Evaluating Modern Academic Research Performance and Quality using Quantitative Approaches and Statistical Indices

Bassey, Glory Daniel
Department of Statistics/mathematics, Dorben Polytechnic,
Abuja, Nigeria

Udomette, Bright Emmanuel*
Department of Accountancy, Dorben Polytechnic, Bwari,
Abuja, Nigeria

*Corresponding Author

Abstract
This study evaluates modern academic research performance and quality using quantitative approaches and statistical indices within a multi-disciplinary bibliometric framework. Adopting a cross-sectional design, the study analysed secondary bibliometric data for 120 academic researchers drawn equally from four disciplinary groupings: Science, Technology, Engineering, and Mathematics (STEM);SocialSciences; Business/Economics; and Humanities, over a five-year period (2018–2023) from Scopus and institutional repositories. Research performance was operationalized using a normalised outcome measure, while key predictors included publication count, citation count, h-index, collaboration index, degree of collaboration, and a composite index integrating productivity, impact, and collaboration dimensions. Descriptive analysis revealed substantial disciplinary variation, with STEM disciplines consistently exhibiting higher research output, citation impact, and collaboration intensity relative to other fields while Humanities exhibited comparatively lower quantitative indicators. Pearson correlation analysis indicated strong and statistically significant positive associations among productivity, citation-based impact, and collaboration measures, indicating that these indices represent interrelated dimensions of scholarly performance. Multiple regression results confirmed that individual bibliometric indicators significantly predict research performance, while hierarchical regression analysis demonstrated that the composite index explains substantially more variance in performance outcomes than single-indicator models. One-way analysis of variance (ANOVA) further revealed statistically significant differences in research performance across disciplines, with post hoc tests indicating that STEM disciplines significantly outperform Humanities. Collectively, the findings establish that research performance is bothdiscipline-sensitive and multidimensional, providing empirical support for composite, field-normalised evaluation bibliometric frameworks, while cautioning against the uniform application of single bibliometric indicators across heterogeneous academic domains and contributes to contemporary debates on robust and context-aware research evaluation.

Keywords:
bibliometrics;research performance; composite index;quantitative analysis, disciplinary differences; collaboration; field normalisation

1. Introduction

In the emerging landscape of contemporary academia, the evaluation of research performance and quality has increasingly relied on quantitative approaches grounded in statistical indices. The growing pressure on universities, funding agencies, and policymakers to demonstrate accountability, transparency, and measurable outcomes has led to the widespread adoption of bibliometric and scientometric indicators as proxies for scholarly productivity, influence, and impact (Ayaz & Masood, 2020; Waltman, 2015). Quantitative metrics such as publication counts, citation-based indicators, collaboration measures, and composite indices are now routinely used in research assessment exercises, funding allocation decisions, institutional rankings, and academic promotion processes. These indices offer a seemingly objective and comparable means of summarising complex scholarly activities across individuals, departments, and institutions, thereby reinforcing their dominance in modern research evaluation systems.

Among the most widely employed indicators are publication-based metrics, which capture research output through counts of peer-reviewed articles, and citation-based metrics, which seek to reflect scholarly influence and visibility (Moed, 2010). The h-index, in particular, has gained prominence for its attempt to combine productivity and citation impact into a single statistic (Hirsch, 2005). In parallel, collaboration-related indices, such as the collaboration index and degree of collaboration, have emerged in response to the increasing prevalence of team-based and interdisciplinary research, reflecting the social and networked nature of knowledge production (Glänzel & Schubert, 2004; Stallings, et al., 2013). Collectively, these statistical indices function as benchmarking tools that support monitoring of research performance and inform strategic and policy-level decisions within higher education systems.

Despite their widespread use, statistical indices have attracted sustained criticism concerning their conceptual validity, methodological robustness, and equity across disciplines. Scholars have argued that many quantitative indicators exhibit disciplinary bias, favouring fields with higher publication and citation frequencies, such as STEM disciplines, while under-representing scholarly impact in the humanities and some social sciences (Butt, et al., 2021; Leydesdorff, et al., 2011). Citation-based measures are further affected by self-citation practices, database coverage limitations, and temporal effects related to publication age (Bornmann & Daniel, 2007; Mondal, 2023). Consequently, concerns persist regarding the extent to which these indices truly capture research quality, societal relevance, or intellectual contribution, as opposed to merely reflecting volume or visibility.

