Impact of Ownership Structure on Provision of Staff and Infrastructure for Implementing Computer Aided Design Curriculum in Universities in South-East Nigeria

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Abstract—Instruction towards acquiring skills in the use of Computer Aided Design technologies has become a vital part of architectural education curriculum in the digital era. Its implementation, however, requires deployment of extra resources to build new infrastructure, acquisition and maintenance of new equipment, retraining of staff and recruitment of new ones who are knowledgeable in this area. This study sought to examine the impact that ownership structure of Nigerian universities had on provision of staff and infrastructure for implementing computer aided design curriculum with a view to developing a framework for the evaluation for appropriate implementation by the institutions. Survey research design was employed. The focus was on departments of architecture in universities in south-east Nigeria accredited by the National Universities Commission. Data were obtained in the areas of infrastructure and personnel for CAD implementation. A multi-stage stratified random sampling method was adopted. The first stage of stratification involved the accredited departments. Random sampling by balloting was then carried out. At the second stage, sampling size formulae was applied to obtain respondents' number. For data analysis, analysis of variance tool for testing differences of means was used. With ρ < 0.5, the study found that there was significant difference between private-funded, state-funded and federal-funded departments of architecture in the provision of personnel and infrastructure. The implications of these findings were that for successful implementation leading to attainment of CAD proficiency to occur in every institution regardless of ownership structure, minimum evaluation guidelines needed to be set. A regular comparison of implementation in institutions was recommended as a means of rating performance. This will inform better interaction with those who consistently show weakness to challenge them towards improvement.

Keywords—Computer-aided design, curriculum, funding, infrastructure.

I. INTRODUCTION

IN such fields as medicine, tourism, travel, business, law, banking, engineering and architecture, the impact of Information and communication technology (ICT) as an indispensable part of the contemporary world has been enormous [1]. Education, which prepares entrants to this world has therefore, logically not been left out of the change.

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It has, to different degrees in different parts of the world, continued to adapt itself to new realities by changing curricula and adopting new techniques and methodologies for preparing its candidates for effective socio-economic participation. In the field of architectural education, one major technology that has transformed the landscape is computer-aided design technology and the necessity to incorporate it into the education process.

Computer-aided design (CAD) has been defined by Autodesk [2] as the use of computer technology for design and design documentation. In its various forms, manual drawing methods are replaced by the use of specialised computer software for drawing. CAD education is vital for the architect because CAD has become the expected mode for communication of ideas and information in the industry. Several stakeholders in architectural education have called for its inclusion in curriculum review efforts [3]-[5]. Also, [6] posited that Nigerian universities still produced CAD-illiterate graduates despite the high demand for CAD literate graduates. These were despite the inclusion of CAD courses into curricula of various universities as documented in literature [7], [8].

Funding as a determinant of quality of education obtained in tertiary institutions has been underlined in literature. Ahmed [9], highlighting the problem of funding facing Nigerian universities, agrees with the World Bank that universities in Africa found it increasingly difficult to maintain adequate student-teacher ratio, lecture halls are overcrowded, buildings fall into disrepair, teaching equipment is not replaced, and investment in research is insufficient. It blames inadequate public financing and resource diversification, stating that these led to deterioration in quality of graduates. It has been observed that government owned universities had lower unit cost of graduate production which is an indirect indicator of production of "low quality graduates". This was attributed to too much reliance on their proprietors for funding [9]. The class of proprietorship of institutions i.e. Federal, State or Private could therefore be a determinant of effectiveness in implementation of curriculum. Whereas the implementation of CAD education content in the curriculum is explicitly required by the National Universities Commission (NUC), the extent and rate of implementation are still not agreed [10]. Funding therefore becomes a focus of evaluation, useful to certifying agencies in the quest to improve the curriculum of architecture

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courses. This work then set out to examine how the ownership, which determined funding, of accredited universities within the study area have affected implementation of the CAD in architecture curriculum as required by the NUC. The particular focus was on the provision of staff and infrastructure vital for successful implementation. It is the expectation that the result of this research will form a basis for advising deficient categories.

