Prioritizing the Conservation of Pondok Pesantren as Cultural and Religious Heritage

Agung Sedayu

Universitas Islam Negeri Maulana Malik Ibrahim Malang Indonesia

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ABSTRACT

The conservation of Pondok Pesantren as a cultural and religious heritage considers user perception to evaluate the technical aspects. Many building studies are based on technical aspects and rarely involve user perception. Pondok Pesantren as an Islamic religious, educational institution was developed by a social and multicultural approach. The results of this study are used to develop maintenance and conservation priorities that benefit in the development of educational institutions, cultural preservation, economic and investment improvement, the application of sustainable buildings, and the development of educational and religious tourism.This research determines the priority of conservation and maintenance efforts at Pondok Pesantren heritage. The priority is determined by analyzing the level of influence and optimisation of building performance factors by implementing green building principles**.** The method used is multiple linear regression and optimisation by using dynamic programming. Research data is the perception of user consisting of residents and visitors. Residents of Pondok Pesantren include teachers and students.The priority of improving the performance includes: Security protection for residents and visitors; Free from dangerous materials and devices; Function of natural lighting; Aesthetics of park, landscape, and vegetation; Ease of indoor and outdoor circulation horizontally; Performance and reliability of roof structures; Durability of dormitory buildings; Regularity in buildings arrangement; Availability of information and communication facilities for visitors; and Alternative energy from wind sources or Environmental drainage and utility systems.

Keywords: Priority, Conservation, Cultural and Religious Heritage, User Perception, Green Building Principles

INTRODUCTION

Pondok Pesantren, or Islamic boarding schools, are Islamic religious education institutions that are developing in Indonesiaby a tradition and culture. Teachers at Pondok Pesantren are called *kyai* or *ustadz*, while students are called *santri* (Busyairi, 2017). Pondok Pesantren Sidogiri is one of the oldest Islamic boarding schools in Pasuruan, East Java, Indonesia and was founded in 1718. Pondok Pesantren Sidogiri is a traditional boarding school characterised by students who live in small houses or huts. Pondok Pesantren, as a centre for the development of Indonesian human resources, needs to be supported by physical facilities and building utilities that are ideally suited to accommodate the activities and functions that are carried out in them.The Indonesian Ministry of Education and Culture (2017) explained that Pondok Pesantren Sidogiri became one of the cultural and religious heritage that became the centre of educational development with a multi-cultural approach in Indonesia. The multicultural approach adopted can develop a moderate Islamic education and prevent acts of radicalism (Muazza et al, 2018). Until now, Pondok Pesantren Sidogiri has became a religious and educational tourism destination in the national and international levels.

This research aims to determine the priority of conservation and maintenance efforts of Pondok Pesantren heritage to keep functioning properly. The research variables to be evaluated and optimized refer to the green building principles by Green Building Council of Indonesia (GBCI). The implementation of green building principles can support building functions that ensure security, safety, health for the user. The green building principles can be applied to Pondok Pesantren to prevent Covid-19 pandemic (Kurniawan, 2020). This research is a continuation of study on determining the priorities in maintaining the reliability of the sustainable

construction at the Ampel Mosque Surabaya Indonesia (Sedayu, 2018). The methods used were importance performance analysis (IPA) and quality function deployment (QFD). The data obtained from the research concluded that the requirements in highest demand are the convenience and accessibility levels, in terms of the maintainability of structural components. Sedayu et al. (2021) also conducted research on the reliability of the Kotagede Mosque in Yogyakarta, in terms of both its construction and its function as a place of worship that fosters tolerance toward people of other faiths living in the surrounding area.

METHOD

The first step is to analyse the different levels of influence of the performance variables.The measurement of the performance of Pondok Pesantren involves the perceptions and views of the user. This consideration involves hearing the views of user because technical studies of buildings pay more attention to technical aspects and little attention to user needs. The research instrument is a questionnaire distributed to respondents. The selection of respondents is based on the users of the Pondok Pesantren (Islamic boarding school) and its facilities. These users are familiar with the level of service provided by the pondok pesantren and all of its facilities. The facilities at the Pondok Pesantren encompass both primary and supporting facilities.The respondents are the user of Pondok Pesantren, namely teachers (*kyai* or *ustadz*), students (*santri*), and visitors.Determination of research samples is based on the Bernoulli equation:

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

Thus becoming

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

Description: N = the minimum number of samples; Z = normal distribution value; e = error rate; p = proportion of the number of questionnaires that are considered correct; and q = proportion of the number of questionnaires that are considered incorrect. The correct value is 95% and incorrect is 5%. To avoid shortages of data, it was decided to use 100 respondents.

