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A Mathematical Model for Estimating the Ideal Number of Outsource Academic Staff for Private Universities in Nigeria

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Authors' contributions

This work was carried out in collaboration between authors OE and AAO. Both authors designed the study, performed the statistical analysis, wrote the protocol and the first draft of the manuscript. They managed the analyses of the study and the literature searches. Both authors read and approved the final manuscript.

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Abstract

We developed a model for determining the ideal number of outsourcing academic staff in privately owned universities in Nigeria. The method takes National Universities Commission (NUC) guideline on staff regulation into consideration. The estimated ideal number of outsourcing academic staff will complement the available academic staff so as to meet the staff-mix by rank ratio stipulated by the NUC.

Keywords: Outsource staff; permanent academic staff; ideal; complement; universities.

1 Introduction

The study anchors on the theory of manpower planning in organizations McClean [1]. Human resource planning is concerned with both the demand and supply of labour. The theoretical underpinning of the production function relating input (academic staff) to output (student enrolment) approach to universities human resource planning constitutes the basic premise upon which the theory anchors Satope [2]. The authors opine that the academic staff needs to be properly managed to guarantee better student enrolment.

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Human resource planning in the Nigerian university systems before accreditation was different from what is existing during accreditation period Satope [2]. Human resource planning during accreditation was influenced by the NUC criteria. In spite of the record of increasing enrolment, the academic staff strength continued to show fluctuations over time. The number of academic staff is supposed to follow enrolment trends. But this may not be in the direct proportion in the case of academic staff in the Nigerian universities.

Despite the planning, most universities (government and private) still had interim or denied accreditation status due to inadequate staffing and inability to meet NUC human resource requirement. See Okojie [3] on data of trends in accreditation status of programmes in Nigerian universities. Secondary data prepared from university statistics by NUC on annual teacher-students ratio revealed that too many students given the staff situation of low staff strength indicate that human resource planning was not effective.

Abiodun-Oyebanji [4] gave a theoretical review towards effective management of private university education in Nigeria. Some of the problems that militate against the effective management of private universities were identified. Among such problems are profit maximization motive on the part of proprietors, shortage of academic staff to mention a few. Management of some of these universities outsources academic staff from Federal universities so as to remain in business. The question now is, if staff must be outsourced, what would be the ideal number of outsourcing staff for a given university to maintain the laydown standard?

The aim of this paper is to put a mechanism in place to check the over-dependent on outsourcing of academic staff by the management of universities. Accordingly, this mechanism will check the excesses of management of private universities as regards the engagement of outsourcing academic staff.

The specific objectives of this paper are to

(i) Determine the ideal number of outsourcing academic staff in each category needed to complement the available academic staff so as to meet the staff-mixed by rank ratio specified by NUC.
(ii) Estimate the ideal number of outsourcing academic staff for private universities in Nigeria.

2 Literature Review

The study seeks to adopt outsourcing as a strategic goal to manage the academic staff properly so as to guarantee better student enrolment. Human Resource Outsourcing (HRO) has been considered in the literature. Among the issues as identified in Manisha and Deepa [5] are decisions regarding what is core and noncore in HRO, the tactical and managerial complexities of HRO deals, the challenges of trying to manage HRO process, its effect on a global scale and across different cultures among others. The article also highlights the fact that the human resource outsourcing should be viewed having the pros and cons in mind.

Keije and Nwaoma [6] examined some issues and challenges faced by management pertaining to outsourcing policy in the Nigerian public universities. A qualitative study was conducted. In particular, primary data were collected from principal officers of the selected universities. The author's aim was to determine the unique experiences in relation to management outsourcing decisions in these universities. The major issue is that the universities management are cautious about the implementation of the outsourcing policy because of communal agitation of fear of losses of job that will affect the members of the host communities. Also, if implemented, the host communities will be redundant or idle and will still earn full salaries in some of the universities.

