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Exploring the Quality Parameters in Higher Education: A Factor Analysis Approach

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Abstract:

This research paper aims to investigate the quality parameters in Indian Higher Education institutions by analyzing the perceptions of students. It examines various factors related to learning environment, content of education, educational outcomes, research and scholarly ability, training and placement, internationalization, faculty characteristics, employee retention, administrative characteristics, reliability and viability of the university, safety measures, infrastructural facilities, and student welfare. The study utilizes a structured questionnaire to collect primary data from 600 students, and statistical analysis is conducted using IBM SPSS version 23. The reliability and validity of the instrument are assessed through Cronbach's alpha, indicating high internal consistency. Furthermore, exploratory factor analysis, specifically principal component analysis, is employed to identify underlying factors that represent the interrelationships among the quality parameters.

The paper discusses the suitability of the data for factor analysis, as demonstrated by the high Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (0.975) and the significant Bartlett's test of sphericity ($p < 0.05$). The factor extraction process involves determining the minimum number of factors required to represent the data set effectively. The eigenvalues and total variance explained are analyzed to determine the retained factors, which collectively explain a substantial portion of the total variance.

By exploring the quality parameters in higher education institutions, this research contributes to understanding the factors that influence the overall quality of education in India. The findings can inform policymakers, university administrators, and other stakeholders in implementing measures to enhance the quality of higher education and meet the growing expectations for self-dependence in the country.

Keywords: Quality parameters, Higher education, Factor analysis, Quality of education, New Education Policy, Accreditation, and ranking.

Introduction:

In recent years, India has demonstrated a strong desire for self-dependence, evident in its ability to invent and produce essential items during the pandemic. This aspiration for self-reliance extends to higher education, where there is increasing pressure to produce high-quality graduates in fields such as research, engineering, and medicine. The recent implementation of the "New Education Policy" in India highlights the government's commitment to improving the quality of schools, colleges, and universities.

Accreditation and ranking systems, such as "UGC NAAC," "NBA," "NIRF Ranking," and the introduction of the "Atal Ranking of Institutions on Innovation Achievements (ARIIA)," have been promoted by the government to ensure quality and innovation in higher education. These assessments focus on various aspects, including curricular content, teaching and learning practices, research, infrastructure, student support, leadership, governance, and new and innovative practices. Private ranking bodies like QS also consider factors such as quality of life and student community.

This research paper explores the quality parameters in Indian higher education institutions from the perspective of students. The authors have compiled a comprehensive list of quality parameters by reviewing existing literature and engaging with university students. The identified parameters cover various dimensions, including the learning environment, content of education, educational outcomes, research and scholarly ability, training and placement, internationalization, faculty characteristics, employee retention, administrative characteristics, reliability and viability of the university, safety measures, infrastructural facilities, and student welfare.

While the authors present a detailed table outlining the quality parameters, it is essential to note that literature is full of all quality parameters in education from accreditation agency point of views and authors of this manuscript has identified various quality parameter through reviewing the literature and interacting with university students. Following table shows the parameter and its easy elaboration from student point of views:

Table 1: Quality Parameter for a University

S. No.	Factor	Variable Code	Variable
1	Learning Environment	LE1	University is providing me opportunity for higher education as well as foreign education
		LE2	University is providing me Safe learning atmosphere
		LE3	University is providing me Healthy atmosphere
2	Content of Education	CE1	University is providing me Industry Oriented Syllabus
		CE2	University is providing me Relevant (Updated) Syllabus
		CE3	Examinations and evaluation process is helping me for improvement
3	Educational Outcomes	EO1	University is providing me Knowledge
		EO2	University is providing me opportunity to Participate in Society
4	Research & Scholarly Ability	RSA1	Teachers are knowledgeable and research-oriented
		RSA2	Student gets adequate research opportunity
		RSA3	Student gets stimulation for Higher Education
5	Training and Placement	TP1	University is providing me good Internship Opportunity
		TP2	University is providing me regular Training and skill development opportunity for startup's
		TP3	University is providing me Industry Oriented Training and Job opportunity
6	Internationalization	INTER1	University provides Student Exchange/Short Training program at national and international level
		INTER2	University has Industrial Tie-Up's
		INTER3	University has Academic Tie-Up's
7	Faculty Characteristics	FC1	University faculties are Knowledgeable and well qualified
		FC2	University faculties are referring Research Papers and Articles
8	Employee Retention	ER1	Stability of Faculty is there
		ER2	Stability of Administrative Staff is there
9	Administrative Characteristics	AC1	University staff is User Friendly and transparent
		AC2	University staff is Professionally Skilled
10	Reliability and Viability of University	RVU1	University is Reliable and trustworthy
		RVU2	University provides all the information in a transparent manner (handbook)