A. Statement of Problem

Stakeholders in academia and industry have variously stated that the curriculum being used in architectural education in Nigeria needs review [3], [8]. The common argument is that evolution of society has brought significant challenges and changes which are redefining the architect's role and these make it necessary to redraw the basis of training so as to ensure better equipping for the new realities [11]. Some of the areas suggested include ICT [5]. Inclusion of ICT (CAD) curriculum involves increased funding for expansion of the vital factors for effective implementation of CAD education i.e. content, infrastructure and personnel. Ownership structure (private, state, federal) is an important indicator of funding for progammes in the university and should be a focus for stakeholders' evaluations. The documented lack of needed skills for industry exhibited by graduates of universities [12] creates a problem which evaluation of performance of universities will aid regulators (National Universities Commission) to resolve.

B. Objective of the Study

The research sought to investigate the difference between private-funded, state-funded and federal-funded schools of architecture in providing personnel and infrastructure to implement CAD in their curriculum. Deriving from the objective, the research sought to ask the following question: Are there differences between private-funded, state-funded and federal-funded schools of architecture in providing personnel and infrastructure to implement CAD in their curriculum? Also from this, the following was proposed as hypothesis: 'There is no significant difference between private-funded, state-funded and federal-funded schools of architecture in the existing ratio of CAD personnel to students and number of available CAD workstations for implementing CAD in their curriculum'.

C. Justification

The study is necessary because of the need for stakeholders in architectural education to ensure that the vital CAD skills are acquired during the training period in school. This is as a result of documented gaps between the skills adjudged to be needed for successful careers after graduation from university and the skills that employers affirm that the graduates possess. The results will assist the effective regulation of architecture programmes and be beneficial to both the institutions and their graduates. This is the case, as observations made in literature highlight the need for evaluation and improvement. Some of these include, Olotuah [13] which stated that less than 30% of Nigerian Architects learnt the use of CAD software during

their course of study. Reference [12] also underlined a trend where students graduating from Nigerian Universities did not have the set of skills required by employers in the labour market. These observations were made at a time when commentators agreed that ICT was having tremendous influence on architecture [1] and very profound changes to the tools which architects use and their working methods have caused CAD-systems to become the main tool for the architects' work [14]. To remain relevant therefore, architectural education adapt to new realities brought by CAD technologies. By doing this, it ensures that its graduates have greater prospects for successful careers. The evaluation of differences provision of vital factors for successful implementation of CAD curriculum is therefore necessary in achieving this goal.

D. The Study Area

South-east Nigeria is the study area. Reference [15] informs that Nigeria is part of West Africa. Geographically it is situated between longitude 3 degrees and longitude 14 degrees east of the Greenwich meridian and latitudes 4 degrees and latitude 14 degrees north of the equator. It is divided into 36 states and the Federal Capital Territory [15] (see Fig. 1). These states have been grouped into six geopolitical regions. The regions are North-East, North-Central, North-West, South-West, South-East and South-South. South-East which is the study area consists of Abia State, Anambra State, Ebonyi State, Enugu State and Imo State [16] (Fig. 1).

The scope was delimited to Nigerian Universities Commission accredited departments of architecture within South-East Nigeria. The work sought, therefore, to investigate and establish differences between funding categories i.e. federal, state and private in provision of infrastructure and personnel critical to implementation of CAD in architecture curricula.

II. LITERATURE REVIEW

A. Theoretical Framework

This study is a part of a wider research on Implementation of CAD curriculum in architecture departments in southeast Nigeria. Talcott Parson's expansion of the theory of structural functionalism has been chosen to undergird this research. Structural functionalism is a sociological macro theory which proposed that society was made up of four parts namely norms, customs, traditions and institutions. Communication and interaction between these four parts led to the equilibrium or maintenance of the steady state in the system [17]. Parson viewed society as a system with four basic functional pre-requisites, namely Adaptation, Goal attainment, Integration and Pattern maintenance. As long as these functions are carried out, society maintains equilibrium and is kept from collapse. He identifies these as the core problems society must solve in order to continue to exist. Solutions to these problems become institutionalized such that these solutions become normative, ordered and persist through time [18].

