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Analytic Statistical Technique to Determine the Effective Factors on Improvement the Efficiency of University Performance in the Jordanian Universities by using the Factor Analysis / Principal Components Method

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Abstract

This study aimed to investigate the analytic statistical technique to determine the effective factors on improvement the efficiency of university performance in the Jordanian universities by using the Factor Analysis / Principal Components method. To achieve this object a statistical questionnaire has been build which include seven requirements for the university education, and the university performance. Then the sincerity of the tool and its reliability were tested, and was applied to the study sample of (116) teaching staff of Zarqa University, chosen from the study population. The study findings including the following:

1. The Factor Analysis results show that the mostly factors which effect on improvement the efficiency of the university performance in the Jordanian universities were (Administrative leadership quality, Quality culture, Improvement and development, Focus on beneficiaries).

2. There were no a statistically significant differences at the significance level ($\alpha = 0.05$), between the means responses of the teaching staff about the efficiency of the university performance, attributed to the (job title, qualification, academic rank, experience years, and faculty specialize).

Key words: Factor analysis, Principal components method, Eigen value, University performance.

1.Introduction

The process of reform programs, policies and strategies of education in general has received considerable attention in most countries of the world, and in this regard has been given a comprehensive quality along much of this interest, as one of the pillars of productivity management model university modern in order to face the changes of local, regional and global order adaptation, and it has become the global community to consider the overall quality system and the educational administration as a basis for the development of peoples and progress, where we can say that the overall quality system is the real challenge that will face united in the coming decades (Ahmed, 2003: p.27).

The renewal of programs and strategies of education through the adoption of Total Quality Management has taken echoed widespread in higher education, where sees specialists in the field of management that the application of total quality management in universities is an integrated approach to system standards can be applied at all levels of the university and colleges to provide for employees and teams the opportunity to satisfy the needs of students and the beneficiaries of higher education.

In light of the foregoing, the educational quality has not tad gift granted by governments, but the opportunity to invest and manufactured Nations peoples, and sacrifice for it time and effort, money and perseverance. And verify the educational quality through the existence of a clear policy for the system of total quality, and efficiency of the administrative organization of educational institutions, the academic in Jordanian universities, and activate the system, monitoring and evaluation to avoid falling into the errors, and provide training system effectively to teaching staff.

2. Methodology

2.1. The Study Problem

The study problem is reflected by exploring on the mechanisms by which used to determine the effective factors on improvement the efficiency of university performance in the Jordanian universities by using the Factor Analysis / Principal Components Method. and the trouble with the study of wonder the following:

a. What are the effective factors on improvement the efficiency of university performance in the Jordanian universities?

b. Is there exist differences between the teaching staff responses about the efficiency of the university performance, attributed to the (job title, qualification, academic rank, experience years, and faculty specialize)?

2.2. The Study Importance

This study gaining its importance as it deals with a subject extremely sensitive is the university education quality, which is reflected in a positive way to improve the efficiency of university performance in Jordanian universities. Also, according to this study provide a number of requirements for university education quality, which can be used to improvement the efficient of university performance of teaching staff at the university on the one hand, on the other hand, benefit the designers of systems, the university education quality by providing them with a list of requirements to ensure quality of teaching, as well as benefit officials in higher education and through the entrances to identify a modern management represented by the (university education quality) and provide requirements to be applied in order to improve the efficiency of university performance in Jordanian universities.

2.3. The Study Objectives

The study aims to achieving the following objectives:

a. To identify the concept of the university education quality, and the university performance concept.

b. To explain the Factor Analysis and the Principal Components Method.

c. To determine the effective factors on improvement the efficiency of university performance in the Jordanian universities.

d. To Measure the differences between the study sample responses about the efficiency of the university performance, attributed to the (job title, qualification, academic rank, experience years, and faculty specialize)?

2.4. The Study Hypotheses

To achieve the study objectives, it has been putting one hypothesis as a null form (H_0), as follows:
H_0: There are no statistically significant differences at the significance level ($\alpha = 0.05$), between the means responses of the teaching staff about the efficiency university performance, attributed to the (job title, qualification, academic rank, experience years, and faculty specialize).

