AJSTME, Volume. 12, Issue 1. 112-118, January, 2026. https://www.ajstme.com.ng
ISSN: 2251-0141 (Print), 2971-6233 (Online)

Influence of Funding and Geopolitical Location on the Accreditation Outcomes of Mathematics Program in Nigerian Universities

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Abstract

The National Universities Commission (NUC) oversees and accredits university programmes in Nigeria, including undergraduate mathematics. However, limited empirical evidence exists on accreditation outcomes across institutions. This study presents a comprehensive analysis of mathematics program accreditation by funding type (federal, state, private) and the 6 geopolitical regions (GPR). Using data from the NUC website, descriptive statistics and the Chi-square test of independence were applied. Out of 286 accreditation results (2002–2021), 197 (68.9%) were fully accredited (F), 78 (27.3%) received interim accreditation (I), and 11 (3.8%) were denied (D). Accreditation status was independent of funding type (Chi-square = 3.910; p-value = 0.418) but significantly associated with GPR (Chi-square = 19.428; p-value = 0.035). Analysis of 198 consecutive accreditation visits showed the following transitions: 90 (45.5%) FF, 64 (32.3%) IF, 23 (11.6%) FI, 7 (3.5%) DF, 4 (2.0%) FD, 4 (2.0%) ID, 3 (1.5%) II, 2 (1.0%) DI, and 1 (0.5%) DD. ANOVA results indicated no significant differences in outcomes based on funding type or GPR. Clustering analysis identified 2 major clusters in the interval between successive accreditations and revealed regional disparities between northern and southern Nigeria. The findings also suggest inconsistent adherence to NUC guidelines, particularly among federal and state universities. Overall, the study highlights the need for improved compliance, regional equity, and strengthened quality assurance mechanisms in mathematics programme accreditation.

Keywords: Accreditation; Cluster; Funding; Geopolitical region; K-mean, Mathematics; Modern Higher Education; Nigeria; NUC; Statistics.

Introduction

The quality assurance system (regulatory and supervisory) in Nigerian universities was first adopted in 1974 by the National Universities Commission (NUC) as a parastatal in the Federal Ministry of Education. Since then, the NUC has evolved and been empowered by the Nigerian Government to establish the Basic Minimum Academic Standards (BMAS) for undergraduate and postgraduate studies and to approve academic programs for Nigerian universities **(Ubogu, 2021)**. The law establishing the NUC was further amended to empower it to initiate and promote the use of ICT for service delivery, upgrade and maintain physical facilities in the Nigerian university system (NUS), match graduate output with the nation's manpower needs, and foster sustainable partnerships between the NUS and the private sector. The NUC's supervisory role mandates it to determine the minimum entry requirements into the NUS in conjunction with other government agencies **(Odukoya et al., 2018)**. According to the NUC, as outlined by **(Akomolafe & Adesua, 2020)**, apart from ensuring the enhancement and maintenance of minimum academic standards, another objective of the accreditation mandate is to ensure that only qualified tutors with the necessary competencies are employed. Additionally, it assures employers of Nigerian graduates and the international community that the programs offered in the NUS meet high standards **(Akomolafe & Adesua, 2020)**.

There are three statuses of accreditation: full (F), interim (I), and denied (D), which correspond to the assessment of the four core areas of academic content, staffing, physical facilities, and learning resources. Full and interim accreditation expire after five and two academic sessions, respectively. Any program with

denied accreditation ceases admitting students until it secures either interim or full accreditation status.

Although, Olaleye and Oyewole (2016) stated that there has been an improvement in the accreditation results of universities in recent years but this has not translated into the production of quality graduates. Many people believe that the quality of education offered by some accredited Nigerian universities is steadily declining, as evidenced by the production of graduates without the necessary skills for industries (Onyeike & Onyeagbako, 2014). Some constraints have been identified that limit the capacity of the NUC to perform its statutory duties. The neutrality of the NUC is often questioned due to issues of funding, corruption, structure, board and staff composition, transparency, capacity, trust, and relevance (Ibiam, 2014; Jacob & Ahaotu, 2021).

The aim of this paper is to analyse the results of the accreditation of mathematics programs in Nigeria. Mathematics is a very important subject because of its wide application in different academic fields. This paper will address two hypotheses:

1. Accreditation status is not statistically associated with the funding type of the universities.
2. Accreditation status is not associated with the geopolitical location of a university.

The paper addresses a clear empirical and policy gap within Nigeria's higher education quality assurance system. Although the NUC conducts accreditation regularly, there is little systematic, data-driven analysis of accreditation outcomes across institutions and over time. Existing discussions are largely descriptive or perception-based, often claiming improvements or declines without robust statistical evidence. This study bridges that gap by analyzing 286 accreditation outcomes (2002–2021) and 198 consecutive visits using inferential statistics and clustering techniques. In doing so, it moves beyond anecdotal claims to provide objective evidence on patterns, transitions, and determinants of accreditation outcomes.

Mathematics is chosen because it is a foundational discipline that underpins science, technology, engineering, economics, and data-driven fields. Its universal presence across universities allows for comparability, while its central role in manpower development makes it a strong indicator of academic quality. Weaknesses in mathematics programs often signal broader systemic issues such as inadequate staffing, poor infrastructure, or weak curriculum implementation.

Funding type is examined because resource availability differs significantly between federal, state, and private universities. These differences influence staffing levels, infrastructure, learning resources, and overall institutional capacity, key criteria in accreditation. Testing funding type helps determine whether financial structure translates into quality differences.

Lastly, geopolitical region (6 GPR) is included to capture structural inequalities across Nigeria. Regional disparities in infrastructure, security, policy implementation, and educational investment may affect accreditation outcomes. By analyzing GPR, the study identifies whether location-based inequities contribute to variations in program quality, as reflected in accreditation status.

Materials and Method

Study Design

This study employed retrospective observational design using secondary archival data from the NUC.

Data

The data was the undergraduate accreditation results available on the NUC website (https://www.nuc.edu.ng/undergraduate-accreditation-results/) and available for free download. Only the data on accreditation results for mathematics program were extracted and analyzed. All the universities were considered irrespective of funding type (federal, state and private), however, only those that had at least two accreditation results were included in the study. This is to ensure that variability can be computed. Subsequently, the results were grouped based on the six geopolitical regions (GPR) of Nigeria, Northcentral (NC), Northeast (NE), Northwest (NW), Southeast (SE), Southsouth (SS) and Southwest (SW). The period was from 2002 to 2021 (These are based on data available at NUC website as at 2023). The total sample size is 87 universities.

Statistical Analysis

The results were presented in tables and the period between two successful accreditations was presented in years. The mean was calculated for years between any two accreditation statuses.

The Chi-square test of independence was used to test the two hypotheses. Analysis of variance (ANOVA) was also applied. K-mean clustering and t-distributed stochastic neighbor embedding (t-SNE) were the two clustering methods used.

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Results

Preliminaries

Limiting the universities that have received at least two accreditation results reduced the data to 87 universities of which 38 (44%), 34 (39%) and 15 (17%) are federal, state and private universities respectively. Grouping the 87 universities based on GPR yielded 17 (19.6%), 10 (11.5%), 13 (14.9%), 14 (16.1%), 15 (17.2%) and 18 (20.7%) in NC, NE, NW, SE, SS and SW respectively.

