EFFECT OF INTERDISCIPLINARY COLLABORATION ON INNOVATIVE PERFORMANCE OF ACADEMIC STAFF OF FEDERAL UNIVERSITIES IN NORTH CENTRAL NIGERIA

By

Suleiman, Ahmed Aremu
Department of Business Administration,
Faculty of Management Sciences, University of Ilorin, Ilorin, Nigeria
E-mail: aremu.ahmed40@gmail.com; suleiman.aa@unilorin.edu.ng

Dauda Abdulsalam, PhD
Department of Business Administration, Faculty of Management Sciences,
Usmanu Danfodiyo University, Sokoto, Nigeria
E-mail: daomoyi@yahoo.co.uk

Nasir, Liman, PhD
Department of Business Administration, Faculty of Management Sciences,
Usmanu Danfodiyo University, Sokoto, Nigeria
E-mail: limannasir@yahoo.com

AbdulSalam Nasiru Kaoje, PhD
Department of Accounting, Faculty of Management Sciences,
Usmanu Danfodiyo University, Sokoto, Nigeria
E-mail: kaoje73@gmail.com

Abstract
This study examines the effect of interdisciplinary collaboration on innovative performance of Academic Staff of Federal Universities in North Central, Nigeria using Structural Equation Model (SEM) to analyse the 378 valid responses collected through the use of questionnaire in Microsoft Form from the Academic Staff. The study used Cross Disciplinary Publication (CDP), Cross Listed Courses (CLC), Inter-Disciplinary Centre (IDC), and Joint Research Project (JRP), as the main proxies for measuring interdisciplinary collaboration, while Research quality is used for measuring innovative performance. The study found that Interdisciplinary collaboration via CDP, CLC, IDC, and JRP has positive and significant effect on research quality of the Academic Staff of Federal Universities in North Central, Nigeria. The study therefore recommends that the management of Federal Universities in North Central, Nigeria, should optimize the use of interdisciplinary collaboration for improving the innovative performance of Academic Staff in the area of qualities research by paying attention to variables such as Cross Disciplinary Publication (CDP), Cross Listed Courses (CLC), Inter-Disciplinary Centre (IDC), and Joint Research Project (JRP) in order to remain relevant as global change movers.

Key words: Cross listed courses, Interdisciplinary collaboration and centres, Innovative performance, Joint research project and publication, Research quality,

I. Introduction

The basic role plays by every academic institution is the production and distribution of knowledge through academic staff whose activities are to teach, engage in research, and community development. Hence, it become necessary for them to engage in interaction among colleagues, various departments, faculties, colleges and even partners with other professional bodies outside the university. With this in place, quality and reliable knowledge can be collected, new knowledge can be created, new methods to solving problems can be learnt, and

perspective from different academic disciplines and professional bodies can be obtained to provide solutions to daily challenges and beyond.

Significantly, institution with this nature of trait values diverse perspectives, creative problem-solving, holistic understanding of phenomenon, and the potential for innovative breakthroughs by combining insights across traditional academic boundaries. Achieving interdisciplinary collaborative goal on performance innovation in academic setting require the presence of indicators such as joint research projects that involve scholars from different disciplines (Petts et al., 2008), cross-disciplinary publications that involving researchers from different disciplines (Leahey et al., 2017), interaction with interdisciplinary centers and institutes within academic institutions (Strieter et al., 2019), cross-listed courses across multiple departments or disciplines (Lattuca, 2003) among others as considered by this study.

Innovative performance which involves the development of unique research methodologies, pioneering discoveries, and the application of new technologies to solve complex problems (Smith et al., 2023) may not likely be achieved without quality research which is a function of scientific methods, significance of findings, and the impact on the field in terms of citations and peer recognition (Johnson & Lee, 2024). That is why the synergy between the two drives the progress of the academics, since as it is necessary for a creative work to have the capacity to solving a problem and capable of being duplicated. This combination is essential for promoting interdisciplinary collaboration, as it attracts diverse expertise, fosters cross-pollination of ideas, and creates a dynamic environment where researchers from various fields can converge to address multifaceted challenges that cannot be solved within the confines of a single discipline (Zhang, 2024).

Given the role of interdisciplinary collaboration is to combine knowledge, methods, and perspectives from different academic disciplines or professional in addressing complex problems or explore new areas of research, to enables more comprehensive solutions and innovations by leveraging on diverse expertise to tackle issues that are too multifaceted for a single discipline to address effectively, remains a complex issue requiring further investigation.

Despite the fact that institutions do not stop the promotion of interdisciplinary initiatives using cross-disciplinary publications, cross-listed courses, interdisciplinary centers, and joint research projects, the effectiveness of these approaches in enhancing research quality and promoting innovation is not fully understood because of the difficulties in measuring and evaluating interdisciplinary outputs, aligning diverse methodologies, and integrating different academic cultures when trying to measure the true value of such collaborations.

More so, the traditional academic structures and evaluation metrics may not adequately put into consideration the unique contributions of interdisciplinary work. This raises critical questions about how academic institutions can best implement, support, and assess interdisciplinary collaborations to maximize research quality and drive innovative breakthroughs. Besides, understanding the relationship between these interdisciplinary indicators and research outcomes is crucial for developing evidence-based strategies to advance knowledge and address complex societal challenges in higher education.

Due to the importance attached to the interdisciplinary collaboration, researches (such as Al-khateeb, 2024; Hugo, 2024; Mushi, 2024; Cagatan & Quirap, 2024) have focused on some of ways in which it can be conducted online to facilitate academic performance, promote suppliers, ease the use of e-government by the citizens, make learning easier among leaners, its levels of adoption among learners, among others. Though, its indicators such as cross disciplinary collaboration, cross listed courses, interdisciplinary centres, and joint research project are yet to be given attention by the researchers in Nigeria, most especially among the Academic Staff of Federal Universities in North Central. Hence, the need for this study.

