Damage Analysis in Building Construction Maintenance Activities

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Abstract. One of the stages in construction project activities is the maintenance stage that must be carried out by the contractor after the Handover I is carried out. At this stage, there may be damage to the construction resulting in additional costs to repair the damage. The purpose of the study is to identify the damage, the amount of damage that occurs, the cause of the damage, the handling of the damage that occurs, and the amount of costs needed to handle the damage. The research method uses quantitative description and is carried out in the form of observation, interviews, and field surveys to obtain the necessary data. The results of the study produced nine types of damage with the division of architectural components of seven damages or 77.78%, and roof and landscape components each amounted to one damage or 11.11%. The amount of damage volume was the corridor ceiling seeping and falling off 24 m^2, dismantling of stucco and wall plaster 1.5 m^2, peeling inner wall paint m^2, corrugated and broken granite floor and lacking mortar 9.5 m^2, stone pairs of random area landscape loose 3 m^2, outer wall paint peeling off 8 m^2, corridor roof leaking 9 m^2, paint of peeled door and window frames 2 units and 2.8 m' landslide drainage channel. The repair cost for damage is Rp. 48,385,908.30.

Keywords: Building Construction, Damage, Maintenance

1 Introduction

A construction project is a series of actions that are only carried out once and have a certain time limit (Yuliana et al., 2023). One of the projects that is often built is the building construction project which aims to provide facilities and infrastructure support to the owner so that they can carry out their daily activities optimally (Supriyatna, 2011). In addition, the existence of buildings has an important role in adjusting to the purpose of building the building (Nizki & Apriani, 2020). The project has several stages, namely the planning stage, the implementation stage, the maintenance stage, and the dismantling stage (Widianto et al., 2015). One of the important stages to be carried out is the maintenance stage which aims to maintain the physical function of the building so that the life of the building can be achieved. The maintenance stage has two types, namely maintenance by contractors and maintenance and operations by building owners. Maintenance which is the contractor's obligation is carried out after the

A. A. N. G. Sapteka et al. (eds.), *Proceedings of the International Conference on Sustainable Green Tourism Applied Science - Engineering Applied Science 2024 (ICoSTAS-EAS 2024)*, Advances in Engineering Research 249,
https://doi.org/10.2991/978-94-6463-587-4_25

construction period or after the submission of the Provisional Hand Over (PHO) with a period of between 6 months to 1 year. During this period, damage may occur that is still the responsibility of the contractor and the contractor must pay for repairs to the defects or damages that occur. Generally, an estimator only estimates the cost for the implementation of the project and rarely calculates the amount of costs required to carry out the maintenance. Maintenance activities are important to be carried out to maintain the function and usefulness of the building as a whole so building maintenance activities must be managed properly and regularly (Supriyatna, 2011). Continuous maintenance and supervision will be very helpful in reducing large financing and can reduce the level of severe damage (Sari & Triwuryanto, 2021). To carry out building maintenance, the level of damage to the building must be known by measuring the volume of existing damage and calculating the estimated cost needed to be able to carry out maintenance on the building (Rohmat, 2020). The best way to avoid building damage is to carry out preventive maintenance (Suritiono et al., 2019). Preventive maintenance is a series of routine activities to prevent damage to buildings (Khalilah *et al*., 2023). Maintenance and maintenance of the building must be carried out for all components, namely foundations, structures, roofs, walls, glass, frames, doors, ceilings, and utility fiber floors (Miftach, 2018). Previous research on building maintenance showed that the value of the building condition index of architectural components was 76.24% with the highest damage in the corridor at 25.47%. The highest maintenance cost is found in the 7th year of USD 580,854 (Susanti et al., 2022). Another study obtained the results of damage to the ceiling, keys, and glass with an estimated maintenance cost of Rp. 9,858,000.00 (Devina et al., 2023). Similar research also resulted in damage to roofs by 45%, columns, and beams by 31.25%, walls by 16.25%, and floors by 11.25% (Wismantoro & Winarno, 2024). Badung Regency as a tourist destination in Bali has attracted many investors to invest their funds in the form of building construction. The construction of this building is still in the construction stage and some are under maintenance. One of the projects that has been completed and is under maintenance is the Jimbaran Hotel project located on Jl. Karang Mas Jimbaran. During this maintenance period, it is undeniable that there will be damages, both major and minor, that must be followed up by the implementing contractor and cause additional costs. These additional costs are usually not taken into account by contractors so they take internal funds to repair the mess that occurs. Therefore, research is needed to find out the problems that usually occur and the amount of costs needed to overcome problems during the maintenance period. The novelty of this study is the cost analysis for each damage that occurs during the maintenance period after the first handover and the grouping of damage per building component. This study is different from the previous study, where the previous study analyzed the cost of damage to buildings that have been operated for a long time after being handed over to the owner.

