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Priority of Building Maintenance Component

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Abstract**—** *At The University of Muhamamdiyah Malang (UMM) there are many buildings that require continuous maintenance with the aim of maintaining the functions and uses of the building as a whole. Appropriate maintenance will make the building a good place for owners or users to conduct activities. Adequate building maintenance activities will also produce a long building life in accordance with the planning, economic value, and economic usefulness of the components in it. Without building maintenance activities, the function of a building will be degraded over time. This is what underlies the need for building maintenance activities. In this study carried out using the Analytical Hierarchy Process (AHP) method in determining the priority scale of maintenance component activities that are more effective, efficient and targeted at buildings at UMM so that they will get a priority sequence of building maintenance components. From the results of the analysis using AHP, it is known that urgency is the main criterion in determining maintenance items that are a priority compared to the execution time with weights of 0.8467 (85%) and 0.1533 (15%), respectively. While maintenance of water channels is a top priority with the highest weight, which is 0.2508 (25%), then ceiling maintenance components are 0.2130 (21%) and AC maintenance components are 0.1691 (17%).*

Keywords**—** *Building Maintenance, Priority Scale, Analytical Hierarchy Process.*

I. INTRODUCTION

In the construction project at the University of Muhammadiyah Malang (UMM), maintenance of buildings is needed to maintain maintenance continuously in order to maintain the function and usefulness of the building as a whole. Appropriate maintenance will make the building a good place for building owners or users to do activities.

Adequate building maintenance activities will also produce a long building life in accordance with the planning, economic value, and economic usefulness of the components in it. Without building maintenance activities, the function of a building will be degraded over time. This is what underlies the need for building maintenance activities.

But with the many buildings owned by UMM, it has not been followed by a good and integrated building maintenance management system. This is due to the maintenance project being carried out without estimating the cost and material requirements, lack of supervision of the project, the workflow of the project that has not been arranged and the absence of information (indicators) when maintenance is needed. As a result, maintenance projects are carried out only when needed or damaged, so the owner must pay more, but the number of buildings maintained is limited.

In the Minister of Public Works Regulation Number: 24 / PRT / M / 2008 concerning the Guidelines for Maintenance and Maintenance of Building Buildings in Chapter IV, it is stated that the technical standards for component inspection and repair are to determine the priority scale of execution time of repairs. Maintenance priority scale. In this study, the Analytic Hierarchy Process (AHP) method was developed by Thomas L. Saaty.

Based on the explanation above, research is needed to make an assessment that can help to determine the priority of building maintenance components to be able to help building maintenance projects at UMM. From this study, it is expected that a more representative method conclusion can be obtained that can be used in determining the priority scale of maintenance activities that are more effective, efficient and targeted at buildings at UMM and obtain priority order of building maintenance components.

II. LITERATURE REVIEW

A. Building Maintenance

According to the Minister of Public Works Regulation Number: 24 / PRT / M / 2008 concerning Guidelines for Building Maintenance and Maintenance, maintenance of building is an activity to maintain the reliability of buildings and infrastructure so that buildings are always preventive maintenance. activities to repair and / or replace parts of buildings, components, building materials, and / or infrastructure and facilities so that buildings remain currative maintenance.

B. Scope of Building Maintenance

Maintenance work includes the types of cleaning, tidying, checking, testing, repairing and / or replacing building materials or equipment, and other similar activities based on guidelines for the operation and maintenance of building. The difference in maintenance with care is located in the scope of work and purpose. Maintenance of buildings aims to keep building buildings in good condition while maintenance of building is an activity to repair and / or replace parts of buildings, components, building materials, and / or infrastructure and facilities so that buildings remain functionally feasible. (Minister of Public Works Regulation Number: 24 / PRT / M / 2008 concerning Guidelines for Building Maintenance and Maintenance).

C. Guidelines for Building Maintenance

This research refers to the Minister of Public Works Regulation No: 24 / PRT / M / 2008. The total maintenance scope reaches 85 components. But in this study not all building components were observed for maintenance due to the limited time of the study. 12 maintenance components will be taken.

