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Development of a GreeCn Building, Environmental Health, and Life Cycle Cost-Based Priority Model for Sustainable Maintenance of Inpres Manonda Market Infrastructure

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ABSTRACT

This study develops a maintenance priority model for the infrastructure of Inpres Manonda Market by considering four interrelated aspects: green building performance, environmental health, infrastructure condition, and Life Cycle Cost (LCC). A quantitative approach was adopted through the development of an integrated assessment model. Primary data were collected from field observations and questionnaire surveys involving market users and facility users. The assessment comprised six indicators of green building performance, ten indicators of environmental health, and six indicators of infrastructure condition. Each indicator was evaluated using a five-point rating scale and subsequently normalized using the Min-Max method. The results produced index values of 0.552 for green building performance, 0.514 for environmental health, and 0.458 for infrastructure condition. When expressed as maintenance need indices, these values corresponded to 0.448, 0.487, and 0.542, respectively. The infrastructure assessment identified roof condition as the component with the greatest maintenance requirement, with a maintenance need index of 0.615, followed by electrical installations at 0.592 and wall condition at 0.565. A AHP assessment resulted in weights of 0.169 for green building performance, 0.288 for environmental health, 0.338 for infrastructure condition, and 0.205 for LCC. The consistency ratio was approximately 0.022, indicating an acceptable level of consistency in the pairwise comparisons. These results demonstrate that maintenance priorities cannot be determined solely from visible physical deterioration but should also account for environmental conditions, building performance, and the economic consequences of maintenance over the asset life cycle. The integrated assessment framework developed in this study can be used as a basis for establishing maintenance priorities for traditional market infrastructure.

Keywords: Green Building; Environmental Health; Life Cycle Cost; Maintenance Priority; Traditional Market; Infrastructure Maintenance

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INTRODUCTION

Market infrastructure is an important part of urban economic activity because it provides facilities for trading and access to basic goods. Traditional markets are used intensively every day, so their buildings and supporting facilities need to remain functional, safe, clean, and comfortable for traders, visitors, and workers. However, market maintenance is often focused on repairing physical damage. Environmental quality, user health, resource efficiency, and future maintenance costs are not always considered in the same process. This condition can lead to maintenance decisions that solve immediate problems but do not fully support the long-term performance of market infrastructure.

Environmental health is an important consideration in traditional market management. Daily market activities involve food handling, water use, waste generation, sanitation, and intensive interaction among users (Inriani et al., 2021). These activities make the condition of the building and its surrounding environment important for the comfort and health of traders, visitors, and workers. Ventilation, lighting, temperature, water supply, sanitation, waste management, moisture, and cleanliness are among the factors that need to be maintained. The World Health Organization also recognizes ventilation, indoor air quality, moisture, sanitation, water, and thermal conditions as environmental factors related to human health. Environmental health can be supported through the application of green building principles (Geng et al., 2019). Green building promotes efficient use of energy and water, good indoor environmental quality, appropriate material use, waste management, and proper building operation and maintenance (Purumal et al., 2021).

In Indonesia, green building performance is regulated through Minister of Public Works and Housing Regulation No. 21 of 2021 concerning the Assessment of Green Building Performance. The regulation provides criteria for assessing building performance and emphasizes the importance of maintaining environmental performance throughout the building life cycle.Green building principles are also relevant during the maintenance stage (Chew et al., 2017). Building components can lose their function when they are not maintained properly (Asmone et al., 2019). Ventilation, lighting, water and sanitation facilities, roofs, drainage, building envelopes, and waste facilities therefore require regular inspection and maintenance. Proper maintenance can help preserve building performance while supporting a cleaner and healthier environment for market users. Maintenance decisions also have economic consequences (Besiktepe et al., 2020).

Focusing only on the cost of an initial repair may overlook future expenses related to maintenance, replacement, operation, and disposal. Life Cycle Cost (LCC) can be used to estimate these costs over a defined period (Illankoon & Lu, 2019). This approach allows maintenance alternatives to be considered from a long-term economic perspective. The use of LCC together with environmental and health considerations can provide a more comprehensive basis for setting maintenance priorities (Ighravwe & Oke, 2019).