In addition, findings from all related and relevant studies (Al-khateeb, 2024; Hugo, 2024; Ngxesha et al., 2024; Mulweye et al., 2024; Siahaan et al., 2024; Thaib et al., 2024; Mushi, 2024; Cagatan & Quirap, 2024; Nazeef et al., 2024; Lorente et al., 2024) of the world emanating from different sectors have shown that interdisciplinary collaboration is impactful since it can influence performance in various organization whether manufacturing or service industry. However, the framework of interdisciplinary collaboration and innovative performance as measured by research quality in existing studies is scarce, most especially in the ones conducted in Nigeria. Hence, it becomes the objective of this study to determine the extent in which interdisciplinary collaboration facilitate the innovative performance of Academic Staff of Federal Universities in North Central Nigeria.

II. LITERATURE REVIEW

2.1 Concept of Interdisciplinary Collaboration

Interdisciplinary collaboration refers to the integration of knowledge, methods, and perspectives from different academic disciplines to address complex problems or research questions that cannot be fully understood or resolved through a single disciplinary lens. It involves scholars, researchers, and professionals from diverse fields working together to create new knowledge, synthesize ideas, and develop innovative solutions. Interdisciplinary collaboration is very important because it brings teams or individuals with different information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice (Hong & Page, 2004).

Several benefits have been attributed to engaging in interdisciplinary collaboration. Some of these include addressing complex problems that span multiple disciplines, such as climate change, health disparities, and sustainable development (Ledford, 2015). It also can promote innovation and new knowledge. This is because it can create novel insights, ideas, and solutions by integrating diverse perspectives and expertise (Jacobs & Frickel, 2009). Besides, it reveals a holistic understanding of complex phenomena by combining different disciplinary lenses (Repko & Szostak, 2020).

Inattention to interdisciplinary collaboration in academic settings can be injurious because it can lead to a significant reduction in innovative performance, since evidence has made it clear that cross-disciplinary interactions are fundamental for generating novel ideas and approaches (Bridle et al., 2013). Hence, failure to promote interdisciplinary work may cause inability to address complex, real-world problems that often require diverse expertise and perspectives (National Academies, 2005). Indeed, this neglect can consequently result in a narrowing of research scope and a decrease in the overall impact and relevance of academic output in an increasingly interconnected global landscape (Rhoten & Pfirman, 2007).

Owing to the inherent need of interdisciplinary collaboration in academics setting, identifying its indicators becomes essential for effectiveness. Some of these indicators are joint research projects that involve scholars from different disciplines (Petts et al., 2008), cross-disciplinary publications involving researchers from different disciplines (Leahey et al., 2017), interdisciplinary centers and institutes within academic institutions (Strieter et al., 2019), cross-listed courses across multiple departments or disciplines (Lattuca, 2003), and collaborative grants and funding targeted towards interdisciplinary research projects (Bromham et al., 2016).

2.2 Innovative Performance in Academic Settings

The concept of innovative performance has been viewed by different authors with different perspectives. For instance, in the view of Karakitapoglu-Aygun (2020), innovative performance is seen as an intentional introduction and application of new work ideas, products,

processes, and procedures to work roles or units necessary for survival in a dynamic and fast-changing global environment. This definition may be applied to this study because, it is interesting to see how improving academic culture with various means (in terms of teaching techniques, technologies, and teaching process, among others) generates a unique improvement in either academic outcome, process, or services necessary for survival in a dynamic and changing world of academic environment.

In another narrow perspective, it is described as a means by which an organization shows innovation efficiency in its operations (Winby & Worley, 2014). An organization that displays innovation efficiency explores opportunities to promote operational aspects of its existing business model(s) with little effect (Etiemble, 2020). This exploration of opportunities to promote the existing model could involve the use of new technologies and techniques to improve operations, distribution, and process innovations. This definition may also be applied to this context because the use of technology is hoped to facilitate teaching and learning efficiency in the academic setting.

2.3 Research Quality

Quality research in academic settings refers to the rigorous and systematic pursuit of knowledge that adheres to high standards of methodological rigor, ethical conduct, and scholarly integrity. It involves the careful formulation of research questions, selection and implementation of appropriate research designs and methods, meticulous collection and analysis of data, with objective interpretation and dissemination of findings (Hazari et al., 2019; Rocco & Plakhotnik, 2009). Quality research in academic settings has been characterized by several key elements. These include the development of new theories (Rocco & Plakhotnik, 2009); presences of methodological rigor (Hazari, et al. 2019; Singh & Shakir, 2021), ethical conduct (Resnik, 2015), scholarly integrity (Steneck, 2007); and peer review process (Bornmann, 2011).

The benefits attributable to quality research in academic settings are numerous. However, some common ones are identified to include knowledge advancement (Hazari et al., 2019) and in informed policy and practice owing to its ability to provide evidence-based decision-making, policy formulation, and the development of best practices in various fields (Rocco & Plakhotnik, 2009; Singh & Shakir, 2021). Researchers such as Bornmann (2013) supported that with quality research, an establishment can generate innovative ideas, products, and technologies that benefit society (Bornmann, 2013). It is also worthy of note that academic institutions and researchers that produce quality research enhance their credibility and reputation, attracting funding, collaborations, and talented students and scholars (Hazari et al., 2019). Indicators of quality research in academic settings include, publication in high-impact, peer-reviewed journals (Bornmann, 2011). Citations and recognition by other researchers in the field (Hartley & Betts, 2009) and likewise a successful acquisition of competitive research grants and funding (Bornmann, 2013). Not only that, the adoption or implementation of research findings in practical settings (Hazari et al., 2019) together with positive peer evaluations and reviews of research proposals and outputs (Bornmann, 2011; Singh & Shakir, 2021).

2.4 Empirical Review

Al-khateeb (2024) used regression to explore the effect of e-collaboration on Academic performance of 170 lecturers who were randomly selected in Jordanian University and found out that e-collaboration has a positive significant relationship with both teaching and research performance. The outcome of the study may be true because, the e-collaboration was measured with information and exchange tools that include simple emails to a more complex interactive computer-aided design (CAD) system which are more common among the academic lecturers to learning new things from their colleagues that are far. However, the generalization of the

outcome of this study may be limited because it failed to capture Professors and Assistant Lecturers in the university. Further study would be needed to incorporate all levels of Academic Staff, and its replications in other higher institutions within the same environment for a wider generalization. That is why there is a need for this study in Africa, most especially in Nigeria and among the Academic Staff of Federal Universities in the North Central.

