A Structural Equation Modeling of Factors Affecting Student Motivation in Thesis Preparation

By Eri Setiawan

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E Setiawan[1], A Pratiwi[2], N Herawati[1], K Nisa[1], A Faisol[1]

[1]Department of Mathematics, Faculty of Mathematics and Natural Sciences, University of Lampung, Jl. Sumantri Brojonegoro no 1, Bandar Lampung, Indonesia
[2]Undergraduate School of Mathematics, Faculty of Mathematics and Natural Sciences, University of Lampung, Jl. Sumantri Brojonegoro no 1, Bandar Lampung, Indonesia

email: erstatis@gmail.com[1], amalia.pratiwi1005@students.unila.ac.id[2], netti.herawati@fmipa.unila.ac.id[1], khoirin.nisa@fmipa.unila.ac.id[1], ahmadfaisol@fmipa.unila[1]

Abstract. Structural equation modelling is a multivariate statistical analysis technique that is used to analyse structural relationships. This technique is the combination of factor analysis and multiple regression analysis, and it is used to analyse the structural relationship between measured variables and latent constructs. The purpose of this study is to use structural equation modelling to better understand student motivation in thesis preparation and its causal determinants. The study creates a plausible structural equation model (SEM) and tests it. The data used were students' responses of a questionnaire survey about the student motivation in thesis preparation. Based on the results of the study, it was found that the relationship between lecturer and student and the environmental conditions have significant influence to student motivation in thesis preparation.

Keyword: multivariate analysis, structural equation modelling, thesis preparation

1. Introduction

Relation between student's motivation and academic achievement has been studied by many authors; some results were described in literatures e.g. [1-4]. Some of the studies were an investigation of student motivation in thesis preparation. Students who are writing their thesis are vulnerable to stress. Stress is a feeling of emotional or physical tension. It can come from any event or thought that makes you feel frustrated, angry, or nervous. This research was conducted to see the structural relationship between students' motivation for their preparation of the thesis and two factors that might affecting it using structural equation model, i.e. the relation between student and supervisors and the environmental condition.

Structural equation modelling is a multivariate statistical analysis technique that is used to analyse structural relationships between variables. This technique is the combination of factor analysis [5] and multiple regression analysis [6-7], and it is used to analyse the structural relationship between measured variables and latent constructs. Structural equation model (SEM) can conceptually be used to answer any research question involving the indirect or direct observation of one or more

independent variables or one or more dependent variables. However, the primary goal of SEM is to determine and validity a proposed causal model. Therefore, SEM is a confirmatory technique.

There are two types of models in SEM, i.e. the "measurement model" which represents the theory that specifies how measured variables come together to represent the theory and "structural model" which represents the theory that shows how constructs are related to other constructs. SEM is also called causal modeling because it tests the proposed causal relationships. Let $\boldsymbol{y}' = (y_1, y_2, \dots, y_p)$ and $\boldsymbol{x}' = (x_1, x_2, \dots, x_q)$ be vectors of the observed or measured variables. The measurement model of SEM is defined as follow [8]

$$\boldsymbol{y} = \boldsymbol{\Lambda}_y \boldsymbol{\eta} + \boldsymbol{\epsilon}$$

$$\boldsymbol{x} = \boldsymbol{\Lambda}_x \boldsymbol{\xi} + \boldsymbol{\delta}$$

where
$\boldsymbol{\epsilon}$ is the $(p \times 1)$ vector of measurement errors for $\boldsymbol{y}$,
$\boldsymbol{\delta}$ is the $(q \times 1)$ vector of measurement errors for $\boldsymbol{x}$,
$\boldsymbol{\Lambda}_y$ is the $(p \times m)$ matrix of factor loadings or coefficients relating $\boldsymbol{y}$ to $\boldsymbol{\eta}$, and m is the number of elements of $\boldsymbol{\eta}$,
$\boldsymbol{\Lambda}_x$ is the $(q \times n)$ matrix of factor loadings of coefficients relating $\boldsymbol{x}$ to $\boldsymbol{\xi}$, and m is the number of elements of $\boldsymbol{\xi}$,
$\boldsymbol{\eta}$ the $(m \times 1)$ vector of endogenous latent variables,
$\boldsymbol{\xi}$ is the $(n \times 1)$ vector of exogenous latent variables.