The stages of this research include the determination of research instruments, validity and reliability testing of these instruments, multiple linear regression analysis, and dynamic programming. The research instruments are based on a survey of the existing conditions at the study site—the Sidogiri Islamic Boarding School (Pondok Pesantren Sidogiri) in Pasuruan—and are further supported by previous studies and established building standards. The research instruments consist of questionnaires to be completed by respondents participating in this study. The research instrument was first distributed to 30 respondents to carry out a trial which then tested the validity of the test, which is strongly correlated if the correlation value is above 0.6 (Sedayu, 2020).The reliability test was used to find out the level of accuracy, stability, or consistency of the instrument. The internal consistency is tested by using a consistency coefficient (Cronbach's Alpha). The calculation has the provision that the alpha coefficient value (Cronbach's Alpha coefficient) is above 0.60 (Sedayu, 2020).The validity and reliability were tested with the help of SPSS. The data collection tool used is a questionnaire with a measurement scale as follows:

Table I. Measurement scale of research instruments

Variable	Level of user satisfaction (Sat)	Level of user importance (Imp)
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

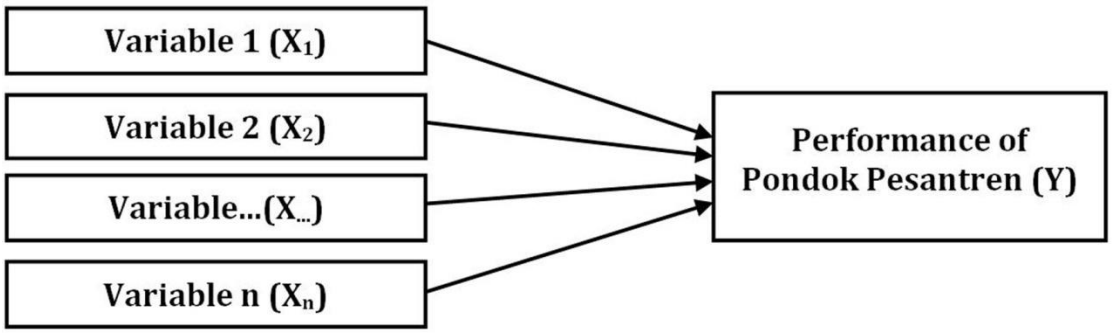


Figure 1. The relationship between performance variables of Pondok Pesantren

Multiple linear regression analysis is used to determine the influence of the variables on the heritage performance. Figure 1 shows the relationship of the 10 independent variables to the one dependent variable. This analysis also produces a model to evaluate the performance of Pondok Pesantren, which is measured by the level of the user satisfaction. Multiple linear regression requires a classical assumption test, which includes normality, linear regression line, multicollinearity, autocorrelation, heteroscedasticity, and partial influence (Sedayu, 2020).This analysis step uses an SPSS for statistical calculations. Multiple regression models are developed with the following functions:

$$Y = a_0 + a_1X_1 + a_2X_2 + ...+ a_nX_n + e(2)$$

Description: Y = dependent variable of the green building performance; a_0 = constant; a_1, a_2, a_3 = coefficient of independent variables; X_1 = 1stindependent variable; X_2 = 2ndindependent variable; X_n = nth independent variable.

Dynamic programming is a technique for solving problems that involve a set of decisions that are interconnected in order to achieve overall activity (Boomen et al, 2019). Optimisation in dynamic programming uses network diagrams to facilitate the drawing of relationships (branches) between variables (see Figure 2). Optimising the performance of Pondok Pesantren, calculating the value of the data gap between the level of user importance and user satisfaction, is then added to the goal to be achieved.The satisfaction level indicates how satisfied users are with the Islamic boarding school (Pondok Pesantren) and its facilities. In contrast, the importance level reflects the significance users place on the performance of the Islamic boarding school and its facilities. In this context, the performance of the Islamic boarding school refers to its buildings and other physical facilities, encompassing both indoor and outdoor areas.The goal is the level of satisfaction performance that is expected to be achieved with a gap value formula is as follows:

$$\text{Gap Value} = \text{User Satisfaction (Sat)} - \text{User Importance(Imp)} + \text{Goal} \quad (3)$$