In a similar study, Nazeef et al. (2024) regressed the responses of 290 undergraduate students who were purposively selected from Karachi University of Pakistan when examining the influence of collaborative learning on the academic performance of undergraduate students focusing on social factors such as interaction with peers, interaction with teachers, and social media usage leveraging on the social constructivism theory. The findings from the study indicated that all the independent variables were positively effective on collaborative learning which in turns helps improve their academic performance and achieve their goals. Though the study provided a clear frame work upon which the work was built, but focused only on the student of a particular department ignoring others. It was also failed to state the scale used in measuring the variables considered in the study. However, the result might be differ, if students from other department were to be included. Findings also might not be the same if the same variables were used in other public universities of the same and other countries. That is why there is a need for further studies in countries like Nigeria, most especially among the Academic Staff of Federal universities in North Central.

More so, in Spanish, Lorente et al. (2024) used SEM-AMOS to evaluate the randomly selected 229 undergraduate universities' students when examining the effect of cooperative, collaborative and interdisciplinary learning in higher education as well as when exploring the relationship between perceived group cooperation and self-ability to work in a group, coupled with the differences among educational Spanish contexts, methodologies and gender. The findings of the study revealed that out of the students from the four faculties, it was only among the female students of the computer science that perceived cooperative activity and self-ability to work in a group are highly correlated, which suggested that interdisciplinary that focused on software tool development may be the most effective methodology to improve team and cooperative learning outcomes. Placing a focus on students from four faculties may hinder the generalization of the results to the entire students in the universities. Hence, the need for further studies to incorporate students at all levels of faculties to improve the generalization of the findings.

In addition, Siahaan et al. (2024) in Indonesia evaluated how job satisfaction can be used to optimize lecturers' performance during an innovative and cultured sustainable educational transformation in the era of an independent campus among 360 university lecturers who were randomly selected. Using path analysis, the data collected shows that collaboration skills and emotional intelligence have positive and significant effect on job satisfaction and lecturers' performance. Job satisfaction also has a positive and significant effect on lecturer's performance. Applying the same variables to different context might reverse the existing result, hence limiting the generalization of the findings. This accounts for the need for the current study in Nigeria most especially among the Academic Staff of Federal Universities in the North Central.

Mulweye et al. (2024) also evaluated the influence of supplier's collaboration on the performance of food and beverage manufacturing firms in Kenya via the moderating effect of supply chain technology. Using the SEM-AMOS to analyze the data collected from 270 senior managers of the companies, their study found that supplier collaboration can significantly influence the performance of food and beverage manufacturing firms in Kenya with and without the moderating factor of supply chain technology. The outcome may be so, because the study approached the supplier collaboration via factors such as risk reduction, external linkages, and negotiated prices, which are necessary for increasing the organization bottom

line. However, the result may not be the same given the same factors in other sector of the economy. Hence, limiting the generalization of the result. This reason explains why the current study is important in other African countries like Nigeria, most especially in education sector with a focus on Academic staff of Federal Universities in North Central.

In Indonesia, Thaib et al. (2024) examined the influence of factors such as internal organization, operation, infrastructure and spiritual Sharia capitals as components of collaboration strategy on the relationship between innovative strategy and business performance among 300 Sharia bank executives using SEM-PLS. The findings from their analysis that operational Sharia Capital among other capitals has significant effect on collaboration strategy, while innovation and collaboration strategies independently influence business performance. In addition, strategic collaboration was found to positively and significantly mediate the relationship between innovation strategy and business performance. However, the study failed to reveal the scale used in measuring the variables used. Though, using the same variables to measure the strategic collaboration, the reverse might be the case in other sector of the economy of the same nation. That is why there is a need for further research in places like Nigeria, most especially among the Academic Staff of Federal Universities in the North Central to increase the generalizability of the results.

Similarly, Cagatan and Quirap (2024) used regression to analyze learners' collaborative learning and their academic performance in elementary schools of Laguidingan District of Philippines, within the period of 2023-2024 among 202 students who were randomly selected with a focus on variables such as positive interdependence, promotive interaction, and individual accountability. The findings from the study recognized promotive interaction as the highest and individual accountability as the lowest indicators of collaborative learning. It further demonstrated a significant relationship between collaborative learning and learners' academic performance. Though, the study focused on a selected 5 schools in the district of Lagiundingan ignoring other schools within the environment which led to achieving its objectives but failed to identify the scale used in capturing its variables. Very little or no attention was also given to expressing the learners' academic performance. Hence limiting the generalization of the findings. There is also no probability that given the same variables the result may be true in another context. Hence, the need for further research which facilitate the current study in Nigeria, most especially among the Academic staff of Federal Universities in the North Central.

2.5 Gaps identified

The focus of the researchers on the review of the existing articles considered relevant for this study, was how the interdisciplinary collaboration could influence performance (Al-Khateeb, 2024; Hugo, 2024; Ngxesha et al., 2024; Mulweye et al., 2024; Siahaan et al., 2024; Thaib et al., 2024; Mushi 2024; Cagatan & Quirap, 2024; Nazeef et al., 2024; Lorente et al., 2024) without specifying the focus of such performance or how it is being captured.

Also, researchers such as Al-Khateeb (2024); Hugo, (2024); Mushi, (2024); Cagatan and Quirap, 2024) have also looked at interdisciplinary collaboration in the ways by which it can be conducted online among the academic staff to facilitate academic performance, promote suppliers among the suppliers' chain manager, make learning easier among leaners, and extent to which is practiced among learners, among others, while ignoring its indicators such as cross disciplinary collaboration, cross listed courses, interdisciplinary centres, and joint research project.

In addition, some of the studies considered relevant (Al-khateeb, 2024; Hugo, 2024; Ngxesha et al., 2024; Mulweye et al., 2024; Siahaan et al., 2024; Thaib et al., 2024; Mushi 2024; Cagatan & Quirap, 2024; Nazeef et al., 2024; Lorente et al., 2024) could not provide a

framework of interdisciplinary collaboration and innovative performance as measured by research quality in the current study.