Accreditation Result based on Funding Type

A total of 286 accreditation results were published by the NUC for mathematics program from 2002 to 2021. Full, interim and denied accreditation were presented in **Table 1** where it could be seen that the number of full, interim and denied accreditations are 197 (68.9%), 78 (27.3%) and 11 (3.8%) respectively. A component bar chart of the accreditation status based on funding type of the universities is presented in **Figure 1**.

Table 1: Undergraduate mathematics program NUC accreditation result based on funding type (2002 to 2021)

Funding	Number	F	I	D	Total
Federal	38	89	29	3	121
State	34	77	34	7	118
Private	15	31	15	1	47
Total	**87**	**197**	**78**	**11**	**286**

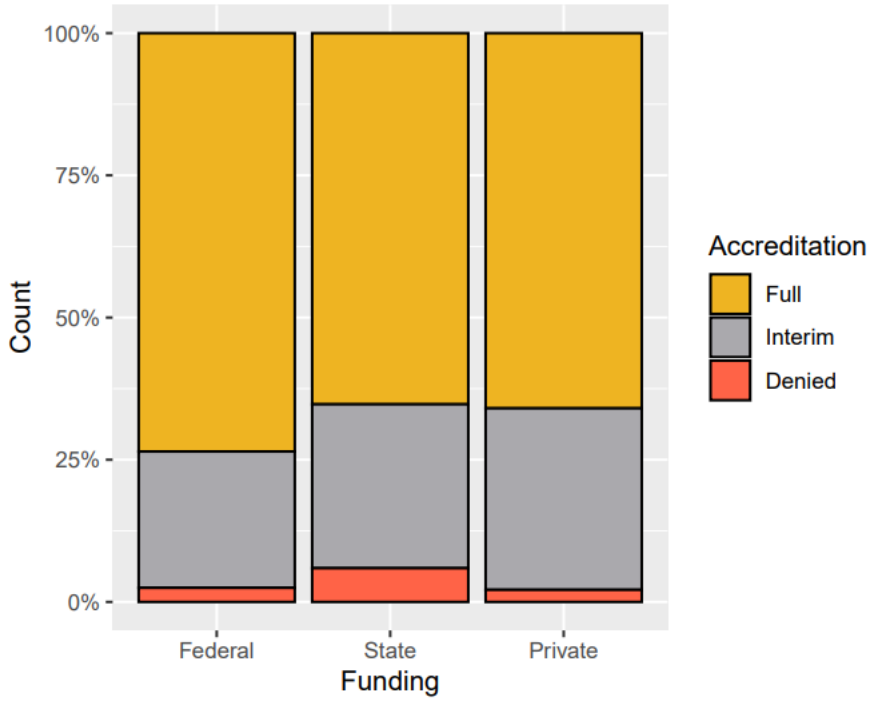

Figure 1. Accreditation status by funding type

A further breakdown of the results showed the following.

a). For mathematics program in federal universities in Nigeria, 89 (73.6%) of the accreditation resulted in full accreditation status, 29 (24%) resulted in an interim and 3 (2.4%) were denied accreditation.

b). For mathematics program in state universities in Nigeria, 77 (65.3%) of the accreditation resulted in full accreditation status, 34 (28.8%) resulted in an interim and 7 (5.9%) were denied accreditation.

c). For mathematics program in private universities in Nigeria, 31 (70%) of the accreditation resulted in full accreditation status, 15 (31.9%) resulted in an interim and 1 (2.1%) were denied accreditation.

The test of hypothesis one yielded a Chi-square statistic of 3.910 and a p-value of 0.418. The result is not significant and hence, accreditation status is independent of the funding type of the universities.

Accreditation Result based on Geopolitical Regions

The accreditation results were grouped into the six GPR in Nigeria and are presented in **Table 2** and **Figure 2** respectively. Out of the 286 accreditation results, the SS region has the highest of 59 visits, followed by SW, SE, NC, NW and NE with 57, 51, 51, 40 and 28 respectively in descending order.

Table 2. Undergraduate mathematics program NUC accreditation result based on GPR (2002 to 2021)

GPR	Number	F	I	D	Total
NC	17	34	17	0	51
NE	10	21	7	0	28
NW	13	27	11	2	40
SE	14	29	17	5	51
SS	15	37	19	3	59
SW	18	49	7	1	57
Total	87	197	78	11	286

A further breakdown of the result showed the following.

a). In terms of full accreditation, SW leads with 49, followed by SS (37), NC (34), SE (29), NW (27) and NE (21) in descending order.

b). In terms of interim accreditation, SS leads with 19, jointly followed by SE (17) and NC (17), NW (11), NE (7) and SW (7) in descending order.

c). In terms of denied accreditation, SE leads with 5, followed by SS (3), NW (2) and SW (1). However, NC and NE are yet to record a denied status.

d). Out of the 51 accreditation results for universities in NC, 34 (66.6%) are full while 17 (33.3%) are interim.

e). Out of the 28 accreditation results for universities in NE, 21 (75%) are full while 7 (25%) are interim.

f). Out of the 40 accreditation results for universities in NW, 27 (67.5%) are full, 11 (27.5%) are interim and 2 (5%) are denied.

g). Out of the 51 accreditation results for universities in SE, 29 (56.9%) are full, 17 (33.3%) are interim and 5 (9.8%) are denied.

h). Out of the 59 accreditation results for universities in SS, 37 (62.7%) are full, 19 (32.2%) are interim and 3 (5.1%) are denied.

i). Out of the 57 accreditation results for universities in SW, 49 (86%) are full, 7 (12.3%) are interim and 1 (1.7%) are denied.

