

Table 1. Operationalization table of the study

Concept	Variable	Indicators	Question Number	Measurement Scale
Demographics		Age Gender Category	1 2 3	Manual Data Selection
Dependent Variable	Adoption of Cloud	Usage Implementation	4, 5 6	Likert scale

	computing applications		
Independent Variables	Cost-effectiveness	Affordability	7
		Savings	8
	Data Security	Privacy	9
		Protection	10
	Availability	Uptime	11
		Reliability	12
	Flexibility	Adaptability	13
		Versatility	14
	Student Outcomes	Achievement	15, 16
		Learning	17
	Institutional Outcomes	Performance	18
		Reputation	19
	Communication and Collaboration	Cooperation	20
		Coordination	21

Sample Population

Participants were selected for this study based on the designations they held in educational institutions. The population targeted included students, staff, and management. The size of the sample was determined by the number of participants and their willingness to participate in the study. Participants were selected based on experience, knowledge and involvement with cloud computing applications within the institutions. Participants were chosen from different departments to ensure diversity.

This study included students from grades 9 to 11, staff and management from these two schools. The total population was 88360. For this study 95 % confidence level and a 5 % margin of error was used to determine the sample size. The Slovin's formula (Wati, 2018) was used to determine the sample size,

$$\mathbf{n = N/(1 + Ne^2)}$$

where; [n = required sample size, N = size of the population, e = margin of error (expressed as a proportion, typically ranging from 0 to 1]

n = 88360/ (1 + (88360) $(0.05)^2$ = 88360/ (1+ (88360)(0.0025)
=88360/221.9
=**398.19**

The mathematical calculation of the sample size was 398 with the level of confidence of 95 % and an error margin of 5 % for a population of 88360. The sample size for this study was capped at 173 participants due to the short amount of time available to gather responses. The data collected were analyzed using R-Studio software. Descriptive statistics, correlation analysis, and regression analysis were done. Data visualization tools, such as charts, graphs, and tables were also used. The responses were summarized based on frequency distributions, measures for central tendency and measures for variability. Inferential statistics, such as regression analysis and correlation analysis were used to test research hypotheses and explore relationships between variables. The reliability of the questionnaire was measured by Cronbach's alpha, correlation, regression, and R-squared. This is important to establish the relationship between dependent and independent variables.

Development of the Questionnaire

The questionnaire consisted of 21 questions, with 18 for each indicator of critical variables and 3 for demographic data such as gender, age, and job role of respondents. These demographic questions assist generate suggestions and understand the effectiveness of response profiles. The questionnaire was distributed using Google Forms via the emailing system to students, staff, and management at educational institutions such as The City School and The Smart School. A Likert scale (Tanujaya et al., 2023) was used in this questionnaire to examine opinions of respondents about several indicators of critical variables. Likert is a well-established measurement tool in social science research that accurately reflects respondents' views and attitudes regarding various domains.

Data Analysis

The data collected was through simple random sampling, and the same was analyzed through descriptive statistics, inferential statistics, and data visualization using R-Studio software.

Results and Discussion

Hypothesis 1

The R-squared value was 0.030 (Figure 2), indicating that cost-effectiveness explains 3% (r2 = 0.030) of the variance in the adoption of cloud computing applications. This suggests that 97% of adoption is influenced by other variables.

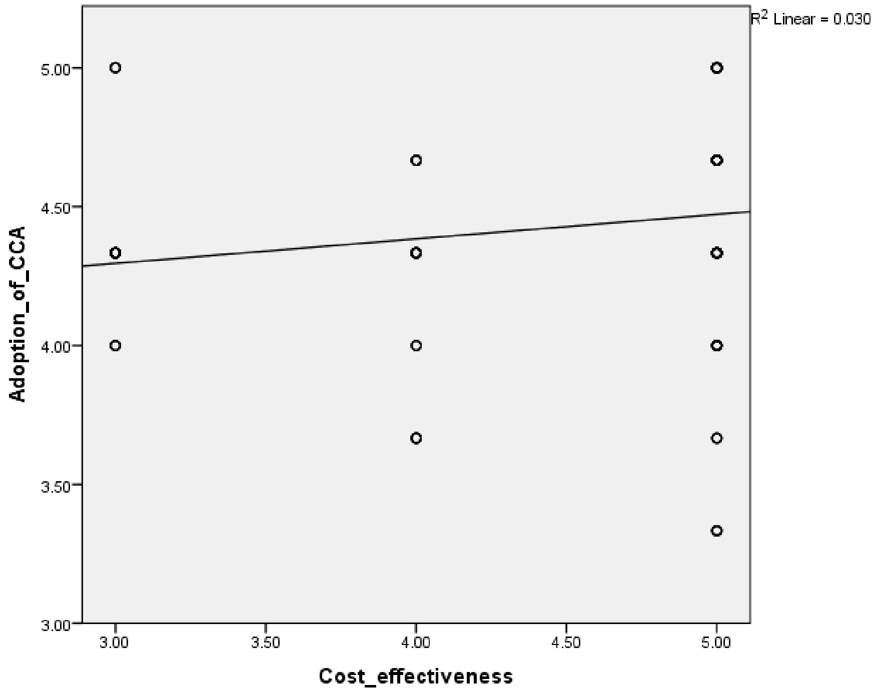

Figure 2. Scatter Plot of Adoption of CCA (Cloud Computing Applications) vs. Cost Effectiveness

Table 2 shows the correlation coefficients between the "Adoption of cloud computing applications" and "Cost-effectiveness". The Pearson correlation value was 0.172, indicating a weak positive relationship. This implies that while there is a positive association between cost-effectiveness and the adoption of cloud computing applications, it is not strong, suggesting limited awareness about cost-effectiveness.