Dynamic programs attempt to obtain the total minimum number of gap values for each performance variable.The dynamic programming uses recursive formula is as follows:

$$f_n(S) = \min\{P_{z_nS} + f_{n-1}(z_n)\} \quad (4)$$

Description:

z_n = Decision variable at stage n (n=0,1,2,3,4 and so on)

P_{z_nS} = Minimum gap value from S to z_n

$f_{n-1}(z_n)$ = Cumulative number of minimum gap values at n-1 or before n

$f_n(S)$ = Minimum gap value of$P_{z_nS} + f_{n-1}(z_n)$

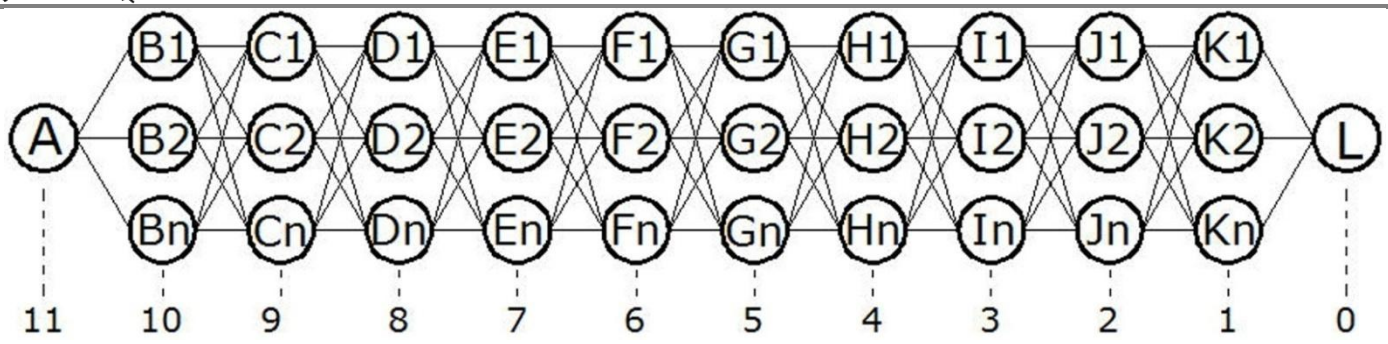


Figure 2. Network model in a dynamic programming

RESULTS AND DISCUSSION

The UNESCO World Heritage Centre and the Research Centre for Islamic History, Art and Culture (IRCICA) have cooperated regularly since 1996 on areas relating to the safeguarding of cultural heritage in Islamic countries, as well as cultural policies, international cooperation, scholarly research, documentation and training (UNESCO, 2009). Pondok Pesantren plays an important role in explaining the unique and different historical values in Indonesia compared to other countries. Figures 3 and 4 show the existing condition of the Sidogiri Islamic Boarding School (Pondok Pesantren Sidogiri), the site of this research. To this day, the boarding school remains actively engaged in educational activities, accommodating a very large number of students (santri).



Figure 3. Conditions in Pondok Pesantren



Figure 4. Condition of Santri Dormitory Area

Pondok Pesantren that accommodate many people require security, health, safety, and comfort of buildings, especially during the Covid-19 Pandemic. The green building principle can support security, health, safety, and comfort for the user, namely residents and visitors (Widyasari et al, 2020). In addition, the application of green building supports conservation and maintenance efforts of a cultural and religious heritage against building damage due to climate change. Climate change is having a negative impact on humans and cultural heritage sites both tangible and intangible (ICOMOS, 2017). The research variables were developed refer to green building principles (GBCI, 2013) and Leadership in Energy and Environmental Design (LEED) (Kim et al, 2017). This variable is the dependent variable and encompasses indicators of satisfaction, importance, and goals, based on users' perceptions of the performance of the Pondok Pesantren (Islamic boarding school) buildings.The research variables used as research instruments shown in Table II consist of Security (X_1), Health and safety(X_2), Facility functions(X_3), Architectural aesthetics(X_4), Ease and accessibility(X_5), Structural reliability(X_6), Building durability(X_7), Comfort and regularity(X_8), Availability and capacity of public facilities(X_9), and Application of environmentallyfriendly concepts(X_{10}).