It is assumed that $\boldsymbol{\eta}$, $\boldsymbol{\xi}$, $\boldsymbol{\epsilon}$ and $\boldsymbol{\delta}$ are random vectors with zero means; $\boldsymbol{\epsilon}$ is uncorrelated with $\boldsymbol{\eta}$, $\boldsymbol{\xi}$ and $\boldsymbol{\delta}$; and $\boldsymbol{\delta}$ is uncorrelated with $\boldsymbol{\xi}$, $\boldsymbol{\eta}$ and $\boldsymbol{\epsilon}$. All observed variables are measured in deviations from their mean.

The structural model of SEM is as follows

$$\boldsymbol{\eta} = \mathbf{B}\boldsymbol{\eta} + \boldsymbol{\Gamma}\boldsymbol{\xi} + \boldsymbol{\zeta}$$

where
$\boldsymbol{\zeta}$ the $(m \times 1)$ vector of latent errors in equations,
$\mathbf{B}$ the $(m \times m)$ matrix of coefficients for endogenous latent variables,
$\boldsymbol{\Gamma}$ is the $(m \times n)$ matrix of coefficients for exogenous latent variables.

There are some methods that can be used for SEM estimation. In this paper we used weighted least square (WLS) method for SEM estimation on modelling the student motivation data. The WLS estimator is obtained by minimizing the fit function in a quadratic form as follows

$$F_{WLS} = [\boldsymbol{s} - \boldsymbol{\sigma}(\boldsymbol{\theta})]' \, \boldsymbol{W}^{-1} [\boldsymbol{s} - \boldsymbol{\sigma}(\boldsymbol{\theta})],$$

where
$\boldsymbol{s}$ is vector of non-redundant elements in the empirical covariance matrix,
$\boldsymbol{\sigma}(\boldsymbol{\theta})$ is the vector of non-redundant elements in the model-implied covariance matrix,
$\boldsymbol{\theta}$ is the $(t \times 1)$ vector of parameters,
$\boldsymbol{W}$ is a $(k \times k)$ positive definite weight matrix with $k = p(p+1)/2$ and p = number of observed variables.

WLS requires that the matrix $\boldsymbol{W}$ is a consistent estimate of the asymptotic covariance matrix of the sample variances and covariances (or correlations) being analyzed. Under the assumption of multivariate normality, the WLS fitting function F can be rewritten as

$$F_{WLS} = \mathrm{tr}\{[\boldsymbol{S} - \boldsymbol{\Sigma}(\boldsymbol{\theta})]'[\boldsymbol{S} - \boldsymbol{\Sigma}(\boldsymbol{\theta})]\boldsymbol{W}^{-1}\}$$

where
tr is the trace of the matrix,
$\boldsymbol{S}$ is the empirical covariance matrix,
$\boldsymbol{\Sigma(\theta)}$ is the model-implied covariance matrix.

The covariance matrix in practice serves as dataset to be analysed. In the context of SEM, covariances and correlations between variables are essential because they allow one to include a relationship between two variables that is not necessarily causal. In practice, most structural equation models contain both causal and non-causal relationships. Obtaining covariance estimates between variables allows one to better estimate direct and indirect effects with other variables, particularly in complex models with many parameters to be estimated.

Let **V** be an asymptotic covariance matrix and $\mathbf{W}=\boldsymbol{V^{-1}}$ is weight matrix with elements $w_{ii} = \frac{1}{\sigma_i^2}$ for $i = 1,2,\dots,(p+q)$, then the weight matrix $\boldsymbol{W}$ is expressed as follows

$$\boldsymbol{W^{-1}} = \begin{bmatrix} \frac{1}{\sigma_1^2} & 0 & \cdots & 0 \\ 0 & \frac{1}{\sigma_2^2} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \frac{1}{\sigma_i^2} \end{bmatrix}.$$

The resulted model estimation is evaluated using some goodness fit tests. There are some goodness of fit tests that are commonly used in SEM, e.g. Chi-square, Root Mean Square Error of Approximation (RMSEA), Adjusted Goodness of Fit Index (AGFI) [9-10].

2. Method

The SEM analysis was conducted using LISREL 9.30 software [11-12]. The data in this study are primary data obtained from the survey results in the form of a factor analysis questionnaire. This study contained 17 observable variables and 3 latent variables with a sample size of 200 students of University of Lampung. After the validity and reliability test, there we e five variables that are not valid, then the 5 variables are eliminated, the rest of 12 variables were observed. The 12 variables are indicator variables of 3 latent variables constructed; 4 variables (Y_i) are indicators of one endogenous latent variable "student motivation in thesis preparation" and 8 variables (X_j) are indicators of two exogenous latent variables namely "the relationship between supervisors and student" and "environmental conditions".