The correlation coefficient had a p-value of 0.024. Since the p-value is less than the significance level of 0.05, the null hypothesis was rejected. Therefore, there is a statistically significant positive relationship between cost-effectiveness and the adoption of cloud computing applications in education institutions.

Table 2. Results of correlation between Adoption of Cloud computing applications and Cost effectiveness

		Adoption of CCA	Cost effectiveness
Adoption of CCA	Pearson Correlation	1	0.172
	Sig. (2-tailed)		0.024
	N	173	173
Cost effectiveness	Pearson Correlation	0.172	1
	Sig. (2-tailed)	0.024	
	N	173	173

*Correlation is significant at the 0.05 level (2-tailed)

The R-square of the model was 0.030 (Table 3), which means that only 3 % of cost-effectiveness impacts on the adoption of cloud computing applications. The adjusted R-square of 0.024 indicated that the cost effectiveness of the model has not been improved the fit significantly.

Table 3. Model summary from R-square test

Model	R	R-square	Adjusted R Square	Std. Error of the Estimate
1	0.172[a]	0.030	0.024	0.38467

a. Predictors (Constant), Cost_effectiveness

The ANOVA table (Table 4) indicates that adding the cost-effectiveness factor to the regression model significantly improved its fit (F = 5.219, p = 0.024). This indicates that the cost-effectiveness is a factor in the adoption of cloud computing applications.

Table 4. ANOVA[a] results for the relationship between Adoption of CCA and Cost Effectiveness

Model		Sum of Squares	df	Mean Squares	F	Sig.
1	Regression	0.772	1	0.772	5.219	0.024[b]
	Residual	25.304	171	0.148		
	Total	26.076	172			

a. Dependent Variable: Adoption_of_CCA
b. Predictors: (Constant), Cost_effectiveness

The coefficient table (Table 5) indicates that the intercept value was 4.031. This means that if cost-effectiveness equals zero, then the adoption rate of cloud computing is predicted to be 4.031. The coefficient for cost effectiveness was 0.088. This means that, for every unit increase in cost efficiency, cloud computing adoption is predicted to be increased by 0.088. The t-value for cost-effectiveness was 2.284 and the associated p-value was 0.024, which is statistically significant at the 0.05 level. These results indicate that cost-effectiveness plays a major role in predicting the adoption of cloud computing in the education industry. Without making investments in physical infrastructure, educational institutions can scale services to meet their needs, which drastically lowers costs (CyberDB, 2024; Nayar & Kumar, 2018).

Table 5. Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.031	0.175		22.993	0.000
	Cost_effectiveness	0.088	0.039	0.172	2.284	0.024

a. Dependent Variable: Adoption_of_CCA

Hypothesis 2

The R-squared value was 0.002 (Figure 3), indicating that data security accounts for only 0.2% of the variance in the adoption of cloud computing applications. This suggests that 99.8% of the adoption is influenced by other variables.

