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Acceptance of Computer Supported Collaborative Work (CSCW) in Architectural Firms in Nigeria

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----------**ABSTRACT**----------

Computer Supported Collaborative Work (CSCW) is a platform for the optimization of Building Information Modelling (BIM) software among architects and construction industry professionals. It is a product of cloud computing technology which enables these professionals to collaborate on projects online at real-time. This study is aimed at testing an extended Technology Acceptance Model (TAM) on the adoption of CSCW in architectural firms in Nigeria. The study adopted the survey research approach in conjunction with qualitative research. Data from 118 Architectural firms drawn from six cities in the country were analysed using descriptive statistics, multiple regression analysis and content analysis. The study concludes 37.3% of architectural firms in Nigeria have adopted the technology. Perceived ease-of-use, security and quality of installed systems emerged as predictors of acceptance while perceived usefulness was not a predictor. A graphical extended TAM model was developed from the results. Architectural firms will accept CSCW if they consider it easy to use, secure and appropriate quality of systems are available.

KEYWORDS : *Acceptance, Adoption, Architectural Firms, BIM, Collaboration.*

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I. INTRODUCTION

The deployment of the Internet, intranet and extranet technologies in the Architecture, Engineering and Construction (AEC) industry has created new ways of doing business that has obvious effect on all areas such as prospects, service provision and ultimately the clients of architectural firms. Web based collaborations however provide new opportunities that lead to the formation of virtual enterprises that are dynamically formed to meet market opportunities as and when it arises [15], [16], [11] and [12]. Veeramani and Russell [16] argue that the usefulness of web technologies as widely reported, should necessarily involve the firms as stakeholders and partners in the process of improving and developing these technologies to produce industry specific solutions.
Gaboury [4] and [5] present convergent views on the duration of the existence of the Internet, starting as a network between academics sharing research information to the present point of ubiquity. It now provides access to colossal volumes of information that is constantly expanding each minute. The quality of Internet services are usually determined by speed of transmission resulting in the speed of access to information by the client as provided via available infrastructure.

Klinc et al [7] opines that the AEC industry is still in the early stages of the adoption of modern web based technology even though other industries are way ahead. Several issues of concern have arisen in the course of web usage which includes affordability, availability, accessibility, security and infrastructure development [13], [11], [9] and [10]. Architectural firms should be studied to confirm specifically this assertion and provide empirical evidence in this regard.The introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper.

II. TECHNOLOGY ACCEPTANCE MODEL (TAM)

The Technology Acceptance Model (TAM) was developed in the mid 1980's from the studies of Davis. TAM takes a position that makes two particular beliefs on the part of users; perceived usefulness and perceived

ease-of-use, strong determinants of decisions for computer and technology acceptance. The theory is noted as one that leads to testable propositions which can be achieved by empirical studies. Other related theories or research models are: Theory of Innovation Diffusion (IDT); Theory of Reasoned Action (TRA); Theory of Planned Behaviour (TPB) and Task-Technology Fit (TTF) model [1], [6] and [9].

Leong [8] opines that Usage in technology studies has been considered as a significant dependent variable and is now attracting increasing interests from researchers. Therefore TAM is regarded has being a relatively robust theoretical model for understanding ICT use and it leads to testable propositions that can be investigated empirically. It is also useful for predicting whether users will adopt new information and Communications technology. Two distinct variables crucial to understanding user acceptance discovered by researchers include perceived usefulness and perceived ease-of-use. People tend to use or reject an application to the extent they believe it will help them perform better. On the other hand a useful technology may be seen as hard to use and effort outweighs the performance benefits of usage. This shows that usage is also influenced by the perceived ease of use.

Adesina et al. [1] observed that the validity of TAM can be increased by exploring the nature and specific influences of technological and usage-context factors. This usually results in the formulation of an extended TAM model. The model as developed by [8] is presented in Fig.1 below.

