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THE RELATIONSHIP BETWEEN TEACHING PROCESS AND QUALITY USING THE LINEAR STRUCTURE (LISREL) MODEL IN INDUSTRIAL ENGINEERING DEPARTMENT

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ABSTRACT

In this globalization era Industrial Engineering (IE) in Indonesia holds a vision to be a well known national university and an advantageous center in developing science and technology, art and management orienting to involve parties and acknowledged by external parties as well. To make this vision a reality, it realizes to keep improving the quality in its responsibility to the customers and to the will of various social groups. In order to face the market competition requirements, IE conducts a measurement on the teaching process influence to the teaching quality. This becomes the main point of self-evaluation, where students, lecturers, and facilities available are the inputs to produce quality graduates as the output. The evaluation of teaching process depends on a number of certain factors, such as: during teaching time (during lecture), material presentation approach (delivery way) and lecturer's attitude. Equality model with linear structure (LISREL) which connects the whole research model of teaching process shows that exogenous latent variable as the most influential factor to "Lecture Quality" (η) is "During Lecture" (ξ_1) with a score of 0,849. This is not released from the influential indicator in exogenous latent variable (during lecture) and endogenous latent variable (lecture quality). The most influential indicator in "during lecture" is "delivering material/references" (78.4%). Meanwhile, the most influential indicator to "lecture quality" is "delivering the lecture fluently" (84.9%). The students of the University S's Industrial Engineering Department really appreciate the time their lecturers deliver their lectures and wish that their lecturers do not merely left them to study the materials by themselves. They also completely believe in the quality of the lecturers that teach and transferring their knowledges fluently and view their learning process as a need; therefore, lecturers are expected to pay more attention towards their students' limitations.
Key words: IndustriaL Engineering, Quality, LISREL.

1. INTRODUCTION

The role of a university in delivering high quality human resources and taking part in developing the country is highly important. Universities in Indonesia and the world are highly aware about this matter, especially in this globalization era. Various efforts are conducted through accreditation, self evaluation, and the implementation of ISO 9000 to monitor and enhance the quality of a university. Demands from various parties like job market, stakeholders, etc force the university to perform changes and to be proactive more rapidly. The community demand for a university that can supply high quality human resources leads to a change in the university's internal components like students, lecturer staffs, curriculum, supporting staffs, etc as a system. Essentially, vision and mission are the paradigms that can assure the success of a university, where the university staffs agree to be the facilitators, develop values within the academic staffs, conduct benchmarkings, dare to take the risks, and eliminate wasteful actions.

Therefore, students are directly and indirectly involve in the university's learning and service delivering process. Basically, there are four main process in a university. They are: curriculum development process, teaching and learning process, grading process, and administration process. This research objective is to determine the relationship between the education quality and the teaching process using the linear structure approach. The four processes will be measured to determine the education

and teaching proceses which include the curriculum development process to translate a number of knowledges and intellectual expertises that is expected to be transferres to the students. The learning process is grouped into the students who directly involve in the learning process and quality improvement by decreasing the number of variations in lecturers, learning materials, learning material sources, etc.

2. THEORETICAL BACKGROUND

The variable based statistical model with endogenous variable has an important role in the multivariate data analysis. This structured equation model with endogenous variable is widely used in some fields like sociology, economics, marketing, psychology, biology, and engineering.The objective of this modeling is to decrease the dimension of the data disclosed in the endogenous construction which has a small number to represent it. This is naturally prevail since most endogenous variables in sociology, psychology, economics, and marketing researches are not able to be measured directly. Therefore, the endogenous variable is linked to the manivestation variable or some clues that may be measured directly. Statistic-wise, the issue is to create an inference to the endogenous variable and significantly relating them. This approach is allowed in the variable erratum model, trajectory analysis, factor analysis, covariant structured analysis, and this linear hidden structured model. The implementation of this equation system is called the Linear Structured Equation or LISREL Model.

Structured equation model questions about the study's data and cause-and-effect variables where each equation in the model represents a causal effect. The linear structured parameter does not pile up with the regression multiplier between the endogenous variables. This modeling needs more statistics method than the regression analysis and variant analysis. This model is pioneered by Wright in 1934 through trajectory analysis (Turkey 1954). The trajectory analysis technic has been remodeled and reused by the famous researchers Lazarsfeld and Henry (1968), Goldberger (1972), Duncan (1975), Heise (1975), and Li (1975). This trajectory analysis offers an algorithm that reveals the distribution moment and endogenous variable in terms of structured parameter. In marketing research, this structures equation system has been reported by researchers like Bagozzi (1977, 1980, and 1982), Bagozzi and Yi (1989), and Kumar and Dillon (1992). This model can be widely use in psychometry by McDonald (1978, 1980), Bentler (1983,1986), Browne (1984), Muthen and Hollis (1987), Muthen (1989), Sobel (1990), McCloy, et al. (1994), Sik-Yum Lee and Bentler (1992). Besides, Bollen (1989) has described further about this linear structures modeling with his own illustration. Essentially, the name linear structured modeling, covariants structured analysis, and trajectory analysis possesses the same meaning.

Linear structured equation modeling or LISREL aims towards the existence of relationship between endogenous variables, determines construct or the proper dimension to all endogenous system besides quantifying the endogenous construct. In solving the problem using this model, the greater sample size will provide more accurate result. However, in the endogenous variable modeling, a certain model type that inhibit the formation of a more accurate result despite the great sample size existed is also possible to happen (Haagen, et al. 1993).