The problem associated with centralized human resource management and training structure of the public sector that do not permit for flexibility and tapping of the enormous gains and potentials of human resource outsourcing Nwabueze [7] is also a major problem of human resource outsourcing in Nigeria public sector. However, there is the need that uniform outsourcing directives by the Federal Government be reviewed. This is consequent on the fact that outsourcing strategies have gained thorough root in international business.

Osagiede et al. [8] gave an instance which is consistent with the theoretical foundation of the university system. The authors observed that wastage and shortages in manpower needs were vital issues in the academic system. The authors determined the financial implication for management of the university to deal with such complications by outsourcing academic staff.

Abu [9] examined a detailed review of the merits and demerits of outsourcing Information Technology (IT) the Nigerian Polytechnic libraries. The author opines that most of the Nigerian Polytechnics have not yet embrace outsourcing as a strategic initiative of enhancing the processes in Nigerian Polytechnics libraries. The author pointed out some critical consideration in the planning and implementation of IT outsourcing intervention that will be useful to management and staff of the Nigerian Polytechnics. A global perspective of the benefits, challenges, and risk associated with IT outsourcing was considered in the work of Dhar [10]

The study by Elmuti [11] examined the relationships between outsourcing strategies and organizational performance. A survey of outsourcing strategy was developed through a computer database and distributed to 1500 organizations in the United States. The study revealed through multiple regression analysis that a positive relationship exists between outsourcing activities and organizational performance. However, the author is of the view that organizations generally considered themselves successful at outsourcing by achieving important improvement in their performance.

Saka [12] considered the nature of outsourcing in Nigeria universities. The motives for outsourcing were identified as insufficient senior resource persons, cost-saving advantage and National University Commission regulations. The paper also considered how outsourcing can improve university programme effectiveness, through effective management, cost cutting, and operational flexibility. Contrariwise, the author also examined how outsourcing can hinder university programme effectiveness through overreliance on adjunct and contract staff. Future of outsourcing implication on the survival and development of the universities in Nigeria were also highlighted.The paper was of the opinion that outsourcing strategic function could be helpful in bridging these gaps between private and government owned universities.

Sali and Akor [13] opined that the guideline for quality assurance in Nigeria universities is the benchmark minimum academic standard (BMAS). The BMAS [14] specifies among others the staff-student ratio per discipline; the staff mix by rank ratio, physical facilities, library facilities. The paper gave information on the strategies adopted by NUC to ensure that Nigeria universities adhere to these guidelines. For example, the conduct of accreditation (quality assurance process) is a major process by which comprehensive assessment of human, financial and material resources of universities are conducted against the set prescribed norm.

The authors identified "Institutional accreditation" as one of the types of educational accreditation. The authors opined that the main goal of this type of accreditation is to ensure that every part of the entire university contributes to the achievement of the university objectives. Also, there is the need for close supervision of establishment of universities, resource verification, the conduct of accreditation curriculum review and post accreditation monitoring visit.

The paper gave information on a fourteen - step procedure laid down by NUC that needs to be followed by prospective proprietors. Some of the procedures are the submission of a written application form, interview of the prospective proprietor to mention a few. Some of the challenges that inhibit the strict adherence to the specified NUC guidelines were also examined. Amongst others are illegal affiliation arrangement, window dressing during accreditation periods, the announcement of inspection and monitoring visits to universities, the establishment of unapproved part-time programmes to mention a few. The paper also gave recommendations as regards funding that need to be made available to both NUC and the universities so as to complement the efforts of adherence to these guidelines.