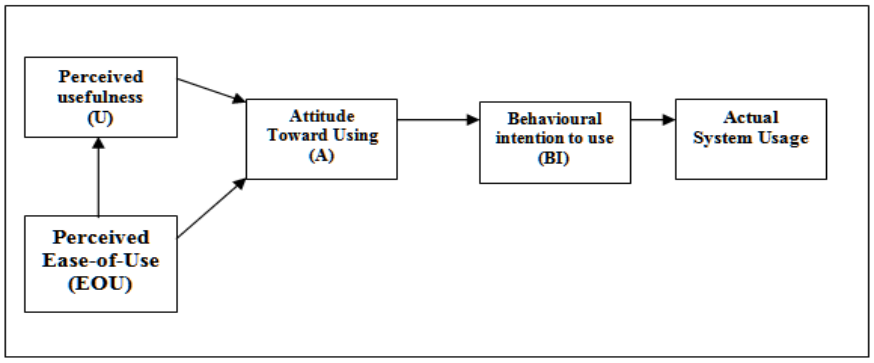


Figure 1: technology acceptance model
Source: Leong [8]

III. AIM OF THE STUDY AND HYPOTHESES

The aim of this paper is to determine the level of acceptance of Computer Supported Collaborative Work (CSCW) in architectural firms in Nigeria. Therefore, the following hypotheses were developed in order to
Hypothesis 1:
H1o - There is no significant relationship between the deployment of CSCW and its perceived Usefulness in architectural firms in Nigeria.
Hypothesis 2:
H2o - There is no significant relationship between the adoption of CSCW and its perceived ease-of-use.
Hypothesis 3:
H3o - There is no significant relationship between the adoption of CSCW and its security and the quality of installed systems.

3.1 METHODOLOGY

The survey approach to data collection was used for this paper. The sample was drawn from the official list of architectural firms which are entitled to practice in Nigeria. The Multistage sampling adopted consist: stage 1- City selection stage each drawn from six regions created for this study; Stage 2- derivation of sample size within each city; and lastly random sampling of particular firms in each city to be studied. A total of 159 firms were derived as Sample using a sample size calculator from the 649 firms in the 2010 register of architectural firms in the nation published by the Architects registration Council of Nigeria (ARCON). This paper is derived from a parent study [3] in which a total of 118 out of the 159 firms responded giving a response rate of 74.21%. The data derived from the sample were analysed using descriptive statistics. Table 1 describes details of the sample and return rate for the study.

Table 1: Table showing the number, percentage of duly completed questionnaire and overall response rate

CITY (LOCATION)	No. of Firms per City	calculated sample size	NUMBER OF DULY COMPLETED QUESTIONNAIRES	PERCENTAGE OF DULY COMPLETED QUESTIONNAIRES
KADUNA	45	16	16	100%
MAIDUGURI	4	2	2	100%
ABUJA	96	34	23	67.65%
LAGOS	221	78	52	66.67%
ENUGU	41	15	11	73.33%
PORT HARCOURT	40	14	14	100%
TOTAL	**447**	**159**	**118**	**74.21%**

Source: Dare-Abel [3]

IV. ADOPTION OF CSCW IN ARCHITECTURAL FIRMS

It was found from the study that many firms (60.2%) have not adopted the technology while 37.3% of the sampled architectural firms have adopted CSCW. Three firms representing 2.5% of the sample were undecided in their response. The interview with principals or managing partners of selected firms provided some insight to the positions submitted above.

One of the respondents had this to say, *"We are not aware of such terminology or technology and it is our view that many others are in our shoes. However we do not rush into acquiring technologies, so we wait and see how it goes with other firms who have tried it before we go ahead. The cost of acquisitions may also scare many firms who are just trying to stabilize financially. If it is good and affordable we can invest in it"*.

Another Architect responded by saying, *"we always try to lead the pack, and be first in everything. This is because one of our business principles is - the first takes the majority share. This principle has worked for us for many years and has earned us partners and projects outside Nigeria. We have been using Buzzsaw for more than five years to collaborate and have trained many of our architects to use the platform. I think many firms do not invest in acquiring knowledge that's why many are stagnant".*

One architect responded *"in our firm we invest in technology wisely, even though we don't buy every new thing (hardware and software) we see, we try to stay current and relevant. Collaborative work is the vogue, and it is my opinion that any firm that does not invest in both technology and human capacity may be left behind"*.