More so, the concept was highly put into use by managers in various companies (Mulweye et al., 2024; Ngxesha et al., 2024; Shahadat et al., 2024; Thaib et al., 2024) compared to academic staff in various universities where its roles are equally important (Al-khateeb, 2024; Siahaan et al., 2024). Also, the reviewed existing studies, shows larger part of the work carried out on interdisciplinary collaboration and performance were done in Asia (Al-khateeb, 2024; Cagatan & Quirap, 2024; Nazeef et al., 2024; Shahadat et al., 2024; Siahaan et al., 2024; Thaib et al., 2024), followed by Africa (Mulweye et al., 2024; Mushi, 2024; Ngxesha et al., 2024), most especially in countries like Kenya, South Africa, and Tanzania (Mushi, 2024; Mulweye et al., 2024; Ngxesha et al., 2024) with none from Nigeria.

2.6 Theoretical Framework

Among other theories that explains the nexus between interdisciplinary collaboration and innovative performance (research quality), this study adopts Cognitive Diversity Theory which was propounded by Scott E. in the year 2007 in one of his publications titled "The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies" (Page, 2007). The theory assumes that diverse perspectives and heuristics lead to better problem-solving and predictions, benefits of cognitive diversity often exceed the benefits of individual ability (Hong & Page, 2004), cognitive diversity is distinct from identity diversity, though can be related, and cognitive diversity can outperform homogeneity in complex environment.

The proponents of this theory have found that diverse groups can outperform groups of high-ability problem solvers (Hong & Page 2004), and group performance is a function of cognitive diversity of its members (Woolley et al., 2010) while diverse groups are more likely to reexamine facts and remain objective (Phillips, 2014). For the critic, it is argued that the benefits of diversity can be outweighed by communication difficulties (Horwitz & Horwitz, 2007), it may not account for power dynamics and social hierarchies within groups (Van-Knippenberg & Schippers, 2007), likewise it may be challenging to implement and measure cognitive diversity in real-world settings (Harrison & Klein, 2007). It however, stresses on diversity of: (i) perspectives (ii) heuristics, (iii) interpretations, and (iv) predictive models.

Relating to interdisciplinary collaboration and innovative performance, the theory posits that interdisciplinary collaboration can enhance innovative performance via research quality by bringing together diverse cognitive tools and approaches from different disciplines (Fagerberg et al., 2012); encouraging the integration of different perspectives, leading to more comprehensive problem-solving (Uzzi et al., 2013); promoting creativity through the combination of different knowledge domains (National Academies, 2005); challenging assumptions and biases inherent in single disciplines (Rhoten & Pfirman, 2007); and enabling teams to tackle complex, multifaceted research problems more effectively (National Academies, 2005). Therefore, leveraging cognitive diversity through interdisciplinary collaboration, research teams can achieve higher levels of innovation and produce higher quality research outcomes (Page, 2007; Fagerberg et al., 2012). That is why theory is adopted by the current study.

III. METHODOLOGY

3.1 Design and Population

This study adopted survey research design because the researcher is interested in the situation already existing in the field and no variable is to be manipulated. A questionnaire was designed and administered to examine the effect of interdisciplinary collaboration on innovative performance of Federal Universities in North Central Nigeria. The population of

this study is made up of a total number of the entire Academic Staff of the Seven (7) Federal Universities in North Central Nigeria which stands at 7100 (National University Commission's Website as at 2019 till date).

3.2 Sample and Sampling Techniques

The sample size for the study was ascertained using Yamane (1973) sample size determination formular as shown below:

$$n = \frac{N}{1 + N(e)^2}$$

Where:
n= Sample size
N= Population size (7100)
e= Significance level (5% or 0.05)

Therefore,

$$n = \frac{N}{1 + N(0.05)^2}$$

$$n = \frac{7100}{1+7100(0.05)^2}$$

$$n = \frac{7100}{1 + 7100(0.0025)}$$

$$n = \frac{7100}{1+17.75}$$

$$n = \frac{7100}{18.75} = 378.67 \text{ Approximately } 379$$

To cater for incomplete records and un-submitted responses by the respondents which may be due to some contingencies, a 10% provision is made to anticipate a minimum sample size of 417 responses from the respondents. This is deemed suitable and used for the study as supported by Andrade (2020) among others. Proportionately, 91 Academic Staff were from the University of Ilorin, 53 from FUT Minna, 30 from the University of Abuja, 49 from FUA Markurdi, 10 from FU Lokoja, 25 from FU Lafia, and 159 from the University of Jos.

This study adopts a multi-stage sampling technique by firstly including all the Seven Federal Universities in North Central, Nigeria using census. Secondly, it focuses on the Academic Staff who were the target audience for the study, purposely because of its suitability. Other stages equally reflected in the administration of a questionnaire where the link to the Microsoft form which contains the respondents' biodata and questionnaire items was sent to various platforms, so as to enable whoever came in contact with it among the Academics to fill it at their convenience. This makes it accidental and convenient sampling. Furthermore, restriction for submission was also set for the receipt of the responses from the respondents once the expected sample size was reached from the respondents in each university.

3.3 Research Instruments

The study measured interdisciplinary collaboration using proxies such as Cross Disciplinary Publication with 5 items Likert scale adapted from Boardman and Bozeman (2007) with Cronbach value of 0.87, Cross listed Course with 5 items Likert scale adapted from Nguyen & Choi (2022) with α value of 0.88; Interdisciplinary Centre with 5 items Likert scale adapted from Nguyen and Choi (2021) at α value of 0.87; 5 items Likert scale was equally used

to measure Joint Research Project with α value of 0.88 from Nguyen and Choi (2022); while innovative performance was measured using Research Quality with 5 items Likert scale of α value of 0.92 from Lambie and Vaccaro (2011).

3.4 Techniques for Data Analysis

The study adopted Structure Equation Modeling (SEM) because it is the most appropriate techniques for measuring opinions of respondents considering the sample size and ordinal data scale that were used in the study. The SEM technique combines both principal component factor analysis and regression analysis but can handle all kinds of data and multiple variable relationship testing. Hence, this research work used SEM to test the effect of interdisciplinary collaboration on innovative performance as measured with research quality of Academic Staff of Federal Universities in North Central, Nigeria.

IV. RESULTS AND FINDING

4.1: Objective and Hypothesis Restatement

Objective One: Examine the extent to which interdisciplinary collaboration instigates innovative performance using research quality among Academic Staff of Federal Universities in North Central Nigeria.

