Optimization model of performance factor of green and smart building in islamic boarding school

Optimization model of performance factor of green and smart building in islamic boarding school

A Sedayu[1]*

[1]Faculty of Science and Technology
Maulana Malik Ibrahim State Islamic University of Malang

* E-mail:uinsedayu@gmail.com

Abstract. An Islamic Boarding School is one of Islamic religious education institutions that have an important role in supporting Islamic religious education in Indonesia. Islamic Boarding School has physical facilities to support the learning activities and all supporting activities. This study aims to determine the influence model between the performance factors of physical facilities based on Islamic Boarding School needs and user satisfaction. The research location is Islamic boarding school Al-Fatah Malang Regency East Java. Performance factors are structured with reference to green and smart building principles. The methods used are Multiple Linear Regression, Dynamic Programming, and Quantitative Method (QM). The research results generated ten performance factors including Security, Safety and Healthy, Facilities Function, Architectural Aesthetics, Easiness and Affordability, Structural Reliability, Building Durability, Comfortable and Regularity, Availability and Capacity of Facilities, and Implementation of Environmentally Friendly Concept. The ten performance factors have a significant influence on green and smart building performance. The steps of optimization results include Security on Luggage-Free from accidents caused by building design-Natural lighting function-Aesthetic in landscapes, sculpture, and vegetation-Easy in location accessibility from the surrounding areas-Comfort in roof structure performance-Condition in dormitory building-Comfort in dormitory rooms-Availability and capacity of bathrooms-Alternative energy from solar source.

1. Introduction

An Islamic boarding school is an educational institution in the field of Islamic religion had been established for a long time and became a special character for Indonesia. The education system in Islamic boarding school is managed and implemented with traditional and modern systems. Islamic boarding school is supported by complementary facilities both physical and non-physical. Physical facilities in the form of buildings with facilities and supporting utilities affect the success of teaching and learning process at the Islamic boarding school. Many Islamic boarding schools in Indonesia have buildings and facilities that not fulfilled the feasibility standards, so their performance needs to be improved. This study aims to evaluate and optimize the performance factor of Islamic boarding school building by considering green and smart building. Green and smart building is a building concept that is environmentally friendly, energy efficient, and efficient in resource consumption.

The facilities of the Islamic boarding school building include the management building, class, dormitory, library, cafeteria, and others. These facilities need to be improved and enhanced for supporting the learning quality in Islamic boarding schools are guaranteed well and also support the achievement of Indonesia's excellent human resources. The location and object of this research is Islamic boarding school in Al-Fatah Malang Regency. The evaluation and optimization of Islamic boarding school performance analyze user perception that management officers, teachers, students, and visitors of the Islamic boarding school. This study has a novelty compared to previous studies. Several studies to become references to this study were Serbouti et. al. [1] conducted research about application of sensitivity analysis and genopt to optimize the energy performance of a building in Morocco. The aim of this study is to help engineers improve the energy performance of residential buildings by coupling the TRNSYS software both with a sensitivity analysis method and with an

optimization tool. Ali et. al (2018) conducted research about factors impeding the industrialized building system (IBS) implementation of building construction in Malaysia.

This study seeks to identify the barriers to the uptake of IBS and to propose the strategies to enhance the implemen-tation IBS in Malaysian housing construction process from the perspectives of consultants. Sedayu (2016) [3] who conducted a study evaluating the performance of green building in Islamic boarding school. The research variables are Sustainable, Earth friendly, High performance building with Importance-Performance Analysis (IPA), Quality Function Deployment (QFD). Sedayu in 2016 [4] also conducts research on quality evaluation of housing procurement projects with a review of sharia construction management and green building principles. The methods used are Importance Performance Analysis (IPA), Quality Function Deployment (QFD), Multiple linear regression that produce research variables such as assurance, responsiveness and reliability, performance, aesthetics, easiness, durability, environmentally friendly, and Islamic design.

2. Method

2. 1. Determination of Building Performance Factor

The research instruments were developed by referring to and comparing with previous research. Huda (2013) [5] conducted a research can produce research variables that can be adopted such as appropriate site development, energy efficiency and refrigerant, water conservation, material resources and cycle, and indoor Aar health and comfort. Muzammil [6] produces research variables from his research in 2014. The variables can be developed which are flood intensity, ground water quality, flood areas, and soil types. This research develops research variables from Hasan (2014) [7] which consists of energy efficiency, energy audit, and building automation system. Komalasari (2014) [8] conducted a study that became the variable reference of this study.

The research topics discussed are Green Building assessment based on energy efficiency and conservation with comparison study method, modeling with software, and direct measurement. Research variables reviewed include energy efficiency measurement, natural and artificial lighting, ventilation, Climate Change Impact, Vertical transportation, and Air condition system. The Research belongs to Adebara et. al. (2014) [9] become a reference for the methods development. The research is influence analysis of timber as building construction material with investigation, ranking scoring, and quality control measures. The research variables reviewed include domestic purposes, deforestation, over cultivation, poor irrigation, loss of biological aspects, and economic productivity of the land. Nurakumala (2014) [10] conducted a study aimed at determining factors affecting productivity in construction projects with dynamic systems. The methods used are second data observation, qualitative description, and dynamic programming. The research variables that are resulted include employee, time of execution, cost, and work environment. Sugiama (2015) [11] conducts research on service quality modeling on green open space or with Importance Performance Analysis (IPA) method, Quality Function Deployment (QFD), and Focus Group Discussion (FGD).

