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Factor Analysis and its Importance on the Application of Total Quality Management and its Implications for Higher Education Institutions (A Field Study on Bright Star University)

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Abstract **Review Article**

This study aims at clarifying the importance of the application of total quality management and its implications on higher education institutions. Bright Star University in Brega was selected as a study field for the possibility of applying the concept of total quality management to higher education services for continuous improvement and quality assurance of performance and outputs. Questionnaire was used as the main instrument for collecting the necessary data; total of (148) questionnaires were prepared and distributed to the target sample, Bright Star teaching staff members, (112) were collected. To achieve the objective of this study, SPSS v.25 software package was used as a tool for data analysis. Several interesting results have been reached, the most important of which are (the proportion of the explained variables variance for the application of comprehensive quality management), as it was sufficient for the variables of the university administration's interest in the application of total quality management, it gave an explanation of approximately 57%, and (the proportion of the explained variables variance of the application of comprehensive air management, it was sufficient for the variables of the role of faculty members in improving performance and raising quality in higher education institutions, it gave an explanation of approximately 60%.

Keywords: Total quality - higher education institutions - factor analysis - latent roots - common variances - rotation.

INTRODUCTION

Total quality management is a modern management philosophy based on a number of modern concepts that are related to combinations of fundamental administrative means, innovative efforts and specialized technical skills to raise the level of performance and continuous improvement. The factor analysis is a statistical method used in the study of phenomena with the aim of returning them to the factors affecting them. It is a mathematical process that aims to explain the positive correlation coefficients that have statistical significance between the various variables. Therefore, it was used to determine the importance of applying total quality management to higher education institutions, to create new variables that summarize all the information that can be available in the original variables, to determine whether the resulting variables reflect patterns of relationships with each other, and to reach the least possible number of themes or factors that enable us to express the greatest degree of variance between these variables.

Research problem

- What are the most important factors that affect the application of total quality management?
- What are the variables that explain the greatest possible total variance?

Objectives of the study

- Using the exploratory factor analysis in the manner of the main components to extract the factors affecting the total quality management on higher education institutions.
- Summarizing the variables in a smaller number of factors affecting TQM on higher education institutions.
- Highlighting a set of latent elements that explain the relationships between the variables in the study of total quality on higher education institutions.

The Hypotheses of the study

- Administrative leaders contribute to the application of total quality to higher education institutions.
- The existence of administrative factors affecting faculty members in improving the overall quality of higher education institutions.

The Study Sample

The field study community consists of faculty members at Bright Star University in Brega, whose total number is (148) faculty members working in different faculties (Faculty of Economics - Faculty of Sciences - Faculty of Technology).

The Scope of the study

Spatial limits: This study was limited to the Bright Star University, located in the city of Brega, which is located in the southwest of Benghazi, about 200 km.

Time period: This study was conducted in the period of (2018/2019).
Participants: Bright Star University University teaching staff members.

The Study Methodology

A number of 148 questionnaires were distributed, and we were able to obtain 112 out of 148, wh 36 forms were excluded because we were unable to obtain them from the participants of the study. To achieve the goal of this study, the IBM SPSS Statistics v.25 software was used, as a tool for analyzing the study data. The questionnaire included two parts:

Firstly, the preliminary data

It includes gender, nationality, and educational qualification, university that granted the educational qualification, college, degree and years of experience.

Secondly, the themes of the study

First part: It contains 12 questions related to the extent of the university administration's interest in the application of total quality management.

x_{1} :The university administration is concerned with the application of total quality standards, $x_{2:}$ The university administration is interested in future strategic plans and strives to achieve them , $x_{3:}$ The university administration is interested in highlighting its mission and goals and striving to implement them, $x_{4:}$ The university administration is keen to spread the culture of quality, $x_{5:}$ The university and colleges administration sets annual operational plans and works to achieve them, $x_{6:}$ The university administration is seeking to obtain local and international institutional accreditation, $x_{7:}$ The university administration is concerned with the total quality system and the importance of its application, $x_{8:}$ The university administration is keen on the policy of implementing the total quality system, $x_{9:}$ The university administration is keen that the application of quality management be through strategic and executive planning, $x_{10:}$ The university administration has granted sufficient powers to the quality management official to perform his duties, $x_{11:}$ The university administration is keen to follow up the progress in following and applying the quality management system, $x_{12:}$ The university administration is interested in holding periodic meetings with the quality management official.

