

Hotelling's T^2 Analysis of Academic Staff Profiles: A Case Study of the Akwa Ibom State University, Nigeria

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ABSTRACT: *The study aimed at analyzing the profiles of academic staff in the Akwa State University. The categories of staff included Professors/Associate Professors, Senior Lecturers and Lecturer1/Below with a total number of 26, 73 and 289 respectively. Hotelling's T^2 was adopted for the pair wise analysis between Professors/Associate Professors and Senior Lecturers, Professors/Associate Professors and Lecturer1/Below and Senior Lecturer and Lecturer1/Below. The results of the analysis revealed that there is a significant difference between the profiles of Professors/Associate Professors and Senior Lecturer, Professors/Associate Professors and Lecturer1/Below and Senior Lecturers and Lecturer1/Below respectively. This research appraises the average productivity of each category of academic staff in Akwa Ibom State University. This will serve as reference document for further research.*

KEYWORDS: academic staff, Hotelling's T^2 , professor's/associate professors, senior lecturers and lecturer1/below.

INTRODUCTION

The composition of academic personnel within a university is a pivotal determinant in shaping the educational landscape of the institution. Professors and Associate Professors, occupying the apex in the academic hierarchy, are notably distinguished by their extensive experience, demonstrated research leadership, and notable contributions to their respective fields. Senior Lecturers serve as intermediaries between accomplished academics and emerging educators, embodying a blend of instructional excellence and potential research contributions. The majority, Lecturer 1/Below, assume the responsibility of imparting foundational courses and nurturing students' intellectual growth. Despite the heightened expectations often attributed to more experienced Professors and Associate Professors, instances exist where select Senior Lecturers and Lecturer 1/Below exhibit remarkable academic performance in research and pedagogy comparable to highly experienced academicians. The defining factors of academic staff productivity in university settings encompass qualifications, years of cognate experience, and research publications. Notably,

several young lecturers with limited experience have demonstrated exceptional proficiency in terms of research contributions within their respective domains. There are other factors that may contribute to academic staff productivity. This study specifically underscores qualifications, years of experience, and research publications as pivotal contributors to productivity levels within the academic system. Notably, the focus of this research centers on the Akwa Ibom State University, which serves as the case study for the investigation.

The concept of academic productivity encompasses an individual's performance in teaching, research outputs, and other associated functions (Brocato and Mavis, 2005). Effectiveness and productivity are related and both are important in teaching and learning processes. Productivity shows whether the activity of an organisation is efficient and effective in terms of output and input (Saxena, 2014). Effectiveness is the extent to which application of input brings the desired result in output and Quality. It is a function of method, technique, personnel skills, knowledge, attitude and aptitude. The output factors in educational institutions are the students, while input factors include the technology, finance, time, equipment, facilities, energy, materials and lecturers. The need for lecturers' productivity in Nigerian universities cannot be over-emphasized as this ensures the delivery of quality education. Print and Hattie (1997) defined research productivity as 'the totality of research performed by academics in universities and related contents within a given time period' (p.454). Research productivity in this study means the publications published by academic staff in the research institutes surveyed: such publications include books, journal articles, chapters in books, conference papers and proceedings, technical reports, patents, scientific peer- review bulletin, occasional papers, monographs, co-authored books, theses/dissertations and Journal publications published. Research productivity is very important in the appointment and promotion of academic staff of these institutions as it is spelt out in the Conditions of service governing their appointments and promotions. By virtue of their work and positions, apart from educational qualifications and cognate experience, they are required to have considerable high level of research output for prestige, recognition and career progression. It is expected of them to be carrying out research and publishing such as research output in reputable publishing outlets in and outside the country. The observed low research productivity has been affecting the promotion and career progression of the academic staff as the slogan "publish or perish" is practiced (Kwanya, 2020). The importance of research productivity in the career advancement and prestige of researchers in these institutes is quite obvious as such it is not taken with levity by academic staff and employers. Educational institutions are established to produce well-rounded professionals worthy of learning and character. However, the extent to which this objective could be achieved depends greatly on the level of productivity of the academic staff. Odunaga and Agila (2000) defined lecturer productivity as a measure of the efficiency with which the overall process of teaching and learning utilizes its labour force towards the achievement of educational goals and objectives.

Prior research has explored the distribution and profiles of academic staff within institutions, primarily aimed at identifying areas for improvement and proposing solutions

for enhanced service delivery. This significance arises due to instances where lecturers, regardless of rank, bearing doctoral degrees, shoulder substantial responsibilities, including teaching, student supervision, committee membership, and leadership roles. Despite parity in academic rank, disparities in individual lecturer productivity persist. These differences can be attributed to qualifications, years of service within the academic system, and research contributions. Consequently, it is imperative for academic institutions' management to prioritize performance evaluations to address challenges impeding academic productivity. Thus, this study aims to analyze academic staff profiles using the Multivariate Test of Hypothesis, using the Akwa Ibom State University as case study.

