Building maintenance priority assessment for building components

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Abstract. The aim of the research was to identify the building structure components that needed to be fixed first according to the priority assessment. The object of the research was traditional market buildings in West Jakarta managed by PD Pasar Jaya. The research was conducted through a survey, sending out questionnaires, and conducting interviews with experts. Building components were analysed using relative importance index to identify the most important building components to be maintained. Out of 135 building components there are 32 building components which are identified to be important. Through analytical hierarchy process (AHP), 9 building components need to be mitigated to avoid further damage to the traditional market building.

Keywords: building maintenance, priority building assessment, building components

1. Introduction
The growth of modern market in Indonesia has increased up to 31,4% per year while the traditional market decreases to 8% per year. The Indonesian Market Traders’ Association recorded up to 400 traditional market closes every year across the country. In Jakarta, one of the Governor’s work program in the Provincial Regulation of the Special Capital Region of Jakarta No. 3 of 2009 concerning Management of Market Area, every traditional market in Jakarta have to be maintained to keep the value of benefits and function of the market. However, several issues arise such as limited human resources and funds in the maintenance of traditional market [1]. Other research shows that leakage is seen as the most common issue in buildings in general. This is mainly caused by the insufficient technical staff to cover a vast area of building, the unawareness of building occupants’ and availability of maintenance budget [2]. A condition assessment needs to be the base on decision making in maintenance management the development of sustainable construction [3]. To better distribute financial resources throughout the needs for building maintenance, maintenance calls are based on monthly demand, building lot and nature of the service requested [4]. Therefore, a priority assessment of building components needs to be done in building maintenance. The goal of this research is a prioritized list of building sub-elements that are frequently experiencing damage with a proposed mitigation solution.

1.1. Building maintenance and treatment
Building maintenance and treatment are two different activities. Building maintenance are all the activities to ensure the reliability of the building and its facilities to function well. Whereas building treatment are all the activities to repair and/or replace building components, building material, and/or
building facility to maintain the feasibility of the building [5]. There are several problems arises in building treatments in Indonesia. The level of damage and deterioration of quality of the building material, the level of building management services, the level of building occupants’ involvement and the level of maintenance budget availability are some of the factors influencing the condition of buildings in Indonesia [2]. Other factors are faults during construction stage, unavailability of as built drawing, changes in the function of the building, unavailability of historical data on building utilities, unavailability of spare parts and no technical guidelines for building maintenance and treatment [5].

2. Methodology
The object of the research were traditional market buildings in West Jakarta managed by PD Pasar Jaya. Data were achieved through surveys, sending out questionnaires and conducting interviews with experts. Twenty-four traditional market buildings located in West Jakarta, only 16 were qualified as the object of this research. The 16 traditional market buildings were chosen based on the location of the market. Some traditional markets were not based on a permanent building, rather than they were based on the pedestrian which is a temporary placing. Only traditional market which was placed in a building that was chosen to be the object of the research. Surveys were conducted to the 16 buildings to identify the components, elements and sub-elements of building structure associated with traditional market building.

Questionnaire were conducted in 2 stages. The 1st stage of questionnaires was conducted to identify the importance index of each building sub-elements which is usually worn down in a traditional market building using the relative importance index method. The building sub-elements identified in the 1st stage questionnaire is used in the 2nd stage of questionnaire to identify the priority list of the important building sub-elements that needs to be mitigated, that is analyzed through analytical hierarchy process (AHP). Mitigation solutions were later proposed through a series of interviews with experts to analyze even further regarding the impact, the cause, the preventive solution, and the corrective solution for the building sub-elements.

2.1. Relative importance index (I)
The relative importance index (I) analyses the frequency of an event occurring using the formula (1). The event in the research is the damages that occur on the building components of a traditional market building.

\[
I = \frac{\sum_{i=1}^{5} a_i x_i}{\sum_{i=1}^{5} x_i}
\]

\(I\) = Relative importance index
\(i\) = Category index. The value of \(i\) can be seen in Table 1.

| \(i\) value | Frequency   |
|------------|-------------|
| 1          | Very rarely |
| 2          | Rarely      |
| 3          | Seldom      |
| 4          | Often       |
| 5          | Very often  |

\(a_i\) = Numeric value based on \(i\). The value of \(a_i\) for can be seen in Table 2.
Table 2. Category index ($i$)

| $i$ value | $a_i$ |
|-----------|-------|
| 1         | 0     |
| 2         | 1     |
| 3         | 2     |
| 4         | 3     |
| 5         | 4     |

$x_i = \text{The total frequency of } i \text{ on every event occurring}$

The result of $I$ is then plotted using Table 3 to categorise its scale [6].

