Chapter 6: Data Analysis: Model Fit Analysis and Hypotheses Testing

6.1. Introduction
Data analysis is divided into two chapters. This chapter is divided into two parts. In the first part (Study 1: Model Fit Analysis), the proposed research model will be tested and modified by considering the goodness of fit of the model to the data. Consequently, a specific model of Teacher’s Engagement that best fits the data will be generated.

In the second part (Study 2: Hypotheses Testing), the hypotheses mentioned in chapter 1 will be tested by considering the standardized regression weights estimates of the various paths of the final revised model. This study will examine whether the mediator significantly mediates the relationship between independent variables and dependent variable.

Data analysis of the moderating hypotheses testing has been discussed in the next chapter, Chapter 7: Data Analysis: Moderating Hypotheses Testing.

The causal relationships between the independent variables and the dependent variable could be best analysed by using Structural Equation Modelling (SEM) (Hair, Black, Babin, Anderson & Tatham 2006; Schumacker & Lomax 1996). Hence for this study, Structural Equation Modelling (SEM) has been used to analyse the data and it is used to generate the models using AMOS version 21. AMOS is used to specify, estimate, assess, and present the model in an intuitive path diagram to show hypothesized relationships among variables (Arbuckle 2005).

6.2. Unstandardized and Standardized Estimates
In path analysis, both unstandardized and standardized estimates of the model fit will be presented. Arbuckle (1999, 2005) has stated that AMOS’s default method of computing parameter estimates is called maximum likelihood, and it produces estimates with very desirable properties. In an unstandardized model, the regression weights, covariance, intercepts (only when mean structures are analyzed) and variances will be displayed in the path diagram. Regression weights represent the influence of one or more variables on another variable (Byrne 2006). In contrast, in a standardized model, the standardized regression weights (i.e. provided mean = 0, variance = 1.0 (Hayduk 1987)), correlation, squared multiple correlations will be displayed. The standardized
regression weights and the correlations are independent of the units in which all variables are measured, and will not be affected by the choice of identification constraints (Arbuckle 2005).

6.3. Measures of Fit

It becomes essential to understand how to evaluate the model, before analysing it. Model evaluation is one of the most unsettled and difficult issues connected with structural modeling. Bollen and Long (1993), MacCallum (1990), Mulaik, et al. (1989), and Steiger (1990) have present a variety of viewpoints and recommendations on structural equation modeling (SEM). Dozens of statistics, besides the value of the discrepancy function at its minimum, have been proposed as measures of the merit of a model.

Fit measures are reported for each model specified by the user and for two additional models called the saturated model and the independence model.

In the saturated model, no constraints are placed on the population moments. The saturated model is the most general model possible. It is a vacuous model in the sense that it is guaranteed to fit any set of data perfectly. Any Amos model is a constrained version of the saturated model.

The independence model goes to the opposite extreme. In the independence model, the observed variables are assumed to be uncorrelated with each other. When means are being estimated or constrained, the means of all observed variables are fixed at 0. The independence model is so severely and implausibly constrained that you would expect it to provide a poor fit to any interesting set of data.

There are various groups of measures of fit such as measures of parsimony, minimum sample discrepancy function, measures based on the population discrepancy, comparison to a baseline model, and a goodness of fit index (GFI). Each type of measure of fit has its specific capability in model evaluation.

(1) Measures of Parsimony

Models with relatively few parameters (and relatively many degrees of freedom) are sometimes said to be high in parsimony, or simplicity. Models with many parameters (and few degrees of freedom) are said to be complex, or lacking in parsimony. When it comes to parameters all other things being equal, less is more. At the same time, well-fitting models are preferable to poorly fitting ones. Many fit measures represent an attempt to balance these two conflicting
objectives—simplicity and goodness of fit.

**NPAR**

**NPAR** is the number of distinct parameters \( (q) \) being estimated. For example, two regression weights those are required to be equal to each other count as one parameter, not two.

**Degree of Freedom (DF)**

**DF** is the number of degrees of freedom for testing the model

\[
df = d = p - q
\]

where, \( p \) is the number of sample moments and \( q \) is the number of distinct parameters.

