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APPLICATION OF HOTELLING T SQUARE IN COMPARING STUDENTS' ENROLLMENT IN SOME SELECTED NIGERIA TERTIARY INSTITUTIONS

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ABSTRACT

Tertiary education has been identified to be central to the creation of the intellectual capacity on which knowledge production and utilization depend and to the promotion of lifelong learning practices, hence the necessity for stakeholders to be actively involved in the growth of education at primary and secondary levels which have implications on tertiary education. This research work compares student enrollment in some selected tertiary institutions with the aims of knowing the difference in the number of enrolment between Private, State and Federal owned Polytechnics and Universities. Hotelling T squared and multiple bar charts are used and it is observed that there is no significant difference between the number of student enrolment in the polytechnic and university over the years under investigations. The multiple bar charts show that there is more student enrolment in the universities, but the difference is not significant.

Keywords: Hoteling T Squared, Students Enrolment, Tertiary Institutions.

INTRODUCTION

The global developments over the past decades indicate that higher education sector has moved from a state of decline and disrepair to a state of revival and revitalization in this century. 1980s was a period of decline of higher education when student enrolment declined even in the developed countries [1]. The developing countries, especially in Africa, experienced a state of erosion of facilities and capacities [2]. The fiscal crisis and the resultant decline in state funding were considered to be a major cause of the decline.

The higher education system in the developed countries was fast in responding to the decline through 'cut back management' policies and measures to withdraw public subsidies. The developing countries were slow and delayed in their response, although they too adopted reforms to reduce cost (including staff reduction, a freeze on new appointments, and a freeze on increase in staff salary, etc.), share cost, generate income, and to improve efficiency of the system. Some of the reforms drove academic staff away from the university jobs to other more lucrative avenues of employment within the country and migration to other countries. Some of these policies also led to a deterioration of physical facilities and academic standards, contributing to a sharp decline in the quality of teaching and research.

These trends are reversed in this century in the developing countries, notably in Africa. Between 2000 and 2010, the system not only expanded considerably adding more than 7.7 million students annually, but the developing countries also accounted for a major share of this increase in enrolment; budgetary allocation to higher education increased; staff salaries improved, as did teaching-learning conditions, leading to a revival of the sector. Today the rates of growth of higher education are the highest in countries in Africa, although their enrolment base still continues to be low. It is important to note that the expansion of the system in this millennium was relying increasingly on non-state funding. Tertiary education according to the provisions of the National Policy on Education is that Education given after-secondary education, in Universities, Colleges of Education and Polytechnics in Nigeria.

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These institutions are owned by either the Federal or State Governments, corporate bodies or individuals. Some Federal agencies have are tasked with monitoring and supervising and accrediting courses in these institutions irrespective of their proprietorship. For the universities, the National Universities Commission (NUC) is in charge while in the Polytechnics and Colleges of Education, the agencies are respectively the National Board for Technical Education (NBTE) and National Commission for Colleges of Education (NCCE).

While the first tertiary institution in Nigeria, the Yaba Higher College was founded some seventy five years ago, the University College, Ibadan was opened in 1948 and the first Advanced Teachers College commenced training of teachers in 1962. So the youngest of the three main types of tertiary education is forty-five years old.

The phenomenon of globalization, which has changed various sectors of world economy, has also had some remarkable impact on education as students' option for tertiary education has increased and it is no longer limited by national boundaries. In Nigeria, there is an increased recognition of the economic potential of higher education. On the importance of tertiary education, [3] observed that tertiary education is necessary for the creation, dissemination and application of knowledge as well as for building technical and professional capacity. Tertiary education indeed has been identified to be central to the creation of the intellectual capacity on which knowledge production and utilization depend and to the promotion of lifelong learning practices. It therefore becomes important for stakeholders to be actively involved in the management of a system that will focus on quality in spite of numbers.

Globalization and the growth of education at primary and secondary levels have implications for tertiary education. Nigeria's being a signatory to world conventions on Education for All gave birth to the National Policy on the Universal Basic Education. With these, all school age children are expected to be in schools and the progressive pupil's population in both the primary and secondary levels have increased.

