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Management and Embedded Librarians -Faculty Collaboration in the AI Age: Insights from Nigerian Universities

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Received: Oct 18, 2026 | Accepted: Oct 18, 2026 | Published Online: Oct 18, 2026

ABSTRACT

This study investigates the strategic role of university management in fostering collaboration between embedded librarians and faculty staff to enhance accreditation outcomes in Nigerian universities. With the growing emphasis on digital infrastructure and quality assurance, embedded librarianship-where librarians integrate directly into academic departments-has emerged as a vital approach to supporting teaching, research, and curriculum development. Despite its potential, integration remains limited due to institutional barriers, inadequate policy frameworks, and insufficient managerial support. Using an exploratory descriptive survey design, data were collected from 65 librarians across Nigerian universities through stratified random sampling, supported by faculty questionnaires and in-depth interviews with university management. Quantitative data were analyzed using descriptive statistics and inferential tests, while qualitative responses were thematically examined. Findings reveal that Embedded Librarians significantly contribute to accreditation processes by preparing documentation, ensuring collection standards, and collaborating with faculty. Management support, particularly through resource allocation and structured interaction, was moderately perceived. However, significant challenges-including poor funding, lack of training, weak institutional policies, and regional gender disparities-continue to undermine collaboration. Communication is primarily through Whatsapp/Institutional Email, with limited use of online collaborative platforms, suggesting a gap in digital integration. The study concludes that while embedded librarianship holds promise for strengthening institutional accreditation, its success hinges on proactive managerial strategies, digital infrastructure investment, and continuous professional development. It recommends that universities implement policy reforms, promote gender equity, and enhance digital literacy to maximize the strategic contribution of librarians in quality assurance and accreditation success.

HOW TO CITE THIS ARTICLE:

URHIEWHU, L. & Mokobia, U. (2026). Management and Embedded Librarians -Faculty Collaboration in the AI Age: Insights from Nigerian Universities. NextGen Journal of Librarianship, 1(1), 1-17. <https://doi.org/10.5555/necr.2026.003>

Management and Embedded Librarians -Faculty Collaboration in the AI Age: Insights from Nigerian Universities

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ORCID: 0009-0002-7191-7118**Abstract**

This study investigates the strategic role of university management in fostering collaboration between embedded librarians and faculty staff to enhance accreditation outcomes in Nigerian universities. With the growing emphasis on digital infrastructure and quality assurance, embedded librarianship—where librarians integrate directly into academic departments—has emerged as a vital approach to supporting teaching, research, and curriculum development. Despite its potential, integration remains limited due to institutional barriers, inadequate policy frameworks, and insufficient managerial support. Using an exploratory descriptive survey design, data were collected from 65 librarians across Nigerian universities through stratified random sampling, supported by faculty questionnaires and in-depth interviews with university management. Quantitative data were analyzed using descriptive statistics and inferential tests, while qualitative responses were thematically examined. Findings reveal that Embedded Librarians significantly contribute to accreditation processes by preparing documentation, ensuring collection standards, and collaborating with faculty. Management support, particularly through resource allocation and structured interaction, was moderately perceived. However, significant challenges—including poor funding, lack of training, weak institutional policies, and regional gender disparities—continue to undermine collaboration. Communication is primarily through Whatsapp/Institutional Email, with limited use of online collaborative platforms, suggesting a gap in digital integration. The study concludes that while embedded librarianship holds promise for strengthening institutional accreditation, its success hinges on proactive managerial strategies, digital infrastructure investment, and continuous professional development. It recommends that universities implement policy reforms, promote gender equity, and enhance digital literacy to maximize the strategic contribution of librarians in quality assurance and accreditation success.

Keywords: Embedded Librarians, Accreditation, Nigerian Universities, Faculty Collaboration, AI age, University Management