**PRATIO**

The parsimony ratio (James, Mulaik, and Brett, 1982; Mulaik, et al., 1989) expresses the number of constraints in the model being evaluated as a fraction of the number of constraints in the independence model

\[
PRATIO = \frac{d}{d_i}
\]

where \( d \) is the degrees of freedom of the model being evaluated and is the degrees of freedom of the independence model.

(2) **Minimum Sample Discrepancy Function**

The following fit measures are based on the minimum value of the discrepancy.

**CMIN**

**CMIN** (chi-square statistics \( (\chi^2) \)) is the minimum value of the discrepancy.

In the case of maximum likelihood estimation, **CMIN** contains the chi-square statistic. The chi-square statistic is an overall measure of how many of the implied moments and sample moments differ. The more the implied and sample moments differ, the bigger the chi-square statistic, and the stronger the evidence against the null hypothesis.

**P**

**P** is the probability of getting as large a discrepancy as occurred with the present sample (under appropriate distributional assumptions and assuming a correctly specified model). That is, **P** is a “\( p \) value” for testing the hypothesis that 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.

**CMIN/DF**

CMIN/DF ($\chi^2 / df$) is the minimum discrepancy divided by its degrees of freedom; the ratio should be close to 1 for correct models. Wheaton et al. (1977) suggest a ratio of approximately five or less ‘as beginning to be reasonable.’ But according to Arbuckle (2005), it is not clear how far from 1 should we let the ratio get before concluding that a model is unsatisfactory. Since the chi-square statistic ($\chi^2$) is sensitive to sample size it is necessary to look at others that also support goodness of fit. $\chi^2$ to 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 (Carmines and McIver, 1981, p. 80). Different researchers have recommended using ratios as low as 2 or as high as 5 to indicate a reasonable fit (Marsh and Hocevar, 1985). In contrast, Byrne (2006) suggested that ratio should not exceed 3 before it cannot be accepted. Since the chi-square statistic ($\chi^2$) is sensitive to sample size it is necessary to look at others that also support goodness of fit.

(3) **Measures Based On the Population Discrepancy**

Steiger and Lind (1980) introduced the use of the population discrepancy function as a measure of model adequacy. The population discrepancy function is the value of the discrepancy function obtained by fitting a model to the population moments rather than to sample moments. The most commonly used is RMSEA which is the population root mean square error of approximation.

**RMSEA**

According to Arbuckle (2005), the RMSEA value of about 0.05 or less would indicate a close fit of the model in relation to the degrees of freedom. This figure is based on subjective judgment. It cannot be regarded as infallible or correct, but it is more reasonable than the requirement of exact fit with the RMSEA = 0.0. The 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(Browne and Cudeck, 1993).
(4) **Comparison to Baseline Model**

Bentler and Bonett (1980) and Tucker and Lewis (1973) suggested fitting the independence model or some other very badly fitting baseline model as an exercise to see how large the discrepancy function becomes. The object of the exercise is to put the fit of your own model(s) into some perspective.

**NFI**

The Bentler-Bonett (1980) **Normed Fit Index (NFI)** or \( \Delta_1 \) in the notation of Bollen (1989b) can be written as

\[
NFI = \Delta_1 = 1 - \frac{\hat{C}}{\hat{C}_b} = 1 - \frac{\hat{F}}{\hat{F}_b}
\]

where \( \hat{C} = n\hat{F} \) is the minimum discrepancy of the model being evaluated and \( \hat{C}_b = n\hat{F}_b \) is the minimum discrepancy of the baseline model.

NFI indicates that model being evaluated has a discrepancy that is way between the (terribly fitting) independence model and the (perfectly fitting) saturated model.

According to Arbuckle (2005), models with overall fit indices of less than 0.9 can usually be improved substantially.

**TLI**

The Tucker-Lewis coefficient was discussed by Bentler and Bonett (1980) in the context of analysis of moment structures and is also known as the Bentler-Bonett non-normed fit index (NNFI).

The typical range for TLI lies between 0 and 1, but it is not limited to that range. TLI values close to 1 indicate a very good fit.