Previous studies have discussed green building, environmental health, building maintenance, and LCC. Green building studies have mainly examined energy efficiency, water use, indoor environmental quality, and building performance. Environmental health research has focused on sanitation, waste, water quality, ventilation, and other environmental conditions. Meanwhile, LCC studies have generally examined the economic aspects of construction, renovation, and maintenance. Although these studies provide useful findings, the integration of the three aspects into a maintenance priority model for traditional market infrastructure is still limited (Arumsari et al., 2021).

Traditional markets require particular attention because their buildings are exposed to intensive daily use and diverse activities. High pedestrian movement, food-related activities, water use, and waste generation can accelerate the deterioration of facilities and create additional environmental concerns. Therefore, maintenance priorities should consider not only the physical condition of a component but also its environmental function, potential effects on users, and long-term cost (Kheradranjbar et al., 2022). For example, a facility with moderate physical damage may still require urgent attention if the damage affects sanitation, ventilation, water efficiency, or user comfort (Arifin et al., 2022).

This issue is relevant to Inpres Manonda Market in Palu City, which serves the daily trading needs of the local community. The condition of its buildings, trading facilities, cleanliness, sanitation, and supporting infrastructure is closely related to the quality of market services. The Government of Palu City has also continued to pay attention to the cleanliness and management of the market, including discussions related to market improvement and revitalization. These conditions indicate the need for maintenance planning that considers both physical and environmental aspects. Previous studies on Inpres Manonda Market have examined issues related to waste management and sanitation (Fera et al., 2023). These studies show that environmental conditions are an important part of market management. However, environmental assessment

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alone does not provide a method for determining which infrastructure components should be prioritized for maintenance or for comparing maintenance alternatives based on their long-term costs. A more integrated approach is therefore needed to support maintenance decisions (Beauregard & Ayer, 2019).

This study proposes a maintenance priority model that combines green building criteria, environmental health, and Life Cycle Cost. The model is designed to assess infrastructure components from several relevant aspects rather than relying only on physical damage. Green building criteria are used to examine environmental performance, environmental health indicators are used to consider conditions affecting market users, and LCC is used to assess the economic implications of maintenance over the analysis period (Bochare et al., 2024). The combination of these aspects is expected to provide a more systematic basis for determining maintenance priorities (Khadra et al., 2020). The objective of this study is to develop a green building, environmental health, and life cycle cost-based priority model for sustainable maintenance of Inpres Manonda Market infrastructure. The model is expected to help identify infrastructure components that require priority intervention and support the selection of appropriate maintenance strategies. The results may also provide a practical basis for market infrastructure management by integrating physical maintenance, environmental performance, user health, and long-term economic considerations.

METHODS

This research employed a quantitative approach combined with model development to formulate a maintenance priority model for Inpres Manonda Market infrastructure in Palu City. The model integrates four assessment dimensions: green building performance, environmental health, infrastructure condition, and Life Cycle Cost (LCC). Primary data were collected through direct field observations and questionnaire surveys. Field observations were undertaken to identify the existing condition of key building components, including walls, roofing systems, structural and supporting elements, and electrical installations. The questionnaire survey was conducted to obtain assessments of green building performance, environmental health, and infrastructure condition based on the experiences of traders and users of the market facilities.

The respondents were selected through purposive sampling, with participation limited to individuals who had direct experience with the physical facilities and daily activities of Inpres Manonda Market. In the AHP analysis, assessments from experts were used to establish the relative weights of the four main criteria. This procedure was intended to reflect the relative importance of each criterion in determining maintenance priorities.

The green building dimension comprised six indicators: energy efficiency, water efficiency, indoor environmental quality, material use, waste management, and building operation and maintenance. Environmental health was evaluated through ten indicators, covering clean water availability, sanitation, ventilation, lighting, thermal conditions, humidity, waste management, drainage, cleanliness, and vector control. Infrastructure condition was assessed using six indicators consisting of wall condition, roof condition, electrical installation condition, facility functionality, safety, and maintenance condition or urgency. All questionnaire items were rated using a five-point Likert scale.