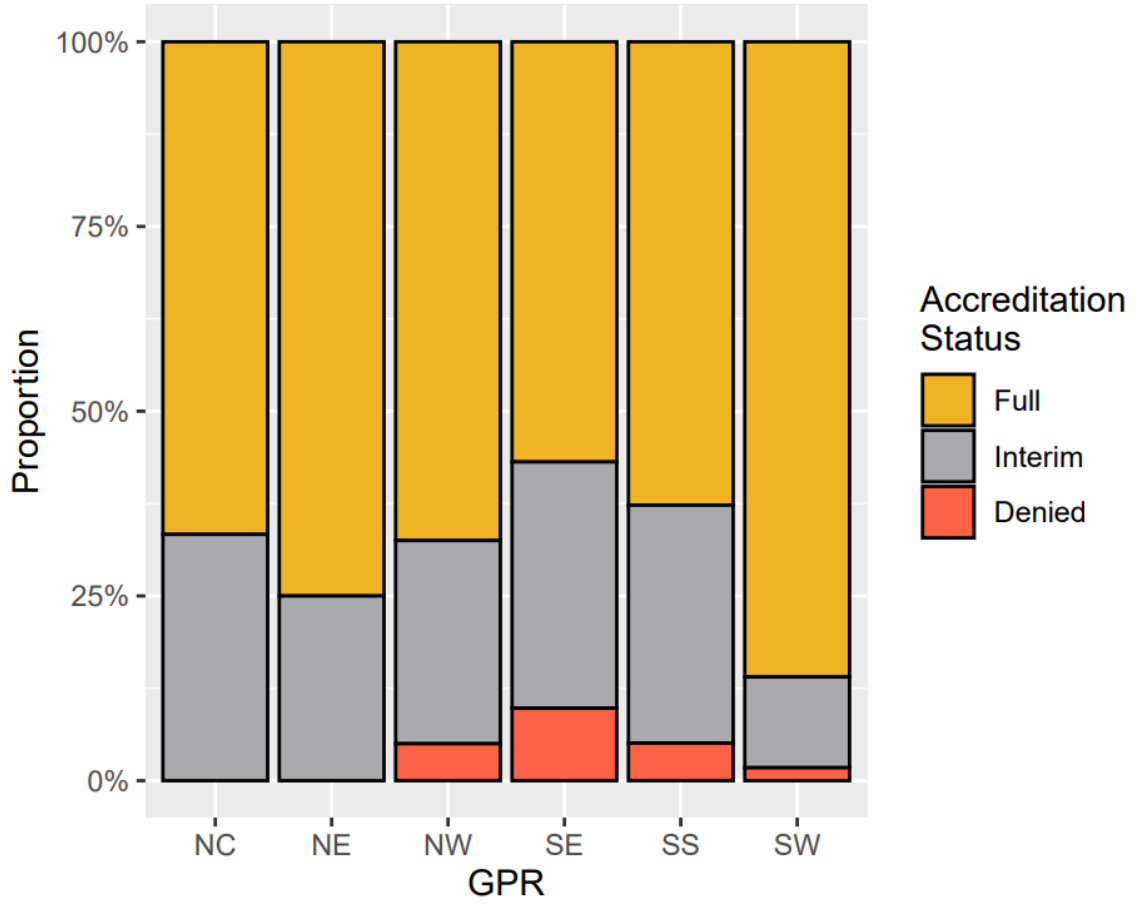

Figure 2. Accreditation status by GPR

The test of hypothesis two yielded a Chi-square statistic of 19.428 and a p-value of 0.035. The result is significant and hence, accreditation status is associated with the GPR where the universities are located. However, given the differences seen in **Figure 2**, it is important to compute the pairwise chi-squared results with a Bonferroni correction to discover where the significant differences lie. While this can be run row by row (or column by column) the chisq.posthoc.test package in the R software allows the residuals and p-values to be calculated in one go **(Table 3)**.

Table 3: Post-hoc Chi-square tests for the GPR result

GPR	Value	Full	Interim	Denied
NC	Residual	-0.3768	1.0721	-1.5717
	P values	1.0000	1.0000	1.0000
NE	Residual	0.7363	-0.2843	-1.1142
	P values	1.0000	1.0000	1.0000
NW	Residual	-0.2034	0.0348	0.4092
	P values	1.0000	1.0000	1.0000
SE	Residual	-2.0451	1.0721	2.4407
	P values	0.7352	1.0000	0.2638
SS	Residual	-1.1489	0.9545	0.5553

	P values	1.0000	1.0000	1.0000
SW	Residual	3.1133	-2.8402	0.9177
	P values	**0.0333**	0.0812	1.0000

It could be seen from **Table 3** that the accreditation status of the universities in the SW region is statistically significantly different from the other five regions.

3.4 Exploring the GPR, funding type and accreditation outcomes

Exploring the relationships using a scatter plot showed an obvious no pattern among the trio as shown in **Figure 3**.

Figure 3: Accreditation by Funding Type and GPR

Period between Two Consecutive Accreditation based on Funding Type

The period (measured in the number of years) between two consecutive accreditation for all the universities were explored. Nine different cases were obtained. These are full accreditation followed by another full accreditation (FF), interim accreditation followed by full accreditation (IF), full accreditation followed by interim accreditation (FI), interim accreditation followed by another interim accreditation (II), full accreditation followed by denied accreditation (FD) and denied accreditation followed by full accreditation (DF). Others are denied accreditation followed by interim accreditation (DI), interim accreditation followed by denied accreditation (ID) and denied accreditation followed by another denied accreditation (DD). The number of accreditation visits that resulted in the nine different cases based on funding type of the universities was presented in **Table 4**.

AJSTME, Volume. 12, Issue 1. 112-118, January, 2026. https://www.ajstme.com.ng
ISSN: 2251-0141 (Print), 2971-6233 (Online)

Table 4: Frequency of the nine cases of analysis of two Consecutive Accreditation based on Funding Type

Funding	FF	FI	FD	IF	II	ID	DF	DI	DD	Total
Federal	43	10	0	24	1	2	3	0	0	83
State	33	10	3	27	1	2	4	2	1	83
Private	14	3	1	13	1	0	0	0	0	32
Total	90	23	4	64	3	4	7	2	1	198

Federal universities lead with 43 consecutive accreditations that resulted in FF while state universities lead with 27 consecutive accreditations that resulted in IF. Only one case of DD was recorded for state universities. Private universities are yet to record DF, DI, ID and DD while federal universities are yet to record FD, DI and DD.

Out of the total frequency of consecutive accreditation visits, the respective frequencies and percentages of FF, IF, FI, DF, FD, ID, II, DI and DD are 90 (45.5%), 64 (32.3%), 23 (11.6%), 7 (3.5%), 4 (2.0%), 4 (2.0%), 3 (1.5%), 2 (1.0%) and 1 (0.5%).

Analysis of variance (ANOVA) was used to determine whether the outcomes of consecutive accreditation visits are the same or different across the three funding types. The ANOVA result was not significant ($F = 0.695$, p value = 0.509), which means that the outcomes of consecutive accreditation visits for mathematics programs in Nigeria across federal, state, and private universities are the same.

The mean number of years between any two accreditation visits that resulted in different statuses were presented in **Table 5** where the federal universities lead in FF and FI. The state universities lead in IF, II, FD, DF, DI, 1D and DD. The private universities lag in all nine cases except for cases where they recorded zero.

Table 5: Mean years between two consecutive accreditation visits based on Funding type

Funding	FF	FI	FD	IF	II	ID	DF	DI	DD
Federal	6.37	7	n/a	2.63	3	2	1.67	n/a	n/a
State	5.78	5.4	5.33	2.78	4	2.5	3.5	2.5	2
Private	5.07	5.33	5	2.62	2	n/a	n/a	n/a	n/a

Generally, the average time and standard deviation between two accreditation visits irrespectively of the status (full, interim, denied) is presented in **Table 6**.

Table 6: Mean years between two consecutive accreditation visits based on Funding type (irrespective of outcome)

Funding	Mean	SD
Federal	5.01	2.42
State	4.00	1.48
Private	4.42	1.94

SD = Standard Deviation

From **Table 6**, the federal universities lead with 5 years and the state universities are the least with 4 years between two consecutive accreditations.

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Period between Two Accreditation Visit based on GPR

The number of accreditation visits that resulted to the nine different cases based on GPR location of the universities were presented in **Table 7**.

Table 7: Frequency of the nine cases of analysis of two Consecutive Accreditation based on GPR

GPR	FF	FI	FD	IF	II	ID	DF	DI	DD	Total
NC	13	4	0	17	0	0	0	0	0	34
NE	9	2	0	7	0	0	0	0	0	18
NW	13	1	0	7	1	2	2	0	0	26
SE	9	8	3	13	0	0	2	2	0	37
SS	16	7	1	15	1	1	2	0	1	44
SW	30	1	0	5	1	1	1	0	0	39
Total	90	23	4	64	3	4	7	2	1	198

Table 7 shows that the SW region leads with 16 while the NE and SE have the joint lowest FF of 9. The SS has entries in all the cases except DI. The NC and NE have only entries in FF, IF and FI.