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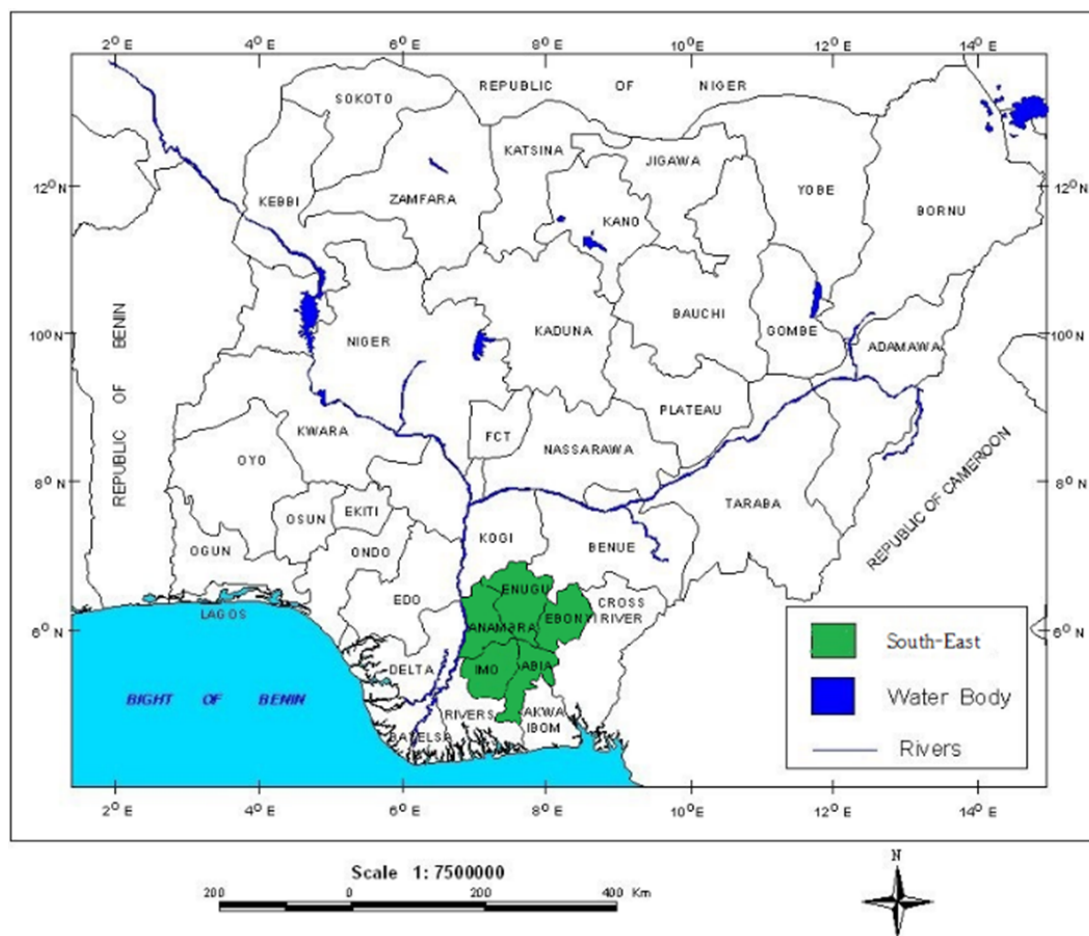International Journal of Educational and Pedagogical Sciences
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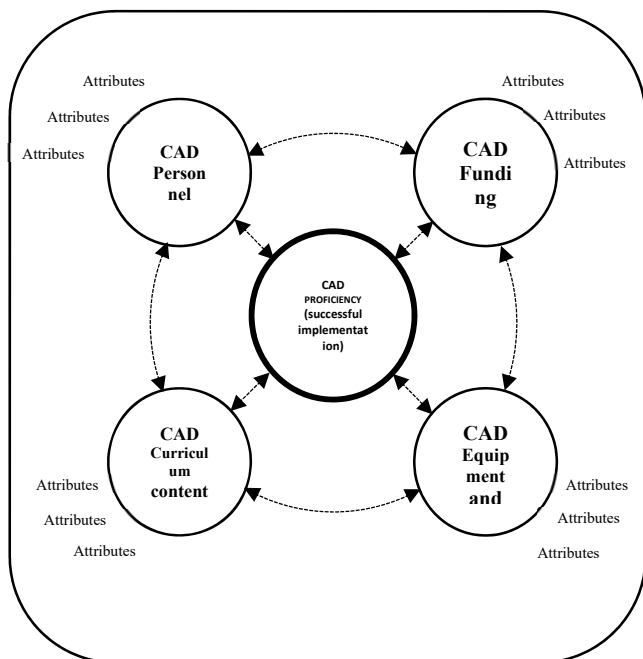Fig. 1 Nigeria, showing the Location of South-East States

Fig. 2 Conceptual diagram of CAD education system

The system whose component was being examined in the study is the 'CAD educational system' which is conceptualized as comprising four components, namely

1. CAD content in curriculum
2. CAD Equipment and Infrastructure
3. CAD Funding available for implementation
4. CAD Personnel available to teach CAD content
   The focus of this paper is the funding factor.