**CFI**

The Comparative Fit Index (CFI; Bentler, 1990) is given by

\[
CFI = 1 - \frac{\max(\hat{C} - d, 0)}{\max(\hat{C}_b - d_b, 0)} = 1 - \frac{\text{NCP}}{\text{NCP}_b}
\]

where \( \hat{C} \), \( d \) and \( \text{NCP} \) are the discrepancy, the degrees of freedom, and the non-centrality parameter estimate for the model being evaluated, and \( \hat{C}_b \), \( d_b \) and \( \text{NCP}_b \) are the discrepancy, the degrees of freedom, and the non-centrality parameter estimate for the baseline model. CFI values
close to 1 indicate a very good fit.

(5) GFI and Related Measures

GFI

The GFI (goodness-of-fit index) was devised by Jöreskog and Sörbom (1984) for ML (Maximum Likelihood) and ULS (Un-weighted Least Squares) estimation, and generalized to other estimation criteria by Tanaka and Huba (1985). GFI is always less than or equal to 1. GFI = 1 indicates a perfect fit.

AGFI

The AGFI (adjusted goodness-of-fit index) takes into account the degrees of freedom available for testing the model.

The AGFI is bounded above by 1, which indicates a perfect fit. It is not, however, bounded below by 0, as GFI is.

Among the many measures of fit, five popular measures are: Chi-square ($\chi^2$), normed chi-square ($\chi^2 /df$), goodness of fit index (GFI), Tucker-Lewis Index (TLI), Root Mean-Square Error of Approximation (RMSEA) (Holmes-Smith 2000).

However, all fit measures in Table 6.1 are used to evaluate goodness of fit of the models in this research.

Table 6.1

Measures of Fit

<table>
<thead>
<tr>
<th>Measures of Fit</th>
<th>Indications of Model Fit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normed Chi-square CMIN/DF ($\chi^2 /df$)</td>
<td>A value close to 1 and not exceeding 3 indicates a good fit.</td>
</tr>
<tr>
<td></td>
<td>A value less than 1 indicates an over-fit of the model.</td>
</tr>
<tr>
<td>CFI</td>
<td>The CFI value is between 0 and 1. A value close to 1 indicates a very good fit.</td>
</tr>
<tr>
<td>TLI</td>
<td>The TLI value lies between 0 and 1, but is not limited to this range. A value close to 1 indicates a very good fit.</td>
</tr>
<tr>
<td>NFI</td>
<td>The NFI value lies between 0 and 1. A value close to 1 indicates a very good fit.</td>
</tr>
</tbody>
</table>
The GFI value is always less than or equal to 1. A value close to 1 indicates a perfect fit.

The AGFI value is bounded above by 1 and is not bounded by 0. A value close to 1 indicates a perfect fit.

A value about 0.05 or less indicates a close fit of the model. A value of 0.0 indicates the exact fit of the model. A value of about 0.08 or less indicates a reasonable error of Approximation. A value should not be greater than 0.1.

6.4. Squared Multiple Correlations (SMC)

Though, how well the model fits the data is indicated by the fit measures, the strength of the structural paths in the model is determined by the squared multiple correlations (SMC). According to Hayduk (1987) SMC is the proportion of its variance that is accounted for by its predictors. Simple regression uses a single predictor of the dependent variable, whereas multiple regressions use two or more predictors. Therefore, it is important for this research to consider the SMC of each dependent variable together with fit measures in order to best describe the structural model (Arbuckle 2005).

Interpretation of SMC is analogous to the $R^2$ statistic in multiple regression analysis (Sharma 1996). SMC is a useful statistic that is also independent of all units of measurement (Arbuckle 2005).
6.5 The Proposed Research Model: Teacher’s Engagement Model

Figure 6.1: Proposed Research Model: Teacher’s Engagement Model
6.6. Study 1: Model Fit Analysis

The unstandardized estimates model demonstrates regression weights, covariance and variances. The standardized estimates model demonstrates standardized regression weights, correlations, and square multiple correlations.

The initial model before modification is presented in Figure 6.2 with unstandardized estimates and Figure 6.3 with standardized estimates.