The variables in LISREL equation system are the direct endogenous variables and exogenous variables (hypothesized construct variables). The exogenous variables are linked to the endogenous indicator guidance. That way, this LISREL modeling as a whole is able to adapt to the endogenous variables, measurements erratum, and interdependency.

The implementation of this LISREL model covers various fields. Bhatla, et al. (1990) has implemented this endogenous structured model to analyze the impact of lecturer's attitude and method of lecture

delivery towards the learning process, and so has Mokhtar et.al (1996).

3. RESEARCH METHOD

3.1 Model Construct

The trajectory analysis model covers three main items. They are: . Model Construct figures; equation that connects correlation or covariants to the parameter; and effect and cause-and-effect descriptions. Essentially, a trajectory figure is a figure of an equation system. The figure shows the relationship between all variables including the noise variate and erratum. This simultaneous equation system is equal to the covatiants structure equation. The trajectory analysis model leads to a linear-structured equation multiplier coefficient parameter estimation that represents a caused-and-effect hypothesized relation. Direct effect means that there is no mediation in the relationship between variables while indirect effect means that there are variables that posed as a mediator in the relationship. Therefore, the end result is the sum of the direct and indirect effect.

Joreskog (1973) has made a general structured equation model that summarizes the trajectory figure and the trajectory analysis traits into a formula and LISREL model analysis. The cause-and-effect model contains the exogenous (independent) variables and endogenous (dependent) variables with equation line up based on the trajectory figures. The whole LISREL is modeled to adapt to the endogenous variables based on the actual directing variable's covariant matrix. This model shows endogenous variable as a result of the similar endogenous variable in the factor analysis model. The assumption used in this model is that the variable is multinormal.

3.2 Linear Structured Equation Model Used in the Research

The linear structures equation model with hidden variable (LISREL) estimated structured model parameters and measurement model altogether at once. Structured model is a cause-and-effect equation that includes covariation between hidden variables that contains variant and covariants. (Figure 1, attachment)

3.3 Research Questionaire

This research questionnaire was meant to measure the students' response towards the teaching process conducted by the lecturers through the assessment level using the Likert scale. The questionnaire consists of three parts. Part I contains questions on the grading of the lecturers during teaching process. This is important to seek further about the grading characteristics during the time a lecturer delivers the material. Part II is useful to find out how satisfied a student is towards the way the lecture material is delivered. Part III is the part to assess the lecturer's attitude. There are 30 attributes used in this research and they are divided into three parts (Table 1, attachment)

Research questionnaire is made based on the attributes obtained from the lecturing process in a university. There are 160 questionnaires distributed for University X-Industrial Engineering (IE).

The modified linear structured relationship model is as followed. Say a random vector

$$\eta' = (\eta_1, \eta_2, \ldots, \eta m)$$

and $\xi' = (\xi_1, \xi_2, \ldots, \xi n)$

as endogenous variables and hidden exogenous variables or constructs in the structured equation system below:

$$\eta = B\eta + \Gamma\xi + \zeta$$

with **B(mxn) and Γ(mxn) parameter matrices (multipliers) and**

$$\zeta' = (\zeta_1, \zeta_2, \ldots, \zeta m)$$

is random vector (erratum in the equation or random noise). **B** represents the direct impact of η variable against other η variable, and Γ represented the direct impact of ξ variable against η variable. The component η is an endogenous hidden construct variable. The component ξ is an exogenous hidden construct variable. The endogenous and exogenous constructs are linked by a structured equation system with **B, Γ,** and ζ matrices.

The multivariate variable vector measured contains

y' = (y1, y2, …. , yp)
and **x' = (x1, x2, …. , xq)**

Therefore, the measurement model for y and x are:

$y = \wedge,\eta + \varepsilon$
$x = \wedge,\xi + \delta$

where ε and δ are intra-variable-erratum measurement vectors. Random vectors y and x are the observable endogenous and exogenous clues that are linked to η and ξ variables by a linear equation system in a measurement model. This model owns the Λ_y (p x m) and Λ_x (q x n) multipliers that are the regression matrix y in η and x in ξ.

The assumption in this modeling is that the distribution of x and y are multinormal. ζ is not correlated to ξ; ε is not correlated to η; δ is not correlated to ξ; ζ, ε, and δ is not correlated. I-B is non singular. $E(\eta) = 0$, $E(\xi) = 0$, $E(\varepsilon) = 0$, and $E(\delta) = 0$. Measurement erratum is not correlated to η, ξ, and δ, but might be correlated to one another.

The covariant structure C (SAS 1990) for this LISREL model is as followed:

$C = J(I\text{-}A)^{-1}\, p(I\text{-}A)^{-1}J'$

that shows the covariants structure plan in the LISREL structured modeling.

$$A = \begin{bmatrix} 0 & 0 & \wedge_Y & 0 \\ 0 & 0 & 0 & \wedge_X \\ 0 & 0 & \beta & \Gamma \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

and P =

$$\begin{bmatrix} \theta_\varepsilon & & & \\ & \theta_\delta & & \\ & & \phi & \\ & & & \phi \end{bmatrix}$$

A is a non singular multiplier matrix; P is a covariant matrix; and J is a choice matrix. And

$\phi = E(\xi\xi')$
$\psi = E(\zeta\zeta')$
$\theta_\delta = E(\delta\delta')$
$\phi_\varepsilon = E(\varepsilon\varepsilon')$

where ϕ (n x n) and ψ (m x m) are covariant matrices of ξ and ζ consecutively, and θ_ε and θ_ε are each covariant matrix for ε and δ. The covariant matrix E to z = (y', x') is

$$\sum = \begin{bmatrix} \wedge_y (I-B)^1(\Gamma\phi\Gamma'+\psi)(1-B)^{-1}\wedge_y' + \theta_\varepsilon & \wedge_y(I-B)\,\Gamma\phi\wedge_X' \\ \wedge_y \phi\Gamma'(1-B)^{-1}\wedge_y & \wedge_X\phi\wedge_X'+\theta\delta \end{bmatrix}$$

E is the function of Λ_y, Λ_x, B, Γ, Φ, ψ, θ, and θ_δ. Λ_y, Λ_x, B and Γ are constant. Other matrices may have their own constant, restricted, or free elements.