2.5. The Study Terms

a. Factor Analysis

Factor Analysis is defined as: "a statistical method used to describe the variability between observed, correlated variables in terms of a potentially lower number of the unobserved variables called factors", also, Factor analysis searches for such joint variations in response to unobserved latent variables (Daffier & Tariq, 2002: p. 29).

b. Principle Component Analysis

Principle Component Analysis (PCA) is defined as: "one of the most commonly used methodologies in the Statistics and Data-Mining community", or simply PCA, is a statistical procedure concerned with elucidating the covariance structure of a set of variables. It serves as a general purpose tool with applications ranging from information extraction over dimension reduction to data visualization, because of its applicability, the range of data subject to PCA is also increasing (Sebastian. & Gunther, 2010: p. 1).

c. University Education

University Education is defined as: "an administrative process based on a set of values, and derive energy movement of information, which employs the talents of employees, and invest their intellectual creatively to ensure continuous improvement of the organization, which is a translation of the needs and desires of graduates of the University of the output of the education system in universities to the characteristics and standard specified in the graduate, as a basis for designing programs continuous development" (Rhodes, 2005: p.37).

d. University Performance

University Performance is defined as: "to contribute the effective system of administrative and regulatory framework with all its elements in achieving efficient investment of available resources (raw materials, equipment, human power and information, strategic management, standards and specifications ..., etc), so that

all contribute in the quest to achieve the goal of the organization which is concentrated in achieving optimal saturation of the final consumer" (Sunil, 2006: p. 35).

3. The Theoretical Part

3.1. Factor Analysis

The **Factor analysis** attempts to identify underlying variables, or factors, that explain the pattern of correlations within a set of observed variables. Factor analysis is often used in data reduction to identify a small number of factors that explain most of the variance observed in a much larger number of manifest variables. Factor analysis can also be used to generate hypotheses regarding causal mechanisms or to screen variables for subsequent analysis (for example, to identify collinearity prior to performing a linear regression analysis). The factor analysis procedure offers a high degree of flexibility (IBM, SPSS- 20).

And when we studying any phenomenon of phenomena can express relationships between variables that control the formation of this phenomenon for many statistical measures depends on some simple methods to estimate the indicators. It is these common measures, the correlation coefficient, which determines the degree and nature of the relationship between the variables, but the presence of a large number of variables involved in the formation of the phenomenon or controlling makes it difficult to interpret these coefficients efficiently and easily because of the large number of these coefficients on the one hand, and being a measure of the relationship between only two variables and unaware the interrelationships with another variables. From here began the need for advanced statistical methods enable researchers to diagnose the factors that determine the nature and direction of the correlations between variables, to take into account all transactions when estimating these factors, and from these methods is the (**Factor Analysis**). Which is defined as a method of **Multivariate Statistical Analysis Methods** used in the study of complex phenomena, which contain a large number of variables in order to be returned to the most prominent factors that effected them. That is mean it help in reducing the large number of variables with a smaller number of factors that are not linked with each other, which reflects the existing relations between variables by linear function or a non-linear called factor, and is interpreted in the light of the contents of significant variables (with effect), whether positive or negative. These factors, which are called common factors and its hypothesized factors which the named depend on the kind of variables that comprise them. The **Factor model** can be formulated in the form as follows (Daffier and Tariq, 2002: pp. 28-30):

$$X = AF + U \qquad \ldots(1)$$

Where:

X : Variables vector.

A : Factors loading matrix with order (pxk).

F : Common factors vector with (kx1), where each factor from these coefficients represent the loading **j** from variables **i** of the factor, and the factors number is less than the variables number.

U : Specific factors vector with (px1), where each variable represents the privacy factor **j** in the formation of the phenomenon.

And since, the purpose of the **Factor Analysis** is the correlation coefficients analysis, and not the original values of the data, so the above model can be expressed in terms of correlations between variables by the following formula:

$$\Sigma = A\ \Phi\ A' + \Psi \qquad \ldots(2)$$

Where:

Σ : Variance-covariance matrix, and represents the correlation matrix between variables when converting the values to the standardized formula.

Φ : Correlation coefficients matrix between the extraction factors.

Ψ : Co-variance matrix for all variables, and it is diagonal matrix.

3.2. Principal Components Method

By assumption that we have (p) variables which are (X_1, X_2, …., X_p), and to obtain on the uncorrelated and standardized variables represents by (Z_1, Z_2, ….., Z_P). Therefore, the main equation in **Factor Analysis** is given by the following formula (Jon, 2003: pp. 2-3):

$$X = WZ + E \qquad \ldots(3)$$

Where:

X : Correlated variables vector**.**

W : Weighted component matrix, and named by (loadings) matrix.

Z : Common factors vector.

E : Random error term.

The **First Transformation** of the new variables are (Y_1, Y_2, ….., Y_P), which achieve the following formula:

$$Y = U' X \quad , \quad X = U Y \qquad \ldots(4)$$

Where:

Y : New variables vector, and Y = [Y_1, Y_2, ….., Y_P].

U : Orthogonal matrix, with length one.

