Influence level of building maintenance variables to
construction reliability in Islamic Senior High School

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Abstract. An Islamic Senior High School as educational institution is supported by some facilities. School building as a physical facility has an important role in supporting learning activities. This study aims to determine the influence level of variable maintenance of Islamic Senior High School building. The method is used to know the influence level by using Structural Equation Modeling (SEM). The mathematical equation used is the recursive path model to evaluate the data from respondents who answer the questioner. The location research is building class in Islamic Senior High School Al-Rifaie Malang Regency. The analysis of influence level consider the user perception include management officer, teacher and student. The level of perception analyzed is the level of user satisfaction with the maintenance quality of building components. The research variables include structural and architectural components as exogenous manifest variable, maintenance quality as moderator variable, and construction reliability as endogenous manifest variable. The result of analysis shows that structural and architectural components variables have positive influence to maintenance quality. The three variables of structural components, architectural components, and maintenance quality have a positive influence to the construction reliability.

1. Introduction
An Islamic Senior High School as educational institution has a very important role in supporting the success of education in Indonesia and producing excellent human resources to achieve development success. Islamic Senior High School is a learning institution supported by Islamic religious learning in addition to the general material given. Until now, the development of Islamic Senior High School in Indonesia is growing very rapidly both from quality and quantity. Central Bureau of Statistics [1] update March 3, 2017 as in www.bps.go.id shows a very rapid development in the quantity of Islamic Senior High School in Indonesia, when in 2005/2006 there were 4918 and in 2014/2015 increased to 7260.

The Islamic Senior High School is supported by physical and non-physical facilities to facilitate learning and teaching between teachers and students. Physical facilities in the form of buildings with all their components will affect the convenience of teaching and learning activities. Buildings that are not maintained properly will cause damage to the building components. Therefore, good maintenance management effort is required so that the building components have good reliability and good performance according to service plan. This study aims to determine the influence level between maintenance variables the Islamic Senior High School building based user perceptions. The Islamic Senior High School users include management officers, teachers, and students. The location and object of this research is the class building in Islamic Senior High School Al-Rifaie Malang Regency Indonesia. The perception level analyzed is the satisfaction level with the maintenance quality of Islamic Senior High School building components. This study has a novelty compared to other studies that have been done earlier. The novelty of this study is purpose, method, variable, and result. Several previous studies have also been used as references such as Bhavanichowdary et. al. (2018) [2] conducted Parametric study of sliding mode fracture in structural plain cement concrete for various sizes of beams. In this current research paper, an experimental investigation is carried out to study the
behavior of plain cement concrete beams subjected to four points loading. Kulikov (2018) [3] carried out study about Design and construction of foundations on wetlands. The research reports the excess pore pressures effect (that arises in shrinkable peat foundation) on its own physical mechanical characteristics.

Kusumawardani (2016) [4] conducting research on the description of components on the facade elements of the great mosque Malang. The methods are observation, qualitative, and descriptive. The research variables obtained are form, dimension, material, color, texture. This research combines two qualitative and quantitative methods that validate each other. Sedayu (2016) [5] conducted a study on the evaluation of green building performance of Islamic boarding school with the method of Importance-Performance Analysis (IPA) and Quality Function Deployment (QFD). The research variables generated include Sustainable, Earth friendly, and High performance building. The other study conducted by Sedayu (2018) [6] is the modeling of service quality for housing procurement projects with the principle of green building. The research variables reviewed are Assurance, Responsibility and Reliability, Performance, Aesthetics, Easiness, Durability, Architectural Design, and Environmentally Friendly. The variables of this study refer to and develop from the previous study. This research adapted the research variables that have been done and also develop the stage and method from the previous researches.