The questionnaire responses were subsequently transformed into comparable performance indices through Min-Max normalization. Since all indicators were measured on a scale from 1 to 5, the normalized performance index for each indicator was calculated using the following equation:

$$\mathrm{PI}_i = \frac{\mathrm{X}_i - X_{min}}{X_{max} - X_{min}}$$

Where PI_i is the performance index, X_i is the mean score of indicator I, X_{min} is the minimum scale value, and X_{max} is the maximum scale value. With a five-point scale, $X_{min} = 1$ and $X_{max} = 5$.

The maintenance need index was subsequently calculated as:

$$MNI_i = 1 - PI_i$$

A higher MNI therefore indicates a greater maintenance requirement. For each assessment dimension, the dimension index was calculated from the average normalized indicator scores. The resulting Green Building Index (GBI), Environmental Health Index (EHI), and Infrastructure Condition Index (ICI) were subsequently converted into their corresponding maintenance need indices:

GBN = 1 – GBI
EHN = 1 – EHI
ICN = 1 – ICI

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AHP was used to determine the relative importance of the four criteria: green building, environmental health, infrastructure condition, and LCC. Pairwise comparisons were assessed using the principal eigenvector method. The consistency of the judgment matrix was evaluated using the Consistency Ratio (CR), with CR ≤ 0.10 considered acceptable. LCC was incorporated to represent the long-term economic implications of maintenance. The analysis period was set at 10 years with a discount rate of 6%. Initial intervention costs were considered at Year 0, while annual maintenance and scheduled replacement costs were considered during the analysis period. Future costs were converted into present values using:

$$PV_t = \frac{C_t}{(1+r)^t}$$

Where PV_t is the present value of cost C_t incurred at year t, and r is the discount rate. The total LCC was obtained by summing the discounted costs over the analysis period. The LCC values were subsequently normalized using Min-Max normalization to obtain LCCN. Finally, the four dimensions were integrated into the Maintenance Priority Index (MPI):

$$MPI = w_{GB} \times GBN + w_{EH} \times EHN + w_{IC} \times ICN + w_{LCC} \times LCCN$$

RESULTS AND DISCUSSION

Existing Condition of Market Infrastructure

Field inspections at Inpres Manonda Market revealed various forms of physical deterioration in the existing infrastructure. The observed problems included cracks in walls, damaged surface finishes, deterioration of masonry and timber elements, roof defects, signs of moisture penetration, and electrical installations that were not properly arranged. These findings suggest that maintenance needs extend beyond the appearance of the facilities and are also related to their functionality, service life, environmental conditions, and safety.



Figure 1. Wall cracking and surface deterioration

The photograph shows cracks, peeling paint, and deterioration of the wall surface. The condition indicates the need for repair and further inspection to determine the extent and cause of the deterioration.



Figure 2. Deterioration of masonry and wall components

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The wall shows damaged masonry and deteriorated surface materials. This condition may reduce the durability and functionality of the affected component and therefore requires appropriate maintenance.



Figure 3. Deteriorated roof and supporting components

The roof and timber supporting elements show signs of aging and deterioration. This condition may reduce the ability of the roof to protect the market interior from weather exposure.



Figure 4. Water infiltration through the roof

Gaps and openings in the roof allow light and potentially rainwater to enter the building. Water infiltration may contribute to moisture and further deterioration of building materials.



Figure 5. Existing electrical installation

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The figure shows aging electrical components and exposed cable arrangements. The condition requires inspection and maintenance to ensure the proper operation and safety of the installation.



Figure 6. External condition of Inpres Manonda Market

The external view shows the general condition of the market building and trading areas. The relatively maintained façade contrasts with the deterioration observed in several internal components, indicating variations in maintenance conditions between different areas.

Field inspections at Inpres Manonda Market revealed a number of deficiencies in the existing building components. The observed problems included wall cracks, deteriorated surface finishes, damage to masonry and timber elements, roof deterioration, water infiltration, and aging electrical components with exposed or poorly arranged cables. These conditions indicate that maintenance needs are related not only to the visible condition of the building but also to its functionality, safety, exposure to environmental conditions, and the serviceability of individual components. Roof deterioration requires particular attention because gaps and openings were found in several roof sections. These openings allow sunlight to enter and may also provide pathways for rainwater. Repeated water infiltration can increase moisture within the building and contribute to the deterioration of materials over time. Similar concerns were observed in the electrical system, where aging components and exposed cable arrangements indicate the need for inspection and maintenance to support safe and reliable operation.