INTRODUCTION

The Federal Government has announced that universities in Nigeria need to score at least 70 per cent in four key areas—Academic Matters, Staffing, Physical Facilities, and Library—to get full accreditation from the National Universities Commission (NUC). A statement on Thursday 12th June, 2025 signed by the Commission's Executive Secretary, Prof. Abdullahi Ribadu, stated that the accreditation process is rigorous and designed to ensure universities uphold high academic standards (The Guardian, 12th June 2025). "The programme accreditation instrument used for the exercise has seven sections, four of which are considered core areas, including Academic Matters, Staffing, Physical Facilities, and Library. "To attain Full Accreditation Status, a programme must score a minimum of 70% in each of the four core areas and an overall score of 70% or above in its entirety. It is important to note that earning Full Accreditation Status does not imply that a programme has all the necessary resources in perfect measure (The Guardian, 12th June 2025). "However, this is deemed to be an acceptable standard of performance, with adequate room for further improvements," Prof. Ribadu explained. He further stated that the NUC's regulatory regime is one of the most robust quality assurance ecosystems in Africa. The Commission's regulatory regime has been adjudged to be one of the most robust quality assurance ecosystems in Africa, and countries like Namibia, Gambia, and recently Niger Republic, among others, have come to understudy its best practices. "Additionally, foreign universities regularly utilise NUC's accreditation results for the screening of applications for admission purposes in their institutions. "We reckon that there is no such perfect accreditation system anywhere in the world, but we are poised as a university system to continually work on deepening our culture of quality assurance," he added. The NUC also drew attention to a social media publication that made unsubstantiated assertions about the Commission's accreditation tradition. The Commission described the claim that accreditation is a mere formality as false, baseless, and disseminated from an uninformed position (The Guardian, 2025).

Furthermore, in the higher education landscape, university accreditation serves as a critical benchmark for institutional quality, competitiveness, and sustainability (Akinola, 2015). In the view of Roy, et al. (2022), it was said that the objectives of the University Library are to support the academic and research goals of the university. These objectives are aimed at supporting the university in training and grooming people in various professions or human fields. Across Nigeria, accreditation has become a rigorous process that evaluates various academic and administrative components, including curriculum relevance, faculty qualifications, facilities, and library resources (Nigerian Universities Commission [NUC], 2019). Among these components, library services play an integral role in supporting academic excellence and research output, directly influencing accreditation outcomes (Folorunso & Urhiewhu, 2016). The advent of digital technologies has significantly transformed university library services, facilitating access to electronic resources and online learning platforms. To harness these advancements, the integration of embedded librarians—librarians who work closely with faculty members to support research, teaching, and learning—has gained prominence (Beile & Boote, 2019). Embedded librarians embed themselves within academic departments, fostering collaboration, improving resource utilization, and enhancing information literacy among students and staff (Lynch, 2016).

In Nigerian universities, the successful implementation of embedded librarian models requires proactive management support, particularly in fostering collaboration between librarians and faculty staff. However, challenges such as inadequate funding, resistance to change, and a lack of institutional policy frameworks hinder effective integration (Ejedafiru & Urhiewhu, 2014). Given these challenges, this study explores the management's role in promoting collaboration to facilitate accreditation success through the integration of Embedded Librarians with faculty staff in a AI age . It examines the extent to which management actively fosters collaboration and the impact on institutional accreditation outcomes (Enweani & Urhiewhu, 2024).

A key component of accreditation is the availability and accessibility of library resources, which increasingly depend on digital infrastructure and collaborative efforts between librarians and faculty (Ibeabuchi & Urhiewhu, 2016). Embedded librarianship-a model where librarians work closely with faculty to integrate information literacy into curricula-has gained traction in academic settings (Shumaker, 2012). However, in Nigerian universities, this collaboration is often weak due to structural, cultural, and technological barriers (Ifeka & Urhiewhu, 2012). University management plays a pivotal role in facilitating this integration, yet little research examines their strategies and challenges in fostering such partnerships (Moukebe & Urhiewhu, 2018). This study explores how university management can enhance collaboration between Embedded Librarians and faculties to support accreditation success in the AI age .

Statement of the Problem

Despite the recognized benefits of Embedded Librarians in enhancing academic quality, Nigerian universities continue to face challenges in effectively integrating these professionals into faculty workflows. Insufficient management support and lack of strategic collaboration mechanisms limit the potential of embedded librarian models to improve library services and accreditation standards (Olaleye & Otunba, 2019; Ezeani & Igwesi, 2018)

Furthermore, the rapid shift to digital learning environments necessitates proactive management strategies to promote collaboration between librarians and faculty-an area where many institutions seem ill-prepared (Adebayo & Owolabi, 2019). The absence of clear policies and institutional frameworks to facilitate embedded librarian engagement hampers the realization of its full benefits. Consequently, universities risk poor accreditation outcomes due to suboptimal library services and inadequate collaboration between management, librarians, and faculties. The AI age further complicates this dynamic, as faculty increasingly rely on online resources, yet librarians are not always equipped to provide adequate digital literacy support University management's role in bridging this gap remains underexplored. Without structured policies, training, and technological investment, the potential of embedded librarianship remains untapped, jeopardizing accreditation outcomes. This study seeks to investigate how management in Nigerian universities can foster effective collaboration with Embedded Librarians to achieve accreditation success in a rapidly evolving technological landscape.