3.4 Model specification and determination

The characteristic of a suitable structured model is the parameters are correctly estimated, providing cause-and-effect in the endogenous variables. Trajectory figure is utilized to present various cause-and-effect systems with several hidden constructs only.

Figure1 shows the trajectory figure for LISREL model with hypothesis of L_1, L_2, L_3, L_4 simultaneously. The model shows the impact of attitude and delivery method towards the lecture's quality whose variables are measured with the erratum. This L_1 model consists of three exogenous hidden clue variables. Essentially, this trajectory figure simplifies the presentation of LISREL structured equation.

4. RESULT AND DISCUSSION

In this research, the questionnaire is based on three main factor of the Lecture quality (During Lecture, Delivery Method, and Lecturer's Attitude), where every attribute is graded during the lecture and based on the way the lecturer deliver his/her lecture. The score used are:

Table 2. Lecture Process Grading Scale

Grading Score	Execution Level
1	Never
2	Sometimes
3	Often
4	Always
5	Certainly Always

The result of the questionnaire is a raw data that is needed to assess the quality of the lecturer. Then, it will be further processed based on the pre-determined path diagram (Look at Figure 1) using LISREL 7 program.

4.1 Calculation using the LISREL Modelling (Figure 2, attachment)

Based on the raw data obtained, the next step is to re-assemble the data based on the "Lecturing Process in the Higher Education/University" which is divided into:

Based on the raw data obtained, the next step is to re-assemble the data based on the "Lecturing Process in the Higher Education/University" which is divided into:

1. **"During Lecture" question group (ξ1):**
   - ⇒ Explaining object/lecture material (X1)
   - ⇒ Explaining lecture structure (topic/implementation/grading) (X2)
   - ⇒ Describing text/references (X3)
   - ⇒ Using the teaching aids (Projector, Microphone, Infocus, Internet, Extra Notes, etc.) (X4)
   - ⇒ Giving exercises/assignments (X5)
   - ⇒ Conducting quiz/exam (X6)
   - ⇒ Discussing the exercise/exam questions solutions (X7)
   - ⇒ Conducting continuous grading (X8)
   - ⇒ Presenting the grading allocation (Tutorial Class/Mid Term Exam/Final Exam) (X9)
2. **"Delivery Method" question group (ξ2):**
   - ⇒ Delivering the objective of the lecture well (Y20)
   - ⇒ Starting the lecture on time (Y21)
   - ⇒ Finishing the lecture on time (Y22)
   - ⇒ Able to modify his/her lecturing ways according to the students' background/ability (Y23)
   - ⇒ Able to connect the lecture subject to the issues found in daily life (Y24)
3. **"Lecturer's Attitude" question group (ξ3):**
   - ⇒ Encouraging students to ask questions (Z25)
   - ⇒ Sensitive towards the students' reactions (Z26)
   - ⇒ Able to trigger/increase students' motivations (Z27)
   - ⇒ Willing to listen to the students' opinions/views/problems (Z28)
   - ⇒ Fair/doesn't pick favorites among students (Z30)
4. **"Lecture Quality" question group (η1):**
   - ⇒ Appears ready to give lecture (Y10)
   - ⇒ Showing interest/being serious (Y11)
   - ⇒ Delivering the lecture fluently (Y12)
   - ⇒ Clear/easy to be understood (Y13)
   - ⇒ Creative/Innovative in delivering the lecture's material (Y14)
   - ⇒ Clearly audible (Y15)
   - ⇒ Mastering the taught subject well (Y16)
   - ⇒ Delivering the lecture convincingly (Y17)
   - ⇒ Successfully stirring students' interests in the subject (Y18)
   - ⇒ Timeliness in using the lecture time (Y19)

For a beginning stage, the formal specification that can be illustrated by this model consists of:

Structured relationship:

- ⇒ Lecture quality = f (During Lecture, Delivery Method, Attitude, Erratum)

Endogenous Variables:

- ⇒ Appears ready to give lecture = f (Lecture Quality, Erratum)
- ⇒ Showing interest/being serious = f (Lecture Quality, Erratum)
- ⇒ Delivering the lecture fluently = f (Lecture Quality, Erratum)
- ⇒ Clear/easy to be understood = f (Lecture Quality, Erratum)
- ⇒ Creative/Innovative in delivering the lecture's material = f (Lecture Quality, Erratum)
- ⇒ Clearly audible = f (Lecture Quality, Erratum)
- ⇒ Mastering the taught subject well = f (Lecture Quality, Erratum)
- ⇒ Delivering the lecture convincingly = f (Lecture Quality, Erratum)
- ⇒ Successfully stirring students' interests in the subject = f (Lecture Quality, Erratum)

⇒ Timeliness in using the lecture time = *f* (Lecture Quality, Erratum)

Exogenous Variables:

⇒ Explaining object/lecture material = *f* (During Lecture, Erratum)
⇒ Explaining lecture structure (topic/implementation/grading) = *f* (During Lecture, Erratum)
⇒ Describing text/references = *f* (During Lecture, Erratum)
⇒ Using the teaching aids (Projector, Microphone, Infocus, Internet, Extra Notes, etc.) = *f* (During Lecture, Erratum)
⇒ Giving exercises/assignments = *f* (During Lecture, Erratum)
⇒ Conducting quiz/exam = *f* (During Lecture, Erratum)
⇒ Discussing the exercise/exam questions solutions = *f* (During Lecture, Erratum)
⇒ Conducting continuous grading = *f* (During Lecture, Erratum)
⇒ Presenting the grading allocation (Tutorial Class/Mid Term Exam/Final Exam) = *f* (During Lecture, Erratum)
⇒ Delivering the objective of the lecture well = *f* (During Lecture, Erratum)
⇒ Starting the lecture on time = *f* (During Lecture, Erratum)
⇒ Finishing the lecture on time = *f* (During Lecture, Erratum)
⇒ Able to modify his/her lecturing ways according to the students' background/ability = *f* (During Lecture, Erratum)
⇒ Able to connect the lecture subject to the issues found in daily life = *f* (During Lecture, Erratum)
⇒ Encouraging students to ask questions = *f* (Attitude, Erratum)
⇒ Sensitive towards the students' reactions = *f* (Attitude, Erratum)
⇒ Able to trigger/increase students' motivations = *f* (Attitude, Erratum)
⇒ Willing to listen to the students' opinions/views/problems = *f* (Attitude, Erratum)
⇒ Fair/doesn't pick favorites among students = *f* (Attitude, Erratum)

where *f* shows a linear function

Measurement model with lecture quality erratum **(η1 = Lecture Quality, ξ1 = During Lecture, ξ2 = Delivery Method, ξ3 = Attitude)** :

$Y_{10} = \lambda_{11}\eta_1 + \varepsilon_1$
$Y_{11} = \lambda_{21}\eta_1 + \varepsilon_2$
$Y_{12} = \lambda_{31}\eta_1 + \varepsilon_3$
$Y_{13} = \lambda_{41}\eta_1 + \varepsilon_4$
$Y_{14} = \lambda_{51}\eta_1 + \varepsilon_5$
$Y_{15} = \lambda_{61}\eta_1 + \varepsilon_6$
$Y_{16} = \lambda_{71}\eta_1 + \varepsilon_7$
$Y_{17} = \lambda_{81}\eta_1 + \varepsilon_8$
$Y_{18} = \lambda_{91}\eta_1 + \varepsilon_8$
$Y_{17} = \lambda_{101}\eta_1 + \varepsilon_8$
$Z_{29} = \lambda_{111}\eta_1 + \varepsilon_8$

Measurement model with main factor erratum that affects the lecture quality:

$X_1 = \lambda_{11}\xi_1 + \varepsilon_1$
$X_2 = \lambda_{21}\xi_1 + \varepsilon_2$
$X_3 = \lambda_{31}\xi_1 + \varepsilon_3$
$X_4 = \lambda_{41}\xi_1 + \varepsilon_4$
$X_5 = \lambda_{51}\xi_1 + \varepsilon_5$
$X_6 = \lambda_{61}\xi_1 + \varepsilon_6$
$X_7 = \lambda_{71}\xi_1 + \varepsilon_7$
$X_8 = \lambda_{81}\xi_1 + \varepsilon_8$
$X_9 = \lambda_{91}\xi_1 + \varepsilon_9$
$Y_{20} = \lambda_{102}\xi_2 + \varepsilon_{10}$
$Y_{21} = \lambda_{112}\xi_2 + \varepsilon_{11}$
$Y_{22} = \lambda_{122}\xi_2 + \varepsilon_{12}$
$Y_{23} = \lambda_{132}\xi_2 + \varepsilon_{13}$
$Y_{24} = \lambda_{142}\xi_2 + \varepsilon_{14}$
$Z_{25} = \lambda_{153}\xi_3 + \varepsilon_{15}$
$Z_{26} = \lambda_{163}\xi_3 + \varepsilon_{16}$
$Z_{27} = \lambda_{173}\xi_3 + \varepsilon_{17}$
$Z_{28} = \lambda_{183}\xi_3 + \varepsilon_{18}$
$Z_{30} = \lambda_{193}\xi_3 + \varepsilon_{19}$

Structured equation model that linked the whole model:

$\eta_1 = \gamma_{11}\,\xi_1 + \gamma_{12}\xi_2 + \gamma_{13}\xi_3 + \zeta_1$

This equation shows that γ is a direct relationship between ξ and η.

4.2 Result of the Calculation of the Questionnaire Result of Industrial Engineering (IE)

Based on the questionnaire, the first step to do is to obtain the covariants values of the data matrix (see Appendix) as an

input for the LISREL 7 program. The number of data for the University X-IE is 160

4.3 Model Illustration (Figure 3, attachment)

Calculation model with lecture quality erratum **(η1 = Lecture Quality, ξ1 = During Lecture, ξ2 = Delivery Method, ξ3 = Attitude) :**