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D. Determination of Maintenance Priority with AHP

To determine the priority of maintenance components in this study we will weight the multi-criteria method, namely by evaluating pairwaise comparative matrix based on the Analytical Hierarchy Process (AHP) method whose main input is perception, where human instincts can estimate simple quantities through the senses. (Ismanto, 2017).

AHP is a decision support model developed by Thomas L. Saaty. This decision support model will describe multi-factor problems or complex multi criteria into a hierarchy, according to Saaty (1993), hierarchy is defined as a representation of a complex problem in a multi-level structure where the first level is a goal, followed by a factor level, criteria, sub criteria, and so on down to the last level of the alternative. With hierarchy, a complex problem can be broken down into groups which are then organized into a hierarchical form so that the problem will appear more structured and systematic. AHP stages are as follows.

In the AHP method steps are taken (Syaifullah, 2010):

- Define the problem and determine the desired solution.
- Create a hierarchical structure that starts with the main goal.
- Make a paired comparison matrix that describes the relative contribution or influence of each element to the goal or criteria that are above it.
- Defines pairwise comparisons so that the total number of judgments is n x [(n-1) / 2], with n being the number of elements compared.
- Intensity of Interest
- The opposite
- Calculate eigenvalues and test their consistency.
- Repeat steps 3,4 and 5 for all levels of the hierarchy.
- Check hierarchy consistency.

III. Research Method

A. Research sites

The building which is the object of study is located at Third Campus of UMM. This Campus is located in Tegalgondo Village, Karangploso District, Malang Regency, about 7 KM west of Malang City towards Batu City. The location is a border area between Malang City and regency. Third Campus having its address at Jalan Raya Tlogomas No. 246 Malang. Third Campus stands on an area of 30 hectares, part of the area (30%) including in Malang City Area and 70% is included in Malang Regency.

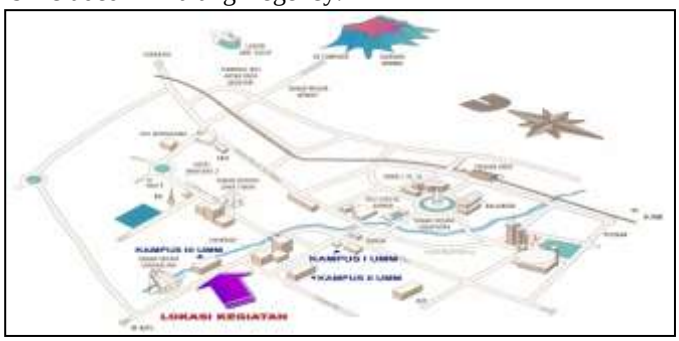

Fig. 1. Research sites

B. Research Concept Framework

The concept of this research departs from the problem of the number of buildings at UMM which reach dozens of buildings that need to be paid attention by the owner. In the Minister of Public Works Regulation Number 24 / PRT / M / 2008 it is stated that Maintenance of building functions serves to maintain the reliability of buildings and infrastructure and facilities so that buildings are always function-worthy.

To find out in detail the building maintenance at UMM, it is necessary to have existing data that can provide an overview of this.