Second part: It contains 8 questions regarding the role of faculty members in improving performance and raising quality in higher education institutions.

$x_{1:}$ There is a clear plan for selecting faculty members according to certain conditions and criteria, $x_{2:}$ The university administration is interested in making the application of the total quality system clear to faculty members, $x_{3:}$ Faculty members are committed to applying the standards of the scientific quality system, $x_{4:}$ A good relationship between faculty members and the administration increases performance and raises quality, $x_{5:}$ Granting material incentives to faculty members has a positive impact on improving performance and excellence in teaching and scientific research, $x_{6:}$ Granting job promotions to faculty members has a positive impact on improving performance and excellence in teaching and scientific research, $x_{7:}$ The university administration seeks to raise the level of efficiency of faculty members through joint cooperation with various scientific institutions, The university administration seeks to raise the level of efficiency of faculty members through joint cooperation with various scientific institutions, $x_{8:}$ Matching the academic qualifications of faculty members with the nature of work increases performance improvement.

Of the Questionnaire validity Reliability and

The validity and reliability of the study data were measured, and the results were as follows: that the value of the reliability coefficient (Cronbach's Alpha) for the study themes was (0.902 and 0.830) and for all study themes (0.927). The data collection tool is considered valid for the study themes, where the values of self-honesty were approximately (0.95 and 091), and for all study themes (0.96), these values are higher than 0.7.Therefore, it can be said that the study themes are stable. (Fouad, 1979).

Table-1: General characteristics of the study sample

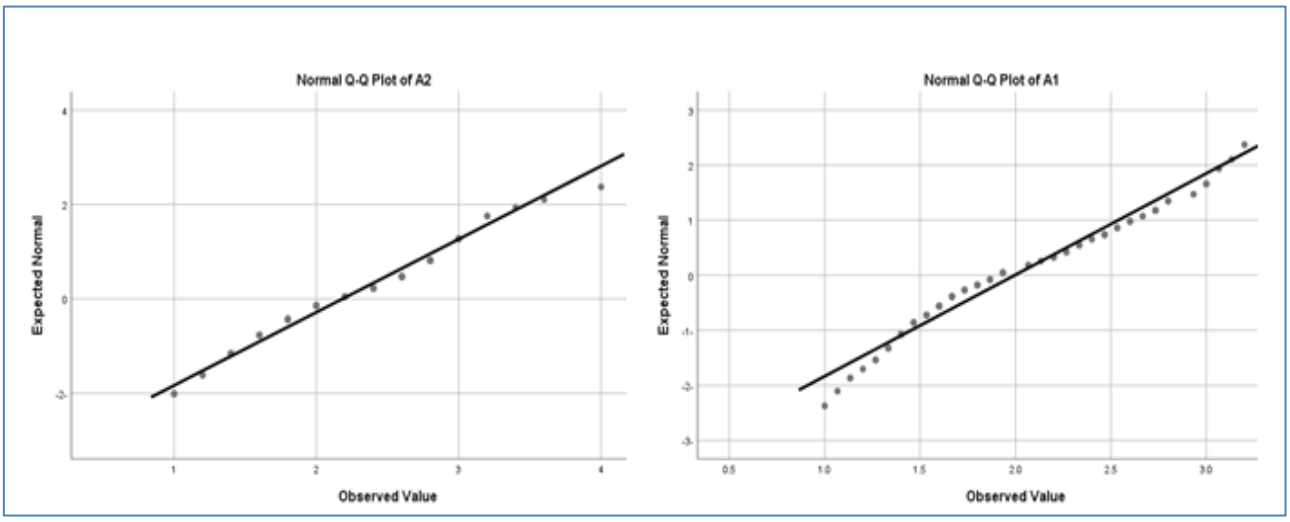
Statement		Frequency	Percentage
Sex	Male	99	88.4%
	Female	13	11.6%
Qualification	Master	98	%87.5
	Doctorate	14	%12.5
Faculty	Admistration	31	%27.7
	Technical Engineering	50	%44.6
	Engineering Sciences	31	%27.7
Experience in years	From 1 to less than 6	63	%56.3
	From 6 to less than 10	26	%23.2
	From 10 to up	23	%20.5