Satope [2] examined both the incremental labor output and the human resource requirement approach for forecasting the demand for labor in the Nigerian university systems. This was to ensure that correct number or quantity of all resources is available when needed. The study is hinged on the fact that there is a strong connection between the quality of inputs (academic staff) of the university and its output (student's

enrolment). The author opined that the inputs need to be effectively managed to guarantee better output. The technique as given by Satope (2014) is

$$\alpha = \frac{\Delta L_1}{\Delta Y}$$

where

$\alpha =$ The teacher/students ratio
$\Delta L_1 =$ change in academic human resource
$\Delta Y =$ change in output

Again, Satope [2] proposed another approach that deals with a conditional forecast that involved the combination of incremental labor output ratio and teacher/students ratio (Density ratio). The required academic staff is given by this approach as

$$L_{1t} = \alpha E_t$$

where

$\alpha = a$verage National University Commission Teacher student ratio
$E_t = o$utput or enrolment
$L_{1t} = r$equired academic staff

Abiodun- Oyebanji [15] examined human resource situation in Nigerian Universities. In particular, a case study of Ekiti State University, Ado - Ekiti was considered. A descriptive survey design was used to consider all academic staff in the institution. Secondary data was collected from the relevant section of the institution. Eighty-one academic staff were in the professorial cadre, 65 of the academic staff were senior lecturers and 272 academic staff belongs to the category of Lecturer I and below. The result implies that 19.4% of the academic staff belongs to the category of the professorial cadre. This is a range of NUC ideal recommendation of 20%.

However, the institution was bottom heavy in terms of staff mix with 15.6 % and 65.1 % of the academic staff being senior Lecturers and Lecturer I and below respectively. This did not meet the NUC ideal recommendation of 35 % and 45% respectively. The results from the findings indicate the university fair very well in terms of academic staff in the professorial cadre. It was recommended that more academic staff in the senior lecturer cadre should be recruited. This could simply mean more load for senior lecturer category because academic staff structure of this government-owned university is bottom heavy. Management of privately owned universities in the catchment areas may outsource for senior academic staff from this university not minding the fact that the staff in this category are stress-up as a result of excess workload. The issue therefore is does excess workload has a significant effect on the output or productivity of the academic staff?

Sajuyigbe et al. [16] considered the influence of job-stress on job performance among academic staff at the University of Ibadan, Nigeria. Data was collected through a questionnaire from 60 respondents from different faculties. A multiple regression analysis was applied to the explanatory variables namely: workload, time pressure, student indiscipline, and conduct of examination, a compilation of results and lack of infrastructure. The result from the study indicates that job-stress dimensions independently and jointly adversely influence job performance.

Furthermore, Omoniyi [17] also identified workload as one of the sources of stress in workplaces among university lecturers in south-west Nigeria. Two hundred and twenty-three and 141 male and female lecturers were drawn respectively from eight Universities in Nigeria. A constructed questionnaire was used to draw out information from the respondent. Data were collected and analyzed using descriptive statistics and t-test

statistic. The result indicated that the level of perceived stress among male and female lecturers was not significantly different. The authors opined that the level of perceived stress among university lecturers will remain a permanent feature should these stressors remain unattended to, and that it may have a detrimental effect to the lecturer in particular, and the nation in general.

Omolayo and Omole [18] considered the influence of mental workload on job performance. A well-structured multiple resource questionnaire and perceived work performance scale were used to gather information from fifty academic and 50 non-academic staff comprising 68 male and 32 female in Ekiti State University, Nigeria. The gathered data were analyzed using Pearson correlation, independent t-test and univariate analysis of Variance s. One of the findings revealed that male workers do not exhibit greater mental workload than female workers. Also, there is a significant difference in the level of mental workload of academic and non-academic workers.

Nwikina and Nwanekezi [19] identified excessive workload ranging from excessive paperwork and record keeping as a form of burnout in academic institutions among teachers. The paper presented the causes, symptoms, prevention, and remedies of the burnout syndrome. Recommendations were made on how to manage the syndrome. The paper is of the view that if the burnout syndrome is not recognized and treated the individual teacher becomes less flexible and responds to students with negativism.