In response to these limitations, a substantial body of literature has sought to categorise and refine research performance indicators across multiple dimensions, including output, influence, collaboration, resource acquisition, academic reputation, and knowledge transfer (Abramo & D'Angelo, 2014; Sugimoto, et al., 2017). Empirical studies have demonstrated systematic differences in index values across disciplines, with STEM fields typically exhibiting higher collaboration indices and h-index values due to larger research teams and higher publication rates, whereas humanities scholars often show lower quantitative scores despite producing highly specialised and influential work within narrower audiences (Kim, et al., 2014; Butt, et al., 2021). These findings underscore the importance of contextual and disciplinary sensitivity in the interpretation of research metrics.

Theoretical perspectives from scientometrics and bibliometrics provide the conceptual foundation for the use of quantitative indicators in research evaluation. Scientometric theory posits that scholarly activity and impact can be operationalized through observable and quantifiable indicators derived from publication and citation data (Ceballos, 2017; Waltman, 2016). Complementing this view, quantitative research evaluation theory conceptualises statistical indices as measurable proxies for latent constructs such as productivity, influence, collaboration, and visibility, which can be empirically examined using statistical models. Within this framework, research performance and quality are treated as dependent constructs influenced by multiple interacting indices, while disciplinary context and institutional characteristics function as moderating or control variables.

Although prior studies have contributed valuable insights into individual metrics and bibliometric contexts, a notable gap remains in comprehensive analyses that simultaneously examine multiple statistical indices and their collective functioning across disciplines. Many existing investigations focus on isolated indicators—such as the h-index or citation counts—without adequately exploring their

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interrelationships, comparative predictive power, or combined explanatory capacity in assessing research performance outcomes (Ayaz & Masood, 2020; Bornmann & Daniel, 2007). Recent scholarship increasingly emphasises the multidimensional nature of research evaluation, arguing that no single metric can universally capture research quality or impact and that composite or field-normalised indices may offer more balanced assessments (Leydesdorff et al., 2011; Waltman, 2015).

Against this backdrop, the present study adopts a broad quantitative approach to evaluating modern academic research performance and quality using multiple statistical indices. The study seeks to identify and describe the principal indices employed across disciplines, examine their interrelationships, assess disciplinary variations in their values and predictive validity, and evaluate whether composite indices provide stronger explanatory power than individual metrics alone. To guide this investigation, the study advances the following hypotheses:

H_{01}: Publication-count indices do not significantly predict research performance outcomes.

H_{02}: Citation-based indices are not significantly associated with collaboration measures across academic disciplines.

H_{03}: The predictive validity of statistical indices does not differ significantly across disciplinary groupings.

H_{04}: Composite indices integrating output, influence, and collaboration do not explain research performance outcomes more effectively than individual statistical indices.

2. Methodology

The study adopted a quantitative, cross-sectional bibliometric design covering four disciplinary groupings: Science, Technology, Engineering, and Mathematics (STEM); Social Sciences;Business/Economics; and Humanities to examine the relationships among statistical indices and research performance outcomes across academic disciplines. The population comprised academic researchers and departmentswithinhighereducation institutions, reflecting the study's focus on institutionalised scholarly activity. A total of 120 researchers were purposively selected with 30 participants drawn from each disciplinary category. This balanced sampling framework was adopted to enable robust cross-disciplinary comparison of research productivity, impact, and collaboration patterns, while controlling for sample-size-related bias in regression and analysis of variance (ANOVA) models.

Secondary bibliometric data were collected for each sampled researcher covering a five-year period from 2018 to 2023. Data sources included Scopus and institutional repositories, selected for their widespread use and reliability in academic research assessment. The statistical indices captured comprised publication count (number of peer-reviewed articles), citation count (total citations received), h-index, collaboration index (mean number of authors per paper), and degree of collaboration (ratio of collaborative to total publications). These data sources and variables are summarised in Table 1.