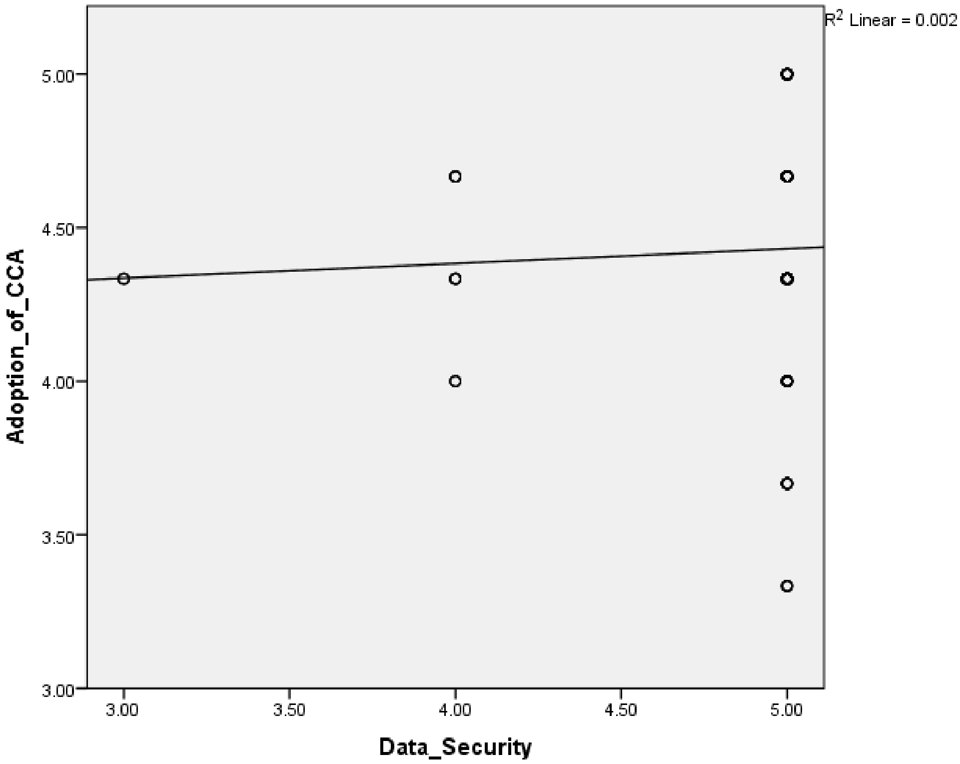

Figure 3. Scatter Plot of Adoption of CCA vs. Data Security

Table 6 shows the correlation coefficients between "Adoption of cloud computing applications" and "Data security". The pearson correlation value was 0.045, indicating a very weak positive relationship. This implies that data security is not a major concern for users, and they tend to trust cloud computing providers.

Table 6. Results of correlation between Adoption of Cloud computing applications and Data Security

		Adoption of CCA	Data Security
Adoption of CCA	Pearson Correlation	1	0.045
	Sig. (2-tailed)		0.560
	N	173	173
Data Security	Pearson Correlation	0.045	1
	Sig. (2-tailed)	0.560	
	N	173	173

CCA – Cloud computing applications

*Correlation is significant at the 0.05 level (2-tailed)

P value was 0.560. So, the null hypothesis was accepted. Hence, there was no positive relationship between data security and the adoption of cloud computing applications in educational institutions. The output provided is from a model of linear regression used to predict data security and its impact on the adoption of cloud computing applications (Table 7). Since the R-square of the model was 0.002, only 0.2 % of data security concerns impacted the adoption of cloud computing applications. The adjusted R-square of 0.004 indicates that the data security of the model has not improved significantly.

Table 7. Model summary from R-square test

Model	R	R-square	Adjusted R Square	Std. Error of the Estimate
1	0.045[a]	0.002	0.004	0.39011

a. Predictors (Constant), Data Security

The ANOVA table (Table 8) indicates that adding the data security factor to the regression model significantly improved its fit (F = 0.341, p = 0.560). This indicates that data security is not a factor in the adoption of cloud computing applications.

Table 8. ANOVA[a] results for the relationship between Adoption of CCA and Data Security

Model		Sum of Squares	df	Mean Squares	F	Sig.
1	Regression	0.052	1	0.052	0.341	0.560[b]
	Residual	26.024	171	0.152		
	Total	26.076	172			

a. Dependent Variable: Adoption_of_CCA
b. Predictors: (Constant), Data Security

These results indicate that data security does not plays a major role in predicting the adoption of cloud computing. Because people are less care about the data security concerns and they trust the cloud computing providers, and the security of the cloud computing applications are high, as well as there are no reported security breaches in last couple of years. As with any technologies, there are security risks associated with cloud computing (Ishaq and Brohi, 2015). Data is continuously created, saved, and erased in the digital world. Additionally, the Internet is by default open, allowing for the sharing of any data that interacts with it. Schools are obligated to protect student information, so this presents a challenge. Because of this, It is essential that these cloud services and schools or school districts have confidentiality agreements (Bathon, 2013).

Hypothesis 3

R-squared value was 0.009 (Figure 4). Hence, availability has an impact on the adoption of cloud computing applications was 1 % (r^2 = 0.009). there are other variable impacts of 99 % adoption of cloud computing applications.