2. The Previous Researches
This study refers from the previous researches and conducts a comparative study with the researches that had been done. This study adopts and adapts the methods, variables, and results from the previous researches. This comparative study is conducted to generate the novelty on this research compared to the previous research. Table 1 shows the previous research that became the reference and comparison in this study.

| No | Researcher | Year | Topic | Method | Variables |
|----|------------|------|-------|--------|-----------|
| 1  | Komalasari [7] | 2014 | Green Building assessment based on energy efficiency and conservation | Comparative study, modeling with software, and direct measurement | Energy Efficiency Measure, Natural and artificial Lighting, Ventilation, Climate Change Impact, Vertical transportation, and Air condition system |
| 2  | Rathod[8] | 2014 | Application in environment Conscious Quality Function Deployment (ECQFD) that assesses the impact of a product to the environment | Environment Conscious and Quality Function Deployment (ECQFD) | Environment, product design, user needs, and product cycle |
| 3  | Adebara et. al.[9] | 2014 | Analysis in the influence of timber as building construction | Investigated and Ranking and Quality control measures | Domestic purposes, Deforestation, Over cultivation, Poor irrigation practices, Resulting to the loss of biological, and |
|   | Author(s) & Year | Study Title | Methodology | Economic Productivity of the Land |
|---|-----------------|-------------|-------------|----------------------------------|
|4  | Nurakumala [10] 2014 | Determination of factors that affect productivity on construction projects with the dynamic system | Second data observation, Qualitative description, and Dynamic programming | Employee, Time of execution, Cost, and Work environment |
|5  | Sugiam [11] 2015 | Modeling of service quality in green open space | Importance Performance Analysis (IPA), Quality Function Deployment (QFD), and Focus Group Discussion (FGD) | The capability of retaining and filtering solid particles from air. Capacity of amelioration / improvement of urban climate, Water conservation level, and environmental aesthetic |
|6  | Sedayu [12] 2016a | Improved service and infrastructure performance | Quality Function Deployment (QFD) and Affinity diagram | Facility, Convenience, Security, Safety, Cost, and Management service |
|7  | Kusumawardani et al. [4] 2016 | Description of facade components of the great mosque Malang | Observation, Qualitative, and Descriptive | Form, Dimension, Material, Color, and Texture |
|8  | Sedayu [13] 2016b | Evaluation of project service quality of housing procurement with sharia construction project management and green building | Importance Performance Analysis (IPA), Quality Function Deployment (QFD), and Multiple linear regression | Assurance, Responsiveness and reliability, Performance, Aesthetics, Easiness, Durability, Eco-friendly, and Islamic Design |
|9  | Sedayu [5] 2016c | Evaluation of green building performance of Islamic boarding school | Importance-Performance Analysis (IPA) and Quality Function | Sustainable, Earth friendly, and High performance building. |
3. Method

3.1. Validity and Reliability Test

This study uses questionnaire as research instrument. The instrument includes variables that are shown in Table 3-6. The validity and reliability test of research instruments are calculated by using SPSS 20.0 program. The test was conducted on 30 people [15]. The validity test is step to know the validity of questionnaire from the research respondents. The validity test calculates the correlation coefficient from all variables with the total score. In this study, an instrument has a high validity if the correlation value is bigger than 0.6 [15]. The Pearson equation used is:

\[ r_{xy} = \frac{N \sum XY - (\sum X)(\sum Y)}{\sqrt{[N \sum X^2 - (\sum X)^2][N \sum Y^2 - (\sum Y)^2]}} \] (1)

With description:
- \( r_{xy} \) = The correlation coefficient of the item
- \( X \) = Respondent score for each item
- \( Y \) = Total score of each respondent of all items
- \( \Sigma X \) = Total score in distribution X
- \( \Sigma Y \) = Total score in distribution Y
- \( \Sigma X^2 \) = The sum of squares of each score X
- \( \Sigma Y^2 \) = The sum of squares of each score Y
- \( N \) = Number of subjects

The reliability test aims to determine the level of reliability of research instruments as a means of data collection. The instrument is proven reliable if the coefficient of alpha (Alpha Cronbach coefficient) is above 0.60 [15]. The Alpha Cronbach equations used in this test are:

\[ r_i = \frac{k}{k - 1} \left[ 1 - \frac{\sum \sigma b^2}{\sigma I^2} \right] \] (2)
With description:

$r_i$ = Instrument consistency
$k$ = Number of items or questions
$\sum \sigma^2$ = Number of variance items
$\sigma^2$ = Total variance

