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A Proposed Model for Improving Job Performance in the Technical and Vocational Training Corporation in Saudi Arabia: Based on Combining Six Sigma Methods and Structural Equation Modeling

Mohammed Naji Al-Ghamdi
King Abdulaziz University, Faculty of Science, Department of Statistics, Jeddah 21589, Saudi Arabia

Ezz H. Abdelfattah (Corresponding Author)
King Abdulaziz University, Faculty of Science, Department of Statistics, Jeddah 21589, Saudi Arabia
Email: malghamdi1411@stu.kau.edu.sa

Farouq Alam
King Abdulaziz University, Faculty of Science, Department of Statistics, Jeddah 21589, Saudi Arabia

Ahmed Ezz
King Abdulaziz University, Faculty of Science, Department of Statistics, Jeddah 21589, Saudi Arabia

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Abstract

The Six Sigma methodology has become a frequently used term in discussions regarding quality management and it is considered to be an important management philosophy, which supports organizations in their efforts to obtain satisfied customers. In this study, we proposed Six Sigma methodology to improve the Job Performance in the Technical and Vocational Training Corporation (TVTC) in Saudi Arabia. We focus on three dimensions in our study; first: preparations for the application of the Six Sigma methodology in TVTC, second: the application requirements of Six Sigma methodology and third: the application of the Six Sigma methods affects Improve Job performance in TVTC. Since the neural of Six Sigma methodology depends on the mediator statistical analysis, we suggest using the Structural Equation Modeling (SEM) to test the proposed Six Sigma model in TVTC. From SEM results, we find that the Six Sigma preparations have a significant effect on the application requirements and that the application requirements have significant effect on the Job performance in TVTC. Based on that, we recommend using of the Six Sigma methodology in TVTC to improve the performance in these corporations.

Keywords: Confirmatory factor analysis; Convergent validity; Reliability, Saudi Arabia, Six sigma, Structural equation modeling; AMOS.

1. Introduction

When total quality management began to expand, the Six Sigma quality method appeared, which is considered one of the modern methods used in the continuous development and improvement of the quality of services and products, and this method is used to try to reduce and overcome errors (see [1-3]. The Six Sigma methodology is applied in many sectors of industry, business, education and training, which aims to improve the quality of outputs by trying to reduce errors and defects so that they do not exceed 3.4 errors per million production or service processes. The Six Sigma method contains a methodology and a management philosophy based on a main principle that seeks to focus efforts to obtain products and services that approach greatly the highest levels of quality and proficiency at the lowest cost and in record time.

Six Sigma methods rely on the increasing analysis of data and collected statistics to identify defects and defects in procedures or products, to work to address them permanently and try to reduce the percentage of errors to nearly zero whenever possible. The Six Sigma concept is based on basic standards based on defining procedures, measuring their level, analyzing them, developing them, and reaching the highest stages of quality control in procedures and production.

In general, the idea of Six Sigma is that if institutions can measure the number of defects in a process, they can scientifically reduce those defects to the point of approaching the point of eliminating defects.

Many administrative organizations find in the issue of quality, a priority of their priorities and an urgent necessity imposed by the reality of a competitive nature. The Technical and Vocational Training Corporation (TVTC) is one of those institutions. It is considered responsible for preparing and preparing the national workforce to meet the needs of the labor market.

Total quality has become an important strategic process for every institution that seeks to improve its work and optimize the investment of its material and human resources and capabilities and hence, the spread of the culture of total quality has become a major goal of the Technical and Vocational Training Corporation (TVTC) in order to graduate technical and professional staff at a high level of quality and ability to develop and merging into the labor market with high efficiency and great effectiveness, as well as improving the quality of administrative procedures at the college level in light of the directives of the Technical and Vocational Training Corporation (TVTC).