$Y_{10} = \lambda_{11}\eta_1 + \varepsilon_1 = \eta_1 + 0{,}243$
$Y_{11} = \lambda_{21}\eta_1 + \varepsilon_2 = 0{,}981\ \eta_1 + 0{,}277$
$Y_{12} = \lambda_{31}\eta_1 + \varepsilon_3 = 0{,}975\ \eta_1 + 0{,}288$
$Y_{13} = \lambda_{41}\eta_1 + \varepsilon_4 = 0{,}587\ \eta_1 + 0{,}419$
$Y_{14} = \lambda_{51}\eta_1 + \varepsilon_5 = 0{,}677\ \eta_1 + 0{,}549$
$Y_{15} = \lambda_{61}\eta_1 + \varepsilon_6 = 0{,}807\ \eta_1 + 0{,}328$
$Y_{16} = \lambda_{71}\eta_1 + \varepsilon_7 = 1{,}243\ \eta_1 + 0{,}515$
$Y_{17} = \lambda_{81}\eta_1 + \varepsilon_8 = 1{,}301\ \eta_1 + 0{,}310$
$Y_{18} = \lambda_{91}\eta_1 + \varepsilon_8 = 0{,}501\ \eta_1 + 0{,}477$
$Y_{17} = \lambda_{101}\eta_1 + \varepsilon_8 = 0{,}478\ \eta_1 + 0{,}608$
$Z_{29} = \lambda_{111}\eta_1 + \varepsilon_8 = 0{,}588\ \eta_1 + 0{,}740$

Measurement model with main factor erratum that has an impact to the lecture quality:

$X_1 = \lambda_{11}\xi_1 + \varepsilon_1 = \xi_1 + 0{,}645$
$X_2 = \lambda_{21}\xi_1 + \varepsilon_2 = 0{,}775\ \xi_1 + 0{,}453$
$X_3 = \lambda_{31}\xi_1 + \varepsilon_3 = 1{,}091\ \xi_1 + 0{,}363$
$X_4 = \lambda_{41}\xi_1 + \varepsilon_4 = 0{,}802\ \xi_1 + 0{,}781$
$X_5 = \lambda_{51}\xi_1 + \varepsilon_5 = 0{,}611\ \xi_1 + 0{,}688$
$X_6 = \lambda_{61}\xi_1 + \varepsilon_6 = 0{,}969\ \xi_1 + 1{,}119$
$X_7 = \lambda_{71}\xi_1 + \varepsilon_7 = 0{,}478\ \xi_1 + 0{,}758$
$X_8 = \lambda_{81}\xi_1 + \varepsilon_8 = 0{,}696\ \xi_1 + 0{,}534$
$X_9 = \lambda_{91}\xi_1 + \varepsilon_9 = 1{,}091\ \xi_1 + 0{,}582$
$Y_{20} = \lambda_{102}\xi_2 + \varepsilon_{10} = \xi_2 + 0{,}352$
$Y_{21} = \lambda_{112}\xi_2 + \varepsilon_{11} = 0{,}440\ \xi_2 + 0{,}845$
$Y_{22} = \lambda_{122}\xi_2 + \varepsilon_{12} = 0{,}656\ \xi_2 + 0{,}744$
$Y_{23} = \lambda_{132}\xi_2 + \varepsilon_{13} = 0{,}894\ \xi_2 + 0{,}423$
$Y_{24} = \lambda_{142}\xi_2 + \varepsilon_{14} = 1{,}189\ \xi_2 + 0{,}664$
$Z_{25} = \lambda_{153}\xi_3 + \varepsilon_{15} = \xi_3 + 0{,}423$
$Z_{26} = \lambda_{163}\xi_3 + \varepsilon_{16} = 1{,}781\ \xi_3 + 0{,}283$
$Z_{27} = \lambda_{173}\xi_3 + \varepsilon_{17} = 1{,}735\ \xi_3 + 0{,}394$
$Z_{28} = \lambda_{183}\xi_3 + \varepsilon_{18} = 1{,}895\ \xi_3 + 0{,}414$
$Z_{30} = \lambda_{193}\xi_3 + \varepsilon_{19} = 1{,}560\ \xi_3 + 0{,}990$

Structures equation model that links the whole model is:

$\eta_1 = \gamma_{11}\xi_1 + \gamma_{12}\xi_2 + \gamma_{13}\xi_3 + \zeta_1$
$= 0{,}849\ \xi_1 - 0{,}569\ \xi_2 + 0{,}969\ \xi_3 + \zeta_1$

4.4 Industrial Engineering Department Lisrel Modelling Result Analysis

Based on the model illustration in LISREL notation formulated, it is shown that during lecture, lecure material's delivery method, and lecturer's attitude affect the teaching quality in University X-IE. This model consists of 19 indicators (X1-X19) which is divided into 3 exogenous latent variables (During lecture = ξ1, Delivery method = ξ2, Lecturer's attitude = ξ3). Eleven indicators (Y1-Y11) are a part of the endogenous latent variable "Lecture Quality" (η).

Table 3.The Relationship between Endogenous Variables and Their Indicators in LISREL Notation Measurement Result

Indicator	R Value for IE
Y_1	0,812
Y_2	0,788
Y_3	0,780
Y_4	0,529
Y_5	0,532
Y_6	0,696
Y_7	0,766
Y_8	**0,849**
Y_9	0,446
Y_{10}	0,389
Y_{11}	0,425

The result shows that the indicator that influence the "Lecture Quality" the most is Y8 (Delivering the lecture fluently) by 84.9%.

From the hypothesis testing, it is shown that the relationship between the endogenous latent variable (Lecture Quality) and its indicators for University X-IE is real and accurate.

Table 4. The Relationship between Exogenous Variables and Their Indicators in LISREL Notation Measurement Result

Indicator	R Value for University X-IE
X_1	0,657
X_2	0,627
X_3	**0,784**
X_4	0,535
X_5	0,457
X_6	0,539
X_7	0,358
X_8	0,554
X_9	0,707
X_{10}	**0,564**
X_{11}	0,190
X_{12}	0,295
X_{13}	0,486
X_{14}	0,508
X_{15}	0,469
X_{16}	**0,757**
X_{17}	0,691
X_{18}	0,707
X_{19}	0,476

From the result obtained, the indicator that affects the "During Lecture" the most is X3 (Describing text/references) by 78.4%; for "Delivery Method" is X10 (Delivering the objective of the lecture well) by 56.4% and the one that affects "Lecturer's Attitude" the most is X16 (Sensitive towards the students' reactions) by 75.7%.

