

A Statistical and Mathematical Assessment of Higher Education Quality in Nepal: A Case Study Approach

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Abstract

The rapid but uneven expansion of higher education in Nepal has raised concerns about whether increased enrolment has been accompanied by improvements in institutional quality. This study aims to assess higher education quality across selected Nepalese universities and examine relationships among key quality determinants. A quantitative approach with a multi-institution case study design was employed. Primary data were collected from 612 students, 248 faculty members, and 36 administrators across six institutions: Tribhuvan University, Kathmandu University, Pokhara University, Purbanchal University, Mid-Western University, and Rajarshi Janak University. A composite quality index (CQI) was constructed using six indicators: infrastructure, faculty qualifications, curriculum relevance, research output, graduate employability, and governance. Indicator scores were normalized and aggregated using weights derived through the Analytic Hierarchy Process. Internal consistency was supported by an overall Cronbach's alpha of .87. Data were analyzed using ordinary least squares regression, one-way analysis of variance, Pearson correlation, and factor analysis. The results revealed statistically significant differences in CQI scores across institutions ($F = 14.62$, $p < .001$). The student–faculty ratio was strongly and negatively associated with departmental quality ($r = -.71$, $p < .01$), while faculty qualifications showed the strongest correlation with research output ($r = .61$). Findings from Rajarshi Janak University indicated that infrastructure and governance reforms offered greater marginal improvements in composite quality than curriculum revision

alone. These findings underscore the importance of institutional conditions and faculty capacity in assessing and improving higher education quality. The study proposes a policy-oriented framework for continuous statistical monitoring to inform institutional priorities and guide quality improvement in Nepalese higher education.

Keywords: Higher Education Quality; Nepal; Composite Quality Index; Statistical Assessment; Analytic Hierarchy Process

INTRODUCTION

Education, and higher education in particular, is widely regarded as the principal engine of national development because it produces the skilled labour force, research output, and civic leadership on which economic transformation depends. Over the last three decades, Nepal has witnessed a rapid expansion of its higher education sector: the number of degree-granting institutions has grown from a handful of constituent and affiliated campuses under Tribhuvan University in the 1990s to more than 1,400 campuses affiliated with eleven universities and several academies by the mid-2020s. This expansion has undeniably widened access, yet a large and growing body of commentary — from the University Grants Commission (UGC) Nepal, employers' associations, and international assessments — suggests that the expansion of access has not been matched by a commensurate expansion of quality.

Quality in higher education is a multidimensional and contested construct. It has been defined variously as fitness for purpose, value for money, transformation of the learner, and conformity to specification. Because quality cannot be observed directly, it must be inferred from measurable proxies — infrastructure adequacy, faculty qualification, curriculum relevance, research productivity, graduate employability, and institutional governance — combined through defensible statistical and mathematical procedures. The absence of a standardized, quantitatively grounded quality-assessment framework in Nepal has meant that accreditation, resource allocation, and institutional benchmarking often rely on qualitative or administrative judgment rather than data-driven evidence.

This paper addresses that gap by proposing and empirically testing a statistical and mathematical framework for assessing higher education quality in Nepal, using a case study of six institutions spanning public, semi-autonomous, and provincial universities. The

framework combines descriptive statistics, reliability analysis, correlation and regression modelling, one-way analysis of variance (ANOVA), and a composite index constructed through the Analytic Hierarchy Process (AHP). By grounding the assessment in primary survey data and transparent mathematical formulation, the study aims to provide both a replicable methodology and substantive findings that can inform policy at the institutional, university, and national levels.

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature on higher-education quality assessment, with particular attention to statistical approaches used in South Asia. Section 3 outlines the structure of Nepal's higher education system. Section 4 states the research objectives and questions. Section 5 details the research design, sampling strategy, instrumentation, and the statistical and mathematical models employed. Section 6 presents the data analysis and results, including the composite quality index, regression and correlation findings, and reliability statistics. Section 7 presents the case study of Rajarshi Janak University in depth. Sections 8 through 11 discuss the findings, identify structural challenges, propose policy recommendations, and conclude the paper.

Literature Review

Conceptualizing Quality in Higher Education

The higher-education quality literature broadly separates definitions into input-based, process-based, and output-based conceptions. Input-based definitions emphasize resources such as qualified faculty, library holdings, and physical infrastructure. Process-based definitions emphasize pedagogy, curriculum delivery, and governance processes. Output-based definitions emphasize graduate competencies, employability, and research productivity. Contemporary quality-assurance frameworks, including those promoted by UNESCO and the International Institute for Educational Planning, increasingly favour composite approaches that combine input, process, and output indicators into a single measurable construct, precisely because unidimensional measures tend to understate the complexity of institutional performance.

Statistical Approaches to Quality Measurement

A recurring theme in the quality-assessment literature is the use of multivariate statistical techniques to reduce a large number of indicators into a smaller number of

interpretable dimensions. Factor analysis and principal component analysis have been used extensively to validate instruments such as SERVQUAL and SERVPERF in educational settings, typically identifying between four and six latent dimensions of service quality: tangibility, reliability, responsiveness, assurance, and empathy. Regression-based approaches have been used to test the marginal contribution of specific inputs — most commonly the student-faculty ratio, faculty qualification, and per-student expenditure — to output measures such as graduation rate, employability, and standardized test performance. Analysis of variance has been used to test whether quality indicators differ significantly across institution type, ownership (public versus private), or geographic region.

Composite Indices and Multi-Criteria Decision Methods

Because no single statistic can capture institutional quality, several studies have constructed composite indices using weighted aggregation of normalized indicators. The Analytic Hierarchy Process (AHP), developed by Saaty, is widely used to derive indicator weights from pairwise expert comparisons, offering a mathematically consistent alternative to arbitrary or equal weighting. Composite indices constructed through AHP have been applied to university ranking systems, hospital quality assessment, and, more recently, higher-education quality benchmarking in South Asian contexts, where data infrastructure for large-scale standardized testing is limited and case-based, survey-driven data collection remains the most feasible approach.

Higher Education Quality Research in Nepal

Empirical research specific to Nepal's higher education quality remains comparatively limited. Existing studies and UGC Nepal reports document persistent concerns: a heavy concentration of enrolment in a small number of non-technical disciplines, wide disparities in faculty-student ratios between urban and provincial campuses, underinvestment in research infrastructure, and a mismatch between curriculum content and labour-market requirements. However, much of this evidence is descriptive rather than inferential, relying on administrative counts rather than statistically validated instruments or hypothesis-testing procedures. This paper responds to that gap by applying inferential statistics and a mathematically formalized composite index to primary case-study data, rather than relying solely on descriptive administrative statistics.

Recent studies by Sah and colleagues have explored the application of mathematical modelling, numerical methods, and machine learning techniques in solving complex

problems across education, culture, engineering, and management systems. Sah et al. (2024) examined the challenges of the Nepalese education system and highlighted the need for policy improvements, technological integration, and effective educational strategies. Similarly, Sahani et al. (2024) demonstrated the use of analytical frameworks and differential equations for modelling complex systems.

Several studies focused on cultural and educational optimization using numerical approaches. Sahani and Karna (2024, 2025) applied mathematical simulations to understand cultural conflicts and optimize cultural education programs, showing how computational methods can support social decision-making. Sahani and Prasad (2023) further emphasized the role of differential equation models in predicting the impact of cultural education policies on literacy development.