The research variables include the capability filtering solid particles from the air, capacity of amelioration/improvement of urban climate, water conservation level, and environmental aesthetics. This study refers to research conducted by Sedayu (2016) [12] on Improving service and infrastructure performance with Quality Function Deployment (QFD) and Affinity diagram. The variables studied are facilities, convenience, security, safety, cost and management services. This study is also reinforced by research belongs to Kusumawardani et. al. (2016) [11] on the description of components on the facade elements of the great mosque in Malang with observation, qualitative, and descriptive method. The research variable consist of form, dimension, material, color, and texture. Sedayu (2017) [12] conducts research on method and stage of maintenance of historic mosque construction components. The methods used are Quality Function Deployment (QFD), Structural Equation Modeling (SEM), Autodesk RSAPro 2017, and dynamic programming. The research produces variables including ease, serviceability, durability, security and safety, architectural aesthetics, and comfort and regularity. This study refers to previous studies to develop research instruments. The

research instruments are questionnaires distributed to the respondents. The measurement scale used is likert scale as described in Table 1. The respondents are the users of Islamic senior high school including the management officers, teachers, students, and visitors. The determination of the number of respondents in the advanced survey was calculated by the Bernoulli equation [1]:

$$N \geq \frac{\left(Z_{a/2}\right)^2 p.q}{e^2} \quad (1)$$

The result is $N \geq \frac{(1,96)^2 x0.95x0.05}{(0.05)^2} \rightarrow N \geq 72.99 \approx 73$

With description,
N = number of minimum sample
Z = normal distribution value
e = error rate
p = proportion of questionnaires that are assumed correct
q = proportion of questionnaire that are assumed incorrect

The value is considered correct equal to 95%, and then questionnaires that are considered incorrect equal to 5%. To avoid lacking of data because of mistake of filling or the questionnaires are not return, so the number of respondents to be used are 100 persons.

2.2. Validity and Reliability Test

The validity and reliability tests of research instruments are analyzed by using SPSS 20.0 program. The test was conducted on 30 persons [15]. The validity test is done to know the validity of questionnaire to the respondent. The validity test calculates the correlation coefficient of each item 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:

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

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
ΣX = Total score in distribution X
ΣY = Total score in distribution Y
ΣX^2 = The sum of squares of each score X
ΣY^2 = The sum of squares of each score Y
N = Number of subjects

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

$$r_1 = \left[\frac{k}{k-1}\right]\left[1 - \frac{\sum \sigma b^2}{\sigma.t^2}\right] \quad (3)$$

With description :
r_1 = Instrument consistency
k = Number of items or questions
$\Sigma\sigma b^2$ = Number of variance items
σb^2 = Total variance

Table 1. Measurement Scale in Research Intrument

Variable	Level of User Satisfaction (S)	Level of User Importance (I)
Measurement Scale	1 = Not satisfactory 2 = Less satisfactory 3 = Quite satisfactory 4 = Satisfactory 5 = Very satisfactory	1 = Not important 2 = Less important 3 = Quite important 4 = Important 5 = Very important

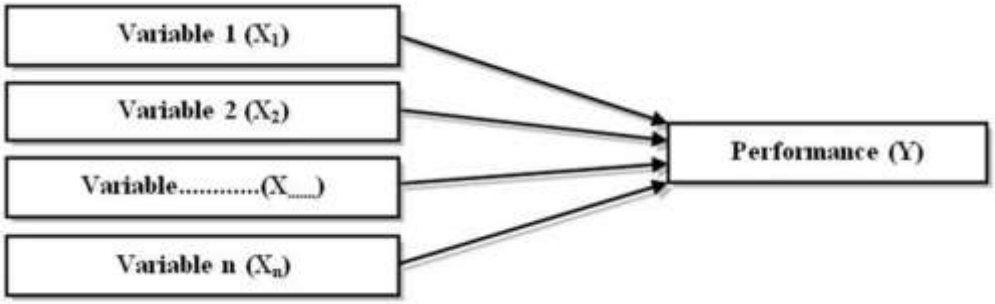

Figure 1. The relationship of 10 independent variables to one dependent variable

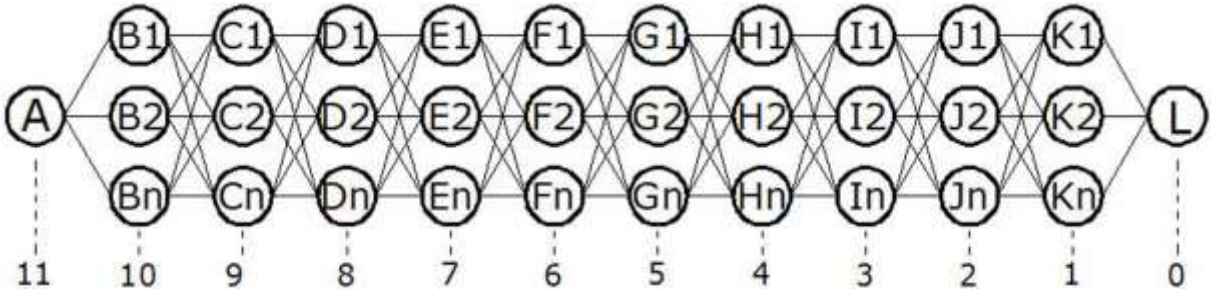

Figure 2. Network Model in Dynamic Programming and Quantitative Method (QM)