Omoniyi and Ogunsanmi [20] examined stress among academic staff in South West Nigeria. Eight universities were considered for the study. Comprising three Federal universities, Three State Universities, and two Private universities. A sample of 223 males and 141 female lecturers was considered for the study. Stratified random sampling technique was used for the selection process in each university.

The researchers constructed a questionnaire and used it to elicit information from the respondents. A statistical test of the hypothesis was formulated to determine whether or not a significant level of stress exist between the two subjects in the universities. A t-test statistic was applied. The statistic was compared with the tabulated t-value. The findings showed that the level of stress among male and female lecturers in south-west Nigeria universities is significantly high. However, counseling implications were given to reduce stress among academics in south west Nigeria.

Ubangari and Bako [21] considered the relationship between stress and performance among university lecturers in Nigeria, the poor working un-conducive environment, poor condition of service and motivation among the university lecturers as stressors culminate to slow down productivity among university teachers in Nigeria. Among the recommendations given was the need to drastically reduce the work load of university lecturers in Nigeria.

The existing literature reviewed indicates that lecturers from government-owned universities are burnout as result of excess workload. Accordingly, outsourcing academic staff from these universities to mentor privately owned universities may not contribute optimally to the quality of learning anticipated in the universities that require their services. This is a major motivation for this paper.

Accordingly, we have developed a model that can be used to estimate the ideal number of outsourcing academic staff for private universities in Nigeria. The proposed model is a modification of Tella and Daniel [22]. It is modified to meet the desired academic staff- mix by a rank ratio as specified by NUC.

3 Methodology

The following assumptions are necessary to develop the model

(i) The categories of academic staff-mix by rank follow is given by the set E= {1, 2, 3} in order of categories of staff-mix by rank as professors/readers, senior lecturer, lecturer I and below respectively (excluding the position of graduate assistant).
(ii) The number of permanent staff in each staff-mix by rank in each session is certain.
(iii) An academic staff in the system can belong to only one of the categories.
(iv) Student enrolment is computed session by session in the university.

3.1 Notations

The following notations are used in the model

w : category of academic staff-mix by rank
E : set of category of academic staff in the system given as E= {1, 2, 3}, $w \in E$
X_{rw} : number of staff to be added to the available academic staff in session r, category w, r = 1, 2, 3…, d; $w \in E$
$X_{rw}^{(A)}$: number of staff available in session r, category w, r = 1, 2,3,…,d ; $w \in E$
Y_r : student enrolment in session r
F : percentage of the desired number of staff in the Professorial cadre
S : percentage of the desired number of staff in the Senior Lecturer cadre
L : percentage of the desired number of staff in the Lecturer I and below cadre
α : average lecturer/students ratio
r : academic sessions
d : number of academic sessions
Z_{rw}: desired academic staff in session r, category w

3.2 Model development

Percentage of the desired number of staff in the Professorial cadre is given as

$$F = \frac{100(X_{r1}^{(A)} + X_{r1})}{(X_{r1}^{(A)} + X_{r2}^{(A)} + X_{r3}^{(A)}) + (X_{r1} + X_{r2} + X_{r3})} \quad (1)$$

Percentage of the desired number of staff in the Senior Lecturer cadre is given as

$$S = \frac{100(X_{r2}^{(A)} + X_{r2})}{(X_{r1}^{(A)} + X_{r2}^{(A)} + X_{r3}^{(A)}) + (X_{r1} + X_{r2} + X_{r3})} \quad (2)$$

Percentage of the desired number of staff in the Lecturer I and below cadre category is given as

$$L = \frac{100(X_{r3}^{(A)} + X_{r3})}{(X_{r1}^{(A)} + X_{r2}^{(A)} + X_{r3}^{(A)}) + (X_{r1} + X_{r2} + X_{r3})} \quad (3)$$

Average Lecturer/students ratio is given as

$$\frac{(X_{r1}^{(A)} + X_{r2}^{(A)} + X_{r3}^{(A)}) + (X_{r1} + X_{r2} + X_{r3})}{Y_r} = \alpha \quad (4)$$