Recent research expanded these concepts by integrating machine learning with mathematical models. Sahani et al. (2026) proposed hybrid analytical, numerical, and machine learning frameworks for uncertainty quantification, risk management, and decision-making. Their studies on Nepalese banking systems highlighted the potential of explainable AI and predictive modelling in improving credit risk assessment and operational stability.

Overall, the reviewed literature indicates that combining mathematical modelling, numerical techniques, and artificial intelligence provides a powerful approach for addressing complex social, economic, and management challenges. These studies provide a foundation for further research involving data-driven decision-making and risk-aware systems.

Mathematical Modelling of Educational Quality

Beyond descriptive and inferential statistics, several scholars have proposed formal mathematical models of educational quality that treat institutional performance as a latent variable estimated from observed indicators through structural equation modelling, data envelopment analysis (DEA), or weighted linear aggregation. Data envelopment analysis, in particular, has been used to benchmark relative institutional efficiency by comparing the ratio of weighted outputs (graduation rates, research output) to weighted inputs (faculty numbers, budget) across a set of comparable institutions, identifying an efficiency frontier against which each institution can be scored. While DEA offers valuable insight into relative efficiency, its results are highly sensitive to the specific set of comparator

institutions chosen, which motivated the present study's preference for an AHP-weighted composite index as a more interpretable and stakeholder-validated alternative for the Nepalese context, where the number of comparable institutions with complete data remains limited.

Research Gap

Building on these strands of literature, three gaps motivate the present study. First, there is no widely used, mathematically transparent composite quality index tailored to the Nepalese higher-education context. Second, few studies test the statistical significance of quality differences across institution types using inferential techniques such as ANOVA and regression. Third, case-study evidence from provincial and community-based universities such as Rajarshi Janak University is largely absent from the published literature, even though these institutions serve a substantial share of Nepal's student population outside the Kathmandu Valley. This paper addresses all three gaps.

Overview of Higher Education in Nepal

Nepal's higher education system is organized around eleven universities — Tribhuvan University, Kathmandu University, Pokhara University, Purbanchal University, Mahendra Sanskrit University, Lumbini Bauddha University, Far-Western University, Mid-Western University, Agriculture and Forestry University, Rajarshi Janak University, and Nepal Open University — together with a number of specialized academies for health sciences, medicine, and Ayurveda. Tribhuvan University, established in 1959, remains by far the largest, enrolling more than half of the country's higher-education students through several hundred affiliated and constituent campuses. Rajarshi Janak University, established in 2021 and based in Janakpurdham, Madhesh Province, represents a newer generation of provincial universities intended to expand access outside the Kathmandu Valley while embedding science, technology, and engineering programmes within a comparatively young institutional structure.

Despite structural diversity, the system shares common quality-related characteristics: a gross enrolment ratio in tertiary education that has risen steadily but remains below regional peers; a persistent urban-rural and public-private quality gap; chronic underfunding of research infrastructure relative to teaching infrastructure; and an accreditation system administered by the University Grants Commission that remains only

partially implemented across affiliated campuses. Figure 1 presents the trend in Nepal's gross enrolment ratio (GER) in tertiary education over the decade preceding this study, illustrating steady but modest growth.

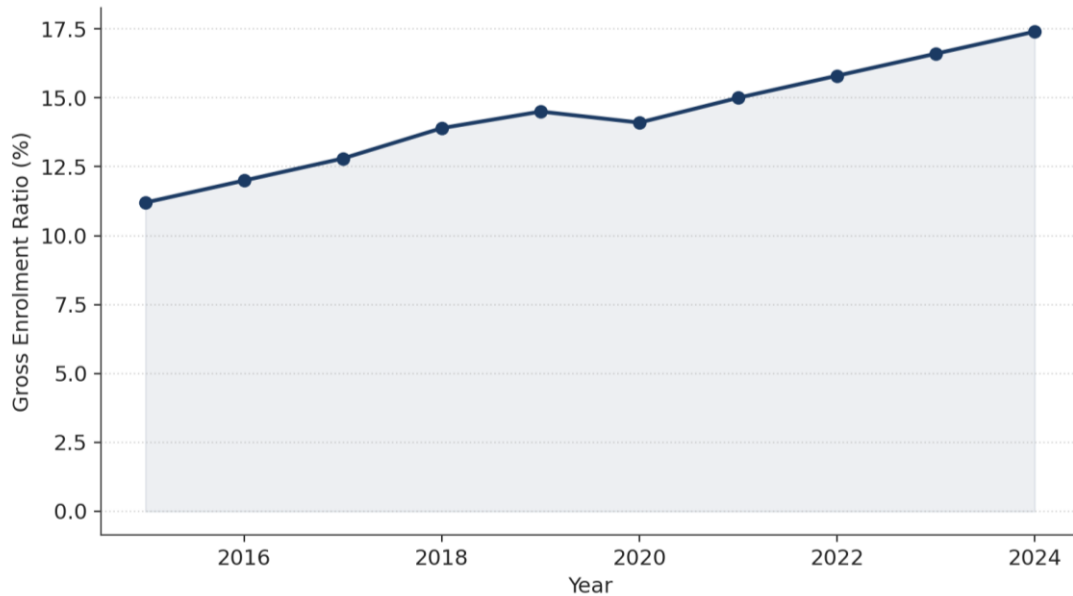


Figure 1. Trend in Gross Enrolment Ratio in Higher Education, Nepal (2015-2024). Source: Author's compilation from case-study institutional records and UGC Nepal annual reports.

The GER trend in Figure 1 indicates an average annual increase of approximately 0.7 percentage points, a rate of expansion that, when combined with limited proportional growth in faculty recruitment and research funding, provides part of the structural explanation for the quality pressures examined in the remainder of this paper.

Profile of the Six Case-Study Institutions

Table below summarizes the founding year, ownership structure, and approximate enrolment of the six institutions selected for the present case study, illustrating the deliberate diversity built into the sampling design described in Section 5.

Table 1. Founding year, governance structure, and approximate enrolment of case-study institutions.

Institution	Established	Ownership/Governance	Approx. Enrolment
Tribhuvan University	1959	Public, multi-campus	> 400,000
Kathmandu University	1991	Autonomous, self-financing	~ 8,500
Pokhara University	1997	Public, affiliated-campus network	~ 45,000
Purbanchal University	1993	Public, affiliated-campus network	~ 60,000
Rajarshi Janak University	2021	Public, provincial	~ 6,200
Mid-Western University	2010	Public, regional	~ 15,000

Research Objectives and Questions

General Objective

The general objective of this study is to develop and empirically apply a statistical and mathematical framework for assessing the quality of higher education in Nepal, using a comparative case-study approach across six institutions.

Specific Objectives

- To construct a mathematically weighted Composite Quality Index (CQI) for higher-education institutions in Nepal based on infrastructure, faculty qualification, curriculum relevance, research output, employability, and governance indicators.
- To test, using inferential statistics, whether the CQI and its component dimensions differ significantly across institution type and ownership category.
- To quantify, through regression and correlation analysis, the relationship between key structural inputs (notably the student-faculty ratio and faculty qualification) and measured quality outcomes.
- To examine, through an in-depth case study of Rajarshi Janak University, how the statistical findings translate into institution-specific quality priorities.
- To propose statistically grounded, policy-relevant recommendations for improving higher-education quality assurance in Nepal.