Table 1. Latent and Observable Variables

Latent Variable	Observable Variable	Variable	No
Relationship between Supervisors and Student	I felt hopeless, when the effort / hard work in completing my thesis lecturer less in line with expectations	X1	1
	I feel hopeless, when my efforts / hard work in completing the thesis are not in accordance with the expectations of the supervisors	X2	2
	I always do my thesis guidance regularly and continuously	X3	3
	I immediately get emotional when the supervisors don't understand my limitations in doing this research	X4	4
	I am not trying to find friends who can be invited for sharing ideas, when it is difficult to work on my thesis	X5	5
Environmental conditions	My friends often invite me to go to the library to complete my thesis	X6	6
	My friends often invite me to go to the library for completing my thesis	X7	7
	I often do my thesis with my friends	X8	8

Motivation in thesis preparation	Although I often feel depressed working on my thesis, I believe I can finish it well	Y1	9
	When I'm tired of thinking about doing a thesis, I take a moment for a rest	Y2	10
	Every time I feel hopeless in working on a thesis, I pray to be given an ease for completing this thesis until finished	Y3	11
	I prefer watching movies on my laptop or going to the cinema to get rid of the stress in my mind	Y4	12

The followings are the analysis procedure steps:

1. validity and reliability tests of the questionnaire items
2. if there are indicators that are invalid and unreliable then these variables will be eliminated
3. model specification by designing structural models and measurement models
4. create a path diagram by connecting the latent variables, the path diagram was formed based on the research hypothesis
5. SEM estimation using VLS method
6. testing the estimated model and evaluate the model using the goodness of fit (GOF) index

3. Result and Discussion

3.1. Validity and Reliability test

The validity test of the questionnaire items was done by calculating the Pearson correlation statistic of each item (i.e. variable) and compare the statistic with the r-table value for n=200 at a significance level $\alpha = 0.05$. In Table 2 below we present the result.

Table 2. Pearson Correlation

Variable	Pearson Correlation (r)
X1	0,598
X2	0,571
X3	0,559
X4	0,577
X5	0,597
X6	0,619
X7	0,547
X8	0,543
Y1	0,578
Y2	0,559
Y3	0,659
Y4	0,558

The Pearson correlation r-table value for n=200 and $\alpha = 0.05$ is 0.1388, since the r-statistics value of all indicators is greater than the value of the r-table, this means that all items or indicators are valid. The reliability test of the indicators was done using Cronbach's alpha. We obtained the value of Cronbach's alpha statistics was 0.816. A questionnaire can be said to be reliable if the Cronbach's alpha value is greater than 0.7. In the question items on motivation in thesis preparation at size 200 the Cronbach's alpha value is more than 0.7. Then it can be concluded that the question items are reliable.

3.2. Model Specification

The relations between observable variables and latent variables was specified in the form of path diagram as presented in Figure 1. Endogenous latent variable η_1 represents the "student motivation in thesis preparation" (motivation), first exogenous latent variable ξ_1 represents "the relationship between supervisors and student" (relation), and second exogenous latent variable ξ_2 represent the "environmental conditions" (environment).

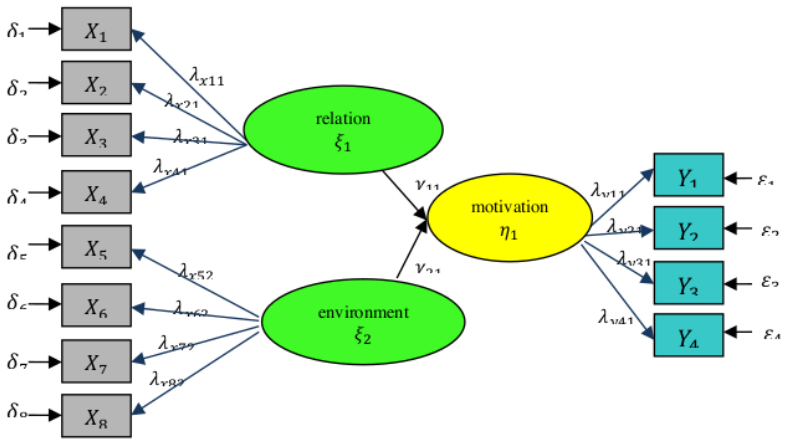

Figure 1. Model specification

3.3. Parameter Estimation

Using Equation (1), it can be shown that the WLS estimator of the model parameters are given in the following formulas.