6.6.1. Initial Teacher’s Engagement Model (Model 1)

![Initial Teachers Employee Engagement Model (Model 1) Unstandardized Estimates](image)

Figure 6.2: Initial Teacher’s Engagement Model (Model 1) with Unstandardized Estimates
Figure 6.3: Initial Teacher’s Engagement Model (Model 1) with Standardized Estimates

The potential co-variances with higher Modification Indices were joined with double arrows. Thus, a modified model (Model 2) was obtained. The modified model after modification is presented in Figure 6.4 with unstandardized estimates and Figure 6.5 with standardized estimates.
6.6.2. Modified Teacher’s Engagement Model (Model 2)

Figure 6.4 : Modified Teacher’s Engagement Model (Model 2) with Unstandardized Estimates
Figure 6.5 : Modified Teacher’s Engagement Model (Model 2) with Standardized Estimates

It was found that there is no sample correlations exceeding 0.8. However, Standardized Residual Co-variances were higher (greater than 2 in absolute value) for items T_EE4 and T_PSS2 (see Standardized Residual Co-variances in Appendix IV), hence were removed from the model and the modified model, which is called the Revised Teacher’s Engagement Model (Model 3) was obtained. The revised model after further modification is presented in Figure 6.6 with unstandardized estimates and Figure 6.7 with standardized estimates.
6.6.3. Revised Teacher’s Engagement Model (Model 3)

Revised Teacher’s Engagement Model (Model 3) with Unstandardized Estimates

Figure 6.6: Revised Teacher’s Engagement Model (Model 3) with Unstandardized Estimates
Revised Teachers Employee Engagement Model (Model 3) Standardized Estimates

Figure 6.7: Revised Teacher’s Engagement Model (Model 3) with Standardized Estimates
6.7. Model Fit Analysis Summary

Table 6.2
Model Fit Analysis Summary

<table>
<thead>
<tr>
<th>Model</th>
<th>$\chi^2$</th>
<th>Df</th>
<th>CMIN/df</th>
<th>NFI</th>
<th>TLI</th>
<th>CFI</th>
<th>GFI</th>
<th>RMSEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Model (Model 1)</td>
<td>541.940</td>
<td>198</td>
<td>2.737</td>
<td>0.918</td>
<td>0.937</td>
<td>0.946</td>
<td>0.930</td>
<td>0.050</td>
</tr>
<tr>
<td>Modified Model (Model 2)</td>
<td>407.524</td>
<td>193</td>
<td>2.112</td>
<td>0.938</td>
<td>0.960</td>
<td>0.966</td>
<td>0.948</td>
<td>0.040</td>
</tr>
<tr>
<td>Final Revised Model (Model 3)</td>
<td>281.263</td>
<td>151</td>
<td>1.863</td>
<td>0.948</td>
<td>0.969</td>
<td>0.975</td>
<td>0.961</td>
<td>0.035</td>
</tr>
</tbody>
</table>

The final revised model in Figure 6.6 (with unstandardized estimates) and in Figure 6.7 (with standardized estimates), yields a $\chi^2$ (chi-square) of 281.263, degree of freedom = 151 and p value = 0.000 indicating that the model fits the data very well. However, because the chi-square statistic is very sensitive to the sample size it is more appropriate to look at other fit measures. Fortunately, other fit measures also indicate the goodness of fit of the model to the data (CMIN/df = 1.863, NFI = 0.948, TLI = 0.969, CFI = 0.975, GFI = 0.961 and RMSEA = 0.035).

The independent variables account for the variance of the dependent variables. Teachers Organizational Commitment and Teachers Perceived Organizational Support account for 74 % of the variance of Teachers Job Contribution. Whereas, Teachers Job Contribution, Teachers Rewards and Recognition and Teachers Perceived Supervisor Support account for 60 % of the variance of Teacher’s Engagement (see Table 6.3).
Table 6.3
Squared Multiple Correlations for the Teacher’s Engagement Model

<table>
<thead>
<tr>
<th></th>
<th>Estimate SMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers Job Contribution</td>
<td>0.74</td>
</tr>
<tr>
<td>Teacher’s Engagement</td>
<td>0.60</td>
</tr>
</tbody>
</table>

6.8. Study 2: Hypothesis Testing

We proposed the hypothesized model as follows:

![Diagram of Teacher's Engagement Model]

Figure 6.8: Hypothesized Teacher’s Engagement Model
6.8.1. Direct Path Hypothesis

**Hypothesis 1a**: Teachers Organizational Commitment is positively associated with their Job Contribution.

**Hypothesis 1b**: Teachers Perceived Organizational Support is positively associated with their Job Contribution.

**Hypothesis 2**: Teachers Job Contribution is positively associated with Teacher’s Engagement.

**Hypothesis 3**: Teachers Rewards and Recognition received by University Teachers is positively associated with Teacher’s Engagement.