[4] observed that most Universities and Polytechnics especially the Federal and States enroll far more students than the available qualified lecturers, facilities such as classrooms, laboratories, desks reading materials and equipment. Carrying capacity, which is defined as the maximum number of students that an institution can sustain for qualitative education, based on available human and materials resource have been over shot severally.

Of the 25 Federal owned universities, 18 were found to have over enrolled and [5] reported that 13 out of the 19 state universities over enrolled while only one of 7 private universities over enrolled. It was also reported that of the top 10 over crowded universities, Federal has 5 and State has 5. There is a rapid increase in number of students in Nigeria's higher institutions and the trend is now approaching what is common in mass education system elsewhere. As a result of large student numbers, the space requirements of classrooms, lecture theatres; laboratories and workshops are hardly met in over 70% of the tertiary institutions [6]. Facilities are overstretched thus presenting a recipe for rapid decay in the face of dwindling funds for maintenance. A preliminary report on the state of equipment in workshops and laboratories of tertiary institutions documents a sorry state of affairs in terms of number and operational status. The more worrisome aspect is that the method of delivering courses and the assumptions underpinning these methods remained the same. In March 2002 a National Summit on Higher Education was held to examine specific policy issues arising from the government's university autonomy policy. A reported 1,200 stakeholders attended, representing students, parents, academic staff, management, government and employers. Topics addressed included management, funding, access, curriculum relevance, and social problems [7].

In practice, however, the university system developed less rationally than anticipated. Enrollments in the Federal universities (34% female, 59% in sciences) grew at the rapid rate of 12% annually during the 1990s and totaled 325,299 students by 2000 [8]. Enrollment growth rates were the highest in the South-South Region, followed by the North-East Region. Overall growth rates far exceeded government policy guidelines.

Nigeria's entire tertiary education system (federal, state and private) comprises 220 institutions: 17 Federal Universities, 4 Federal Universities of Technology, 3 Federal Universities of Agriculture, 1 National Open University, 4 National Centers for Specialized Tertiary Instruction, 16 State Universities, 7 Private Universities, 1 Military University, 17 Federal Polytechnics, 27 State Polytechnics, 7 Private Polytechnics, 22 Federal Teacher Training Colleges, 38 State Teacher Training Colleges, 4 Private Teacher Training Colleges, 36 Colleges of Agriculture, 12 Specialized Training Institutes, and 4 Parastatals Supervisory Agencies. The government traditionally categorizes its Federal universities into groups based on their dates of establishment, as follows: 1st Generation (Benin, Ibadan, Ile-Ife, Lagos, Nsukka, Zaria); 2nd Generation (Calabar, Ilorin, Jos, Kano, Maidugari, Port Harcourt, Sokoto); 3rd Generation (Abeokuta, Abuja, Akure, Akwa, Bauchi, Makurdi, Minna, Owerri, Umudike, Uyo, Yola).

In comparison, state university enrollments totaled 104,776 in 1997/98, accounting for 28% of Nigeria's total university enrollments in that year [9].

Rising student numbers generated an enrollment ratio of 340 per 100,000 persons (Asia averages 650 and South Africa 2,500) and an average staff/student ratio of

1:21 (sciences 1:22; engineering 1:25; law 1:37; education 1:25). In terms of academic disciplines, the highest rates of enrollment growth occurred in the sciences and in engineering. As a result, the share of science and engineering in total enrollments rose from 54% in 1989 to 59% in 2000, consistent with national policy targets [6]. Much of this expansion centered in the South-East Region, where a combined annual growth rate of 26.4% in science and engineering led the nation. However, efforts to expand enrollments and improve educational quality are severely constrained by growing shortages of qualified academic staff. Between 1997 and 1999, the numbers of academic staff declined by 12% even as enrollments expanded by 13%. Long term brain drain, combined with insufficient output from national postgraduate programs in the face of rising enrollments, has left the Federal university system with only 48% of its estimated staffing needs filled. Staffing scarcity is most acute in engineering, science and business disciplines. Shortfalls are estimated at 73% in engineering, 62% in medicine, 58% in administration, and 53% in sciences. In contrast, no staffing shortages exist in the disciplinary areas of Arts and Education [8].