Background of the Study

The conception of the Akwa Ibom State University (AKSU) started in October 2000 as Akwa State University of Technology (AKUTECH). The Akwa Ibom State University is a multi-campus institution, with two campuses; the main campus is located in Ikot Akpaden, Mkpata Enin local government area and Obio Akpa Campus in Oruk Anam Local Government Area. Full academic activities started on 1st November 2010 with admission of 300 students into four faculties. The Akwa Ibom State University has since grown with over 8000 students in 38 departments within 9 faculties including General studies and Library. The University has undergraduate and postgraduate programmes.

2. Literature Review:

Tella and Daniel (2013) introduced a Mathematical Model for Nigerian University Academic Staff Mix by Rank. This model offers a simplified mathematical framework aligned with the NUC's existing benchmark for minimum academic standards, facilitating the appointment and distribution of academic staff. Enagbonma and Osagiede (2018) proposed a model for determining the optimal number of outsourced academic staff in privately owned Nigerian universities. Their model, an adaptation of Tella and Daniel's (2013) work, adheres to NUC guidelines on staff regulation, aiming to fulfill desired academic staff-mix ratios by rank. Similarly, Ekhosuehi et al (2014) formulated a population-dynamic model grounded in aggregate-fractional flow balance equations within a discrete-time Markov chain framework. Their work addresses the challenge faced by Nigerian universities in attaining the desired academic staff-mix by rank specified by the NUC. The model's application to a faculty academic staff structure illustrated its utility in Nigeria's university-faculty setting. Despite its accomplishments, challenges surfaced in its implementation, including resource inadequacy, overstaffing, and scarcity of qualified applicants. Nnaji (2014) explored the relationship between social work environment and academic staff productivity in Enugu state universities. Their study formulated three hypotheses and utilized stratified random sampling, revealing that while group identification held limited significance, organizational identification significantly impacted academic staff productivity. Recommendations included fostering group identification mechanisms and enhancing social relations between academic staff, department heads, and students. Likewise, Osagiede et al (2014) addressed manpower wastage and shortages

within the academic system, estimating the financial implications of outsourcing academic staff to manage these challenges.

Ojokoh and Akinsulire (2019) introduced an academic staff performance evaluation system based on rough sets theory, employing a single module algorithm to assess staff status. Their model proposed a rating system for publications, aiming to minimize bias in manual assessments. Experimental validation using a dataset from the Federal University of Technology, Akure, Nigeria, showcased the system's effectiveness. Shittu (2022) conducted a study on classroom organization and lecturers' productivity in Lagos State's public tertiary institutions. Employing a correlational design, their research encompassed 3,850 academic staff across seven institutions. Recommendations emphasized providing conducive learning environments to achieve academic excellence, particularly through adequate classroom facilities. Adesola and Ekundayo (2022) delved into the relationship between institutional factors and academic staff job performance in Southwest Nigeria's public universities. Their survey-based study revealed a high level of academic staff job performance and established the pivotal role of institutional factors, particularly physical facilities and staff workload. Recommendations stressed prioritizing adequate physical infrastructure to enhance teaching and research quality and ensuring equitable assignment of tasks based on competency. Simisaye and Popoola (2022) grounded their research in Campbell's performance theory, exploring latent job performance structures encompassing factors such as task proficiency, communication, effort, discipline, teamwork, leadership, and administration. Additionally, they considered Goleman's emotional intelligence theory. In a different vein, Usoro (2006) conducted a multivariate parametric analysis of students' academic performance across various subjects at the Akwa Ibom State Polytechnic. This comprehensive review has demonstrated a diverse range of studies focused on various facets of academic staff composition, productivity, and performance, shedding light on the intricate dynamics within educational institutions.

In this work, we consider application of Hotelling's T^2 for the analysis of academic staff profiles using qualification, years in service and research publications across the eight faculties in the Akwa Ibom State University, Nigeria.

METHODOLOGY

Source of Data

Data for this research was obtained from the Directorate of Human Resources, Akwa Ibom State University, Ikot Akpaden for all their 388 Academic staff members on pensionable appointment as at August 2022, with respect to the highest qualification, Years of service, number of research publications denoted by Q, Y, R respectively.