(Tvtc.gov.sa, 2013) stated that: "The Technical and Vocational Training Corporation (TVTC) is keen in all its plans and actions to meet the current and future needs of the labor market in the Kingdom. Therefore, it seeks by all means to establish technical colleges in all parts of the Kingdom, and its primary goal in this endeavor is to achieve its mission by actively contributing to achieving sustainable development in both economic and social terms by providing appropriate technical and vocational training for the sons and daughters of this country with a focus on the two elements of quality and sufficiency for the requirements of the labor market and the relentless pursuit of global leadership Everyone testifies.

2. Research Objectives and Main Hypotheses

This study aims to:

1. Knowing the preparations of the TVTC to Six Sigma method.
2. Knowing the requirements for applying the Six Sigma method in the TVTC: Definition requirements, Measurement requirements, Analysis requirements, Improvement requirements, and Control and monitoring requirements.
3. Evaluating the improvement in TVTC's job performance based on the Six Sigma method.

Figure-1. Summarizes these objectives

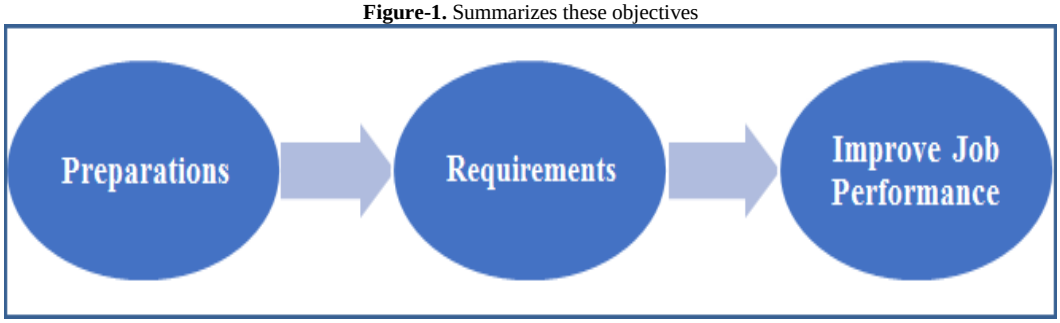


Figure 1: Path diagram of Six-Sigma method

Based on these objectives, we are will test the following hypotheses:

- **The first hypothesis:**

H_1: TVTC preparations for the application of the Six Sigma methods (preparations for support, training preparations, human resources preparations, preparations for organizational culture) affect the college requirements (define requirements, measurement requirements, analysis requirements, improvement requirements, monitoring requirements) to implement the Six Sigma methods.

- **The second hypothesis:**

H_2: The application requirements of Six Sigma methods (identification requirements, measurement requirements, analysis preparations, optimization requirements, control and monitoring requirements) affect Improve Job Performance.

- **The third hypothesis:**

H_3: The application of the Six Sigma methods affects Improve Job Performance.

3. Method and Materials

We suggest using the structural Equation Modeling (SEM) to test these hypotheses. Where the SEM is a type of system equations that is designed to deal with multiple related equations simultaneously; it is used by researchers in various scientific fields. Researchers choose to use SEM because of its comprehensive methods for the quantification and testing of theories [4]. The SEM can test various theoretical models that describe relationship among observed and unobserved variables; these models hypothesize how sets of variables define different constructs, and how these constructs relate to each other [5]. SEM models are usually estimated using cross sectional or panel data with many independent replications, where the estimation process of SEM involves the use of particular fitting function to minimize the difference between population variance-covariance matrix and sample variance covariance in order to estimate a set of all unknown parameters in the model. The quality and validity of the parameter estimates, standard errors, and overall model fit are all depending on the estimation method being used. This should be determined according to the data type, model specification and sample size.

This study is designed to confirm the possibility of applying Six sigma methods to improve job performance in the Technical and Vocational Training Corporation (TVTC), using structural equation modeling. Thus, a comprehensive cross-sectional research perspective is adopted. The target group is all employees of the Technical and Vocational Training Corporation (TVTC).