Ho^{1a}: CDP has no significant effect on RQ of Academic Staff of Federal Universities in North Central Nigeria

Ho^{1b}: CLC has no significant effect on RQ of Academic Staff of Federal Universities in North Central Nigeria

Ho^{1c}: IDC has no significant effect on RQ of Academic Staff of Federal Universities in North Central Nigeria

Ho^{1d}: JRP has no significant effect on RQ of Academic Staff of Federal Universities in North Central Nigeria

Assessment of Measurement Model

In assessing the effect of Interdisciplinary Collaboration on Research quality, variables such as joint Research Project (JRP), Cross Disciplinary Publication (CDP), Interdisciplinary Centre (IDC), and Cross Listed Courses (CLC) were considered by the study against Research quality (RQ).

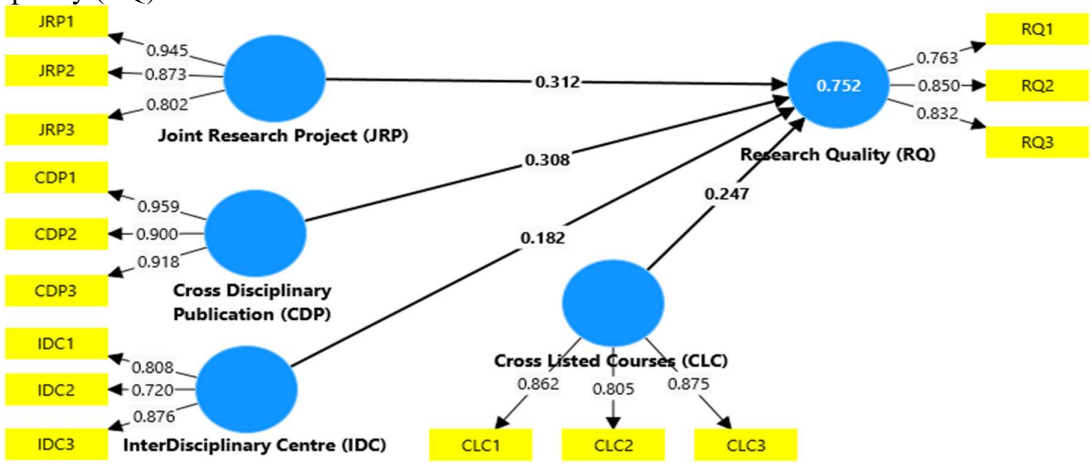

Figure 1: Path model for Interdisciplinary Collaboration variables and Research quality

Source**:** Smart-PLS 4 Output, 2024

Figure 4.1 showed the path model of the Interdisciplinary Collaboration variables and Research Quality where the outer loading for all the observed variables were ≥ 0.5 to 1, and significant at $p<0.05$ which suggest that each item appropriately represents the respective constructs. Likewise, it presents path coefficients or effect values between each of the respective exogenous variables to the endogenous variable. Furthermore, it presents the R square values for the endogenous variable which suggests the total variation accounted for by the exogenous variables in the model.

Table 4.1: Validity and Reliability

	A	CR (rho_a)	CR (rho_c)	(AVE)
Cross Disciplinary Publication (CDP)	0.916	0.921	0.947	0.857
Cross Listed Courses (CLC)	0.805	0.815	0.885	0.719
Inter Disciplinary Centre (IDC)	0.722	0.724	0.845	0.647
Joint Research Project (JRP)	0.844	0.845	0.907	0.766
Research Quality (RQ)	0.750	0.766	0.856	0.665

Source**:** Smart-PLS 4 Output, 2024

Table 4.1 present the internal consistency with Cronbach Alpha's values ranging from 0.75 to 0.916 lying within the acceptable threshold of 0.7, suggesting that the items within each variable are reliable measures of their respective constructs. Likewise, Composite reliability takes into account both the internal consistency and the relationships between items and the latent variables. For all the latent variables, the composite reliability values were ranging from 0.724 to 0.921 which indicates that the variables are reliable indicators of the constructs.
It also present AVE which indicates the degree to which items within a variable are related to each other, and to what extent they measure the same underlying concept. AVE values in the table ranges from 0.647 to 0.857, all of which surpass the recommended threshold of 0.5. This indicates that the items within each latent variable are converging well and will collectively measure their respective constructs effectively.

Table 4.2: Discriminant Validity (Fornell Larcker)

	(CDP)	(CLC)	(IDC)	(JRP)	(RQ)
Cross Disciplinary Publication (CDP)	**0.926**				
Cross Listed Courses (CLC)	0.708	**0.848**			
Inter Disciplinary Centre (IDC)	0.466	0.508	**0.804**		
Joint Research Project (JRP)	0.538	0.613	0.536	**0.875**	
Research Quality (RQ)	0.736	0.749	0.619	0.727	**0.816**

Source: Smart-PLS 4 Output, 2024

Table 4.2 presents discriminant validity which assesses whether the constructs are distinct and not highly correlated with each other. Looking at the correlations between these variables, it is evident that the diagonal values (the square root of AVE) are all substantially higher than the off-diagonal values (the correlations between different variables). This suggest that each latent variable is more strongly related to itself than to the other constructs, supporting the idea that they are distinct and measure different aspects of the overall construct.

Assessment of Structural Model

Satisfying with measurement model leads to the evaluation of PLS-SEM results which is the assessment of the structural model. In doing this, standard assessment criteria that are considered necessary are the test of multicollinearity of construct via Variance Inflation Factor (VIF), Coefficient of determination (R^2), the statistical significance and relevance of path coefficient of the structural model and assessment of effect size (f^2) (Shmueli, et al. 2016).

Test of Multicollinearity

Multicollinearity helps to determine if the two or more independent variables are not producing the same results. The Variance Inflation Factor (VIF) is used in this study to assess likely correlation between the independent variables.

Table 4.3: Multicollinearity (VIF)

	Research Quality (RQ)
Cross Disciplinary Publication (CDP)	2.108
Cross Listed Courses (CLC)	2.425
Interdisciplinary Centre (IDC)	1.536
Joint Research Project (JRP)	1.832

Source**:** Smart-PLS 4 Output, 2024

Table 4.3 represents the result of multicollinearity using VIF values for the latent variables relating to the Research quality. Since all these values are positive and are closer to 3 but less than 5 there is no severe multicollinearity among these latent variables. In other words, these variables are not highly correlated with each other, and are therefore included in this analysis without significant concerns about multicollinearity.