Analysis of variance (ANOVA) was used to determine whether the outcomes of consecutive accreditation visits are the same or different across the six GPR. The ANOVA result was not significant (F = 0.257, p value = 0.934), which means that the outcomes of consecutive accreditation visits for mathematics programs in Nigeria across the six GPR are the same.

The mean number of years between any two accreditation visits that resulted in different statuses were presented in **Table 8** in descending order, the mean years between two consecutive accreditation visits that resulted in FF, according to the GPR are NW, SE, NC, SW, NE and SS. Similarly, for IF, the NE leads, followed by SS, NC, NW, SE and SW. Also, for FI, the NE leads, followed by NC, NW, SE, SS and SW regions in descending order.

Table 8. Mean years between two consecutive accreditation visits based on GPR

GPR	FF	FI	FD	IF	II	ID	DF	DI	DD
NC	6.08	7.25	n/a	2.76	n/a	n/a	n/a	n/a	n/a
NE	5.89	7.5	n/a	2.86	n/a	n/a	n/a	n/a	n/a
NW	6.38	6	n/a	2.57	4	2.5	1.5	n/a	n/a
SE	6.11	5.88	5	2.54	n/a	n/a	5	2.5	n/a
SS	5.5	5.43	6	2.8	3	2	2.5	n/a	2
SW	5.93	5	n/a	2.4	2	2	1	n/a	n/a

Generally, the average time between two accreditation visits irrespectively of the status (full, interim, denied) is presented in **Table 9**.

Table 9: Mean years between two consecutive accreditation visits based on GPR (irrespective of outcome)

GPR	Mean
NC	4.56
NE	4.89
NW	4.59
SE	4.43
SS	4.18
SW	5.13

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From **Table 9**, only the SW region is slightly above 5 years while other regions are between 4.40 and 4.90.

Regional Analysis

The results of the GPR were collapsed into two: north and south and the average time between two consecutive accreditation visits is presented in **Table 10**.

Table 10: Average time between two consecutive accreditation visits by region

Region	Current Status	N	Mean	SD
North	Full	43	6.28	1.61
	Interim	34	2.76	0.99
	Denied	2	1.50	0.71
South	Full	75	5.72	1.30
	Interim	37	2.59	1.21
	Denied	8	2.88	2.59

Table 10 shows the time between 2 accreditation visits when the current accreditation status is as shown in the From column. The Notched boxplot **(Figure 4)** shows the same information visually. On a notched boxplot, if the notches overlap, then it is unlikely that there is a significant difference between distributions. As can be seen only the Interim plot is different suggesting that universities in the North with Interim status have longer to prepare for their next accreditation than universities with interim status in the South. For those with full status or denied status there is no statistically significant difference between the distributions.

Figure 5 is a violin plot that shows the distributions are different by regions and so it is difficult to be certain in the underlying causes.

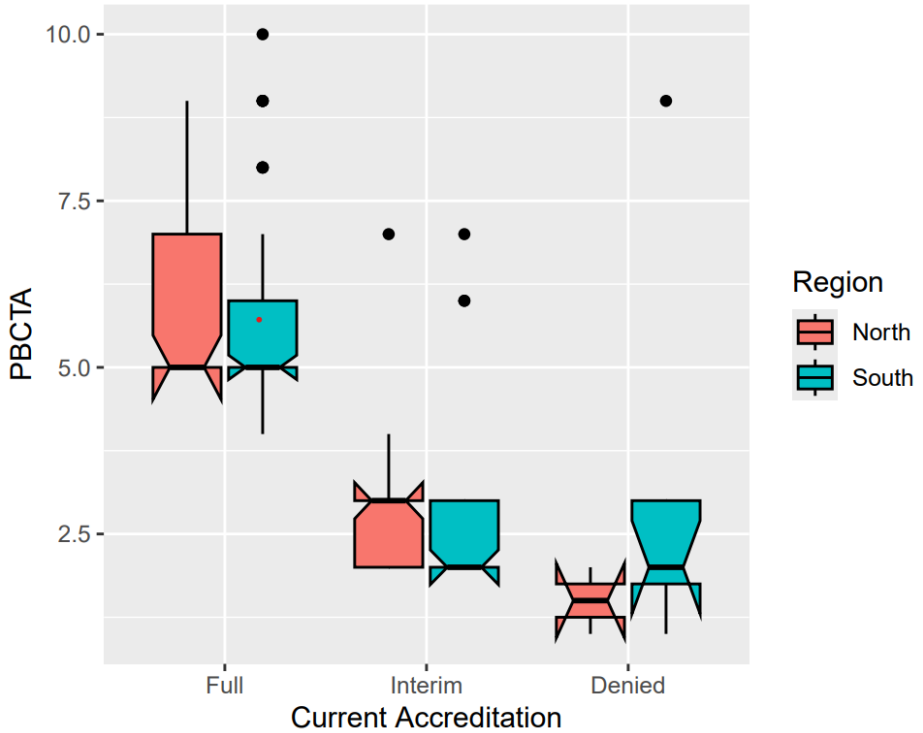

Figure 4: Boxplot of the average time between two consecutive accreditation visits by region

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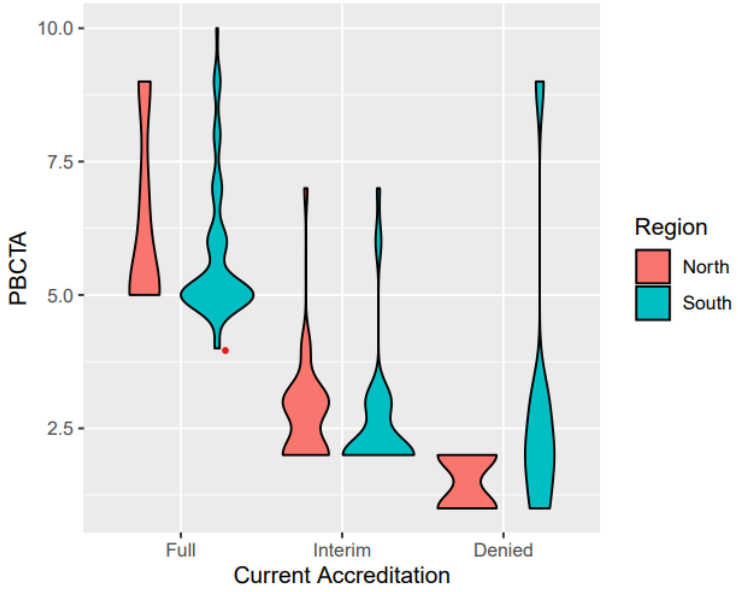

Figure 5: Violin plot of the average time between two consecutive accreditation visits by region

Distribution of the accreditation by year

The distribution of the accreditation status by year showing the distribution of full, interim and denied accreditation over the years is shown in **Figure 6**. Also, the distribution of accreditation status over the tears were disaggregated into region **(Figure 7)** and funding type **(Figure 8)**.