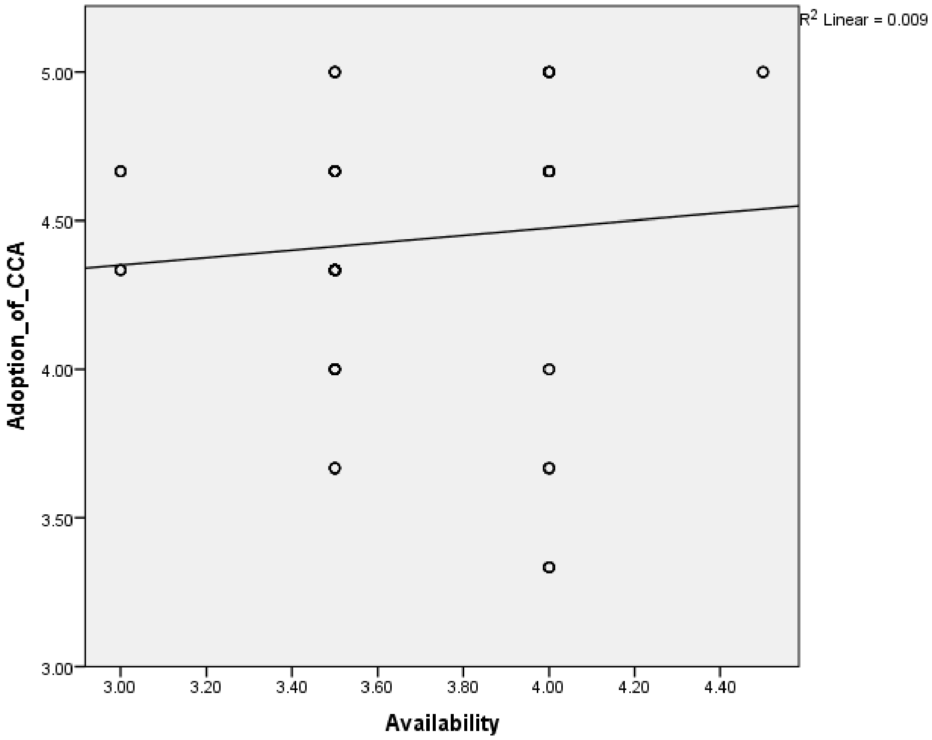

Figure 4. Scatter Plot of Adoption of CCA vs. Availability

Table 9 shows the correlation coefficients between two variables, "Adoption of cloud computing applications" and "Availability ". In this case, the Pearson correlation value was 0.095. Therefore, the independent variable availability towards the adoption of cloud computing applications has a weak positive relationship. It means that people are less care about the availability of cloud computing applications because these applications are always available.

Table 9. Results of correlation between Adoption of Cloud computing applications and Availability

		Adoption of CCA	Availability
Adoption of CCA	Pearson Correlation	1	0.095
	Sig. (2-tailed)		0.213
	N	173	173
Availability	Pearson Correlation	0.095	1
	Sig. (2-tailed)	0.213	
	N	173	173

*Correlation is significant at the 0.05 level (2-tailed)

P value was 0.213. So, the null hypothesis was accepted. Hence, there was no positive relationship between availability and the adoption of cloud computing applications in education institutions. The output provided is from a model of linear regression used to predict availability and its impact on the adoption of cloud computing applications (Table 10). The R-square of the model was 0.009, which means that only 0.9 % of availability concerns impacts the adoption of cloud computing applications. The adjusted R-square of 0.003 indicates that the availability of the model has not improved the model's fit significantly.

Table 10. Model summary from R-square test

Model	R	R-square	Adjusted R Square	Std. Error of the Estimate
1	0.095[a]	0.009	0.003	0.38873

a. Predictors (Constant), Availability

The ANOVA table (Table 11) indicates that adding the data security factor to the regression model significantly improved its fit ($F = 1.564$, $p = 0.213$). This indicates that availability is not a factor in the adoption of cc software.

Table 11. ANOVA[a] results for the relationship between Adoption of CCA and Availability

Model		Sum of Squares	df	Mean Squares	F	Sig.
1	Regression	0.236	1	0.236	1.564	0.213[b]
	Residual	25.839	171	0.151		
	Total	26.076	172			

a. Dependent Variable: Adoption_of_CCA
b. Predictors: (Constant), Availability

These results indicate that availability does not play a major role in predicting the adoption of cloud computing, because currently all of the cloud computing applications are available anywhere anytime in the world.

Hypothesis 4

R-squared value was -0.003. hence, flexibility had a -0.3 % impact on the adoption of cloud computing applications ($r^2 = -0.003$) (Figure 5).

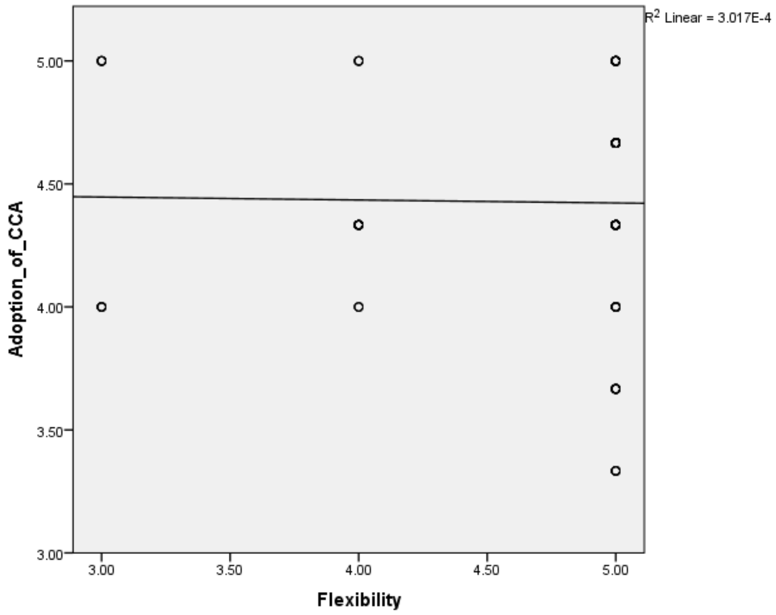

Figure 5. Scatter Plot of Adoption of CCA vs. Flexibility

Table 12 shows the correlation coefficients between two variables, "Adoption of cloud computing applications" and "Flexibility ". In this case, the Pearson correlation value was -0.017. Therefore, the independent variable, flexibility towards the adoption of cloud computing applications had a weak negative relationship. It means that people are less care about the flexibility of cloud computing applications because these applications are already flexible for the users.

