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Predicting Cloud Computing Technology Adoption in Higher Education using Technology Acceptance Model (TAM): A Case Study of Ogun State, Nigeria

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Abstract

Cloud computing (CC) is a nascent paradigm repositioning education system due to global usage of internet-enabled devices with high bandwidth and enhanced mobility requirements of the users. However, some stakeholders in the education system still feel reluctant to adopting CC services due to varying reasons. This paper explores the factors that distance learning system operators consider as important for the adoption and actual usage of CC services in Ogun State, Nigeria. A modified model based on Technology Acceptance Model (TAM) variables was developed. There are seven hypotheses formulated for testing. The researchers administered 389 TAM-based questionnaires to computer literate students in the institutions to obtain datasets. Multiple regression statistics was applied to analyse and test the seven hypotheses using IBM SPSS version 23. Findings revealed that perceived usefulness, ease of use, attitude to use and access cost variables are the most significant predictors of CC adoption. The findings of the study will benefit the management of tertiary institutions towards formulating policies that would promote mass education programmes like open distance learning (ODL) in Ogun State, Nigeria through CC adoption.

Keywords: *Cloud computing services, Technology acceptance, Higher education, Behavioural intention*

1. INTRODUCTION

Cloud computing (CC), a newly developed computing paradigm, is aimed at presenting everything-as-a-service to various organizations. In higher education institutions (HEIs), CC is deployed as an integral part of institution experience [1]. The technology, through the Internet, provides an appropriate consortium of computing resources with its scalability property and use of virtual resources as services. The resources are combination of network servers, applications, platforms, infrastructure segments. CC delivers services independently base on demand by the users and provides sufficient network access, data resource environment and powerful flexibility. Due to centralized storage, memory, computing capacity of personal computers and servers, the technology is used more efficiently as well as cost effective computing. Due to the advantages of CC, the world expects that this technology will revolutionize the e-learning aspect of education. According to Parte [2], CC applications provide flexibility for all stakeholders in education. It enables all players in educational organizations including colleges and universities to access services provided by its three platforms: *Software-as-a-Service* (SaaS), *Platform-as-a-Service* (PaaS), and *Infrastructure as a Service* (IaaS) [3]. As such, CC is now an important facilitator of distance and online educational programmes such as e-learning and mobile learning [4].

According to Taherdoost [5], the interests of both academicians and practitioners are now

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on studying the factors that compel users' acceptance or rejection of the new information technologies (IT). The purpose is to research into more efficient methods towards designing, evaluating and predicting the response of the users. Technology Acceptance Models (TAM) as well as its theories are applied to variety of fields to predict and interpret user's behaviours like pattern of dieting, family planning, voting, donating blood, women's occupational orientations, choice of transport mode, breast cancer examination, consumer's purchase behaviours, and computer usage [37]. Underdevelopment of the cloud services is one of the challenges of CC in academic institutions. In higher education, decisions to adopt CC are influenced by more than technical and cost considerations. There is no doubt that in a successful academic system, information flow is lifeline and decisions on how to manage that information can have far-reaching effects on the students, faculty and the society in terms of political, social and economic considerations. As against the use of traditional outsourcing arrangement, CC adoption comes with lot of risks as well as other challenges such as security, interoperability, control, performance, integrity and reliability [16].

aimed to providing further understanding of issues bothering on the acceptance of CC by students of tertiary institutions using the TAM model. This will help the management of tertiary institutions for the purpose of formulating policies that will promote mass education programmes through open distance learning (ODL).

The rest of the paper is organized as follows: Section 2 reviews related literatures on characteristics, services, deployment models of CC, concerns over adoption, CC in education systems and TAM concepts. Section 3 focuses on materials and methods of study. Results are presented in Section 4. Section 5 deals with the findings and discussion while conclusion is made in Section 6.

2. REVIEW OF LITERATURES

2.1 Cloud Computing Concepts

CC is a model for omnipresent, convenient, on demand and real-time network access pool of configurable computing resources like networks, servers, storage, applications and services that are available to institutions towards performing their organizational operations.

