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Building Maintenance Priority Decision Support System Using the Method Profile Matching

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ABSTRACT

Along with the increasing age of a building, maintenance activities become things that need to be done to minimize damage that occurs such as damage to the ceiling or ceramics. Therefore, this study aims to determine the priority of building elements in the treatment of architectural components in buildings A and B ITK campus using Profile Matching method. Based on the results of analysis and observations in the field, the elements that are the main priority in the architectural component of Building A are ceiling elements, the second priority element is sanitary elements, the third priority element is floor elements and door and window elements, the fourth priority element is painting elements, and the last priority element is Wall pair elements. Whereas in the architectural component of Building B, the main priority elements are ceiling elements and sanitary elements, the second priority element is the wall pair element, the third priority element is the floor element and the door and window element, and the last priority element is the painting element.

Keywords: building maintenance; priority building maintenance; profile matching; painting.

INTRODUCTION

The lecture building is a supporting infrastructure that supports learning activities for students in a tertiary institution. As the age of a building increases, the damage that occurs cannot be avoided. To minimize the damage, it is necessary to carry out maintenance activities in a building. The complexity of the elements and sub-elements that make up a building causes the need for a mechanism to determine priorities in building maintenance.

Building maintenance priorities are determined based on the condition of the building elements. Assessment of building conditions can be obtained from the calculation of the building condition index value (Kusnadi, 2011). In addition, several previous studies related to determining maintenance priorities were carried out based on the components studied such as architecture, structure, utilities, and environmental planning (Hartono *et al.*, 2017). Meanwhile, according to Hamka and Harjono, it was explained that the priority for building repairs was carried out based on building damage that occurred in the sub-elements, elements, and components of the building (Hamka and Harjono, 2019).

Decision-making by implementing a Decision Support System (DSS) can facilitate the determination of the priority scale of building maintenance, especially for high-rise buildings. In this study used one form of the method in DSS, namely the method of *Profile Matching*. Where the analysis is done using the help *Composite Condition Index* (CCI) to calculate the value of the gap between profiles on building elements, the smaller the gap value obtained, the greater the weight value (Handojo and Setiabudi, 2010). In the profile matching analysis, there is also an ideal level of predictor variables that must be met as a result of assessing the condition of the building (Diana, 2018). This predictor value is obtained by weighting each element and sub-element of the building.

According to the Regulation of the Minister of Public Works No.24/PRT/M/2008, building maintenance is an effort made to repair damage to buildings that have occurred so that functional buildings can be used properly. Maintenance activities for buildings include repairs and/or replacement of building components, building materials, and/or infrastructure so that they remain functional (*curative maintenance*) (Permen PU No. 24/PRT/M/2008, 2008). The various types of maintenance activities in buildings include:

a. Rehabilitation.
The activities carried out include repairs to parts of the building that have been partially damaged but functionally the building from an architectural and/or structural point of view is still maintained in accordance with the original condition of the building, while building utilities may change according to conditions.
b. Renovation.
Repair activities for buildings that have suffered severe damage, some with conditions where the functional building can remain or change.
c. Restoration
Repair activities for buildings that have been severely damaged where the function of certain parts can be maintained or changed permanently in terms of the architecture of the building, while for structural and utility buildings changes can still occur.

Based on the explanation of Permen PU No.24/PRT/M/2008, damage to buildings can be divided into 3 (three) levels, including:

a. Light damage
It is a damaged condition of the building and occurs mainly in the non-structural component parts of the building such as roof coverings, floor coverings, infill walls, and ceilings.
b. Moderate damage
Is damage to the building in some non-structural components such as floor elements, roof structures, and so on.
c. Heavy damage

Is damage to buildings that mostly occur in building components which if after getting repairs, the functional parts of the building can function properly

With this in mind, this study aims to determine the priority of building repairs which can then be used as a reference in calculating maintenance costs that will be incurred in carrying out building maintenance. So that it is hoped that research results will be obtained that are more in line with the conditions experienced by practitioners and will have an influence on the decision-making process later. Determining building maintenance priorities can produce results that are more accurate and on target.