3.1. Tools

A questionnaire was prepared for this study and it consists of four parts: The first part explains the purpose of the study. The second part included some demographic information about the targets. The third part consists of questions used to measure the study axes and these axes consist of three types of variables: An independent variable which is the focus of preparations for the application of Six Sigma methods, a mediator variable which is the focus of Six Sigma operations requirements, and a dependent variable which is improving job performance. We used the

expressions (strongly agree, agree, neutral, disagree, strongly disagree) for each entry in the questionnaire related to measuring the dimensions of the study, and we used the five-point Likert scale developed by Likert [6] to measure responses using values (5, 4, 3, 2, 1) respectively.

3.2. Data Collection

Employee emails in the Technical and Vocational Training Corporation database were used to reach the target group in this study and a total sample of (356) received.

3.3. Sample Characteristics

Table 1 illustrates sample characteristics for respondents.

Table-1. Sample characteristics

Dimension	Frequency
Gender	14.3 % female. 85.7 % male.
The type of its unit	0.8 % Administration within a training unit. 7 % General Administration. 80.9 % College. 11.2 % Industrial institute.
Level of Education	6.7 % Diploma, 46.3 % Bachelor , 41.3 %M.A. 5.6 % PhD,
education	77.8 % academic 8.1 % Administrative. 14 % Technical
Work inside the unit	12.9 % Administrative work only. 41.3 % Administrative and training work. 45.8 % Training work only
Courses Management	14.9 % no. 85.1 % yes
Quality courses	23 % no 77 % yes

3.4. Data Analysis and Results

This study is designed to evaluation improve job performance in the Technical and Vocational Training Corporation (TVTC) when applying Six Sigma methods. Thus, a cross-sectional quantitative research perspective is adopted. The target population mainly is all employees of the TVTC. The questionnaire is attached in Appendix.

SPSS software V. 27 has been used to analyze the data and get the descriptive statistics, Cronbach's α that used to verify the internal consistency reliability, and correlation coefficients. Moreover, AMOS software V. 23 has been used to conduct the structural equation modeling (SEM). AMOS is designed to estimate and test SEM. The SEM is a statistical model of linear relationships among latent (unobserved) variables and manifest (observed) variables. Its purpose is estimating the coefficients in a set of structural equations. For this research AMOS is used to investigate the causal relationships, where the path coefficients are tested for significance and goodness-of-fit. The overall model fit measures were used to evaluate the fit of the structural model. The goodness-of-fit indices that used for measurement and structural models are: χ^2 test, normed χ^2, Goodness of Fit Index(GFI), Normed Fit Index (NFI), Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA). The standardized estimates were used in reporting the causal relationships between the exogenous and endogenous constructs.

3.5. Measurement Model

Begging, our sample is sufficiently large (356 employees),[1] over the recommended size of 200 cases [7], the scale of observed variables is continuous, and no violations of multivariate normality are found in the survey responses.

The proposed structural model was estimated by SEM, which included a test of the overall model fit and individual tests of the significance of the relationships among the variables. We used the maximum likelihood (ML) method to estimate the model parameters and the overall fit index of the measurement model. The basic assumptions of ML method [8, 9] are met or closely approximated in our study.

[1] This sample after removing observations that have a zero standard deviation and it is not completed.

Table-2. Fit Statistics and Model Selection Criteria for Measurement Model

Measure	CFA Model		Cut-off value
	Full items	Revised	
Normed χ^2	3.339	2.648	Less than 3
Goodness of Fit Index (GFI)	.807	.901	More than .90
Normed Fit Index (NFI)	.859	.903	More than .90
Comparative Fit Index (CFI)	.896	.937	More than .90
Root Mean Square Error of Approximation (RMSEA)	.080	.067	Less than .09
Root mean square residual (RMR)	.054	.050	Less than .09
Akaike information criterion (AIC)	1835.294	1319.621	-------
Bayes information criterion (BIC)	2277.520	1793.154	-------

Confirmatory factor analysis was used to assess the convergent and discriminant validity for the variables. After several trials using modification indices, 32 items were included in our analysis and the other items (less than 0.5) were deleted (Y2 and Y3), see Table 2.

