A Mathematical Model that Analyzes the Financial Implication of Outsourcing Policy 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.

Article Information

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Abstract

Wastages and shortages of academic personnel in universities are issues of great concern to management of universities (Both public and private). However, in the available literature, there are no adequate mathematical models that evaluate the cost implications of personnel outsourcing policy for private universities to deal with such issues. We develop a mathematical model that can address such real life problems. The idea of Linear algebra was used to develop the model for the case scenario. The model is able to compute the financial implication of outsourcing academic staff for private universities. The result obtained gave the financial implication of maintaining the entire personnel outsourcing policy.

Keywords: Outsourcing policy; academic staff; cost implication; universities.

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1 Introduction

This paper consider two types of personnel, namely: permanent academic staff and outsource staff. The outsource staff is limited to two categories only-adjunct and part-time. However, the outsourcing model presented in this work can be applied to any tertiary institution where outsourcing (academic staff) policy is of high priority. Outsourced academic staff enters into the existing system as adjunct and contract staff to run the most of their programmes at cheaper cost rate compared to universities with regular manpower. In this case, the amount paid to adjunct staff is higher than that paid to part–time staff. Further on minimizing cost paid to these outsource staff (adjunct and part–time staff) management of these universities make it a policy that an adjunct staff is assigned at least, two courses per semester.

In addition, only one course is rated as adjunct course while the other courses are rated part – time courses. However, in few cases an adjunct staff may be assigned one course only according to area of need and the bargaining ability of the adjunct staff concerned. Depletions and scarcities of academic staff in universities are problems of great concern to management of both private and public universities. We adopt outsourcing as a strategic organizational goal to solve the problem associated with wastage and shortage of academic staff in private universities in Nigeria.

However, in the available literature, there are no sufficient mathematical models that evaluate the financial implications of personnel outsourcing policy for private universities to deal with such issues. There is need to develop a mathematical model that can address such real life problems.

To deal with the issue of wastage and shortage of academic staff in privately owned universities, this paper is aimed at developing a mathematical model that can address such real life situations. This paper is intended to achieve the following objectives:

- To develop a mathematical model that can evaluate the financial implication of outsourcing academic staff for private universities.
- To develop a model that will estimate the cost implication for the entire personnel outsourcing policy (both permanent and adjunct staff) for private universities. We give the definitions to make our discussion clearer to a broader audience.

Definition 1.1

- **Staff:** Academic employee only.

Definition 1.2

- **Adjunct staff:** This is an employee of a university that is approved officially to teach for another institution for a period of one year which may be subject to renewal at the expiration of the year contract.

Definition 1.3

- **Part-Time staff:** The agreement to teach in this case is between the staff himself and the institution that need him for the part-time service. A part-time staff may not be an employee of any institution.

Definition 1.4

- **Adjunct course:** A course in an academic programme assigned to be taught by an adjunct staff.

Definition 1.5

- **Part-time course:** A course in an academic programme assigned to a part-time staff.

2 Literature Review

Sang [1] conducted a study on outsourcing trend in Kenyan universities. In particular, six public universities were examined to find out the opportunities and challenges of outsourcing of services in the aforementioned universities. Data were collected from relevant section of the universities through a well-structured questionnaire. The results from the study indicate that financial savings accruing from outsourcing initiatives ranked highest among some of the outsourcing achievements examined.

The author investigation revealed that though management of these universities had some general policy statement concerning outsourcing of services, there were no known regulatory framework on outsourcing of services in these universities presently. Osagiede, et al. [2] developed a framework that will be useful in computing cost implication of outsourcing academic staff for manpower organizations.

Pahivathan [3] examined outsourcing in universities. In particular, the author is of the view that outsourcing as a goal has become the most prominent strategic change in private sector of the economy. The author examined the merits and demerits of outsourcing of services in universities. Although cost saving was identified as one of the advantage of outsourcing functional activities by universities management. The article is of the opinion that the major limitation of over dependent on outsourcing human resource ranges from issue of loss of jobs by permanent staff to the fact that the loyalty of these outsourced personnel to the organization may not be certain. Similarly, Elmulti [4] considered outsourcing strategies on the quality of employee on job performance. The author view was that when decisions are made regarding outsourcing personnel by management of organizations, the human cost should be put in mind and not just the cost implication only.