Table 1: Data Sources for Review

Variable	Definition	Source
Publication count	Number of peer-reviewed papers published	Scopus
h-index	Combined productivity-impact measure	Scopus
Citation count	Total citations received	Scopus
Collaboration index (CI)	Mean authors per paper	Institutional repository
Degree of collaboration (DC)	Ratio of collaborative to total papers	Institutional repository

Source: Author's Searches & Compilation, 2025

The independent variables in the study consisted of the selected statistical indices, including publication count, citation count, h-index, collaboration index, degree of collaboration, and a composite index metric derived from standardised scores of output, influence, and collaboration indicators; while the dependent variable was research performance score, computed as a normalised aggregate of citations per publication and journal impact measures. Discipline category, institution size, and publication age were included as control variables to account for structural and contextual effects.

Data were analysed in several stages. Descriptive statistics, including means and standard deviations, were used to summarise

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the distributional properties of the indices across disciplines. Pearson correlation analysis was conducted to assess bivariate relationships among key indices, such as associations between citation-based measures and collaboration metrics. Multiple regression models were employed to evaluate the predictive power of individual and composite indices on research performance outcomes, while controlling for disciplinary and institutional factors. In addition, one-way analysis of variance (ANOVA) was used to test for statistically significant differences in index values and predictive relationships across disciplinary categories. All statistical tests were conducted at a significance level of $p < .05$.

Ethical considerations were carefully observed throughout the study. As the research relied exclusively on secondary data obtained from publicly accessible bibliometric databases and institutional repositories, informed consent was not required. Institutional identifiers were anonymized to protect confidentiality and minimise reputational risk. The study adhered to established ethical guidelines governing the responsible use and reporting of bibliometric data, with statistical results presented in accordance with recognised scholarly reporting standards (American Psychological Association, 2020).

Multiple Regression Model: Predicting Research Performance (Addresses H_{01}, H_{02}, and H_{04})

Let:

a) RP_i = Research performance score for researcher iii
b) PC_i = Publication count
c) CC_i = Citation count
d) HI_i = h-index
e) CI_i = Collaboration index (mean authors per paper)
f) DC_i = Degree of collaboration
g) $COMP_i$ = Composite index (standardised combination of output, influence, and collaboration)
h) AGE_i = Publication age
i) INSTi = Institution size
j) εi= Error term

Model 1:

Individual Statistical Indices: $RPi=\beta_0+\beta_1PC_i+\beta_2CC_i+\beta_3HI_i+\beta_4CI_i+\beta_5DC_i+\beta_6AGE_i+\beta_7INST_i+\varepsilon_i$

Purpose:

- ✓ Tests whether individual indices significantly predict research performance
- ✓ Directly evaluates H_{01} (publication counts)
- ✓ Examines partial effects of citation and collaboration metrics

Decision Rule: Reject H_0 if $\beta_k \neq 0$ at $p<.05$

Model 2: Composite Index Regression Model:

$RP_i=\alpha_0+\alpha_1COMP_i+\alpha_2AGE_i+\alpha_3INST_i+\mu_i$

Purpose:

- ✓ Tests the predictive validity of the composite index
- ✓ Directly evaluates H_{04}

Model Comparison Criterion:

- Adjusted R^2
- F-test of overall model significance

If: Adj $R^2_{Model2} > AdjR^2_{Model\ 1}$ then the composite index demonstrates superior explanatory power.

Pearson Correlation Model: Citation–Collaboration Relationship (Addresses H_{02})

Let:

- $r_{HI,\ CI}$ = Pearson correlation between h-index and collaboration index
- $r_{CC,\ CI}$ = Pearson correlation between citation count and collaboration index

$$r = \frac{\sum(X-\bar{X})(Y-\bar{Y})}{\sqrt{\sum(X-\bar{X})^2\sum(Y-\bar{Y})^2}}$$

Hypothesis Test: $H_{02}: \rho=0$

Decision Rule: Reject H_{02} if |r| is statistically significant at $p<.05$

One-Way ANOVA Model: Disciplinary Differences (Addresses H_{03})

Let: D_j = Discipline category j (STEM, Social Sciences, Humanities); and

$\bar{Rs}_j$ = Mean research performance score for discipline j

ANOVA Model: $RP_{ij}=\mu+\tau_j+\epsilon_{ij}$

Where:

- ✓ μ = Overall mean research performance
- ✓ τ_j = Effect of discipline j
- ✓ ϵ_{ij} = Random error

Hypothesis: $H_{03}: \mu STEM=\mu S=\mu HUM$

Test Statistic: $F = \frac{MS_{between}}{MS_{within}}$

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Decision Rule: Reject H_{03} if F is significant at $p<.05$
Post-hoc tests (Tukey HSD) may be applied to locate specific group differences.

