Original Research Article

Optimization of the Maintenance Factors in Ampel Mosque, Surabaya, Indonesia

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ABSTRACT

The Ampel Mosque in Surabaya is an important historical site for Muslims in Indonesia. The architecture of the Ampel mosque is strongly influenced by Javanese and Arabic culture. a very harmonious integration between Javanese architecture as a form of authenticity and local wisdom in buildings, while Arabic architecture as a complementary and additional component. This research was, therefore, conducted to optimize the maintenance factor in the mosque building to ensure it functions properly and sustainably towards serving as a historic worship place for future generations. Data were collected using questionnaires distributed to the congregants or users of the mosques and analyzed through optimization using a dynamic program based on the level of importance. The results showed seven maintenance factors including the complexity of construction and design, serviceability, building durability, security and safety, aesthetics of the building, user comfort, and maintenance capability. Moreover, the optimization process prioritized the ease in construction work, stability of the construction, durability against structural damage to the building, use of non-hazardous materials, aesthetics of the building, the comfort of indoor and outdoor spaces, and ease of maintenance. These are expected to be the focus of the mosque manager in maintaining the authenticity of the building components. This, therefore, means the Ampel Mosque building can be maintained as a religious tourism destination at the national and international levels in order to ensure its historical value is sustained while the local and national economy is improved.

Keywords: optimization, maintenance, arabic and javanese architecture, structure, mosque building, Indonesia

1. INTRODUCTION

Ampel Mosque in Surabaya is one of the important historical sites for Muslims in Indonesia. It is an old building with high historical and memory value. The mosque was built in 1421 and still functions effectively up to the present moment (Sedayu 2018). The architectural style of the Ampel Mosque combines local Javanese and Arabic cultures. The Ampel Mosque as one of the Islamic Heritage in Indonesia is expected to remain durable and function properly in a sustainable manner. Several maintenance efforts have also been implemented by the mosque manager to maintain its authenticity and this is indicated by the development and improvement of its physical components to support all its activities (UNESCO and World Heritage Convention 2016). This research was, therefore, conducted to determine the maintenance factors required for the Ampel Mosque building to function properly and sustainably after which they were prioritized for the optimization and maintenance to ensure reliability against loading and damage. This was conducted through the analysis of these factors' level of importance using the data obtained from users or congregants. The maintenance of the mosque as a religious heritage can sustain its historical values and memories to make it a religious tourism destination for national and international tourists and consequently improve local and national economy (UNESCO 2015; Sedayu et. al. 2021).

Several previous studies were used as references for comparisons in this research. For example, Sedayu (2019a) evaluated the performance of green and smart buildings in Islamic boarding schools using the multiple linear regression method and the results showed a model where the building's physical facility factors were influenced by user requirements (Sedayu 2019a.). Moreover, Sedayu et. al. (2020) also conducted another study to improve the performance of construction projects using green building principles (Sedayu et. al. 2020). The findings showed the possibilities of applying green building to ensure sustainable architecture and construction concepts needed to protect social, economic, and environmental aspects. The mosque is, however, an important heritage site for a nation to sustainably maintain its history and culture for future generations (Nursanty et. al. 2020; Ashour 2020; Alafalah 2020). The maintenance of these heritage buildings is usually focused on all the components including the structure and architecture. Meanwhile, the structural aspect is required to be maintained to withstand the loads such as natural disasters, environmental influences, weather changes, material pest attacks, and human behavior on the building (Zolkafli et. al. 2018).