Figure 1: Architecture of Cloud Computing [8]

Consequently, investigating the causes of under-utilization of CC for teaching, learning and research by the students in Ogun State, Nigeria remains the principal motivation of this paper. As compared to the countries in the Western world, Nigeria can not afford to continue lagging behind in the adoption and usage of technological innovations for the benefits of the organisations in all spheres of life including education. Hence, this paper

Cloud adoption pertains to the scheme that renders positive motivational influences to both the public and private institutions to use the technology for their computing requirements for the purpose of efficient and sustainable services [9]. CC deals with the applications delivered as services (the hardware and systems software from the data centres) through the Internet that provides those services [7]. Many users in real-time can

access CC (a collection of applications and hardware technologies). Figure 1 shows a block diagram representing a collection of the hardware and system software (cloud) that run different applications accessible by the users online.

2.1.1 Cloud Computing: Characteristics, Service, Deployment Models and Storage

The basic characteristic of CC (an on-demand self-service) is determined by the availability of reliable internet connection for consumers to have unlimited computing capabilities without the need of human interaction with services providers [10]. Also CC, provides the user the flexibility of accessing data in real-time without any delay regardless of the device (mobile phone, laptop etc.) that is being used by the client. The final characteristic of CC is its ability to optimize resources by freeing up valuable resources and make possible by reassigning the unused resources by moving them to where consumer demand is at the highest [11].

According to Mell and Grance [12], there are three typical kinds of CC service. These are:

i. *Platform-as-a-Service (PaaS)*: This deals with the cloud delivering operating systems and affiliated services over the Internet without the need to download or install on the local computers or connecting devices. Amazon web services (AWS), Elastic Beanstalk, Windows Azure, Google App Engine, Apache Stratos etc. are some areas of PaaS application.
ii. *Infrastructure-as-a-Service* (IaaS): The storage, hardware, servers, and networking components are outsource to support CC operations. Some areas applications of IaaS are Amazon EC2, Windows Azure, GoogleCompute Engine etc.
iii. *Software-as-a-Service* (SaaS): A software distribution model where the vendors or service providers host applications that are offered to the customers over the Internet. These applications are Microsoft Office 365, Google Apps e.g. Google Docs and Web e-mail (like Gmail and Yahoo!). Cloud storage presents a data physical storage model where storage of digital data holds in logical pools that cut across multiple servers available in different locations. A hosting company owns and manages the physical environment of cloud storage. The responsibility to make the data available, accessible and run in real-time in a protected manner lies on the cloud storage providers. Interested consumers and organizations only buy or lease storage capacity from the providers while, on behalf of user and organization, the provider stores the application data. The cloud delivers conveniently synchronize files stored on multiple computers and access the files from any computer or device with Internet connectivity. Some of the cloud storage services are Google Drive, SkyDrive (now OneDrive), Dropbox, SugarSync and MediaFire.

2.2 Cloud Technology in Education System

There is a widespread usage of CC in higher institutions, propelled by the pedagogical significance that is created by the technology of resources sharing. Patil [13] suggests that CC is capable of replacing the present complex configurations of IT devices and software systems. Thus, it enables higher institutions of learning to put more emphasis on teaching and research rather than management of IT.

According to Ramayah *et. al.* [15], CC technology via the Internet offers solutions for educational system by allowing user to have full control and access data. The primary users of higher education cloud involve the students, for their respective work.