Table (1), shows that most of the sample members are males with percentage 88.4%, and most of them have master degree with percentage 87.5%. It also shows that most of the sample members are from technical engineering with percentage 44.6%. Their years of experience was from 1 to less than 6 years with percentage 56.3%.

Using factor analysis to extract, identify and analyze the results of the study

To determine the importance of applying total quality in higher education institutions, the factor analysis test will be used, which requires some conditions that will be verified and then the factor analysis tests will be performed. These hypotheses are as follows (Shraz 2009, 147).

- Sample size: the sample should not be small in size, and not be biased. If the sample size is 50 observations or less, it is not possible to perform factor analysis of this data, as the study sample numbered 112 individuals and it satisfies the sample size condition.
- Independence of hypotheses: This assumption requires an individual answer to the questionnaire items, and this condition is fulfilled in the study.
- Sample suitability scale (Kaiser-Meyer-Olkin and Bartlett's): This scale indicates the efficiency of the sample for factor analysis, and if the KMO value exceeds 0.50, it proves the suitability of the sample. It's found that the KMO value for all study themes is greater than (0.5) and this reffers to the possibility of dependence on factors obtained from factor analysis.
- Correlation matrix: factor analysis depends on the presence of correlations between variables, the stronger the correlations, the better and more accurate the factor analysis. Also the determinant of the matrix to measure the autocorrelation problem must be a value greater than 0.0001 and this means that there is no autocorrelation problem. (Teghza, 2012, 2) (Fahmy, 777, 2005).
- MSA values in the (Anti\-image Matrices). The diagonal cells of the correlation coefficients must exceed the value 0.5. It was found that the MSA value for all study themes is greater than 0.5, which indicates that the level of correlation between each variable with the other variables in the matrix is sufficient to perform the factor analysis.
- It is required that the variables be normally distributed, which was evident by the results of the study. This satisfies the condition of moderation, as was observed and confirmed by the Q-Q Plot charts as follows:



The matrix of simple correlations for the first theme: From The matrix of simple correlations we found that there are moderate and weak direct correlations between the different variables, the highest correlation was between x1 and x7 and its value is approximately 59%. The determinant of the matrix to measure the autocorrelation problem = 0.002, which satisfies the condition that the determinant must be greater than 0.0001 and what means there is no autocorrelation problem. (Teghza, 2012, 2) (Fahmy, 777, 2005).

Table-2: Sample Size Adequacy Test (Kaiser-Meyer-Olkin and Bartlett's (KMO))

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**.8890**
Bartlett's Test of Sphericity	Approx. Chi-Square	643.656
	df	66
	Sig.	.0000

Table (2) indicates the extent of the accuracy and adequacy of the sample size, as the value of KMO is equal to .8890, which is greater than (0.5), and this indicates the possibility of reliability on the factors obtained from the factor analysis for the sufficiency of the sample size used in the study, it's also found that the value of the significance level of Bartlett's circularity test is sig=0.000 which is less than 0.05 and this indicates that the relationship is a statistical function, that is, there is a correlation between the variables, which indicates the possibility of conducting factor analysis on the data.

Measure of Sampling Adequacy (MSA)

From the Measure of adequacy of the sample we found that The MSA values in the (Anti\-image Matrices) show that the diagonal cells of the correlation coefficients of Table (6) all exceed the value 0.5, which indicates that the level of correlation between each variable with other variables in the correlation matrix is sufficient to perform the factor analysis.