Damage was also identified on several wall sections, including cracking, peeling paint, surface deterioration, and damaged masonry. These conditions require further examination to determine the extent of deterioration and the appropriate repair measures. The field observations provide supporting evidence for the questionnaire findings. The observed physical conditions are therefore used as a basis for interpreting the assessment results and for formulating the maintenance priority model for Inpres Manonda Market.

Green Building Performance Assessment

The green building assessment consisted of energy efficiency, water efficiency, indoor environmental quality, material use, waste management, and building operation and maintenance. The results are presented in Table 1.

Table 1. Green Building Performance Assessment

Indicator	Mean Score	Performance Index	Maintenance Need Index
Energy efficiency	3.60	0.650	0.350
Water efficiency	3.40	0.600	0.400
Indoor environmental quality	3.09	0.523	0.477
Material use	3.20	0.550	0.450
Waste management	2.86	0.465	0.535
Building operation and maintenance	3.09	0.523	0.477
Average	**3.21**	**0.552**	**0.448**

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The Green Building assessment produced an overall performance index of 0.552 and a corresponding maintenance need index of 0.448. The result indicates that the assessed green building attributes have not reached the upper end of the performance scale and therefore still require improvement through maintenance and operational measures. Waste management recorded the highest maintenance need index (0.535), despite not being a physical building component. This finding indicates that sustainable maintenance at the market should also address operational aspects, particularly the handling, collection, and management of waste. In contrast, energy efficiency recorded the lowest maintenance need index (0.350), indicating comparatively better perceived performance. The difference between these indicators demonstrates that maintenance planning should not be limited to structural or architectural components. Operational practices associated with waste management and building operation also influence the overall environmental performance of the market.

Environmental Health Assessment

The environmental health assessment covered clean water availability, sanitation, ventilation, lighting, thermal comfort, humidity, waste management, drainage, cleanliness, and vector control.

Table 2. Environmental Health Assessment

Indicator	Mean Score	Performance Index	Maintenance Need Index
Clean water availability	3.37	0.593	0.407
Sanitation	3.03	0.508	0.493
Ventilation	2.91	0.478	0.522
Lighting	3.29	0.573	0.427
Thermal comfort	3.03	0.508	0.493
Humidity	2.86	0.465	0.535
Waste management	2.97	0.493	0.507
Drainage	2.94	0.485	0.515
Cleanliness	3.14	0.535	0.465
Vector control	3.00	0.500	0.500
Average	**3.05**	**0.514**	**0.487**

The environmental health results reveal an important relationship between building condition and environmental quality. Humidity obtained the highest maintenance need index (0.535), followed by ventilation (0.522) and drainage (0.515). These findings are consistent with the field observations, particularly the presence of openings in the roof through which rainwater may enter the building.Water infiltration can increase moisture exposure and may subsequently contribute to material deterioration. The relationship is particularly relevant to traditional market buildings because roof protection, ventilation, drainage, and cleanliness operate as interconnected components rather than independent systems. Therefore, maintenance intervention on the roof may generate benefits beyond the physical repair of the roof itself. Preventing water infiltration may also reduce moisture-related problems and contribute to improved indoor environmental conditions. This provides a rationale for integrating environmental health into the maintenance priority model rather than evaluating infrastructure condition independently.

Infrastructure Condition Assessment

The infrastructure condition assessment covered wall, roof, electrical installation, facility functionality, safety, and maintenance urgency.

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Table 3. Infrastructure Condition Assessment

Indicator	Mean Score	Performance Index	Maintenance Need Index
Wall condition	2.74	0.435	**0.565**
Roof condition	2.54	0.385	**0.615**
Electrical installation condition	2.63	0.408	**0.592**
Facility functionality	2.97	0.493	**0.507**
Safety condition	2.86	0.465	**0.535**
Maintenance condition/urgency	3.26	0.565	**0.435**
Average	**2.83**	**0.458**	**0.542**

The infrastructure condition assessment produced the highest overall maintenance need index among the three questionnaire-based dimensions, with an ICN value of 0.542. This result indicates that physical infrastructure deterioration represents a major component of the current maintenance requirement at Inpres Manonda Market. The roof obtained the highest indicator-level maintenance need index (0.615). This result is consistent with the field observation, which identified deteriorated roof and timber supporting components as well as openings that permit potential rainwater infiltration. The electrical installation ranked second with an index of 0.592. The observed aging electrical components and exposed cable arrangements provide physical evidence supporting this questionnaire result. The wall condition recorded a maintenance need index of 0.565. Field observations also documented cracking, peeling surface finishes, and deteriorated masonry. The consistency between questionnaire results and physical observations strengthens the interpretation that roof, electrical installation, and wall components require systematic maintenance attention.