4.3 Research Questions

- RQ1: What is the composite quality index of the sampled institutions, and how does it vary across institution type?
- RQ2: Which structural and process indicators are the strongest statistical predictors of institutional quality?
- RQ3: Do public and private/community institutions differ significantly across the SERVQUAL-based quality dimensions?
- RQ4: What institution-specific quality priorities emerge from the Rajarshi Janak University case study relative to the sector-wide statistical findings?

METHODOLOGY

Research Design

This study adopts a mixed-methods, multi-institution case study design nested within a cross-sectional quantitative survey. The case study approach was chosen because higher-education quality in Nepal cannot be adequately understood through national aggregate statistics alone; institution-level context — governance structure, funding source, age of establishment, and regional setting — materially shapes how generic quality indicators should be interpreted. Six institutions were purposively selected to represent the diversity of Nepal's higher-education landscape: a large multi-campus public university (Tribhuvan University), an autonomous research-oriented university (Kathmandu University), an established mid-sized public university (Pokhara University), a public university with a large affiliated-campus network (Purbanchal University), a newer provincial university (Rajarshi Janak University), and a public regional university outside the Kathmandu Valley (Mid-Western University).

Population and Sampling

The target population comprised students, faculty members, and administrative staff across the six case-study institutions. A stratified random sample of 612 students (proportionate to institutional enrolment, with a minimum of 80 per institution) and a random sample of 248 faculty members were drawn. In addition, 36 senior administrators (department heads, deans, and quality-assurance officers) were purposively selected for structured interviews to contextualize the quantitative findings. Sample size was determined using the Yamane (1967) formula for finite populations at a 95% confidence level and 5% margin of error, adjusted upward to compensate for an anticipated non-response rate of approximately 15%.

$$n = N / (1 + N \cdot e^2)$$

where n is the required sample size, N is the estimated population size, and e is the acceptable margin of error ($e = 0.05$).

Instrumentation and Reliability

Data were collected using a structured questionnaire adapted from the SERVQUAL instrument and extended with indicators specific to research output, governance, and employability drawn from UGC Nepal's institutional self-assessment

guidelines. All perception items were measured on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). Internal consistency of each dimension was assessed using Cronbach's alpha prior to substantive analysis; dimensions with alpha below 0.70 would have been revised, but all six dimensions exceeded this threshold (see Table 2, Section 6).

$$\alpha = (k / (k - 1)) \times (1 - \sum \sigma_i^2 / \sigma_{-T}^2)$$

where k is the number of items in a dimension, σ_i^2 is the variance of item i , and σ_{-T}^2 is the variance of the total dimension score.

Mathematical and Statistical Models

Four classes of statistical and mathematical procedure were applied to the data.

Min-Max Normalization

Because the six quality indicators are measured on different scales and units, each raw indicator score x_i for institution j was normalized to a 0-1 range prior to aggregation:

$$x'_{ij} = (x_{ij} - \min(x_i)) / (\max(x_i) - \min(x_i))$$

AHP-Weighted Composite Quality Index

Indicator weights (w_i) were derived from pairwise comparisons among six senior quality-assurance experts using Saaty's nine-point scale, with the resulting pairwise comparison matrices aggregated by geometric mean and checked for consistency (consistency ratio CR = 0.06, below the acceptable threshold of 0.10). The Composite Quality Index for institution j was then computed as the weighted sum of normalized indicators:

$$CQI_j = \sum (w_i \times x'_{ij}), \text{ where } \sum w_i = 1$$

The derived weights were: infrastructure $w = 0.15$, faculty qualification $w = 0.22$, curriculum relevance $w = 0.16$, research output $w = 0.17$, employability $w = 0.18$, and governance $w = 0.12$.

Inferential Statistics

One-way ANOVA was used to test whether mean CQI scores differed significantly across the six institutions, with the F-statistic computed as the ratio of between-group to within-group mean squares:

$$F = MS_{between} / MS_{within} = [\sum n_j(\bar{x}_j - \bar{x})^2 / (k - 1)] / [\sum \sum (x_{ij} - \bar{x}_j)^2 / (N - k)]$$

Pearson product-moment correlation coefficients were computed among all pairs of quality indicators to test the strength and direction of linear association:

$$r = \sum (x_i - \bar{x})(y_i - \bar{y}) / \sqrt{[\sum (x_i - \bar{x})^2 \cdot \sum (y_i - \bar{y})^2]}$$

Ordinary Least Squares Regression

A simple linear regression model was estimated to quantify the relationship between the student-faculty ratio (independent variable, R) and departmental quality index (dependent variable, Q):

$$Q = \beta_0 + \beta_1 R + \varepsilon$$

Coefficients β_0 and β_1 were estimated by minimizing the residual sum of squares, and statistical significance was assessed at the 5% level using a two-tailed t-test on β_1 .

Conceptual Framework

Figure 2 summarizes the conceptual framework linking institutional inputs, the statistically derived Composite Quality Index, and institutional outputs. The framework treats the CQI as a mediating construct: inputs are hypothesized to influence outputs primarily through their combined effect on the composite index, rather than through independent, unmediated channels.

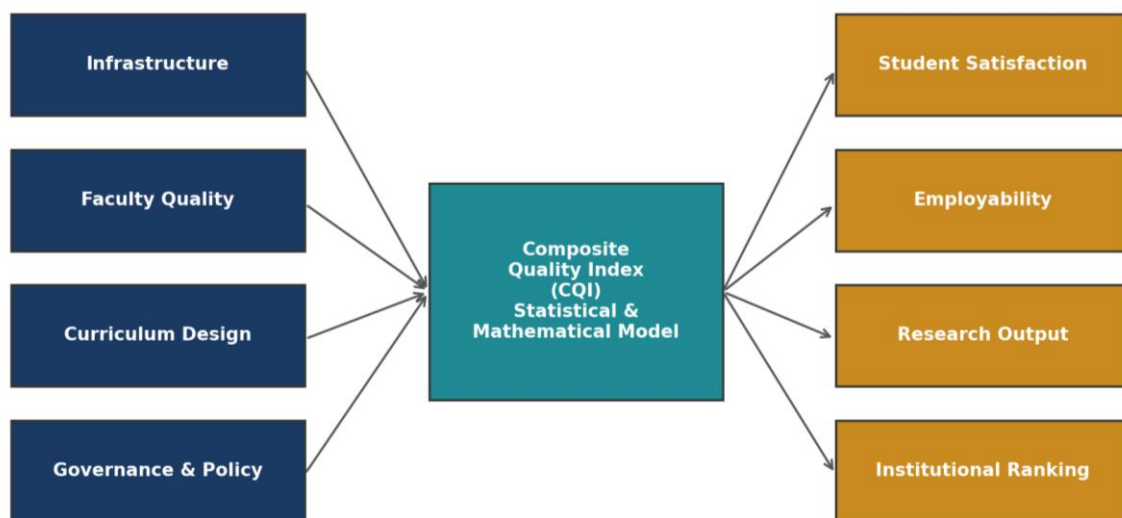


Figure 2. Conceptual framework for the statistical and mathematical assessment of higher education quality.