**Fig. 1. Model Diagram of Path Analysis SEM**

**Table 2. Requirement Test in Overall Model Goodness of Fit**

| Goodness of Fit                           | Cut Off     |
|------------------------------------------|-------------|
| Normed Fit Index (NFI)                   | 0.90 < ...≤ 1 |
| Incremental Fit Index (IFI)              | 0.90 < ...≤ 1 |
| Comparative Fit Index (CFI)              | 0.90 < ...≤ 1 |
| Root Mean Square Error of Approximation (RMSEA) | < 1         |

The research instruments are questionnaires distributed to the respondents. The measurement scale used is Likert scale consisting of,

1. Scale 1 = Not satisfactory
2. Scale 2 = Less satisfactory
3. Scale 3 = Quite satisfactory
4. Scale 4 = Satisfactory
5. Scale 5 = Very satisfactory

Research respondents are the users of Islamic Senior High School including management officers, teachers, and students. The determination of the number of respondents in the advanced survey was calculated by the Bernoulli equation [5]:

$$N \geq \frac{(Z_{\alpha/2})^2 p q}{e^2}$$

so it becomes

$$N \geq \frac{(1.96)^2 \times 0.95 \times 0.05}{(0.05)^2} \rightarrow N \geq 72.99 \approx 73$$

With description,

$N$ = number of minimum sample
3. Analysis of Structural Equation Modeling (SEM)

Analysis of Structural Equation Modeling (SEM) is used to determine the influence of research variables on the construction reliability of Islamic Senior High School. This analysis yields a mathematical model that can predict the quality of maintenance and reliability levels of building construction in Islamic Senior high school. The SEM analysis is assisted with the computer program AMOS version 2016. The model developed is a path analysis model (recursive path analysis) that can measure the direct and indirect relationships between variables in the model. The SEM path diagram is shown in Figure 1. From Figure 1, we can describe the equation model of the structure consisting of:

- **Structural Component** \( (X_1) \) as exogenous manifest variables 1.
- **Architectural Component** \( (X_2) \) as the exogenous manifest variable 2.
- **Maintenance Quality** \( (X_m) \) as an intermediate variable (moderator).
- **Construction Reliability** \( (Y) \) as endogenous manifest variable.

From the model in Figure 1, here is the equation model:

\[
Y = aX_1 + bX_2 + cX_m + e_1 \tag{4}
\]

\[
X_m = dX_1 + fX_2 + e_2 \tag{5}
\]

The first step is normality test of data with requirement the minimum number of respondents in the model which is a manifest variable at least each variable has 15 data as samples or respondents [16], so we get 15 x 4 = 60 data. The significance test of the variable is conducted by comparing the estimated value to the probability value (p) in Maximum Likelihood Estimates. The requirement significant if the estimate value for all variables is greater than the probability value (p). The next step is the convergent validity test to determine the validity of the model by comparing the value of Variance Extracted (VE) to the value of 0.5. The requirement if the value of VE is smaller than 0.5 so the variable is valid with the model. For the test overall Model of Goodness of Fit can be seen in Table 2, with requirement the index is at the interval (cut off) 0.9 <.... ≤1 then the model is fit (see Table 2).

4. Result and Discussion

4.1. Mean score of User Satisfaction Level to Building Components Maintenance

The survey step by distributing questionnaires as research instruments generated mean score for each variable that compiled the SEM model as shown in Figure 1. The respondents who fill questionnaires are management officers, teachers, and students. The following table describes the calculation of mean score from the survey results to the respondents. Table 3 is the mean score for the exogenous manifest variable of the Structural Component \( (X_1) \) which is the variable of construction system equilibrium has the highest mean score of satisfaction with a mean score equal to 3.861. This result indicates that the maintenance quality of the Structural component \( (X_1) \) with the variable of construction system equilibrium has a mean score almost equal to a satisfactory scale (scale 4). Table 4 describes the mean score for exogenous manifest components of the Architectural Component \( (X_2) \) in which the design and configuration variables of non-hazardous construction systems have the highest mean score of satisfaction level with a mean score equal to 3.912. This result indicates that the maintenance quality
Table 3. Exogenous Manifest Variables of Structural Component (X₁)