The impact of outsourcing strategy on procurement performance of some selected technical universities in Ghana was considered in Asare and Prempeh [5]. Information obtained were collected through a structured questionnaire. Purposive and stratified sampling techniques were used for study. The results indicates that contracting, comprehensive outsourcing, licensing agreement and selective outsourcing strategies were the major determinants of procurement.

Iqbal and Dad [6] examined the current trend and future direction of outsourcing services in the last ten years. The authors considered both manufacturing and service outsourcing industries. According to the researchers, organizations will continue to outsource to offshore location. Outsourcing strategies was viewed from two sides of a coin, first, it create winners and losers and it could also been seen as a win-win situation. The authors were of the view that there is a shift from Business Process Outsourcing (BPO) to Knowledge Process Outsourcing (KPO). This shift has been adopted by many nations.

Arshad et al. [7] and Abu [8] considered the benefits, issues and risk factors associated with Information Communication Technology (ICT) outsourcing. A global perspective of the scenario was considered in the work in Dhar and Balakrishnan [9]. Nwabueze [10] considered the theories and challenges of the various processes of outsourcing in Nigeria Public organizations. The issues regarding recruitment and prospect of outsourcing as a strategic organizational goal were also examined. The author opined that human resource strategy should be adopted leveraging the gains especially for its cost saving advantage.

In a similar manner, Judit and Dieu [11] were also of the view that organizations are progressively outsourcing for human resource in order to reduce costs. Nevertheless, the authors opined that outsourcing strategy could be sustainable only in the short term, and that the usefulness of the strategy is arguable in the long term. The reasons for outsourcing were identified as inadequate senior resource persons, cost saving advantage in Nigerian universities in the work of Saka [12]. The author examined how outsourcing can improve university programme usefulness, through effective management .However, overreliance on these adjunct and contract staff was also identified as an issue that can impede university programme effectiveness and future of outsourcing implication on the existence and growth of the universities in Nigeria.

In order to check the excesses or immoderation of outsourcing academic staff, Enagbonma and Osagiede [13] developed a mathematical model that estimates the ideal number of outsource academic staff for private

universities in Nigeria so as to meet the desired staff- mix by rank ratio stipulated in the Benchmark Minimum Academic Standard (BMAS) of the. National Universities Commission (NUC) of Nigeria [14].

The dynamics of workforce-mix geared towards obtaining the most economical workforce-mix for the manpower system, with respect to the fluctuations in personnel caused by wastage and hiring temporary staff was considered in Ekhosuehi [15]

Manisha and Deepa [16] examined the strategic and managerial difficulties of Human Resource Outsourcing (HRO) deals, the challenges of trying to cope with HRO process, its effect on a global scale. The paper opined that HRO should be viewed having the merits and demerits in mind.

Knowledge Process Outsourcing (KPO) were examined in Ranjana and Syeedun [17]. The authors established that a number of degrees are produced by universities. The issue in the paper is does the quality of the number of degrees produced suffice for KPO? However, the authors advised that the educational sector of the economy needs to be inspected to strike a balance between demand and supply of knowledge personnel.

The tasks faced by organizations in spite of the advance potential of BPO sector were examined in James and Faisal [18]. Labour attrition were identified as key issue faced by management in the two states of India. The authors view point was that the effect of this diminishes the development of the sector. The authors suggested that introducing high competitive remuneration packages in BPO sector will assistant to address this issue.

Kshetri [19] scrutinized the drivers of both offshore BPO and Information Technology Outsourcing (ITO) applying institutional theory as a lens. Among the arguments in the paper is that institutions unceasingly change due to entropy, a tendency towards chaos, disorder or disorganization. An implication of the entropy - like features is that establishments can change and replicate institutions.

3 Methodology

The following assumptions are necessary to develop the model:

- (i) An adjunct staff can also be a part - time staff but the reverse is not true.
- (ii) There is variation in the amount of financing adjunct staff in different grades.
- (iii) The permanent staff in grade i earn average personnel cost for that grade.

3.1 Mathematical notations

The following notations used in the model and their meanings are:

$TRCO\ (T, V)$: total cost of financing adjunct staff in the university

i : grade of the university academic staff $i = 1,2,3,…,7$

1 denotes Graduate Assistant, 2 denotes Assistant Lecturer, 3 denotes Lecturer II, 4 denotes Lecturer I, 5 denotes Senior Lecturer, 6 denotes Reader and 7 denotes Professor.