Table-3: The percentage of the total explained variance

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.884	49.033	49.033	5.884	49.033	49.033	3.732	31.103	31.103
2	1.009	8.408	57.440	1.009	8.408	57.440	3.160	26.337	57.440
3	0.922	7.684	65.124						
4	0.848	7.070	72.194						
5	0.688	5.731	77.925						
6	.5760	4.798	82.724						
7	.4860	4.048	86.772						
8	.4220	3.519	90.291						
9	.3740	3.121	93.411						
10	.3460	2.883	96.294						
11	0.265	2.206	98.501						
12	.1800	1.499	100.000						
Extraction Method: Principal Component Analysis.									

Table (3) gives a detailed explanation of the total variance in three successive stages and the method of extracting factors using the Principal Component Analysis method.

Phase I: Initial Eigenvalues: The previous table contains 12 (combinations) of a linear relationship to the data and the initial values of the latent roots of each component. The value of the latent roots of the first component is 5.884, where the variances of this component explain 49.033% of the total variance, while the value of the latent roots of the second component equals 1.009 and explains 8.408% of the total variance.

Phase II: Extraction Sums of Squared Loadings: At this stage, two factors were extracted, and the other ten factors that do not have a root value greater than one were neglected. It's found that the sum of what is explained by the first and second components is 57.440% of the total variance.