2. 3. Analysis of Multiple Linear Regression

A Multiple Linear Regression is used to determine the influence between research variables on the performance of green and smart building in Islamic boarding school. This analysis also produces a model to evaluate the performance of Islamic boarding school. The performance of Islamic boarding school is measured from the level of user satisfaction (S). Multiple linear regression requires a test requirement called Classical Assumption Test that includes Normality, Linearity of Regression Lines, Multicollinearity [16], Autocorrelation, Heteroscedasticity, and Partial Effect. This stage of analysis uses computer program for statistics which is SPSS 20. This research generates 10 independent variables and one dependent variable. Figure 3 is the relationship of 10 independent variables to one dependent variable. The multiple regression model is developed by using the following functions:

$$\mathbf{Y = a_1X_1 + a_2X_2 + ...+ a_nX_n + e} \quad (4)$$

With Y =Dependent variable**;** a_0 = Intercept; a_1, a_2, a_3=Independent coefficient**;** X_1= Independent variable 1**;** X_2= Independent variable 2**;** X_n= Independent variable at n

2.4. Optimization Steps by using Dynamic Programming and Quantitative Method

Dynamic Programming is a technique for solving a problem that involves a set of interconnected decisions in order to achieve the overall activity [17]. The optimization of Dynamic programming uses network diagrams to describe relationships (branches) between variables. Performance optimization of Islamic boarding school calculates the value of user importance (I) to user satisfaction (S) then added with goal to be achieved. The goal value is the expected level of satisfaction performance can be achieved by using formula :

Gap value = Level of User Satisfaction (S) - Level of User Importance (I) + Goal

Dynamic programming seeks to generate the minimum total of gap value for each performance variable. The terms used in problem solving of dynamic programming are Stage, States, Decision, Return Function, and Recursions. The dynamic programming formula is as follows,

$$f_i^*(s_i)=min\{D(s_i,d_i)+f_{i+1}^*(d_i)\} \quad (5)$$

Beside with dynamic programming, optimization is also done with Quantitative Method (QM). Network model in dynamic programming and QM shown are in Figure 4. Quantitative Method (QM) process which is done by using DS Win program equal to dynamic programming that is looking for minimum gap value which need priority improvement of performance of Islamic boarding school.

3. Result and Discussion

3.1. Performance Factors in Islamic Boarding School

Islamic Boarding School in Al-Fatah is supported by several building physical facilities for office, classroom, mosque, laboratory, library, student dormitory, and commercial facilities. The research founds 10 performance factors of Islamic Boarding School. The factors are Security (X_1), Safety and Healthy (X_2), Facilities Function (X_3), Architectural Aesthetics (X_4), Easiness and Affordability (X_5), Structural Reliability (X_6), Building Durability (X_7), Comfortable and Regularity (X_8), Availability and Capacity of Facilities (X_9), and Implementation of Environmentally Friendly Concept (X_{10}). These ten performance factors also function as independent variables (X) which affect the performance factors of green and smart building as dependent variables (Y). Table 2 and 3 show mean values of user satisfaction and importance, goal, and gap. The gap value is the difference between the level of user satisfaction with the importance plus the goal value. This result is used in the next analysis phase.

Table 2. The Level of User Satisfaction and Importance to Performance Factor of Islamic Boarding School Al-Fatah Malang

Number	Performance Factor	Mean Score of Satisfaction (S)	Mean Score of Importance (I)	*Goal*	*Gap*
A	**Preparation and arrangement of Research Instruments**				
B	**Security (X_1)**				
1	Available security center	3.82	3.78	4.00	4.04
2	Free from crime	3.76	3.69	4.00	4.07
3	No savage (thugs) or intruder	3.78	3.72	4.00	4.06
4	Security on luggage	3.63	3.97	4.00	3.66
5	Available safe daycare and locker	3.66	3.84	4.00	3.82
C	**Safety and Healthy (X_2)**				
6	Free from accidents caused by building design	3.62	3.91	4.00	3.71