π_i: number of permanent academic staff in grade i
s_i : salaries of permanent academic staff in grade i
v_i : number of adjunct staff in grade i
q_i : amount paid to an adjunct staff in grade i for a course taught in the institution
g_i : number of part-time courses taught by adjunct staff in grade i
p_i : amount paid to part-time staff in grade i for a course taught in grade i
$f(L, \overline{S})$: financial implication for the entire personnel outsourcing policy

3.2 Model for the financial implication of maintaining existing permanent staff

Suppose π_i and s_i are as defined previously. If the assumption that the permanent staff in grade i earn average personnel cost for that grade holds, then the financial implication of maintaining the existing permanent staff in the university for the academic session can be described simply by the relation

$$L(\Pi, \bar{s}) = 12 \sum_{i=1}^{7} \pi_i \bar{s}_i \qquad (1)$$

$L(\Pi, \bar{s})$ is the financial implication of maintaining the existing permanent staff in twelve calendar months. It can be deduced from equation (1) that the term $\sum_{i=1}^{7} \pi_i \bar{s}_i$ is the financial implication of maintaining the existing permanent staff in a month of an academic session. Equation (1) can be transformed to

$$L(\Pi, \bar{S}) = 12\Pi\bar{S}' \qquad (2)$$

where S' denotes the transpose of S. Again, Π, S and L are row vectors

The total cost implication for this outsource staff (adjunct and part-time) in a session is simply the sum of the total cost of adjunct and that of part-time given as

$$TRCO(T, v) = 2 \sum_{i=1}^{7} (v_i q_i + g_i p_i) \qquad (3)$$

Since staff are outsourced, $TRCO(T, v)$ is twice the sum of outsourcing staff for two semesters in a particular academic session.

We can rewrite equation (3) in the form

$$TRCO\ (T, V) = 2(v\ q' + g\ p') \qquad (4)$$

where q' and p' are transpose of q and p respectively.

$$v = (v_1\ v_2\ ,\ldots, v_h)\ , q = (q_1\ q_2\ ,\ldots, q_h)\ , p = (p_1\ p_2\ ,\ldots, p_h)\ ,$$
$$g = (g_1\ g_2\ ,\ldots, g_h)$$

The first and second terms of equations (3) and (4) are cost implication for adjunct and part-time staff respectively.

The corresponding combinations of equations (1) and (.2) with equations (3) and (4) give

$$f(L, \bar{s}) = L(\Pi, \bar{s}) + TRCO(T, v) = \sum_{i=1}^{7} [12\pi_i \bar{s}_i + 2(v_i q_i + g_i p_i)] \qquad (5)$$

and
$$f(L, \bar{S}) = L(\Pi, \bar{S}) + TRCO\ (T, V) = 12\Pi\bar{S}' + 2(v\ q' + g\ p') \quad \text{respectively} \qquad (6)$$

Equations (6) is the model for the computation of the financial implication for the entire personnel outsourcing policy.

4 Numerical Application

Here, we illustrate the use of the proposed model. Data of academic staff (permanent and outsourced) together with the remuneration were collected from the registry department of the privately owned university. The organized data were fitted into the model and analyzed. The university was chosen because outsourcing (academic staff) policy is of high priority in the institution. However there is no sufficient mathematical model that analyzes the financial implication of outsourcing policy in the privately owned university.

4.1 Cost of maintaining personnel outsourcing policy

The model is analyzed using the data in Tables 1, 2 and 3.

Table 1. Staff profile

i	Number of permanent staff in grade i π_i	Number of adjunct staff in grade i $n(V_i)$
1	-	-
2	9	2
3	3	5
4	1	13
5	2	3
6	1	3
7	4	1

Source: Private University B (2013)

Table 2. Operating characteristics

i	Number of permanent staff in grade i π_i	Number of adjunct staff in grade i v_i	Remuneration of adjunct staff in grade i (in ₦) q_i	Number of part-time courses taught by adjunct staff in grade i g_i	Remuneration of part-time staff for a course taught in grade i p_i (in ₦)
1	-	-	-	-	-
2	9	2	80000	3	40000
3	3	5	80000	5	45000
4	1	13	80000	26	50000
5	2	3	80000	8	60000
6	1	3	100000	6	65000
7	4	1	120000	2	70000

Table 3. Average personnel cost for permanent academic staff in grade i

i	1 GA	2 AL	3 LII	4 LI	5 SL	6 Reader	7 Professor
Average permanent personnel cost $\bar{s}_i$ (in ₦)	0	98,133.91	133,409.90	182,152.25	239,822.89	284,346.41	353,963.19