RESEARCH METHODS

This research refers to conceptual modeling in the form of a Decision Support System (DSS) with one of its methods called *Profile Matching*. In the process, in general, a comparison will be made between the actual data values *profile* which will be assessed with a value *profile* expected, so that it can be seen the difference in competence or what is called *gap* (Akhyar, 2017). In determining the level of alternative profiles in building maintenance and repair, the gap value is obtained from the results of the difference in competence between the alternative profile and the target profile. The value acquisition *gap* for each profile is then used as input in the weighting process. The weighting value obtained will then be grouped into two groups, *core factor*, and secondary *factor*, and calculating the percentage value and the total value of *core factor* and *secondary factor* the. Total value percentage core *factor* and *secondary factor* This can then be used as a reference in determining the ranking order of building components that will be recommended for repair and maintenance first. The determination of maintenance priorities for buildings is carried out in buildings A and B of the Kalimantan Institute of Technology Campus in Balikpapan City, East Kalimantan. Where the steps taken are to verify the actual conditions in the field. The technique of data collection was carried out in the form of field observations and verification of four parties related to building maintenance.

Building Component Weight

This method is used to assist in setting priorities with various choices offered and using various selection criteria (multi-criteria). For this reason, Saaty in writing the journal Bintarto sets out a

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comparison scale used to assess the level of importance of building elements (Bintarto, 2007) as follows:

Table 1. Paired Comparison Rating Scale

Scale	Definition
1	Same level of importance
3	The degree of importance is quite important
5	The degree of importance is more important
7	The degree of importance is much more important
9	The absolute importance level is more important
2,4,6,8	Intermediate values
Resprokal	If element i gets one number compared to element j, then element j has the opposite value compared to element i

In calculating the weight of building components and elements, the steps that need to be carried out are as follows:

a. Count *Priority Vector* by multiplying each value of the pairwise comparison matrix and value *priority vector* in order to get the value of the weighted normalized matrix.
b. Count *Vector Eigen Maximum* (*lmax*) by dividing the average value on a weighted normalized matrix with the value of *priority vector*. The equation used is as follows,

$$\lambda_{maks} = \frac{W_i}{\sum W_i} \quad (1)$$

where is the W value I is the weighted normalized matrix value.
c. Calculates the value of *Consistency Index* (CI) which is done by using the following equation,

$$CI = \frac{\lambda_{\text{maks}} - n}{n - 1} \quad (2)$$

where the value of n is the form of the matrix used.
d. Perform value calculations *Consistency Ratio* (CR) based on the following equation,

$$CR = \frac{CI}{RI} \quad (3)$$

where is value *Random Consistency Index* (RI) is obtained from the following table.

Table 2. Paired Comparison Rating Scale

n	RI
1	0
2	0
3	0,58
4	0,90
5	1,12
6	1,24
7	1,32
8	1,41
9	1,45
10	1,49

Building Component Weight

Assessment of the condition of a building can be done by determining the value of the building's Component Condition Index (IKK). Where the determination of the IKK itself is a combination of the component condition values and then multiplied by each weight value of the building components. According to Hudson's opinion in Putri's journal writing, the combined value of the building condition index (*Composite Conditions Index*) (Putri, 2015) can be formulated as in equation (4).

$$CCI = W_1 \cdot C_1 + W_2 \cdot C_2 + ... + W_n \cdot C_n \tag{4}$$

The building condition index value itself has a scale that describes the level of building conditions with a range of 0 (zero) to 100 (one hundred). If the value obtained is 0 (zero), it means that the building cannot function properly, whereas if the value obtained is 100 (one hundred), then the building is still functioning properly. The index scale value can be used as a reference in handling damage to a building as explained in table 3.

Table 3. Building Component Condition Index Scale

Zone	Condition Index	Condition Description
I	85 − 100	Very good: There is no visible damage to the building components but some deficiencies can still be seen
	70 – 84	Good: There is damage on a small scale
II	55 – 69	Moderate: The overall damage does not affect the function of the building structure
	40 – 54	Adequate: There is damage but the condition of the building is still fit for function
III	25 - 39	Bad: There is significant enough damage that can cause the function of the building to be disrupted
	10 - 24	Very bad: There was severe damage, causing the building to function almost unfit for function
	0 - 9	Collapse: The main component of the building begins to collapse

Assessment of the condition of a building is also carried out by calculating the value of the building's Sub-Element Condition Index (IKSE). Where calculations are performed to assess the condition of a building element at the lowest level in the building hierarchy. The formula used in this calculation is presented in equation 5.