B. Review of Empirical Literature

Inadequate funding is a major challenge because it has negatively affected many areas of education in Nigeria [19]. Reference [19] further states that this has affected such areas as funding of ICT projects, training and retraining of teachers, provision of technological infrastructure, development and maintenance of software packages and electricity. Reference [20] characterised this as accessibility stating that literature showed that effective adoption and integration of ICT into education depended mainly on the availability and accessibility of ICT resources such as hardware and software. It opined that access to computers, updated software and hardware were key elements to successful adoption and integration of technology. It further pointed to strong leadership support as the needed driver for a well-designed technology plan for effective implementation of ICT by teachers [20]. Also in discussing adoption of ICT in Nigeria

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Tertiary education, [21] posits that tertiary institutions lack sufficient ICT infrastructure to effectively tap into the opportunities the new technologies offer. It stated that Personal Computers (PCs) were becoming available in Nigerian tertiary institutions, but were not readily accessible to students because of the low PC:student ratio. This ratio was averagely put at about 1 to 40. Reference [22] argues that internet access remains difficult and the problem is further compounded by the lack of adequate power supply, which makes it difficult for educational establishments to run their own ICT infrastructure. Reference [22] also states that low computer literacy level is a critical factor that affects the acceptability of ICT/e-learning by students and teacher in educational institutions. Many tertiary institutions lack sufficient numbers of staff skilled in the use of computers for all aspects of the university work including teaching and learning. It therefore concluded that this led to widespread slow adoption of the technologies.

III. RESEARCH METHODOLOGY

The survey design research method was employed. Primary and secondary data were obtained from sources within the study area by means of physical observation/enumeration, examination of institutional documents, questionnaires and personal interviews. To obtain the study population, a multi-stage stratified random sampling method was adopted. The first stage of stratification involved the NUC-accredited universities in southeast Nigeria. Seven of them offer architecture as a programme of study. Of these, two institutions were federal-funded, four state-funded and one private-funded. With this list, stratification was done according to the nature of funding of these institutions and random sampling by balloting conducted to pick representation from each pool for the sample. A second sample was taken from the state-funded pool because of the larger number in the pool. The listed accredited institutions in their categories are shown in Table I.

TABLE I
LIST OF NUC ACCREDITED DEPARTMENTS OF ARCHITECTURE IN SOUTH-EAST
NIGERIA CATEGORIZED BY FUNDING/OWNERSHIP STRUCTURE [23]

Federal Universities	State Universities	Private Universities
Nnamdi Azikiwe University	Abia State University	Caritas University
University of Nigeria	Enugu State University of Science and Technology	
	Chukwuemeka Odumegwu Ojukwu University	
	Imo State University	

The following universities were picked: Private: - Caritas University (CARITAS); State: - (1) Chukwuemeka Odumegwu Ojukwu University (COOU), (2) Imo State University (IMSU); Federal: - (1.) University of Nigeria (UNN).

At the second stage, the numbers of staff and students for each sampled department were obtained and sampling size

formulae applied to obtain respondents' number. For data analysis, Analysis of variance (ANOVA) tool for testing differences of means was used.

IV. PRESENTATION AND DISCUSSION OF RESULTS

A. Ratio of CAD Personnel to Students

As a measure of effectiveness of CAD tutors, the ratio of their number to student population was investigated. The results showed that two-thirds of respondents indicated their departments had a ratio range of '0- 1/100', a quarter indicated their department's range as '1/100- 1/200' and a tenth indicated '0'. This is illustrated by Table II and Fig. 3.