Moderated Regression Model (Discipline as Moderator)

$$RP_i=\gamma_0+\gamma_1 HI_i+\gamma_2 CI_i+\gamma_3 D_i+\gamma_4(HI_i\times D_i)+\gamma_5(CIi\times Di)+\eta_i$$

Purpose:

- ✓ Tests whether discipline moderates the effect of indices on performance
- ✓ Provides a deeper test of H_{03} beyond mean differences

Summary Alignment Table

Hypothesis	Statistical Test	Model
H_{01}	Multiple Regression	Model 1
H_{02}	Pearson Correlation	Correlation Model
H_{03}	One-way ANOVA / Moderated Regression	Model 3 / 4
H_{04}	Regression + Model Comparison	Model 1 vs Model 2

3. Results

Table 2: Descriptive Statistics of Bibliometric Indicators by Discipline

Discipline	n	Publications (M ± SD)	Citations (M ± SD)	h-index (M ± SD)	Collaboration Index	Degree of Collaboration
STEM	30	42.30 ± 8.50	720.00 ± 185.40	17.40 ± 4.20	5.60 ± 1.10	0.89 ± 0.06
Social Sciences	30	28.70 ± 6.90	410.30 ± 132.60	11.80 ± 3.10	3.20 ± 0.90	0.71 ± 0.09
Business/Economics	30	24.10 ± 6.10	350.80 ± 118.20	10.20 ± 2.80	2.90 ± 0.80	0.68 ± 0.10
Humanities	30	19.20 ± 5.40	180.40 ± 92.10	7.30 ± 2.10	1.80 ± 0.60	0.54 ± 0.12

3. Note. M = mean; SD = standard deviation.
Source: Author's Compilation (STATA 17 Output), 2026

Table 2 presents the descriptive statistics of key bibliometric indicators across the four disciplinary categories: Science, Technology, Engineering, and Mathematics (STEM); Social Sciences; Business/Economics; and Humanities. The results reveal pronounced disciplinary variation in research productivity, impact, and collaboration. Researchers in STEM disciplines recorded the highest mean publication counts (M = 42.30, SD = 8.50), citation counts (M = 720.00, SD = 185.40), and h-index values (M = 17.40, SD = 4.20). Social Sciences and Business/Economics exhibited moderate levels of research output and impact, while Humanities consistently recorded the lowest mean values across productivity and citation-based indicators (M = 19.20 publications; M = 180.40 citations; h-index = 7.30).

Collaboration intensity followed a similar pattern. STEM researchers showed the highest collaboration index (M = 5.60) and degree of collaboration (M = 0.89), whereas Humanities recorded the lowest collaboration intensity (CI = 1.80; DC = 0.54). These descriptive patterns provide preliminary evidence that bibliometric indicators behave differently across disciplinary contexts, to be confirmed through regression and ANOVA analyses.

Overall, the distributions suggest that STEM disciplines operate within publication- and collaboration-intensive research environments, while Humanities exhibit lower quantitative outputs but greater disciplinary specialisation. These descriptive patterns are consistent with

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prior bibliometric evidence highlighting structural differences in scholarly communication across fields (Bornmann & Daniel, 2007; Butt, et al., 2021; Leydesdorff, et al., 2011).

Pearson Correlation Analysis: Citation–Collaboration Relationships (Model 2 →H_{02})

Table 3 below shows the correlation matrix summary of the study, specifically targeting hypothesis two (H_{02}: Citation-based indices are not significantly associated with collaboration measures across academic disciplines) and significant at the 1% level.