Table II. Levels of user satisfaction with the performance of Pondok Pesantren Sidogiri

No.	Performance factors of Pondok Pesantren Sidogiri Pasuruan	Sat	Imp	Goal	Gap
A	Preparation of research instrument				
B	Security (X_1)				
1	Availability of security centre	3.97	3.92	4.00	4.05
2	Free from crime (criminals)	3.73	3.70	4.00	4.03
3	There are no wild people (thugs) or illegal people	3.75	3.74	4.00	4.01
4	Security of luggage	3.52	3.43	4.00	4.09
5	Availability of safe luggage storage	3.75	3.68	4.00	4.07
C	Health and safety(X_2)				
6	Free from accidents due to building design	3.76	3.70	4.00	4.06
7	Free from accidents in circulation and use of facilities	3.72	3.71	4.00	4.01
8	Availability of health service centre	3.82	3.77	4.00	4.05
9	Free from dangerous materials and devices (explosive/polluting)	3.77	3.89	4.00	3.88

10	Free from dangerous building materials	3.80	3.79	4.00	4.01
D	Facility functions (X_3)				
11	Function of natural lighting (source of sunlight)	3.35	4.03	4.00	3.32
12	Function of artificial lighting	3.57	3.85	4.00	3.72
13	Function of natural ventilation (wind circulation)	3.45	3.98	4.00	3.47
14	Function of artificial ventilation (fan and AC)	3.79	3.84	4.00	3.95
E	Architectural aesthetics (X_4)				
15	Aesthetics of facades, elements and design of buildings	3.69	3.68	4.00	4.01
16	Aesthetics of inner space in the building	3.70	3.80	4.00	3.90
17	Aesthetics of corridor and hallway for circulation	3.61	3.86	4.00	3.75
18	Aesthetics of park, landscape, and vegetation	3.58	3.88	4.00	3.70
F	Ease and affordability (X_5)				
19	Ease of the location of Pondok Pesantren from the surroundings	3.56	3.90	4.00	3.66
20	Ease of indoor and outdoor circulation vertically	3.77	3.95	4.00	3.82
21	Ease of indoor and outdoor circulation horizontally	3.60	3.97	4.00	3.63
G	Structuralreliability (X_6)				
22	Performance and reliability of beam structures	3.92	3.80	4.00	4.12
23	Performance and reliability of column structures	3.90	3.82	4.00	4.08
24	Performance and reliability of slab structures	3.77	3.71	4.00	4.06
25	Performance and reliability of roof structures	3.58	3.86	4.00	3.72
26	Performance and reliability of structural materials	3.87	3.86	4.00	4.01
27	Performance and reliability of stair structures	3.82	3.80	4.00	4.02
H	Building durability (X_7)				
28	Durability of management buildings	3.72	3.70	4.00	4.02
29	Durability of lecture buildings or classrooms	3.61	3.85	4.00	3.76
30	Durability of dormitory buildings	3.62	3.88	4.00	3.74
31	Durability of worship buildings	3.78	3.76	4.00	4.02
32	Durability of laboratory and workshop buildings	3.72	3.70	4.00	4.02
I	Comfort and regularity (X_8)				
33	Free from cigarette smoke, vehicle pollution, and bad odours	3.70	3.82	4.00	3.88
34	Free from noise, glare, and poor view	3.68	3.61	4.00	4.07
35	Cleanliness of the inner room	3.60	3.83	4.00	3.77
36	Cleanliness of the outer space	3.58	3.85	4.00	3.73
37	Regularity of road and parking of vehicles	3.55	3.53	4.00	4.02
38	Regularity of commercial facilities	3.58	3.50	4.00	4.08
39	Availability and comfort of the guest lounge	3.64	3.87	4.00	3.77
40	Regularity in buildings arrangement	3.59	4.04	4.00	3.55
41	Availability and comfort of classrooms	3.60	3.93	4.00	3.67
42	Comfort free from outside disturbances	3.57	3.52	4.00	4.05
43	Comfort in the dormitory room	3.54	3.91	4.00	3.63
J	Availability and capacity of public facilities (X_9)				
44	Availability and capacity of parking area	3.85	3.83	4.00	4.02
45	Availability of rooms and lodging facilities for guests	3.68	3.80	4.00	3.88
46	Availability and capacity of kiosks and retail	3.63	3.84	4.00	3.79
47	Availability of waste facilities	3.55	3.85	4.00	3.70
48	Availability of information and communication facilities for guests	3.47	3.94	4.00	3.53
49	Availability of canteens, restaurants and food stores	3.79	3.72	4.00	4.07
50	Availability and capacity of bathrooms	3.94	3.82	4.00	4.12
51	Availability and capacity of worship spaces	3.63	3.83	4.00	3.80
52	Availability of telecommunication and internet facilities	3.53	3.45	4.00	4.08
53	Availability of television	3.63	3.62	4.00	4.01
54	Availability of bank	3.63	3.61	4.00	4.02