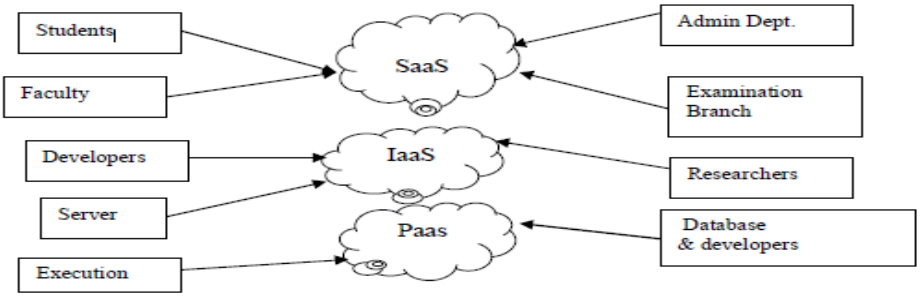

Figure 2: Users of an Education Cloud Computing System [14]

Faculty members, administrative staff, and examination as well as admission offices as shown in Figure 2. The users are connected to the cloud but each with separate login details Shana and Abulibdeh [16] state that CC offers a collaborative platform of instructions such that users can store data and share these instructions with other users. Mircea and Andreescu [17] use the term "agility" to depict the quality of CC to speedily move forward with minimal cost and effort. Ashtari and Eydgahi [18] identified five ways CC is changing education as follows:

i. No more expensive textbooks.
ii. No more out-dated learning materials.
iii. No expensive hardware required.
iv. No expensive software required.
v. Reaching more diverse students.

2.3 Technology Acceptance Model (TAM)

According to Marangunic and Granic [19], due to constant furtherance in technology, particularly ICT related applications, the choice to make decision on its acceptance and rejection is a nightmare. Consequently, different models and theories have emerged that further explained the actual use of technology. In all the models, TAM leads on the issue of examining factors that affect user's acceptance of any technological innovation.

2.3.1 TAM Main and External Variables

According to Ducey [20], the major TAM variables (or beliefs) that determine a user's behavioural intention to adopt a system are:

(i) Perceived Usefulness (PU) is the level at which an individual believes that using a particular system would enhance his or her productivity.
(ii) Perceived Ease of Use (PEU) is the level an individual believes that using a particular system would be free of effort [21].

Between these two variables, PEU has an immediate consequence on both PU and eventual use of technology [22], [21]. Additionally, for users to adopt a new technology, they must consider it as convenient, useful and socially suitable not minding the fact that they may not enjoy using the technology [23]. Thus, there is a possibility of a direct relationship that exists between beliefs and intentions. Winarto [24] affirms that there exist some external variables that can be applied to the TAM showing indication to methods to follow in the use and adoption of new skills. Yarbrough and Smith [25] classified these external variables into organizational characteristics, system characteristics, user`s personal characteristics and other variables.

2.4 Related Works

Nicholas-Omoregbe *et al.* [26] investigated some variables influencing the adoption of e-Learning Management System (eLMS) in higher education. The study was based on the Unified Theory of Acceptance and Use of Technology (UTAUT), Social Learning Theory (SLT), as well as two other variables focusing on technology culturation and power (i.e. electricity). The researchers administered questionnaires to 472 undergraduate students of three selected private universities in Ogun state, Nigeria. Based on the results, social influence, attitude and technology culturation remained topmost factors of determining the intention to adopt eLMS. However, performance expectancy and power have no significant effect on the behavioural intention to adopt eLMS.

Ashtari and Eydgahi [18] examined the relative effects of individual perception of the user towards the CC applications. The framework used by the researchers focused on the relationship between some variables (perceived ease of use, computer anxiety, IT self-efficacy, and users' perception of the usefulness) that have influence on the perceptions of CC technology by the students in Southeast Michigan university. The analysis of the adoption of CC by the students was based on TAM. The findings showed that perceive ease of use was a determining factor for adoption.

Arpaci [27] used the TAM variables to investigate the possible antecedents and outcomes of CC adoption in higher education towards achieving knowledge management. Questionnaires were administered to one of the Turkish universities undergraduates and data were analysed using structural equation modelling. The findings of the study pointed out that increase in the awareness of

knowledge management by the educational institutions actually promote CC adoption.

Marangunic and Granic [19] conducted a research on the adoption of CC technology in Africa's higher education and concluded that higher education institutions positively reacted to the changes in pedagogy occasioned by the requirements of an Internet-connected academic society.