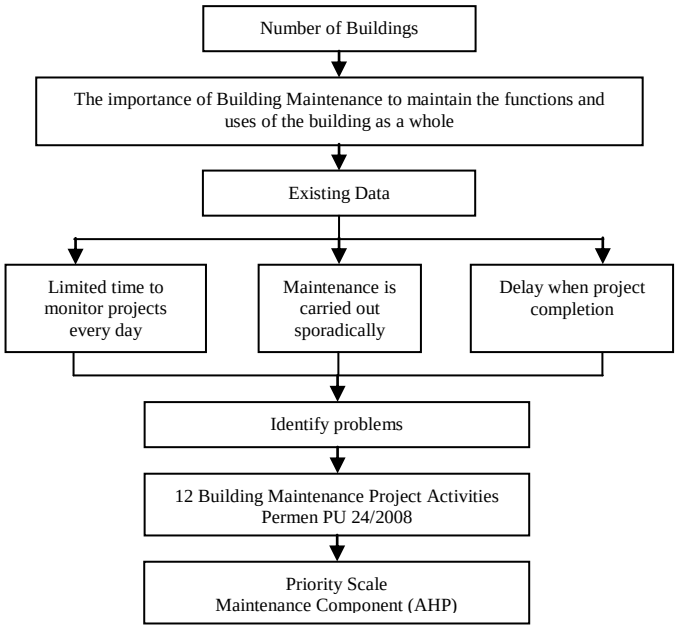

Fig. 2. Research conceptual framework

C. Determination of Weighting Criteria

In the Minister of Public Works Regulation 24/2008 in Chapter IV, it is stated that the technical standards for component inspection and repair are to determine the priority scale of the execution time of repairs. 12 The components taken in this research are.

TABLE I. Building Maintenance Project Components

NO	COMPONENT	TYPE OF ACTIVITY
1	Brick wall	Brick wall
2	Floor Coating	Ceramics
3	Wallcoverings	Glass wall
		Ceramic and Granite Walls
4	Ceiling Cover	Ceiling
5	Frames, Doors & Windows	Wood
		Aluminum
6	Clean and Dirty Water channels	Clean and Dirty Water channels
7	Air System	Air Conditioning
8	Vertical Transportation System	Lift
9	Fire Protection System	APAR
		Sprinkler
10	Lighting	Lighting
11	Telephone & Internet Network	Telephone & Internet Network
12	TV & CCTV channels	TV & CCTV channels

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Of the 12 components, 6 criteria will be taken to make it easier for respondents to answer, namely:

- Maintenance of Brick Walls
- Maintenance of ceiling cover (ceiling)
- Maintenance of Water channels
- Maintenance of the Air Conditioning System (AC)
- Maintenance of Air Conditioning (lift)
- Fire Protection System

The basis for determining the six criteria for the maintenance component is that the component intersects directly with users (users) and needs to be done routinely. Whereas the other 6 criteria were not included (floor coatings, wall coatings, frames, doors & windows; lighting lamps; Telephone and Internet networks; TV and CCTV channels) because based on the initial survey and habits at the study location, new maintenance was done if there was damage (for example tile floors, frames, etc.) or if there are reports. For more details about determining the priority scale of building maintenance project work items can be seen in the following figure.

Fig. 3. Research conceptual framework

IV. Results And Discussion

A. Analysis of Analytical Hierarchy Process (AHP)

In this section an analysis and discussion of the analytical hierarchy process (AHP) method will be given in determining the priority items for building maintenance project work. There are two criteria that form the basis of the determination, namely the cleanliness (how important) and the execution time (duration). Urgency means the importance of a building maintenance item that has a very basic function in supporting activities in the building. The execution time is the time needed to complete the building maintenance project items. So that maintenance items will be a priority if the item has high purity and can be completed in a short time.

Furthermore, maintenance items analyzed using the AHP method amounted to 6 (six) items as mentioned previously, which included maintenance of brick walls, maintenance of ceilings, maintenance of water channels, maintenance of the air system, maintenance of lift and maintenance of fire protection systems. Where the six items will be compared with one another based on the criteria of urgency and time of execution. So from the results of questionnaires filled by stakeholders, what items will be prioritized in building maintenance will be known.

For the AHP method the actual assessment can be done by one expert respondent. But if it is done by 5 experts, then the data processing will then be formulated as a geometric average. The questionnaire was distributed to 5 expert respondents in the field of building and directly related to building maintenance projects at UMM.

B. Calculation of Weight of Component Criteria

First we will calculate the Criteria for urgency, for example from the respondent. From the questionnaire that was filled in by the respondents we tabulated in the form of excel which then made a comparison matrix from the contents of the questionnaire respondents as shown in the following table.