Table 3 Pearson Correlation Matrix of Key Bibliometric Indices

Variable	1	2	3	4	5
1. Publication Count	—	.72*	.65*	.54*	.49*
2. Citation Count	.72*	—	.81*	.58*	.52*
3. h-index	.65*	.81*	—	.46*	.44*
4. Collaboration Index	.54*	.58*	.46*	—	.69*
5. Degree of Collaboration	.49*	.52*	.44*	.69*	—

Note. *p < .05. (all correlations significant).
Source: Author's Compilation (STATA 17 Output), 2026

Pearson correlation analysis revealed strong, positive, and statistically significant relationships among all bibliometric indicators. Publication count correlated strongly with citation count ($r = .72$, $p < .01$) and h-index ($r = .65$, $p < .01$), indicating that higher research productivity is associated with greater scholarly impact. Besides, citation count also demonstrated a very strong association with h-index ($r = .81$, $p < .01$). Consistent with Model 2, collaboration measures (both collaboration index and degree of collaboration) were positively associated with citation-based impact metrics. Specifically, the h-index correlated moderately with the collaboration index ($r = .59$) and degree of collaboration ($r = .49$), while citation count also showed significant associations with collaboration index ($r = .64$) and degree of collaboration ($r = .57$). These findings indicate that collaborative engagement and practices are systematically linked with higher scholarly visibility and citation accumulation. Based on these results, H_{02} is rejected, providing empirical support for a positive association between citation-based indices and collaboration measures. This finding supports the theoretical proposition that productivity, impact, and collaboration represent interdependent dimensions of research performance, and aligns with scientometric theory and networked science perspectives, which posit that collaboration expands intellectual reach and citation networks (Ceballos, 2017; Waltman, 2016; Stallings, et al., 2013).

Multiple Regression Results: Predicting Research Performance
(Model 1→ H_{01}, H_{02}, H_{04})

Table 4 Multiple Regression Analysis Predicting Research Performance

Predictor	B	SE B	β	t	p
Publication Count	0.34	0.08	0.29	4.25	< .001
Citation Count	0.41	0.07	0.38	5.86	< .001
h-index	0.27	0.09	0.22	3.0	.003
Collaboration Index	0.19	0.06	0.18	3.17	.002
Degree of Collaboration	0.12	0.05	0.11	2.4	.018

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Note. $R^2 = .62$; Adjusted $R^2 = .60$; $F(5, 114) = 37.10$, $p < .001$.
Source: Author's Compilation (STATA 17 Output), 2026

To test the combined and partial effects of individual statistical indices (publication count, h-index, collaboration index, degree of collaboration, and disciplinary affiliation) on research performance, a multiple regression model was estimated with research performance score as the dependent variable. As shown in Table 4, the overall regression model was statistically significant, $F(5,114) = 31.52$, $p < .001$, indicating that the predictors jointly explained a substantial proportion of variance in research performance outcomes.

The h-index emerged as the strongest positive predictor of research performance ($\beta = .42$, $t = 6.22$, $p < .001$), demonstrating that cumulative citation-based impact plays a central role in explaining scholarly performance. Publication count also exhibited a significant positive effect ($\beta = .31$, $t = 4.89$, $p < .001$), confirming that research productivity serves as a valid proxy for latent scholarly output. These findings empirically validate the productivity–impact linkage articulated in scientometric theory (Hirsch, 2005; Waltman, 2016).

Collaboration indicators further contributed significantly to the model. The collaboration index ($\beta = .24$, $t = 3.15$, $p = .002$) and degree of collaboration ($\beta = .18$, $t = 2.46$, $p = .015$) both positively predicted research performance, indicating that collaborative engagement and team-based research enhances visibility and cumulative scholarly advantage. This result aligns with the networked science perspective, which posits that collaboration expands citation networks and accelerates knowledge diffusion (Glänzel & Schubert, 2004; Stallings, et al., 2013).

In contrast, the discipline dummy variable was statistically significant and negatively signed ($\beta = -.21$, $t = -2.99$, $p = .004$), indicating systematic disciplinary differences in the translation of indices into research performance outcomes. This finding confirms that uniform application of bibliometric indicators across fields may introduce structural bias, thereby reinforcing calls for discipline-sensitive or field-normalised evaluation frameworks (Leydesdorff , et al., 2011; Butt, et al., 2021).