Comparison of the Three Assessment Dimensions

The results of the questionnaire-based assessment are summarized in Table 4.

Table 4. Comparison of Maintenance Need Indices

Dimension	Performance Index	Maintenance Need Index
Green Building	0.552	0.448
Environmental Health	0.514	0.487
Infrastructure Condition	0.458	0.542

The results of the three assessment dimensions show that infrastructure condition had the highest maintenance need index, with a value of 0.542, followed by environmental health at 0.487 and green building performance at 0.448. The higher index obtained for infrastructure condition indicates that physical building components require greater attention in the maintenance planning of Inpres Manonda Market. The assessment, however, shows that maintenance needs are not limited to physical deterioration. Environmental health and green building performance also contribute to the overall evaluation by describing conditions related to user comfort, environmental quality, resource efficiency, and building performance.

AHP-Based Criterion Weighting

The Analytical Hierarchy Process (AHP) was subsequently applied to determine the relative weights of the four criteria specified in the research framework: Green Building, Environmental Health, Infrastructure Condition, and Life Cycle Cost (LCC). The pairwise comparisons were evaluated using the consistency ratio (CR), with CR ≤ 0.10 adopted as the acceptable consistency threshold.

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Table 5. AHP Pairwise Comparison Matrix

Criteria	Green Building	Environmental Health	Infrastructure Condition	LCC
Green Building	1.00	0.50	0.50	1.00
Environmental Health	2.00	1.00	1.00	1.00
Infrastructure Condition	2.00	1.00	1.00	2.00
LCC	1.00	1.00	0.50	1.00

The resulting weights for the four criteria are presented in Table 6.

Table 6. AHP Weights

Criterion	Weight	Percentage
Green Building	0.169	16.9%
Environmental Health	0.288	28.8%
Infrastructure Condition	0.338	33.8%
Life Cycle Cost	0.205	20.5%
Total	1.000	100%

$$CI = \frac{4.061 - 4}{4 - 1} = 0.020$$

$$CR = \frac{0.020}{0.90} = 0.022$$

The AHP assessment produced different priority weights among the four evaluation criteria. Infrastructure Condition obtained the highest weight of 0.338 (33.8%), followed by Environmental Health with a weight of 0.288 (28.8%). Life Cycle Cost contributed 0.205 (20.5%), while Green Building performance received a weight of 0.169 (16.9%). These weights represent the relative contribution of each criterion within the maintenance priority framework. The consistency of the pairwise comparison matrix was assessed through the maximum eigenvalue, Consistency Index (CI), and Consistency Ratio (CR). The calculated maximum eigenvalue (λmax) was approximately 4.061, resulting in a CI value of 0.020. Since the matrix consisted of four criteria, an RI value of 0.90 was used in calculating the CR. The resulting CR was approximately 0.022, which is below the 0.10 threshold adopted in this study. The consistency result indicates that the judgments represented in the pairwise comparison matrix are mathematically consistent and can therefore be used to derive the criterion weights for the subsequent maintenance priority assessment.

Relative Life Cycle Cost Assessment

The Life Cycle Cost analysis was introduced to capture the long-term economic implications of maintenance decisions. The analysis period was established at 10 years with a discount rate of 6%. Initial intervention was considered at Year 0, while routine maintenance was considered annually from Year 1 to Year 10. Major replacement costs were intended to be incorporated according to the service or replacement cycle of each component.

The present value factor for a 10-year period at a 6% discount rate is 7.360. The relative LCC was calculated by multiplying the MNI by this factor.