Table 12. Results of correlation between Adoption of Cloud computing applications and Availability

		Adoption of CCA	Flexibility
Adoption of CCA	Pearson Correlation	1	-0.017
	Sig. (2-tailed)		0.821
	N	173	173
Flexibility	Pearson Correlation	-0.017	1
	Sig. (2-tailed)	0.821	
	N	173	173

*Correlation is significant at the 0.05 level (2-tailed)

P value was 0.821. Therefore, the null hypothesis was accepted. Hence, there was no positive relationship between flexibility and the adoption of cloud computing applications in education institutions according to this study.

The output provided is from a model of linear regression used to predict flexibility and its impact on the adoption of cloud computing applications (Table 13). The R-square of the model was 0.000, which means there are no flexibility concerns impacts the adoption of cloud computing applications. The adjusted R-square of -0.006 indicates that the flexibility of the model has not improved the model's fit significantly.

Table 13. Model summary from R-square test

Model	R	R-square	Adjusted R Square	Std. Error of the Estimate
1	0.017[a]	0.000	-0.006	0.39044

a. Predictors (Constant), Flexibility

The ANOVA table (Table 14) indicates that adding the flexibility factor to the regression model significantly improved its fit (F = 0.52, P = 0.821). This indicates that flexibility is not a factor in the adoption of cloud computing applications.

Table 14. ANOVA[a] results for the relationship between Adoption of CCA and Flexibility

Model		Sum of Squares	df	Mean Squares	F	Sig.
1	Regression	0.008	1	0.008	0.052	0.821[b]
	Residual	26.068	171	0.152		
	Total	26.076	172			

a. Dependant Variable: Adoption_of_CCA

b. Predictors: (Constant), Flexibility

These results indicate that flexibility does not play a major role in predicting the adoption of cloud computing, because currently all the cloud computing applications are very flexible for the users. Time management flexibility is provided by cloud computing (Paul et al., 2023).

Hypothesis 5

The R-squared value was 0.029 (Figure 6), indicating that student outcomes account for 2.9% of the variance in the adoption of cloud computing applications. This suggests that 97.1% of the adoption is influenced by other variables.

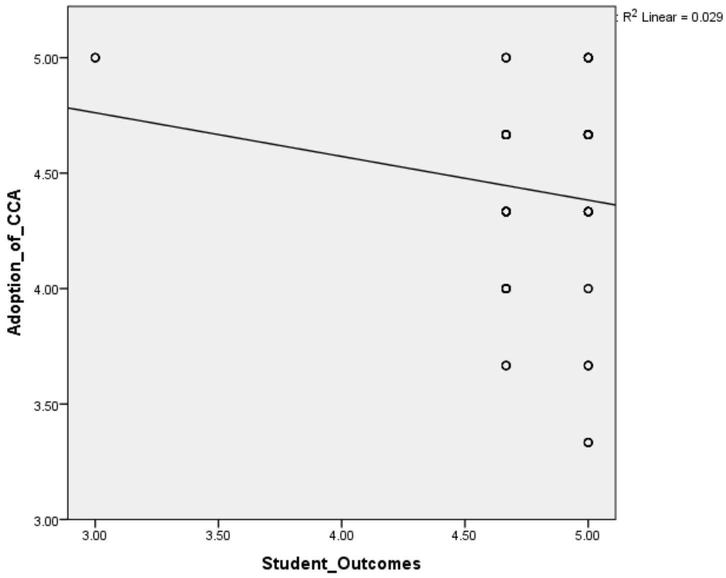

Figure 6. Scatter Plot of Adoption of CCA vs. Student Outcomes

Table 15 shows the correlation coefficients between two variables, "Adoption of cloud computing applications" and "Student outcomes". In this case, the Pearson correlation value was -0.169. Therefore, the independent variable student outcomes towards the adoption of cloud computing applications have a weak negative relationship. This means that as one variable increases, the other tends to decrease, but the relationship is not very strong.

Table 15. Results of correlation between Adoption of Cloud computing applications and Availability

		Adoption of CCA	Student Outcomes
Adoption of CCA	Pearson Correlation	1	-0.169
	Sig. (2-tailed)		0.026
	N	173	173
Student Outcomes	Pearson Correlation	-0.169	1
	Sig. (2-tailed)	0.026	
	N	173	173

*Correlation is significant at the 0.05 level (2-tailed)

This correlation coefficient had a p-value of 0.026. Overall, these results indicate that adoption of cloud computing applications may have impact on student outcomes. P value was 0.026. Therefore, the alternative hypothesis was accepted, and the null hypothesis was rejected. Hence, there is a relationship between student outcomes and the adoption of cloud computing applications in education institutions.

The output provided is from a model of linear regression used to predict the impact of student outcomes on the adoption of cloud computing applications (Table 16). The R-square of the model was 0.029, which means that only 2.9 % of adoption of cloud computing applications impacts student outcomes. The adjusted R-square of 0.023 indicates that the student outcomes of the model have not improved the model's fit significantly.