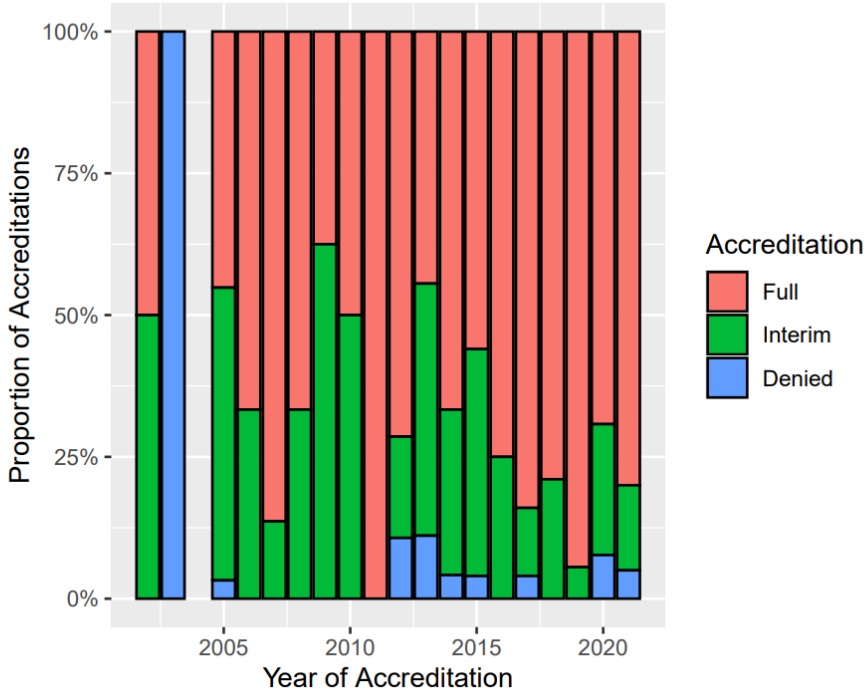

Figure 6: Accreditation Distributions by Year

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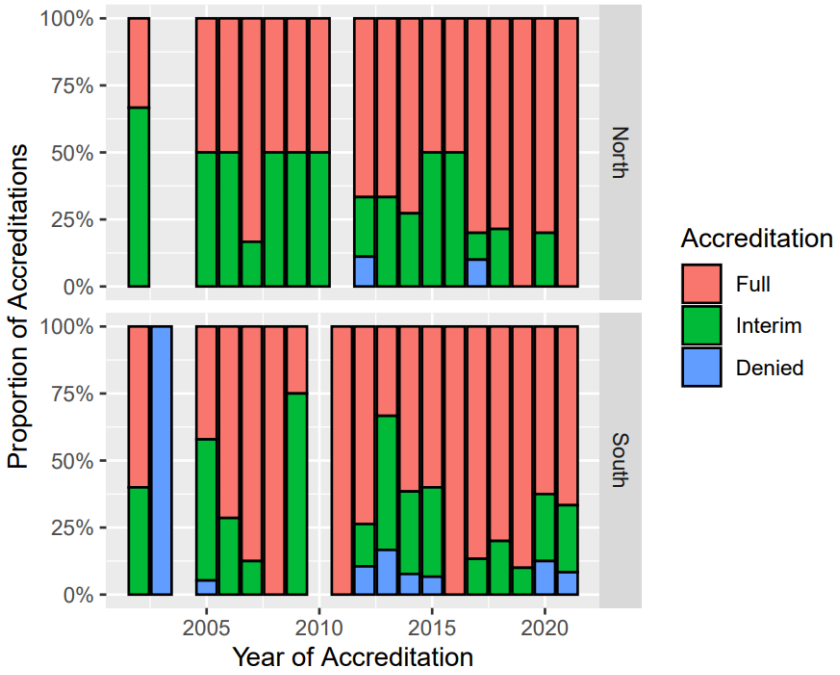

Figure 7: Accreditation Distributions by Year and Region

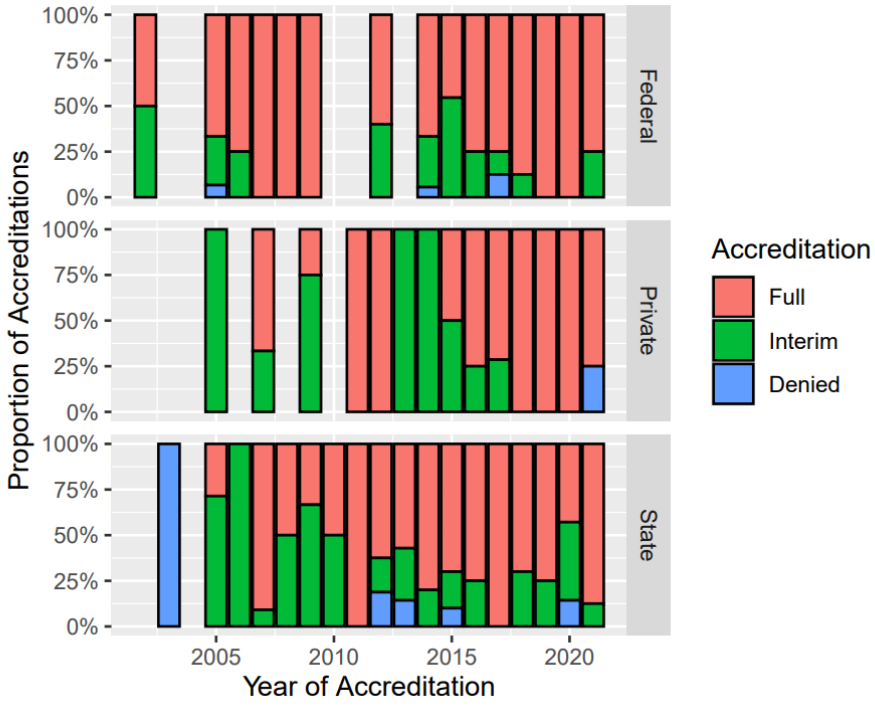

Figure 8: Accreditation Distributions by Year and Funding source

Cluster Analysis

Frequency analysis is inadequate in the identification of inherent patterns in the analysis of the period between two consecutive accreditation (PBTCA) based on either funding Type or GPR. Hence, clustering methods are needed which employ different techniques to group

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similar data points based on their shared characteristics or features. The goal is to identify patterns, similarities, or relationships within the data set without any prior knowledge of the groups or categories **(Okagbue et al., 2022)**. K-mean clustering was used to find unique clusters that explain the PBTCA based on funding type and GPR. K-mean was chosen because it is simple, efficient and scalable, however, one of the major drawbacks is the presence of outliers gravely affect it **(Fränti & Sieranoja, 2019)**. Thankfully, the accreditation data used in this paper has no outliers.

The K-mean method analysis often yields the Silhouette scores or Silhouette coefficient which provides a measure of how well each data point fits into its assigned cluster. Also, it can be used to assess the overall cohesion and separation of the clusters **(Doan et al., 2023)**. The k-mean clustering yielded different Silhouette coefficients for clusters 2 to 8. Afterwards, the mean, median and mode of the Silhouette coefficients for clusters 2 to 8 were obtained and presented in **Table 11**.

Table 11: Comparison of the mean, median and mode of Silhouette scores

Cluster	Mean	Median	Mode
1	0	0	0
2	0.5911	0.5934	0.6288
3	0.5743	0.5634	0.634
4	0.5659	0.5654	0.6116
5	0.565	0.566	0.637
6	0.5648	0.5681	0.6314
7	0.566	0.567	0.6372
8	0.5666	0.5646	0.6423

It is clearly visible that the mean and median Silhouette coefficients for the clusters are similar while the mode is different. However, it is difficult the decipher the optimal cluster until a plot of the mean, median and mode Silhouette coefficients are done and is shown in **Figure 9**.

