

## Covariance Based-Structural Equation Modeling(CB-SEM) Using AMOS in Management Research

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**Abstract:** The purpose of the study is explored of AMOS based-structural equation modeling(CB-SEM) guidelines step by step into statistical process in social science of graphical analysis to test the theory rather than developed the theory. In the business and academic is necessary to shape and develop to test the framework on the basis of empirical fitness through identifying the measurement theory and structural theory. The entire study has conducted of quantitative method and data process management is used by SPSS then conducted for CB-SEM through guidelines of AMOS software for the statistical process. The results have supported using AMOS for covariance based modeling of empirical data which was showed from beginning to end of the analysis. However, test is also showed more interrelated relation among statistical process tool for any beginner for researcher how to conduct a covariance based-structural equation modeling step by step guidelines. Moreover, it is identified a statistical development of EFA, CFA, and Path SEM explores are maintained of CB-SEM.

**Keywords:** CB-SEM, AMOS, Soft TQM

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### I. Introduction

Structural equation modeling (SEM) is dominantly practiced in management research that generates by theoretically to test rather than developed of the theory particularly in covariance based-structural equation modeling (CB-SEM) [1]. SEM is progressively a technique of select for concept and theory development in the social sciences to particularly in management discipline[2]. However, appropriate technique can be a challenge in management research it is essential to assess the complex of multiple latent constructs into relationship measurement and structural theory [3].

Nevertheless, CB-SEM is measured to illustrate its use in exploratory the association between management system standards and organization performance sustainability. Therefore, it is conducting the relationship among latent constructs how well fit through measured variable to perform the indicators of constructs. Though, CB-SEM analysis can be challenging using AMOS to reach a model fits [3].

**Purpose:** The purpose of the study is to examine of theoretical foundation to the guidelines for the covariance based-SEM modeling streams into practically justified in management perspective.

In management research is increasingly using AMOS particularly focusing on reflective model to identify of survey instruments measured constructs. In structural equation model is traditionally used for the theory testing rather than developed the theory [4]. In CB-SEM is important how predictive of structurally models are maintained of theoretical acceptability in the direction of conceptual modeling test.

### II. Literature Review

In Structural equation modeling (SEM) is progressively a technique of select for concept and theory development in the management[5]. In management research there progressively is an essential to evaluate the complex multiple latent constructs and relationships. However, SEM in particular is well suited to examine complex associations among multiple constructs. There are two most prevalent SEM based logical methods are covariance-based SEM (CB-SEM) and variance-based SEM (PLS-SEM)[2]. However, each technique is advantages and limitations. Though, in this study it is focused on CB-SEM using AMOS to demonstrate a step by step procedure and well suited techniques to use Structural Equation Modeling (SEM) is the statistical analysis technique has developed for analyzing the inter-relationships among multiple variables in a model.

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However, it has based on the multivariate normal data with quantified population parameter and sample sizes of survey data analyzing to use AMOS for CB-SEM[6].

**III. Exploratory Factor Analysis (EFA):**

Exploratory factor analysis (EFA) is described as arranged of overview to interrelate into measuring, which is usually used to explore the possible underlying factor structure of survey a set of observed variables inflexible structure on the consequence [7]. However, EFA is normally considered as a technique for large sample sizes with provides the information about factors of measured variable are how well suited[8]. However, there is an essential phase of exploratory factor analysis (EFA) first to confirm for the factors loading before to go next phase such as confirmatory factor analysis (CFA) and so on. Subsequently, EFA is performed to measure the items interrelation which measured variables has identified in management research instruments accordingly.

Therefore, EFA test has performed and each factor is indicated on demonstrated of loadings  $>.50$  which is provides a data has touched cut-off are well above level weights of understanding by respondents. Although, extraction method has conducted to perform rotated component matrix of principle component analysis (PCA) is calculated and results shows there were no cross loading between measured variable.EFA is required to the value of factor loading should be minimum 0.50 then item become valid and reliable to execute in further observation. However, test has also conducted of KMO and Bartlett’s Test which is given a clear understanding of sampling adequacy reached with significant level. Following table has shown test of KMO and Bartlett’s test performed.