Source: Private University B (2013)

The financial implication for the entire personnel outsourcing policy is given by

$$f(L, \bar{S}) = L(\Pi, \bar{S}) + TRCO(T, V) = 12\Pi\bar{S}' + 2(v\,q' + g\,p') \tag{7}$$

The financial implication of maintaining the existing permanent staff for the academic session is

$$L(\Pi, \overline{S}) = 12\Pi \overline{S}' = 12(0 \quad 9 \quad 3 \quad 1 \quad 2 \quad 1 \quad 4)\begin{pmatrix} 0 \\ 98133.91 \\ 133409.90 \\ 182152.25 \\ 239822.89 \\ 284346.41 \\ 353,963.19 \end{pmatrix} = ₦43745000 \qquad (8)$$

The total cost implication for this outsource staff (adjunct and part-time) in a session is

$$TRCO(T, V) = 2(v\, q' + g\, p') = 2\left[(0 \quad 2 \quad 5 \quad 13 \quad 3 \quad 3 \quad 1)\begin{pmatrix} 0 \\ 80000 \\ 80000 \\ 80000 \\ 80000 \\ 100000 \\ 120000 \end{pmatrix} + (0 \quad 3 \quad 5 \quad 26 \quad 8 \quad 6 \quad 2)\begin{pmatrix} 0 \\ 40000 \\ 45000 \\ 50000 \\ 60000 \\ 65000 \\ 70000 \end{pmatrix}\right]$$

$$= ₦9830000 \qquad (9)$$

Hence, the financial implication for the entire personnel outsourcing policy is given as

$$f(L, S) = L(\Pi, \overline{S}) + TRCO(T, V) = 43745000 + 9830000 = ₦53,575,000 \qquad (10)$$

5 Discussion of Results

The results obtained revealed that a total cost of ₦9830000 is used for financing adjunct staff in the university. The cost of maintaining existing permanent staff in the university is ₦43745000. Finally, an aggregate sum of ₦53,575,000 yield the financial implication for maintaining the entire personnel outsourcing policy (both existing permanent staff and adjunct staff). The results from the model analysis are presented and discussed. Note that the results are peculiar to the institution from which the data were obtained. However, the results would have a close resemblance with those universities operating similar outsource policies.

6 Conclusion

We have developed a mathematical model that computes the financial implication of maintaining the entire personnel outsourcing policy (both existing permanent staff and adjunct staff) for private university in Nigeria. The model is able to address the problem associated with wastages and shortages of academic staff in private universities in Nigeria. This paper will be helpful to personnel managers, establishments, government, and academic institutions in the area of staff management. Researchers as well as managers of human resource will find the new model useful because of its simplified nature. Essentially, the study is geared towards management of outsourcing academic staff in a manpower institution. MATLAB codes has been developed to facilitate the mathematical computations in this paper. The codes are depicted in the appendix.

Competing Interests

Authors have declared that no competing interests exist.

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Appendix

Matlab Codes

```
clc
% The codes are written for the numerical application
s = [0 98,133.91 133,409.90 182,152.25 239,822.89 284,346.41 353,963.19] % average personnel cost of financing permanent staff in grade i
sT=transpose(s)
pi=[0 9 3 1 2 1 4] % number of permanent staff in grade i
disp('the financial implication of maintaining existing permanent staff')
12*(pi*sT)
v = [0 2 5 13 3 3 1] % The number of adjunct staff in grade i
q = [0 80000 80000 80000 80000 100000 120000] % amount paid to an adjunct staff for a course taught in grade i
g= [0 3 5 26 8 6 2] % number of part-time courses taught by adjunct staff in grade i
p= [0 40000 45000 50000 60000 65000 70000] % amount paid to part-time staff in grade i for a course taught in grade i
qT=transpose(q)
pT=transpose(p)
disp('costs paid to adjunct staff for a course taught in the institution in Naira.')
2*(v*qT)
disp('cost paid to adjunct staff for teaching more than one course in the institution in Naira.')
2*(g*pT)
disp('Total Relevant Cost for adjunct and part time staff in Naira.')
TRCO = 2*[(v*qT) + (g*pT)]
disp('the financial implication of maintaining the entire outsourcing policy )
12*(pi*sT) + 2*[(v*qT) + (g*pT)]
```