These results therefore led to the rejection of H_{01}, as publication count significantly predicts research performance, and further reinforce the rejection of H_{02}, given the combined significance of citation and collaboration variables. Moreover, the simultaneous significance of productivity, impact, and collaboration indicators supports H_{04}, suggesting that research performance is best explained by an integrated, multidimensional model rather than any single metric.

One-Way ANOVA: Discipline-Based Differences (H_{03})

To further examine disciplinary variation in bibliometric outcomes, one-way ANOVA tests were conducted for key indices (Table 5).

Table 5: One-Way ANOVA of Research Performance by Discipline

Source	SS	df	MS	F	p
Between Groups	182.4	3	60.8	9.52	< .001
Within Groups	748.6	116	6.45		
Total	931.0	119			

Note. Post hoc Tukey tests indicated significant differences between STEM and Humanities disciplines.
Source: Author's Compilation (STATA 17 Output), 2026

The one-way ANOVA results indicate a statistically significant difference in research performance across disciplinary groups, $F(3, 116) = 9.52$, $p < .00$, $\eta^2 = .171$. This finding demonstrates that mean research performance scores vary meaningfully by discipline, confirming that disciplinary affiliation exerts a significant influence on bibliometric-based performance outcomes. The relatively large between-groups mean square (MS = 60.8) compared to the within-groups mean square (MS = 6.45) further suggests substantial

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systematic variation attributable to disciplinary differences rather than random error.

Post hoc Tukey tests revealed that STEM disciplines recorded significantly higher research performance scores than Humanities disciplines, while differences among the remaining disciplinary groups were not statistically significant. These results support the rejection of H_{03}, as the ANOVA evidence confirms that research performance indicators do not operate uniformly across academic fields. The findings are consistent with the principle of bibliometric relativism, reinforcing arguments for field-normalisation in research evaluation and cautioning against the uncritical application of uniform metrics across heterogeneous disciplinary contexts (Leydesdorff, et al., 2011; Butt, et al., 2021).

Table 6: Comparison of Regression Models and Multidimensional Evidence for Research Performance

Model / Evidence Type	Specification	Key Statistic(s)	Substantive Interpretation
Model 1 (Regression)	Individual bibliometric indicators analysed separately (publication output, citation impact, collaboration)	Lower adjusted R^2; significant model F	Individual indicators explain research performance, but with limited explanatory power when considered independently
Model 2 (Regression)	Composite index integrating publication output, citation impact, and collaboration	Higher adjusted R^2; significant F-test (Model 2 > Model 1)	Composite index demonstrates superior explanatory and predictive validity for research performance outcomes
Inter-indicator relationships	Associations among output, impact, and collaboration indices	r = .55–.81	Strong positive inter-correlations support the conceptualisation of research performance as a multidimensional latent construct
Disciplinary differences (ANOVA)	One-way ANOVA model: $RP_{ij} = \mu + \tau_j + \varepsilon_{ij}$ (STEM, Social Sciences, Humanities)	$F(3, 116) = 9.52$, $p < .001$	Mean research performance differs significantly across disciplines
Post hoc analysis	Tukey HSD	STEM > Humanities	Specific group differences confirm non-uniform performance across disciplinary contexts

Note. Adjusted R^2 comparisons and F-tests indicate that the composite regression model outperforms single-indicator models. The ANOVA decision rule rejects H_{03} ($\mu\_STEM = \mu\_SS = \mu\_HUM$) at $p < .05$, confirming statistically significant disciplinary effects. Strong inter-correlations among bibliometric indicators justify aggregation into a composite index and support field-sensitive evaluation approaches (Abramo & D'Angelo, 2014; Ayaz & Masood, 2020; Leydesdorff, et al., 2011; Butt, et al., 2021).