55	Availability of ATM centre	3.67	3.63	4.00	4.04
56	Availability of ramp, travelator, escalator, and elevator	3.70	3.66	4.00	4.04
57	Availability of sport facilities	3.72	3.85	4.00	3.87
58	Availability of open space facilities	3.75	3.85	4.00	3.90
K	Application of environmentally friendly concepts(X_{10})				
59	Security facilities with monitoring and CCTV	3.63	3.62	4.00	4.01
60	Disaster management: fire and earthquake	3.83	3.80	4.00	4.03
61	Alternative energy from solar sources	3.62	3.90	4.00	3.72
62	Alternative energy from wind sources	3.67	3.96	4.00	3.71
63	Environmentally friendly and local building materials	3.73	3.70	4.00	4.03
64	Outdoor building materials are environmentally friendly and from local area	3.75	3.71	4.00	4.04
65	Environmental drainage and utility systems	3.54	3.83	4.00	3.71
66	Availability of retention pool	3.65	3.62	4.00	4.03
67	Special circulations for elderly people, pregnant women, and disabled people	3.78	3.75	4.00	4.03
68	Differences in pedestrian and vehicle circulation paths	3.75	3.70	4.00	4.05
69	Integration with the surrounding environment (can be a corridor, etc.)	3.84	3.81	4.00	4.03
70	No negative areas, either inside or outside space	3.83	3.80	4.00	4.03
L	Preparation of research instrument for distribution to respondents				

The results of the validity and reliability test of the research instrument against the 30 respondents showed it to be declared valid and reliable, making it feasible and able to meet the requirements for analysis and subsequent testing. The resullts explain all the correlation values>0.6 and alpha values also> 0.6, which means that the research instruments are valid and reliable as a data collection tool.Previous researches by interview, questionnaire, and observation methods were conducted to resolve conflicts between development and conservation without eliminating the historical, cultural, and architectural value of cultural heritages (Bose, 2020). Metropolitan cities with the rapid development of high-rise buildings can change cultural heritages into modern buildings. Sustainable managements of heritage can improve the usability and historical value of becoming a landmark in a city. The city's residents have a high interest in the existence of heritage because it can maintain historical value and increase economic investment, especially the tourism sector. The level of public interest can be known by a survey, interview, and questionnaire methods. Public data and informations are needed to improve the main and supporting services on the cultural heritage (Benkari, 2018). Basically, maintenance and conservation management aims to maintain a sustainable cycle of buildings. The maintenance quality can be measured based on the satisfaction of all stakeholders (Pukite et. al, 2017; Ogbeifun, 2018; Seyfi et. al., 2018). In the religious tourism sector, heritage maintenance management is always updated based on stakeholder perception, especially investor and visitor satisfaction (Ahmed et. al., 2019). The results of the Determination of performance factors are shown in Table II, which also lists the mean value of user satisfaction, the mean value of user importance, the goal, and a gap value for each performance factor.Table II shows 10 research variables detailed into 70 factors as research instruments to determine the priorities of conservation and maintenance efforts of Pondok Pesantren.These results are used for the purposes of multiple linear regression analysis and the optimisation of performance at PondokPesantren.

The results of multiple linear regression analysis to determine the influence between research variables are shown in Table III.This result also obtained a regression model equation for calculating and evaluating the performance of the green building in Pondok Pesantren. The process of calculating this analysis uses SPSS 20 software. The results of the analysis obtain the influence of 10 performance variables represented by the value of R square = 0.92, meaning that the variation in performance of Pondok Pesantren can be explained by a regression equation of 92% while the remaining 8% is explained by other variables outside the model equation.The value of R = 0.96 means that the influence of the 10 performance variables is very strong. From the analysis process, the regression model can be made as follows:

$$Y=26.12+3.21X_1+5.27X_2+6.16X_3+3.64X_4+2.81X_5+4.42X_6+1.92X_7+2.23X_8+5.11X_9+6.75X_{10}$$

Description: Y = green building performance of cultural and religious heritage; X_1 = security; X_2 = health and safety; X_3 = facility functions; X_4 = architectural aesthetics; X_5 = ease and accessibility; X_6 = structural

reliability; X_7 = building durability; X_8 = comfort and regularity; X_9 = availability and capacity of public facilities; X_{10} = application of environmentally friendly concepts.