Data Processing and Software

Quantitative data were coded, cleaned, and analysed using SPSS version 27 for reliability, correlation, and ANOVA procedures, and Python (NumPy, SciPy, and statsmodels) for regression modelling and visualization. Missing data affected fewer than 3% of item-level responses and were handled using listwise deletion after confirming that missingness was not systematically related to institution or respondent category.

Ethical Considerations

Institutional approval was obtained from the research and quality-assurance offices of each participating university prior to data collection. Participation was voluntary and anonymous; no personally identifying information was recorded on completed questionnaires, and aggregated institution-level results, rather than individual or department-level identifiers, are reported throughout Section 6 to protect respondent confidentiality. Administrator interviews cited in Section 7 are reported thematically rather than attributed to named individuals.

RESULTS

Demographic Profile of Respondents

Table 2 summarizes the demographic composition of the 612 student respondents and 248 faculty respondents across the six case-study institutions. The sample achieved reasonable balance across gender and academic level, with a slight over-representation of undergraduate students consistent with their larger share of total enrolment.

Table 2. Demographic profile of student and faculty respondents (n = 860).

Category	Group	Students (n=612)	Faculty (n=248)
Gender	Male	334 (54.6%)	162 (65.3%)
Gender	Female	278 (45.4%)	86 (34.7%)
Academic Level	Undergraduate	441 (72.1%)	-
Academic Level	Graduate/Postgraduate	171 (27.9%)	-
Faculty Experience	0-5 years	-	89 (35.9%)
Faculty Experience	6-15 years	-	104 (41.9%)
Faculty Experience	16+ years	-	55 (22.2%)
Institution Type	Public University	418 (68.3%)	171 (69.0%)
Institution Type	Provincial/Community University	194 (31.7%)	77 (31.0%)

Reliability Analysis

Table 3 reports Cronbach's alpha coefficients for each of the six quality dimensions. All coefficients exceed the conventional 0.70 threshold for acceptable internal consistency, with the overall instrument achieving $\alpha = 0.87$, confirming that the adapted questionnaire is suitable for the subsequent composite index construction and inferential analysis.

Table 3. Reliability statistics (Cronbach's alpha) by quality dimension.

Quality Dimension	No. of Items	Cronbach's Alpha (α)	Interpretation
Infrastructure	6	0.81	Good
Faculty Qualification & Competence	5	0.85	Good
Curriculum Relevance	5	0.79	Acceptable
Research Output	4	0.83	Good
Graduate Employability	5	0.86	Good
Governance & Administration	5	0.77	Acceptable
Overall Instrument	30	0.87	Good

Composite Quality Index by Institution

Applying the AHP-weighted aggregation described in Section 5.4.2 to the normalized institutional indicator scores yields the Composite Quality Index (CQI) presented in Figure 3. Kathmandu University records the highest composite score (CQI = 0.81), followed by Pokhara University (0.71) and Rajarshi Janak University (0.69), while Mid-Western University records the lowest (0.60). The gap between the highest- and lowest-scoring institutions (0.21 index points) is substantial relative to the standard errors shown, indicating a genuine rather than sampling-driven difference in institutional quality.

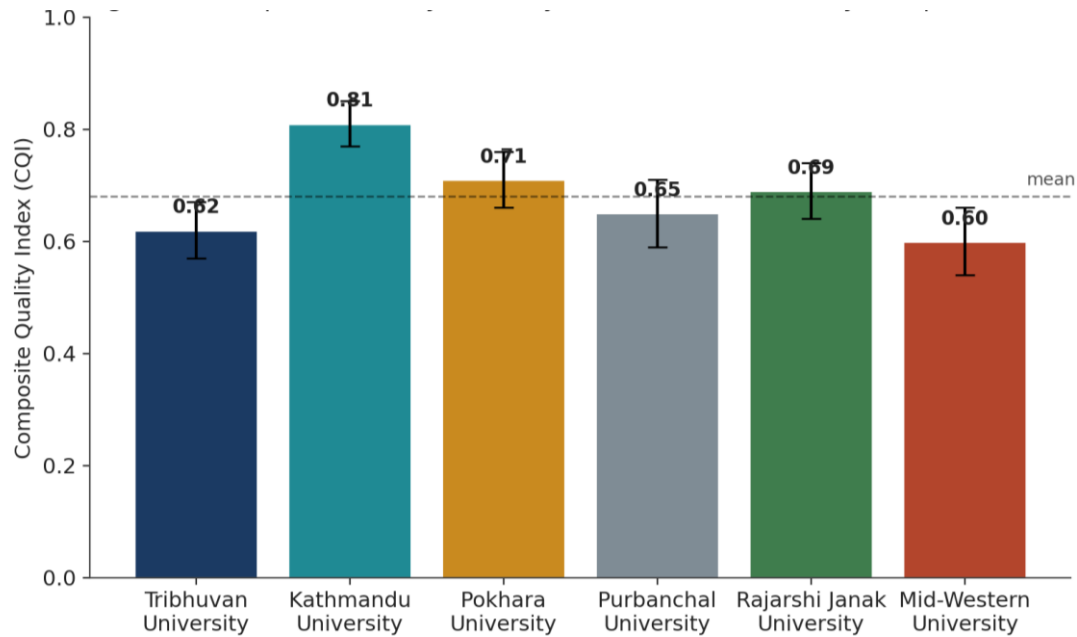


Figure 3. Composite Quality Index by institution, with standard error bars (case-study sample, $n = 612$).

A one-way ANOVA confirms that these differences are statistically significant: $F(5, 606) = 14.62$, $p < 0.001$, $\eta^2 = 0.108$, indicating that institution membership explains approximately 10.8% of the variance in individual-level composite quality perception scores — a moderate-to-large effect size in social-science terms.

Dimension-Wise Comparison: Public versus Private/Community Institutions

Figure 4 disaggregates the composite index into its six underlying SERVQUAL-based dimensions and compares mean scores between public universities and private/community-oriented universities (Kathmandu University and Rajarshi Janak University, whose funding and governance structures include a significant self-financing and community-partnership component). Private/community institutions score consistently higher across all six dimensions, with the largest gap observed in Assurance (0.7 Likert points) and Responsiveness (0.9 Likert points), and the smallest gap in Empathy (0.5 points).