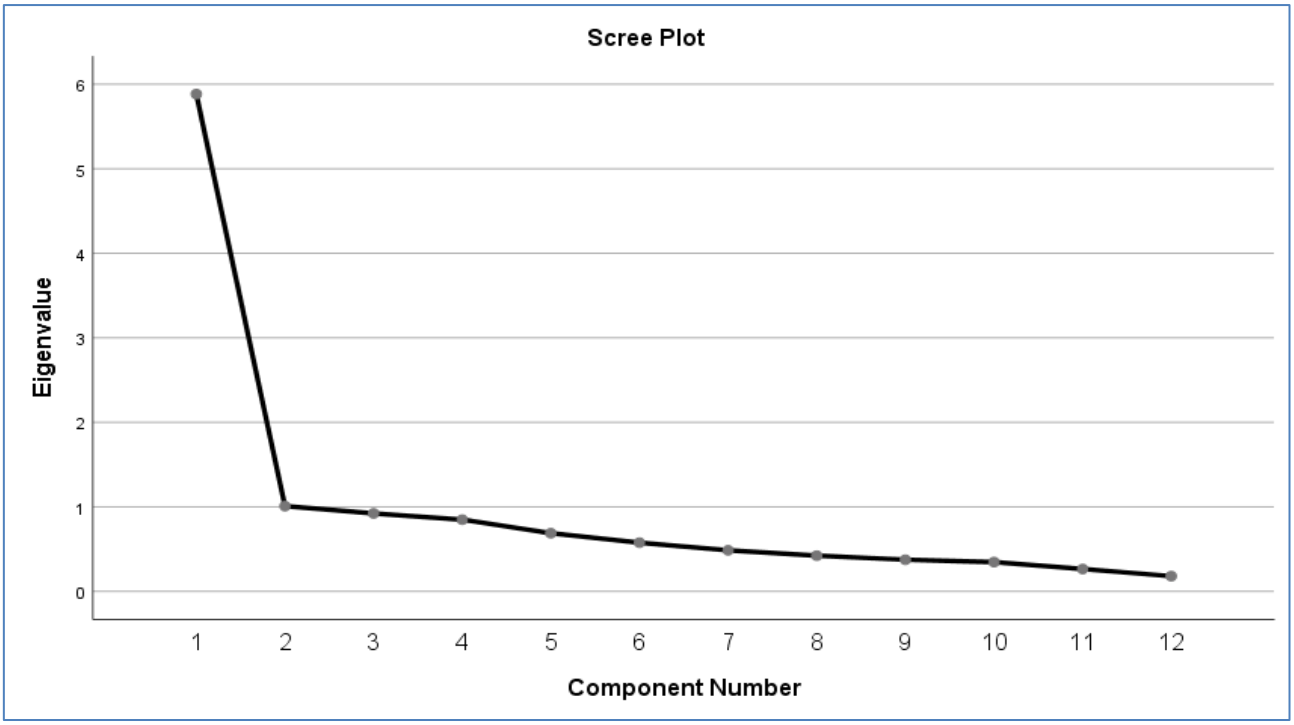


Fig-1

Figure (1): The values of the latent roots: Figure (1) Scree plot shows the values of the latent roots of each factor on the y-theme and the number of the component on the x-theme. It's noticed that the curve started to stabilize after the second factor because the first and second factors have a potential root greater than the one.

Phase III: Rotation Sums of Squared Loadings

At this stage, the values of the latent roots that emerged in the second stage were rotated, as these values appear in the table, besides the extent of their contribution to the total variance before and after the rotation process.

Common Variances

From the results shows the amount of common variances for each statement after the process of extracting its underlying factors it's obvious that the common factors explain the percentage of variance of variables that range between (0.404 and 0.692), as the highest percentage of variable x8 is approximately 69% of the variance in the variable is explained by the common factors.

Table-4: Component matrix before and after rotating

Component matrix before rotating			**Component matrix after rotating**		
Component			Component		
	1	**2**		**1**	**2**
x_1	0.767		x_1	0.652	
x_2	0.796		x_2	0.608	
x_3	0.690	-0.426	x_3	0.799	
x_4	0.737		x_4	0.697	
x_5	0.639	-0.461	x_5	0.784	
x_6	0.631		x_6	0.522	
x_7	0.738		x_7		0.601
x_8	0.829		x_8		0.601
x_9	0.713		x_9	0.535	
x_{10}	0.546	0.391	x_{10}		0.655
x_{11}	0.630	0.514	x_{11}		0.803
x_{12}	0.634	0.322	x_{12}		0.662
Extraction Method: Principal Component Analysis.					

From Table (4) shows the matrix of components or factors Component Matrix and the results of factor extraction before rotation, which includes two factors according to the method of Principal Component analysis, saturations that are less than 0.3 were neglected due to their lack of importance.

It is known that in factor analysis the factors extracted before rotation are less clear, so it is necessary to improve these results through rotation. The results were represented in the following table:

From Component matrix after rotating shows the matrix of the components or factors Component Matrix and the results of extracting the factors after rotation according to the method of analyzing the principal components and the method of rotating the factors using the criterion of the largest variance, which is the Rotation Method Varimax. Two factors were extracted, namely:

The first factor has strong relationships with 7 out of 12 variables. It is the most important factor extracted and explains 31.103% of the total variance and includes the following six variables:

x1: The university administration is concerned with the application of total quality standards, x2: the university administration is concerned with future strategic plans and strive to achieve them, x3: the university administration is concerned with highlighting its mission and goals and striving to implement them, x4: the university administration is keen to spread the culture of quality, x5: the university and colleges administration puts annual operational plans and work to achieve them. X6: the university administration seeks to obtain local and international institutional accreditation, x9: the university administration is keen that the application of quality management is through strategic and executive planning, and this factor can be called a factor (strategic planning).

The second factor has strong relationships with 5 out of 12 variables. It explains 26.337% of the variance remaining after extracting the first factor and includes the following seven variables:

X7: the university administration is concerned with the total quality system and the importance of its application, x8: the university administration is keen on the policy of implementing the total quality system, x10: the university administration has granted sufficient powers to the quality management official to perform his duties, x11: the university administration is keen to follow up the progress in following and implementing the system Quality Management, x12: the university administration is interested in holding periodic meetings with the quality management official. This factor can be called the (administrative control) factor.