Apply (4) in (1) to obtain

$$100(X_{r1}^{(A)} + X_{r1}) = \alpha F Y_r \quad (5)$$

The number of academic staff in the Professorial cadre to be added to available academic staff in session r, category 1 is given as

$$X_{r1} = \frac{\alpha F Y_r}{100} - X_{r1}^{(A)}, \quad r = 1,2,\dots,d \quad (6)$$

Similarly applying (4) in (2) and (3) yield

$$X_{r2} = \frac{\alpha\, S\, Y_r}{100} - X_{r2}^{(A)}\ , \qquad r = 1,2,\dots,d \qquad \text{and} \tag{7}$$

$$X_{r3} = \frac{\alpha\ L\, Y_r}{100} - X_{r3}^{(A)}\ , \qquad r = 1,2,\dots,d \tag{8}$$

Equation (7) and (8) represent the number of outsourced staff to be added to the categories of senior lecturer and lecturer I and below respectively.

Summing (6), (7) and (8) yields

$$\sum_{w=1}^{3} X_{RW} = \frac{\alpha \sum_{r=1}^{d} Y_r}{100}(F + S + L) - \sum_{w=1}^{3} X_{RW}^{(A)} \quad , \quad r = 1,2,\dots,d \tag{9}$$

The desired number of academic staff in the institution is given as

$$\sum_{w=1}^{3}\left(X_{RW} + X_{RW}^{(A)}\right) = \sum_{w=1}^{3} Z_{RW} = \alpha \sum_{r=1}^{3} Y_r\ , \qquad r = 1,2,\dots,d \tag{10}$$

4 Numerical Application

Relevant data for the illustration of the model are presented in Tables 1, 2 and 3.

Table 1. National university commission norm for lecturer/student ratio

Discipline	Mean Teacher/Students Ratio By Discipline For Nigerian Universities		
	1999/2000	2005/2006	Current
Administration	1:20	1:30	1:30
Agriculture	1:9	1:15	1:15
Arts	1:20	1:30	1:30
Education	1:24	1;30	1:30
Engineering/Technology	1:9	1:15	1:30
Environmental Sciences	1:10	1:15	1:15
Law	1:20	1:30	1:30
Medicine	1:6	1:10	1:15
Pharmacy	1:10	1:15	1:15
Sciences	1:10	1:20	1:20
Social Sciences	1:20	1:30	1:30
Veterinary Medicine	1:6	1:10	1:10
Average	**1:14**	**1:21**	**1: 23**

Source: NUC 2010 university statistics

Table 2. The staff - mix by rank ratio

Rank	Percentage of total (%)
Professors/Associate Professors	20
Senior Lecturers	35
Lecturer I and below	45

Source: NUC 2010 University Statistics

Table 3. Student enrolment in session r and number of available academic staff in each category in session r excluding graduate assistance

Session r	Student enrolment in session r Y_r	Number of Professors/Associate Professors available in session r $X_{r1}^{(A)}$	Number of Senior Lecturers available in session r $X_{r2}^{(A)}$	Number of Lecturer I and below available in session r $X_{r3}^{(A)}$
1	1891	9	8	29
2	1823	9	8	30
3	1740	9	9	29

Source: Private University A

Applying the data given in Tables 1, 2 and 3 to equation (9) give the total number of professors, senior lecturers and lecturer I and below to be added to the number of available staff in categories 1, 2 and 3 respectively in session r.