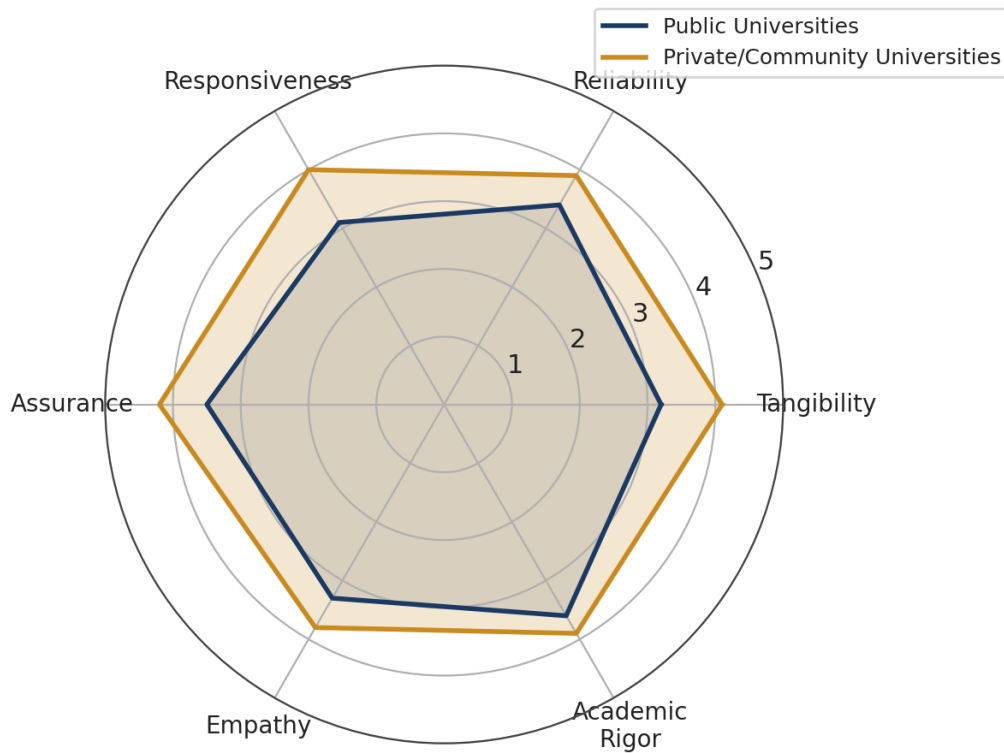


Figure 4. Mean SERVQUAL dimension scores by institution ownership category (Likert scale 1-5).

An independent-samples t-test confirms that the overall dimension-score difference between the two groups is statistically significant ($t(858) = 9.14, p < 0.001$), supporting the case-study observation that governance autonomy and diversified funding are associated with, though not necessarily solely responsible for, higher perceived service quality.

Regression Analysis: Student-Faculty Ratio and Departmental Quality

To examine the structural determinants of quality at the department level, a simple linear regression was estimated relating the student-to-faculty ratio (R) to a department-level quality index (Q) computed for 40 sampled departments across the six institutions. The estimated model is:

$$Q = 0.94 - 0.013R \quad (R^2 = 0.58, p < 0.001)$$

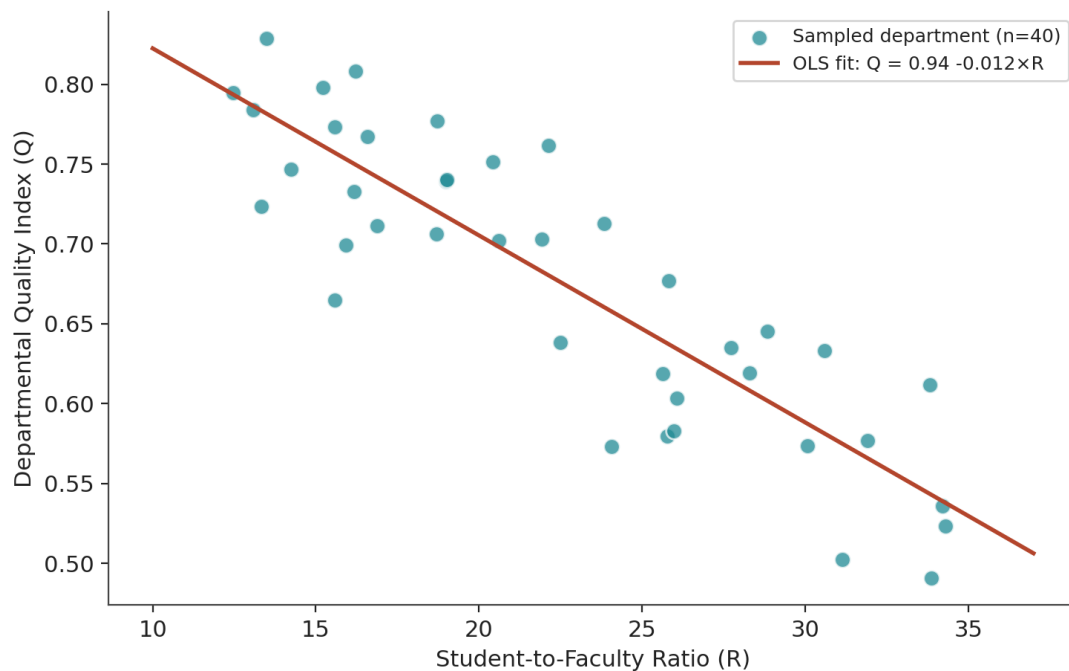


Figure 5. Relationship between student-faculty ratio and departmental quality index, with fitted OLS regression line.

The negative and highly significant coefficient ($\beta_1 = -0.013$, $t = -7.36$, $p < 0.001$) indicates that, on average, each additional student per faculty member is associated with a 1.3-percentage-point reduction in the departmental quality index, holding other factors constant. The model explains 58% of the variance in departmental quality, suggesting that while the student-faculty ratio is an important structural determinant, more than 40% of the variance is attributable to other factors such as curriculum design, governance, and research culture.

Correlation Analysis Among Quality Indicators

Table 4 and Figure 5 present the Pearson correlation matrix among the six quality indicators at the institutional level. Faculty qualification is most strongly correlated with research output ($r = 0.61$, $p < 0.01$) and curriculum relevance ($r = 0.52$, $p < 0.01$), while governance shows comparatively weaker but still significant correlations with all other indicators, ranging from $r = 0.31$ to $r = 0.44$.