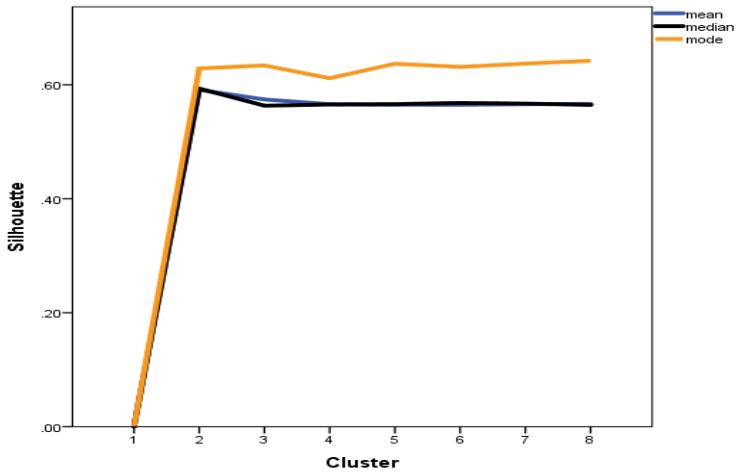

Figure 9: Determining the optimal Clusters that revealed the patterns in PBTCA visits

The line graph **(Figure 9)** showed convergence at two and hence two clusters have emerged in the PBTC. The mean and median Silhouette scores are almost the same from 3 clusters onwards. Hence, no new information may be revealed by the clusters. The violin plot was used to plot the Silhouette values of the two clusters **(Figure 10)**.

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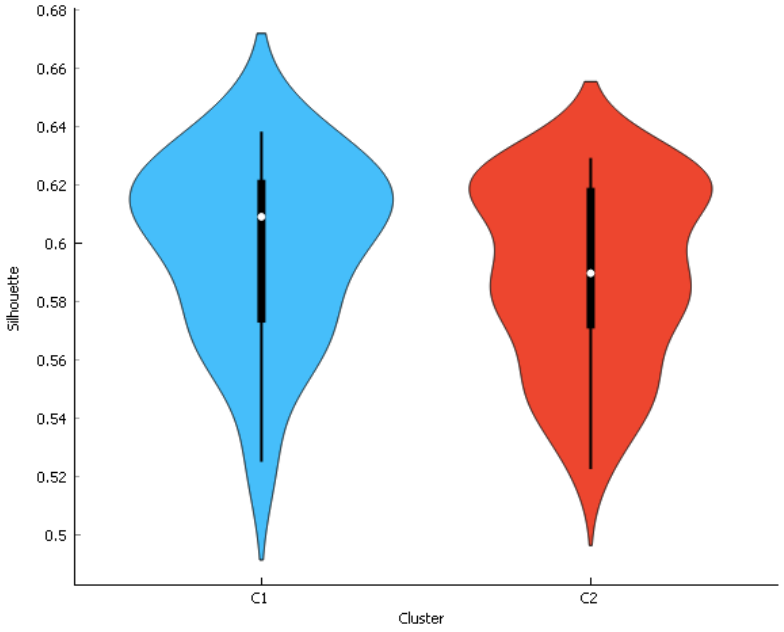

Figure 10: Violin plot of Silhouette of the two clusters of PBTCA

The violin plot revealed that the two clusters are skewed differently. This is an indication that the nature of the accreditation are different. Cluster 1 contains 18 universities with the average Silhouette scores (ASS) of 0.598419 and Cluster 2 contains 69 universities with the average Silhouette scores of 0.589132. The detailed of the GPR and funding composition of the universities in the clusters are presented in **Table 12**.

Table 12: Summary of the Cluster Result

GPR	Cluster 1	Cluster 2
NC	Federal = 2; State = 2; Private = 0	Federal = 6; State = 4; Private = 3
NE	Federal = 2; State = 0; Private = 0	Federal = 3; State = 5; Private = 0
NW	Federal = 0; State = 1; Private = 0	Federal = 8; State = 4; Private = 0
SE	Federal = 2; State = 2; Private = 2	Federal = 3; State = 3; Private = 2
SS	Federal = 2; State = 2; Private = 1	Federal = 4; State = 4; Private = 2
SW	Federal = 0; State = 0; Private = 0	Federal = 6; State = 7; Private = 5
Total	Federal = 8; State = 7; Private = 3	Federal = 30; State = 27; Private = 12

The k-mean clustering has two distinct clusters. Cluster 1 is made up of 8 federal, 7 state and 3 private universities while Cluster 2 is comprised of 30 federal, 27 state and 12 private universities. Moreover, cluster 2 has more representation across the 6 GPR than cluster 1.

The k-mean was unable to provide a clear visualization, thereby t-Distributed Stochastic Neighbor Embedding (t-SNE) was used to reduce the high dimensions to a 2-dimension. Although, the intrinsic structure of the data points was preserved unlike the principal component analysis (PCA) and correspondence analysis (CA) that focused mainly on global structure and variance in the data **(Platzer, 2013)**. As a data point preserving

AJSTME, Volume. 12, Issue 1. 112-118, January, 2026. https://www.ajstme.com.ng
ISSN: 2251-0141 (Print), 2971-6233 (Online)

dimension reduction technique, the PBTCA was visualized in terms of GPR **(Figure 11)** and funding type **(Figure 12)**. In the process of applying t-SNE, standardization or normalization was done on each column by subtracting the column mean and dividing by the standard deviation. Secondly, global structures inherent in the data were preserved by combining two different values of perplexity measures.

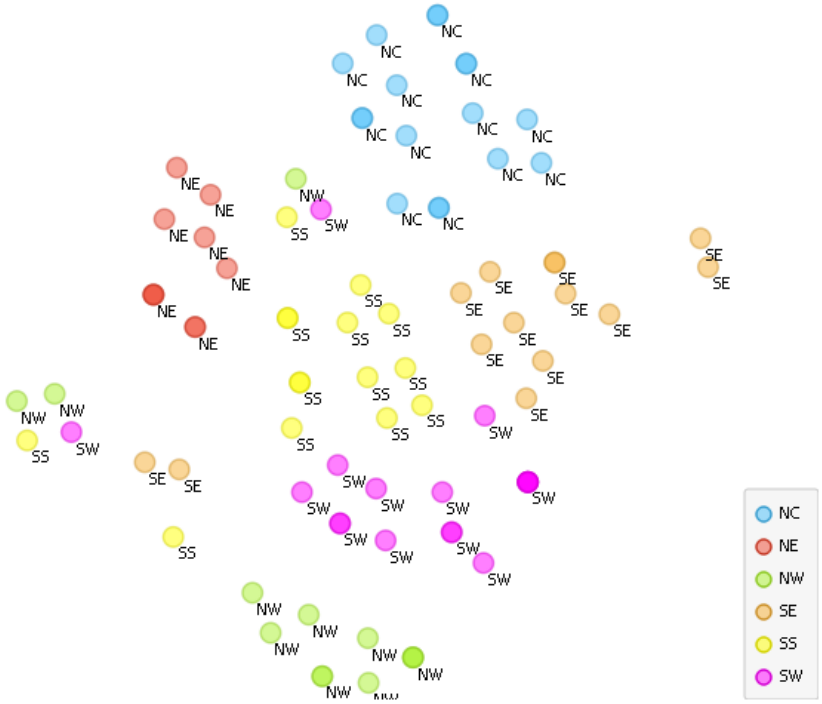

Figure 11: t-SNE plot of PBTCA based on GPR

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ISSN: 2251-0141 (Print), 2971-6233 (Online)