11	Safety Measures	SM1	University provides a Secure Campus
		SM2	University provides Medical Facility
		SM3	University provides Camera Monitored campus
12	Infrastructural Facilities	IF1	Infrastructural Facilities are up to mark like Classrooms, Labs and Libraries
		IF2	Canteen and mess have proper infrastructure and well-maintained
		IF3	Sport Complex and H are sufficient with proper infrastructure
13	Student Welfare	SW1	University provides student Help Desk
		SW2	Amenities are proper and up to mark
		SW3	University provides Student Scholarship

Although authors has compiled all the parameter with the help of literature in above table but students and their parents are also interested in the outcome of the university education not only in terms of degree and job but also in terms of student's skills improvement and his ability to learn new things, evaluate the situation and his ability to apply gained knowledge in real world like a management graduate must know how to lead and motivate team or how to develop interpersonal relationship.

Method:

Instrument Reliability and Validity: The structured questionnaire was designed to collect primary data. The data were collected from the students. Total 650 questionnaires were distributed among the students but only 600 respondents provided their reactions to the statements. All the statistical analysis has been performed using IBM SPSS version 23.

Cronbach's Alpha: The reliability of a questionnaire is examined with Cronbach's alpha. It provides a simple way to measure whether a score is reliable. It is used under the assumption that there are multiple items measuring the same underlying construct, such as in Quality of Education survey, there are few questions all asking different things, but when combined, could be said to measure overall quality of education. Cronbach's alpha is a measure of internal consistency. In general, Cronbach's alpha value more than 0.7 is considered as acceptable. In this research the Cronbach's value is 0.914. A high level of alpha shows the items in the test are highly correlated.

Factor Analysis: This study employs exploratory factor analysis to examine the data set to identify complicated interrelationships among items and group items that are part of integrated concepts. Due to explorative nature of factor analysis, it does not differentiate between independent and dependent variables. Factor analysis clusters similar variables into the same factor to identify underlying variables and it only uses the data correlation matrix. In this study, factor analysis with principal components extraction used to examine whether the statements represent identifiable factors related to quality of education. The principal component analysis (PCA) signifies to the statistical process used to underline variation for which principal data components are calculated and bring out strong patterns in the dataset.

Steps Involved in Factor Analysis

This study has followed three major steps for factor analysis: a) assessment of the suitability of the data, b) factor extraction, and c) factor rotation and interpretation.

There are two statistical measures to assess the factorability of the data: Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of Sphericity.

Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy & Bartlett's Test of Sphericity

During factor analysis, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity are commonly used to assess the suitability of the data for factor analysis. Let's understand the results you provided:

KMO Measure of Sampling Adequacy: The KMO measure evaluates the adequacy of the data for factor analysis. It assesses the extent to which the variables in this research are suitable for analysis. The KMO statistic ranges from 0 to 1, with values closer to 1 indicating better suitability. In this research, a KMO value of 0.975 suggests that the variables in this research are highly suitable for factor analysis.

Bartlett's Test of Sphericity: Bartlett's test is another statistical test used to examine the suitability of the data for factor analysis. It tests the null hypothesis that the correlation matrix is an identity matrix, indicating that there is no relationship between the variables. If the p-value associated with Bartlett's test is less than a chosen significance level (e.g., 0.05), we reject the null hypothesis and conclude that the correlation matrix is not an identity matrix, suggesting that the variables are related. In this research, the approximate chi-square value of 1.036 with 561 degrees of freedom and a p-value of 0.000 indicates that Bartlett's test is statistically significant, providing evidence to reject the null hypothesis. This suggests that there are significant relationships between the variables, supporting the suitability of the data for factor analysis.

In summary, based on the results calculated, both the KMO measure and Bartlett's test indicate that data is highly suitable for factor analysis. The variables in dataset exhibit strong relationships, and the data is appropriate for extracting meaningful factors.

Table 2: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.975
Bartlett's Test of Sphericity	Approx. Chi-Square	1.036
	df	561
	Sig.	.000

Factor Extraction

Factor extraction encompasses determining the least number of factors that can be used to best represent the interrelationships among the set of variables. There are many approaches to extract the number of underlying factors. For obtaining factor solutions, principal component analysis and common factor analysis can be used. This study has used principal component analysis (PCA) because the purpose of the study is to analyze the data to obtain the minimum number of factors required to represent the available data set.

Correlation Matrix

The correlation matrix displays that there are sufficient correlations to justify the application of factor analysis. The correlation matrix shows that there are few items whose inter-correlations > 0.3 between the variables and it can be concluded that the hypothesized factor model appears to be suitable. The value for the determinant is an important test for multicollinearity. The determinant score of the correlation matrix is 0.038 > 0.00001 which indicates that there is an absence of multicollinearity. In a correlation matrix, the determinant score represents a measure of the linear dependence among the variables included in the matrix. The determinant of a matrix is a scalar value that provides important information about the matrix's properties.