Matrix of simple correlations for the second theme: From The matrix of simple correlations we found that there is moderate and weak direct correlation between the different variables, the highest correlation was between x1 and x7 and its value is approximately 51%.

It's also foun that the determinant of the matrix to measure the autocorrelation problem = 0.061, which satisfies the condition that the determinant must be greater than 0.0001 and this means that there is no autocorrelation problem. (Teghza, 2012, 2) (Fahmy, 777, 2005).

Table-5: Sample Size Adequacy Test (Kaiser-Meyer-Olkin and Bartlett's (KMO))

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**8040**
Bartlett's Test of Sphericity	Approx. Chi-Square	300.388
	df	28
	Sig.	.0000

Table (5) gives the extent of the accuracy and adequacy of the sample size, as the value of KMO is equal to .8040, which is greater than (0.5), and this indicates the possibility of reliability on the factors that were obtained from the factor analysis for the sufficiency of the sample size used in the study. The value of the significance level of Bartlett's circularity test is sig=0.000 which is less than 0.05 and this indicates that the relationship is a statistical function, that is, there is a correlation between the variables, which indicates the possibility of conducting factor analysis on the data.

Measure of Sampling Adequacy (MSA)

From the Measure of adequacy of the sample we found that The MSA values in the (Anti\-image Matrices) show that the diagonal cells of the correlation coefficients of table (14) all exceed the value 0.5, which indicates that the level of correlation between each variable with other variables in the correlation matrix is sufficient to perform the factor analysis.

Table-6: The percentage of the total explained variance

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.719	46.486	46.486	3.719	46.486	46.486	2.846	35.573	35.573
2	1.072	13.394	59.880	1.072	13.394	59.880	1.945	24.306	59.880
3	0.857	10.707	70.587						
4	0.722	9.027	79.614						
5	0.509	6.366	85.980						
6	0.482	6.022	92.002						
7	0.355	4.437	96.439						
8	0.285	3.561	100.000						
Extraction Method: Principal Component Analysis.									

Table (6) gives a detailed explanation of the total variance in three successive stages and the method of extracting factors using the Principal Component Analysis method.

Phase I: Initial Eigenvalues: The previous table contains 8 (combinations) of linear relationships for the data and the initial values of the latent roots of each component. The value of the latent roots of the first component is 3.719, where the variances of this component explain 46.486% of the total variance, while the value of the latent roots of the second component is 1.072 and explains 13.394% of the total variance.

Phase II: Extraction Sums of Squared Loadings: At this stage, two factors were extracted, and the other six factors that do not have a root value greater than one were neglected. It's found that the sum of what is explained by the first and second components is 59.880% of the total variance.