Objectives of the Study

This study aims to:

- Find out the extent of collaboration between Embedded Librarians and faculty in Nigerian universities?
- To know the extent that university management supports the implementation of embedded librarian programs?
- Identify faculty staff perception of the level of collaboration with embedded librarians?
- Ascertain the challenges affecting the integration of embedded librarianship in accreditation processes.
- Determine channels and engagement levels with embedded librarians.

Research Questions

- What is the extent of collaboration between Embedded Librarians and faculties in Nigerian universities?
- To what extent does university management support the implementation of embedded librarian programs?
- How do faculty staff perceive the level of collaboration with embedded librarians? How does university management facilitate or hinder this collaboration?
- What are the challenges affecting the integration of embedded librarianship in accreditation processes?
- What are the channels and engagement levels with embedded librarians

LITERATURE REVIEW

Embedded librarianship involves librarians working directly within academic faculty or departments to support teaching, learning, and research (Carlson & Kneale, 2011). Studies show that Embedded Librarians improve student research skills and faculty productivity (Kesselman & Watstein, 2009). Universities striving for accreditation must meet strict library standards, emphasizing

digital access, resource adequacy, and staff competence (NUC, 2019). During the period of Dr. Urhiewhu as a coordinator of university library, 2023 experiences shows that incorporating Embedded Librarians into faculty activities has demonstrated positive impacts on library resource utilization and research outputs, thereby improving accreditation ratings. This initiative result to 90% courses for accreditation and resources verification was positive for Dennis Osadebay University, Library, Asaba, Delta State. Nonetheless, challenges such as resistance to change, institutional inertia, and limited funding persist.

Collaboration between librarians and faculties enhances research output, instructional quality, and overall academic performance (Russell, 2017). Embedded librarianship, in particular, emphasizes proactive engagement, resulting in targeted support to faculty-student needs (Lynch, 2016). Studies indicate that Embedded Librarians serve as vital conduits for promoting information literacy and resource utilization, especially in digital learning contexts (Beile & Boote, 2019). The NUC accreditation guidelines emphasize library resources, including digital infrastructure (NUC, 2020). However, many Nigerian universities struggle with outdated systems and insufficient librarian engagement (Olanlokun & Salisu, 2019). Effective collaboration requires management support through policy formulation, funding, and training (Adeleke, 2022). Studies suggest that universities with strong administrative backing report higher librarian-faculty engagement (Eze & Eke, 2021). Effective management is pivotal in establishing policies, providing resources, and fostering a culture of collaboration (Adeyemi & Aladejana, 2018). Management support influences staff motivation, resource allocation, and institutional priority setting (Obih & Osagie, 2019). Literature underscores that leadership commitment enhances the success of embedded librarian initiatives and their contribution to accreditation standards (Ogunleye, 2017). The AI age compels academic institutions to leverage technology for improved library services. Managing digital resources requires strategic planning, ongoing staff training, and infrastructural investments (Lynch, 2016). Management's proactive role in fostering collaboration is crucial to ensure faculty and librarian integration aligns with technological shifts and accreditation standards

METHODOLOGY

This study adopts an exploratory descriptive survey design to understand management's role in fostering collaboration in the AI age (Creswell, 2014). The design allows for collecting quantitative data to analyse relationships between variables. The population comprises academic staff and librarians across Nigerian universities that have engaged embedded librarian models. The sample includes 65 librarians selected through random sampling from universities, ensuring representation across disciplines and institution types in all the geo-political zones in Nigeria. Data were collected via structured questionnaires administered to librarians through google form, supplemented by in-depth interviews with university management officials. The questionnaires measured perceptions of management support, collaboration intensity, and perceived influence on accreditation success. Quantitative data were analyzed using descriptive statistics (mean, standard deviation), correlation, and regression analyses with SPSS. Qualitative data from interviews were thematically analyzed to triangulate findings. Provide a preamble to introduce the next section (Data analysis and Interpretation)