**Hypothesis 4**: Teachers Perceived Supervisor Support is positively associated with Teacher’s Engagement.

AMOS version 21.0 was used to assess the degree to which Teachers Organizational Commitment and Teachers Perceived Organizational Support were related to Teachers Job Contribution. Further, the degree to which Teachers Job Contribution, Teachers Rewards and Recognition and Teachers Perceived Supervisor Support were related to Teacher’s Engagement was also assessed using AMOS version 21.

The standardized regression weights are used since they allow the researcher to compare directly the relative effect of each independent variable on the dependent variable (Hair, Black, Babin, Anderson and Tatham 2006).

The Table 6.4 presents the standardized regression estimates and allowed us to examine the direct association between the study constructs. We note that the level of significance is based on the critical ratio (CR) of the regression estimate (Biswas, Giri & Srivastava, 2006; Byrne, 2001). Thus, when CR values are greater than or equal to 2.58, it indicates a 99 percent level of significance.
## Regression Estimates

### Table 6.4

**Standardized Regression Estimates of the Teacher’s Engagement Model**

<table>
<thead>
<tr>
<th>Teacher’s Engagement Model</th>
<th>Standardized Estimate</th>
<th>S.E.</th>
<th>C.R.</th>
<th>P</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers Organizational Commitment → Teachers Job Contribution</td>
<td>0.501</td>
<td>0.056</td>
<td>7.468</td>
<td>***</td>
<td>H1a accepted</td>
</tr>
<tr>
<td>Teachers Perceived Organizational Support → Teachers Job Contribution</td>
<td>0.469</td>
<td>0.076</td>
<td>7.259</td>
<td>***</td>
<td>H1b accepted</td>
</tr>
<tr>
<td>Teachers Job Contribution → Teacher’s Engagement</td>
<td>0.258</td>
<td>0.037</td>
<td>5.733</td>
<td>***</td>
<td>H2 accepted</td>
</tr>
<tr>
<td>Teachers Rewards and Recognition → Teacher’s Engagement</td>
<td>0.125</td>
<td>0.022</td>
<td>3.119</td>
<td>***</td>
<td>H3 accepted</td>
</tr>
<tr>
<td>Teachers Perceived Supervisor Support → Teacher’s Engagement</td>
<td>0.578</td>
<td>0.032</td>
<td>10.70</td>
<td>***</td>
<td>H4 accepted</td>
</tr>
</tbody>
</table>

**Note:** \( N = 689; \) The C.R (Critical Ratio) is the commonly recommended basis for testing statistical significance of SEM components with C.R. values beyond \( \pm 2.58 \) establishing significance at \( p < 0.01 \) level.

Accordingly, we report that Teachers Job Contribution regresses significantly and positively on Teachers Organizational Commitment (standardized estimates = 0.501, C.R. = 7.468) and Teachers Perceived Organizational Support (standardized estimates = 0.469, C.R. = 7.259). Thus, **Hypothesis 1a and Hypothesis 1b were accepted.**

Further, Teachers Job Contribution was significantly and positively associated with Teacher’s Engagement (standardized estimates = 0.258, CR = 5.733), thus **Hypothesis 2 was accepted.**
Moreover, Teachers Rewards and Recognition (standardized estimates = 0.125, CR = 3.119) and Teachers Perceived Supervisor Support (standardized estimates = 0.578, CR = 10.700). Consequently, **Hypothesis 3 and Hypothesis 4 were accepted.**

Figure 6.9 : Final Teacher’s Engagement Model with Standardized Regression Estimates and Significance Level.