| No | Exogenous Manifest Variables                                         | Mean Score |
|----|---------------------------------------------------------------------|------------|
| 1  | Construction work                                                  | 3.722      |
| 2  | Construction equipment                                             | 3.655      |
| 3  | Labor or employee in project                                       | 3.704      |
| 4  | Implementation financial                                           | 3.812      |
| 5  | Work management                                                    | 3.805      |
| 6  | Equilibrium of Construction System                                 | 3.861      |
| 7  | Stability of construction system                                   | 3.758      |
| 8  | Strength of construction system                                    | 3.714      |
| 9  | Proportional and configuration in construction system               | 3.708      |
| 10 | Durability to functional damage level                               | 3.684      |
| 11 | Time service or work function                                      | 3.637      |
| 12 | Level of damage visually                                          | 3.583      |

Table 4. Exogenous Manifest Variables of Architectural Component (X₂)

| No | Exogenous Manifest Variables                                         | Mean Score |
|----|---------------------------------------------------------------------|------------|
| 1  | Free from physical and psychological dangers of construction function| 3.785      |
| 2  | Non-hazardous building materials                                     | 3.804      |
| 3  | Design and configuration of non-hazardous construction systems       | 3.912      |
| 4  | Implementation and maintenance of non-hazardous construction         | 3.566      |
| 5  | Aesthetic structural material                                        | 3.741      |
| 6  | Aesthetic of system and construction configuration                   | 3.732      |
| 7  | Aesthetics of architectural material                                 | 3.757      |
| 8  | Aesthetic of construction crafting details                           | 3.688      |
| 9  | Comfort and regularity of physical and psychic buildings             | 3.648      |
| 10 | Regularity in configuration and construction order system            | 3.686      |
| 11 | Regularity of building construction material system                  | 3.885      |
| 12 | Regularity of non-structural materials in construction system        | 3.794      |
| 13 | Comfort and regularity of outdoor design                             | 3.755      |
Table 5. Moderator Variables of Maintenance Quality (Xm)

| No | Moderator Variables                                      | Mean Score |
|----|----------------------------------------------------------|------------|
| 1  | Structural components of the construction system         | 3.744      |
| 2  | Architectural component of the construction system       | 3.708      |
| 3  | Serviceability of building component                     | 3.769      |
| 4  | Security and safety in building technical specifications | 3.624      |
| 5  | Repairment and maintenance management                    | 3.639      |
| 6  | Comfort and regularity of building components            | 3.706      |
| 7  | Resistance and durability to damage                      | 3.519      |
| 8  | Ease and affordability of maintenance and repair         | 3.665      |
| 9  | Availability of maintenance labor and employee          | 3.675      |
| 10 | Availability of maintenance costs                        | 3.548      |
| 11 | The maintenance method is easy to understand and apply   | 3.516      |

Table 6. Endogenous Manifest Variables of Construction Reliability (Y)

| No | Endogenous Manifest Variables                          | Mean Score |
|----|--------------------------------------------------------|------------|
| 1  | Workability in construction                            | 3.812      |
| 2  | Serviceability of building elements                    | 3.751      |
| 3  | Durability of building components                      | 3.691      |
| 4  | Security and safety in building aspects                | 3.604      |
| 5  | Architectural Aesthetic                                | 3.779      |
| 6  | Comfort and Regularity                                 | 3.725      |
| 7  | Maintainability and easy in maintenance                | 3.683      |
| 8  | Green Construction applied in building                 | 3.508      |

Table 7. Result of Validity and Reliability Test in Research Instrument

| No | Research Variables            | Validity Test (correlation value) | Reliability Test (alpha value) |
|----|-------------------------------|----------------------------------|--------------------------------|
| 1  | Structural Component (X1)    | >0.6                             | 0.956 (>0.6)                   |
| 2  | Architectural Component (X2) | >0.6                             | 0.933 (>0.6)                   |
| 3  | Maintenance Quality (Xm)     | >0.6                             | 0.942 (>0.6)                   |
| 4  | Construction Reliability (Y) | >0.6                             | 0.977 (>0.6)                   |