Table 4.4: Coefficient of Determination

	R-square	**R-square adjusted**
Research Quality (RQ)	0.752	0.749

Source**:** Smart-PLS 4 Output, 2024

The Table 4.4 displays the coefficient of determination score (R^2) which is commonly used assess the model's predictive effect. This value (R^2) is found to be 0.752 which suggested that Interdisciplinary collaboration variables accounted for 75.2% variation in research quality. It also shows that the model is satisfactory as the predictive effect (R^2) of 0.752 falls within the established threshold of 0.25-0.75 (Hair, et al., 2019 and is greater than the threshold of 0.10 (Pirouz, 2006). Also, the result shows that the model has not failed in its capacity to measure the predictive power of the data.

Table 4.5: Assessment of the Effect size (f^2)

	f-square
Cross Disciplinary Publication (CDP) -> Research Quality (RQ)	0.181
Cross Listed Courses (CLC) -> Research Quality (RQ)	0.102
Inter Disciplinary Centre (IDC) -> Research Quality (RQ)	0.087
Joint Research Project (JRP) -> Research Quality (RQ)	0.215

Source**:** Smart-PLS 4 Output, 2024

The table 4.5 presents the effect size Cross Listed Courses and Inter Disciplinary Centre were constituting weak effect as their effective sizes were within 0.02 and 0.15. Meaning they were constituting a low effect to research quality in this context. Similarly, Cross Disciplinary

Publication and Joint Research Project with 0.181 and 0.215 respectively lies within 0.15 to 0.35, suggesting a moderate effect on research quality in the academic settings.

Table 4.6: Bootstrapping Results Showing Path Coefficient for Structural Model

Hypotheses		Original sample (O)	T statistics (|O/STDEV|)	P values
Ho^{1a}	Cross Disciplinary Publication (CDP) -> RQ	0.308	7.270	0.000
Ho^{1b}	Cross Listed Courses (CLC) -> RQ	0.247	5.800	0.000
Ho^{1c}	Inter-Disciplinary Centre (IDC) -> RQ	0.182	5.258	0.000
Ho^{1d}	Joint Research Project (JRP) -> RQ	0.312	7.800	0.000

Source**:** Smart-PLS 4 Output, 2024

Where: RQ = Research Question

The bootstrap path coefficient analysis presented in Table 4.6 was conducted to test the null hypothesis which state that Inter Disciplinary Collaboration does not have a significant effect on Innovative performance (Research Quality) among Academic Staff of Federal Universities in Nigeria. The result indicated that all the four Inter Disciplinary Collaboration variables produced a significant effect on Research Quality. This is because their T-statistics value was greater than ±1.96 and likewise their P values were less than 0.05 (Wong, 2019). Hence, it could be said that Inter Disciplinary Collaboration variables subject to Cross Disciplinary Publication (CDP), Cross Listed Courses (CLC), Inter Disciplinary Centre (IDC), and Joint Research Project (JRP) have significant effect on Research Quality among Academic Staff of Federal Universities in North Central Nigeria. Conclusively, the individual variation accounted for in Research Quality by each of the constructs is 30.8%, 24.7%, 18.2%, and 31.2% respectively. These shows that the percentage difference of each construct is 69.2, 75.3, 81.8, and 68.8 respectively are variations accounted for by other factors that are not captured by this model.

4.2 Discussion of Finding

This study examines the extent to which interdisciplinary collaboration instigates research quality among academic staff of Federal Universities in North Central Nigeria. In relation to this objective, all the proxies used in measuring interdisciplinary collaboration (namely; cross disciplinary publication, cross listed courses, inter-disciplinary centre, and joint research project) as evidenced in table 4.6 were observed having positive coefficient with their t-values greater than ±1.96 at p-value less than 0.05. This signifies that interdisciplinary collaboration, subject to its variables were positively and significantly effective to research quality among academic staff of Federal Universities in North Centre Nigeria. This implies that the more the interdisciplinary collaboration is promoted, the better the research of the academic staff of Federal Universities are rated higher. The implication of this finding is that universities which foster interdisciplinary collaboration would have to lay more emphasis on cross disciplinary publication, cross listed courses, interdisciplinary centre, and joint research project among others in order to turn out a good research quality most especially in the area of formulation of research questions, design of a good research study, and analysis and interpretation of research data among others.

The finding of this study coincides with that of Okamura (2021) who proves that interdisciplinary research papers receive more citations than each paper does in their respective fields. Also, as concluded by Xu et al. (2022), interdisciplinary research has more capacity to address complex societal challenges, than single discipline paper would do. In collaboration to

this, it was the view of Bromham et al. (2023) that proposals with higher interdisciplinary scores would have higher chances of securing funding, depending on the nature of the programme. On this note, Hofstra et al. (2020) also offered a similar conclusion that introduction of new methodological approach is more pronounced in interdisciplinary collaborations papers compared to single-discipline papers. Likewise, in a study by Li et al. (2022), interdisciplinary papers were 18% more likely to be published in top-quartile journals within their respective fields. While the impact of interdisciplinary papers citation rate is more sustained, compared to single-discipline papers (Stegehuis et al., 2023).

V. Concluding Remarks

5.1 Conclusion

This study established that, interdisciplinary collaboration has significant effect on research quality among Academic Staff of Federal universities in North Central, Nigeria when attentions are paid to cross disciplinary publication, cross listed courses, inter-disciplinary centers, and joint research project. This is may be so because, academic staff do not naturally rely on a single disciplinary publication, they publish in a department and faculty that is outside but related to their domains. Likewise, they teach courses involving students from other departments to avoid duplication of efforts. Also, they are used as resources persons within the centers in the university where students of various department go to learn, besides they join hands with lectures of other department to develop initiative project that would enable them to win grants among others.

5.2 Recommendation

Based on the conclusion, the study recommends that Academic Staff of Federal Universities in North Central Nigeria can always improve the quality of research output using interdisciplinary collaboration which encompasses factors such as cross disciplinary publication, cross listed courses, inter-disciplinary centers, and joint research project among others. Doing this would not only facilitate quality of research and promote innovative performance, but would to a larger extent enable the reliability of ideas, methods and diverse perspectives among the academic lecturers.