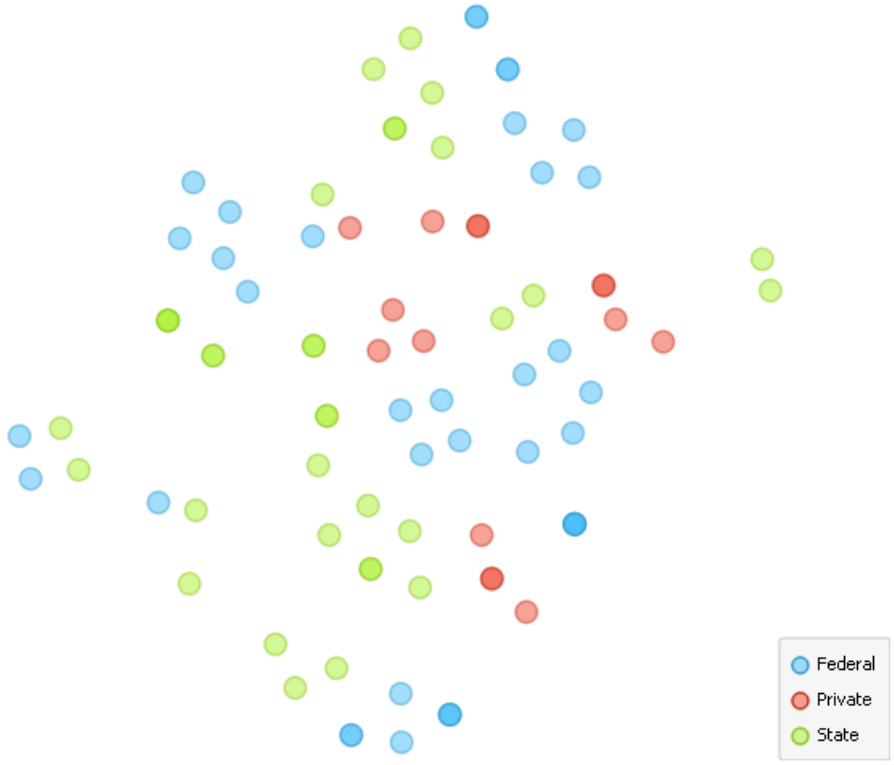

Figure 12: t-SNE plot of PBTCA based on Funding

The t-SNE plots showed different visualizations of PBTCA based on GPR and funding. The t-SNE plot distinctly clusters the PBTCA based on the GPR of the universities. It can be observed that only the NE and NC regions are homogeneous, indicating that their PBTCA is similar, regardless of the funding type. However, other regions were mixed with each other. This is because the funding type has a greater influence than GPR. Therefore, universities with similar funding types are clustered together, despite their differences in GPR.

A remarkable pattern in **Figure 11** is that private universities appear to be positioned between federally and state-funded universities. This clearly demonstrates that the PBTCA of private universities is bridging the gap between federal and state universities.

Discussion

The NUC, which is the statutory licensing and regulatory body charged with the responsibilities of promoting quality higher education in Nigeria, is enjoying a sort of monopoly in accreditation. For instance, the data used in this paper could only be obtained from them. They are the only ones that host the statistics of the accreditation and other related data of the NUS **(Olukanni, 2022)**. Hence, the data cannot be validated using another related accreditation measure. The gaps present in the raw data would have been complemented if other alternative accreditation bodies were licensed to operate. Hitherto, only accreditation bodies for professional courses such as medicine, law, engineering, architecture, building, pharmacy, nursing, and other related courses are allowed by Nigerian law **(Ezema et al., 2016)**. The accreditation criteria are different and hence present no other means of validating the results of one against another. Programs such as mathematics could only be accredited locally by NUC. Research suggested that NUC should relinquish the accreditation of professional courses, and professional bodies should instead be statutorily empowered to be the sole body in charge of accreditation, which according to the authors, will remove bureaucracy and government influence and expose underfunding of education bedeviling the NUS **(Agboola & Elinwa, 2013)**. A decentralization model of accreditation should be the way forward, as suggested by **Okoroma (2007)**.

Federal universities lead in the number of full accreditations of mathematics programs, followed by state and then private universities. When the result was

probed further, it showed that full accreditation constituted 73.6%, 65.3%, and 70% when compared to interim and denied accreditation when viewed separately. This corroborated an earlier study that revealed that federal and private universities have more incidence of obtaining full accreditation **(Osokoya et al., 2017)**. However, this study found no evidence that the accreditation status is independent of the funding type of the universities.

The percentage of interim accreditation is very high at 27.3% and combining it with 3.8% of denied accreditation means that the probability of obtaining full accreditation for mathematics programs in Nigeria is about 70%. This equally means that 3 out of every 10 accreditation visits will not result in full accreditation. This is unacceptably high if quality education is anticipated in Nigeria.
The total autonomy of NUC is recommended since it is not possible for demonopolizing it since it is one of several regulatory agencies in Nigeria. Hence, they should be allowed to function without external influences.

Although the SW region of Nigeria has the highest representation in the sample, the region leads in the highest number of full accreditations, while the three regions of SE, NE, and NW have fewer instances of full accreditations of their respective mathematics programs domiciled in those regions. A further probe showed that the SW secedes from other five regions in terms of full accreditations. The SW region is undoubtedly the education hub of Nigeria as it has the highest number of universities in the country **(Mogaji, 2019)** and the region is known for being very effective in university administration leading to full accreditation **(Akomolafe & Adesua, 2020)**. Competition is high there, and it is not surprising that the SW region leads in the number of full accreditations. The high number of denied accreditation in the SS and SE regions should be further investigated by researchers. For universities in the SE, improvement of academic contents **(Nnorom et al., 2022)**, provision of facilities **(Obiakor & Nwakpa, 2022)**, and adequate investment in learning resources **(Mbagwu & Udo-Anyanwu, 2021)** could be possible solution options. For the SS region, survey research rated the level of adequacy of requirements for accreditation of academic programs in the region as moderate **(Akpan & Etor, 2016)**. Another survey concluded that the gap in the adequacy of requirements for accreditation of academic programs in the SS region is due to the quality of teaching staff, funding, physical facilities, and learning resources **(Agboola & Bassey, 2021)**. Furthermore, recruitment of quality teaching staff is urgently needed to reduce the student-lecturer ratio **(Opanuga et al., 2019)** and reverse the brain drain that is currently depleting the human capital stocks that are indispensable in delivering quality education. In this line, a recent article has suggested some retention strategies that, when implemented, reduce the brain drain syndrome as witnessed today in NUS **(Salau et al., 2021)**. Implementation of these measures is vital to change the status quo, as this paper also showed that the two regions (SE and SS) have the least percentage of full accreditation when compared with interim and denied.