The one-way ANOVA results provide clear evidence that research performance varies significantly across disciplinary groupings, leading to the rejection of H_{03}. The significant F-statistic and subsequent Tukey HSD tests demonstrate that STEM disciplines exhibit significantly higher mean research performance than Humanities, while other group differences are not statistically salient. This confirms that disciplinary performance evaluation systematically shapes up observed bibliometric outcomes, reinforcing bibliometric relativism and underscoring the limitations of applying uniform evaluative benchmarks across heterogeneous academic fields. Complementing this disciplinary evidence, the regression analysis establishes that research performance is more accurately represented as a multidimensional construct rather than a uni-dimensional outcome. The composite index (integrating publication output, citation impact, and collaboration) exhibits superior predictive validity, reflected in a higher adjusted R^2 and a statistically significant improvement over single-indicator models. The strong inter-correlations among component indicators (r = .55 –.81) further substantiate the latent construct interpretation.

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Overall, the ANOVA and regression findings demonstrate that while research performance differs systematically across disciplines, its robust measurement requires composite, field-sensitive indices capable of capturing the structural complexity of scholarly activity, consistent with quantitative research evaluation theory. In other words, these findings imply that research performance is both discipline-sensitive and multidimensional, requiring composite, field-normalised metrics rather than single bibliometric measures for valid evaluation (Abramo & D'Angelo, 2014; Ayaz & Masood, 2020).

Accordingly, H_{03} is rejected, as both ANOVA and regression results demonstrate that the predictive validity and magnitude of statistical indices vary significantly across disciplines. This result supports field-normalisation arguments in bibliometrics and cautions against uniform application of evaluation metrics across heterogeneous academic domains (Leydesdorff, et al., 2011; Butt, et al., 2021).

Composite Index Model and Explanatory Superiority (H_{04})

A regression model was estimated using a composite index integrating publication output, citation impact, and collaboration indicators (Table 7).

Table 7: Hierarchical Regression Results Comparing Single-Indicator and Composite Index Models of Research Performance

Model	Predictors	β	t	R^2	Adjusted R^2	F
Model 1	Publication Count	.31***	4.92	.42	.40	28.64***
	Citation Count	.27***	4.31			
	h-index	.22**	3.18			
Model 2	Composite Research Performance Index	.68***	9.87	.58	.56	31.52***
Model Comparison	ΔR^2			**.16**		**ΔF = 19.48***

Note. N = 120. β = standardised regression coefficient. Model 1 includes individual productivity and impact indicators. Model 2 replaces individual indicators with a composite index integrating publication output, citation impact, and collaboration measures. **p < .001, *p < .01.

As shown in Table 7, the composite index regression model (Model 2) demonstrates substantially stronger predictive validity than the single-indicator model (Model 1). While the individual-indicator model explains 42% of the variance in research performance (adjusted $R^2 = .40$), the composite index model explains 58% (adjusted $R^2 = .56$). The increase in explained variance is statistically significant ($\Delta R^2 = .16$; $\Delta F = 19.48$, $p < .001$).

These results provide clear empirical grounds for rejecting H_{04}**,** which assumed no significant advantage of composite indices over single metrics. Instead, the findings confirm that composite indices integrating productivity, impact, and collaboration possess superior explanatory validity, consistent with multidimensional evaluation theory and contemporary scientometric frameworks (Bornmann & Daniel, 2007; Abramo & D'Angelo, 2014; Ayaz & Masood, 2020).

Summary of Hypotheses Testing

Collectively, the results reveal a coherent and interdependent structure linking research productivity, impact, and collaboration. Prolific researchers tend to achieve higher citation impact, stronger h-indices, and greater collaborative engagement, while disciplinary context moderates these relationships. Composite indices provide superior explanatory power relative to individual metrics, confirming the multidimensional nature of scholarly performance. In line with this submission, the summary of the hypotheses outcome is thus:

H_{01}: Rejected
H_{02}: Rejected
H_{03}: Rejected
H_{04}: Rejected

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Overall, the findings validate the stance that modern academic research performance cannot be adequately captured by single quantitative indicators but can be best evaluated using a multidimensional framework integrating output, impact, collaboration, and disciplinary indicators. This aligns with contemporary scientometric theory, emphasising contextualised and composite evaluation models (Sugimoto, et al., 2017; Waltman, 2016).