Table 16. Model summary from R-square test

Model	R	R-square	Adjusted R Square	Std. Error of the Estimate
1	0.169[a]	0.029	0.023	0.38487

a. Predictors (Constant), Student Outcomes

The ANOVA table (Table 17) indicates that adding the student outcome factor to the regression model significantly improved its fit (F = 5.043, p = 0.026). This indicates that student outcomes are an important factor in the adoption of cc applications in education.

Table 17. ANOVA[a] results for the relationship between Adoption of CCA and Student Outcomes

Model		Sum of Squares	df	Mean Squares	F	Sig.
1	Regression	0.747	1	0.747	5.043	0.026[b]
	Residual	25.329	171	0.148		
	Total	26.076	172			

a. Dependent Variable: Adoption_of_CCA
b. Predictors: (Constant), Student Outcomes

The coefficient table (Table 18) indicates that the intercept value was 5.329. This means that if student outcomes equal zero, then the adoption rate of cloud computing is predicted to be 5.329. The coefficient for student outcomes was -0.189. The independent variable student outcomes towards the adoption of cloud computing applications have a weak negative relationship. This means that as one variable increases, the other tends to decrease, but the relationship is not very strong. The t-value for student outcomes was 13.215 and the associated P-value was 0.000 %, which indicates that the coefficient is statistically important at the level of 0.05. These results indicate that student outcomes play a somewhat role in predicting the adoption of cloud computing applications. Working together fosters a community where students can get emotional support and develop relationships of trust within the student community. However, this is not limited to student-to-student relationships; cloud computing can also enhance teacher-student interactions. Additionally, cloud computing increases student enthusiasm and efficiency (Hartmann, 2017).

For pupils to succeed, "real time" feedback is essential. Teachers can provide prompt assistance and feedback on their students' work because they can work together to develop knowledge

(Mahalingam & Rajan, 2013). This will build a community that can overcome the apathy of self-study and enhance user interactions (Chandra & Borah, 2011; Hung & Lin, 2013).

Table 18. Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.329	0.403	-0.169	13.215	0.000
	Student_Outcomes	-0.189	0.084		-2.246	0.026

a. Dependent Variable: Adoption_of_CCA

Hypothesis 6

The R-squared value was 0.030 (Figure 7), indicating that institutional outcomes account for 3% of the variance in the adoption of cloud computing applications. This suggests that 97% of the adoption is influenced by other variables.

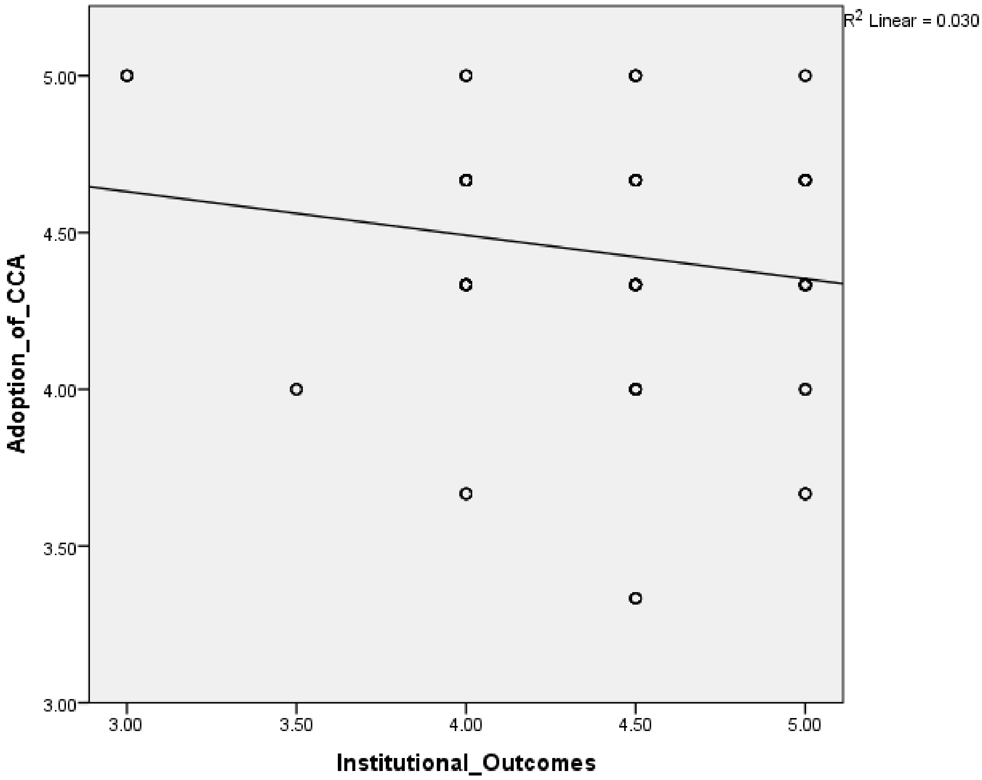

Figure 7. Scatter Plot of Adoption of CCA vs. Institutional Outcomes

Table 19 shows the correlation coefficients between two variables, "Adoption of cloud computing applications" and "Institutional outcomes". In this case, the Pearson correlation value was -0.172. Therefore, the independent variable institutional outcomes towards the adoption of cloud computing applications have a weak negative relationship. This means that as one variable increases, the other tends to decrease, but the relationship is not very strong.