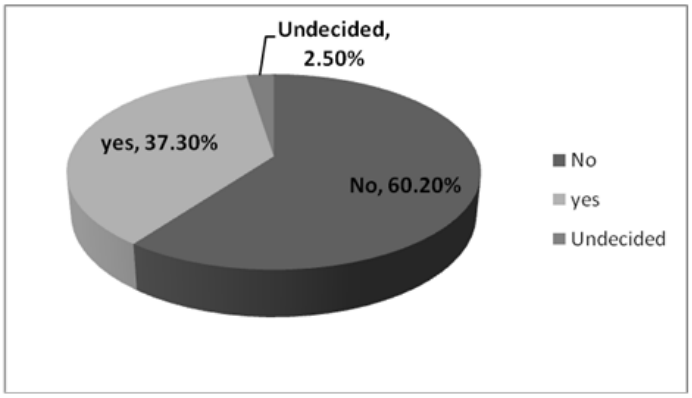


Figure 1: Adoption of CSCW by Architectural Firms

4.1 THE REGRESSION ANALYSIS OF THE EXTENDED TAM MODEL

The outcome (dependent) variable for this extended Technology Acceptance Model is CSCW use/adoption while the predictor (independent) variables are: perceived usefulness of CSCW; perceived ease of use of CSCW; security of the system and the quality of installed systems. The variables involved in this analysis are few; therefore it was not necessary to employ factor analysis as a data reduction method. The variables were simply subjected to multiple regression analysis. Table 2 shows the regression model summary.

The analysis used the stepwise method of exclusion to unveil with precision the variables that have the most effect in the extended TAM model while excluding those that are not significant in this case perceived usefulness of the CSCW system was excluded. The MLR result revealed that the coefficient of multiple determinations for Model 1 is 0.062; it therefore reveals that about 6.2% of the residual variation in the adoption of CSCW and the associated systems is explained. Model 2 has a coefficient of multiple determination of 0.118; therefore about 11.8% of the residual variation in the adoption of CSCW and the associated systems is explained. Model 3 has a coefficient of multiple determination of 0.174 revealing that about 17.4% of the residual variation is explained. Model 3 is selected for having the highest R^2 value and the coefficients are used to present the model equations.

Table 2: Model Summary for CSCW TAM Test

Model	R	R Square	Adj. R Square	Change Statistics				
				R Square Change	**F Change**	**df1**	**df2**	**Sig. F Change**
1	.250[a]	.062	.054	.062	7.648	1	115	.007
2	.344[b]	.118	.103	.056	7.193	1	114	.008
3	.418[c]	.174	.152	.056	7.720	1	113	.006

a. Predictors: (Constant), Ease-of-Use of CSCW
b. Predictors: (Constant), Ease-of-Use of CSCW, Security of CSCW
c. Predictors: (Constant), Ease-of-Use of CSCW, Security of CSCW, Quality of Installed Systems
d. Dependent Variable: Production of Desired Design Data

The regression equation (1) is presented below:

$$Y_{PDDD} = -0.527 + 0.351X_{CWEU} - 0.246X_{CWSC} + 0.221X_{QUIS} \qquad (1)$$

This quantitative equation can however be used to predict the dependent variable. The predictor variable for model 1 is ease of use of CSCW while the predictor variables for model 2 are ease of use of CSCW and security of CSCW. Model 3 predictor variables are ease of use of CSCW and security of CSCW and quality of installed systems. Perceived usefulness of CSCW systems was not a predictor of the adoption of the system. Contrary to the findings of [2] while testing TAM in clinical settings, the results of this study excluded perceived usefulness as a predictor. The reasons of difference in context and what is important to the architectural firms towards acquisition of technology may be responsible for this result. The variable ease-of –use of CSCW (CWEU) has the highest absolute value of beta coefficient. It is therefore the most important predictor of the dependent variable. The regression coefficient 0.351, indicates that 100% increase in the value of the variable will induce 35.1% increase in the Production of Desired Design Data, while holding other variables in the model constant.