2. MATERIAL AND METHODS

2.1. Determination of Research Instruments and Samples

The research instrument used include building maintenance factors compiled in line with the Regulation of the Minister of Public Works of Indonesia in 2008 concerning Guidelines for Building Maintenance as well as the principles of the Green Building Council of Indonesia (GBCI) contained in the GREENSHIP Rating Tools New Building (Minister of Public Works of Indonesia 2008; Green Building Council of Indonesia (GBCI) 2020). These factors were designed in the form of a questionnaire with the validity and reliability determined using 30 respondents (Sedayu 2020). The validity was tested using Pearson's product-moment correlation to calculate the correlation coefficient for each question while the reliability was tested through Cronbach's Alpha consistency coefficient. An instrument is, however, confirmed valid and reliable when it has a correlation value and Cronbach's Alpha coefficient greater than 0.60 (Sedayu 2020). Moreover, the mosque users or congregants with the knowledge of the Ampel Mosque’s physical development were used as respondents while the data retrieved from their perceptions were used to assess the quality of the mosque’s current maintenance status in order to determine the factors to be prioritized for further improvement (Oladokun et. al. 2018; Oluwatobi et. al. 2019). Building users have a level of need and importance that can be used to evaluate building performance (Tecke et. al. 2020). The number of users to be used as samples was determined using the Slovin formula based on the total population of 820 people (Sedayu 2020). The calculation is presented as follows:

$$\mathrm{n} = \frac{\mathrm{N}}{(1+(\mathrm{Nxe}^2))} \quad (1)$$

Therefore,

$$\mathrm{n} = \frac{820}{\left(1+(820\ \mathrm{x}0{,}05^2)\right)} = 268{,}85 \approx 270$$

Description

n = Number of samples/respondents
N = Total population
e = 5% error rate

The results showed 270 people are needed to be used as the respondents. Meanwhile, the questionnaire used as a research instrument was measured based on the following level of importance scale:

- 1 = Not at all important
- 2 = Slightly important
- 3 = Important
- 4 = Fairly important

- 5 = Very important

2.2. Dynamic Program

A dynamic program is a step-by-step decision-making technique to solve a problem by dividing into several stages with the decision-making at each stage considering those made in the previous stage (Boomen et. al. 2019; Aurachman et. al. 2020). This means one stage has a relationship and influence on the next. Meanwhile, the optimization process in dynamic programming uses network diagrams to explain the relationship between factors as indicated in Figure 1. The initial stage is to calculate the value of the gap between the goals to be achieved and the level of importance. The goal was, therefore, the level of importance expected in the future after the increment in repair or maintenance which was determined using the following formula:

Gap value = Goal average score – Average importance level (2)

The dynamic program was used to obtain the minimum value for each maintenance factor using the following recursive equation:

$$f_n(S) = \min\{P_{z_n S} + f_{n-1}(z_n)\} \quad (3)$$

Description:

z_n = Decision variables at stage n-1 (n=0,1,2,3,4 and so on)
S = State at stage n (n=0,1,2,3,4 and so on)
$P_{z_n S}$ = Minimum gap value from S to z_n
$f_{n-1}(z_n)$ = The cumulative number of minimum gap values at n-1 or before n
$f_n(S)$ = Minimum gap value of $P_{z_n S} + f_{n-1}(z_n)$

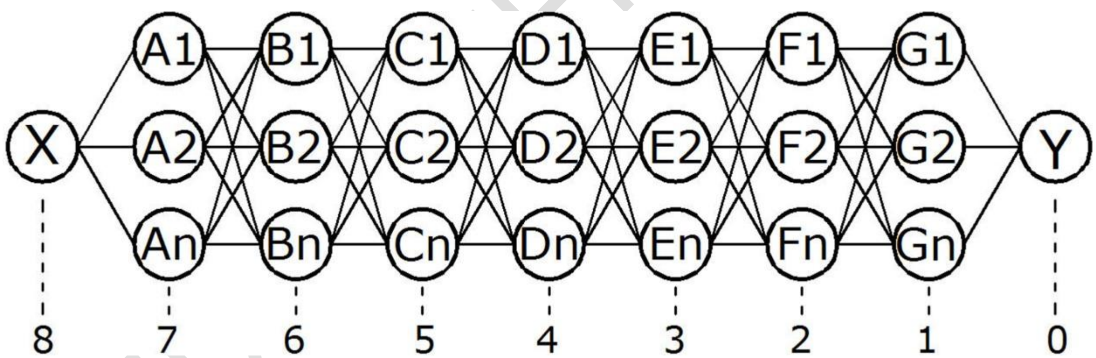

Fig. 1 Network diagram of the maintenance factor optimization for the Ampel Mosque, Surabaya

3. RESULTS AND DISCUSSION

3.1. Determination of Maintenance Factors

The maintenance factors were determined with reference to the Regulation of the Minister of Public Works of Indonesia in 2008 concerning Guidelines for the Maintenance of Buildings as well as the principles of green building by the Green Building Council of Indonesia (GBCI) (Minister of Public Works of Indonesia 2008; Green Building Council of Indonesia (GBCI) 2020). They were further used as components of the optimized research instrument. Moreover, the validity test showed a correlation coefficient greater than 0.6 and this means the instrument is valid while the reliability test produced a consistency coefficient (Alpha

Cronbach) greater than 0.60 which means it is reliable. The factors were also adjusted to the condition of the Ampel Mosque building through a preliminary survey and the results are presented in Table 1.