Claar *et. al.* [28] conducted a survey research to examine diverse technology acceptance variables based on TAM. Findings established that perceived ease of use (PE) has a significant positive influence on perceived usefulness (PU) while PU has a significant positive influence on attitude toward using AT. Also, PE has a significant positive influence on attitude toward using AT; PU has a significant positive influence on behavioural intentions (BI) to use; AT showed positive influence on BI intentions to technology.

From the literatures reviewed, no study has integrated *access cost* and *gender* of the user to determine their effects on the acceptance of CC among students in higher institutions in Ogun State, Nigeria. These two factors were considered imperative for studying due to low economic status and low level of technology diffusion in most African countries including Nigeria. Hence, the possible effects of these two factors remain the focus of the study.

Therefore, the purpose of this study is to determine the strength of the eight variables/predictors on the adoption of CC. The variables are: Perceived Ease of Use (PEU), Perceived Usefulness (PU), Attitude of the user (AT), Perceived Complexity (PC) and Voluntary of Usage (VU). Others variables are Access Cost (AC) and behavioural intention (BI), and Gender of the User (GU) to adopt CC for teaching, learning and research in the open distance learning (ODL) or e-learning environment. The factors that may influence CC acceptance by students of higher institutions in Ogun State are as illustrated in research model (Figure 3). The study is based on the modified TAM as developed by [21] which has both internal (main) and external variables. The external variables added to the existing model are cost and gender.

2.4 Research Model and Hypotheses

2.4.1 Research Model

Figure 3 shows the research model of the study.

2.4.2 Research Hypotheses

The previous studies by [10], [29], [30]; [31]; and [32] were used as the basis for formulation of hypotheses in this work. Hence, seven null hypotheses were postulated for statistical test as follows:

Ho1: There is no significant relationship between perceived usefulness (PU) and behavioural intention (BI) to adopt CC.

Ho2: There is no significant relationship between perceived ease of use and behavioural intention to adopt CC.

Ho3: There is no significant relationship between attitude towards usage (AT) and behavioural intention to adoption of CC

Ho4: There is no significant relationship between perceived complexity (PC) of using CC services and behavioural intention to adopt CC.

Ho5: There is no significant relationship between voluntariness of usage (VU) and behavioural intention to adoption of CC.

Ho6: There is no significant relationship between access cost (AC) and behavioural intention to adopt CC services.

Ho7: There is no significant relationship between gender of the user (GU) and behavioural intention to adopt CC services.

3 METHODOLOGY

3.1 Research Participants

The students who are highly skilled in IT in the four (4) tertiary institutions in Ogun State, Nigeria made up the population of the study. To obtain the opinions of the representatives of target population, the researchers adopted a descriptive survey. 400 copies of the questionnaire were administered in the four (4) public tertiary institutions (Olabisi Onabanjo University, Tai Solarin University of Education, Ogun State College of Health Technology and Tai Solarin College of Education) in Ogun state, Nigeria. One hundred highly computer literate students were surveyed in each institution. 389 copies of

questionnaire were returned which represents a respondent rate of 94.8%.