In this research, a determinant score of 2.16E-008 (scientific notation for 2.16 x 10^(-8)) indicates that the variables in the correlation matrix are very close to being linearly dependent. When the determinant of a matrix is close to zero, it implies that the variables are highly correlated or that there is a strong linear relationship among them.

A determinant score of 2.16E-008 suggests a very strong correlation or dependency among the variables. It indicates that there is a high degree of linear association between the variables in the correlation matrix.

Discussion

In factor analysis, eigenvalues and the total variance explained are important measures that help in determining the number of factors to retain.

Eigenvalues (EV): Eigenvalues represent the amount of variance explained by each extracted factor. In the table you provided, the "Initial Eigenvalues" column displays the eigenvalues for each component before rotation, while the "Rotation Sums of Squared Loadings" column shows the eigenvalues after rotation.

Total Variance Explained: The total variance explained indicates the cumulative amount of variance accounted for by each component/factor. It helps in understanding how much of the total variation in the original variables is captured by the extracted factors.

Analyzing the "Total Variance Explained" section of the table 3:

Component 1 has an initial eigenvalue of 12.782, explaining 37.594% of the total variance. After rotation, its eigenvalue decreases to 9.195, explaining 27.045% of the variance. The cumulative percentage for component 1 is also shown, indicating that component 1 alone explains 37.594% of the total variance.

Component 2 has an initial eigenvalue of 3.759, explaining 11.057% of the total variance. After rotation, its eigenvalue decreases to 6.442, explaining 18.947% of the variance. The cumulative percentage for component 2 indicates that components 1 and 2 combined explain 48.651% of the total variance.

The subsequent components follow a similar pattern, with decreasing eigenvalues and cumulative percentages. Each component explains a smaller percentage of variance compared to the previous ones, resulting in a cumulative increase in the total variance explained.

It is common practice to retain components/factors with eigenvalues greater than 1 (a threshold rule of thumb) or factors that collectively explain a substantial portion of the total variance (e.g., 70% or more). Based on the information provided, the first two components explain 45.992% of the total variance, while the first three components explain 51.683%. The decision on how many factors to retain ultimately depends on the specific context, research objectives, and the point of diminishing returns in terms of variance explained.

Please note that the "Extraction Method: Principal Component Analysis" mentioned at the end of the table indicates the technique used to extract the factors in this analysis.

Table 3: Eigenvalues (EV) and Total Variance Explained

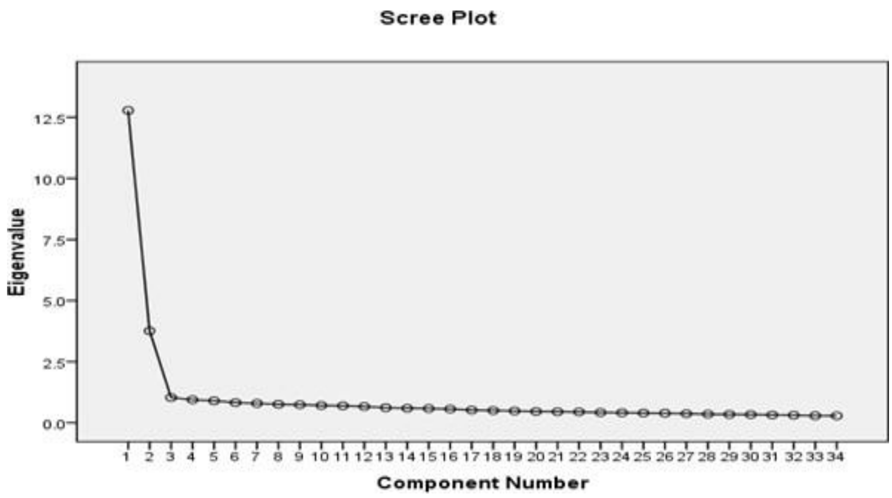
Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	12.782	37.594	37.594	9.195	27.045	27.045
2	3.759	11.057	48.651	6.442	18.947	45.992
3	1.031	3.031	51.683	1.935	5.690	51.683
4	.940	2.764	54.446			
5	.899	2.645	57.091			
6	.823	2.421	59.512			
7	.791	2.326	61.838			
8	.753	2.214	64.052			
9	.736	2.165	66.217			
10	.709	2.084	68.301			
11	.691	2.033	70.334			
12	.663	1.950	72.284			
13	.616	1.812	74.096			
14	.592	1.741	75.837			
15	.583	1.713	77.550			
16	.562	1.652	79.202			
17	.518	1.524	80.725			
18	.501	1.472	82.198			
19	.482	1.417	83.615			
20	.460	1.352	84.967			
21	.450	1.323	86.290			
22	.444	1.307	87.597			
23	.420	1.236	88.833			

24	.409	1.202	90.034			
25	.398	1.170	91.205			
26	.390	1.146	92.351			
27	.370	1.089	93.439			
28	.352	1.037	94.476			
29	.342	1.007	95.483			
30	.335	.985	96.468			
31	.318	.934	97.403			
32	.311	.915	98.318			
33	.288	.847	99.165			
34	.284	.835	100.000			

Extraction Method: Principal Component Analysis.