Table 1. Maintenance Factors of the Ampel Mosque Building

No	Maintenance Factors	Description
A	Complexity of construction and design	Maintenance depends on the ease of building construction work, complexity of the design, and the technical specifications
B	Serviceability	Maintenance increases the serviceability of the building in the form of stability and strength of its construction
C	Building durability	Maintenance increases the durability of buildings against structural and architectural damage
D	Security and safety	Maintenance ensures safety and security aspects by implementing non-hazardous construction processes, materials, and building designs. It is also supported by the availability of security and safety facilities in the building
E	Aesthetics of the building	Maintenance maintains the aesthetics of architectural components and building construction
F	User comfort	Maintenance ensures user comfort by applying building construction regularity, building visual order, and comfortable indoor and outdoor spaces.
G	Maintenance capability	It is the ability of maintenance by building managers supported by schedule, cost, organization, and ease of building maintenance (maintainability)

Table 1 presents the seven maintenance factors of the Ampel Mosque with most aspects of the original building observed to be preserved up to the present moment due to its religious and cultural heritage associated with its high historical and memory value as well as the combination of traditional Javanese and Arabic architectural styles. The influence of Arabic architecture can be seen in the application of the minarets, the curved shape of the walls, and Arabic calligraphy carvings. Figure 2 presents the original building which is well maintained to ensure its authenticity and sustainability for future generations. Meanwhile, Table 1 shows the complexity of construction and design (No. A) affects the intensity of maintenance planned and conducted in line with the findings of previous studies that the quantity of maintenance depends on the complexity of the design, technical specifications, and building construction applied (ICOMOS 2003; Sedayu 2018; Ikedionu et. al. 2019; Pikas et. al. 2020; Dahal et. al. 2020). It was also discovered that the complexity of the design and construction also determines the serviceability (No. B) such as the stability and strength of the building construction. This was supported by intensive and serious maintenance efforts and previous studies which showed that construction stability and strength are influenced by careful and valid structural analysis and design conducted by engineers with high skills and expertise (Sedayu 2019b; Yasin et. al. 2019).

Fig. 2 The original building of the Ampel Mosque. Source: Akhmad 2014

Figure 3 shows the main hall of the mosque with a frame construction made of teak wood. This is due to the fact that teak wood is a local material which was easily and cheaply available when the mosque was built. It was also discovered that stable and strong construction protects the building against structural and architectural damage (No. C). This durability, however, needs to be supported by good maintenance management to preserve the original building of the mosque (ICOMOS 2003; Jasiczak et. al. 2017; Jonbi 2018). The safety and security associated with using the building (No. D) also need to be guaranteed by applying non-hazardous construction, materials, and building designs as well as the availability of appropriate facilities in the building (Sedayu, 2018; Losev et. al. 2019). Moreover, the aesthetics of the mosque building, both architectural and structural components, also need to be maintained (No. E). This is due to the ability of the security and safety supported by appropriate aesthetics to attract domestic and foreign tourists. It has been discovered that aesthetics is usually felt directly by visitors both physically and psychologically (Sutrisno et. al. 2019). Furthermore, the use of heritage buildings as tourism icons in an area has the ability to improve the social, economic, and environmental aspects (ICOMOS 2017; Li et. al 2021) which need to be considered in the maintenance process to ensure proper and sustainable functioning of the structures.