**Table no 1: KMO and Bartlett's Test**

<b>Kaiser-Meyer-Olkin Measure of Sampling Adequacy</b>		.855
<b>Bartlett's Test of Sphericity</b>	Approx. Chi-Square	4212.552
	df	105
	Sig.	.000

**IV. CB-SEM using AMOS**

Covariance based-structural equation modeling (CB-SEM) is identified a very complex models which is indicated gradually performing by both of graphically relationship and numerical results accordingly. Confirmatory Factor Analysis (CFA) was used to certify the basic factors produced by PCA using Comparative Fit Index value (CFI), Tucker Lewis Index (TLI) and RMSEA [9]. Therefore, following phases are developed in the view of past research directions from an extensive literature reviews accordingly. Anyway, in this study is following phases of CFA and Path SEM are explored accordingly.

**Confirmatory Factor Analysis (CFA):**Confirmatory factor analysis (CFA) is a statistical procedure used to confirm the factor structure of a set of observed variables. Although, CFA allows the investigator to test the hypothesis that a association between observed variables and underlying of latent constructs exists[7]. CFA is a measurable data analysis technique that goes to the family of structural equation modeling (SEM) techniques. However, CFA permits for the calculation of fit between observed data and conceptualized model, theoretically grounded model that identifies the hypothesized causal associations between latent factors and observed indicator variables. Moreover, CFA can justified the theory are accepted or rejected through observed data by statistically indication. Though, in past references are given for a more in-depth study of CFA and SEM methods in the social and behavioral sciences[10].

Nevertheless, CFA is a multivariate statistical formula that is used to test how well the measured variables which are represented the number of constructs. However, in the confirmatory factor analysis, it can specify the number of factors essential in the data and which is measured variable is to relate of which latent variable is ainstrument that is to confirm or reject the measurement theory[11].But in confirmatory factor analysis (CFA), researchers can specify the number of factors required in the data and which measured variable is related to which latent variable. Confirmatory factor analysis is an instrument that is used to confirm or reject the measurement theory[12].Therefore, CFAallows us to test how well of the measured variables signify the constructs. The significant advantage is that the researcher can rationally test a conceptually grounded theory clarifying how different measured items signifyvitalsuch as in management research[13].

Subsequently, CFA is measured through graphically and numerically fits to the grounded theory to test whether the model is statistically significant or not. Normally CFA should be justified by empirical data to the relations of the theory is accepted. Following empirical results are given for the goodness of fit indices which are corresponding to good model fit respectively.

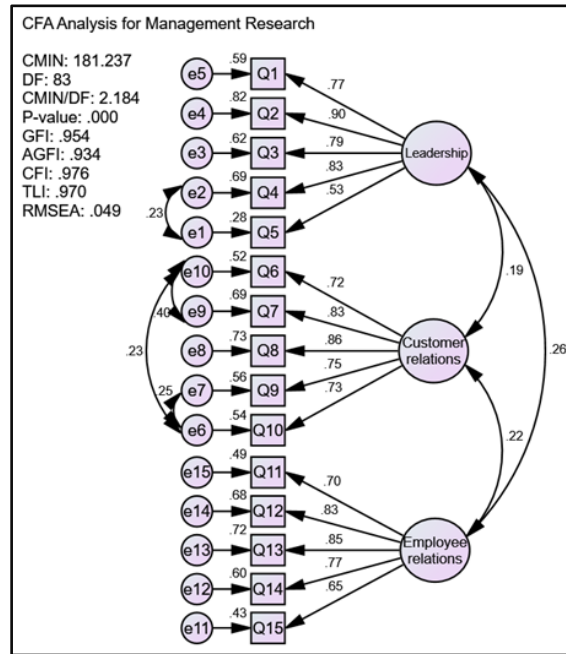


Figure no 1: Measurement Model of CFA Analysis of Soft TQM Dimensions

Above figure has showed relationship among three constructs covariance are supported at the level of their fit indices of GFI, AGFI, CFI, TLI, RMSEA, P-value, and CMIN/DF which are indicated a good model and theoretically supported of empirical data in management instruments[14]. Therefore, following table is also provided regarding numerical data that is supported by estimates of standardized covariance among exogenous variables. However, critical ratio (C.R.) of constructs is more than 1.96 and correlations among constructs are also highly indication which close to 0.20 between two constructs [14].