And by assumption that the variance of (Y_i) is (λ_i), therefore the variance co-variance of (X) indicated by (A), and if the standardized values are taken for (X), then (A) is called correlation matrix, and:

$$U' A U = \Lambda \qquad \ldots(5)$$

Where:

Λ : Orthogonal matrix**,** and Λ = [λ_1, λ_2, ….., λp], and arranged as descending.

λ_i : Eigen value.

u_i : Eigen vector corresponding to eigen value (λ_i).

The **Principal Components** (Z_1, Z_2, ….., Z_P), will be obtained by make the variables (Y_1, Y_2, ….., Y_P), as standardized variables for obtaining the variance for (Z_i) equal to (1), so that:

$$Z_i = \lambda_i^{-1/2} Y_i \qquad , i = 1,2, \ldots\ldots, p$$

$$= \lambda_i^{-1/2} U'_i X \qquad \ldots(6)$$

The above equation (6), can be written by matrices as follows:

$$Z = \Lambda^{-1/2} Y = \Lambda^{-1/2} U' X \qquad \ldots(7)$$

By multiply the equation (7), by ($U \Lambda^{1/2}$) from the left side, we have:

$$X = U \Lambda^{1/2} Z \qquad \ldots(8)$$

And by substitution the ($W = U \Lambda^{1/2}$) in equation (8), we have:

$$X = W Z \qquad \ldots(9)$$

And the above equation (9) is equivalent to equation (3).

Therefore, and by using (5) and (9), we see that ($W W^{'} = A$) and ($W^{'} W = \Lambda$), so that:

$$\Sigma \lambda_{ii} = \Sigma a_{ii} = tr(A) = tr(\Lambda)$$

In order to simplify the interpret of the result, we can obtain the new matrix, called (**Rotation Factors**) as follows:

$$\Gamma = W T \qquad \ldots(10)$$

Where:

T : Rotation matrix, and it is orthogonal.

And the amount (ΣW_i^2) of the matrix (W) in equation (10), is called (**Communalities),** such that the (Communalities) represents the power of the relationship between the **variables** and the (**Extraction factors**).

4. Methods and Procedures

4.1. The Study population and the Sample

The study population consists of all faculty members whom are working in Zarqa university, and numbered (253) teaching staff does not include part-time lecturers. And the study sample consists of (127) teaching staff (Dean, dean assistant, department head, and faculty members), chosen randomly by a stratified random sample method, by (50%) from the study population. After that (127) questionnaire are distributed and (116) questionnaire are returned.

4.2. The Study Tool & its Sincerity and Reliability

Depend upon the study objectives, the researcher built a tool to measure the extent of the effective factors on improvement the efficiency of university performance in the Jordanian universities by using the Factor Analysis / Principal Components method. The tool consisted three parts, the first part included the personality properties as (job title, qualification, academic rank, experience years, and faculty specialize), and the second part dealt with the requirements of the university education quality represent by (Administrative leadership quality, educational quality, quality culture, focus on beneficiaries, employees in the university, improvement and development, service quality of students and community), while the third part dealt with the variable of university performance, and the final questionnaire included (45) items. After that was measured the tool sincerity (Face Validity), through display on a group of experts and arbitrators with expertise and knowledge programs of total quality in education and educational administration at Zarqa University and Jordanian universities, and the aim of arbitration examining the extent of appropriate formulation of items linguistically, and the extent of items belonging to the variables of the study, so that the questionnaire is designed in its final form. And was measured the tool reliability (Check the internal consistency of the questionnaire items), through using the (Cronbach Alpha Coefficient), and the reliability coefficient for the overall tool is equal to (0.92).

4.3. The Statistical Methods

After completion of the discharge resolution data in the computer, were used some statistical descriptive and analytical methods, which its available in the Statistical Package for Social Sciences (SPSS), in order to test the study hypothesis, and the statistical methods that were used for the purposes of statistical analysis of data are:

1. Variance Inflation Factor (VIF) Test.
2. Factor Analysis
3. Principal Components Analysis (PCA).
4. Kruskal-Wallis Test.

5. The Statistical Analysis of Data

This section interesting by the statistical analysis of the study data through some measures, which was available in the Statistical Package for Social Sciences (IBM-SPSS-Ver. 20).

Before testing the study hypothesis, should be verified from the distribution of the data, and is the data distributed (**Normal Distribution**) or not?