Table-3. Properties of measures (convergent validity and reliability)

Construct	Symbol	Items	Cronbach's α	AVE	CR
Preparations (X)					
Management's support	X1	4	.862	.638	.874
Training	X2	2	.846	.738	.849
Human resources	X3	2	.828	.713	.831
Organizational Culture	X4	2	.848	.737	.849
Operations Requirements (M)					
Define	M1	3	.812	.559	.791
Measure	M2	3	.905	.761	.905
Analyze	M3	4	.883	.637	.874
Improve	M4	3	.909	.766	.908
Monitoring and Control	M5	4	.923	.769	.930
Improve Job Performance (Y)		5	.883	.609	.885

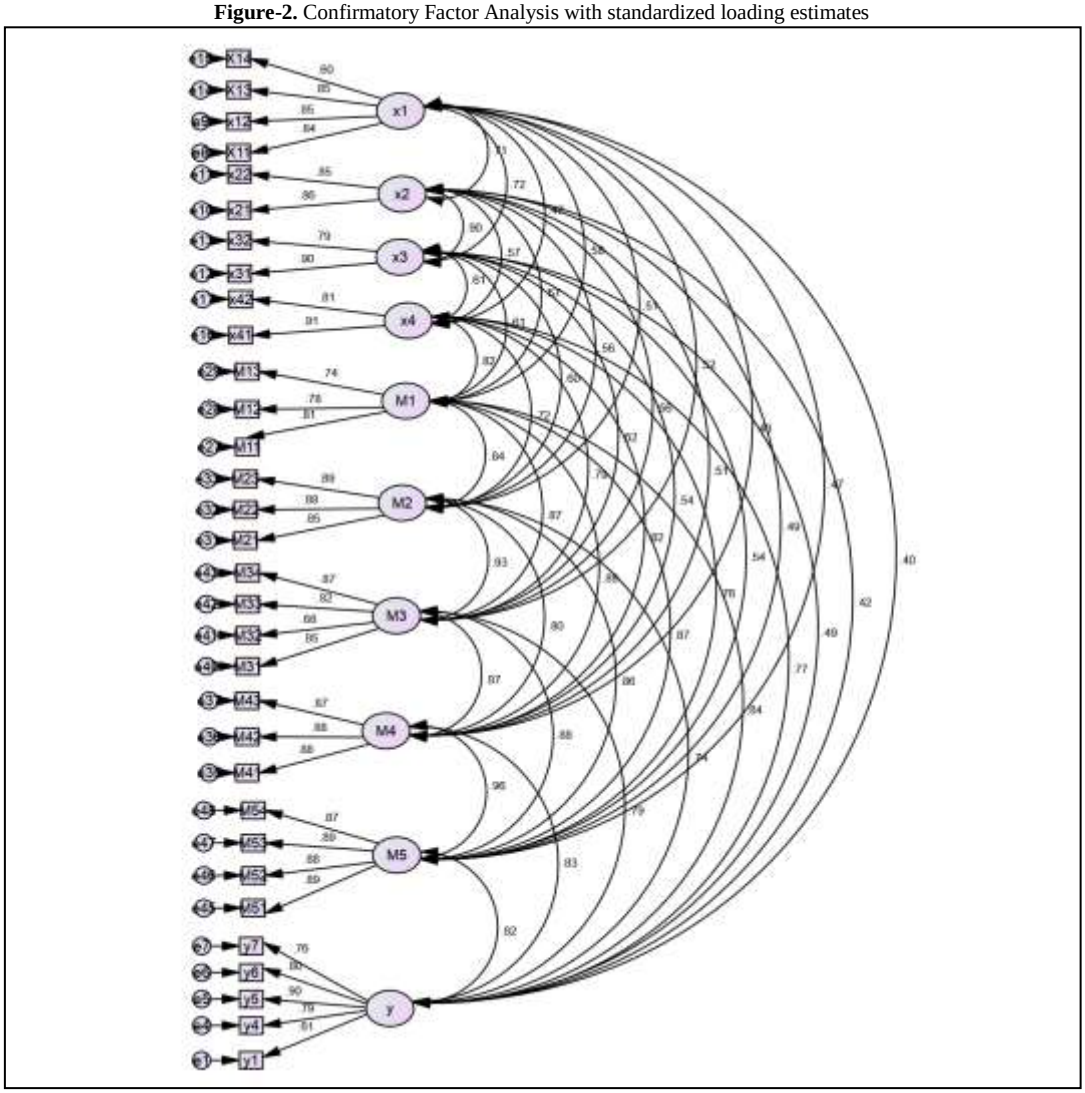
Note: CR, construct reliability; AVE, average variance extracted. **Cronbach's α of all constructs is .**969