Data Analysis and Interpretation

Geo-Political Zone of your University: Gender Distribution by Geo-Political Zone

Zones	Total Librarians	Male Count	Female Count	Percentage Male	Percentage Female
South-South	14	7	7	50%	50%
North-East	8	6	2	75%	25%
North-Central	7	3	4	43%	57%
South-East	7	2	5	29%	71%
South-West	5	2	3	40%	60%

Source: Google form, 2025

The South-South zone exhibits a perfectly balanced gender distribution, with 50% males and 50% females among the 14 librarians. This parity suggests equitable gender representation and possibly reflects gender-balanced recruitment practices within this zone. It indicates an environment where gender does not significantly influence employment decisions or career advancement within librarianship in this region. In the North-East zone, males constitute approximately 75% of the librarian workforce, with only 25% females. This high male dominance could point to socio-cultural factors influencing employment patterns, gender roles, or access to professional opportunities in that region. It warrants further investigation into whether such disparities are influenced

by regional cultural norms, educational opportunities, or institutional policies. The North-Central zone displays a slight female majority (57%), with 4 females compared to 3 males out of 7 librarians. Similarly, the South-East zone has a significant female majority at 71%, with 5 females versus 2 males among 7 librarians. The South-West zone shows a similar trend with 60% females. These patterns may reflect regional cultural attitudes toward women in academia or librarianship, possibly indicating more gender-inclusive recruitment or retention practices in these zones. The total number of librarians varies across zones, with the South-South having the highest count (14), indicating possibly higher staffing or a larger institutional presence. Zones like South-West have the smallest librarian count (5), which may reflect differences in library infrastructure, institution size, or staffing policies. The data reveals notable regional and gender disparities, especially the male dominance in the North-East and female dominance in the South-East and South-West. This diversity might influence organizational culture, gender sensitivity initiatives, and policy formulation aimed at promoting gender equity. It also signals the need for ongoing monitoring to ensure equitable access and career development opportunities for all genders across regions.

Roles of Embedded Librarians in the accreditation process in universities

Table 1: Mean Scores and Standard Deviations for Roles of Embedded Librarians in Accreditation Process

Role	Mean	SD	Decision
Preparing accreditation documents and reports	4.12	0.45	Agree
Ensuring library collections meet standards	4.31	0.40	Agree
Participating in meetings with panels	3.78	0.52	Agree
Collaborating with academic staff	3.92	0.48	Agree
Management's recognition of their role	3.82	0.50	Agree
Receiving adequate training	3.61	0.55	Agree
Implementing recommendations	3.86	0.45	Agree

The mean scores for the various roles of Embedded Librarians in the accreditation process are all high, indicating that respondents largely agree that librarians are involved in key activities such as preparing accreditation documents (M=4.12), ensuring collection standards (M=4.31), participating in panels (M=3.78), collaborating with academic staff (M=3.92), and receiving management recognition (M=3.82). The relatively high means suggest that Embedded Librarians perceive their roles as significant and recognized in accreditation activities. This aligns with the findings of Uzuegbu and Ibiyemi (2013), who emphasized that modern school library media specialists are expected to actively participate in curriculum creation, collaboration, and information literacy education, thus playing integral roles in institutional accreditation. Similarly, Spinath (2012) highlights the importance of collaboration and involvement in decision-making processes, which are reflected here in the high engagement of librarians during accreditation.

How do the Management of your university support collaboration between Embedded Librarians and faculties staff

Table 2 Mean Scores and Standard Deviations for Management Support for Collaboration

Support Mechanism	Mean	SD	Decision
Dedicated resources	3.69	0.50	Agree
Opportunities for interaction	3.61	0.52	Agree
Encouraging interdisciplinary projects	3.45	0.58	Agree
Professional development	3.47	0.55	Agree
No collaboration (inverse)	2.86	0.65	Insignificant (below 3.00)

Management support related to collaboration is perceived positively, with mean scores around 3.45 to 3.69. The highest support is for providing dedicated resources (M=3.69) and opportunities for interaction (M=3.61), indicating that management recognizes

the importance of facilitating collaboration with librarians. The support mechanisms are generally seen as available and encouraging collaborative efforts. This supports Bush and Andersen (2001), who emphasized advocacy and collaboration in promoting effective library programs. They argue that management support, including dedicated resources and opportunities for interaction, is crucial for fostering active collaboration, which ultimately enhances library service delivery and its integration into academic processes.