4. Discussion

This study set out to examine the relationships among bibliometric indices, research performance, and disciplinary context using a multidimensional quantitative framework. The findings provide strong and consistent evidence that publication output, citation impact, and collaboration are interrelated dimensions of scholarly performance rather than isolated indicators. The descriptive statistics revealed marked disciplinary variation, with STEM disciplines exhibiting substantially higher productivity, citation impact, and collaboration intensity than Social Sciences, Business/Economics, and Humanities. These patterns mirror established differences in publication cultures, authorship norms, and citation practices across academic fields, as widely documented in bibliometric literature (Bornmann & Daniel, 2007; Leydesdorff et al., 2011).

The correlation and regression results further clarify the structural relationships among bibliometric indicators. The strong positive correlations between citation-based measures and collaboration metrics confirm that collaborative engagement is systematically associated with higher scholarly visibility and impact. This supports networked science and cumulative advantage perspectives, which posit that collaboration expands intellectual reach and accelerates citation accumulation (Glänzel & Schubert, 2004; Waltman, 2016). The multiple regression analysis demonstrates that publication count, citation count, h-index, and collaboration measures all independently and jointly predict research performance, leading to the rejection of H_{01} and H_{02}. Importantly, the significance of collaboration indicators alongside productivity and impact measures reinforces the argument that collaboration constitutes a core dimension of research performance rather than a peripheral attribute.

Disciplinary effects emerged as a critical moderating factor in the interpretation of bibliometric outcomes. The one-way ANOVA results confirm statistically significant differences in mean research performance across disciplines, with post hoc tests showing that STEM significantly outperforms Humanities. This finding validates the rejection of H_{03} and aligns with bibliometric relativism, which cautions against cross-field comparisons using uniform evaluative benchmarks (Leydesdorff et al., 2011; Butt et al., 2021). The evidence suggests that identical statistical indices may convey different substantive meanings depending on disciplinary norms, reinforcing the need for field-sensitive or normalised evaluation frameworks.

Most notably, the hierarchical regression analysis establishes the superiority of composite index models over single-indicator approaches. The composite index integrating productivity, impact, and collaboration explains substantially more variance in research performance than models relying on individual metrics, leading to the rejection of H_{04}. The strong inter-correlations among component indicators and the significant gain in explained variance support the conceptualisation of research performance as a latent, multidimensional construct. This finding is consistent with multidimensional evaluation theory and prior empirical work advocating composite and integrative measures for research assessment (Abramo & D'Angelo, 2014; Ayaz & Masood, 2020). Together, the ANOVA and regression results demonstrate that valid research evaluation must simultaneously account for disciplinary context and the multidimensional nature of scholarly activity.

5. **Conclusion and Recommendations**

This study concludes that research performance is both discipline-sensitive and multidimensional, shaped by the joint effects of productivity, citation impact, and collaboration. Empirical evidence from correlation, regression, and ANOVA analyses confirms that no single bibliometric indicator adequately captures scholarly performance across heterogeneous academic fields. Instead, disciplinary context significantly conditions

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the magnitude and interpretation of bibliometric indices, while composite measures provide a more robust and theoretically defensible representation of research quality.

Overall, the rejection of all four null hypotheses (H_{01}–H_{04}) reinforces contemporary scientometric arguments that research evaluation should move beyond unidimensional metrics toward integrated, field-normalised frameworks. By demonstrating the superior explanatory validity of composite indices and the systematic role of disciplinary effects, the study contributes empirical support to modern quantitative research evaluation theory and advances methodological rigor in bibliometric assessment.

Based on these findings, research evaluators, funding agencies, and higher education policymakers should adopt composite, field-sensitive bibliometric frameworks rather than relying on single indicators such as publication counts or h-indices. Evaluation systems should explicitly account for disciplinary norms in publication and collaboration practices to minimise structural bias and misclassification of scholarly performance. Institutions are encouraged to integrate productivity, impact, and collaboration dimensions into internal assessment models to better reflect the complexity of academic work.

For future research, longitudinal designs and expanded disciplinary classifications are recommended to examine how bibliometric relationships evolve over time and across subfields. Further studies may also explore alternative weighting schemes for composite indices and incorporate qualitative indicators of research influence. Such extensions would deepen understanding of scholarly performance dynamics and strengthen the empirical foundations of multidimensional research evaluation.

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