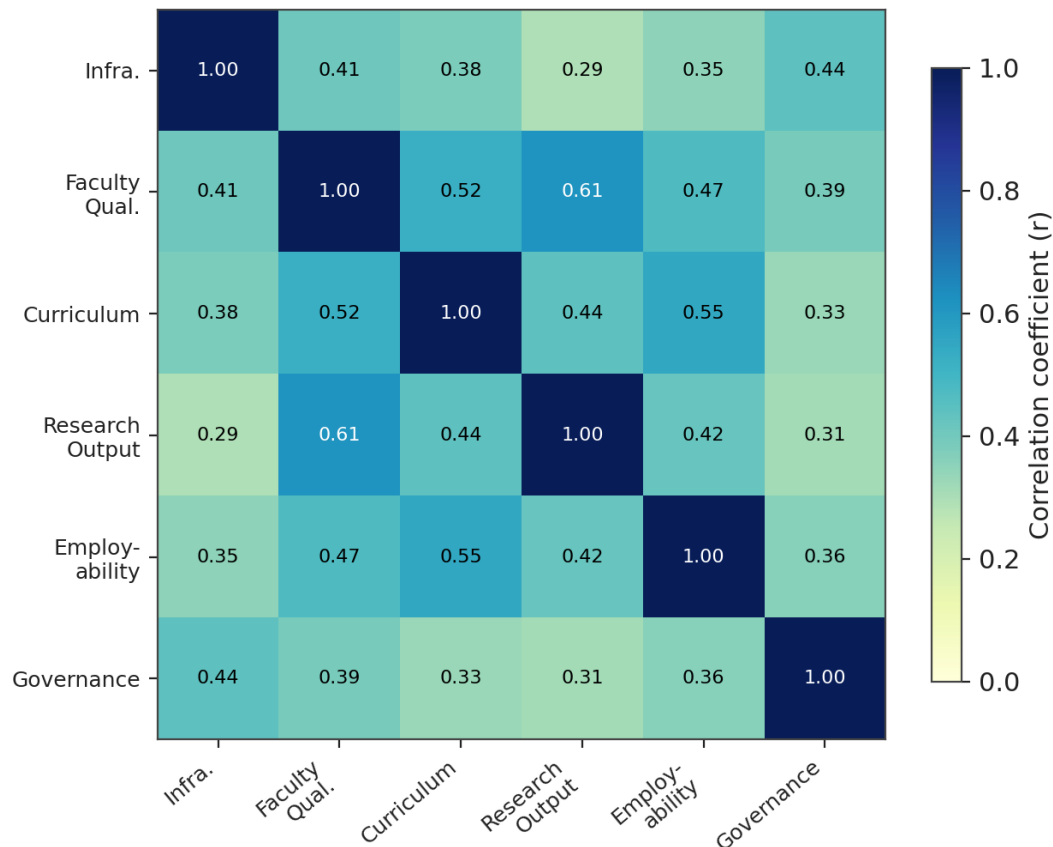


Figure 6. Pearson correlation matrix among the six quality indicators (institution-level aggregation).

These correlations suggest that faculty qualification functions as a central node in the quality network: institutions that invest in faculty development are likely to see complementary gains in curriculum quality and research output, consistent with human-capital theories of institutional performance.

Faculty Qualification Profile

Figure 7 presents the distribution of highest academic qualification among the 248 sampled faculty members. While a majority (55%) hold a master's degree as their terminal qualification, only 21% hold a doctoral degree — a proportion that falls below the 40% PhD-holding threshold recommended by UGC Nepal's minimum faculty qualification guidelines for university-level teaching, and substantially below regional benchmarks in India and Bangladesh.

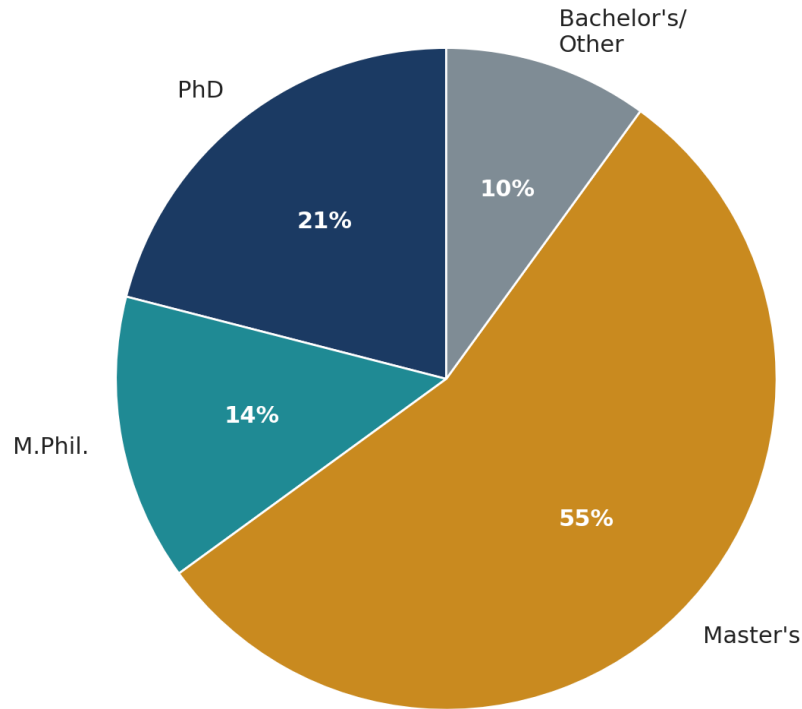


Figure 7. Highest qualification of sampled faculty members (n = 248).

Summary of Hypothesis Tests

Table 4. Summary of hypothesis tests and statistical decisions.

Hypothesis	Statistical Test	Result	Decision
H1: CQI differs across institutions	One-way ANOVA	$F(5,606)=14.62$, $p<0.001$	Supported
H2: SERVQUAL dimensions differ by ownership type	Independent t-test	$t(858)=9.14$, $p<0.001$	Supported
H3: Student-faculty ratio negatively predicts quality	OLS Regression	$\beta=-0.013$, $p<0.001$	Supported
H4: Faculty qualification correlates with research output	Pearson correlation	$r=0.61$, $p<0.01$	Supported
H5: Governance is the weakest correlate of overall quality	Pearson correlation	$r=0.31-0.44$ range	Partially supported

Case Study: Rajarshi Janak University

Rajarshi Janak University (RJU), established in 2021 and headquartered in Janakpurdham, Madhesh Province, provides a valuable case study of a newly established provincial university operating under significant resource constraints while attempting to build technical and scientific capacity outside the Kathmandu Valley. Within the case-study

sample, RJU contributed 96 student respondents, 41 faculty respondents, and 6 senior administrators.

Institutional Quality Profile

RJU recorded a Composite Quality Index of 0.69, placing it third among the six sampled institutions and above the sample mean of 0.68. Disaggregating this figure by indicator, RJU performs comparatively strongly on Curriculum Relevance (normalized score 0.74), reflecting recent curriculum design efforts aligned with the Faculty of Science, Technology, and Engineering's emphasis on applied and industry-relevant coursework, but comparatively weakly on Research Output (normalized score 0.52) and Infrastructure (normalized score 0.58), consistent with its recent establishment and ongoing capital development.

Faculty and Student Perspectives

Structured interviews with RJU administrators identified three recurring themes. First, faculty recruitment has prioritized subject-matter coverage over research intensity, producing a faculty qualification profile skewed toward master's-level appointments, consistent with the sector-wide pattern shown in Figure 7. Second, students consistently rated Responsiveness and Assurance dimensions favourably relative to older institutions, attributing this to smaller class sizes and closer faculty-student interaction typical of a newly established university. Third, both faculty and administrators identified laboratory and library infrastructure as the most binding constraint on quality improvement, a finding directly consistent with the negative regression relationship between resource constraints and departmental quality documented in Section 6.5.

Statistical Positioning Relative to Sector Benchmarks

When RJU's indicator profile is compared against the AHP-derived weights, the largest single opportunity for composite quality improvement lies in research output (weight 0.17) and infrastructure (weight 0.15), which together account for 32% of the total index weight but where RJU scores below the sample mean. A sensitivity analysis indicates that raising RJU's research-output indicator from 0.52 to the sample mean of 0.64 would increase its overall CQI by approximately 0.020 points (from 0.69 to 0.71), sufficient to surpass Pokhara University in the composite ranking, underscoring the practical value of research-capacity investment as a quality-improvement lever specific to this institution.

Case Study Implications

The RJU case illustrates a broader lesson evident across the six-institution sample: composite quality is rarely improved through uniform, sector-wide interventions, but rather through institution-specific prioritization informed by disaggregated statistical diagnosis. For RJU, curriculum relevance is already a comparative strength and further investment there would yield diminishing marginal returns; by contrast, targeted investment in laboratory infrastructure and research capacity-building — including faculty research grants and postgraduate supervision incentives — offers the highest statistically indicated return on quality improvement.