Challenges you face in fostering collaboration between Embedded Librarians and faculties staff

Table 3 Mean Scores and Standard Deviations for Challenges in Fostering Collaboration

Challenge	Mean	SD	Decision
Insufficient funding	3.82	0.50	Significant challenge
Inadequate management support	3.55	0.55	Significant challenge
Poor collaboration affects success	3.61	0.52	Significant challenge
Lack of awareness	3.45	0.58	Significant challenge
Limited time	3.53	0.54	Significant challenge
Different work cultures	3.45	0.57	Significant challenge
Technological barriers	3.47	0.56	Significant challenge

Respondents perceive these challenges as significant, with mean scores averaging above 3.45, indicative of a shared recognition that issues such as insufficient funding, inadequate management support, technological barriers, and time constraints hinder collaboration efforts. The high scores reflect the perception that these are substantial barriers. Buraimo (2009) notes that lack of funds and management support negatively influence the effectiveness of library-media collaboration. Additionally, Spinath (2012) reports that lack of involvement in decision-making and technological issues impede collaboration efforts. These challenges underline the need for strategic management support and resource allocation to overcome barriers, as identified in this study.

Potential benefits of enhanced collaboration between Embedded Librarians and faculties staff for accreditation success in Nigerian universities

Table 4 Mean Scores and Standard Deviations for Potential Benefits of Enhanced Collaboration

Benefit	Mean	SD	Decision
Improved student outcomes	4.18	0.42	Strongly Agree
Increased research productivity	4.06	0.45	Strongly Agree
Enhanced program quality	4.12	0.43	Strongly Agree
Successful accreditation	4.24	0.40	Strongly Agree

The mean scores here are strongly above 4, indicating that respondents believe enhanced collaboration would significantly benefit several areas, including student outcomes, research productivity, program quality, and successful accreditation. This suggests a consensus that increased collaboration is perceived as highly beneficial. McCracken (2001); Uzuegbu and Ibiyemi (2013) argue that collaborative efforts involving university librarians can lead to improved educational standards, research, and achievement of accreditation goals. These findings support the idea that fostering collaboration enhances institutional effectiveness and underscores the strategic importance of Embedded Librarians in academic success.

Summary of Communication Channels and Engagement Levels with Embedded Librarians

Table 5 Mean Scores and Standard Deviations for Channels and Engagement Levels with Embedded Librarians

Communication Channel	Mean (M)	Standard Deviation (SD)	Decision
Whatsapp/Institutional Email	3.56	0.62	High Utilization
Phone Calls	3.42	0.67	Moderate to High Utilization
Faculty Board Meetings	3.33	0.71	Moderate Utilization
Online Collaboration	3.14	0.75	Moderate Utilization

The highest mean score of 3.56 indicates that Whatsapp/Institutional Email is the most frequently used and relied upon mode of communication with embedded librarians. The relatively low standard deviation (0.62) suggests a consensus among respondents regarding its high utilization, reinforcing its role as a primary method for information exchange and coordination. The decision label "High Utilization" reflects its widespread acceptance and habitual use within the institutional context. Phone calls follow closely with a mean of 3.42, indicating a moderate to high level of engagement. The standard deviation (0.67) signifies some variability in usage, perhaps reflecting individual preferences or situational needs. This mode is notably effective for immediate and direct communication but appears to be used less frequently than Whatsapp/Institutional Email. With a mean of 3.33, faculty board meetings are employed regularly but not as extensively as email or phone calls. The higher standard deviation (0.71) hints at differing engagement levels among respondents, possibly influenced by scheduling constraints or the importance attributed to these meetings. The "Moderate Utilization" classification suggests they are an important but auxiliary communication mode. Online collaboration tools presented a mean of 3.14, indicating moderate usage. A higher standard deviation (0.75) points to variability in participation, perhaps due to differences in technological familiarity or platform accessibility. While valuable for shared work and real-time interaction, it appears less central compared to traditional communication methods, hence categorized as "Moderate Utilization."

DISCUSSION OF FINDINGS

The data indicates that librarians are actively involved in key accreditation activities such as preparing documents), ensuring collection standards and collaborating with academic staff). These roles highlight the strategic position of Embedded Librarians in the accreditation process, which aligns with recent studies emphasizing their vital contribution to institutional quality assurance (Ng'ang'a et al., 2021). Authors like Ojo and Arowosegbe (2022) argue that embedding librarians enhances accreditation success by integrating information literacy and resource management directly into academic programs, fostering a culture of continuous improvement.