Table III. Results of multiple linear regression analysis

Variables	Unstandardized Coefficients	t-count	t-table	Criteria
(constant)	26.12		1.04 (degree of freedom = 50 and alpha = 5%)	
Security (X_1)	3.21	6.57		t-count> t-table
Health and safety (X_2)	5.27	3.23		t-count> t-table
Facility functions (X_3)	6.16	2.89		t-count> t-table
Architectural aesthetics (X_4)	3.64	3.71		t-count> t-table
Ease and affordability (X_5)	2.81	3.23		t-count> t-table
Structural reliability (X_6)	4.42	3.15		t-count> t-table
Building durability (X_7)	1.92	4.26		t-count> t-table
Comfort and regularity (X_8)	2.23	5.12		t-count> t-table
Availability and capacity of public facilities (X_9)	5.11	3.55		t-count> t-table
Application of environmentally friendly concepts (X_{10})	6.75	6.23		t-count> t-table
R = 0.96 R square = 0.92 α = 0.05		Explanation : - Amount of data (respondents) = 100 - Dependent variable (Y)		

The resulting regression model shows that the variable constant is positive. This means that the value of the variable X will add the Y value positively. The results of the normality test were obtained from the Kolmogorov–Smirnov test Z value, which explains each performance variable has a value of Asymptotic Significance 2-tailed, which is greater than alpha level 0.05 (Asymptotic Significance 2-tailed > 0.05), meaning that the data comes from populations that are normally distributed. The results of the linearity test show that the significance value is> 0.05 for the 10 performance variables, so that the regression line model is linear. The results of the multicollinearity test show that the significance value is greater than the alpha level of 0.05, so it can be concluded that there is no multicollinearity among the independent variables. The results of the autocorrelation test obtain a Durbin–Watson value of 1.975, and this value is expressed close to two values, so it can be concluded that there is no autocorrelation between the observational data. The results of the heteroscedasticity test for the 10 variables obtain a significance value greater than the alpha value (0.05), so there is no heteroscedasticity. The results of the partial test show that the 10 influential variables are very strong and that the results are t-count> t-table. The conclusion that can be obtained is that the regression model created has met the classical assumption test and can be used to predict the level of performance of Pondok Pesantren from the 10 variables.

Architecture, Urbanism, and culture have a strong influence on the development of Islamic civilization throughout Muslim countries or regions. The social, economic, educational, and political aspects of the Muslim community are rapidly evolving into unique and different civilizations in each country or region. Islamic schools in the United States and the United Kingdom are also influenced by the socio-cultural factors of the community. The influence is seen in the interaction between students, teachers, and the surrounding community. Pondok Pesantren accommodates teaching activities between teachers and students that require a lot of open gathering space. The conservation efforts of study spaces in Pondok Pesantren support the function can run properly and maintain historical heritage value in buildings (Efendi et al, 2019). The maintenance of heritage can provide history lessons for the next generation. A well-functioning Heritage shows that building resources can be reused by the application of sustainable concepts (Gharib, 2017). The building also affects the behavioral characteristics of teachers and students, physical and psychological comfort, health and safety, and architectural value (Wilson et al, 2018).

This optimisation process uses recursive equations that are calculated backward according to the network model in Figure 2. Table II describes the results of the minimum gap value. The goal is the expected level of satisfaction with the targeted score is 4, because the top mean value of the user satisfaction level close to score of 4 (satisfactory level). The priority of heritage conservation and maintenance is the improvement of performance factors based on the minimum gap value. At stage 0 (n=0) the variable No. L =Improving the performance according to optimisation.At stage 1 (n=1), the variable No. K = Application of environmentally friendly concepts (X_{10}) has two factors that have a same gap value, namely Alternative energy from wind sources (no. K4) and Environmental drainage and utility systems (No. K7) with a gap value = 3.71.The minimum gap value is calculated by the function $P_1(K4) = \min\{R_{K4\text{-}L} + P_0(K4)\} = 3.71 + 0 = 3.71$ and $P_1(K7) = \min\{R_{K7\text{-}L} + P_0(K7)\} = 3.71 + 0 = 3.71$. The application of eco-friendly concepts can improve sustainable performance in the heritage components of Pondok Pesantren (Mubarok et al, 2018).The use of alternative wind-sourced energy is supported by Indonesia's tropical climate, while the provision of utility systems and environmental drainage to prevent floods. Indonesia's tropical climate with high rainfall causes many floods that will damage heritage and interfere the safety and comfort.