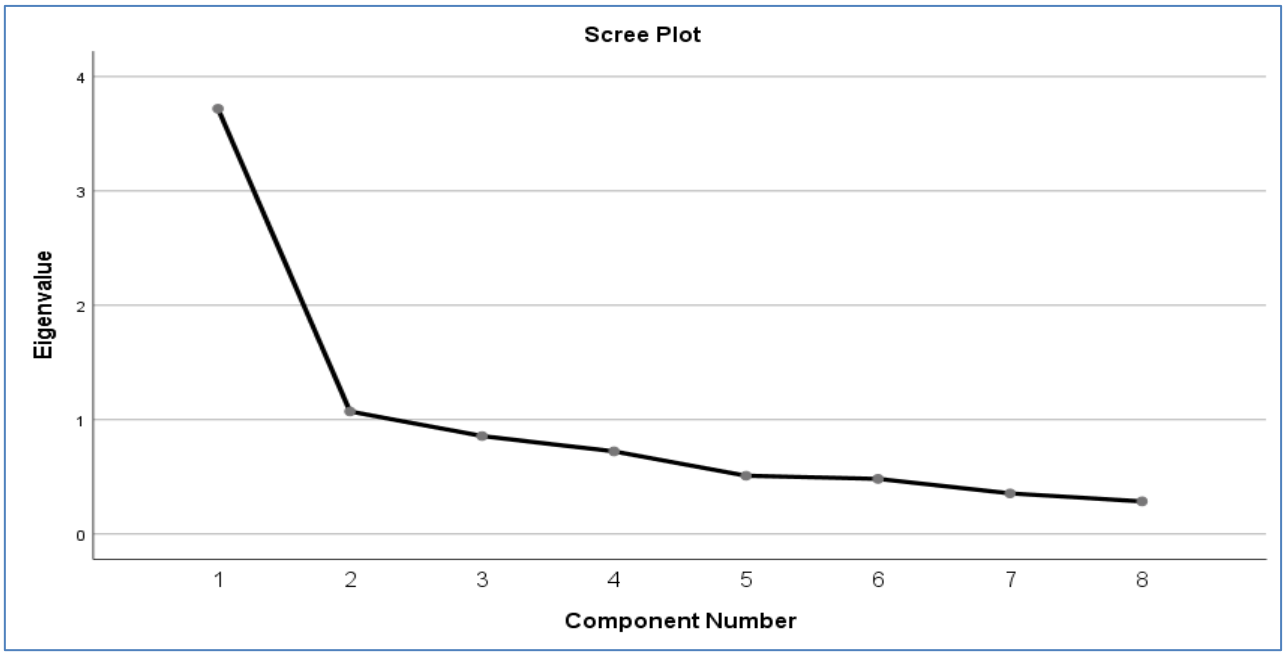


Fig-2

Figure (2): The values of the latent roots: Figure (2) Scree plot shows the values of the latent roots of each factor on the y-theme and the number of the component on the x-theme. It's noticeable that the curve started to stabilize after the second factor because the first and second factors have a potential root greater than the one.

Phase III: Rotation Sums of Squared Loadings: At this stage, the values of the latent roots that emerged in the second stage were rotated, as these values appear

in the table with the extent of their contribution to the total variance after the rotation process.

Common Variances

From the results shows that the common factors explain the percentage of variance of variables that range between (0.411 and 0.708), as the highest percentage of variable x8 is approximately 71% of the variance in the variable is explained by the common factors.

Table-7: Component matrix before and after rotating

Component matrix before rotating			**Component matrix after rotating**		
Component			Component		
	1	**2**		**1**	**2**
x_1	0.694	0.434	x_1		0.753
x_2	0.525	0.658	x_2		0.840
x_3	0.638		x_3	0.561	
x_4	0.656		x_4	0.665	
x_5	0.736	-0.369-	x_5	0.814	
x_6	0.787		x_6	0.783	
x_7	0.648	0.341	x_7		0.651
x_8	0.738		x_8	0.772	
Extraction Method: Principal Component Analysis.					

From Table (7) shows the matrix of components or factors Component Matrix and the results of factor extraction before rotation, which includes two factors according to the method of Principal Component analysis, saturations that are less than 0.3 were neglected due to their lack of importance.

It is known in the factor analysis that the factors extracted before rotation are less clear, so it is necessary to improve these results through rotation. The results were represented in the following table:

From Component matrix after rotating shows shows the matrix of components or factors Component Matrix and the results of the extraction of factors after rotation according to the method of analysis of the principal components and the method of rotation of factors using the standard of greatest variance, which is the Rotation Method Varimax. Two factors were extracted, namely:

The first factor has strong relationships with 5 out of 8 variables. It is the most important factor extracted and explains 35.573% of the total variance and includes the following five variables:

x3: Faculty members are committed to applying the standards of the scientific quality system, x4: Good relationship between faculty members and with the administration increases performance and raise quality, x5: Granting material incentives to faculty members positively affects improving performance and excellence in teaching and scientific research, x6 : Granting job promotions to faculty members positively affects improving performance and excellence in teaching and scientific research: x8: The conformity of the academic qualifications of faculty members with the nature of work increases performance improvement, and this factor can be called an active factor). (Academic performance).