TABLE III. The questionnaire comparison matrix is based on the criteria for urgency

Item Maintenance	Wall Brick	Ceiling	Channel Water	System Air (AC)	Elevator	Protection Fire	Weight	CM
Brick wall	0,0600	0,1061	0,0497	0,0259	0,1957	0,1250	0,0937	6,3912
Ceiling	0,1800	0,3182	0,3477	0,3879	0,1957	0,2917	0,2869	6,6459
Water channels	0,4200	0,3182	0,3477	0,3879	0,3261	0,2083	0,3347	7,0195
Air Conditioning (AC)	0,3000	0,1061	0,1159	0,1293	0,1957	0,2083	0,1759	7,1240
Elevator	0,0200	0,1061	0,0695	0,0431	0,0652	0,1250	0,0715	6,0996
Fire Protection	0,0200	0,0455	0,0695	0,0259	0,0217	0,0417	0,0374	6,3017

From the comparison matrix, we can calculate the weight value of each item of maintenance activity. For example, in table the item 'water channel' has the largest weight with a value of 0.3347 or 33.47%. This value is obtained from calculating the average value of each item comparing other items with water channel items. Where in table it is known that the value of each item is 0.4200; 0.3182; 0.3477; 0.3879; 0.3261; 0.2083. For example, the value of 0.4200 is obtained by dividing the value of the questionnaire in the comparison of the water channel - brick wall with its total value.

Where in the table it is known that the questionnaire contents in the comparison are "7" which means that water channel maintenance items are very urgent compared to the maintenance of brick walls. So the value of 0.4200 in table 2 is the result of:

$$0{,}4200 = \frac{7}{16{,}67}$$

Where, 7 is the content of the questionnaire and 16.67 is the number in the brick wall column (vertical) table 1. The same method of calculation is also used to obtain the value of the comparison between items in table 2. Then the value is averaged to obtain the weight of each maintenance item.

$$\text{Water Channels} = \frac{0{,}4200+0{,}3182+0{,}3477+0{,}3879+0{,}3261+0{,}2083}{6}$$

$$= 0{,}3347$$

$$= 33{,}47\%$$

So that the weight of each maintenance item can be calculated in the same way. Where in the example of this calculation it is known that the value of the highest maintenance item weight is on the weight of the water channel with a weight of 0.3347. Furthermore, ceiling maintenance items with a weight of 0.2869, air conditioning system with a weight of 0.1759, maintenance of brick walls with a weight of 0.0937, maintenance of lift with a weight of 0.0715 and finally the fire protection system 0.0374. This means that from the questionnaire results, it can be concluded that according to Norman Ruchyat as Head of the Control and Renovation of Buildings at the University of Muhammadiyah Malang, water

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channel maintenance items have the highest prevalence compared to the other five maintenance items.

However, the contents of the questionnaire must also be tested for consistency as part of the analytical hierarchy process method. Where the equation used to calculate the consistency ratio is:

$$\mathbf{CR} = \frac{CI}{RI} \quad \text{.....(i)}$$

CI is the consistency index obtained from the equation:

$$\mathbf{CI} = \frac{\lambda \max - n}{n-1} \quad \text{..... (ii)}$$

While the RI value (ratio index) is obtained from table 5.13. Because in the analysis of this section there are 6 items that are compared with each other, the RI value is 1.24.

TABLE III. Index Value Ratio

RI	1	2	3	4	5	6	7	8	9	10
Value	0,00	0,00	0,58	0,90	1,12	1,24	1,32	1,41	1,45	1,49

$$\lambda_{max} = \frac{\sum CM}{n}$$

$$= \frac{6,3912 + 6,6459 + 7,0195 + 7,1240 + 6,0996 + 6,3017}{6}$$

$$= 6,5970$$

The CM value is obtained through multiplication of the comparison matrix of questionnaire entries with weights

$$\begin{pmatrix} 1 & 1/3 & 1/7 & 1/5 & 3 & 3 \\ 3 & 1 & 1 & 3 & 3 & 7 \\ 7 & 1 & 1 & 3 & 5 & 5 \\ 5 & 1/3 & 1/3 & 1 & 3 & 3 \\ 1/3 & 1/3 & 1/5 & 1/3 & 1 & 3 \\ 1/3 & 1/7 & 1/5 & 1/3 & 1/3 & 1 \end{pmatrix} \begin{pmatrix} 0,0937 \\ 0,2869 \\ 0,3347 \\ 0,1759 \\ 0,0715 \\ 0,0374 \end{pmatrix} = \begin{pmatrix} 6,3912 \\ 6,6459 \\ 7,0195 \\ 7,1240 \\ 6,0996 \\ 6,3017 \end{pmatrix}$$