Table 3 presents the reliability of the measurement items was verified using Cronbach's α to assess the internal consistency of the constructs in the model. The level of internal consistency for each construct was acceptable which exceeded the minimum hurdle of 0.50 [10]. All included measurement items have standardized loading estimates (see figure 2) higher than 0.5, indicating the convergent validity of the measurement model. Also, construct reliability (CR) was verified to estimate convergent validity; each construct had acceptable construct reliability, because all ten constructs exceeded the minimum criterion of 0.5 (ranging from .791 to .930) [10]. Moreover, because the average variance extracted (AVE) from all ten constructs exceeded the minimum criterion of 0.5 (ranging from .559 to 0.769), convergent validity was assured [10]. The AVE and CR are calculated by:

$$\text{AVE} = \frac{\sum_{i=1}^{n} \lambda_i^2}{n}; \quad CR = \frac{(\sum_{i=1}^{n} \lambda_i)^2}{(\sum_{i=1}^{n} \lambda_i)^2 + \sum_{i=1}^{n}(1 - \lambda_i^2)}$$

where λ_i is standardized loading estimate of item *i*, and *n* is the number of items.

Figure-2. Confirmatory Factor Analysis with standardized loading estimates



For testing the discriminant validity among the constructs, we estimated the correlations among of the constructs, Fornell and Larcker [11] stated that to check the discriminate validity, the level of square root of AVE should be greater than the correlations involving the constructs. In Table 4 the square root of AVE for each construct is shown in the last row along with the correlation coefficients for each construct in the relevant column. For some constructs there are little disputes. However, the difference is too small and can be ignored (see [12]. Overall, discriminant validity can be accepted for this measurement model and supports the discriminant validity between the constructs.

Table-4. Correlation matrix and the discriminant validity

	X1	**X2**	**X3**	**X4**	**M1**	**M2**	**M3**	**M4**	**M5**	**Y**
X1	1									
X2	.697	1								
X3	.706	.943	1							
X4	.461	.596	.617	1						
M1	.669	.633	.671	.850	1					
M2	.504	.546	.582	.726	.887	1				
M3	.509	.559	.608	.797	.907	.938	1			
M4	.428	.511	.539	.825	.906	.813	.891	1		
M5	.469	.500	.548	.768	.913	.867	.892	.962	1	
Y	.395	.436	.487	.765	.878	.727	.831	.791	.815	1
$\sqrt{AVE}$	**.80**	**.86**	**.84**	**.86**	**.75**	**.87**	**.80**	**.88**	**.88**	**.78**

Notes: All correlations are significant at the 0.01 level (two-tailed).