Number	Performance Factor	Mean Score of Satisfaction (S)	Mean Score of Importance (I)	*Goal*	*Gap*
7	Free from circulation accidents and facilities usage	3.75	3.71	4.00	4.04
8	Availability of health care center	3.88	3.80	4.00	4.08
9	Free from hazardous materials and devices (explosive / polluted)	3.67	3.93	4.00	3.74
10	Free from the dangers of building materials	3.50	3.71	4.00	3.79
D	**Facilities Function (X_3)**				
11	Natural lighting function (solar source)	3.38	4.15	4.00	3.23
12	Artificial lighting function (lamp illumination)	3.57	3.86	4.00	3.71
13	Natural air function (wind circulation)	3.65	3.88	4.00	3.77
14	Artificial winds function (fans and air conditioners)	3.77	3.85	4.00	3.92
E	**Architectural Aesthetics (X_4)**				
15	Aesthetics in facade, element, and building design	3.64	3.68	4.00	3.96
16	Aesthetics in building space	3.73	3.78	4.00	3.95
17	Aesthetics in corridors for circulation	3.81	3.76	4.00	4.05
18	Aesthetic in landscapes, sculpture, and vegetation	3.53	3.81	4.00	3.72
F	**Easiness and Affordability (X_5)**				
19	Easy in location accessibility from the surrounding areas	3.45	3.87	4.00	3.58
20	Easy in vertically indoor and outdoor circulation	3.77	3.85	4.00	3.92
21	Easy from horizontally indoor and outdoor circulation	3.63	3.95	4.00	3.68
G	**Structural Reliability (X_6)**				
22	Comfort in beam structure performance	3.62	3.70	4.00	3.92
23	Comfort in column structure performance	3.65	3.72	4.00	3.93
24	Comfort in floor plate structure performance	3.65	3.88	4.00	3.77
25	Comfort in roof structure performance	3.57	3.89	4.00	3.68
26	Comfort in structural material performance	3.85	3.76	4.00	4.09
27	Comfort in stair structure performance	3.80	3.76	4.00	4.04
H	**Building Durability (X_7)**				
28	Condition of management officer building	3.74	3.68	4.00	4.06
29	Condition of lecture or class building	3.63	3.82	4.00	3.81
30	Condition of dormitory building	3.58	3.84	4.00	3.74
31	Condition of worship building	3.84	3.75	4.00	4.09
32	Condition of laboratory building or workshop	3.74	3.80	4.00	3.94
I	**Comfortable and Regularity (X_8)**				
33	Free from cigarette smoke, vehicle pollution, and odor	3.72	3.83	4.00	3.89
34	Free from noise, glare, and unfavorable view	3.75	3.71	4.00	4.04
35	Cleanliness in the indoor	3.68	3.80	4.00	3.88
36	Cleanliness in the outdoor	3.60	3.87	4.00	3.73
37	Regularity of road order and vehicle parking	3.50	3.43	4.00	4.07
38	The regularity of commercial facilities	3.58	3.50	4.00	4.08
39	Availability and Comfort in the reception area	3.76	3.81	4.00	3.95
40	Regularity in the building arrangement	3.69	4.04	4.00	3.65
41	Availability and Comfort in classrooms	3.64	3.95	4.00	3.69
42	Comfort form interference from outside	3.71	3.72	4.00	3.99
43	Comfort in dormitory rooms	3.42	4.09	4.00	3.33

Number	Performance Factor	Mean Score of Satisfaction (S)	Mean Score of Importance (I)	*Goal*	*Gap*
J	**Availability and Capacity of Facilities (X_9)**				
44	Availability and capacity of parking area	3.75	3.70	4.00	4.05
45	Availability of guest room and facilities	3.65	3.82	4.00	3.83
46	Availability and capacity of kiosks and retail	3.58	3.64	4.00	3.94
47	Availability of garbage facilities	3.65	3.86	4.00	3.79
48	Availability of information and communication facilities for guests	3.62	3.66	4.00	3.96
49	Availability of cafeteria, restaurant, and food store	3.75	3.78	4.00	3.97
50	Availability and capacity of bathroom	3.39	3.97	4.00	3.42
51	Availability and capacity of prayer place	3.65	3.82	4.00	3.83
52	Availability of telecommunication facilities and internet	3.66	3.48	4.00	4.18
53	Availability of television	3.64	3.58	4.00	4.06
54	Availability of Bank	3.66	3.68	4.00	3.98
55	Availability of ATM center	3.65	3.75	4.00	3.90
56	Availability of ramp, travelator, escalator, and elevator	3.72	3.56	4.00	4.16
57	Availability of sports facilities	3.78	3.90	4.00	3.88
58	Availability of open space	3.77	3.87	4.00	3.90
K	**Implementation of Environmentally Friendly Concept (X_{10})**				
59	Security by monitoring tower and CCTV	3.75	3.83	4.00	3.92
60	Disaster handling: fire and earthquake	3.85	3.82	4.00	4.03
61	Alternative energy from solar source	3.62	3.92	4.00	3.70
62	Alternative energy from wind source	3.67	3.96	4.00	3.71
63	Building materials is environmentally friendly	3.63	3.73	4.00	3.90
64	Building materials is derivied from local area	3.65	3.71	4.00	3.94
65	Drainage and utility systems for environmental	3.74	3.81	4.00	3.93
66	Flood reservoir pool (retention pool)	3.75	3.72	4.00	4.03
67	Special circulation for elderly, pregnant women, disabled, and toddlers	3.80	3.77	4.00	4.03
68	Separation of pedestrian ways with vehicle circulation paths	3.78	3.73	4.00	4.05
69	Integration with surrounding areas (can be corridor, pedestrian ways, etc)	3.80	3.84	4.00	3.96
70	There is no negative area either inside or outside space	3.86	3.88	4.00	3.98
L	**Preparation for Dissemination of Research Instruments to Respondents**				