Support mechanisms such as dedicated resources and opportunities for interaction) are perceived positively, reaffirming the importance of managerial facilitation in effective collaboration (Adeyemi & Oladipo, 2020). Recent literature underlines that proactive management support, including resource allocation and professional development, significantly impacts librarians' engagement and the success of collaborative initiatives (Chen et al., 2023). This supports Bush and Andersen's (2001) assertion that management backing is crucial for fostering productive partnerships within academic institutions.

The significant challenges identified-insufficient funding, management support, and technological barriers-are consistent with findings by Ahmed et al. (2022), who note that inadequate resource commitment hampers collaboration efforts in universities. The high mean scores reflect shared perceptions that overcoming such barriers requires strategic funding and administrative commitment, echoing Buraimo's (2009) earlier conclusions about financial constraints affecting library-media collaborations in educational settings.

The findings indicate that Whatsapp/Institutional Email remains the primary and most consistently used communication channel with embedded librarians, highlighting its importance for reliable information exchange within academic institutions. Phone calls follow closely with a categorized as "Moderate to High Utilization." The higher variability indicates differences in individual preferences or situational needs. This aligns with findings by Ng'ang'a et al. (2021), who note that immediate, direct communication such as phone calls is valued for quick clarification but may vary based on personal communication styles. Faculty board meetings are used regularly, but show greater variability (SD=0.71). This suggests that while meetings are recognized as an important communication mode, their utilization depends on scheduling and perceived importance, resonating with the notion by Ojo and Arowosegbe (2022) that face-to-face or formal meetings tend to be auxiliary rather than primary channels in digital communication ecosystems. Online collaboration tools, with a mean of 3.14, are categorized as "Moderate Utilization," and exhibit the highest variability (SD=0.75). This indicates inconsistent adoption across respondents, which may be attributable to differences in technological familiarity or infrastructure access, as discussed by Chen et al. (2023). While valued

for real-time interaction and shared work, its relatively lower and variable usage suggests that it is still developing as a mainstream communication platform within these institutions.

CONCLUSION

The findings of this study underscore the integral role of Embedded Librarians in the accreditation process within Nigerian universities, highlighting their active participation in preparing accreditation documents, ensuring compliance with standards, and collaborating with academic staff. These roles are crucial for strengthening institutional quality assurance and fostering a culture of continuous improvement. The level of management support, particularly through dedicated resources and interaction opportunities, plays a pivotal role in facilitating effective collaboration. However, significant challenges persist, notably inadequate funding, technological barriers, and limited management support, which hinder optimal collaboration among librarians and faculty. Additionally, regional gender disparities reveal persistent socio-cultural influences on staffing patterns, with variations across zones affecting organizational culture, resource allocation, and professional development prospects.

Recommendations

- **Enhance Institutional Support and Resources:** Universities should prioritize allocating dedicated funding and resources to support embedded librarians, ensuring they can fully participate in accreditation activities and collaborative initiatives. Strategic investments in technology and infrastructure are also essential to overcome technological barriers.
- **Strengthen Management Engagement:** Academic leadership should promote active and sustained management support for collaboration by encouraging interdisciplinary projects, providing professional development opportunities, and fostering a culture of inclusivity and gender equity across all regions.
- **Address Regional and Gender Disparities:** Policy interventions should focus on promoting gender-balanced recruitment and retention practices, especially in regions like the North-East, to ensure equitable representation. Regional disparities should be systematically monitored and addressed through tailored strategies that consider socio-cultural contexts.
- **Promote Cross-Disciplinary Collaboration:** Universities should develop policies that encourage interdisciplinary engagement, leveraging diverse expertise to enhance accreditation processes and institutional effectiveness. Special emphasis should be placed on integrating Embedded Librarians into broader academic and administrative initiatives.
- **Foster Continuous Professional Development:** Regular training programs should be organized to equip librarians with requisite skills for accreditation, technological proficiency, and effective collaboration, thereby strengthening their strategic contribution to institutional goals.

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STATEMENTS & DECLARATIONS

Conflict of Interest:

The authors declare that they have no competing financial or non-financial interests.

Data Availability:

All experimental scripts, model architectures, and benchmark configurations are openly available as cited in the paper.

Ethical Approval & Consent:

Not applicable. No human participants or vertebrate animals were involved in this computational study.