For example, to get a value of 6.3912, the operation carried out is:

$$= \frac{1 \times 0,0937 + (1/3 \times 0,2869) + (1/7 \times 0,3347) + (1/5 \times 0,1759) + (3 \times 0,0715) + (3 \times 0,0374)}{0,0937}$$

$$= 6,3912$$

The same way is done for other CM values. By obtaining a value of λmax, the value of CI and CR can be calculated using equations (ii) and equation (i).

$$\text{CI} = \frac{6,5970 - 6}{6-1}$$

$$= 0,1194$$

$$\text{CR} = \frac{0,1194}{1,24}$$

$$= 0,0963 \quad < \quad 0,1$$

Be accepted

Because the CR value is less than 0.1, the questionnaire is accepted.

C. Weighting between criteria

From the calculation method as in Part A, then with the same calculation step, the analysis was carried out on the other respondents' questionnaire contents both from the criteria of urgency and the criteria for execution time. Where the questionnaire contents of the respondents must be tested for consistency with a consistency ratio of less than 0.1. If the CR value is still greater than 0.1 then an interview or re-data collection is carried out to the respondent concerned. From the results of the analysis of each respondent obtained results as table 3 and table 4.

TABLE III. Recap of Urgency Criteria

Respondents	I	II	III	IV	V
Maintenance item	Fire	Lift	Ceiling	Brick	Water
	Lift	Water	AC	Ceiling	Ceiling
	Ceiling	AC	Water	Water	AC
	Air	Fire	Brick	AC	Brick
	Brick	Brick	Fire	Lift	Lift
	AC	Ceiling	Lift	Fire	Fire
CR	**0,0739**	**0,0944**	**0,0736**	**0,0740**	**0,0963**

TABLE IV. Recap of Execution Time Criteria

Respondents	I	II	III	IV	V
Maintenance item	Fire	Lift	Ceiling	Fire	Water
	Ceiling	Ceiling	Brick	Lift	Brick
	Lift	AC	AC	AC	Ceiling
	Water	Water	Lift	Water	AC
	Brick	Brick	Water	Ceiling	Lift
	AC	Fire	Fire	Brick	Fire
CR	**0,0525**	**0,0753**	**0,0969**	**0,0956**	**0,0691**

From table 3 and table 4, information is obtained that the value of the consistency ratio of the respondents is less than 0.1, so the questionnaire is acceptable. However, from the results of the analysis, we cannot yet conclude which maintenance items are the priority. This is because the analysis is done only on each respondent. So the respondents have their own preference in determining priority maintenance items. Whereas to obtain conclusions in full, namely the determination of priority maintenance items, a joint analysis of the questionnaire contents of the respondents is needed. Where the contents of the questionnaire are combined by calculating the geometric mean value using the equation:

$$U = \sqrt[n]{a1 \; x \; a2 \; x \; a3 \; \ldots\ldots\ldots an}$$

So the value of the questionnaire to form a comparison matrix between the maintenance of brick walls and maintenance of water channels from the criteria of urgency is:

$$U = \sqrt[5]{\frac{1}{7} x \; \frac{1}{8} \; x \; 1 \; x \; 3 \; x \frac{1}{7}}$$

$$= 0,38$$

D. Global Weighting

From the calculation method as in section B, then in the same way it is used for the value of comparison of other maintenance items on the criteria of urgency and execution time that combine the questionnaire questionnaire so that it forms the matrix as follows.

By using the same calculation in the previous example, the consistency ratio value of 0.0252 is obtained. This value indicates that the contents of the combined questionnaire from the respondents are consistent and acceptable. Where from table it is known that the maintenance items that are a priority based on the criteria of urgency are maintenance of water channels with a weight of 0.2688 (26.88%). While for the smallest priority in building maintenance based on the criteria of urgency is the fire protection component with a value of 10.14%.