Table 3. Level of User Satisfaction on Green and Smart Building Performance (Y) in Islamic Boarding School Al-Fatah Malang

Number	Performance Factor	Mean of KP
1	Security in luggage, free from criminal acts, availability of security posts, and availability of locker facilities	3.883
2	Guarantee in safety and healthy from hazardous material accidents and	3.717

Number	Performance Factor	Mean of KP
	availability of health facilities	
3	Lighting function and air conditioning in building outdoor and indoor by applying natural and artificial systems	3.873
4	Architectural aesthetics on the building facade, rooms, corridors, parks, landscaping, and vegetation arrangements	3.708
5	The ease and affordability in the location accessibilty and the clarity in space circulation	3.751
6	Structural reliability on the building elements performance such as beams, columns, floor plates, roofs, structural materials, and stair	3.740
7	Durability in management building, lecture/class, dormitory, service room, laboratory, library, auditorium, and seminars/workshop.	3.722
8	Comfort and regularity from pollution, cleanliness in indoor and outdoor, comfort in indoor, free from external disturbance	3.796
9	Availability and capacity in public facilities include living room, kiosk / retail, worship place , guesthouse, canteen, telecommunication facilities, bathroom, ATM, sports facilities, open space, ramp, travelator, escalator, and elevator	3.824
10	Implementation of environmentally friendly concepts in security with CCTV, disaster management, alternative energy, building materials which environmentally friendly, drainage systems, retention pool, facilities for disabled person, integrated environment, useless areas, and pedestrian ways and vehicle circulation paths	3.735

Table 4. Result of Validity and Reliability Test in Research Instrument

Number	Research Variable	Validity Test (correlation value)	Reliability Test (alpha value)	Decision
1	Level of Importance (TK)	All items > 0.6	0.982 (>0.6)	Valid and Reliable
2	Level of Satisfaction (KP)	All items > 0.6	0.947 (>0.6)	Valid and Reliable

Table 5. Analysis Result of Multiple Linear Regression

Variables	*Unstnd.*	t-count	t-table	Criteria
(*constant*)	32.87			
Security (X_1)	2.36	4.90		t count > t table
Safety and Healthy (X_2)	4.49	2.47		t count > t table
Facilities Function (X_3)	7.51	3.04		t count > t table
Architectural Aesthetics (X_4)	3.86	4.11	1.02	t count > t table
Easiness and Affordability (X_5)	2.33	3.78	(dk =	t count > t table
Structural Reliability (X_6)	5.05	4.09	50 and	t count > t table
Building Durability (X_7)	2.17	3.43	*alpha* =	t count > t table
Comfortable and Regularity (X_8)	3.04	6.01	5%)	t count > t table
Availability and Capacity of Facilities (X_9)	6.72	2.59		t count > t table
Implementation of Environmentally Friendly Concept (X_{10})	7.23	5.35		t count > t tabl e
R	= 0.97	Description :		

R *Square*	= 0.94	- Number of data (respondent) = 100
α	= 0.05	- Dependent variable (Y)

3.2. Result of Validity and Reliability Test

The result of validity and reliability test for the research instrument on 30 persons as the minimum respondent in a trial is shown in Table 4. Table 4 explains the correlation value for the two research instruments is above of 0.6, which means that the research instrument is valid. Table 4 also provides information that the alpha value is above of 0.6 which means the instrument is reliable. This result states that the instrument can be used at a continuous stage in collecting data. The results of data collection with this instrument can be used in the further analysis of multiple linear regression analysis.

3.3. Result of Multiple Linear Regression Analysis

3.3.1. Preparation of Regression Model for Green and Smart Building Performance. The calculations results in Table 2 and 3 are used in the stage in multiple linear regression analysis. The results of the multiple linear regression analysis to determine the effect among the research variables are shown in Table 5. The result also generates equation of regression model to calculate and evaluate the green and smart building performance of Islamic Boarding School. The calculation process of this analysis use SPSS 20 software. The results of the analysis obtained the influence of ten performance variables represented by the value of R Square = 0.94. It means that the variability of the building performance can be explained by the regression equation equal to 94%, while the remaining 6% is explained by other variables outside of the model equations. The R-value equal to 0.97 describes that the influence of ten performance variables are significant. From the analysis process, the model can be produced as follow in:

$$\mathbf{Y=32.87+2.36X_1+4.49X_2+7.51X_3+3.86X_4+2.33X_5+5.05X_6+2.17X_7+3.04X_8+6.72X_9+7.23X_{10}}$$

With description,

Y = Green and Smart Building Performance
X_1 = Security
X_2 = Safety and Healthy
X_3 = Facilities Function
X_4 = Architectural Aesthetics
X_5 = Easiness and Affordability
X_6 = Structural Reliability
X_7 = Building Durability
X_8 = Comfortable and Regularity
X_9 = Availability and Capacity of Facilities
X_{10} = Implementation of Environmentally Friendly Concept

The regression model explains the variable constants are positive. This means that the value of the variable X will add a positive to the variable Y.