At stage 2 (n=2), the variable No. J = Availability and capacity of public facilities (X_9) has one factor that has a minimum gap value, namely Availability of information and communication facilities for visitors (No. J5) with a gap value = 3.53. The minimum gap value is calculated by the function $P_2(J5) = \min\{R_{J5\text{-}K4 \text{ or } K7} + P_1(J5)\} = 3.53 + 3.71 = 7.24$. Easy access to information and communication for user is necessary to know in detail about the heritage. Information technology can also be used to detect the damage of heritage building (Aicardi et al, 2018).

At stage 3 (n=3), the variable No. I = Comfort and regularity (X_8) has one factor that has a minimum gap value, namely Regularity in buildings arrangement (No. I8) with a gap value = 3.55. The minimum gap value is calculated by the function $P_3(I8) = \min\{R_{I8\text{-}J5} + P_2(I8)\} = 3.55 + 7.24 = 10.79$. The user comfort in Pondok Pesantren is supported by the regularity of the relationship between the circulation and layout of the building. The distance between buildings supports air circulation and natural lighting in building (Guo, et. al, 2026).

At stage 4 (n=4), the variable No. H = Building durability (X_7) has one factor that has a minimum gap value, namely Durability of dormitory buildings (No. H3) with a gap value = 3.74. The minimum gap value is calculated by the function $P_4(H3) = \min\{R_{H3\text{-}I8} + P_3(H3)\} = 3.74 + 10.79 = 14.53$. The durability of buildings can be strengthened by efforts to maintain structural and architectural materials. Materials are one of the factors that support building resilience (Nemati et al, 2026).

At stage 5 (n=5), the variable No. G = Structural reliability (X_6) has one factor with the minimum gap value, namely Performance and reliability of roof structures (No. G4) with a gap value = 3.72. The calculation of the gap value with a function $P_5(G4) = \min\{R_{G4\text{-}H3} + P_4(G4)\} = 3.72 + 14.53 = 18.25$. The reliability of the roof structure in Indonesia's tropical climate is necessary to ensure the comfort and safety for user in Pondok Pesantren, especially student dormitories. Damage to roof structures in heritage buildings can be avoided with material maintenance and roofing assembly (roof structure configuration) (ICOMOS, 2003).

At stage 6 (n=6), the variable No. F = Ease and accessibility (X_5) has a factor with the minimum gap value, namely Ease of indoor and outdoor circulation horizontally (No. F3) with a gap value = 3.63. The calculation of the gap value with a function $P_6(F3) = \min\{R_{F3\text{-}G4} + P_5(F3)\} = 3.63 + 18.25 = 21.88$. The ease of circulation between building spaces for residents and visitors affect the user comfort. This can be realized by providing corridors between buildings, circulation signage boards, clear circulation flows, easy walking distance, and pedestrian facilities. Disable personsalso get easy access and circulation with the availability of facilities for them (Smarz et. al, 2026)

At stage 7 (n=7), the variable No. E = Architectural aesthetics (X_4) has a factor with the minimum gap value, namely Aesthetics of park, landscape, and vegetation (No. E4) with a gap value = 3.70. The calculation of this gap value with a function $P_7(E4) = \min\{R_{E4\text{-}F3} + P_6(E4)\} = 3.70 + 21.88 = 25.58$. The availability of green open spaces, parks, and landscaping can support the comfort of indoor and outdoor spaces. The aesthetic

arrangement in open space becomes comfortable gathering places, thus supporting activities in Pondok Pesantren (Mubarok et al, 2018)

Stage 8 (n=8) with variable No. D = Facility functions (X_3) has a factor with the minimum gap value is Function of natural lighting (source of sunlight) (No. D1) with a gap value = 3.32. The calculation of this gap value with a function $P_8(D1) = \min\{R_{D1\text{-}E4} + P_7(D1)\} = 3.32 + 25.58 = 28.90$. Supporting facilities are required to provide services to the user in order for functions and activities in heritage buildings can run properly (Ogbeifun, 2018). Natural lighting sourced from sunlight provides a thermal comfort and health impact for the user (Andiyan et. al, 2026)