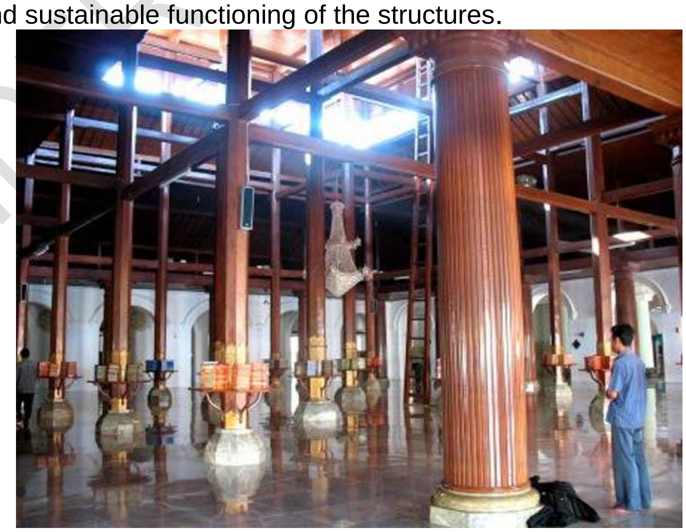

Fig. 3 Wooden construction in the main hall of the Ampel Mosque.
Source: Nusagates 2018

Aesthetics is generally associated with comfort (No. F) both inside and outside the building (Rahman et. al. 2017; Sedayu et. al. 2020; Pikas et. al. 2020; Zhen et. al. 2021). Therefore, the maintenance needs to ensure the building is physically and psychologically comfortable to support user activity and productivity. The mosque as a place of worship for many people requires the comfort of the inner space so that worship activities become comfortable (Shohan et. al. 2021). The comfort of a room improves the health of users and avoids diseases and this is achievable by regulating the construction and visual appearance of the building. The aforementioned six factors are, however, supported by the ability to conduct building maintenance (No. G). This means building managers need certain maintenance capabilities such as the availability of schedules, costs, organization, and ease of maintenance (Sotsek et. al. 2018; Chua et. al. 2018; Besiktepe et. al. 2020). The staff or employees in the maintenance department need high motivation, skills, and competence as well as the latest and sophisticated technology and maintenance methods (Sotsek et. al. 2018).

3.2. Determination of Maintenance Priority

The dynamic program was used to determine the repair, maintenance, and improvement efforts to be prioritized in the mosque building based on the minimum gap between the goals and the level of importance. The results of the gap value calculated at each stage are presented in Table 2 with the initial stage used to determine the maintenance factors followed by the calculation of the gap value for the seven maintenance factors, and the final stage is focused on determining the maintenance priority. This optimization process was conducted using a recursive equation known as the backward calculation based on the network diagram in Figure 1. Meanwhile, Table 2 explains the gap obtained using the goal which was averagely set a 4 and level of importance of each of the factors. It is important to note that at Stage 0 (n = 0) = Determination of maintenance priority (No. Y) and the function at this stage is $f_0(Y) = 0$. Furthermore, the level of importance was determined by the mosque users used as respondents to obtain similarities between the technical aspects of maintenance and user needs through quantitative data (Oladokun et. al. 2018; Oluwatobi et. al. 2019; Sedayu 2019c).

Table 2. Value of the gap between goals and importance level

State	Stage	Average Value		
		Goal	Importance Level	Gap
X	**Stage 8: Determination of maintenance factors**			
A	**Stage 7: Complexity of construction and design**			
A1	Ease in building construction work	4	3.926	0.074
A2	Complexity of building design and technical specifications	4	3.820	0.180
B	**Stage 6: Serviceability**			
B1	Stability of building construction	4	3.875	0.125
B2	Strength of building construction	4	3.768	0.232
C	**Stage 5: Building durability**			
C1	Durability to structural damage to the building	4	3.879	0.121
C2	Durability to architectural damage to the building	4	3.837	0.163
D	**Stage 4: Security and safety**			
D1	Free from hazardous construction	4	3.729	0.271
D2	Use of non-hazardous materials	4	3.974	0.026
D3	Harmless building design	4	3.958	0.042