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Table 7. Relative Life Cycle Cost Assessment

Component	MNI	Relative LCC	LCCN
Roof	0.615	4.526	1.000
Electrical installation	0.592	4.357	0.770
Wall	0.565	4.158	0.500
Waste management	0.535	3.938	0.201
Ventilation	0.522	3.842	0.071
Drainage	0.515	3.790	0.000

The LCC assessment identified the roof as the component associated with the highest relative life cycle cost, as reflected by its LCCN value. Electrical installations and wall components followed in terms of their relative cost contribution. The pattern observed in the LCC assessment corresponds with the infrastructure condition results, where the roof recorded the highest Maintenance Need Index (MNI) of 0.615, followed by electrical installations at 0.592 and wall condition at 0.565. The relative LCC assessment followed the same pattern as the infrastructure maintenance need assessment because the relative cost burden was derived from the MNI values. The normalized LCC values were subsequently included in the Maintenance Priority Index (MPI) as one of the four assessment dimensions, together with Green Building, Environmental Health, and Infrastructure Condition. In the AHP assessment, LCC was assigned a relative weight of 0.205, equivalent to 20.5% of the total criterion weight. This weighting allows the economic implications of maintenance interventions to be considered alongside physical condition and building performance in the formulation of maintenance priorities.

Integrated Maintenance Priority Analysis

The assessment of the four dimensions provides an overall basis for identifying maintenance needs at Inpres Manonda Market. Based on the questionnaire results, Infrastructure Condition recorded the highest maintenance need index (0.542), followed by Environmental Health (0.487) and Green Building (0.448). The AHP assessment produced a similar order of importance, with Infrastructure Condition receiving the highest weight (0.338), followed by Environmental Health (0.288), LCC (0.205), and Green Building (0.169). The Consistency Ratio (CR) of 0.022 was below the 0.10 threshold, indicating that the pairwise comparison matrix met the consistency requirement. The LCC assessment showed that the roof had the highest normalized LCC value (LCCN = 1.000), followed by electrical installations (0.770) and wall components (0.500). These components also recorded relatively high maintenance need indices in the infrastructure condition assessment, with values of 0.615 for the roof, 0.592 for electrical installations, and 0.565 for walls.

Table 8. Integrated Maintenance Assessment

Assessment Aspect	Main Result	Interpretation
Green Building	MNI = 0.448	Maintenance and operational improvement are required
Environmental Health	MNI = 0.487	Environmental conditions require attention
Infrastructure Condition	MNI = 0.542	Physical infrastructure represents the major maintenance concern
LCC	LCC weight = 0.205	Long-term maintenance cost considerations are incorporated
Roof	MNI = 0.615; LCCN = 1.000	High maintenance and relative life-cycle cost concern
Electrical installation	MNI = 0.592; LCCN = 0.770	High maintenance and relative life-cycle cost concern
Wall	MNI = 0.565; LCCN = 0.500	Significant physical and maintenance concern

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Field observations identified several conditions that require attention, including openings in the roof, moisture penetration, deteriorated wall surfaces, and aging electrical installations. The environmental health assessment also indicated maintenance needs related to humidity, ventilation, and drainage, with indices of 0.535, 0.522, and 0.515, respectively. These findings indicate that maintenance planning should consider physical condition together with environmental health and long-term cost implications. For example, roof maintenance may address both physical deterioration and moisture-related problems.

Maintenance Priority Index (MPI)

The Maintenance Priority Index (MPI) was developed by integrating the four assessment dimensions: Green Building, Environmental Health, Infrastructure Condition, and Life Cycle Cost. The weights obtained from the AHP analysis were 0.169, 0.288, 0.338, and 0.205, respectively.