The second factor has strong relationships with 3 out of 8 variables. It explains 24.306% of the remaining variance after extracting the first factor and includes the following three variables: x1: There is a clear plan for selecting faculty members according to certain conditions and criteria, x2: The university administration is concerned that the implementation of the total quality system is clear to faculty members, x7: The university administration seeks to raise the level of efficiency of faculty members through joint cooperation with various scientific institutions. This factor can be called the (performance development) factor.

The Results

- The results of the factor analysis of the first hypothesis showed the intresr of the administrative leaders in the application of the comprehensive quality to the institutions of higher education, where the proportion of the explained variance of the variables of the application of comprehensive quality management was sufficient for the variables of the first theme, it gave an explanation of 57.440%.
- The results of the factorial analysis of the second hypothesis showed the presence of administrative factors affecting faculty members in improving the overall quality of higher education institutions, where the proportion of the explained variance of the variables of the application of comprehensive air management was sufficient for the variables of the second theme; it gave an explanation of 59.880%.
- To conclude, the variables involved in the factor analysis have an impact on the rise of these percentages, and the influence ratios have varied

from one factor to another, as it's found that the highest percentage of influence was for the second theme of the role of faculty members in improving performance and raising overall quality in higher education institutions.

- After conducting the factor analysis, it's noticed that the matrix of components after the rotation of the theme of the university administration's interest in the application of comprehensive quality management was collected in the first component, as it included 7 variables, all related to the subject of (strategic planning), as for the variables of the theme of the role of faculty members in improving performance and raising the overall quality in higher education institutions were collected in the first component if it included 5 variables, all related to the subject of (academic performance).

RECOMMENDATIONS

- The possibility of conducting research for other universities within the country for the purpose of making actual comparisons to verify the level of job satisfaction of employees within the universities.
- Choosing a leading and effective official based on appropriate foundations and criteria in order to provide justice, transparency and clarity in dealing with employees. As well as giving employees training courses in their field of specialization to develop their job performance.
- Considering clarity and transparency when granting incentives and justice in dealing with members which gives them psychological comfort, and instill intimacy among colleagues that increases the desire to improve job performance.

REFERENCES

Arabic References

1. جبريل , رامي صلاح (2020). تحليل البيانات خطوة بخطوة في spss Data Analysis Step by Step in SPSS, (الطبعة الأولى). بنغازي, ليبيا: دار الكتب الوطنية.
2. فؤاد البهي السيد (1979)" علم النفس الإحصائي وقياس العقل البشري"، دار الفكر العربي القاهرة ,ط 3,، ص 532

REFERENCES

1. Anderson, T. W. (1958). An Introduction to Multivariate Statistical Analysis. New Yor k : Wile y. (2003) 3rd ed ., Ne w York: W ile
2. Baglin, J. (2014). Improving your exploratory factor analysis for ordinal data: A demonstration using FACTOR. Practical Assessment, Research & Evaluation, 19(5), 1-15.
3. Cudeck, R. (2000). Exploratory factor analysis. In Tinsley, H. E. A., Brown, S. D. (Eds.), Handbook of applied multivariate statistics and mathematical modeling (pp. 265-296). New York, NY: Academic PressJ Baglin - 2014
4. Hair, J. F., Black, B., Babin, B., Anderson, R. E., & Tath, R. L. (2010).Multivariate data analysis. Prentice Hall. Inc. Upper Saddle River, NJ, the USA.
5. Lok, P., Crawford, J. (2004). "The effect of organizational culture and leadership style on job satisfaction and organizational commitment: A cross-national comparison". Journal of Management Development, *23*(4), 321-338.
6. Md. Rifayat Islam1, Md. Tauhid Rasul, Wali Ullah, G. M. (2012). "Analysis of the Factors that Affect Job Satisfaction: A Case Study on
7. Private Companies Employees of Bangladesh, *European Journal of Business and Management*, *4*(4).
8. Steven, K. (2012). Thompson. Sampling. Third Edition. Hoboken, NJ: John Wiley & Sons, Inc. ISBN 978-0-470-40231-3.