3.3.2. Result of Classic Assumption Test. The result of normality test generates Kolmogorov-Smirnov Test Z value. This result explains that each performance variable has Asymp value. Sig. 2 tailed is greater than alpha level equal to 0.05 (Asymp Sig. 2 tailed> 0.05). It means that the data is from a normally distributed population. The result of linearity test describes significance value>0,05 for ten performance variables. The regression line model is linear. The result of multicollinearity test indicates that the significance value greater than alpha level equal to 0.05. It can be concluded that all independent variables do not occur multicollinearity. The results of autocorrelation test obtained

Durbin-Watson value of 1.984, and this value is to be close to two values, so it can be concluded there is no autocorrelation between the observation data. The result of heteroscedasticity test for ten variables obtained significance value greater than alpha level 0,05, hence there is no heteroscedasticity. The result of partial effect test describes ten variables have a significant influence with the result of t-count> t-table. The conclusion can be genereted that the regression model is according to the requirements of classical assumption test and can be used in predicting the performance level of Islamic boarding school by analyzing ten building performance variables.

3.4. Result of Performance Optimization

3.4.1. Results of Optimization with Dynamic Programming. The optimization process minimizes the gap value at each stage. From all stages in Table 2, the optimum obtain step to increase the performance of green and smart building by considering the minimum gap value is as follows:

1. Stage 0 (stage in Preparation for Dissemination of Research Instruments to Respondents)
   With the function (n) = 0, will get f0(L) = 0 ; L0 = stop. This stage is the end of the process of optimizing the performance of facilities and utilities at Islamic boarding school. So in stage 0 the optimization stops.
2. Stage 1 (stage in Implementation of Environmentally Friendly Concept (X_{10}))
   Step in stage 1 with function as n = 1, f1(S) = Jn-1+ f0(x) and g1(S) = Jn-1 + g0(x). The minimum step in this stage is f1(K61) = {JK61L + f0(L)} = 3.70 + 0 = 3.70, K1(K61) = go to L. State K61 is Alternative energy from solar source.
3. Stage 2 (stage in Availability and Capacity of Facilities (X_9))
   This Stage 2 with function n = 2, f2(S) = Jn-1+ f1(x) and g2(S) = Jn-1 + g1(x). The minimum step in this stage is f2(J50) = {JJ50K61+f1(K61)} = 3.42 + 3.70 = 7.12, K2(J50) = go to K61. State J50 is Availability and capacity of bathroom.
4. Stage 3 (stage in Comfortable and Regularity (X_8))
   This Stage with function n = 3, f3(S) = Jn-1 + f2(x) and g3(S) = Jn-1 + g2(x). The minimum step in this stage is f3(I43) = {JI43J50+f2(J50)} = 3.33 + 7.12 = 10.45, K3(I43) = go to J50. State I43 is Comfort in dormitory rooms.
5. Stage 4 (stage in Building Durability (X_7))
   This Stage has function with n = 4, f4(S) = Jn-1 + f3(x) and g4(S) = Jn-1 + g3(x). The minimum step in this stage is f4(H30) = {JH30I43+f3(I43)} = 3.74 + 10.45 = 14.19, K4(H30) = go to I43. State H30 is Condition of dormitory building.
6. Stage 5 (stage in Structural Reliability (X_6))
   This Stage has function with n = 5, f5(S) = Jn-1 + f4(x) and g5(S) = Jn-1 + g4(x). The minimum step in this stage is f5(G25) = {JG25H30+f4(H30)} = 3.68 + 14.19 = 17.87, K5(G25) = go to H30. State G25 is Comfort in roof structure performance.
7. Stage 6 (stage in Easiness and Affordability (X_5))
   This Stage has function with n = 6, f6(S) = Jn-1 + f5(x) and g6(S) = Jn-1 + g5(x). The minimum step in this stage is f6(F19)= {JF19G25+f5(G25)} = 3.58 + 17.87 = 21.45, K6(F19) = go to G25. State F19 is Easy from the location from the environment.
8. Stage 7 (stage in Architectural Aesthetics (X_4))
   This Stage has function with n = 7, f7(S) = Jn-1 + f6(x) and g7(S) = Jn-1 + g6(x). The minimum step in this stage is f7(E18) = {JE18F19+f6(F19)} = 3.72 + 21.45 = 25.17, K7(E18) = go to F19. State E18 is Aesthetic in landscapes, sculpture, and vegetation.
9. Stage 8 (stage in Facilities Function (X_3))
   This Stage has function with n = 8, f8(S) = Jn-1 + f7(x) and g8(S) = Jn-1 + g7(x). The minimum step in this stage is f8(D11) = {JD11E18+f7(E18)} = 3.23 + 25.17 = 28.40, K8(D11) = go to E18. State D11 is natural lighting function (solar source).
10. Stage 9 (stage in Safety and Healthy (X_2))

This Stage with function n = 9, f9(S) = Jn-1 + f8(x) and g9(S) = Jn-1+ g8(x). The minimum step in this stage is f9(C9) = {JC9D11+f8(D11)} = 3.71 + 28.40 = 32.19, K9(C6) = go to D11. State C6 is Free from accidents caused by building design.