Table no 2: Estimates of Standard Covariance

	Estimates	S.E.	C.R.	P-value	Label
Leadership <-> Customer relations	0.194	.045	3.743	***	Accepted
Leadership <-> Employee relations	0.257	.048	4.931	***	Accepted
Customer relations <-> Employee relations	0.225	.043	4.250	***	Accepted

Note: \*\*\* means p-value at significant level is <0.001 in AMOS output

**Structural Equation Modeling (SEM):** SEM increasingly is using in management study by dominantly based on structural model where almost completely and often mistakenly applied without having proper guidance on covariance-based SEM or variance-based SEM[1]. Although in this study is identifying why CB-SEM is using in management research. Actually, CB-SEM is measured of variable indicators and correlations among constructs that theoretically has supported and identified of each factor. Therefore, when considering of structural equation modeling (SEM) and selecting between covariance-based (CB-SEM) and variance-based partial least squares (PLS-SEM) can be challenging[15].

However, CB-based SEM analysis is corresponding such as AMOS and PLS-SEM is conducting with Smart-PLS to analysis the data. AMOS has a technique to measure measurement model where Smart-PLS does not have measurement model except only structural model among constructs. Therefore, in management research is more appropriate to conduct with AMOS to measure the measurement model through CFA and it tells to the researchers testing the theory rather than develop the theory.

Covariance-Based SEM (CB-SEM) from social science or in management studies concerning the fitness indices are more suitable to identified of good model such as CFI, GFI, AGFI, TLI, RMSEA, and P-value with CMIN/DF, sample size requirement if over 400 then factor loadings with indices can be good for identifying of model fits, and normality assumption accordingly [16].

Subsequently, example of has been conducted through human dimension of (soft) TQM constructs following figure and table provided interrelation and output results have showed of path structural model with standardized regression output respectively.

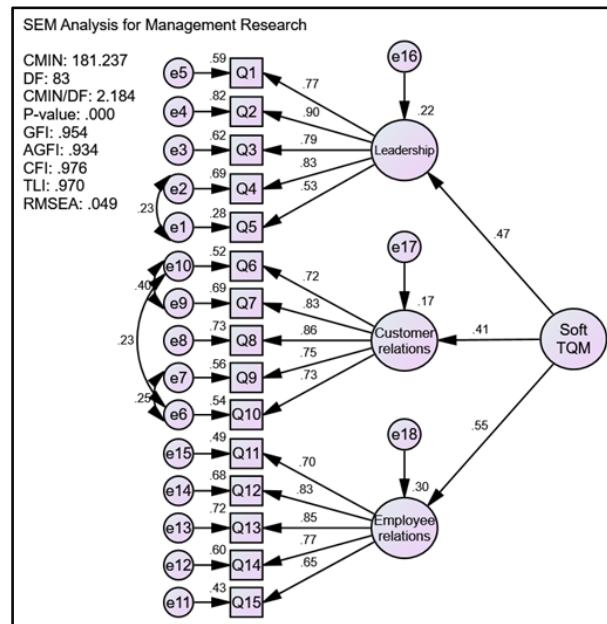


Figure no 2: Structural Model Identified of Soft TQM Dimensions

Therefore, above figure has showed relationship with leadership, customer relations, and employee relations of soft TQM constructs covariance are supported at the level of their fit indices of GFI, AGFI, CFI, TLI, RMSEA, P-value, and CMIN/DF which are indicated a good structural model of empirical data in management by measured variables of each human (soft) dimension [14]. Nevertheless, following table has also provided regarding numerical data that is supported by estimates of standardized regression weights among soft dimension of TQM constructs. However, critical ratio (C.R.) of constructs is more than 1.96 and indicators of soft dimensions are very highly indicationis closed to 0.40 from constructs to dimension which is accumulated by measured variables[14].