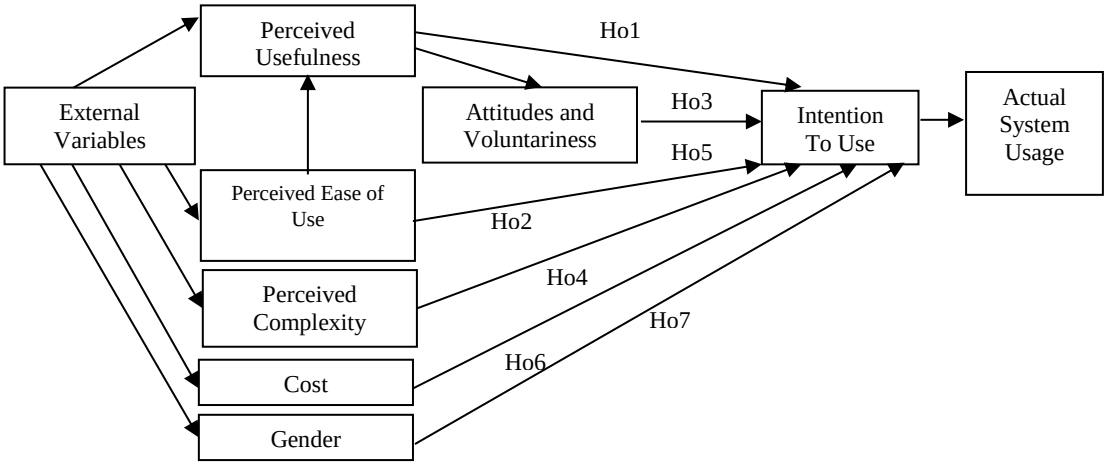

Figure 3: Proposed Modified Technology Acceptance Model of the Study

3.2 Research Instrument

A Cloud Computing Technology Adoption Questionnaire (CCTAQ) was developed based on the existing TAM variables with additional two variables by the researchers and used as the instrument in this study. The CCTAQ consisted of two parts. The first part requested the respondents to state their background information such as gender, name of institution, course of study, year of study, level of computer literacy, duration of using Internet and type of mobile phone they were using. The second part was set out to elicit students' responses on the adoption of CC in their course of study based on perceived usefulness, perceived ease of use, attitude toward using technology, behavioural intention to use, perceived complexity, voluntariness of using and access cost of CC.

This second part comprised of 31 items with the choice of five-point rating Likert scale as Strongly Disagree = 1, Disagree = 2, Undecided = 3, Agree = 4 and Strongly Agree = 5 since the questionnaire were made up of all positive statements.

3.3 Validity and Reliability of Instrument

The Part B of the instrument based on Likert scales were checked for content validity by three Tests and Measurement experts. All the items had content validity higher than 0.6 that made them acceptable for administration.

To test the reliability of the instrument, the questionnaire was administered on 40 undergraduate students who were not part of the target group. The reliability of CCTAQ was determined through the use of Cronbach's alpha to measure the internal consistency of the instruments yielding 0.76. Hence, the instrument was considered reliable. The construct reliability (an internal consistency of the model) measures the degree that items of the constructs have no random error and they produce consistent results.

Table 1: Cronbach's Alpha.

Construct	***Cronbach's Alpha***
Perceived Usefulness of Cloud Computing	0.879
Perceived Ease of Use	0.852
Attitude	0.810
Behavioural Intention	0.874
Perceived Complexity	0.788
Voluntariness	0.843
Access Cost	0.866
Gender of User	0.816

Source: Survey Data (2019)

The results of Cronbach's alpha are displayed in Table 1. The results show that the alpha values of all the constructs exceeded the threshold level of 0.70 [33] with the lowest

being perceived complexity at 0.788. Thus, the results evidently proved the acceptance of reliability as well as depicting that the internal consistency exists among the items of measurement.

3.4 Method of Data Analysis

The earlier formulated hypotheses were tested using a parametric (multiple regression) statistical technique on IBM SPSS version 23 to determine how the seven independents variables positively or otherwise predict the actual behavioural intention to use (dependent variable) CC.

4. RESULTS PRESENTATION

4.1 Demographic Information

From Table 2, 186 (47.8%) and 203 (52.2%) participants were male and female respectively. The year of study ranged from Year 1 to 4 with Year 4 and Year 2 having a minimum and maximum of 95 and 99 participants respectively. Only 168 of the participants were highly skilled in computer literacy while 190 (48.8%) participants have been using Internet for over 4 years only on their phone.