A. Histogram

To test the Normal Property was used the **Histogram**, as shown in Figure (1) as follows:

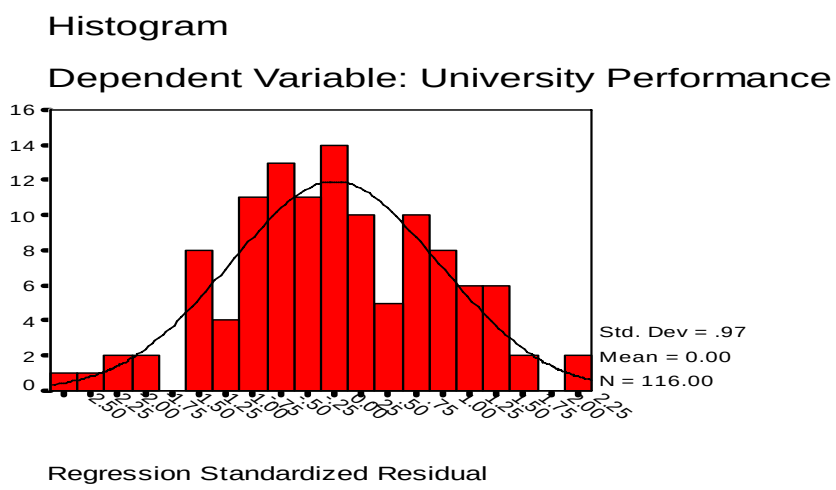

Figure 1: Test the Normal property by the Histogram

The above chart in figure (1), explained that the study data distributed (**Normal Distribution**).

B. Variance Inflation Factor (VIF) Test

To test the **Multicollinearity** problem between the requirements of the (university education), the researcher used (VIF) Test. Table (4) shows the results as follows:

Table 1. Results of (VIF) Test

Requirement Symbol	Requirements of university education	Tolerance	VIF
X_1	Administrative Leadership Quality	0.302	3.312
X_2	Educational Quality	0.631	1.585
X_3	Quality Culture	0.460	2.176
X_4	Focus on Beneficiaries	0.349	2.863
X_5	Employees in the University	0.498	2.009
X_6	Improvement and Development	0.510	1.962
X_7	Service Quality of Students and Community	0.724	1.380

Critical value of (VIF) = 5

The results in Table (1), explained that there was no Multicollinearity between all the requirements of the university education quality, which are confirmed by the calculated values of (VIF) test, and all these values are less than the critical value of (VIF) test which is equal to (5).

After it was certained that the distribution of the data is (Normal Distribution), and there is no (Multicollinearity) between the requirements of the (university education), it has become possible to make all the tests of the study hypothesis, as follows:

5.1. Steps of the Factor Analysis

1. Communalities

The results shown in Table (2), explained the (Communalities) of the requirements, which defined as "a ratio variance in a given requirement, which habituate to the common factors", for example, the requirement

(Administrative Leadership Quality) that 84.8% of the variance correlated with the first factor, contained in the (Component Matrix), and so on for the other requirements.

Table 2. Communalities

Requirement Symbol	Requirements of university education	Initial	Extraction
X_1	Administrative Leadership Quality	1	0.848
X_2	Educational Quality	1	0.568
X_3	Quality Culture	1	0.725
X_4	Focus on Beneficiaries	1	0.749
X_5	Employees in the University	1	0.752
X_6	Improvement and Development	1	0.679
X_7	Service Quality of Students and Community	1	0.600

Extraction Method: Principal Components Analysis

2. Total Variance Explained

The final results contained in Table (3), the contrast ratio of the interpreter in detail for the total variation, as follows:

Table 3. Total Variance Explained

Component	Initial Eigen values		
	Total	% of Variance	Cumulative %
1	3.637	51.951	51.951
2	1.285	18.359	70.310
3	0.650	9.287	79.597
4	0.530	7.577	87.174
5	0.413	5.893	93.067
6	0.274	3.919	96.986
7	0.211	0.014	100.000

Extraction Method: Principal Components Analysis

The results in Table (3), explained that the factor analysis model of requirement gives seven linear relationships of observations, and give the initial values of (Eigen values) in general which the (Eigen Values) is greater than one. The (Eigen value) for the first component amount (3.637) where explain this component accounted to (51.951%) of the total variance, while the (Eigen value) for the second component amount (1.285) where explain this component accounted to (18.359%) of the total variance, so that the cumulative percentage became explained by the two components (70.31%) of the total variance.

3. Components Matrix before (Rotation)

The results in Table (4), refers to the Components Matrix which represents the results of (**Extraction**) the factors **before** (**Rotation**) by using (PCA) method, where selected two factors only will be distributed to them by seven requirements of the university education.