Table 3. Relative Importance Index Scale

| Not Important | Somewhat Important | Important | Very Important | Extremely Important |
|--------------|------------------|-----------|---------------|-------------------|
| 0,00 – 0,80  | 0,81 – 1,60      | 1,61 – 2,40 | 2,41 – 3,20  | 3,21 – 4,00       |

2.2. Analytical hierarchy process (AHP)
The research uses AHP to analyse the priority degree in building maintenance of the building sub-element achieve from the relative importance index analysis. This method was introduced by Saaty by using pairwise comparisons [7]. AHP can solve multi object and multi criteria problem based on the preference comparison for each element in the hierarchy. The use of AHP needs to weigh each element to later be analyzed in pairwise comparison against each element, constructing a hierarchical structure between elements and calculating a consistency ratio [8]. The illustration of the AHP hierarchy modelling structure for this research can be seen in Figure 1.

Figure 1. Illustration of AHP Hierarchy Modelling Structure

3. Results and discussion
Through literature studies, 163 sub-elements were obtained that were associated with buildings in general which often experience damages. However only 135 sub-elements were associated with traditional market building. These sub-elements were obtained from the surveys conducted to the 16 traditional market buildings in West Jakarta.
On the 1st questionnaire, questionnaires were given out to 16 traditional market buildings in West Jakarta to achieve the relative importance index of sub-elements of the building based on the frequency of damage using the Likert Scale. Seven sub-elements were categorized as “very important” and 25 sub-elements were categorized as “important” based on the scale in Table 3. Only these 32 sub-elements were used in the next stage to be prioritised as it is seen to be the most important element in the building.

On the 2nd questionnaire, structured interviews using the Saaty scale were given out to 3 experts that specializes on the building maintenance and treatment. The Saaty scale defines a quantitative scale from 1 to 9 to assess the comparison of the importance of one element to other elements. A scale from 1 to 9 is said to be the best scale to qualify an opinion. Therefore 9 categories are given, whereas each of the categories have different intensity of interest [9].

Using the analytical hierarchy process (AHP) the 32 sub-elements retrieve from the 1st questionnaire is then prioritised. The priority ranking from the AHP analysis can be seen in Table 4. It can be seen from Table 4 that damages in tile or roof cover makes the top priority to be mitigated compared to the damages/flaws in ceiling paint.

**Table 4. Priority Ranking of Sub-Elements of Traditional Market Component**

| Sub-elements            | Priority Ranking | Sub-elements            | Priority Ranking | Sub-elements            | Priority Ranking |
|-------------------------|------------------|-------------------------|------------------|-------------------------|------------------|
| Tile or roof cover      | 0,10090          | Shop security door handle | 0,03113          | Concrete rebates/floor plastering | 0,01049          |
| Fire extinguisher       | 0,08332          | Shop security door leaf  | 0,03100          | Ceiling cover           | 0,00830          |
| Water pump              | 0,08239          | Shop security door lock  | 0,03096          | Balcony railing paint   | 0,00517          |
| Tap water               | 0,07544          | Door handle             | 0,02319          | Stair railing paint     | 0,00514          |
| Switch                  | 0,06586          | Door lock               | 0,02242          | Outer wall paint        | 0,00493          |
| Fitting                 | 0,05924          | Door leaf               | 0,02118          | Door paint              | 0,00447          |
| Lamp                    | 0,05801          | Fence                   | 0,01644          | Shop security door paint | 0,00467          |
| Electric socket         | 0,05591          | Latch                   | 0,01533          | Fence and gate paint    | 0,00473          |
| Rainwater gutter        | 0,05460          | Ceramic floor/inner floor cover | 0,01304 | Inner wall paint         | 0,00432          |
| Floor drain             | 0,04782          | Ceramic/outer floor cover | 0,01146      | Ceiling paint           | 0,00400          |
| Shop security door rail | 0,03353          | Parking pavement area   | 0,01061          |                         |                  |

In determining the critical sub-elements, data of potentially damage sub-elements is needed. Those data can be achieved through critical analysis approach [10] which is categorized in 4 criteria: high damage frequency, the impact damage to the system, difficulty in disassembling and assembling and expensive price of the components.

The priority ranking on Table 4 was then validated back to the 3 experts and another deep interview were conducted to narrow down the priority list and to analyse the impact, the cause, the preventive measure, and the corrective action for damages occurring in the building sub-elements. There are 4
categories in prioritizing the sub-elements in building maintenance. It is based on operational, safety, supply and disposal, and security [11]. Based on the 4 categories the 32 sub-elements were narrowed down to 9 prioritised sub-elements those are critical in building maintenance and treatment of a traditional market building. The 9 sub-elements and the mitigation solutions can be seen in Table 5. Water supply system, power supply system and fire protection system were also listed as the utilities that require routine maintenance to enhance the performance of the maintenance tasks [12].