Stage 9 (n=9) which is variable No. C = Health and safety (X_2) has a factor with the minimum gap value is Free from dangerous materials and devices (explosive/polluting) (No. C4) with a gap value = 3.88. The calculation of this gap value with a function $P_9(C4) = \min\{R_{C4\text{-}D1} + P_8(C4)\} = 3.88 + 28.90 = 32.78$. The application of reuse and recycle materials can avoid user accidents in heritage buildings. A maintenance management should consider the use of technology and maintenance equipment that protects human resources from work accidents (Sedayu et al, 2020)

Stage 10 (n=10) which is variable No. B = Security (X_1) has a factor with the minimum gap value, namely Security protection for residents and visitors (No. B3) with a gap value = 4.01. The calculation of this gap value with a function $P_{10}(B3) = \min\{R_{B3\text{-}C4} + P_9(B3)\} = 4.01 + 32.78 = 36.79$. The building management organization guarantees the availability of services and security facilities for user (Sedayu et al, 2020). The conservation efforts aim to maintain the safety aspect of heritage buildings from damage caused by loads, including natural disasters (Dewi, 2017). Finally, Stage 11 (n=11) with variable No. A = Determination of performance factors is the final stage of this optimisation. The calculation of total gap values with a function $P_{11}(A) = \min\{R_{A\text{-}B3} + P_{10}(A)\} = 0 + 36.79 = 36.79$.

The Sidogiri Islamic Boarding School (Pondok Pesantren) in Pasuruan is one of the oldest Islamic educational institutions in Indonesia, particularly in East Java. Such institutions play a vital role in cultivating the nation's human resources—fostering individuals with noble mental and spiritual qualities. In this era of rapid technological change, high-level technical skills alone are insufficient; strong moral character and a noble mindset are essential to ensuring that life within the nation and state remains orderly and principled. Beyond its success in Islamic religious education, the Sidogiri Islamic Boarding School has also excelled in developing a retail business, operating a chain of minimarkets spread across Indonesia, with a strong presence in East Java. These retail outlets—known as "Basmalah" and "Hamdalah"—provide daily necessities at affordable prices, thereby meeting the public's needs and contributing to the local economy. The Sidogiri Islamic Boarding School serves a comprehensive purpose for the nation and the state: it acts as a guardian of religion and culture, a hub for Islamic educational civilization, and a catalyst for socio-economic self-reliance through entrepreneurship. The institution is also actively engaged in various other sectors, including Islamic finance, cooperatives, printing, and transportation (Redaksi Sidogiri, 2019).

CONCLUSION

Pondok Pesantren Sidogiri as one of the religious and cultural heritage becomes an educational and religious tourism destination in the national and international levels. Efforts to maintain and conserve Pondok Pesantren can support the development of religious education, the preservation of Indonesian culture, economic and investment improvement, the application of sustainable concepts in heritage, and the development of educational and religious tourism. The results obtained 10 performance variables according to green building principles, including security, health and safety, facility functions, architectural aesthetics, ease and accessibility, structural reliability, building durability,comfort and regularity, availability and capacity of public facilities, and application of environmentally friendly concepts.The resultsobtained the influence of the 10 performance variables represented by the value of R square = 0.92, meaning that the variation in performance of Islamic boarding schools can be explained by a regression equation of 92% while the remaining 8% is explained by other variables outside the model equation. The value of R = 0.96 means that the influence of the 10 performance variables is very strong. The optimisation results show that the priority stages

have a minimum cumulative gap value of 36.79. The priority stages areimproving the performance of Pondok Pesantren include:Security protection for residents and visitors; Free from dangerous materials and devices (explosive/polluting); Function of natural lighting (source of sunlight); Aesthetics of park, landscape, and vegetation; Ease of indoor and outdoor circulation horizontally, Performance and reliability of roof structures; Durability of dormitory buildings; Regularity in buildings arrangement; Availability of information and communication facilities for visitors; and Alternative energy from wind sources and Environmental drainage or utility systems. The management organization of Pondok Pesantren is recommended to consider the ten performance variables, evaluation results of the regression model, and optimisation stages of the performance.Maintenance efforts that strengthen the influence of these factors can preserve and ensure the performance of buildings and facilities, thereby upholding the function and role of the Sidogiri Islamic Boarding School (Pondok Pesantren Sidogiri) as a religious and cultural heritage site—a hub for Islamic educational civilization, a catalyst for the socio-economic self-reliance of the community, and a contributor to other relevant areas.

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