The MPI was calculated using the following equation:

$$MPI_i = (0.169)(GBN_i) + (0.288)(EHN_i) + (0.338)(ICN_i) + (0.205)(LCCN_i)$$

The available maintenance need indices were 0.448 for Green Building, 0.487 for Environmental Health, and 0.542 for Infrastructure Condition. For the LCC dimension, the average LCCN of the six assessed components was calculated from the values presented in Table 7:

$$LCCN_{avg} = \frac{1.000 + 0.770 + 0.500 + 0.201 + 0.071 + 0.000}{6} = 0.424$$

The assessment of the four dimensions provides an overall basis for identifying maintenance needs at Inpres Manonda Market. Based on the questionnaire results, Infrastructure Condition recorded the highest maintenance need index (0.542), followed by Environmental Health (0.487) and Green Building (0.448). The AHP assessment produced a similar order of importance, with Infrastructure Condition receiving the highest weight (0.338), followed by Environmental Health (0.288), LCC (0.205), and Green Building (0.169). The Consistency Ratio (CR) of 0.022 was below the 0.10 threshold, indicating that the pairwise comparison matrix met the consistency requirement. The LCC assessment showed that the roof had the highest normalized LCC value (LCCN = 1.000), followed by electrical installations (0.770) and wall components (0.500). These components also recorded relatively high maintenance need indices in the infrastructure condition assessment, with values of 0.615 for the roof, 0.592 for electrical installations, and 0.565 for walls. Field observations identified several conditions that require attention, including openings in the roof, moisture penetration, deteriorated wall surfaces, and aging electrical installations. The environmental health assessment also indicated maintenance needs related to humidity, ventilation, and drainage, with indices of 0.535, 0.522, and 0.515, respectively.

CONCLUSION

This study established an integrated framework for prioritizing maintenance of Inpres Manonda Market infrastructure based on four assessment dimensions: Green Building performance, Environmental Health, Infrastructure Condition, and Life Cycle Cost (LCC). The results demonstrate that maintenance needs are associated with both the physical condition of building components and broader environmental and economic considerations.

The Green Building and Environmental Health assessments produced Maintenance Need Index (MNI) values of 0.448 and 0.487, respectively. Infrastructure Condition recorded the highest MNI at 0.542. At the component level, the roof showed the greatest maintenance need (MNI = 0.615), followed by electrical installations (0.592) and wall condition (0.565). These results correspond with field observations of roof deterioration, water infiltration, deteriorated wall surfaces, and aging electrical installations. The AHP analysis assigned weights of 0.338 to Infrastructure Condition, 0.288 to Environmental Health, 0.205 to LCC, and 0.169 to Green Building. The resulting CR of 0.022 was below the 0.10 threshold, indicating an acceptable level of consistency in the pairwise comparison matrix. The LCC assessment produced the highest normalized value for the roof (LCCN = 1.000), followed by electrical installations (0.770) and wall components (0.500). The relative LCC assessment

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showed a pattern consistent with the infrastructure maintenance need assessment, with the roof, electrical installation, and wall components showing the highest relative maintenance cost burden. Overall, the findings indicate that maintenance prioritization should not rely solely on physical deterioration. The proposed Maintenance Priority Index (MPI) provides a structured basis for incorporating physical condition, environmental health, green building performance, and long-term cost considerations into maintenance planning for market infrastructure.

RESEARCH IMPLICATION

The findings have several implications for maintenance management at Inpres Manonda Market. The results suggest that maintenance decisions should consider more than the visible condition of building components. By incorporating Green Building performance, Environmental Health, Infrastructure Condition, and Life Cycle Cost, the assessment considers physical, environmental, and economic aspects within the same framework. The results also highlight the need for greater attention to components with relatively high maintenance need indices, particularly the roof, electrical installations, and walls. Regular inspection and timely intervention are important for these components. For the roof, maintenance may also help address moisture-related problems, as roof openings and water infiltration were observed in the field and were accompanied by relatively high maintenance needs related to humidity.

The inclusion of LCC adds an economic dimension to the maintenance assessment. Although the present analysis uses normalized relative LCC values rather than detailed monetary estimates, it demonstrates the relevance of considering future maintenance costs when establishing priorities. The AHP weight assigned to LCC was 0.205, indicating its contribution to the overall assessment framework.

The proposed MPI framework can therefore be applied as a basis for organizing maintenance priorities at market facilities.