Table 19. Results of correlation between Adoption of Cloud computing applications and Institutional Outcomes

		Adoption of CCA	Institutional Outcomes
Adoption of CCA	Pearson Correlation	1	-0.172
	Sig. (2-tailed)		0.024
	N	173	173
Institutional Outcomes	Pearson Correlation	-0.172	1
	Sig. (2-tailed)	0.024	
	N	173	173

*Correlation is significant at the 0.05 level (2-tailed)

This correlation coefficient had a P-value of 0.024. This means that it is statistically significant when 0.05 is used as the threshold (2-tailed). Overall, these results indicated that adoption of cloud computing applications may have impact on institutional outcomes. The P-value was 0.024, therefore the alternative hypothesis was accepted, and the null hypothesis was rejected. Hence, there is a relationship between Institutional outcomes and the adoption of cloud computing applications in education institutions.

The table (Table 20) provided is from a model of linear regression used to predict institutional outcomes and impact of the adoption of cloud computing applications. The R-square of the model was 0.030, which means that only 3 % of adoption of cloud computing applications impacts institutional outcomes. The adjusted R-square of 0.024 indicates that the institutional outcomes of the model have not improved the model's fit significantly.

Table 20. Model summary from R-square test

Model	R	R-square	Adjusted R Square	Std. Error of the Estimate
1	0.172[a]	0.030	0.024	0.38470

a. Predictors (Constant), Institutional Outcomes

The ANOVA table (Table 21) indicates that adding the institutional outcomes factor to the regression model significantly improved its fit (F = 5.199, p = 0.024). This indicates that institutional outcomes are a factor in the adoption of cc applications in education.

Table 21. ANOVA[a] results for the relationship between Adoption of CCA and Institutional Outcomes

Model		Sum of Squares	df	Mean Squares	F	Sig.
1	Regression	0.769	1	0.769	5.199	0.024[b]
	Residual	25.306	171	0.148		
	Total	26.076	172			

a. Dependent Variable: Adoption_of_CCA
b. Predictors: (Constant), Institutional Outcomes

The coefficient table (Table 22) indicates that the intercept value was 5.047. This means that if institutional outcomes equal zero, then the adoption rate of cloud computing applications was predicted to be 5.047. The coefficient for institutional outcomes was -0.139. The independent variable institutional outcomes towards the adoption of cloud computing applications have a weak negative relationship. This means that as one variable increases, the other tends to decrease, but the relationship is not very strong. The t-value for institutional outcomes was 18.419 and the associated P-value was 0.000 %. These results indicate that institutional outcomes play a somewhat role in predicting the adoption of cloud computing applications. For educational institutions, particularly those with limited funding, cloud computing is a great way to run their information systems efficiently without having to invest additional money in computers and network equipment (Ercan, 2010). Cloud computing can be used in various aspects of the testing process when it comes to evaluation and examination. For instance, using a cloud platform to access the E-answer script, taking an online test live viva-voce, or using a soft copy (Paul *et al*., 2023).

Table 22. Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.047	0.274		18.419	0.000
	Institutional_Outcomes	-0.139	0.061	-0.172	-2.280	0.024

a. Dependent Variable: Adoption_of_CCA

Hypothesis *7*

The R-squared value was 0.030 (Figure 8), indicating that communication and collaboration account for 3% of the variance in the adoption of cloud computing applications. This suggests that 97% of the adoption is influenced by other variables.

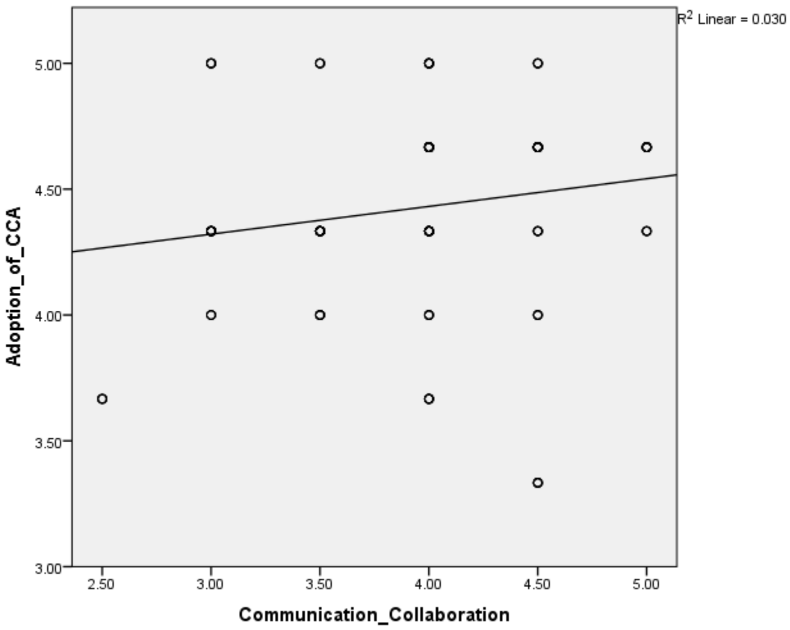

Figure 8. Scatter Plot of Adoption of CCA vs. Communication & Collaboration

Table 23 shows the correlation coefficients between two variables, "Adoption of cloud computing applications" and "communication and collaboration". In this case, the Pearson correlation value was 0.172. Therefore, the independent variable communication and collaboration towards the adoption of cloud computing applications has a weak positive relationship.