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TABLE V. Weight based on the criteria of urgency

Maintenance item	Wall Brick	Ceiling	Channel Water	System Air (AC)	Elevator	Protection Fire	Weight	CM
Brick wall	0,1105	0,1708	0,0999	0,0700	0,1197	0,1200	0,1152	6,1073
Ceiling	0,1377	0,2128	0,2711	0,2843	0,1815	0,1559	0,2072	6,2005
Water channels	0,2929	0,2079	0,2648	0,2989	0,3235	0,2249	0,2688	6,2012
Air Conditioning (AC)	0,2441	0,1158	0,1370	0,1546	0,1723	0,2114	0,1725	6,1755
Elevator	0,1214	0,1542	0,1077	0,1180	0,1315	0,1865	0,1366	6,1339
Fire Protection	0,0934	0,1385	0,1194	0,0742	0,0715	0,1014	0,0997	6,1175

However, this is still not the final conclusion in determining priority building maintenance items. Because there are still analyzes that have not been carried out, namely analysis based on the execution time criteria. By means of the same calculation, the analysis is then carried out based on the time of execution time and the results can be seen in the following table

TABLE VI. Building Maintenance Priority Scale Recap

No.	Maintenance item	Criteria	
		Urgency	Execution time
1.	Maintenance of Brick Walls	0,1152	0,2149
2.	Covering the Ceiling (Ceiling)	0,2072	0,2453
3.	Maintenance of Water channels	0,2688	0,1516
4.	Maintenance of the Air Conditioning System (AC)	0,1725	0,1500
5.	Maintenance of Vertical Transportation Systems (Lift)	0,1366	0,2158
6.	Maintenance of Fire Protection Systems	0,0997	0,1125

From table 7 above, it can be seen that for the components that are prioritized based on the execution time criteria, the maintenance of ceiling components weighs 0.2453 (24.53%). While for the smallest priority in building maintenance based on the execution time criteria is the fire protection component with a value of 11.25%. The smallest priority value in building maintenance both the criteria for urgency and execution time is the same, namely the fire protection component.

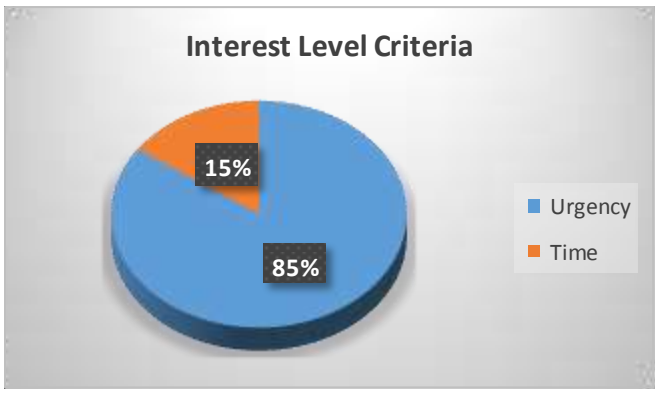

Fig. 4. Comparison of the importance of building maintenance criteria

After knowing the priority scale weights for urgency criteria and execution time criteria, then analyze the comparison between the two criteria. Where by means of the same calculation we obtained the weight for the urgency criteria of 0.8467 (85%) and the execution time criteria of 0.1533 (15%). This shows that respondents have the view thaturgency is the main criterion in determining maintenance items that are a priority.

After the comparison of the importance level of criteria (urgency and execution time) is known, then we calculate the weight of global components by multiplying the matrix weighting the maintenance components with the weighting criteria matrix. The method of calculation is by multiplying the weight of the component by the weight of the criteria which will then be included in each of the criteria. After calculating the matrix multiplication, the final results of AHP can be identified in determining the priority of building maintenance items at UMM as shown in the following table.

$$\begin{pmatrix} 0{,}1152 & 0{,}2149 \\ 0{,}2072 & 0{,}2453 \\ 0{,}2688 & 0{,}1516 \\ 0{,}1725 & 0{,}1500 \\ 0{,}1366 & 0{,}2158 \\ 0{,}0997 & 0{,}1125 \end{pmatrix} \begin{pmatrix} 0{,}85 \\ 0{,}15 \end{pmatrix} = \begin{pmatrix} 0{,}1166 \\ 0{,}2130 \\ 0{,}2508 \\ 0{,}1691 \\ 0{,}1487 \\ 0{,}1017 \end{pmatrix}$$