D4	Availability of security and safety facilities	4	3.867	0.133
E	**Stage 3: Aesthetics of building**			
E1	Aesthetics of building architectural	4	3.733	0.267
E2	Aesthetics of building construction	4	3.878	0.122
F	**Stage 2: User comfort**			
F1	Regularity of building construction	4	3.832	0.168
F2	Visual order/visible building	4	3.866	0.134
F3	Comfort of indoor and outdoor spaces	4	3.911	0.089
G	**Stage 1: Maintenance capability**			
G1	Availability of maintenance schedule	4	3.725	0.275
G2	Availability of maintenance costs	4	3.644	0.356
G3	Availability of maintenance organization	4	3.846	0.154
G4	Ease of maintenance (maintainability)	4	3.851	0.149
Y	**Stage 0: Determination of maintenance priority**			

At Stage 1 (n=1), the maintenance ability (No. G) has one factor with the minimum gap value which is ease of maintenance (No. G4) with 0.149 obtained from the function $f_1(G4) = \min\{P_{Y\text{-}G4} + f_0(Y)\} = 0.149 + 0 = 0.149$. It was determined by the size, function, and details of the building. Meanwhile, the level of complexity of design and building materials also affected the intensity and cost of maintenance while some other influential factors include the methods, technology, and maintenance workers used (Zhu et. al. 2018; Khalek et. al. 2019; Chew 2021). It was also discovered that the ease of maintenance ensures occupational safety and health for the maintenance workforce (Chew et. al. 2017). Moreover, at Stage 2 (n=2), user comfort (No. F) has one factor with the minimum gap value which is the comfort of indoor and outdoor spaces (No. F3) with 0.089 obtained from function $f_2(F3) = \min\{P_{G4\text{-}F3} + f_1(G4)\} = 0.089 + 0.149 = 0.238$. The comfort of the building increases the quality of its function as a place of residence and activity while easy-to-apply maintenance has the ability to improve the comfort experienced in both the indoors and outdoors of a building (ICOMOS 2017; Rahman et. al. 2017; Bortolini et. al. 2018; Pikas et. al. 2020; Zhen et. al. 2021). This factor also aids human immunity to diseases including those associated with the COVID-19 pandemic. At Stage 3 (n = 3), aesthetics of building (No. E) has one factor with the minimum gap value and this is aesthetics of building construction (No. E2) with 0.122 from function $f_3(E2) = \min\{P_{F3\text{-}E2} + f_2(F3)\} = 0.122 + 0.238 = 0.360$.

Building comfort is related to its aesthetics including the architectural and construction components due to the ability of construction components to ensure the stability and strength of building against damage apart from providing an impression of beauty (Ogunoh et. al. 2018). Furthermore, the elements of authenticity including components, materials, symbols, and ornaments need to be maintained to sustain the original historic mosque building with its previous high historical value, memory, symbols, and local wisdom (Sutrisno et. al. 2019; Gaputra, 2020). At Stage 4 (n = 4), security and safety (No. D) has one factor with the minimum gap value which is the use of non-hazardous materials (No. D2) with 0.026 obtained from function $f_4(D2) = \min\{P_{E2\text{-}D2} + f_3(E2)\} = 0.026 + 0.360 = 0.386$. This is in line with previous findings that building aesthetics were supported by the application of non-hazardous materials to improve the health and safety of users (Dahal et. al. 2020; Zhang e. al. 2019; Kamarudin et. al. 2019).

The implementation of environmentally friendly materials at the construction stage also reduces losses and damages for users and the environment. Choosing building materials should pay attention to the principle of sustainability from the supply, application, and maintenance of the material (Shishegaran et. al. 2021). These efforts are also continued up to the building maintenance phase through renovation, rehabilitation, and reconstruction.