Table 23. Results of correlation between Adoption of Cloud computing applications and Communication and Collaboration

		Adoption of CCA	Communication and Collaboration
Adoption of CCA	Pearson Correlation	1	0.172
	Sig. (2-tailed)		0.024
	N	173	173
Communication and Collaboration	Pearson Correlation	0.172	1
	Sig. (2-tailed)	0.024	
	N	173	173

*Correlation is significant at the 0.05 level (2-tailed)

This correlation coefficient had a p-value of 0.024. Overall, these results indicate that adoption of cloud computing applications may have impact on communication and collaboration. P value was 0.024. So, the alternative hypothesis was accepted. Hence, there is a relationship between communication and collaboration and the adoption of cloud computing applications in education institutions.

Table 24 provides a model of linear regression used to predict communication and collaboration and impact of the adoption of cloud computing applications. The R-square of the model was 0.030, which means that only 3 % of cost-effectiveness impacts the adoption of cloud computing applications. The adjusted R-square of 0.024 indicates that the communication and collaboration of the model has not improved the model's fit significantly.

Table 24. Model summary from R-square test

Model	R	R-square	Adjusted R Square	Std. Error of the Estimate
1	0.172[a]	0.030	0.024	0.38468

a. Predictors (Constant), Communication and Collaboration

The ANOVA table (Table 25) indicates that adding the cost-effectiveness factor to the regression model significantly improved its fit (F = 5.211, p = 0.024). This indicates that communication and collaboration are a factor in the adoption of cloud computing applications.

Table 25. ANOVA[a] results for the relationship between Adoption of CCA and Communication and Collaboration

Model		Sum of Squares	Df	Mean Squares	F	Sig.
1	Regression	0.771	1	0.771	5.211	0.024[b]
	Residual	25.305	171	0.148		

Total	26.076	172	

a. Dependent Variable: Adoption_of_CCA
b. Predictors: (Constant), Communication and Collaboration

The coefficient table (Table 26) indicates that the intercept value was 3.991. This means that if communication and collaboration equal zero, then the adoption rate of cloud computing is predicted to be 3.991. The coefficient for communication and collaboration was 0.110. This means that, for every unit increase in communication and collaboration, cloud computing adoption is predicted to rise by 0.110. The t-value for communication and collaboration was 20.703 and the associated p-value was 0.024. These results indicate that communication and collaboration play a major role in predicting the adoption of cloud computing applications. Most of the widely used Learning Management Systems (LMS) can provide a variety of communication channels for group knowledge creation. One example is the usage of Moodle on Azure to track group work progress and enable students from various locations to access online resources (Wang *et al*., 2015). The initial cost of cloud implementation is somewhat high and necessitates significant financial resources for infrastructure, software, technology, and purchases. However, the resources may be used in a lifetime process after deployment (Paul *et al*., 2023).

Table 26. Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.991	0.193	0.172	20.703	0.000
	Communication_and_Collaboration	0.110	0.048		2.283	0.024

a. Dependent Variable: Adoption_of_CCA

Conclusion

The conclusions of this study highlight cloud computing's transformational potential in education institutions. Cloud adoption appears as a critical factor in transforming operating paradigms, with cost-effectiveness, communication, and collaboration recognized as main drivers of integration. However, while the benefits are obvious, it is critical to consider potential negatives to ensure a balanced adoption strategy. Despite being modest, the measured impact values (0.2% to 3%) show gradual changes in intricate institutional systems where even minor adjustments over time can greatly increase agility and efficiency. The exploratory style of this study intends to indicate opportunities for more investigation by identifying trends rather than clear causal linkages. These results highlight the potential long-term advantages of adopting cloud computing and its function in addressing changing institutional requirements.

However, the study also reveals subtle problems, notably in terms of student and institutional results, prompting a careful examination of adoption implications. In response to these observations, a series of suggestions emerges to guide institutional strategies for efficiently using the potential of cloud computing. Institutions can confidently navigate the complexities of cloud adoption by prioritizing comprehensive cloud computing strategies, focusing on data security and privacy, providing robust training and support mechanisms, encouraging communication and collaboration, and implementing continuous evaluation frameworks.

Recommendations

Addressing data security is a critical issue when using cloud computing in educational institutions. Institutions should invest in cybersecurity measures such as encryption, multi-factor authentication, and regular security assessments. Risks can also be mitigated by informing staff and students about safe cloud practices through training sessions. Institutions can employ cloud computing to promote flexibility, teamwork, and overall operational efficiency by prioritizing these efforts.

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