$$IKSE = 100 - \sum_{i=1}^{p} \sum_{j=1}^{m} \alpha(T_j, S_j, D_{ij}) * F(t,d) \tag{5}$$

with,

a = Deductible value
P = Total damage to the building that occurred in the sub-element of the building reviewed by type
M = Total level of damage based on the type of damage reviewed
F(t,d) = Correction factor value based on the combination of damage to the building

According to Sutikno, the deductible value for each element or sub-element is different for each damage depending on the percentage of the volume of damage to the building (Sutikno, 2009). The volume of damage is then divided into 4 (four) levels of intervals, including:

a. Light damage (0% - 15%), with NP = 25 (twenty five)
b. Moderate damage (15% - 35%), with NP = 50 (fifty)
c. Heavy damage (35%-65%), with NP = 75 (seventy five)
d. Damage is not feasible function (> 65%), with NP = 100 (one hundred)

In this calculation there is a correction factor that is obtained based on the level of danger for each type of damage and the total value of the correction factor is one.

Table 4. Damage Correction Factor

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Number of Damage Combinations	Damage Priority	Number of Damage Combinations
2	I	0,6 – 0,8
	II	0,4 – 0,2
3	I	0,5 – 0,6
	II	0,3 – 0,4
	III	0,1 – 0,2

Method Profile Matching

Profile match method (*profile matching*) or the gap method, is a mechanism in decision-making by assuming that there is an ideal predictor variable level that must be owned by the subject being reviewed. Method *profile matching* is one of the appropriate methods used in determining building maintenance priorities because there is an ideal level of predictor variables that must be met by alternative competencies, in this case the results of assessing building conditions (Hamka and Harjono, 2019). The results of the building condition assessment will then calculate the value of the Sub Element Condition Index (IKSE) and Element Condition Index (IKE) of the building and will calculate the gap value based on these indicators. As for further explanation of the stages in the method *profile matching* is among others.

Gaps Calculation

Calculation *gap* or also known as *gap analysis* is an evaluation process carried out to assess a performance. *Gap analysis* is one of the important stages in the planning or evaluation of work. Say "*gap*" himself explains that there is a difference *disparity*) between one thing and another (Kusrini, 2007). In determining the level of alternative profiles in building maintenance and repair, the gap value is obtained from the difference in competency scores between the alternative profile and the target profile. Where the gap value is obtained by comparing the condition index value of the building elements with the ideal profile value. Calculation of the gap for each building element in each building is carried out based on the value of the standard condition of the building in zone II, that is, deterioration or damage begins to occur but does not affect the function of the building structure as a whole.

Gap weighting

Value acquisition *gap* for each ideal profile obtained from the weighting calculation process. The value of the weighting itself is an assessment of the weight gap based on the following table (Hamka and Harjono, 2019).

Table 5. Gap Weights

Difference	Value Weight	Information
0	5	The value of competence is the same as the value *profile target*
1	4,5	*Profile* alternative has a value of 1 level above
-1	4	*Profile* alternative has a value of 1 level below
2	3,5	*Profile* alternative has a value of 2 levels above
-2	3	*Profile* alternative has a value of 2 levels below
3	2,5	*Profile* alternative has a value of 3 levels above
-3	2	*Profile* alternative has a value of 3 levels below
4	1,5	*Profile* alternative has a value of 4 levels above
-4	1	*Profile* alternative has a value of 4 levels below

Value Calculation Core Factor (CF) and Secondary Factor (SF)

The assessments carried out were divided into two groups, namely, *core factor* and the *secondary factor*. *Core factor* itself is the most needed aspect or competency, in this case, it is the most important building element in the building structure. Where is the value of core *factor* obtained from the formula (Hamka and Harjono, 2019) the following:

$$\mathrm{NCF} = \frac{\sum_{\mathrm{i=1}}^{\mathrm{n}} NC}{\sum_{\mathrm{i=1}}^{\mathrm{n}} IC} \tag{6}$$

with,

NCF = Value of *Core Factor*
NC = Total score for *core factor*
IC = Total variables for *core factor*

The secondary factor or also known as the structural support factor of the building is a value obtained from a review of aspects other than those contained in a core *factor*. For the value of the secondary *factor* obtained from the formula (Hamka and Harjono, 2019) the following:

$$\mathrm{NSF} = \frac{\sum_{\mathrm{i=1}}^{\mathrm{n}} NS}{\sum_{\mathrm{i=1}}^{\mathrm{n}} IS} \tag{7}$$

with,

NSF = Value *Secondary Factor*
NS = Total value of s*econdary factor*
IS = Number of variable secondary *factor*