From the hypothesis testing, it is shown that the relationship between the exogenous latent variables ξ_1, ξ_2, and ξ_3 and their indicators for University X-IE is real and accurate except for X11 (Starting the lecture on time). X11 does not affect the "Delivery Method" (ξ_2) at all.

Structured equation model that relate the whole model for IE Dept :

$$\eta = \gamma_{11}\xi_1 + \gamma_{12}\xi_2 + \gamma_{13}\xi_3 + \zeta_1$$
$$= 0{,}849\,\xi_1 - 0{,}569\,\xi_2 + 0{,}969\,\xi_3 + \zeta_1$$

This model shows that the relationship value between the entire model, where the value of the relationship between "During Lecture" and "Lecture's Quality" (γ_{11}) is 0.849. The relationship value for the relationship between "Delivery Method" and "Lecture's Quality" (γ_{12}) is –0.569 and 0.969 for the relationship between "Lecturer's Attitude" and "Lecture's Quality" (γ_{13}).

The relationship value between "Lecturer's Attitude" and "Lecture Quality" (γ_{13}) is 0.969 and they are directly proportionate to one another. This means that "Lecturer's Attitude has the most impact on the "Lecture Quality" in the University X-Industrial Engineering Department.

The relationship between "During Lecture" and "Lecture Quality" (γ_{11}) is also directly proportionate with a value of 0.849. This also means that what is happening "During Lecture" will affect the "Lecture Quality" in University X-Industrial Engineering Department.

The negative value (-0.569) in the relationship between "Delivery Method" and "Lecture Quality" (γ_{12}) shows the inversed proportional relationship. It means that the better the "Delivery Way" will have an inversed effect on the "Lecture Quality".

From the hypothesis test conducted (Table 4.23), the relationship between latent exogenous variable ξ_1 (During Lecture), ξ_2 (Delivery Way), and ξ_3 (Lecturer's Attitude) towards "Lecture Quality" (η1) can be seen clearly.

The conclusion taken from this hypothesis test is that "During Lecture" (ξ_1) affects "Lecture Quality" (η) in University X-IE. This result shows that that matters the most is the process during the lecture itself, and it affects the lecture quality in University X-Industrial Engineering Department.

5. CONCLUSION

The structured equation model that linked the entire model for University X's Industrial Engineering Department shows that the exogenous latent variable that affects the "Lecture Quality" (η) the most is "During Lecture" (ξ_1). This is also an effect of the indicators that affects the exogenous latent variable (During Lecture) and endogenous latent variable (Lecture Quality). The indicator that affects "During Lecture" the most is "Describing text/references" while

the indicator that affects "Lecture Quality" the most is "Delivering the lecture fluently". This result shows that the students of the University S's Industrial Engineering Department really appreciate the time their lecturers deliver their lectures and wish that their lecturers do not merely left them to study the materials by themselves. The students also completely believe in the quality of the lecturers that teach and transferring their knowledges fluently.Students also view their learning process as a need, therefore, lecturers are expected to pay more attention towards their students' limitations.

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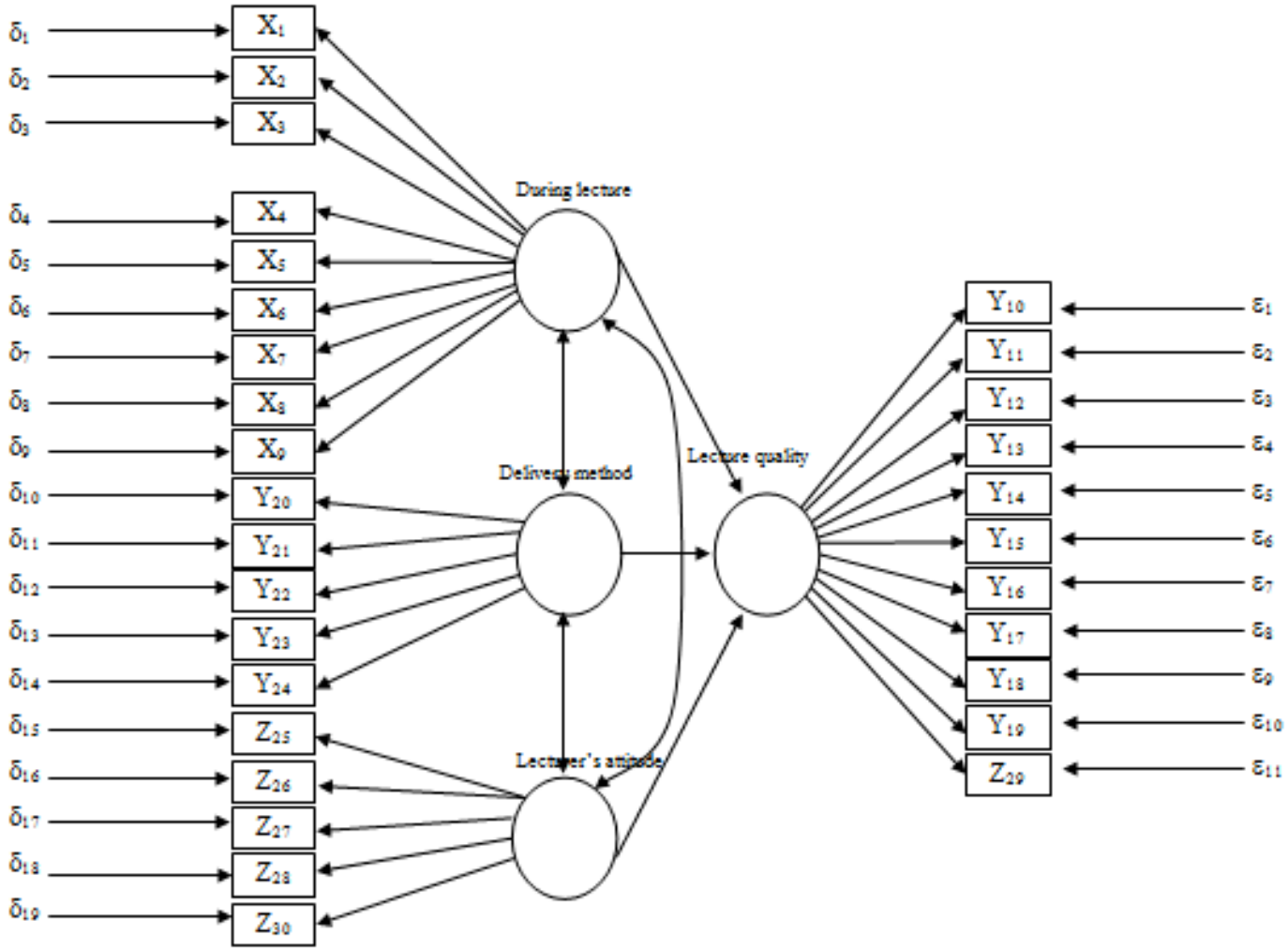