The result of the ANOVA shows that for all the three (3) there was significant effect on the adoption of CSCW, for Model 1 - $F(1, 115) = 44.21$, $p < 0.05$. Model 2 – $F(2, 114) = 41.58$, $p < 0.05$ while for Model 3 – $F(3, 113) = 38.92$, $p < 0.05$ showing significant effect of ease of use of CSCW, security of CSCW and quality of installed systems on the adoption/acceptance of CSCW.

Therefore at 5% level of significance, it can be concluded that the predictors are useful for predicting the adoption/acceptance of CSCW.

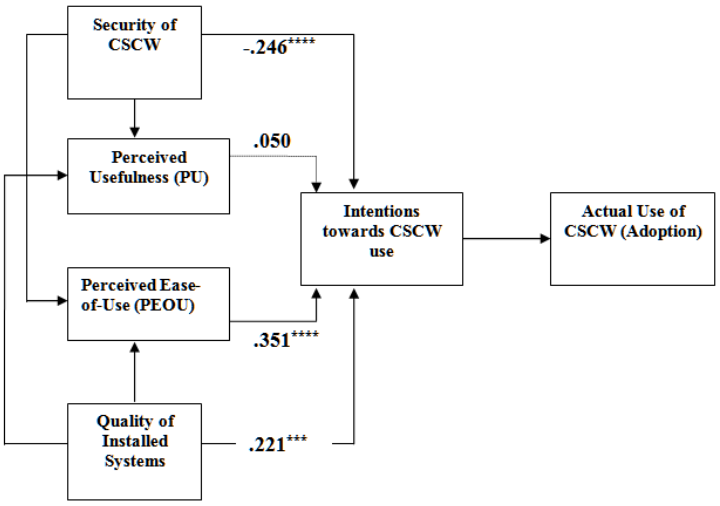
The reports of the beta weights reveal that for:
Model 3: $B_1 = 0.35$, t1 (113) = 4.37, $P < 0.05$
$B_2 = -0.25$, t2 (113) = -3.38, $P < 0.05$
$B_3 = 0.22$, t3 (113) = 2.78, $P < 0.05$

The intercepts (value of y when x = 0) for the models are 0.20, 0.23 and -0.53 respectively. The multiple regression results report P values of less than 0.05, therefore, the null hypothesis will be rejected and the alternative hypothesis is accepted. Finally, the plot shows that there is not much deviation from normality in the actual data values. The scatter-plot of the outcome variable reveals patterns of linearity.

4.2 THE EXTENDED TAM MODEL

The study of [2] developed an extended TAM model with such variables as: self efficacy towards computers; perception of external control; anxiety towards computers and intrinsic motivation. The final model for the above study excluded self efficacy towards computers because its effect was insignificant. The revised model for this study is shown in the figure 1 above. Acceptance of computer supported collaborative work is growing within Architectural firms in Nigeria with 37.3% of the sample already adopting the technology. The TAM model test used gave partially similar results with the studies of [14] and [2] used TAM to predict the acceptance of virtual reality as a treatment option in clinical settings and the result showed that only perceived usefulness was responsible for predicting acceptance and actual usage.

This is at variance with the result of this study perceived usefulness not a prediction of acceptance of CSCW. However, perceived ease-of-use, security and quality of installed systems were significant predictors from the results of regression analysis as seen in Fig. 2. It follows that Architectural firms in Nigeria will adopt CSCW if the technology is easy to use (user friendly); secure for their data and they possess right quality of systems (Network environment, software and hardware). Therefore, it is crucial for the Nation to develop Network infrastructure especially broadband access and stable power supply that will foster the adoption of the technology thereby improving global interaction and collaboration in Architectural practice. Most new CSCW software has user friendly and easy to use virtual environments which definitely will encourage acceptance and actual usage. Intentions to use is highly related to actual usage in this environment