Table 4. Components Matrix before (Rotation)

Requirement Symbol	Requirements of university education	Component	
		1	2
X_1	Administrative Leadership Quality	0.831	- 0.397
X_2	Educational Quality	0.669	0.348
X_3	Quality Culture	0.741	- 0.420
X_4	Focus on Beneficiaries	0.865	0.034
X_5	Employees in the University	0.648	0.576
X_6	Improvement and Development	0.716	- 0.408
X_7	Service Quality of Students and Community	0.519	0.574

Extraction Method: Principal Component Analysis.

4. Rotated Components Matrix

The results in Table (5), refers to the Components Matrix which represents the results of (Extraction) factors **after** (**Rotation**) calculated according to the method of (**Varimax with Kaisers Normalization**), where these results represent the ratios of (Loading) for each requirement of the two factors. And that the aim of the (Rotation) process is to extract the final ratios of (Loading).

Table 5. Rotated Components Matrix

Requirement Symbol	Requirements of university education	Component	
		1	2
X_1	Administrative Leadership Quality	0.898	0.204
X_2	Educational Quality	0.308	0.688
X_3	Quality Culture	0.842	0.131
X_4	Focus on Beneficiaries	0.657	0.563
X_5	Employees in the University	0.150	0.854
X_6	Improvement and Development	0.815	0.124
X_7	Service Quality of Students and Community	0.050	0.773

Rotation Method: Varimax with Kaiser Normalization

5.2. Test of the study hypothesis

H_0: There are no statistically significant differences at the significance level ($\alpha = 0.05$), between the mean responses of the teaching staff about the efficiency of the university performance, attributed to the (job title, qualification, academic rank, experience years, and faculty specialize).

To test the above hypothesis was used the **Kruskal-Wallis Test**, as shown in Table (6) the following:

Table 6. Kruskal -Wallis Test, to test the differences between the means of the study sample responses about the university performance, attributed to the personality variables

Personality Variables	Chi-Square (χ^2)	df.	Sig	$\chi^2_{(0.05)}$
Job title	3.155	3	0.368	7.815
Qualification	0.007	1	0.935	3.841
Academic rank	0.568	3	0.904	7.815
Experience years	6.560	3	0.078	7.815
Faculty specialize	2.587	1	0.108	3.841

The results in Table (6), indicates to there were no a statistically significant differences at the significance level ($\alpha = 0.05$), between the mean responses of the teaching staff about the efficiency of the university performance, attributed to the (job title, qualification, academic rank, experience years, and faculty specialize). Which are supported by the calculated values of (χ^2) for the mentioned variables, with values equals to (3.155, 0.007, 0.568, 6.560, 2.587) respectively, which are less than $\chi^2_{(0.05)}$, as well as all the values of statistical significance (Sig.) (0.368, 0.935, 0.904, 0.078, 0.108), are greater than the significance level ($\alpha = 0.05$). This means that will be **accepted** the null hypothesis (H_0).

6. Conclusions and Recommendations

In this section will be discussion the study results, and includes the most important recommendations of the study in light of the results, as follows:

6.1. Conclusions

The study reached to some conclusions, as follows:

a. The Factor Analysis results appearance, that the mostly factors which effect on improvement the efficiency of the university performance in the Jordanian universities, were (Administrative leadership quality, Quality culture, Improvement and development, and Focus on beneficiaries).

b. The results refers to the (Administrative leadership quality) requirement came in the first rank by loading (0.898), the (Quality culture) requirement came in the second rank by loading (0.842), the (Improvement and development) requirement came in the third rank by loading (0.815), and the latter the (Improvement and development) requirement came in the fourth rank by loading (0.657).

c. The results of the Kruskal -Wallis Test appearance that, there were no a statistically significant differences at the significance level ($\alpha = 0.05$), between the means responses of the teaching staff about the efficiency of the university performance, attributed to the (job title, qualification, academic rank, experience years, and faculty specialize).

6.2. Recommendations and suggestions

Depend on the above results, the study recommended and suggested the following:

a. The study recommended of the Jordanian universities to interest by the requirements (Educational quality, Employees in the university, and Service quality of students and community), in order to improve the university performance in Jordanian universities, and through holding workshops on a regular basis, is of which illustrate the importance of the mentioned requirements.

b. Necessarily to send the teaching staff in Jordanian universities, to training courses inside or outside Jordan, to learn about the experiences of the world about the higher education quality, in order to gain the experience and knowledge, and the development of teaching skills so as to improvement the efficiency of university performance.

c. The study suggest to doing the comparative studies between institutions of higher education, which determining the importance factors on improvement the efficiency of university performance, between other identical institutions didn't use the quality system, to identify differences in outputs, and treat the weaknesses that are believed to hinder the process of the university education quality requirements.

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