Figure 1. Structured Relationship in Teaching Process

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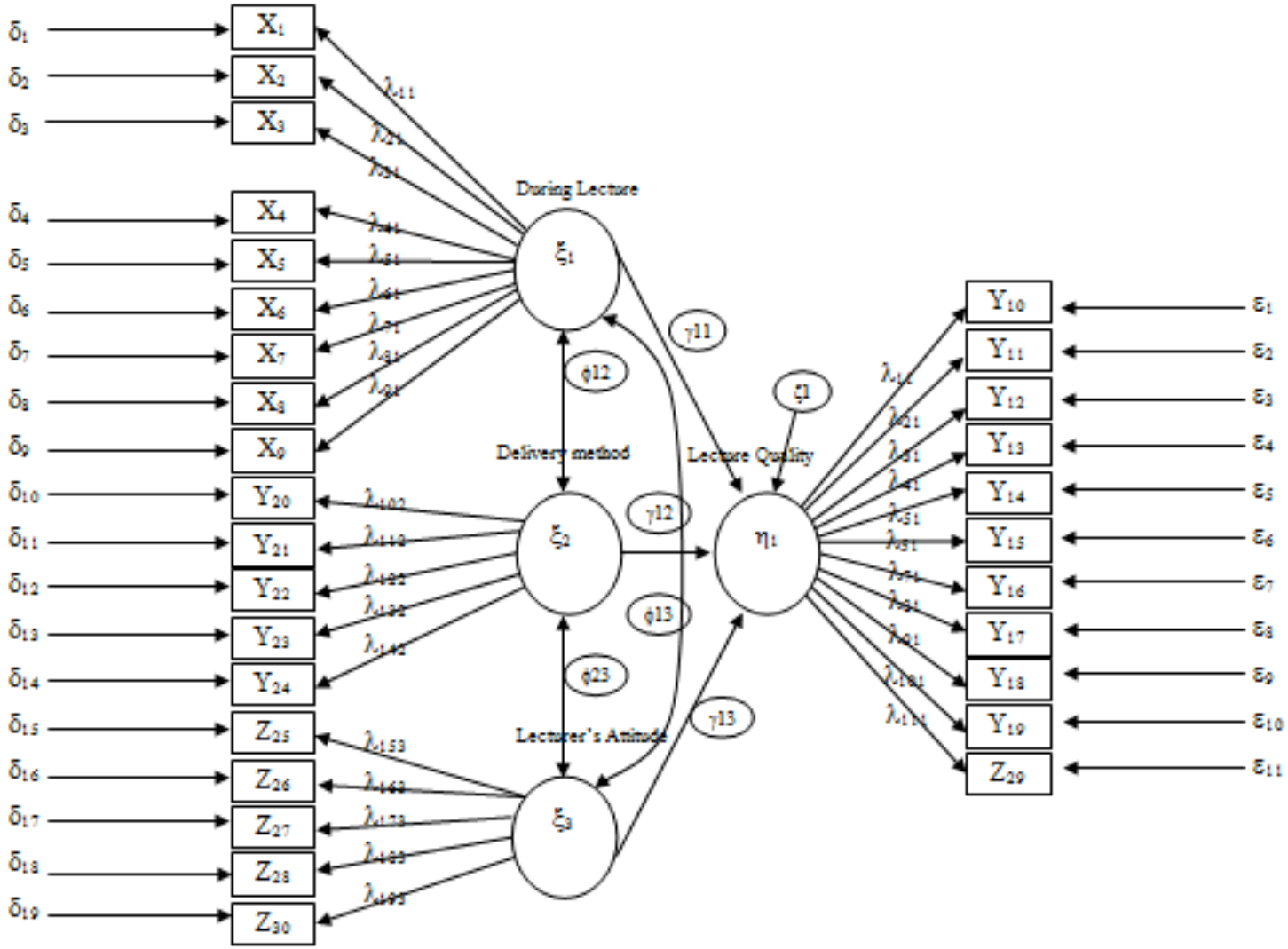