TABLE II
AGGREGATED DATA ON RATIO OF CAD PERSONNEL TO STUDENTS

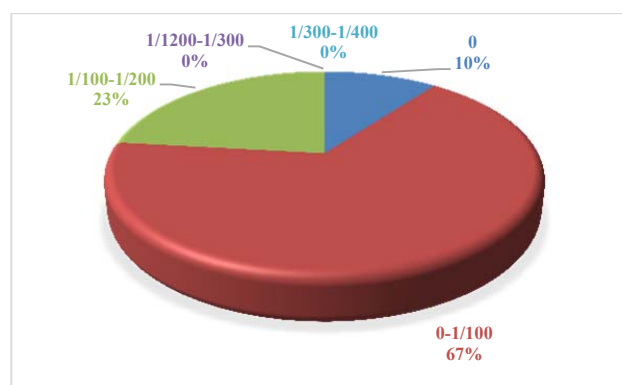| Value label	%	Cum %
0	10.2	10.2
0-1/100	66.6	76.8
1/100-1/200	23.2	100.0
1/200-1/300	0.0	100.0
1/300-1/400	0.0	100.0
Total	100.0	

Fig. 3 Analysis of ratio of CAD personnel to students

B. Number of Available Workstations

Over half of the respondents indicated that their departments had '26-50' workstations dedicated to CAD instruction, while one-third of them indicated that their departments had 'above 50' CAD workstations. The remaining one tenth indicated not having any dedicated CAD workstations for such use. This is illustrated by Table III and Fig. 4.

TABLE III
AGGREGATED DATA ON NUMBER OF AVAILABLE WORKSTATIONS

Value label	%	Cum %
0	10.2	10.2
1-25	0.0	10.2
26-50	56.7	66.9
above 50	33.1	100.0
Total	100.0	

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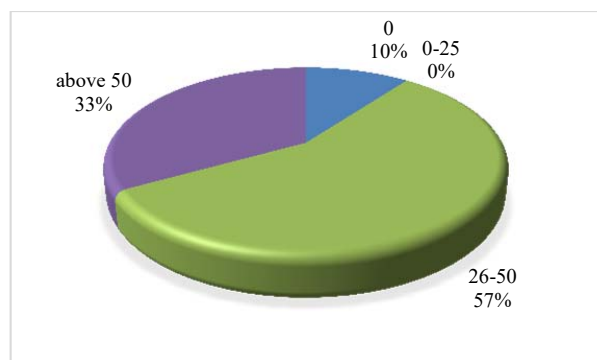International Journal of Educational and Pedagogical Sciences
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Fig. 4 Analysis of number of available workstations

For the hypothesis which was formulated as a guide for research, two variables were chosen from CAD personnel and CAD infrastructure clusters of the four factors into which the wider study work was grouped.

i. Differences in ratio of CAD personnel to students (RCPS): As seen in Table IV, the result of the one-way ANOVA test for this variable indicates a significance value of 0.000, implying that there is a highly significant difference between the three groups. This, therefore, led to a rejection of the null hypothesis. To further establish, more clearly, the nature of difference between the groups, a Tukey HSD posthoc test was carried out (see Table V). The results indicate a significance value of 0.000 for difference between Federal and State, a significance value of 0.000 for difference between Federal and Private, and a significance value of 0.000 for difference between Private and State. These imply that there is significant difference between any pair within the group with regards to the ratio of CAD personnel to students.

ii. Differences in number of available CAD workstations (NACW): Table IV also shows the result of the one-way ANOVA test for this variable. The significance value of the test is 0.000. This also implies a highly significant difference between the groups with regard to the number of available CAD workstations. The null hypothesis for this variable is therefore rejected as well. Similarly, a Tukey HSD posthoc test was carried out to establish the nature of significance with respect to different pairs. The results as seen in Table V shows a significance value of 0.000 for difference between Federal and State, 0.000 for difference between Federal and Private, and 0.000 for difference between Private and State. The conclusion is therefore that there is also significant difference between any of the pairs within the group.

Having rejected the null hypothesis based on the test results, the alternative is accepted. This states that 'there is significant difference between private-funded, state-funded and federal-funded departments of architecture in the ratio of CAD personnel to students and number of available CAD workstations for implementing CAD in their curriculum'.

The results (see Table V) showed that state-funded (institutions) had a higher ratio of CAD personnel to students than federal-funded (.412*), State-funded had a much higher ratio than private-funded (1.412*) and federal-funded also had a much higher ratio than private-funded (1.000*). Also, the results from the same table showed that state-funded had a higher number of available CAD workstations than federal-funded (.588*), state-funded had a much higher number than private-funded (2.588*) and federal-funded also had a much higher ratio than private-funded (2.000*).