5.3 Contributions to Knowledge

The study has contributed to existing knowledge by developing a comprehensive model that present a clearer framework for determining the effect of interdisciplinary collaboration on innovative performance (research quality) of Academic Staff of Federal Universities in North Central, Nigeria. In this model are the mother variable (interdisciplinary collaboration) and latent or sub-variables with their observed variables which are rare among the reviewed articles. This study also represents one of the comprehensive research on interdisciplinary collaboration and innovative performance (research quality) of Academic Staff of Federal Universities in the North Central, Nigeria. Hence, adding to the existing literature in Nigeria and Africa at large.

5.4 Areas for Further Studies

This present study focused on the effect of interdisciplinary collaboration on innovative performance of Academic Staff of Federal Universities in North Central, Nigeria. Future study could focus on other Federal Universities in another zone in Nigeria. Likewise, effort of future researches could be tailored towards determining other factors that could be used to indicate

interdisciplinary collaboration among the Academic Staff of Federal Universities in the same and other zones in Nigeria.

References

Al-Khateeb, B. A. A. (2024). E-Collaboration and Academic Performance of Lecturers: Evidence from a Jordanian University. *International Journal of e-Collaboration, 20*(1), 1-15.

Andrade, C. (2020). Sample size and its importance in research. *Indian J Psychol Med., 42*(1): 102-103. doi: 10.4103/IJPSYM.IJPSYM_504_19

Boardman, C., & Bozeman, B. (2007). Role strain in university research centers. *The Journal of Higher Education, 78*(4), 430-463.

Bornmann, L. (2011). Scientific peer review. *Annual Review of Information Science and Technology, 45*(1), 197-245.

Bridle, H., Vrieling, A., Cardillo, M., Araya, Y., & Hinojosa, L. (2013). Preparing for an interdisciplinary future: A perspective from early-career researchers. *Futures*, 53, 22-32.

Bornmann, L. (2013). What is the societal impact of research and how can it be assessed? A literature survey. *Journal of the American Society for Information Science and Technology, 64*(2), 217-233.

Bromham, L., Dinnage, R., & Hua, X. (2016). Interdisciplinary Research has consistently lower funding success. *PubMed,* 534(7609):684-7. doi: 10.1038/nature18315

Bromham, L., Dinnage, R., & Hua, X. (2023). Interdisciplinary research proposals are more successful. *Nature Human Behaviour, 7*(3), 398-406.

Cagatan, A. N. P. & Quirap, E. A. (2024). Collaborative Learning and Learner's Academic Performance. *International Journal of Multidisciplinary Research and Analysis, 7*(3), 1326-1335.

Etiemble, F. (November 11, 2020). What type of innovation are you talking about? *Strategyzer*. https://www.strategyzer.com/blog/what-type-of-innovation-are-you-talking-about

Fagerberg, J., Fosaas, M., & Sapprasert, K. (2012). Innovation: Exploring the knowledge base. *Research Policy, 41*(7), 1132-1153.

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European business review, 31*(1), 2-24.

Harrison, D. A., & Klein, K. J. (2007). What's the difference? Diversity constructs as separation, variety, or disparity in organizations. *Academy of Management Review, 32*(4), 1199-1228.

Hartley, J., & Betts, L. R. (2009). Publishing before the thesis: 58 rhetorical criteria. *Journal of Academic Ethics, 7*(1), 51-63.

Hazari, Z., Potvin, G., Cribbs, J. D., Godwin, A., Scott, T. D., & Klotz, L. (2019). Indicators of quality in research: Exploring the relationships between faculty research quality and institutional context. *The Journal of Higher Education, 90*(4), 561-591.

Hofstra, B., Kulkarni, V. V., Munoz-Najar Galvez, S., He, B., Jurafsky, D., & McFarland, D. A. (2020). The diversity–innovation paradox in science. *Proceedings of the National Academy of Sciences, 117*(17), 9284-9291.

Hong, L., & Page, S. E. (2004). Groups of diverse problem solvers can outperform groups of high-ability problem solvers. *Proceedings of the National Academy of Sciences, 101*(46), 16385-16389.

Horwitz, S. K., & Horwitz, I. B. (2007). The effects of team diversity on team outcomes: A meta-analytic review of team demography. *Journal of Management, 33*(6), 987-1015.

Hugo, A. (2024). Impact of Digital Technologies on Enhancing Supplier Collaboration and Performance in Sweden. *Global Journal of Purchasing and Procurement Management (GJPPM), 3*(2), 1-12.

Jacobs, J. A., & Frickel, S. (2009). Interdisciplinarity: A critical assessment. *Annual Review of Sociology, 35*, 43-65.

Johnson, A., & Lee, B. (2024). Metrics of excellence: Redefining research quality in the digital age. *Journal of Academic Assessment, 42*(1), 15-28.

Karakitapoglu-Aygun, Z., Gumusluoglu, L., & Scandura, T. A. (2020). How Do Different Faces of Paternalistic Leaders Facilitate or Impair Task and Innovative Performance? *Opening the Black Box. Organisational Studies, 72*(2), 138-152.

Lambie, G. W., & Vaccaro, N. (2011). Doctoral counselor education students' levels of research self-efficacy, perceptions of the research training environment, and interest in research. *Counselor Education and Supervision, 50*(4), 243-258.

Lattuca, L. R. (2003). Creating interdisciplinarity: Grounded definitions from college and university faculty. *History of Intellectual Culture, 3*(1), 1-20.

Leahey, E., Beckman, C. M., & Stanko, T. L. (2017). Prominent but less productive: The impact of interdisciplinarity on scientists' research. *Administrative Science Quarterly, 62*(1), 105-139.

Ledford, H. (2015). How to solve the world's biggest problems. *Nature, 525*(7569), 308-311

Li, J., Yin, Y., Fortunato, S., & Wang, D. (2022). Scientific elite revisited: Patterns of productivity, collaboration, authorship and impact. *Journal of the Royal Society Interface, 19*(186), 20210673.