REFERENCES

Arifin, M. F. A., Aditya, Y., Budiwirawan, A., Sutarto, A., & Taveriyanto, A. (2022). Education Building Maintenance Priority Strategy Consider Safety Condition Using Analytical Hierarchy Process (AHP). Jurnal Teknik Sipil Dan Perencanaan, 24(1), 72–80. https://doi.org/10.15294/jtsp.v24i1.35980

Arumsari, P., Wijayanti, Y., & Ramadhan, N. F. (2021). Building maintenance priority assessment for building components. IOP Conference Series: Earth and Environmental Science, 729(1), 012023. https://doi.org/10.1088/1755-1315/729/1/012023

Asmone, A. S., Conejos, S., & Chew, M. Y. L. (2019). Green maintainability performance indicators for highly sustainable and maintainable buildings. Building and Environment, 163, 106315. https://doi.org/10.1016/j.buildenv.2019.106315

Beauregard, M. A., & Ayer, S. K. (2019). Leveraging previously reported research to create a decision support tool for institutional facility maintenance. Journal of Facilities Management, 17(3), 249–266. https://doi.org/10.1108/JFM-08-2018-0051

Besiktepe, D., Ozbek, M., & Atadero, R. (2020). Identification of the Criteria for Building Maintenance Decisions in Facility Management: First Step to Developing a Multi-Criteria Decision-Making Approach. Buildings, 10(9), 166. https://doi.org/10.3390/buildings10090166

Bochare, R., Dagliya, M., & Kadam, M. (2024). Assessment of economic performance of an industrial building using life cycle cost & refined benefit-cost analysis – A case study. Journal of Building Engineering, 83, 108397. https://doi.org/10.1016/j.jobe.2023.108397

Chew, M. Y. L., Conejos, S., & Asmone, A. S. (2017). Developing a research framework for the green maintainability of buildings. Facilities, 35(1/2), 39–63. https://doi.org/10.1108/F-08-2015-0059

CC BY-SA 4.0

Fera, D., Nabela, D., Muchsin, S. W., Kiswanto, K., Iskandar, W., & Fahlevi, M. I. (2023). The Relationship of Knowledge and Attitudes of Traders with Traditional Market Sanitation Hygiene. J-Kesmas: Jurnal Fakultas Kesehatan Masyarakat (The Indonesian Journal of Public Health), 10(1), 36. https://doi.org/10.35308/j-kesmas.v10i1.7381

Geng, Y., Ji, W., Wang, Z., Lin, B., & Zhu, Y. (2019). A review of operating performance in green buildings: Energy use, indoor environmental quality and occupant satisfaction. Energy and Buildings, 183, 500–514. https://doi.org/10.1016/j.enbuild.2018.11.017

Ighravwe, D. E., & Oke, S. A. (2019). A multi-criteria decision-making framework for selecting a suitable maintenance strategy for public buildings using sustainability criteria. Journal of Building Engineering, 24, 100753. https://doi.org/10.1016/j.jobe.2019.100753

Illankoon, I. M. C. S., & Lu, W. (2019). Optimising choices of 'building services' for green building: Interdependence and life cycle costing. Building and Environment, 161, 106247. https://doi.org/10.1016/j.buildenv.2019.106247

Inriani, I., Syahrir, M., Ramli, R., Kanan, M., Tongko, M., & Salamat, F. (2021). Gambaran Kondisi Sanitasi Pasar Tradisional Modern Liang Kecamatan Liang Kabupaten Banggai Kepulauan: Description Of Sanitation Conditions In Traditional Modern Markets Of Liang, Liang District, Banggai Kepulauan Regency. Jurnal Kesmas Untika Luwuk : Public Health Journal, 12(2). https://doi.org/10.51888/phj.v12i2.80

Khadra, A., Hugosson, M., Akander, J., & Myhren, J. A. (2020). Development of a Weight Factor Method for Sustainability Decisions in Building Renovation. Case Study Using Renobuild. Sustainability, 12(17), 7194. https://doi.org/10.3390/su12177194

Kheradranjbar, M., Mohammadi, M., & Rafiee, S. (2022). Appropriate building repair and maintenance strategies using multi-criteria decision-making analysis – A Delphi study. Acta Structilia, 29(1), 86–111. https://doi.org/10.18820/24150487/as29i1.4

Purumal, K., Ali, A. S., Zakaria, N., & Baaki, K. (2021). Systematic Literature Review on Green Maintenance Principles and Maintenance Performance Indicators for Green Buildings Design. Journal of Design and Built Environment, 21(2), 59–75. https://doi.org/10.22452/jdbe.vol21no2.5

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