Table 2: Demographic Data (N = 389)

Items	Group	Percentage
Sex	Male = 186	47.8
	Female = 203	52.2
Year of Study	Year 1 = 98	25.2
	Year 2 = 99	25.4
	Year 3 = 97	24.9
	Year 4 = 95	24.4
Computer Literacy Level	Highly Skilled = 168	43.2
	Low Skilled = 176	45.2
	No Skill = 45	11.6
Internet Usage Duration via Phone	>= 4 years = 190	48.8
	3 years = 127	32.6
	2 years = 42	10.8
	1 year = 30	7.7

Table 3: Model Summary

R	*R Square*	*Adjusted R Square*	*Std Error of the Estimate*
0.665	.464	.439	2.56

Source: Survey Data (2019)

Table 4: ANOVA[b] for Regression

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	469.374	21	69.480	13.280	.001(a)
	Residual	603.628	377	5.772		
	Total	1048.800	398			

a Predictors: (Constant), Access Cost, Attitude to Use, Gender, Perceived Complexity, Perceived Usefulness, Voluntariness to Use, Perceived Ease of Use

b Dependent Variable: Behavioural Intention to Use Source: Survey Data (2019)

Table 5: Results of Multiple Regression showing *Joint and Relative Effect of Other TAM Factors on Behavioural Intention to Adopt Cloud Computing*

R	*AdjustedR^2*	*F*	*Sig*	*Variables*	*Beta*	*T*	*Sig.*
				PU	0.326	3.5914	.001
				PEU	0.268	2.731	.003
				AT	0.304	3.510	.001
.681[a]	.434	13.280	.001[a]	PC	-0.165	-1.588	.127
				VU	-0.152	-1.274	.321
				AC	-0.132	-1.544	.003
				GU	0.005	0.092	.939

a Predictors: (Constant), Access Cost, Attitude to Use, gender, Perceived Complexity, Perceived Usefulness, Voluntariness to Use, Perceived Ease of Use

Source: Survey Data (2019)

4.2 Hypotheses Testing

Multiple linear regression statistical tool was used to test the hypotheses at the significant value of 0.05 (i.e. p-value = 0.05) and the null hypotheses are reject when p-value >=0.05. In statistics, multiple linear regression tool is used to investigate the effects of one or more predictors or variables in an outcome (independent) variable. It makes the researchers to present statements about how well one or more independent variables predict the outcome of dependent variable.

The model summary is presented in Table 3. The coefficient of determination is 46.4% showing that the variation explained in dependent variable (behavioural intention to adopt CC) due to independent variables (PU, PEOU, AT, PC, VU, AC and GU).

The above Table 4 shows ANOVA where a significant F statistic justifies the appropriateness of TAM.

From Table 5, the calculated significant value of 0.01 that is less than p-value of 0.05 shows that all the seven null hypotheses are rejected and the alternate hypotheses are accepted. This implies that PU, PEU, At, PC, VU, AC and GU are significant factors to determine the adoption and actual usage of CC technology in HEIs. However, some variables (like PU, AT) have more direct effects and predict better than other variables like GU with less significant impact on the adoption of CC.

Table 5 shows an R-value (0.681) with an adjusted R^2 (0.434). This indicates that 43.4% of the variance in behavioural intention to adopt CC is accounted for by the other TAM variables. Since the F-value is 13.280 and significant value less than 0.05 (i.e. 0.01), this indicates that the joint effect of seven variables is significant. PU tops the variable ($\beta = 0.326$) that predicts behavioural intention to adopt and use CC technology. This is supported by the findings of [31] who pointed out that perceived usefulness has a positive and direct effect on the behavioural intention to use websites for learning. Attitude towards usage (AT) is next ($\beta = 0.304$) in predicting behavioural intention to adopt CC. This confirms the position by [34] that many higher institutions have moved to the cloud such as email and other collaboration services. PEU is the third variable ($\beta = 0.268$) that has influence on behavioural intention to adopt and use of CC technology. This is in agreement with the study by [16] on CC application in higher education using Theory of Acceptance Model. The perceived complexity (i.e. self-efficacy towards technology) predicts adoption of CC technology having $\beta = -0.165$). This finding is in tandem with [31] that self-efficacy has a positive relationship with the behavioural intention of students towards learning technology. The study shows that voluntariness to use (VU) minimally predicts behavioural intention to adopt CC technology ($\beta = -0.152$) which goes in tandem with [10] that voluntariness is a moderating factor in determining the behavioral intention to use technology. Additionally, access cost predicts adoption of CC ($\beta = -0.132$). This result is supported by the work of [35] who identified cost of acquiring the required ICT infrastructures, standards requirement, cost of maintenance, electrical power supply, high

financial expenses of the physical security of the facilities and licensing. However, the beta value of 0.005 for gender shows less prediction indicating that there is no significant effect of gender on CC adoption. This is contrary to a study by [36] that opined that men tend to feel more comfortable with computers.