FACULTY	PROFESSOR/ASSOCIATE PROFESSOR	SENIOR LECTURER	LECTURER I/BELOW
Agriculture	4	12	42
Arts	3	10	25
Education	2	2	9
Engineering	0	14	63
Biological Sciences	3	3	34
Physical Sciences	9	21	54
Social Sciences	2	5	32
Management Sciences	2	4	23
Others(Library, General Studies)	1	2	7
TOTAL	26	73	289

Table 1:

Source: Akwa Ibom State University Registry

VARIABLES DESCRIPTION

The analysis involves three variables which are defined below

 $X_{Q(p/A)}$ = Qualification for Professors/Associate Professors $X_{Y(p/A)}$ = Years of service for Professors/Associate Professors $X_{R(p/A)}$ = Research Publications for Professors/Associate Professors $X_{Q(S)}$ = Qualification for Senior Lecturers $X_{Y(S)}$ = Years of service for Senior Lecturers $X_{R(S)}$ = Research Publications for Senior Lecturers $X_{Q(L1/Below)}$ = Qualification for Lecturer1/Below $X_{Y(L1/Below)}$ = Years of service for Lecturer1/Below $X_{R(L1/Below)}$ = Research Publications for Lecturer1/Below

Vectors of Means

The vector of means for qualifications, years of experience and research publications for Professors/Associate Professors, Senior Lecturers and Lecturer1/Below are presented as follows;

$$\underline{\bar{X}}_{(P)} = \begin{pmatrix} \bar{X}_{Q(P/A)} \\ \bar{X}_{Y(P/A)} \\ \bar{X}_{R(P/A)} \end{pmatrix}, \underline{\bar{X}}_{(S)} = \begin{pmatrix} \bar{X}_{Q(S)} \\ \bar{X}_{Y(S)} \\ \bar{X}_{R(S)} \end{pmatrix} \text{ and } \underline{\bar{X}}_{(L1)} = \begin{pmatrix} \bar{X}_{Q(L1)} \\ \bar{X}_{Y(L1)} \\ \bar{X}_{R(L1)} \end{pmatrix}$$

Variance and Covariance Matrix

(i) Let the variance and covariance matrix for j^{th} category of staff be defined as

$$S_j = \begin{pmatrix} V(Q_j) & \text{Cov}(Q_j Y_j) & \text{Cov}(Q_j R_j) \\ \text{Cov}(Q_j Y_j) & V(Y_j) & \text{Cov}(Y_j R_j) \\ \text{Cov}(Q_j R_j) & \text{Cov}(Y_j R_j) & V(R_j) \end{pmatrix}$$

Where:

Q_j represents Qualifications in the j^{th} category of academic staff

Y_j represents Years of experience in the j^{th} category of academic staff

R_j represents Research publication in the j^{th} category of academic staff

(ii) Pooled Variance and Covariance Matrices

Let S represent the pooled variance and covariance matrix.

Therefore,

$$S = \frac{1}{n - m} \sum_{j=1}^m (n_j - 1) S_j \quad (1)$$

Where $n = \sum_{j=1}^m n_j$

$S_j = S_1, S_2, S_3$ are variance and covariance matrices for Professor/Associate Professor, Senior Lecturer and Lecturer 1/below. The inverse of the Matrix S can be defined as

$$S^{-1} = \frac{1}{\text{Det}(M)} \text{Adj}(M) \quad (2)$$

Hotelling's T^2 Statistic

Given that there are three categories of academic staff, we consider pair wise Hotelling's T^2 test statistic for the analysis.

$$T^2 = \frac{n_i n_j}{n_i + n_j} (\bar{X}_i - \bar{X}_j)' S^{-1} (\bar{X}_i - \bar{X}_j) \quad (3)$$

Where, \bar{X}_i and \bar{X}_j are the means from each group, S^{-1} is the inverse of the pooled covariance matrix of the qualifications, years of experience and research publications for the three categories of academic staff.

Critical Region

The critical region which transforms T^2 – distribution to F – distribution is given as

$$T^2 \geq \frac{(n_i + n_j - 2)}{n_i + n_j - p - 1} \sim F_{p, n_i + n_j - p - 1}$$

where, $F_{p, n_i + n_j - p - 1}$ represents F – distribution with $p, n_i + n_j - p - 1$ degrees of freedom.

ANALYSIS AND RESULTS

Variance and Covariance Matrices

The variance and covariance matrices for the three categories of academic staff are,

PROFESSOR/ASSOCIATE PROFESSORS

$$S_{p/Ass} = \begin{pmatrix} 0.00 & 0.00 & 0.00 \\ 0.00 & 3.4871795 & 1.0769231 \\ 0.00 & 1.0769231 & 6.7692308 \end{pmatrix}$$

SENIOR LECTURER

$$S_{SL} = \begin{pmatrix} 0.574787 & -0.281007 & -0.098852 \\ -0.281007 & 4.550167 & -0.101444 \\ -0.098852 & -0.101444 & 6.842651 \end{pmatrix}$$