3.6. Structural Model

Figure-3. Standardized regression coefficients of the proposed model

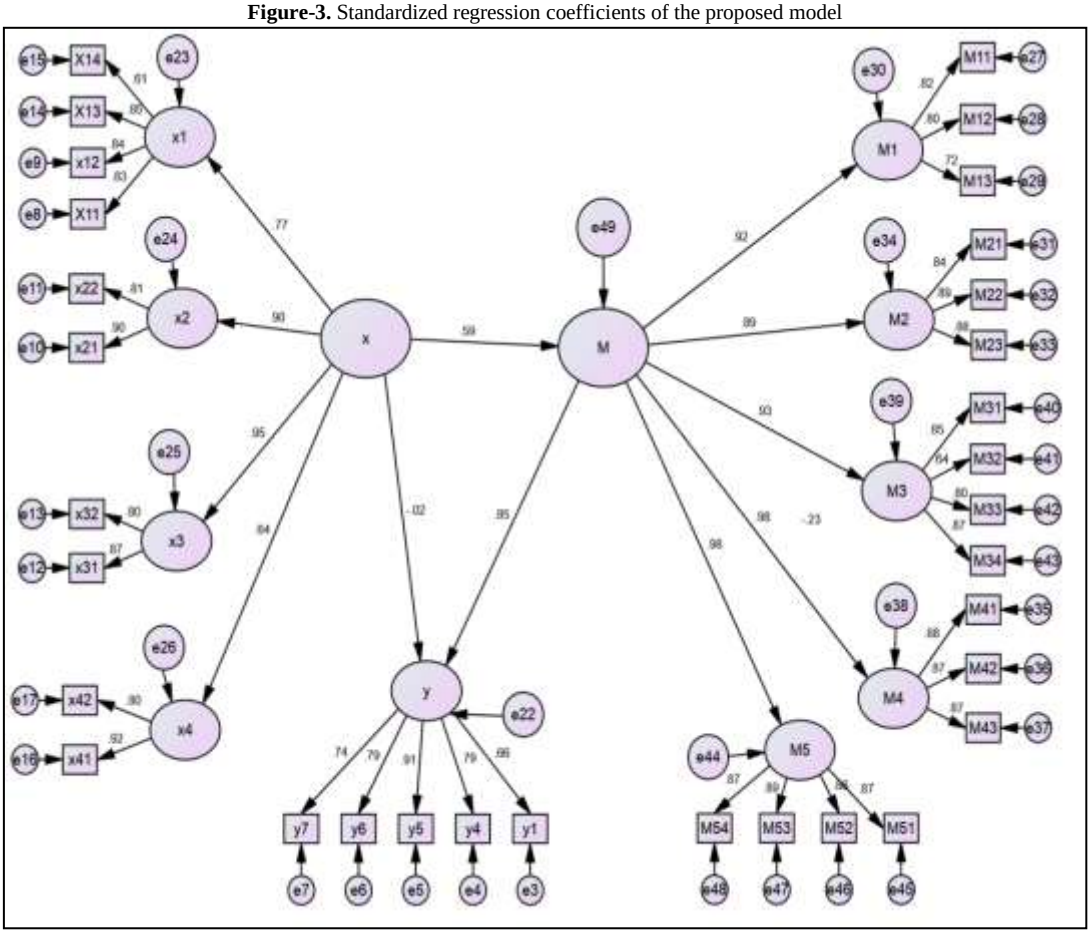


Figure 3 shows the standardized path regression coefficients that indicate the direct influences of the predictor upon the predicted latent constructs for the research model. Table 5 presents the model fit indices of the structural model and the cut-off value of those fit indices. The goodness-of fit statistics show that the structural model fit the data reasonably well and the structural model was a reasonable fit.

Table-5. Model fit statistics

Structural model	Fit statistics	Cut-off value
Normed χ^2	1.609	<3.00
GFI	.902	>0.90
NFI	.941	>0.90
CFI	.977	>0.90
RMSEA	.041	< 0.09
RMR	.036	< 0.09

Table-6. Maximum likelihood estimates for research model

Hypothesis	Independent variable	Dependent variable	Estimate	Standard error	t-statistic	p-value
H1	X	M	.706	.074	9.586	***
H2	M	Y	.616	.051	12.107	***
H3	X	Y	-.014	.033	-.428	.669

Notes: ***significant at the p < 0.001 level (two-tailed).