Relationship significant at: * 0.1, ** 0.05, *** 0.001, **** 0.0001

Figure 2: Extended Technology Acceptance Model for the Acceptance/Adoption of CSCW in Architectural Firms in Nigeria

V. CONCLUSION

The study revealed that only 37.3% of firms have adopted CSCW while more firms (58.5%) are yet to adopt the technology. The result of the correlation matrix was used to review the extended TAM model diagram to reflect the actual linkages and strength of connection with regards to the technology studied.Some of the responses from the interview further suggested low level of awareness of the technology and the fear of committing huge financial resources towards acquisition of the software and hardware demands of CSCW. However firms that have embraced CSCW affirm that their courage towards adoption stems from their corporate principle and the hope of gaining competitive advantage, greater project opportunities and international collaborations. Some of the firms confirm gaining these opportunities and their pace-setting position in the industry is a product of the investment in technology.

Multiple regression analysis was carried out using the stepwise method of exclusion. The analysis revealed that perceived usefulness was not a predictor of the acceptance and adoption of CSCW. However perceived ease of use, security and quality of installed systems were predictors. The predictor variables were responsible for explaining 17.4% variance in the acceptance and adoption of CSCW. It can be concluded that more firms will adopt the technology as long as they believe that it is easy to use; there is a secure environment for the processing and transfer of project information and the right quality of installed systems are available.

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REFERENCES

[1] Adesina A., Ayo C. and U. Ekong, An Empirical investigation of the level of users' acceptance of e-banking in Nigeria: based on technology acceptance model, (2008).
[2] Bertrand M. and S. Bouchard, Applying the Technology Acceptance Model to VR with People who are Favourable to Its Use. Journal of Cyber therapy and rehabilitation, 1(2) 2008.
[3] O.A. Dare-Abel, Information and Communication Technology (ICT) Deployment in Architectural Firms in Nigeria, doctoral diss., Covenant University Ota, Nigeria, 2013.
[4] Gaboury J., Expanding Technology. Design Intelligence: May 12, 2009. http://www.di.net/articles/archives/expanding_technology/
[5] W.H. Gates. *Business @ the Speed of Thought: Succeeding in the Digital Economy* (Grand Central Publishing, 2009).
[6] Gebauer J. and M. Ginsburg, Exploring the Black Box of Task-Technology Fit: The Case of Mobile Information Systems. Fifth Workshop on e-Business (WeB 2006).
[7] Klinc R., Turk G. and M. Dolenc M., ICT Enabled Communication in Construction. February 2010.
[8] Leong L., Theoretical models in IS research and the technology acceptance model (TAM), Idea Group Incorporated, 2003.
[9] Mills E., Middle East Cyberwar hits Israeli Banks, Stock exchange, Airline. CNet News 17th January, 2012.
[10] Mitroff S., Israeli Hackers Attack Saudi and UAE Stock Exchange Websites. VB news, 17th January, 2012. http://venturebeat.com/2012/01/17/israeli-hackers-attack-saudi-uae-stock-exchange-websites/
[11] Ndukwe E., Making ICT Available Accessible and Affordable: Issues, Problems & Opportunities. A paper presented at the 37th World Telecommunications Day Event, 2005.
[12] S. Someya , The Role of R&D in Construction Firms. M.Sc. diss. Civil Engineering Department at the Massachusetts Institute of Technology, Cambridge, MA, 1992.
[13] Staples D.S. and P. Seddon, Testing the technology-to-performance chain model. Journal of Organizational and End User Computing, 16(4), 2004, 17-36.
[14] Szajna B., Empirical Evaluation of the Revised Technology Acceptance Model. Institute for Operations Research and Management Sciences – *Journal of Management Sciences. 42(1), January 1996*.
[15] Thi Lê M. and K. Law, Systemic Dynamic Approach for Simulation of Experience Transfer in the AEC industry. The Journal of Management in Engineering, ASCE/October 2009.
[16] Veeramani D. and J. Russell, Preparing the AEC industry for the Knowledge Economy, 2000. http://www.ce.berkeley.edu/~tommelein/CEMworkshop/veeramani&russell.pe4

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