$$\widehat{\gamma_{11}} = (\xi_1{}^T W^{-1} \xi_1)^{-1} (\xi_1{}^T W^{-1} - \widehat{\gamma_{21}}{}^T \xi_2{}^T W^{-1} \xi_1$$
$$\widehat{\gamma_{21}} = (\xi_2{}^T W^{-1} \xi_2)^{-1} (\xi_2{}^T W^{-1} \eta_1 - \xi_2{}^T W^{-1} \widehat{\gamma_{11}} \xi_1)$$
$$\widehat{\lambda_x} = (\xi^T W^{-1} \xi)^{-1} (\xi^T W^{-1} X)$$
$$\widehat{\lambda_y} = (\eta^T W^{-1} \eta)^{-1} (\eta^T W^{-1} Y)$$

The estimated structural and measurement models of SEM using WLS method for our data on the motivation in preparation of the thesis are presented in following:

Structural model $\eta_1 = 0.30\,\xi_1 + 0.67\,\xi_2 + \zeta_1$

Measurement models:

$X_1 = 0.60\,\xi_1 + 0.33$
$X_2 = 0.53\,\xi_1 + 0.25$
$X_3 = 0.55\,\xi_1 + 0.51$
$X_4 = 0.40\,\xi_1 + 0.40$
$X_5 = 0.41\,\xi_2 + 0.19$
$X_6 = 0.54\,\xi_2 + 0.32$
$X_7 = 0.45\,\xi_2 + 0.34$
$X_8 = 0.39\,\xi_2 + 0.38$

$Y_1 = 0.46\,\eta_1 + 0.19$
$Y_2 = 0.45\,\eta_1 + 0.28$
$Y_3 = 0.52\,\eta_1 + 0.17$
$Y_4 = 0.42\,\eta_1 + 0.54$

The path diagram of the estimated SEM above is presented in Figure 2 where the WLS parameter estimates of the models can be seen in each headed arrow in the diagram.

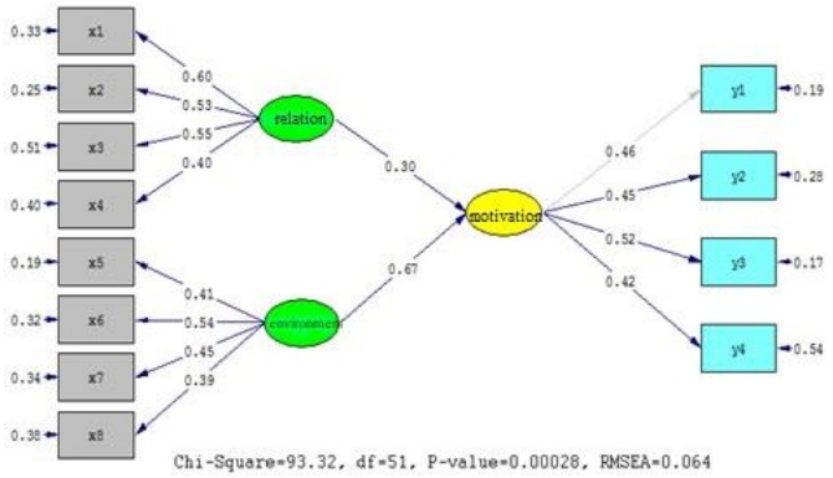

Figure 2. Model and parameter estimates

3.4. Goodness of Fit Test

Table 3 shows the results of goodness of fit test to the estimated model using WLS method. The Chi-square test statistic is significant at 0.05, which suggest that the model fitting is good. The RMSEA is 0.0644 and since it is between 0.05 and 0.08, it indicates a good fit. The AGFI are larger than 0.9 which again reflect a good fit.

Tabel 3. Goodness Of Fit Test

GOF index	GOF criterion	Value	Decision
Chi Square	The smaller value of *Chi-Square* the better the result, a good model fit would provide an insignificant result at a 0.05 threshold.	93.32 (p-value=0.00016)	*Good Fit*
RMSEA	RMSEA < 0.05 shows a poor fit 0.05 < RMSEA ≤ 0.08 shows a good fit	0.0644	*Good Fit*
AGFI	AGFI ≥ 0.90 shows a good fit	0.957	*Good Fit*

Based on the result in Table 3 the estimated model using WLS performs a good fit. Therefore, our estimated model in Figure 2 is a good model. From the model obtained we found that the environmental condition and the relationship between student and supervisors significantly affect the motivation of student in thesis preparation.

4. Conclusion

In this paper we applied SEM for assessing the causal effect of two factors i.e. "relationship between student and supervisor" and the "environmental condition", on "student motivation in thesis preparation". The result shows that the two factors significantly affect the students' motivation in preparing their thesis based in the estimated model obtained.

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