Table no 3: Estimates of Standardized Regression

	Estimates (β)	S.E.	C.R. (t-value)	P-value	Label
Leadership <--- Soft TQM	0.471	0.283	3.271	.001	Accepted
Employee relations <--- Soft TQM	0.546	Regression weights 1.000			Accepted
Customer relations <--- Soft TQM	0.411	0.221	3.379	***	Accepted
Q5 <--- Leadership	0.527	0.047	12.205	***	Accepted
Q4 <--- Leadership	0.833	0.038	23.862	***	Accepted
Q3 <--- Leadership	0.789	0.039	21.892	***	Accepted
Q2 <--- Leadership	0.904	Regression weights 1.000			Accepted
Q1 <--- Leadership	0.768	0.039	20.939	***	Accepted
Q10 <--- Customer relations	0.734	0.048	16.992	***	Accepted
Q9 <--- Customer relations	0.748	0.049	17.425	***	Accepted
Q8 <--- Customer relations	0.857	0.048	20.145	***	Accepted
Q7 <--- Customer relations	0.830	Regression weights 1.000			Accepted
Q6 <--- Customer relations	0.722	0.039	21.557	***	Accepted
Q15 <--- Employee relations	0.655	0.050	15.523	***	Accepted
Q14 <--- Employee relations	0.772	0.048	19.302	***	Accepted
Q13 <--- Employee relations	0.850	Regression weights 1.000			Accepted
Q12 <--- Employee relations	0.826	0.046	21.084	***	Accepted
Q11 <--- Employee relations	0.698	0.048	16.862	***	Accepted

Note: \*\*\* means p-value at significant level is <0.001 in AMOS output

However, path coefficient (β) estimates are justified of this study and found acceptable range among all latent constructs causality of reflective structural model. Anyway, the whole causality of dimension indicators that is more than cut-off value of t-statistics (C.R.) are >1.96 with p-value found statistically significant through AMOS (\*\*\*). Moreover, path coefficient relation accepted when path coefficient should be ≥1.96 of t-statistics with p-value is <0.05 then structural equation become statistically significant [14]. There is another path determination of coefficient goodness fits summary has indicated of R2 statistics above 0.20 except 1 dimension, therefore, it is highly and moderate has considered that generated with each measured variables [5].

## V. Discussion

In AMOS for the CB-SEM has more powerful to test the theory such as model fit through incremental fit and absolute fit indices having with their standardized regression estimates respectively. In the modern era using AMOS is much more popular to measure and identify of the management constructs rather than other tools. AMOS is provided more complex results from bottom line of the empirical data that is tested of grounded theory. Therefore, it has made sure particularly in management for the researchers can understand of theory and existing issues which can tells to the right path on the direction which is looking for from the ground theory.

Nevertheless, the test result is comparing of fit indices and indicated more accurate by goodness of fit for the model which is helped to generate at beginning of structural model from theory. AMOS is providing very complex outputs both of graphically and numerically. Therefore, the outputs have demonstrated of different fit indices (P-value, CMIN/DF, GFI, AGFI, CFI, TLI, and RMSEA) which are explained of model fit summary respectively.

**P-value:** according to AMOS output P is the probability of getting as large a discrepancy as occurred with the present sample. Therefore, P is a "p value" for testing the hypothesis of the model fits perfectly in the population. One approach to model selection employs statistical hypothesis testing to eliminate from consideration those models that are inconsistent with the available data. However, its unsuitability as a device for model selection was pointed out early in the development of analysis of moment structures [17].

**CMIN/DF:** Chi-square/degree of freedom these several expert have suggested the use of this ratio as a measure of fit between 2 to 5 cut-off range is become good fit of the model. Therefore, in this study AMOS result is 2.184 regarding  $\chi^2/df$  and rules of thumb respectively.