Figure 2. Model Illustration in LISREL Notation

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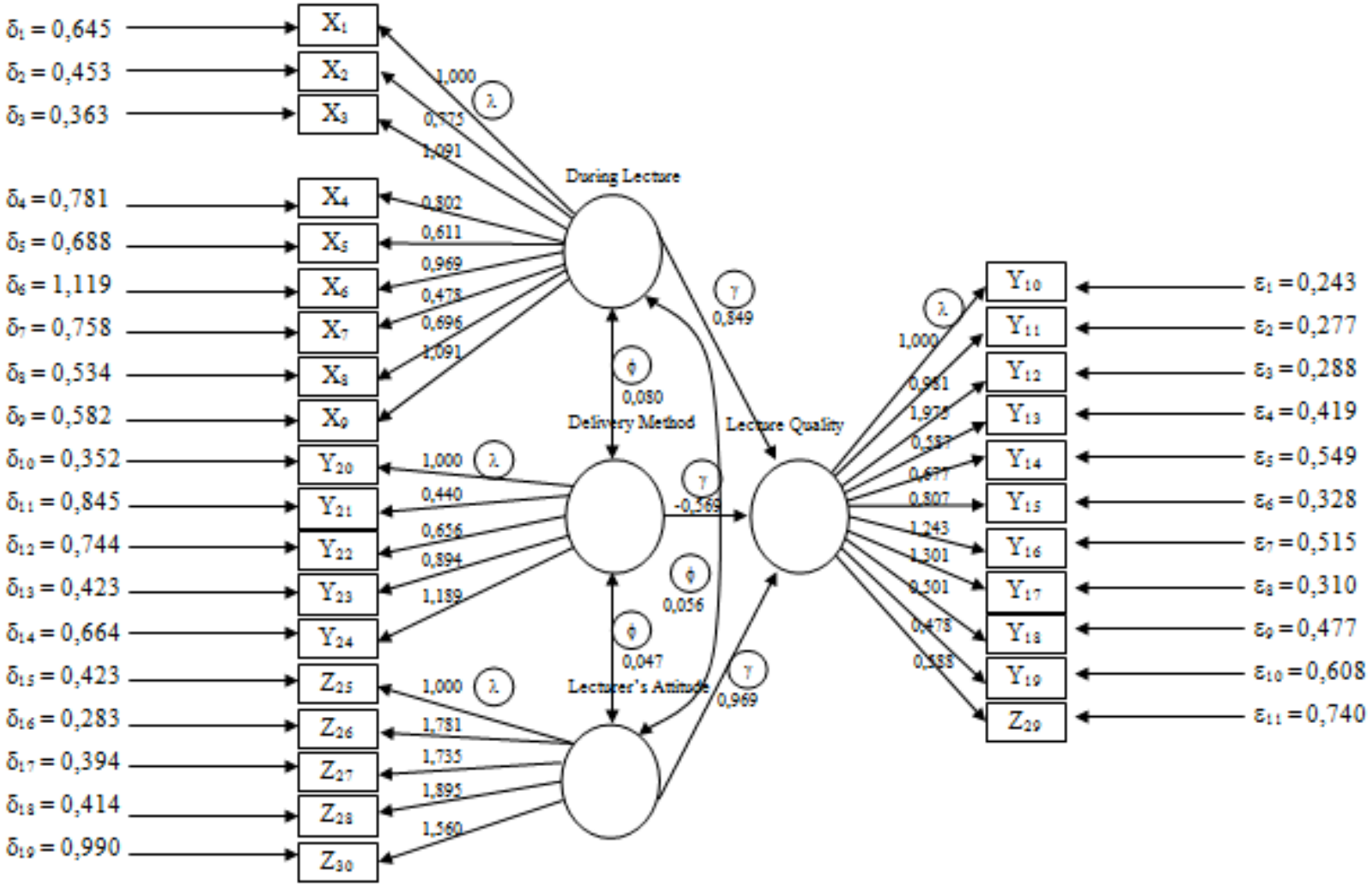

Figure 3. LISREL IE Model Illustration

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Table 1. The 30 attributes of questionnaire

During Lecture	X1	Explaining object/lecture material
	X2	Explaining lecture structure (topic/implementation/grading)
	X3	Describing text/references
	X4	Using the teaching aids (Projector, Microphone, Infocus, Internet, Extra Notes, etc.)
	X5	Giving exercises/assignments
	X6	Conducting quiz/exam
	X7	Discussing the exercise/exam questions solutions
	X8	Conducting continuous grading
	X9	Presenting the grading allocation (Tutorial Class/Mid Term Exam/Final Exam)
Lecture Material's Delivery Method	Y10	Appears ready to give lecture
	Y11	Showing interest/being serious
	Y12	Delivering the lecture fluently
	Y13	Clear/easy to be understood
	Y14	Creative/Innovative in delivering the lecture's material
	Y15	Clearly audible
	Y16	Mastering the taught subject well
	Y17	Delivering the lecture convincingly
	Y18	Successfully stirring students' interests in the subject
	Y19	Timeliness in using the lecture time
	Y20	Delivering the objective of the lecture well
	Y21	Starting the lecture on time
	Y22	Finishing the lecture on time
	Y23	Able to modify his/her lecturing ways according to the students' background/ability
	Y24	Able to connect the lecture subject to the issues found in daily life
Lecturer's Attitude	Z25	Encouraging students to ask questions
	Z26	Sensitive towards the students' reactions
	Z27	Able to trigger/increase students' motivations
	Z28	Willing to listen to the students' opinions/views/problems
	Z29	Always willing to help his/her students
	Z30	Fair/doesn't pick favorites among students