TABLE VII. AHP final results in prioritizing college building maintenance items

No.	Maintenance item	Criteria		Goal
		Urgency	Execution time	
1.	Maintenance of Brick Walls	0,0975	0,0191	0,1166
2.	Covering the Ceiling (Ceiling)	0,1754	0,0376	0,2130
3.	Maintenance of Water channels	0,2276	0,0232	0,2508
4.	Maintenance of the Air Conditioning System (AC)	0,1461	0,0230	0,1691
5.	Maintenance of Vertical Transportation Systems (Lifts)	0,1156	0,0331	0,1487
6.	Maintenance of Fire Protection Systems	0,0845	0,0172	0,1017
	TOTAL	**0,8467**	**0,1533**	**1,0000**

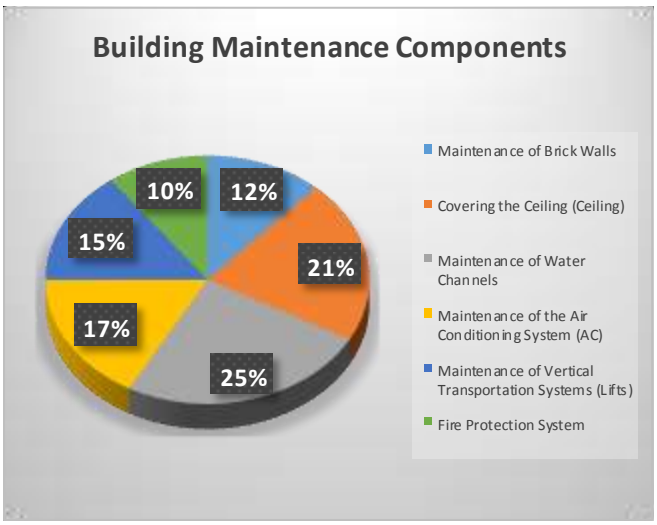

Fig. 5. Fishbone diagram for waste of inventory

From the tables and figures above which are the results of the analysis of the AHP method, it can be concluded that

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maintenance of water channels is a top priority. The results of the analysis of the six components of maintenance based on the criteria of urgency and execution costs indicate that the item has the highest weight of 0.2508 (25%). Then followed by a ceiling component with a weight of 0.2130 (21%) and an AC component with a weight of 0.1691 (17%).

Maintenance of water channels is a top priority because water is the main requirement of respondents on campus. Some respondents who also work as lecturers said that some students as building users were willing to go home or not go to college if the water channel did not work. When a water channel leak occurs, it also makes users uncomfortable and is usually repaired immediately. Compare that with the smallest priority of the maintenance component, namely the fire protection system, which according to respondents is not too urgent because the developing mindset is very rare in fires and does not require too much maintenance.

V. Conclusions and Suggestions

According to Minister of Public Works Regulation Number 24 / PRT / M / 2008 stated that one of the technical standards for inspection and repair of components is to determine the priority scale of execution time, so that building maintenance projects at UMM require maintenance priority scale consisting of 12 components.

From the analysis of Analytical Hierarchy Process (AHP) method, it can be concluded that urgency is the main criterion in determining maintenance items that are prioritized compared to the execution time with weights of 0.8467 (85%) and 0.1533 (15%), respectively.

While maintenance of water channels is the top priority with the highest weight, which is 0.2508 (25%). Then followed by a ceiling maintenance component with a weight of 0.2130 (21%) and an AC maintenance component with a weight of 0.1691 (17%).

From the results of research on Determining the Priority Scale of Building Maintenance Components at UMM there are several suggestions that can be considered for the continuation of this research, including further research which can be added to other components, especially structural maintenance components which include foundations, steel building structures and concrete structures for building structures stable and robust in supporting load loads to withstand earthquakes, wind and fires in accordance with Law No. 28/2002.

Furthermore, in determining the priority scale of building maintenance components with the AHP method in this study only took 6 components, so that further research could be added to other components or buildings in other locations that could allow variations (differences) in determining the priority scale.

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