11. Stage 10 (stage in Security (X_1))
    This Stage with function n = 10, f10(S) = Jn-1 + f9(x) and g10(S) = Jn-1+ g9(x). The minimum step in this stage is f10(B4) = {JB4C6+f9(C6)} = 3.66 + 32.19 = 35.85, K10(B4) = go to C6. State B4 is Security of luggage.
12. Stage 11 (stage in Preparation and arrangement of Research Instruments)
    This Stage has function with n = 11, f11(S) = Jn-1 + f10(x) and g11(S) = Jn-1 + g10(x). The minimum step in this stage is f11(A) = {JAB4+f10(B4)} = 0 + 35.85 = 35.85, K11(A) = go to B4. State A is Preparation and arrangement of Research Instruments.

From the optimization process with the dynamic programming obtain the total value of the minimum gap is 35.85.

3.4.2. Result of Optimization with Quantitative Method. Another method to perform optimization of many priority stages of performance improvement is with Quantitative Method (QM) using DS Win software. Figure 5 and 6 show the optimization process with DS Win. The optimization results indicate the priority step. The steps are A-B4-C6-D11-E18-F19-G25-H30-I43-J50-K61-L with the minimum cumulative Gap value equal to 35.85 (see Table 2). In detail, the steps of optimization results include Preparation and arrangement of Research Instruments - Security on Luggage - Free from accidents caused by building design - Natural lighting function (solar source) - Aesthetic in landscapes, sculpture, and vegetation - Easy in location accessibility from the surrounding areas- Comfort in roof structure performance -Condition in dormitory building - Comfort in dormitory rooms -Availability and capacity of bathrooms - Alternative energy from solar source - Preparation for Dissemination of Research Instruments to Respondents. These results have similarity with optimization results by using dynamic programming.

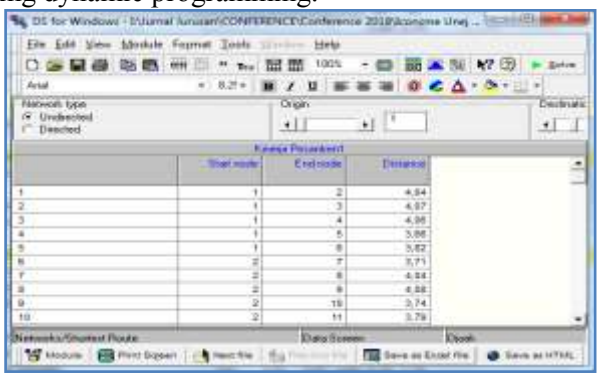

Figure 3. Entry Gap Value to Network

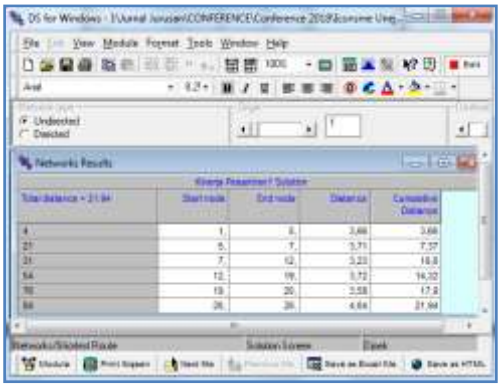

Figure 4. Result of Solve by using DS Win program

5. Conclusion

Islamic boarding school Al-Fatah Malang is supported by several building physical facilities. The facilities include office, classroom, mosque, laboratory, library, student dormitory, and commercial facilities. The research found ten performance factors of Islamic boarding school include Security (X_1), Safety and Healthy (X_2), Facilities Function (X_3), Architectural Aesthetics (X_4), Easiness and Affordability (X_5), Structural Reliability (X_6), Building Durability (X_7), Comfortable and Regularity (X_8), Availability and Capacity of Facilities (X_9), and Implementation of Environmentally Friendly Concept (X_{10}) The result of multiple linear regression analysis to determine the influence between research variables. This result also generates equation of regression model to calculate and evaluate the performance of green and smart building in Islamic boarding school. The results of the analysis obtain the influence of ten performance variables represented by the value of R Square equal to 0.94. It means that the variability of building performance can be explained by the regression equation equal to 94%, while the remaining 6% is explained by other variables outside of the model equations.