5. FINDINGS AND DISCUSSION

The finding of the study that showed the significant effect of access cost (AC), as the first added variable to the TAM, on CC technology adoption contradicts [24] which affirmed that power (a major issue in terms of access cost) was not one of the factors influencing the behavioural intention by students in universities in Ogun state to accept eLMS. One of the reasons for this outcome by [26] may be due to the fact that universities used in the study were all private-owned where things arguably work better than public higher institutions. As regards the second added variable (gender of user), it was deduced that gender has very little and indirect significant effect on the adoption and usage of CC technology in HEIs in Nigeria. However, this finding is in contrary with [16] finding that gender has no impact on students' attitude.

The results of this research showed that "perceived usefulness", "perceived ease of use" as well as "access cost" are the factors militating against the adoption of CC in tertiary education system in Ogun State, Nigeria. In terms of perceived usefulness, the study showed that students in the tertiary institutions have low orientation toward technological innovation in believing that CC technology can enhance their academic productivities. On the perceived ease of use, the study also revealed low level of the students' believes that using CC would be free of effort. As regards access cost of CC services, the students were of the opinion that high cost of internet subscription in Nigeria remains a major factor in the use of CC in sharing knowledge and lecturers also opined that there exist a fewer number of students accessing online course contents and eventual adoption of CC. From the study, digital divides in terms of gender on the adoption of technological innovation almost no longer exist in higher education.

Recently, the focus of higher education administrators has been geared towards full implementation of ICT-based learning systems that provide students with online access to learning contents. This is considered as one of the important alternatives to foster the current knowledge-based society that supports effective open distance learning system in higher education. The developed countries take full advantage of CC innovation to support all levels of educational systems for further development. Conversely, the scenario is quite different in Ogun State, Nigeria.

6. CONCLUSION

The purpose of this study seeks to determine the strength of the eight variables/predictors on CC adoption. Perceived Usefulness (PU), Perceived Ease of Use (PEU), Attitude (AT), Perceived Complexity (PC), Voluntary of Usage (VU), Access Cost (AC) and Gender of the User (GU) on students' behavioural intention (BI) to accept as well as use of CC for teaching, learning and research in the open distance learning (ODL) or e-learning environment. The factors that may influence CC acceptance by higher institutions in Ogun State are illustrated in the research model. The study was based on the modified TAM that has both internal (main) and external variables. The external variables added to the existing model are cost and gender.

This study adopts TAM to determine user's acceptance and adopting CC technology in HEI in Ogun State, Nigeria. Two social factors or variables (gender of user and access cost) were integrated into some existing variables to determine if there exist significant effects on the behavioural intention to adopt and use CC technology. Findings from this study show that these two added factor/variables have no significant effects on behavioural intention to use CC technology. Findings from the study will assist stakeholders (especially the administrators) in planning, implementation and taking investment decisions on the need to use CC technology towards enhancing ODL in Ogun State, Nigeria.

The government needs to critically look into the high cost of Internet charges in Nigeria and possibly subsidize the cost in higher institution. This will complement users'

perceptions of usefulness vis-à-vis cost of the technology towards encouraging actual usage of CC services to enhance development of higher education in the era of ODL to achieve mass education. Hence, based on the role technologies are playing in the teaching and learning process, the HEI administrators should place more importance on the combination of CC technologies and pedagogy in classes. To increase the adoption of the technology, lecturers in HEIs should update their knowledge on how to implement this technology to deliver academic contents. This will help them to arrange the learning tasks more effectively with good support from CC technologies.

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