LECTURER I/BELOW

$$S_{L1/below} = \begin{pmatrix} 2.42095 & 0.09307 & 1.28648 \\ 0.09307 & 3.53103 & 0.20809 \\ 1.28648 & 0.20809 & 4.18089 \end{pmatrix}$$

The pooled Variance and Covariance matrix and its inverse are

$$S = \begin{pmatrix} 1.92373 & 0.02763 & 0.95747 \\ 0.02763 & 3.68843 & 0.14387 \\ 0.95747 & 0.14387 & 4.81512 \end{pmatrix}$$

$$S^{-1} = \begin{pmatrix} 0.57692 & 0.00015 & -0.1147 \\ 0.00015 & 0.27143 & -0.0081 \\ -0.1147 & -0.0081 & -0.0081 \end{pmatrix}$$

Deviations of mean Values

Here, we present vector of means and deviations from each pair of categories.

$$\bar{X}_P = \begin{pmatrix} 10 \\ 10 \\ 10 \end{pmatrix}, \quad \bar{X}_S = \begin{pmatrix} 10 \\ 7.4247 \\ 8.5205 \end{pmatrix}, \quad \bar{X}_L = \begin{pmatrix} 7.9688 \\ 5.4740 \\ 5.0450 \end{pmatrix}$$

$$\bar{X}_{P,S} = (\bar{X}_P - \bar{X}_S) = \begin{pmatrix} 10 - 10 \\ 10 - 7.4247 \\ 10 - 8.5205 \end{pmatrix} = \begin{pmatrix} 0 \\ 2.5753 \\ 1.4795 \end{pmatrix}$$

$$\bar{X}_{P,L} = (\bar{X}_P - \bar{X}_L) = \begin{pmatrix} 10 - 7.9688 \\ 10 - 5.4740 \\ 10 - 5.0450 \end{pmatrix} = \begin{pmatrix} 2.0312 \\ 4.526 \\ 4.955 \end{pmatrix}$$

$$\bar{X}_{S,L} = (\bar{X}_S - \bar{X}_L) = \begin{pmatrix} 10 - 7.9688 \\ 7.4247 - 5.4740 \\ 8.5205 - 5.0450 \end{pmatrix} = \begin{pmatrix} 2.0311 \\ 1.9507 \\ 3.4755 \end{pmatrix}$$

Computations of Hotelling's Statistics

A. Professor/Associate Professor and Senior Lecturer:

$$\left(\frac{26 \times 73}{26+73}\right) (0, 2.5753, 1.4795) * \begin{pmatrix} 0.57692 & 0.00015 & -0.1147 \\ 0.00015 & 0.27143 & -0.0081 \\ -0.1147 & -0.0081 & -0.0081 \end{pmatrix} \begin{pmatrix} 0 \\ 2.5753 \\ 1.4795 \end{pmatrix} = 41.27$$

B. Professor/Associate Professor and Lecturer I/below:

$$\left(\frac{26 \times 289}{26+289}\right) (2.0312, 4.526, 4.955) * \begin{pmatrix} 0.57692 & 0.00015 & -0.1147 \\ 0.00015 & 0.27143 & -0.0081 \\ -0.1147 & -0.0081 & -0.0081 \end{pmatrix} \begin{pmatrix} 2.0312 \\ 4.526 \\ 4.955 \end{pmatrix} = 217.48$$

C. Senior Lecturer and Lecturer I/below, the estimate of the model is obtained:

$$(2.0311, 1.9507, 3.4755) * \begin{pmatrix} 0.57692 & 0.00015 & -0.1147 \\ 0.00015 & 0.27143 & -0.0081 \\ -0.1147 & -0.0081 & -0.0081 \end{pmatrix} \begin{pmatrix} 2.0311 \\ 1.9507 \\ 3.4755 \end{pmatrix} = 211.08$$

Critical Value of F-distribution. $F_{3,\infty,0.05} = 2.60$

Decision: $F_{cal} > F_{critical}$ in each case. Hence, H_0 is rejected for alternative. There is a significant difference in the profiles between Professors/Associate Professors and Senior Lecturers, Professors/Associate Professors and Lecturer1/Below and Senior Lecturer and Lecturer1/below.

CONCLUSION

The role of academic staff in elevating institutional productivity is undeniable, necessitating a robust academic workforce. Professors and Associate Professors, as academic leaders, effectively contribute to research and pedagogy, fostering a culture of excellence. This study delves into the analysis of academic staff profiles, scrutinizing qualifications, experience, and research contributions to discern and evaluate lecturers' productivity levels. Evidently, the findings indicate that Professors and Associate Professors within the Akwa Ibom State University system maintain their academic leadership through their qualifications, experience, and research prowess. These findings underscore the significant impact of seasoned academics and, concurrently, serve as an encouraging beacon for aspiring young academics within the university.

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