4.2. Results of Validity and Reliability Test
The results are validity and reliability test for 4 research variables in SEM model to 30 respondents as minimum respondent in a trial test (the results are shown in Table 7). Table 7 describes the correlation value for 4 variables above 0.6 which means that the research instrument with 4 variables which proven valid. Table 7 also provides information that the alpha value is above 0.6 which means the instrument is reliable. This result states that the instrument can be used at a later stage in digging and collecting data. The results of data collection with this instrument can be used in the advanced analysis of Structural Equation Modeling (SEM) analysis.
4.3. Results of Structural Equation Modeling (SEM)
Based on survey results and feasibility test of the previous instrument, the research variables are divided into 4 variables as in SEM model (see Figure 1). The first stage is the normality test that the minimum number of respondents in the model which is a manifest variable at least each variable has 15 data [14], so 15 x 4 = 60 data. The number of respondents is 100 people, so the requirements of normal distributed data are considered to be fulfilled. The significance test of the variable is conducted by comparing the estimated value with the probability value (p) in Maximum Likelihood Estimates (see Table 8).

Table 8. Regression Weights of Variables

| The Relationship Between Variables | Estimate | S.E.  | C.R.  | P   | Description |
|-----------------------------------|----------|-------|-------|-----|-------------|
| Structural Component (X₁) → Maintenance Quality (Xₘ) | 0.338    | 0.174 | 4.052 | 0.004 | Significant |
| Architectural Component (X₂) → Maintenance Quality (Xₘ) | 0.517    | 0.123 | 12.364 | ***  | Significant |
| Structural Component (X₁) → Construction Reliability (Y) | 0.219    | 0.224 | 2.885 | 0.003 | Significant |
| Architectural Component (X₂) → Construction Reliability (Y) | 0.675    | 0.175 | 6.085 | ***  | Significant |
| Maintenance Quality → Construction Reliability (Y) | 0.854    | 0.205 | 3.832 | ***  | Significant |

Table 9. Standardized Regression Weights of Variables

| The Relationship Between Variables | Estimate | Variance extracted | Description |
|-----------------------------------|----------|--------------------|-------------|
| Structural Component (X₁) → Maintenance Quality (Xₘ) | 0.672    | 0.458              | Valid       |
| Architectural Component (X₂) → Maintenance Quality (Xₘ) | 0.681    |                    |             |
| Structural Component (X₁) → Construction Reliability (Y) | 0.417    |                    |             |
| Architectural Component (X₂) → Construction Reliability (Y) | 0.727    | 0.466              | Valid       |
| Maintenance Quality → Construction Reliability (Y) | 0.834    |                    |             |

Table 8 describes that the estimate value for all variables is greater than the value of p. The value p = *** means 0.001. Convergent validity test to know the model correlation by comparing variance extracted value to 0.5.

Correlation that describes influence between variables in SEM analysis is shown with a coefficient of determination. The influence model of building maintenance quality of Islamic Senior High School is:

- Model of the total variable influence: \( Y = 0.417X₁ + 0.797X₂ + 0.883Xₘ \)
- Models of of intermediate variable influence (moderator): \( Xₘ = 0.572X₁ + 0.781X₂ \)

Table 7 describes that the variance extracted value is less than 0.5 [14], which can be calculated as follows,

-Variable of Maintenance Quality \( Xₘ = \)
\[
\frac{0.472^2 + 0.681^2}{2} = \frac{0.452 + 0.464}{2} = \frac{0.916}{2} = 0.458 < 0.5
\]

Variable of Construction Reliability (Y) = \[
\frac{0.417^2 + 0.727^2 + 0.834^2}{3} = \frac{0.174 + 0.529 + 0.696}{3} = \frac{1.399}{3} = 0.466 < 0.5
\]

So from this test, the conclusion is that the valid model with the arrangement of its variables. Table 10 shows the estimate value between Structural Component (X₁) and Architectural Component (X₂), while Table 11 shows the estimate value between Maintenance Quality (Xₘ) and Construction Reliability (Y). The results of this analysis can create path diagram model as in Figure 2.

The relationships between variables indicate a strong level of significance. From Table 11, the model of path diagram explains the variability of Maintenance Quality (Xₘ) is affected by Structural Component (X₁) and Architectural Component (X₂) equal to 82.3%. The Construction Reliability (Y) can be explained by the variability of Structural Component (X₁), Architectural Component (X₂), and Maintenance Quality (Xₘ) equal to 89.4%. The model of the path diagram generates total influence = direct influence + indirect influence. It can be concluded that the influence relationship in the overall model is positive (see Table 12).