Lorente, S., Arnal-Palacian, M., & Parede-Velasco, M. (2024). Effectiveness of cooperative, collaborative, and interdisciplinary learning guided by software development in Spanish universities. *European Journal of Psychology of Education*. https://doi.org/10.1007/s10212-024-00881-y

Mulweye, D., Shale, N., Namusonge, E., & Wachiuri, E. (2024). Supplier Collaboration and Performance of Food and Beverage. Manufacturing Firms in Kenya. *International Journal of Supply Chain Management, 9*(2), 1–19. https://doi.org/10.47604/ijscm.2326

Mushi, R. (2024). The Role of Collaboration on Acceptance of E-Government in Tanzania. *Journal of Electrial System, 20*(4), 1020-1027.

National Academies. (2005). *Facilitating Interdisciplinary Research*. Washington, DC: The National Academies Press.

Nazeef, N. M., Khan, A. & Ali, J. (2024). Impact of Collaborative Learning on Student`s Academic Performance in Teacher's Education Program. *Journal of Asian Development Studies, 13*(1), 1054-1068."

Nguyen, L. H., & Choi, J. Y. (2021). Evaluating the Interdisciplinary Center Engagement Scale in Higher Education. *Journal of Interdisciplinary Studies in Education, 10*(3), 205-220.

Nguyen, L. H., & Choi, J. Y. (2022). Evaluating the Cross-Listing Opportunities Scale in Higher Education. *Journal of Interdisciplinary Studies in Education, 11*(2), 105-120.

Nguyen, L. H., & Choi, J. Y. (2022). Evaluating the Joint Research Collaboration Scale in Higher Education. *Journal of Interdisciplinary Research, 13*(2), 125-140

Ngxesha, C.N., Langton, I. & Mafini, C. (2024). Municipal supply chain performance through information sharing and stakeholder collaboration. *South African Journal of Economic and Management Sciences 27*(1), a5543. https:// doi.org/10.4102/sajems.v27i1.5543"

Okamura, K. (2021). Interdisciplinarity revisited: evidence for research impact and dynamism. *Palgrave Communications, 7*(1), 1-9.

Page, S. E. (2007). *The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies*. Princeton University Press.

Petts, J., Owens, S., & Bulkeley, H. (2008). Crossing boundaries: Interdisciplinarity in the context of urban environments. *Geoforum, 39*(2), 593-601.

Phillips, K. W. (2014). How diversity makes us smarter. *Scientific American, 311*(4), 43-47.

Pirouz, D. M. (2006). An Overview of Partial Least Squares. *Business Publications*, 24.https://ir.lib.uwo.ca/iveypub/24

Repko, A. F., & Szostak, R. (2020). *Interdisciplinary research: Process and theory (4th ed.)*. *SAGE* Publications.

Resnik, D. B. (2015). What is ethics in research & why is it important? National Institute of Environmental Health Sciences. Retrieved from htts://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm

Rhoten, D., & Pfirman, S. (2007). Women in interdisciplinary science: Exploring preferences and consequences. *Research Policy, 36*(1), 56-75.

Rocco, T. S., & Plakhotnik, M. S. (2009). Literature reviews, conceptual frameworks, and theoretical frameworks: Terms, functions, and distinctions. *Human Resource Development Review, 8*(1), 120-130.

Shmueli, G., Ray, S., Estrada, J. M. V., & Chatla, S. B. (2016). The elephant in the room: Predictive performance of PLS models. *Journal of business Research, 69*(10), 4552-4564.

Siahaan, E.,Dalimunthe, R. F., Lumbanraja, P., Zakaria, Z., Nawi, A. S. & Zulkarnain, S. H. (2024). The Importance of Collaborative Ability and Emotional intelligence in shaping Job Satisfaction and Lecturer Performance in the Transformational Era. *Open Peer Review on Qeios*, 1-15.

Singh, A. K., & Shakir, M. (2021). Quality of research in higher education institutions: Concepts, dimensions, and indicators. *DESIDOC Journal of Library & Information Technology, 41*(2), 123-133.

Smith, R., Garcia, M., & Wong, T. (2023). Innovation catalysts: Identifying drivers of breakthrough research in higher education. *Higher Education Quarterly, 77*(3), 301-315.

Stegehuis, C., Litvak, N., & Waltman, L. (2023). Predicting the long-term citation impact of recent publications. *Journal of Informetrics, 17*(2), 101384.

Steneck, N. H. (2007). ORI Introduction to the Responsible Conduct of Research. Office of Research Integrity. Retrieved from https://ori.hhs.gov/introduction-responsible-conduct-research

Strieter, L., Velarde, M. D., Rebaza, M., & Yahia, N. (2019). Facilitating interdisciplinary collaboration to address complex challenges in environmental research. *Journal of Environmental Studies and Sciences, 9*(3), 252-263.

Thaib, I., Puspaningrum, A., Hussein, A. S., & Prabandari, S. P. (2024). Islamic Banking Performance and Internal Sharia Capital Collaboration. *Revista de Gestão Social e Ambiental*, *18*(1), e05467-e05467.

Uzzi, B., Mukherjee, S., Stringer, M., & Jones, B. (2013). Atypical combinations and scientific impact. *Science, 342*(6157), 468-472.

Van Knippenberg, D., & Schippers, M. C. (2007). Work group diversity. *Annual Review of Psychology, 58,* 515-541.

Winby, S., & Worley, C. G. (2014). Management processes for agility, speed, and innovation. *Organizational Dynamics*, 43.

Wong, C. H., Siah, K. W., & Lo, A. W (2019). Estimation of clinical trial success rates and related parameters. *PubMed,* 20(2):273-286. doi: 10.1093/biostatistics/kxx069.

Woolley, A. W., Chabris, C. F., Pentland, A., Hashmi, N., & Malone, T. W. (2010). Evidence for a collective intelligence factor in the performance of human groups. *Science, 330*(6004), 686-688.

Xu, H., Winnink, J., Yue, Z., Liu, Z., & Yuan, G. (2022). Interdisciplinary research and impact: A scientometric study of the United Nations Sustainable Development Goals. *Scientometrics, 127*(2), 1011-1031.

Zhang, L. (2024). Bridging disciplines: The role of innovative research in fostering academic collaborations. *Interdisciplinary Science Reviews, 49*(2), 112-127.