Table 6 presents the results of the individual tests of the significance (at the significant level of 0.01) of the relationship among the variables. Among the relationships tested, we found that x has significant effect on M and also M has significant effect on Y, but the effect of x on Y directly not significant.

4. Conclusion

In this study, the Six Sigma methodology has been suggested to improve the Job Performance in the Technical and Vocational Training Corporation (TVTC) in Saudi Arabia. The Six Sigma methodology based on three main dimensions: preparations, requirements, and application. It can consider the requirements in this model as a mediator variable, so we suggested use of the SEM to test the proposed Six Sigma methodology in TVTC. Based on our

questionnaire SEM analysis, we find that the Six Sigma methodology in TVTC has a significant effect on the Job performance in TVTC.

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Appendix

The first aspect: Preparations for the application of Six Sigma methods

First: - Management's support and commitment						
	component					
		1	2	3	4	5
1	The Organization management has sufficient funding willingness to implement and support Six Sigma programs.					
2	The Organization management has sufficient human resource readiness to implement and support Six Sigma programs.					
3	The Organization management has the necessary facilities to use Six Sigma.					
4	The Organization management has the preparedness of data and statistical information necessary to analyze results and solve problems.					
Second: Training						
	component					
		1	2	3	4	5
1	The Organization management is ready to provide training requirements on Six Sigma (DMAIC) methodology.					
2	The Organization management is willing to allocate part of its annual budget to consolidate Six Sigma methods.					
Third: - Human resources						
	component					
		1	2	3	4	5
1	The Organization management is prepared to provide appropriate incentives for its employees to use and apply Six Sigma methods.					
2	The Organization management is willing to hire experts and consultants to use Six Sigma.					
Fourth: - Organizational Culture						
	component					
		1	2	3	4	5
1	The Organization management is ready to interact with its employees and work to achieve their needs.					
2	The Organization management is willing to participate in the decision-making of its employees.					

The second aspect: Six Sigma operations requirements

First: - Define						
	component					
1	The Organization management trains its employees on how to perform the work properly to avoid making mistakes.					
2	The Organization management develops workflow plans, assigns tasks and adheres to their timeframe.					
3	The management determines which projects the Six Sigma methods can be applied to.					

Second: Measure						
	component	1	2	3	4	5
1	The Organization management transfers the data and information available to it on the performance into digital data.					
2	The Organization management sets up mechanisms and controls that measure the extent of work conforming to the desired goals.					
3	The management reviews the final results submitted by the work teams.					
Third: Analyze						
	component	1	2	3	4	5
1	The Organization management provides sufficient data covering all activities and operations.					
2	The Organization management determines a coordinator for the work teams called (the shepherd).					
3	The Organization management defines the powers and responsibilities of the members of the work teams.					
4	The Organization management analyzes performance in operations and activities.					
Fourth: Improve						
	component	1	2	3	4	5
1	The Organization management is developing mechanisms to improve the implementation of tasks and activities.					
2	The Organization management is developing a set of innovative solutions to address the detected errors.					
3	The Organization management provides the appropriate environment to improve performance within it.					
Fifth: Monitoring and Control						
	component	1	2	3	4	5
1	The Organization management provides the appropriate mechanisms to evaluate the outputs of each team and compare the results of the work teams.					
2	The Organization management measures the extent to which the final results of the work teams match the desired goals.					
3	The Organization management addresses the errors that occurred during the audit.					
4	The Organization management corrects errors continuously and immediately as soon as they are discovered.					

The third aspect: Improving performance.

	component	1	2	3	4	5
1	There is a familiarity of the employees with the roles assigned to them.					
2	Better performance through teamwork					
3	Job promotions contribute to a greater effort to improve performance					
4	There is coordination between the various administrative levels to complete the work as required					
5	The Organization management finds appropriate solutions to remove the obstacles that hinder the employee from performing his duties					
6	The approved systems in The Organization management help in accomplishing the tasks efficiently					
7	The existence of an ongoing evaluation process that helps to define the work and allocate tasks carefully					