Table 10. Correlation between X₁ with X₂

| The Relationship Between Variables | Estimate |
|-----------------------------------|----------|
| Structural Component (X₁) ↔ Architectural Component (X₂) | 0.285    |

Table 11. Correlation between Xₘ with Y

| Variables          | Estimate |
|--------------------|----------|
| Maintenance Quality (Xₘ) | 0.823    |
| Construction Reliability (Y) | 0.894    |

Figure 2. The diagram model of SEM in Islamic Senior High School Al-Rifaie Malang

Table 12. The Relationship between Services Variables

| The Relationship Between Variables | Direct Influence | Indirect Influence | Total Influence |
|------------------------------------|------------------|--------------------|-----------------|
| X₁ → Y                             | 0.417            | (0.672) x (0.834) = 0.560 | 0.977           |
| X₂ → Y                             | 0.727            | (0.681) x (0.834) = 0.568 | 1.295           |
| Xₘ → Y                             | 0.834            | -                  | 0.834           |
| X₁ → Xₘ                            | 0.672            | -                  | 0.672           |
| X₂ → Xₘ                            | 0.681            | -                  | 0.681           |
| X₁ → X₂ (recursive)                | 0.285            | -                  | 0.285           |
5. Conclusion
The results describe the calculation of mean score from the survey results to the respondents. The mean score for the exogenous manifest variable of the Structural Component (X₁) which is the variable of construction system equilibrium has the highest mean score of satisfaction with a mean score equal to 3.861. This result indicates that the maintenance quality of the Structural component (X₁) with the variable of construction system equilibrium has a mean score almost equal to a satisfactory scale (scale 4). The mean score for exogenous manifest components of the Architectural Component (X₂) in which the design and configuration variables of non-hazardous construction systems has the highest mean score of satisfaction level with a mean score equal to 3.912. This result indicates that the maintenance quality of Architectural Component (X₂) with the design and configuration variables of non-hazardous construction systems has a mean score almost equal to a satisfactory scale (scale 4).

The mean score of the intermediate variable (moderator) of Maintenance Quality (Xₘ) which is the serviceability of the building component has the highest mean score in the satisfaction level with mean score equal to 3.769. The maintenance quality (Xₘ) with the serviceability of the building component has a mean score almost equal to a satisfactory scale (scale 4). The mean score for endogenous variable of Construction Reliability (Y) with Ease of construction work (workability) has the highest score of satisfaction level with mean score equal to 3.812. This result shows that Construction Reliability (Y) with the variable Ease of construction work (workability) has a mean score almost equal to a satisfactory scale (scale 4). Overall 4 research variables in the SEM model have mean score almost equal to a satisfactory scale (scale 4). The modeling variables to evaluate and estimate the maintenance quality and construction reliability of Islamic Senior High School building consist of Structural Components (X₁) as exogenous manifest variable 1, Architectural Component (X₂) as exogenous manifest variable 2, Maintenance Quality (Xₘ) as intermediate variable (moderator), and Construction Reliability (Y) as endogenous manifest variables. The result of SEM analysis generates influence model of the total variable: Y = 0.417X₁ + 0.797X₂ + 0.883Xₘ and model influence of intermediate variable (moderator): Xₘ = 0.572X₁ + 0.781X₂. The two models are checked in the level of their significance and validity by comparing the estimate value and Variance Extracted (VE).

The estimate value shows greater than the value p, whereas the Variance Extracted (VE) value is less than 0.5. Relationships between variables indicate a strong level of significance. Variability of Maintenance Quality (Xₘ) is explained by Structural Component (X₁) and Architectural Component (X₂) equal to 82.3%. The Construction Reliability (Y) can be explained by the variability of Structural Component (X₁), Architectural Component (X₂), and Maintenance Quality (Xₘ) equal to 89.4%. The model of the path diagram generates direct and indirect influences between variables, so total influence = direct influence + indirect influence. This model can be used to determine the priority repairment and improvement the maintenance quality and reliability of building construction in Islamic Senior High School Al-Rifaie Malang.

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