Meanwhile, humans, as the users, are the main priority to be served in a building and its supporting facilities, for example, the safety and security of people with disabilities, the elderly, toddlers, and pregnant women need to be guaranteed and protected when using buildings (Sedayu et. al. 2020). At Stage 5 (n=5), building durability (No. C) has one factor with the minimum gap value which is durability to structural damage to the building (No. C1) with 0.121 from the function $f_5(C1) = \min\{P_{D2\text{-}C1} + f_4(D2)\} = 0.121 + 0.386 = 0.507$. Maintenance ensures the durability of a building against several damages with the material observed to be one of the factors influencing its resistance to loads (Naganna et. al. 2021). It was also discovered that durability makes sure the building functions properly and improve the safety of the users. It, however, lasts a relatively long time when supported by intensive maintenance according to its operational time (Jasiczak et. al. 2017; Jonbi 2018; Sedayu 2019c). At Stage 6, (n=6), serviceability (No. B) also has one factor with the minimum gap value which is the stability of building construction (No. B1) with 0.125 obtained from the function $f_6(B1) = \min\{P_{C1\text{-}B1} + f_5(C1)\} = 0.125 + 0.507 = 0.632$. It is important to note that the durability factor is closely related to the stability of building construction due to its ability to ensure the building is stable against loads (Naganna et. al. 2021). This is, however, necessary due to the ability of loads to cause damage, therefore, maintenance efforts are needed to guarantee the quality of the building (Sedayu 2018; Shi et. al. 2018; Ikedionu et. al. 2019). At Stage 7 (n=7), the complexity of construction and design (No. A) has one factor with the minimum gap value and this is the ease in building construction work (No. A1) with 0.074 from the function $f_7(A1) = \min\{P_{B1\text{-}A1} + f_6(B1)\} = 0.074 + 0.632 = 0.706$.

Construction stability was discovered to be supported by intensive and comprehensive maintenance while the ease of maintenance depends on the level of complexity of the construction and building design (Rilatupa 2019). Moreover, the complexity applied requires high costs, methods, technology, and skills of maintenance staff while the ease of maintenance also influences the process involved in handling the occupational health and safety of the maintenance staff (Khalek et. al 2019; Pikas et. al. 2020; Chew 2021). Lastly, at Stage 8 (n=8), the determination of maintenance factors (No. X) has a gap value = 0 as calculated from the function $f_8(X) = \min\{P_{A1\text{-}X} + f_7(A1)\} = 0 + 0.706 = 0.706$ while the optimization results from Stage 0 (n=0) to Stage 8 (n=8) obtained a minimum gap value of 0.706 as indicated in Table 3.

Table 3. The optimization results for the maintenance factor of the Ampel Mosque building

State	Stage	Maintenance factor	Gap Value
X	8	Determination of maintenance factors	0
A1	7	Ease in building construction work	0.074
B1	6	Stability of building construction	0.125
C1	5	Durability to structural damage to the building	0.121
D2	4	Use of non-hazardous materials	0.026
E2	3	Aesthetics of building construction	0.122
F3	2	Comfort of indoor and outdoor spaces	0.089
G4	1	Ease of maintenance (maintainability)	0.149
Y	0	Determination of maintenance priority	0
		Total	0.706

Table 3 shows the results obtained from calculating the minimum gap value at each stage with the initial stage of optimization used to determine the maintenance factors (No. X), while the final stage was for the maintenance priorities (No. Y). It was discovered that the repair and maintenance improvement efforts first need to prioritize the ease of building construction work which is No. A1 with a gap value of 0.074 followed by the stability of building construction (No. B1 with gap value = 0.125), durability to structural damage to the building

(No. C1 with gap value = 0.121), use of non-hazardous materials (No. D2 with gap value = 0.026), aesthetics of building construction (No. E2 with gap value = 0.122), the comfort of indoor and outdoor spaces (F3 with gap value = 0.089), and ease of maintenance (No. G4 with gap value = 0.149). Meanwhile, the total value of the minimum gap is 0.706. These seven factors need to be prioritized by building managers to implement repairs and maintenance efforts. It is, however, important to note that the maintenance of buildings in Indonesia has several similarities with other countries although the methods, technology, and skills of maintenance staff are applied in different ways depending on the level of technological development and skills possessed by human resources in each country. For example, the maintenance in Nigeria, which is a developing country, is very similar to Indonesia as indicated by the corrective, preventive, and predictive types usually applied (Abisuga et. al. 2017; Ogunoh et. al. 2018; Oluwatobi et. al 2019; Omar et. al. 2019; Obodoh et. al. 2019). Corrective maintenance is usually implemented after a breakdown, preventive to prevent damages while predictive involves predicting the time and scale of damage (Minister of Public Works of Indonesia 2008). Moreover, maintenance can also either be planned or incidental with the planned or scheduled conducted regularly to prevent normal damage while incidental is when it is applied to accommodate the occurrence of sudden damage as indicated by post-disaster maintenance.