Patterns in the structure of university expenditures have improved steadily during the last decade. Whereas in 1991 academic expenses accounted for 49% and administration absorbed 46% of total expenditures, by 1999 these shares were 62% and 35% respectively. In the process, the portions devoted to teaching support and to library development showed positive gains across the system. Direct teaching expenditure per student, however, differed considerably among institutions. In 1997/98 funds spent on direct teaching ranged from a low of 137 naira ($2) per student at Sokoto to a high of 1,683 naira ($21) at Maiduguri. The system-wide weighted average was 331 naira ($4) per student [10, 11].

MATERIALS AND METHODS

The data used for this research is a secondary data which was extracted from the document of the various schools selected. The schools include three university and three polytechnics made up of one each of private, state and federal owned universities and polytechnics

Bar chart

The bar chart or bar graph is a chart with rectangular bars with lengths proportional to the values that they represent. The bars can be plotted vertically or horizontally. A vertical bar chart is sometimes called a column bar chart. A bar graph is a chart that uses either horizontal or vertical bars to show comparisons among categories. One axis of the chart shows the specific categories being compared, and the other axis represents a discrete value. Some bar graphs present bars clustered in groups of more than one (grouped bar graphs), and others show the bars divided into subparts to show cumulate effect (stacked bar graphs). Bar graph can be drawn horizontally or vertically. Bar charts have a discrete range.

Hotelling T^2 Distribution

This distribution is named after Herold Hotelling, who proposed it as a multivariate generalization of the student t-distribution. Hotelling $-T^2$ is used in testing hypothesis of multivariate means. The test statistic is define as : $\tau^2 = n(X-\mu)^T S^{-1}\ (X-\mu)$
Where n is a number of points, x is a column vector of p elements and s is a pxp sample covariance matrix $\frac{m-p+1}{pm}\tau^2 \sim Fp, m-p+1$

Where F is the F- distribution, suppose that X_1,……..X_n column vector whose entries are whole numbers. Let X = (X_1+…..X_n)/n be their mean. Let the px p positive definite matrix $S = \sum_{i=1}(X_1 - X)(X_1 - X)'/(n-1)$ be their sample variance matrix (the transpose of any matrix M is denoted (above m) let be some known p x1 column vector (in applications on hypothesized value of a population mean). The Hotelling T statistic is $\tau^2 = n(X-\mu)^T S^{-1}\ (X-\mu)$. Note that $\tau^2$is closely related to square Mehalanobis distance.
In particular, it can be shown that if X_1……Xn, Np (X) are independent, and $\overline{X}$ and S are as define above then S has Wishart distribution with n-1 degree of freedom W~Wp (v, n-1) and is independent of $\overline{X}$; and $\overline{X}$ ~ Np (v/n) this implies the $\tau^2 = n(X-\mu)^T S^{-1}\ (X-\mu) \sim \tau^2$(p,n-1) Hotelling's two sample T distribution.

If X_1, ……X_n, N_p(,v) and Y1, ~Y_n ~(w,v), with the samples independent multivariate distribution with the same mean and covariance, and we define by

$\bar{y} = \frac{1}{n}\sum_j^k y_j$As the sample mean and $\frac{\sum_{i-1}^{n}(x_1-x)(x_1-x) + \sum_{i-1}^{n}(y_1-y)(y_1-y)}{nx+ny-2}$
As the noticed pooled covariance matrix estimate, then Hotelling's two-sample T is given as $\tau^2 = \frac{nxny}{nx+ny}\ (x-y)'S^{-1}(x-y) \sim \tau^2\ (p, nx+ny-2)$

And it can be related to the F- distribution by $\frac{nx+ny-p-1}{nx+ny-2} \sim \tau^2(p, nx+ny-1-p)$

Data Analysis

Figure 1. Comparing male enrolments in the selected polytechnics and universities

```
-> institution = 1

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
 observation |         15      2537.6    1514.898       160       3892

-------------------------------------------------------------------------------
-> institution = 2

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
 observation |         15    2082.867    1219.265       445       3779


2-group Hotelling's T-squared = .82023475
F test statistic: ((30-1-1)/(30-2)(1)) x .82023475 = .82023475

H0: Vectors of means are equal for the two groups
                F(1,28) =     0.8202
        Prob > F(1,28) =     0.3728
```