Compute a relative chi-square/degree of freedom ( $\chi^2/df$ ) suggest a ratio of approximately 5 or less to be reasonable [18]. However, degrees of freedom ratios in the range of 2 to 1 or 3 to 1 are indicative of an acceptable fit between the hypothetical model and the sample data. Although, it has flexible by different past researcher had recommended using ratios as low as 2 or as high as 5 to indicate a reasonable fit [19]. However,  $\chi^2/df$  ratio should not be  $> 2.00$  which will to be represented an inadequate fit. Therefore, the result is supported by different researchers which are accepted ratio range between 2 to 5.

**GFI:** GFI is stand for Goodness of Fit Index that is provided perfect fit and estimation is conducted in AMOS analysis of the study with maximum like-hood method. However, a value of GFI is 1 or less than then a value indicate perfect fit [5]. The AMOS output result of GFI is 0.954 which is close to 1 and  $>0.95$  that is indicated a value is provided perfect fit of the model.

**AGFI:** It Average Goodness of Fit Index which is generated of average model fit and this estimation is also conducted in AMOS analysis of the study with maximum like-hood method. The AGFI takes into account the degrees of freedom available for testing the model and acceptable cut-off point is above 0.80 then a value indicated perfect fit of model as well [5]. However, in the result executed by AMOS output is 0.934 which showing a highly indication value to be perfect fit.

**CFI:** Comparative Fit Index (CFI) is truncated to fall in the range from 0 to 1 but CFI values close to 1 indicate a very good fit where a very good fit identified is  $>0.95$  then model become perfect fit [5]. However, in this study CFI value has generated through AMOS which is 0.976 and greater than cut-off point near to 1. Therefore, the value is showed a highly indication to be perfect fit on the model fit test within acceptable range.

**TLI:** Tucker-Lewis Index is path coefficient in the context of analysis of moment structures. The typical range is for TLI lies between zero and one, but it is not limited to that range. TLI values close to 1 indicate a very good fit as  $>0.95$  is identifying a model becoming highly perfect fit on the model [5]. Therefore, TLI value is 0.970 which is indicated a very good fit and this value is accepted of AMOS analysis.

**RMSEA:** Root Mean Square Error of Approximation (RMSEA) is taking the square root of the resulting ratio gives the population [20]. Practical experience has made us feel that a value of the RMSEA of about .05 or less would indicate a close fit of the model in relation to the degrees of freedom. Although, the figure is based on subjective judgment and it cannot be regarded as dependable or correct, but it is more reasonable than the requirement of exact fit with the RMSEA [20]. Anyway, it is also of the opinion that a value of about 0.08 or less for the RMSEA would indicate a reasonable error of approximation and would not want to employ a model with a RMSEA greater than 0.1 [5]. The result of AMOS is given of the study is 0.049 which is  $<0.05$  that indicated a value to be perfect fit and accepted range between less than from 0.05 to 0.08.

In the numerical data is provided through AMOS analysis of estimates standards covariance tells us the relationships between constructs have maintained highly correlations and supported the theory. On the other hand, estimates of standardized regression weights in path coefficient ( $\beta$ ) have provided acceptable cut-off point with t-statistics values through statistically significant.

## VI. Conclusion

The purpose of the study is to examine of theoretical foundation to the guidelines for the CB-SEM into practically justified in management perspective through AMOS. A capability is set of understanding, tools and a technique into process management which is to perform in management research through AMOS has suited and efficiently. The soft TQM dimension has identified which was supported by theory to meet the need of management decision and business development. Although, past researcher had identified on mixed dimension to measure rather than soft dimension only to examine the theoretical foundation to the guidelines of CB-SEM using AMOS.

There are two vital of SEM analysis for model identification and model equivalence, both of them has supported during the study. A fundamental of CB-SEM is to multiple regression and factor analysis models which are cover sample size desires. Therefore, the study is demonstrated has to offer CB-SEM on the area of management research to be more accurate to test the theory rather than develop the theory.

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