The implementation of maintenance in Saudi Arabia pays attention to the integration at every stage of Maintenance. The use of technology in maintaining the building is sought to avoid damage to the building. The aesthetics of the building are damaged due to improper maintenance. The technology used is adapted to the conditions and location of the building. The implementation can be adopted by Indonesia in building maintenance especially public buildings. In Saudi Arabia, maintenance efforts are combined with construction work. The use of construction equipment and technology also determines the maintenance that will be carried out after construction is complete. This also has an impact on the protection of worker safety and security from construction to the maintenance phase. Maintenance costs are predictable from the construction phase (Lasod 2019; Moosa et. al. 2020). In Indonesia, the quality of maintenance is improved based on the equipment and technology used by the staff, and the same was also observed in Egypt and Malaysia (Olanrewaju et. al. 2017; Pukite et. al. 2017; El-Malek et. al. 2017). Maintenance agencies can also train their staff regularly to meet the requirements. Furthermore, the use of information technology in building maintenance has been widely applied in China and Latvia and this assists the detection and modeling of potential damages (Almaimani et. al. 2019). The integration of digital systems into Building Information Modeling (BIM) also covers aspects of damage, structural models, building stability, and building loads and this technology has been to all complex buildings serving the public interest in China, Italy, and Latvia (Pukite et. al. 2017; Garzia et. al. 2018; Deng et. al. 2019; Liu, 2020). Its application is currently being developed in Indonesia, especially in complex buildings location big cities mainly due to the ability of the digital sensor system to detect potential damage which can be caused by natural disasters in order to prevent loss of lives and properties. Meanwhile, maintenance management has been adapted to contemporary evolving methods and technologies with the building managers required to periodically evaluate the performance of maintenance conducted by their organizations and maintenance staff. The use of maintenance technology is adjusted to the financial capacity of the building manager. The combination of traditional, conventional, and modern methods in maintaining buildings can be considered according to the ability of maintenance funds. These efforts also need to consider sustainable and environmentally friendly concepts in order to provide a positive impact on economic, social, and environmental aspects (Latief et. al. 2017; Sedayu et. al. 2020; Yadollahi 2020). Maintenance of buildings in Indonesia and Saudi Arabia have similarities in paying attention to environmental sustainability. The impact of environmental damage due to the application of building technology from construction to maintenance is faced by many countries in the world (Yao et. al. 2020; Alhazmi et. al. 2021). The principle of sustainable and green building is, however, the current issue which is suitable to be applied in solving building problems for Indonesia and the world.

4. CONCLUSION

The Ampel Mosque in Surabaya is a historic structure with an important religious heritage for Indonesia. The influence of Javanese and Arabic architectural styles can be seen in this mosque. It is currently being maintained intensively and earnestly to maintain the original element of the building due to the importance of the authenticity of heritage buildings in preserving historical values, memories, symbols, culture, and local wisdom. The maintenance efforts also need to be conducted to develop the national and international religious tourism sector in order to boost the economy of the local and national communities. Meanwhile, the mosque managers need to consider the perceptions of users apart from the technical aspect in improving and maintaining the Ampel Mosque building. Therefore, this research used the mosque's congregants with the knowledge of its physical development as respondents while the maintenance factors were determined based on government standards/stipulations and green building principles compiled by the Green Building Council of Indonesia (GBCI). The results showed seven maintenance factors required include the complexity of construction and design, serviceability, building durability, security and safety, aesthetics of the building, user comfort, and maintenance capability. These factors were broken down into research instruments to determine the maintenance optimization data through the use of dynamic programs and the results showed the ease of building construction work (gap value = 0.074) should be first prioritized in repair and maintenance efforts followed by the stability of building construction (gap value = 0.125), durability to structural damage to the building (gap value = 0.121), use of non-hazardous materials (gap value = 0.026), aesthetics of the construction (gap value 0.122), the comfort of indoor and outdoor spaces (gap value = 0.089), and ease of maintenance (gap value = 0.149). The total value of the minimum gap was found to be 0.706 and these factors are recommended to be prioritized by the manager of the Ampel Mosque building during repair and maintenance in order to preserve and sustain the mosque as a religious heritage building for the benefit of future generations.

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