NUC guidelines state that full and interim accreditation statuses are valid for only five and two years, respectively, while denied accreditation implies that a fresh accreditation visit must be prepared immediately. Otherwise, the affected program is mandated to stop admitting students. This paper showed that, on average, the rules were routinely violated as this research showed that the mean period between two successful full accreditations for federal, state, and private universities for accreditation of mathematics programs at NUS is 6.37, 5.78, and 5.08, respectively. The same results were obtained for the other categories. The federal and state universities appear to be more culpable than the private universities. This could be the effect of political interference in the accreditation process. The private universities have little influence and often must adhere to the stipulated guidelines for fear of undermining their investment, which occurs when they are denied accreditation. Research that surveyed private universities in SW showed encouraging adherence to NUC stipulated guidelines in terms of acceptable capacity levels, satisfactory quality of teaching staff, and considerable compliance level to the national admission requirements **(Adedeji et al., 2019)**. The period between interim and full accreditation for the federal, state and private universities are within the stipulated 2 years. However, the federal universities that have were denied accreditation bounces back faster than the state universities.

The paper also showed regional disparities in the period between northern and southern Nigeria. Two instances are given. First, the mean period (in years) between consecutive two full accreditations (FF) is 6.08 for NC, 5.89 for NE, and 6.38 for NW, while in the southern

region, it is 6.11 for SE, 5.50 for SS, and 5.93 for SW. Second, the mean period (in years) between full and interim accreditations (FI) is 7.25 for NC, 7.50 for NE, and 6.00 for NW, while in the southern region, it is 5.88 for SE, 5.43 for SS, and 5.00 for SW. This can be explained in two ways: any delayed accreditation may most likely result in interim, or universities in some GPRs appear to be given some more concessions than others. Technically, it appears they are given the nod for extra time to prepare adequately for upcoming accreditations, which could be an indication of bias. No wonder the federal universities in NC were reported to be better than those in SW Nigeria **(Binuomote et al., 2020)**. Apart from the usual internal politics of window dressing by some universities in preparation for accreditation **(Ekpoh & Edet, 2017)**, the result presented here is a pointer that historically, politics have been part of the accreditation program at NUS. Notwithstanding, NUC should improve its accreditation role to improve the overall quality of education in NUS, an assertion echoed in **Yinka (2014)**, although accreditation does not necessarily improve the efficiency of university staff **(Oribabor, 2008)** as window dressing **(Isi, 2021)**, corruption, and misrepresentation are often used to mislead NUC visiting teams into securing full accreditation **(Obiakor & Nwakpa, 2022)**. However, a study has shown that it improves the efficiency of graduates (high graduation rate and low attrition) **(Abolo, 2020)** and not employability due to a perceived lack of curriculum innovation **(Asiyai, 2022)**, which advocates a shift from the current focus on certificates to skills acquisition **(Igwe et al., 2022)**.

A look at the raw data published by the NUC and analyzed in this paper, showed that there has been an improvement in accreditation statuses. Federal universities have more programs with full accreditations than state universities. This was also reported by the authors in **Alani and Ilusanya (2008)**. Now, it appears that private universities may soon overtake the state universities as accreditation status improved in subsequent accreditations compared with the state. In this research, it appears that the worst performers are state universities. Further research that would consider different academic programs may yield a similar result. It could be that the state governments in Nigeria are not funding education as mandated by law **(Anugom, 2016)** because funding is a key determinant in achieving full accreditation of academic programs **(Ogunode & Adah, 2022)**. Poor funding coupled with acute infrastructure deficits **(Oluwunmi et al., 2017)**, inadequate learning resources **(Falola et al., 2022)**, corruption and financial misappropriation leading to poor working conditions and lack of investment in university staff **(Chidi, 2019)**, and government noncompliance with laws regarding the establishment and management of universities **(Tijani & Odusote, 2022)** are the major challenges to be tackled head-on if quality education and quality graduates are to be envisioned.

The findings from this research, indicating that the outcomes of consecutive accreditation for mathematics programs in Nigerian universities are consistent across the three funding types (federal, state, and private) and the six GPR, could be interpreted in several ways. Firstly, it could imply that the standards of the programs, whether high or low, remain consistent, or that the accreditation process yields similar outcomes regardless of funding type or GPR location of the universities. Secondly, it could suggest that there is consistency in accreditation outcomes, indicating that quality assurance measures within the mathematics programs are uniformly applied. Thirdly, the utilization of uniform evaluation standards across the board might obscure variations in the quality of mathematics programs, as university authorities could potentially influence the outcomes or might restrict the development of mathematics based on the accreditation metrics prescribed by NUC. This could impede the creativity and innovation necessary for advancing mathematics programs beyond the confines set by regulatory agencies.

Researchers have applied different clustering methods in the accreditation of programs to improve the efficiency and effectiveness of the accreditation process. Examples are grouping similar programs with shared features **(Knight et al., 2013)**, identification of accreditation standards **(Zorek & Raehl, 2013)**, benchmarking and comparison among programs within the same cluster **(Cossani et al., 2022)**. Others include the development of tailored evaluation criteria for each cluster of programs, quality assurance, improved decision-making, and development of a tailored review process and procedure to address programs with shared characteristics **(Ghufron et al., 2020)**. This paper has now expanded the application of cluster analysis to the period between two successive accreditations. Most of the available applications of clustering in the accreditation of programs are based on precipitation of

clusters from school characteristics **(Surarso & Gernowo, 2020)**, geographical distribution **(Cash et al., 2022)**, impact of lecturers' ratings **(Nnorom et al., 2022)**, and maintenance of quality facilities **(Amaechi & Obiweluozor, 2021)**. This paper showed two non-overlapping clusters of the accreditation of mathematics programs in NUS. Technically, the two clusters contained contrasting accreditation outcomes, which policymakers can collapse into one when proper funding of universities is done to improve their accreditation results.

Funding type has been observed to have more influence than GPR; hence, universities of similar funding type are clustered together despite their GPR differences. It appears that federal universities and private universities have better accreditation results compared to state-funded universities. The state universities, irrespective of their geopolitical location, are lagging behind, and private universities should also be monitored to invest a substantial amount of their profits into the improvement of the programs they run **(Daagu et al., 2022)**.

Limitation

The study was solely dependent on the information from NUC and hence, no independent verification of the data. Secondly, there appears to be censored observations, it could be that the programs have closed down or NUC are yet to update the database.

Recommendation

Policymakers in Nigeria should ensure the proper funding of universities, development of robust program curriculum, availability of the prescribed quantity and quality of teaching staff, and availability of physical and learning resources to improve the probability of securing full accreditation of mathematics and other programs **(Francis, 2022)**.

Conclusion

The study reveals regional disparities in accreditation outcomes of mathematics programs in Nigeria. The high percentage of interim accreditation and denied accreditation suggests the need for improvement in funding, curriculum development, teaching staff, and physical and learning resources. The research also identifies political interference and systemic corruption as factors affecting the accreditation process. Furthermore, it discusses the importance of addressing regional disparities and improving the efficiency and effectiveness of accreditation through clustering methods. The paper emphasizes the significance of proper funding and investment in programs for achieving better accreditation results and quality education. Finally, the paper showed that there are no significant differences in the outcomes of consecutive accreditation visits for mathematics programs in Nigeria based on either funding type or GPR.

Funding

No funding is reported.

Ethical Approval

No ethical approval is required. The paper analyzed publicly available data that can be used for research.

Informed consent

This article does not contain any studies with human participants performed by any of the authors.

Author's contribution

All the authors were involved in all the processes that birthed the paper.

Conflict of interest

No conflicting interest is reported.

Data availability statement

The data can be accessed via the NUC website https://www.nuc.edu.ng/undergraduate-accreditation-results/

Consent for Publication

All the authors have agreed on the final version of the paper and have agreed for the paper to be published in a peer-reviewed journal.

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