TABLE IV
ONE-WAY ANOVA ANALYSIS TEST RESULTS SHOWING THE DIFFERENCE BETWEEN FUNDING GROUPS IN RCPS AND NACW

		Sum of Squares	df	Mean Square	F	Sig.
Ratio of CAD personnel to students	Between Groups	53.096	2	26.548	192.589	.000
	Within Groups	39.976	290	.138		
	Total	93.072	292			
Number of available CAD workstations	Between Groups	172.352	2	86.176	625.154	.000
	Within Groups	39.976	290	.138		
	Total	212.328	292			

TABLE V
TUKEY HSD POST HOC ANALYSIS TEST RESULTS SHOWING THE NATURE OF DIFFERENCE BETWEEN FUNDING GROUPS IN RCPS AND NACW

Dependent Variable	(I) University Funding Type	(J) University Funding Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Ratio of CAD personnel to students	Federal	State	-.412*	.047	.000	-.52	-.30
		Private	1.000*	.077	.000	.82	1.18
	State	Federal	.412*	.047	.000	.30	.52
		Private	1.412*	.074	.000	1.24	1.59
	Private	Federal	-1.000*	.077	.000	-1.18	-.82
		State	-1.412*	.074	.000	-1.59	-1.24
Number of available CAD workstations	Federal	State	-.588*	.047	.000	-.70	-.48
		Private	2.000*	.077	.000	1.82	2.18
	State	Federal	.588*	.047	.000	.48	.70
		Private	2.588*	.074	.000	2.41	2.76
	Private	Federal	-2.000*	.077	.000	-2.18	-1.82
		State	-2.588*	.074	.000	-2.76	-2.41

From these findings, the following can be deduced:

i. State-funded institutions in south-east Nigeria were superior to others in the listed categories in ratio of CAD personnel to students and in number of available CAD workstations for implementation of CAD curriculum.

ii. Federal-funded institutions in south-east Nigeria were superior to private-funded institutions in south-east Nigeria in ratio of CAD personnel to students and in number of available CAD workstations for implementation of CAD curriculum.

iii. Private-funded institutions in south-east Nigeria were inferior to others in the listed categories in the two variables examined for implementation of CAD curriculum.

iv. There appeared, therefore, to be a more consistent effort by state-funded institutions to provide for the CAD training in the variables investigated.

V. RECOMMENDATIONS

The statistical proof of existence of significant difference

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between private-funded, state-funded and federal-funded south-east Nigerian universities in providing personnel and infrastructure to implement CAD in their curriculum has been stated. The post hoc test results also indicated that state-funded institutions were superior to other categories in the variables investigated. These were followed by the federal-funded category and lastly by the private-funded category, in making provisions for CAD personnel and CAD workstations needed for CAD training.

While it is intuitive to expect that institutions under the federal-funded category would receive better funding than any other category, it is still the prerogative of each institution to determine her priorities for expenditure. The implication, therefore, is that

i. Stakeholders must robustly engage with the administrators whose responsibility it is to allocate resources so that they can see the necessity to allocate the needed funds for CAD implementation.

ii. Regulators should also track performance of institutions under such variables as ICT budget/expenditure. The data gained would then be used for advising them on preparedness for achieving successful implementation.

iii. Also, such comparative data should be used as a logical basis for ranking on performance and public ranking provides incentive for increased effort towards improvement. The statistics gained in this research could be used in this direction.

VI. CONCLUSION

The use of CAD technology has become synonymous with the practice of architecture all over the world. The attainment of CAD proficiency before the end of formal training is, therefore, critical for any graduate of architecture who expects to gain employment and make professional progress after that period. Even if the training institutions do not provide the forum for the acquisition of this relevant skill, the graduating student is still compelled by the requirements of the job market, to get it through extra-institutional means, if he must compete. It is however, expected that this vital aspect of his training which provides him with the language of communication in practice must be afforded him in school. It is therefore imperative that educators provide it.

Having examined the provision of staff and infrastructure for implementation of CAD curriculum in universities in South-east Nigeria, the research findings showed that implementation was not uniform across schools. It can be concluded that whereas intuitive logic indicated that particular funding groups would outperform others, this did not always prove true. Sufficient funding for implementation of CAD curriculum appeared to depend on the disposition of the administrators at every level who had the power to allocate funds. Those in State-funded institutions did better in the survey than the rest. Whereas, it does not immediately show actual compliance to required benchmarks, comparison data on universities and funding groups would provide a basis for stakeholders to challenge all towards better performance.

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