Calculation of Total Value

The total value is obtained by considering the influence of each aspect on the performance of each profile according to the percentage value core *factor* and secondary *factor*. The equation used to calculate the total variable value (Hamka and Harjono, 2019) is equation (8).

$$\mathrm{NT} = (x)\% \cdot NCF(x) + (x)\% \cdot NSF(x) \tag{8}$$

Where

NT = Total value of all variables
NCF(x) = Average value of the variable for core *factor*
NSF(x) = Average value of the variable for the secondary *factor*
(x)% = Total percentage entered (total 100%)

Alternative Ranking

The final result of the method profile *matching* is the determination of the ranking sequence of a building component that will be recommended for improvement first. Ranking is determined by considering the priority percentage of each aspect of the assessment. The formula used (Hamka and Harjono, 2019) are as follows:

$$Rangking = (x)\% \cdot \mathrm{NT_1} + (x)\% \cdot \mathrm{NT_2} + ... + (x)\% \cdot \mathrm{NT_n} \tag{9}$$

Where,

$\mathrm{NT_1}$ = Total value for variable 1
$\mathrm{NT_2}$ = Total value for variable 2
$\mathrm{NT_n}$ = Total value for the nth variable
$(x)\%$ = Total percentage of each variable (100% total)

RESULTS AND DISCUSSION

The recapitulation of observational data regarding building damage obtained is as follows.

Table 6. Damage to Building Elements

Code	Building Element Damage Amount	
	Building A	B building
A.	Floor job	

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A1	24,84 m^2		13,68 m^2
A2	1,44 m^2		4,32 m^2
A3	4,68 m^2		11,52 m^2
A4	9,36 m^2		0,36 m^2
B.		Ceiling work	
B1	111,25 m^2		59,35 m^2
B2	987,14 m^2		305,28 m^2
B3	914,16 m^2		10,8 m^2
C.		Wall Mounting Work	
C1	0,563 m^2		0,02 m^2
C2	0,062 m^2		0,009 m^2
C3	0,173 m^2		0,1 m^2
C4	-		-
D.		Pointingjaan sanitary	
D1	-		1 unit
D2	2 unit		6 unit
D3	-		-
D4	-		-
D5	1 unit		1 unit
D6	-		-
D7	-		7 unit
D8	5 unit		4 unit
D9	-		-
AND.		Painting Job	
E1	11,16 m^2		0,009 m^2
E2	-		-
F.		Door and Window Work	
F1	7 unit		4 unit
F2	6 unit		10 unit
F3	46 unit		16 unit
F4	2 unit		14 unit

Building Component Weighting

The priority weight for each sub-element and building element is known by first preparing a hierarchical building scheme. The scheme of all the components reviewed is as follows.