That is

$$\sum_{r=1}^{3} X_{r1} = \frac{\alpha F \sum_{r=1}^{3} Y_r}{100} - \sum_{r=1}^{3} X_{r1}^{(A)} = \frac{5454 \text{ x } \frac{1}{23} \text{ x } 20}{100} - 27 = 20$$

$$\sum_{r=1}^{3} X_{r2} = \frac{\alpha S \sum_{r=1}^{3} Y_r}{100} - \sum_{r=1}^{3} X_{r2}^{(A)} = \frac{5454 \text{ x } \frac{1}{23} \text{ x } 35}{100} - 25 = 58$$

$$\sum_{r=1}^{3} X_{r3} = \frac{\alpha L \sum_{r=1}^{3} Y_r}{100} - \sum_{r=1}^{3} X_{r3}^{(A)} = \frac{5454 \text{ x } \frac{1}{23} \text{ x } 45}{100} - 88 = 19$$

and from equation (10)

$$\sum_{w=1}^{3} Z_{rw} = \sum_{w=1}^{3} \left(X_{rw} + X_{rw}^{(A)} \right) = 237, \quad r = 1,2,3 \text{ respectively}$$

5 Discussion of Results

The results obtained from the study indicate that two hundred and thirty-seven is the desired number of staff in the institution. The model specified that 20, 58 and 19 outsourced staff in Professorial, Senior and Lecturer 1 and below is to be added to the three staff mixed categories respectively.

However, if management of this university must outsource academic staff; the results obtained in the study indicates that the ideal number of outsourcing academic staff that will be added to the professorial, senior lecturer and lecturer I below categories are 20, 58 and 19 respectively.

Consequently, these ideal number complement 27, 25 and 88 as available numbers of academic staff on the ground in the three staff - mix by rank categories respectively. The desired numbers of academic staff in the three categories are 47, 83 and 107 respectively. Thus the desired number of academic staff given by equation (10) in the institution is 237 as against 140 existing permanent staff. The implication of these results is that the academic staff-mix by rank ratio specified by the NUC depicted in Table 2 is maintained.

6 Conclusion

If management must outsource academic staff; we have put a mechanism in place to check the excesses of outsourcing academic staff by the management of private universities. We have developed a model to maintain the academic staff-mix by rank ratio specified by the NUC. This mechanism is necessary because of the profit maximization tendencies of private proprietors in Nigeria. The outsourcing model presented in this paper can be applied to any tertiary institution where outsourcing (academic staff) policy is of high priority. The computations in this paper were facilitated by the use of the MATLAB source code depicted in the appendix.

Competing Interests

Authors have declared that no competing interests exist.

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Appendix

Matlab Codes

```
clc
% This Code is written to determine the ideal number of outsourcing academic staff so as to maintain the staff mix by rank ratio
y = [1891 1823 1740] % row vector of student enrolment in session r
yT=transpose(y)
alpha = 1/23 % lecturer-students ratio
F=0.20 % percentage of desired academic staff in the professorial cadre
S=0.35 % percentage of desired academic staff in the senior lecturer cadre
L=0.45 % percentage of desired academic staff in the lecturer I and below cadre
AC1=[9 9 9]%column vector of number of available academic staff in session r,category1
AC1T=transpose (AC1)
AC2=[8 8 9]%column vector of number of available academic staff in session r, category2
AC2T=transpose (AC2)
AC3=[29 30 29] % column vector of number of available academic staff in session r, category 3
AC3T=transpose (AC3)
disp('the total number of staff in the professorial cadre to be added to the available academic staff in session r category 1.')
X1=sum((1/23*yT)*F - AC1T)
disp('the total number of staff in the Senior lecturer cadre to be added to the available academic staff in session r category 2.')
X2=sum((1/23*yT)*S - AC2T)
disp('the total number of lecturer I and below to be added to the available academic staff in session r category 3.')
X3=sum((1/23*yT)*L - AC3T)
AR = [46 47 47] % row vector of number of available academic staff in category w. session r
ART=transpose (AR)
disp('the total number of outsourcing academic staff.')
SX =sum((1/23*yT)*(F+S+L) - ART)
disp('desired number of academic staff in the institution.')
sum(((1/23*yT)*(F+S+L) - ART) + ART)
```


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