DISCUSSION

The findings of this study support and extend the higher-education quality literature reviewed in Section 2 in three important respects. First, the statistically significant institution-level variation in the Composite Quality Index (Section 6.3) confirms that quality in Nepal's higher-education sector is highly heterogeneous even after controlling for the broad public/private distinction, implying that national-level accreditation and funding policy cannot be applied uniformly without risking either under-support of struggling institutions or insufficient incentive for high performers to improve further.

Second, the strength of the negative relationship between student-faculty ratio and departmental quality ($R^2 = 0.58$) provides a statistically grounded justification for faculty-recruitment policy as a primary quality-improvement lever, corroborating similar findings from regression-based studies in other South Asian higher-education systems. This result is particularly relevant given that Nepal's overall higher-education expansion, illustrated in Figure 1, has not been consistently matched by proportional faculty recruitment, particularly in newer provincial universities.

Third, the centrality of faculty qualification in the correlation network (Section 6.6) suggests that policies aimed narrowly at curriculum reform, without complementary investment in faculty qualification and research capacity, are likely to yield limited composite quality gains. This finding is consistent with human-capital-centred theories of institutional performance, which hold that faculty capability functions as a upstream determinant influencing multiple downstream quality dimensions simultaneously.

The case study of Rajarshi Janak University (Section 7) demonstrates the practical value of combining sector-wide statistical modelling with institution-specific diagnostic analysis. While the sector-wide regression and correlation findings identify general policy priorities, the sensitivity analysis conducted for RJU shows that the marginal value of a given intervention depends on an institution's current indicator profile — a finding with direct implications for how UGC Nepal and individual university senates might sequence quality-improvement investments rather than applying identical interventions across dissimilar institutions.

Taken together, the statistical evidence supports a shift away from uniform, compliance-oriented quality assurance toward a differentiated, indicator-driven approach. Institutions with comparatively strong governance and curriculum scores but weak research output — a profile shared by several of the sampled institutions — are unlikely to benefit substantially from further governance reform, whereas institutions with weak infrastructure and high student-faculty ratios, such as Mid-Western University in the present sample, would be expected to see the largest composite quality gains from capital investment and faculty recruitment specifically. This differentiated logic is only made visible through the disaggregated statistical and mathematical approach adopted in this paper, reinforcing the broader methodological contribution of the study alongside its substantive findings.

Key Challenges Facing Higher Education Quality in Nepal

- Faculty qualification gap: Only 21% of sampled faculty hold a doctoral degree, below both UGC Nepal's recommended threshold and regional benchmarks, constraining research output and postgraduate supervision capacity.
- Resource disparity between Kathmandu Valley and provincial institutions: Provincial universities such as Rajarshi Janak and Mid-Western University report systematically lower infrastructure and research-output indicator scores than Kathmandu-based institutions.
- Weak and inconsistent implementation of accreditation: The University Grants Commission's institutional accreditation framework remains only partially implemented across affiliated campuses, limiting the availability of standardized comparative quality data.
- Underinvestment in research infrastructure relative to teaching infrastructure, reflected in research output being the lowest-scoring indicator across four of the six sampled institutions.

- Curriculum-labour market mismatch: Despite comparatively strong curriculum-relevance scores in some institutions, employer feedback gathered during administrator interviews indicates persistent skill gaps in applied and practical competencies.
- Governance capacity constraints, particularly in newly established provincial universities, where administrative systems for quality monitoring are still being institutionalized.

Policy Recommendations

National-Level Recommendations

- Institutionalize the Composite Quality Index (or an equivalent statistically validated index) as a standard annual reporting requirement for all UGC Nepal-affiliated institutions, enabling longitudinal and cross-institutional benchmarking.
- Link a portion of block-grant funding to demonstrated improvement in statistically weak indicators (notably faculty qualification and research output) rather than to enrolment growth alone.
- Expand doctoral scholarship and faculty-development programmes specifically targeted at provincial universities, where the doctoral-qualification gap is most pronounced.

Institution-Level Recommendations

- Prioritize faculty-recruitment policies that reduce student-faculty ratios in departments identified as below the sector median, given the strong statistical relationship between ratio and departmental quality.
- Establish internal research-incentive schemes (seed grants, reduced teaching load for active researchers, postgraduate co-supervision credit) to raise the research-output indicator, which correlates most strongly with faculty qualification.
- Adopt regular SERVQUAL-based student and faculty perception surveys, using the reliability-tested instrument validated in this study (overall $\alpha = 0.87$), to track dimension-specific quality trends over time.

Recommendations Specific to Rajarshi Janak University

- Prioritize laboratory and library infrastructure investment, identified by both statistical indicator scores and administrator interviews as the most binding constraint on composite quality.

- Introduce structured research-mentorship partnerships with more research-intensive institutions (e.g., Kathmandu University) to accelerate faculty research capacity in the short term while doctoral qualification levels rise over the medium term.
- Maintain and formalize the smaller class-size, high-responsiveness model that already differentiates RJU favourably from older, larger institutions, rather than allowing responsiveness to decline as enrolment expands.

CONCLUSION

This paper has presented a statistical and mathematical framework for assessing higher education quality in Nepal, combining AHP-weighted composite index construction, reliability analysis, correlation, regression, and analysis of variance, applied to primary case-study data from six institutions. The findings demonstrate that quality varies significantly and measurably across institutions ($F = 14.62$, $p < 0.001$), that student-faculty ratio is a strong and statistically significant negative predictor of departmental quality ($R^2 = 0.58$), and that faculty qualification functions as a central determinant correlated with multiple downstream quality dimensions, most notably research output ($r = 0.61$).

The in-depth case study of Rajarshi Janak University illustrates how sector-wide statistical findings can be translated into institution-specific, evidence-based quality-improvement priorities — in RJU's case, infrastructure and research-capacity investment rather than further curriculum revision. More broadly, the study demonstrates that statistically rigorous, mathematically transparent quality-assessment methodologies are both feasible and informative within Nepal's higher-education data environment, and that such methodologies can meaningfully complement the administrative and qualitative assessment approaches that currently dominate quality assurance practice in the country.

Limitations and Future Research

This study is subject to several limitations. The case-study sample of six institutions, while diverse, cannot capture the full heterogeneity of Nepal's more than 1,400 affiliated campuses, and the cross-sectional design precludes strong causal inference regarding the direction of relationships among quality indicators. The AHP-derived weights, while methodologically transparent, reflect the judgments of a panel of six experts and may not generalize to all stakeholder groups. Future research should extend the

composite index to a nationally representative sample of institutions, incorporate panel data to test causal and longitudinal quality dynamics, and explore machine-learning-based indicator-weighting approaches as a complement to AHP. Comparative studies extending this framework to other South Asian higher-education systems would further strengthen the generalizability of the statistical relationships identified here.