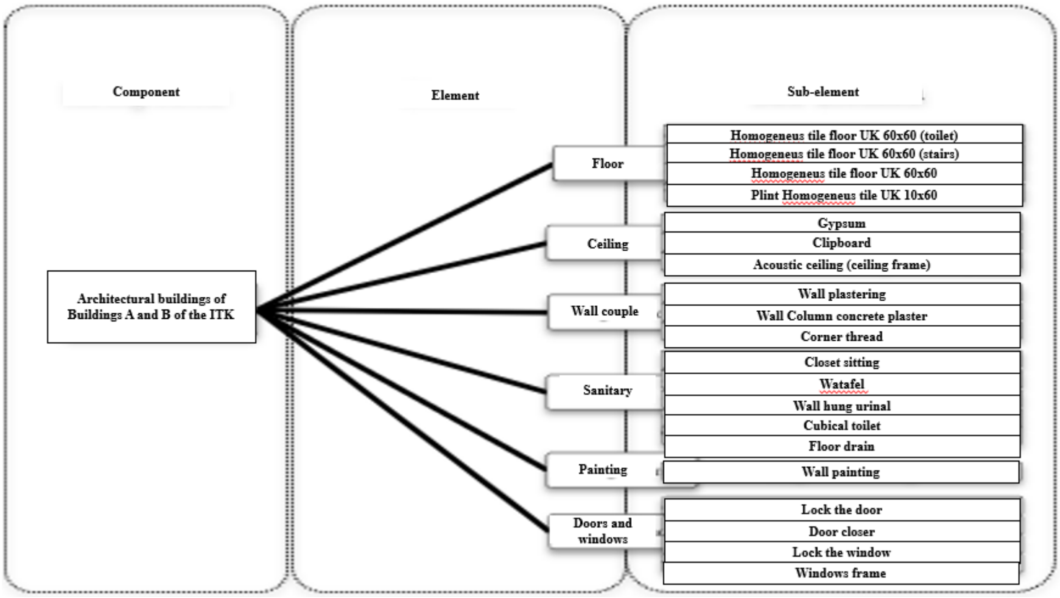

Figure 1. Schematic of the Hierarchy of Building Components

Calculation of the weight of sub-elements and elements is carried out using matrix calculations and comparative assessments. The results obtained from the weighting of sub-elements and building elements are as follows.

Table 7. Weight of Building Elements

Elements	Weight Value	Sub Elements	Weight Value
Floor	0,16	Floor Homogeneus Tile Uk. 60x60 (Toilet)	0,29
		Floor Homogeneus Tile Uk. 60x60 (Ladder)	0,29
		Floor Homogeneous Tile Uk. 60x60	0,29
		Plint Homogeneus Tile Uk. 10x60	0,14
Ceiling	0,14	Gypsum	0,31
		Calsiboard	0,2
		Ceiling Acoustic (Rangka Ceiling)	0,49
pass Wall	0,19	Wall Plastering	0,21
		Column Concrete Grading	0,24
		Angle Thread	0,49
Sanitary	0,17	Sitting Closet	0,31
		Washbasin	0,29
		Wall Hung Urinal	0,14
		Cubical Toilet	0,14
		Floor Drain	0,12
Painting	0,11	Wall Painting	1,00
Door & Window	0,23	Lock the door	0,25
		Door Closer	0,26
Door & Window	0,23	Window Lock	0,19
		Windows frame	0,3

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Assessment of IKSE and IKE Buildings

The assessment is carried out based on the recapitulation data of building damage, types of building damage, volume of building damage and reduction values obtained previously. Furthermore, the value of the building condition index can be calculated. The deduction value is obtained from the percentage of damage to building components. The results of the assessment of the Element Condition Index (IKSE) and Element Condition Index (IKE) are as follows.

Table 8. IKSE and IKE Values Building A

Elements	Sub Elements	ikse	POWER
Floor	Floor Homogeneus Tile Uk. 60x60 (Toilet)	80	81,55
	Floor Homogeneous Tile Uk. 60x60 (Stairs)	80	
	Floor Homogeneous Tile Uk. 60x60	85	
	Plint Homogeneus Tile Uk. 10x60	75	
Ceiling	Gypsum	97,5	84,98
	Calsiboard	90	
	Ceiling Acoustic (Rangka Ceiling)	75	
pass Wall	Wall Plastering	90	90
	Column Concrete Grading	90	
	Angle Thread	90	
Sanitary	Washbasin	85	49,38
	Wall Hung Urinal	92,5	
	Floor Drain	80	
Painting	Wall Painting	92,5	92,5
Doors & Windows	Lock the door	87,5	85,13
	Door Closer	87,5	
	Window Lock	75	
	Windows frame	87,5	

Table 9. IKSE and IKE Values for Building B

Elements	Sub Elements	ikse	POWER
Floor	Floor Homogeneus Tile Uk. 60x60 (Toilet)	80	81,55
	Floor Homogeneus Tile Uk. 60x60 (Ladder)	80	
	Floor Homogeneous Tile Uk. 60x60	85	
	Plint Homogeneus Tile Uk. 10x60	75	
Ceiling	Gypsum	97,5	85,48
	Calsiboard	92,5	
	Ceiling Acoustic (Rangka Ceiling)	75	
pass Wall	Wall Plastering	90	90
	Column Concrete Grading	90	
	Angle Thread	90	
Sanitary	Sitting Closet	92,5	88,83
Sanitary	Washbasin	85	88,83
	Wall Hung Urinal	92,5	
	Cubical Toilet	92,5	
	Floor Drain	80	

Elements	Sub Elements	ikse	POWER
Painting	Wall Painting	92,5	92,5
Doors & Windows	Lock the door	87,5	87,5
	Door Closer	87,5	
	Window Lock	87,5	
	Windows frame	87,5	

Gap Assessment

The gap value is obtained from the comparison of the condition index value of the building elements with the ideal profile value. The gap calculation for each building element is carried out based on the building condition index value that is in the zone II area, namely conditions where deterioration or damage to the building begins but does not affect the overall function of the building structure. As for the results of the assessment of gaps between elements of building components.