In factor analysis, a scree plot is a graphical representation of the eigenvalues associated with each factor/component extracted from the analysis. The scree plot helps in determining the appropriate number of factors to retain.

Figure 1 Scree Plot



The decision of how many factors to retain can be calculated through some general guidelines:

Eigenvalues Greater than 1 Rule: One common rule of thumb is to retain factors/components with eigenvalues greater than 1.

Scree Plot: Visually inspect a significant drop-off point. If there is a noticeable "elbow" or point where the eigenvalues dramatically decrease, it may suggest the number of factors to retain.

Based on the eigenvalues table and scree plot, it is reasonable to consider retaining the first three components with a cumulative variance explained of 51.683%.

Table 4: Rotated Component Matrix

	Component		
	1	2	3
SM2	.786		
SM3	.781		
SW2	.770		
IF1	.762		
ER2	.760		
IF2	.759		
AC1	.759		

ER1	.758		
SW1	.756		
AC2	.756		
IF3	.747		
SW3	.746		
RVU1	.743		
RVU2	.733		
SM1	.733		
RSA1		.741	
TP3		.732	
RSA2		.719	
TP1		.693	
TP2		.690	
RSA3		.657	
EO2		.597	
INTER1		.555	
INTER3		.540	
CE2		.522	
CE1		.522	
CE3		.497	.346
INTER2		.492	
FC1		.479	
LE1		.451	.429
EO1			.718
LE2		.448	.457
FC2			.435
LE3		.420	.433

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

The values in the matrix indicate the strength of association between each variable and each component. Higher positive values suggest a stronger association, while negative values represent a weaker or inverse association. The rotated component matrix helps identify and understand the underlying factors or dimensions that contribute to the overall quality of education by examining the pattern of loadings for each variable across the components.

Component 1: The variables with the highest loadings on Component 1 are SM2, SM3, SW2, IF1, ER2, IF2, AC1, ER1, SW1, and AC2. These variables primarily belong to factors such as Safety Measures, Infrastructural Facilities, Employee Retention, and Administrative Characteristics. Component 1 captures the aspects related to safety, infrastructure, and administrative qualities in the university.

Component 2: The variables with the highest loadings on Component 2 are CE3, INTER2, FC1, LE1, and LE2. These variables belong to factors such as Content of Education, Internationalization, Faculty Characteristics, and Learning Environment. Component 2 represents the dimensions related to the content of education, internationalization efforts, faculty characteristics, and the learning environment of the university.

Component 3: The variables with the highest loadings on Component 3 are CE1, CE2, RVU2, EO1, FC2, LE3, and CE3. These variables relate to factors such as Content of Education, Reliability and Viability of the University, Educational Outcomes, Faculty Characteristics, and Learning Environment. Component 3 represents the dimensions associated with the content of education, reliability of the university, educational outcomes, faculty characteristics, and the learning environment.

Conclusion:

The goal of this study was to examine on the factor analysis of a questionnaire to identify main factors that measure quality of education. The likelihood to use factor analysis for the data set is explored with the threshold values of determinant score, Kaiser-Meyer-Olkin and Bartlett's test of Sphericity. Based on the results of this study, it can be concluded that factor analysis is a promising approach to extract significant factors to explain the maximum variability of the group under study.

Based on the variables and their loadings on the three components with a cumulative variance explained of 51.683% discussed in the factor analysis, the major factors extracted using principal component analysis and varimax orthogonal factor rotation method to measure quality of education are:

Factor 1: Safety and Infrastructure

This factor captures variables related to safety measures, infrastructural facilities, employee retention, and administrative characteristics.

Factor 2: Educational Environment and Faculty

This factor represents variables associated with the content of education, internationalization efforts, faculty characteristics, and the learning environment of the university.

Factor 3: Quality of Education and Reliability

This factor encompasses variables related to the content of education, reliability and viability of the university, educational outcomes, faculty characteristics, and the learning environment.

The application of factor analysis provides very valuable inputs to the decision makers and policy makers to focus only on the few manageable factors rather than many parameters.

The findings of the study cannot be generalized for the large population so advanced study can be done taking more sample size with probability sampling methods. Nevertheless, before making stronger decision on the quality of education to promote education system of country, further research is required to analyze in detail.

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