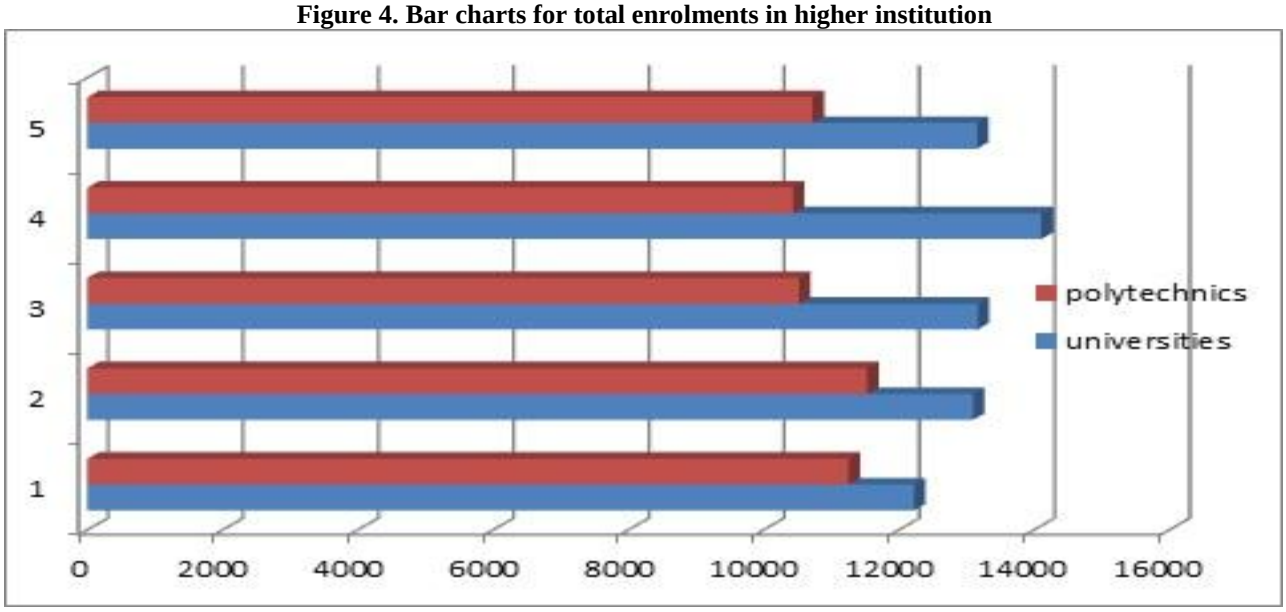
Figure 2. Comparing female enrolments in the selected polytechnics and universities

```
. hotelling obsevation, by(institution)

-------------------------------------------------------------------------------
-> institution = 1

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
  obsevation |         15    1868.733    1126.698       101       3298

-------------------------------------------------------------------------------
-> institution = 2

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
  obsevation |         15    1542.467    896.3959       395       2871


2-group Hotelling's T-squared = .77026995
F test statistic: ((30-1-1)/(30-2)(1)) x .77026995 = .77026995

H0: Vectors of means are equal for the two groups
                F(1,28) =     0.7703
        Prob > F(1,28) =     0.3876
```

Figure 3. Comparing total enrolments in the selected polytechnics and universities

```
-------------------------------------------------------------------------------
-> institution = 1

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
 observation |         15    4382.733    2626.369       261       7010

-------------------------------------------------------------------------------
-> institution = 2

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
 observation |         15    3630.333    2092.551       840       6630


2-group Hotelling's T-squared = .7530282
F test statistic: ((30-1-1)/(30-2)(1)) x .7530282 = .7530282

H0: Vectors of means are equal for the two groups
                F(1,28) =     0.7530
        Prob > F(1,28) =     0.3929
```

Figure 4. Bar charts for total enrolments in higher institution



The graphs showed more students enrolments in the universities.

RESULTS AND DISCUSSION

The analysis shows a non-significant different in the number of student enrolment on gender basis over the years under reviewed between the private, state and federal owned universities and Polytechnics compared. There is also no significant different in the total number of student enrolled in the universities and polytechnics compared.

CONCLUSION

The multiple bar chart indicate more number of student enrollment in the Universities but the difference is not significant this difference may be as a results of the importance attached to university education and on the certificates in Nigeria.

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