Table 5. Mitigation of the Critical Sub-Element in Traditional Market Building

| Sub Element | Impact | Cause | Preventive Measure | Corrective Action |
|-------------|--------|-------|-------------------|------------------|
| 1 Tile or roof cover | Leaks occur, water soaks up components of other buildings and goods sold, causing component damage and losses due to damage to goods sold and cessation of buying and selling activities. | There is a gap between the roof with one another and the gap at the edge of the wall. | Covering the connection between the roof with one another and the wall with a roof using pickles and waterproof | Change the roof material. Cover the roof with waterproofing. Do cleaning. |
| | | Materials that are not suitable for use due to age conditions, so that changes in shape plus cracks and small holes. | Using zincalume galvalume roofing material | |
| | | The growth of plants such as moss and the presence of garbage that causes the flow of water is not smooth and causes seepage. | Roof painting, periodic cleaning | |
| | | Error in the installation process and in the nail section | Patching nail holes, using rubber and tacks | |
| | | There is a renovation in the market building so that the roof is crushed and stepped on | Install a safety net, use the board when stepping on the roof. | |
| 2 Fire Extinguisher | The absence of fire control equipment when an emergency occurs | The physical condition of dirty APAR causing the condition of the | Cooperating with the fire department to | Contact the fire department to replace APAR |
| Sub Element | Impact | Cause | Preventive Measure | Corrective Action |
|-------------|--------|-------|--------------------|-------------------|
| 3 Water pump | The unavailability of clean water supply for market operations and other activities not related to operations. | Damage to one component of the water pump causes the engine to not work | Use a quality water pump | Make improvements. Replace the water pump machine with quality |
| 4 Tap water | The unavailability of clean water supply for market operations and other activities that are not related to operations. Besides that, it can cause wasted water when not in use. | Damage to the tap water opener valve handle and filter component discharge water. There is a gap in the tap water connection with a water pipe. | Using a water tap made of stainless steel. Repair or replace the water tap. | Using seal tape |
| 5 Switch | The switch does not work so the lamp cannot be turned on. | The release of the switch from the switch house. The switch does not function normally. | Use a quality switch | Fix the switch hook with the switch house. Change the switch |
| 6 Fitting | Failure of fittings causes the lamp to not turn on | The ballast component is broken. The fittings are worn out, so the installation of the lights is not tight. | Use quality fittings | Change ballasts or change fittings |
| 7 Lamp | The market area, especially the shop area, is dark, so the process of buying and selling is disturbed. | Disconnect the lamp component | Use quality lights such as LED lights | Change the lamp |
| 8 Electric socket | The non-functioning of the equipment related | Disconnect the socket from the socket | Use a quality socket | Repairing the hook stopper with the socket |
| Sub Element | Impact | Cause | Preventive Measure | Corrective Action |
|-------------|--------|-------|-------------------|------------------|
|             | to the sale and operation of the office ceases. | Components of the socket are burned or burned | Installation of electrical installations and loads is adjusted to applicable standards | outlet. Change the electric socket |
|             | The socket outlet is loose | Position of rainwater gutter that is not suitable | Correct installation. Using quality holders and gutters | Improve rainwater holders and gutters. Replace quality rain shower holders and gutters |
| Rainwater Gutter | The overflow of water into the area of the road pavement causes damage to the pavement and the water seeps into the market area so that it wets merchandise. | The age factor that causes a lot of rainwater gutters to release causes a gap in the gutter | |

4. Conclusion

Based on the analysis, it can be concluded that there are 9 critical sub-elements that needs to be prioritised in the building maintenance and treatment of a traditional market building. Those 9 sub-elements are tile or roof cover, fire extinguisher, water pump, tap water, switch, fitting, lamp, electric socket, and rainwater gutter.

The 1st priority is the tile or roof cover to ensure that all the activities in a traditional market building are still operational [13] & [14]. The 2nd priority that needed to be prioritised is safety. Therefore the availability of fire extinguisher is critical in a building as it is the main indicator for a building reliability requirement to be able to overcome fire hazard [11].

The later priority is supply and disposal. This indicator is split into 2 categories, the supply of electricity and the supply of water, which is related to sub-elements water pump, tap water, switch, fitting, lamp, electric socket and rainwater gutter. Damages related to roof leakage and electricity and water installation have a high impact on the tenants’ activities and can impact other sub-elements when not fixed immediately [15].

The scope of the research is only to identify and priorities building components that frequently experiencing damages and proposed a mitigation solution. Most of the buildings in Indonesia still uses corrective strategy as the building maintenance strategy. Based on the result, a maintenance scheduling for building maintenance in traditional market building can be analysed and proposed. This can minimize further damage to the building components as the life span of each building components has been accounted for. This strategy refers to as a preventive building maintenance strategy, which is a more effective maintenance strategy to ensure the constant and efficient usage of building systems and their components [16]. Routine maintenance is said to be able to support intended function of building components and retain its value [12]. Building maintenance must not only focus on the present condition but also calculate the expected decay rates for the years to come [17].

Acknowledgement

The authors would like to acknowledge Bina Nusantara University for the funding support of the research project.
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