The R-value with 0.97 means the influence of ten performance variables is very significant. The analysis creates regression model $Y = 32.87 + 2.36X_1 + 4.49X_2 + 7.51X_3 + 3.86X_4 + 2.33X_5 + 5.05X_6 + 2.17X_7 + 3.04X_8 + 6.72X_9 + 7.23X_{10}$ with Y = Performance of green and smart building in Islamic boading school. The regression model that has been made has met requirements of the classical assumption test and can be used in evaluating and predicting the performance level of Islamic boarding school of ten building performance variables. The classic assumption test includes normality test, linearity test, Multicolinearity test, Autocorrelation test, and heteroscedasticity test. The optimization uses dynamic programming and the network analysis with Quantitative Method (QM). The Quantitative Method (QM) uses DS Win. The optimization result explains the minimum cumulative Gap value equal to 35.85. In detail, the steps of optimization results include Preparation and arrangement of Research Instruments- Security on Luggage-Free from accidents caused by building design-Natural lighting function (solar source)-Aesthetic in landscapes, sculpture, and vegetation- Easy in location accessibility from the surrounding areas-Comfort in roof structure performance-Condition in dormitory building-Comfort in dormitory rooms-Availability and capacity of bathrooms-Alternative energy from solar source-Preparation for Dissemination of Research Instruments to Respondents. These results have similarity with optimization results by using dynamic programming. The management of Islamic boarding school Al-Fatah Malang can improve the performance of green and smart building by considering the result of evaluation and optimization that has been done in this research.

Acknowledgement

The research was funded by the Directorate of Islamic Higher Education of the Directorate General of Islamic Education of the Ministry of Religion Affair of Republic of Indonesia. The research budget is sourced from the budget allocation of research at the Ministry of Religious Affairs of Republic of Indonesia in 2015. Research includes the scope of Science and Technology applied to educational infrastructure especially in Islamic boarding school building. The development of physical infrastructure of education in the form of building is one of the programs strengthened by the Ministry of Religious Affairs of Republic of Indonesia to improve the quality of Islamic education in Indonesia which is managed by traditional education system.

References

[1] Serbouti and Abdelhadi 2018 Application Of Sensitivity Analysis And Genopt To Optimize The Energy Performance Of A Building In Morocco. *International Journal of Engineering & Technology* **7** (4) 2068-2074.

[2] Ali and Massofia M D 2018 Factors Impeding The Industrialized Building System (IBS) Implementation Of Building Construction In Malaysia *International Journal of Engineering & Technology* **7** (4) 2209-2212.

[3] Agung S 2016 Performance Evaluation of Green Building in Islamic Boarding School *The Presentation Material of Keynote Speaker Proceeding in IPLBI Scientific Meeting 2016 ITN Malang*.
[4] Agung S 2016 Service Quality Evaluation of Housing Procurement Project with Sharia project Management and Green Building. *The 16th annual International Conference on Islamic Studies (AICIS) in UIN Raden Intan Bandar Lampung*.
[5] Huda M 2013 Analisis of Important Factors Evaluation Criteria for Green Building. *The International Journal of Engineering And Science (IJES)* **2** (12) 41-47.
[6] Muzammil R 2014 *Application of Biopore Infiltration Holes as an Alternative to Minimize Flood in Ciledug Indah Housing Area I* (Community Service Program of Esa Unggul University in Jakarta).
[7] Hasan S 2014 *Efficiency Implementation in Building* (IPP Hydro Power).
[8] Komalasari R I 2014 Green Building Assessment Based on Energy Efficiency and Conservation (EEC) Category at Postgraduate Building B of Diponegoro University-Semarang *American Journal of Energy Research* **2** 2 42-46
[9] Adebara et. al 2014 Quality and Utilization of Timber Species for Building Costruction in Minna Nigeria *The International Journal of Engineering and Science (IJES)* 2319-1805.
[10] Nurakumala A 2014 Determination of Factors Affecting Productivity on Construction Projects With Dynamic Systems *Proceedings of National Seminar on Technology Management XXI Study Program of MMT ITS Surabaya*.
[11] Sugiama and Gima A 2015 *The Synergistic Model of Quality Service Design of Green Open Space Asset Through QFD* (Research Report of State Polytechnic of Bandung).
[12] Sedayu A, et. al 2016 Service Improvement of Joyoboyo Public Transport Terminal in Surabaya *Transylvanian Review Journal (indexed by Scopus, ISI Thomson Reuters, Copernicus, Social Sciences Citation Index, Arts and Humanities Citation Index, etc.* 1221-1249.
[13] Kusumawardani, Rizka P, Noviani, Suryasari and Antariksa 2016 Components on Facade Elements of the Great Mosque Malang in Period 1910, 1940, and 2016. Http://arsitektur.studentjournal.ub.ac.id.
[14] Sedayu A 2017 *Maintenance Optimization of Sustainable Construction Reliability of Historical Mosques With Dynamic Programming Applications, Quality Function Deployment, And Robot Structural Analysis Professional* (The Research Institute and Community Service in Maulana Malik Ibrahim State Islamic University of Malang).
[15] Sugiyono 2009 *Statistics For Research* (Alfabeta publisher Bandung).
[16] Sudarmanto R and Gunawan 2005 *Multiple Regression Linear Analysis* (Yogyakarta : Graha Ilmu).
[17] Sedayu A 2010 Dynamic Program Application on Implementation Method for Floor Plate Construction *Journal of Cauchy* 2086-0382.