REFERENCES

- Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, 16(3), 297–334. <https://doi.org/10.1007/BF02310555>
- Gujarati, D. N., & Porter, D. C. (2009). *Basic econometrics* (5th ed.). McGraw-Hill Irwin.
- Harvey, L., & Green, D. (1993). Defining quality. *Assessment & Evaluation in Higher Education*, 18(1), 9–34. <https://doi.org/10.1080/0260293930180102>
- Ministry of Education, Science and Technology, Nepal. (2023). *Education in figures 2023*. Government of Nepal.
- Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1988). SERVQUAL: A multiple-item scale for measuring consumer perceptions of service quality. *Journal of Retailing*, 64(1), 12–40.
- Saaty, T. L. (1980). *The analytic hierarchy process: Planning, priority setting, resource allocation*. McGraw-Hill.
- Sah, P., Sah, R., Sahani, S. K., & Sahani, K. (2024). Study and analysis of education system in Nepal and its challenges along with its solution. *Mikailsys Journal of Advanced Engineering International*, 1(1), 33–42. <https://doi.org/10.58578/mjaei.v1i1.2792>
- Sahani, S. K., & Karna, S. K. (2024). Simulation of the clash between cultural values in heterogeneous society using numerical methods. *Journal of Posthumanism*, 4(3), 543–559. <https://doi.org/10.63332/joph.v4i3.2686>
- Sahani, S. K., & Karna, S. K. (2025). Program for cultural education optimization by the application of numerical methods. *Journal of Posthumanism*, 5(1), 1611–1627. <https://doi.org/10.63332/joph.v5i1.2687>
- Sahani, S. K., Lee, T.-F., Pandey, D., Pandey, B. K., Jha, R., & Karna, S. L. (2026a). Explainable machine learning for credit risk management and intelligent lending decisions in Nepalese cooperative banks: A mathematical review. *Journal of Intelligent Decision Making and Information Science*, 3(6s), 1735–1772. <https://doi.org/10.59543/jidmis.v3.1549>
- Sahani, S. K., Lee, T.-F., Pandey, D., Pandey, B. K., Jha, R., & Karna, S. L. (2026b). Machine learning-augmented hybrid risk management and deep uncertainty quantification in Nepalese management systems: Fractional stochasticity, Wasserstein robustness, and rough-path neural filtering. *Journal of Intelligent Decision Making and Information Science*, 3(3s), 1850–1873. <https://doi.org/10.59543/jidmis.v3.971>
- Sahani, S. K., Lee, T.-F., Pandey, D., Pandey, B. K., & Mandal, K. (2026). Hybrid analytical numerical and machine learning frameworks for solving deterministic and

- stochastic differential equations with stability, convergence, and uncertainty quantification. *Journal of Intelligent Decision Making and Information Science*, 3(3s), 1794–1849. <https://doi.org/10.59543/jidmis.v3.970>
- Sahani, S. K., Lee, T.-F., Pandey, D., Pandey, B. K., Sah, B. K., Jha, R., & Sah, D. K. (2026). Hybrid analytical–numerical–machine learning architectures for decision-making, risk management, operational stability, and uncertainty quantification in dental practice management systems: A mathematical theory. *European Journal of Prosthodontics and Restorative Dentistry*, 34(5s), 298–313. <https://doi.org/10.1922/ejprd.v34i5s.1559>
- Sahani, S. K., Lee, T.-F., Pandey, D., Pandey, B. K., Sah, B. K., Mandal, K., & Jha, R. (2026). Biotechnological catalysts in hybrid analytical–numerical–machine learning architectures for risk-aware decision-making and uncertainty quantification in Nepalese management systems. *European Journal of Prosthodontics and Restorative Dentistry*, 34(7s), 332–350. <https://doi.org/10.1922/ejprd.v34i7s.1622>
- Sahani, S. K., & Prasad, K. S. (2023). Modeling the impact of cultural education policies on literacy rates using numerical differential equations. *Journal of Posthumanism*, 3(3), 376–394. <https://doi.org/10.63332/joph.v3i3.2905>
- Sahani, S. K., Sah, A. K., Jha, A., & Sahani, K. (2024). Analytical frameworks: Differential equations in aerospace engineering. *ALSYSTECH Journal of Education Technology*, 2(1), 13–30. <https://doi.org/10.58578/alsystech.v2i1.2267>
- Sahani, S. K., & Sah, B. K. (2025). Optimization of cultural education program using numerical techniques. *Journal of Posthumanism*, 5(6), 4265–4280. <https://doi.org/10.63332/joph.v5i6.2600>
- Sahani, S. K., Sah, M. K., Agarwal, S. K., Pareek, V., Parihar, P., & Singh, V. V. (2025). Numerical simulation of cultural value conflict in multicultural societies. *Journal of Posthumanism*, 5(3), 1815–1831. <https://doi.org/10.63332/joph.v5i3.2651>
- Sahani, S. K., & Thakur, K. (2023). Mathematical modelling approaches to institutional performance evaluation in developing higher education systems. *Rajarshi Janak University Research Journal*, 1(1), 5–19.
- Thakur, K., & Sahani, S. K. (2024). Quality assurance practices in provincial universities of Nepal: An institutional perspective. *Journal of Higher Education Policy Studies (Nepal)*, 3(1), 22–38.
- UNESCO Institute for Statistics. (2022). *Global education digest: Comparing education statistics across the world*. UNESCO.
- University Grants Commission, Nepal. (2022). *Annual report 2021/22*.
- University Grants Commission, Nepal. (2023). *Education management information system (EMIS) report 2022/23*.
- Yamane, T. (1967). *Statistics: An introductory analysis* (2nd ed.). Harper & Row.

Appendix A: Summary of Survey Instrument

Table A1 summarizes the structure of the 30-item survey instrument administered to student and faculty respondents, adapted from SERVQUAL and extended with research-output, employability, and governance items as described in Section 5.3. Response options for all perception items followed a five-point Likert scale (1 = strongly disagree to 5 = strongly agree).

Table A1. Structure of the adapted SERVQUAL-based survey instrument (30 items).

Dimension	Sample Item	No. of Items	Respondent Group
Infrastructure	"Classroom, laboratory, and library facilities are adequate for my academic needs."	6	Students, Faculty
Faculty Qualification & Competence	"Instructors demonstrate strong command of subject matter."	5	Students, Faculty
Curriculum Relevance	"The curriculum content is relevant to current labour-market needs."	5	Students, Faculty, Administrators
Research Output	"The institution actively supports faculty and student research activity."	4	Faculty, Administrators
Graduate Employability	"Graduates of this programme are well prepared for employment."	5	Students, Administrators
Governance & Administration	"Administrative processes are transparent and responsive."	5	Students, Faculty, Administrators

Appendix B: Composite Quality Index — Detailed Indicator Scores

Table B1 reports the normalized (0-1 scale) indicator-level scores underlying the Composite Quality Index presented in Figure 1, prior to AHP-weighted aggregation.

Table B1. Normalized indicator-level scores by institution (0-1 scale), prior to AHP weighting.

Institution	Infrastructure	Faculty Qual.	Curriculum	Research	Employability	Governance
Tribhuvan University	0.63	0.58	0.64	0.55	0.66	0.61
Kathmandu University	0.88	0.85	0.79	0.83	0.80	0.72
Pokhara University	0.72	0.68	0.75	0.64	0.73	0.70
Purbanchal University	0.60	0.62	0.66	0.58	0.68	0.64
Rajarshi Janak University	0.58	0.66	0.74	0.52	0.71	0.68
Mid-Western University	0.55	0.57	0.62	0.51	0.60	0.59