Table 10. IKSE and IKE Values Building A

Elements	POWER	Min Value	Gap Value
Floor	81,55	69	12,55
Ceiling	84,98	69	15,96
pass Wall	90	69	21
Sanitary	88,83	69	-19,63
Painting	92,5	69	23,5
Doors & Windows	87,5	69	16,13

Table 11. IKSE and IKE Values for Building B

Elements	POWER	Min Value	Gap Value
Floor	81,55	69	12,55
Ceiling	85,48	69	16,48
pass Wall	90	69	21
Sanitary	88,83	69	19,63
Painting	92,5	69	23,5
Doors & Windows	87,5	69	18,5

Gap Weight Assessment

The weight of the gap is determined based on the results of calculating the value of the gap and compared with table 5. The results of the assessment of the gap between building component elements.

Table 12. IKSE and IKE Values Building A

Elements	Gap Value	Gap weight
Floor	12,55	4,5
Ceiling	15,96	4,5
pass Wall	21	-3
Sanitary	-19,63	4
Painting	23,5	3,5
Doors & Windows	16,13	4,5

Table 13. Building B IKSE and IKE values

Elements	Gap Value	Gap weight

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Floor	12,55	4,5
Ceiling	16,48	4,5
pass Wall	21	-3
Sanitary	19,63	4,5
Painting	23,5	3,5
Doors & Windows	18,5	4,5

Assessment *Core Factor* and *Secondary Factor*

Mark *Core Factor* (CF) and *Secondary Factor* (SF) is determined based on the results of calculations using equations (6) and (7). As for the results of the assessment of gaps between elements of building components.

Table 14. Building CF and SF Values A

Elements	Nilai CF	SF value
Floor	-	4,5
Ceiling	4,5	-
pass Wall	-3	-
Sanitary	4	-
Painting	-	3,5
Doors & Windows	-	4,5

Table 15. CF and SF Values of Building B

Elements	Nilai CF	SF value
Floor	-	4,5
Ceiling	4,5	-
pass Wall	3,5	-
Sanitary	4,5	-
Painting	-	3,5
Doors & Windows	-	4,5

Treatment Priority Ranking

The total score is obtained by considering the CF and SF values for each aspect reviewed. In this study, the percentage of CF used was 60% while the percentage of SF used was 40%. The calculation of the total value is obtained by using equation (9). Then the total value obtained can be ranked aspects reviewed using equation (10). The ranking results obtained are as follows.

Table 16. Ranking of Building Maintenance Priorities A

Elements	Total Value	Rank
Floor	1,8	3
Ceiling	2,7	1
pass Wall	-1,8	5
Sanitary	2,4	2
Painting	1,4	4
Doors & Windows	1,8	3

Table 17. Ranking of Building Maintenance Priorities B

Elements	Total Value	Rank
Floor	1,8	3
Ceiling	2,7	1

Elements	Total Value	Rank
pass Wall	2,1	2
Sanitary	2,7	1
Painting	1,4	4
Doors & Windows	1,8	3

Based on these results, it is known that the main priority for repairing architectural components in building A is the ceiling element, the second rank is the sanitary element, the third rank is the floor element and the door and window elements, the fourth rank is the painting element, and the last rank is the wall pairing element. While the top priority for repairing architectural components in building B is the ceiling and sanitary elements, the second rank is the wall pairing elements, the third rank is the floor elements and door and window elements, and the last rank is the painting elements.

CONCLUSION

From the results, it was found that the priority order of maintenance for architectural components in buildings A and B ITK. In the architectural component of building A, the highest priority element is the ceiling element, the second priority element is the sanitary element, the third priority element is the floor element and door and window elements, the fourth priority element is the painting element, and the last priority element is the wall pairing element. Whereas in the architectural components of building B, the top priority elements are ceiling elements and sanitary elements, the second priority elements are wall pairing elements, the third priority elements are floor elements and door and window elements, and the last priority element is painting elements.

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