2 Methodology

2.1 Research Design

The research was carried out at the Jimbaran Hotel Project located on Jl. Karang Mas Jimbaran and is in the maintenance stage after the Provisional Hand Over (PHO) stage. This study uses a quantitative research method with a descriptive format. The research was carried out in the form of observations, interviews, and field surveys to obtain the data needed for analysis. The data that has been obtained will be analyzed to find out the type of damage, the volume of damage, the handling of damage, and the cost of repairing the damage.

2.2 Research Data

This study uses 2 (two) types of data, namely primary data and secondary data. Primary data in this study were obtained from observations, field surveys, and interviews in the project that was the object of the research. Observations were made to observe and record the damage that occurred. The survey was carried out to measure damage using a digital meter. Interviews were conducted to find out the cause of the damage. Secondary data is data that has been compiled by other parties and is reused by researchers for analysis data. The secondary data used in this study are studies from journals, papers, articles, and previous research related to financing for the maintenance of buildings, as built drawings and Badung Regency Unit Price Analysis (AHSP) in 2023.

2.3 Data Analysis

Data analysis was carried out after the collection of primary and secondary data was carried out. There are several stages in data analysis, including: Identifying building damage. Identification of building damage is carried out by recording and documenting the damage that occurs one by one and measuring with a digital meter to be able to record the length, width, or height of the damage that occurs; Calculating the volume of building damage. Volume calculation is carried out by multiplying the length, width, or height of damage based on field results; Determining the cause of the damage. The determination of the cause of damage is carried out by interviewing the project implementer armed with a list of damages that occurred; Determining the handling of damage. Based on the results of the identification of the damage that occurred, it was then determined that the handling must be applied to carry out repairs (repairs). Handling is determined based on the damage that occurs in coordination with the contractor; Cost analysis for damage repair. The cost analysis was carried out by multiplying the volume of damage by the unit price of work obtained from the AHSP of Badung Regency in 2023.

3 Result and Discussion

3.1 Damage Identification

The implementation of building damage identification is carried out through observation and direct surveys in the field. The observation process is carried out with the
project implementer using a damage or defect identification form by reviewing the damage that occurs. The implementation of building damage identification is carried out on all work items that have been completed, be it structural, architectural, mechanical, electrical, and plumbing items as well as garden landscape. In addition to making observations, measurements were also made using a meter and recording the results of the damage dimensions into the form. The results of the identification of building damage are shown in Table 1.

Table 1. Identify the damage

No.	Types of damage	Damage location	Component
1	Corridor ceiling seeps and detaches	Block B, C (General Manager Office)	Architecture
2	Demolition of plaster and wall plastering	Area General Manager Office, Back of House (BOH)	Architecture
3	Peeling inner wall paint	Stair area	Architecture
4	Corrugated and cracked granite floors and less specular	Multifunction Area and Lobby Area, Blocks G&H, A, B, D, Back of House Corridor (BOH)	Architecture
5	Pairs of rocks in random area landscape	Public Area Corridor	Architecture
6	Peeling exterior wall paint	Block H	Architecture
7	The roof of the corridor has a leak	Corridor roof	Structure
8	Peeling paint on door and window frames		Architecture
9	Landslide drainage channel		Landscape

Table 1 shows that nine damages occurred during the maintenance period after the Provisional Hand Over (PHO). When viewed from the building component system consisting of foundations, structures, roofs, walls, glass, frames, doors, ceilings, building utility fiber floors, it is known that the highest damage occurred in architectural components amounting to 7 (seven) damages or 77.78%, and roof and landscape components each amounting to 1 (one) damage or 11.11%. This is because the architectural component is a part that is seen directly by the users of a building so strict supervision is needed in its implementation in addition to structural work. Based on the results of initial interviews with project implementers and site managers, the damage that occurred was caused by the number of subcontractors involved in the

implementation of the work so supervision was not optimally carried out, which had an impact on the inconsistency of work methods in the field. In addition, damage also arises due to a lack of communication and coordination between the project parties and the subcontractor. One example is that the stucco and wall plastering work has been completed but the subcontractor for mechanical, electrical, and plumbing (MEP) has just started the implementation of the cable installation work so the previous plaster and wall plastering inevitably has to be dismantled first so that the cables can be installed.

3.2 Damage Volume Calculation

The calculation of the volume for the damage that occurred was carried out by multiplying the length and width dimensions of the results of measuring and recording the damage so that the amount of damage volume was obtained. The calculation of the volume of damage is not only applied to the point of damage but to some areas within the range of the point of damage because, at the time of repair, all areas affected by the damage must be dismantled and reinstalled. The results of the calculation of the volume of damage are shown in Table 2.

Table 2. Damage volume

No.	Types of damage	Volume	Unit
1	Corridor ceiling seeps and detaches	24	m^2
2	Demolition of plaster and wall plastering	1.5	m^2
3	Peeling inner wall paint	5	m^2
4	Corrugated and cracked granite floors and less specular	9.5	m^2
5	Pairs of rocks in random area landscape	3	m^2
6	Peeling exterior wall paint	8	m^2
7	The roof of the corridor has a leak	9	m^2
8	Peeling paint on door and window frames	2	Unit
9	Landslide drainage channel	2.8	m'

Based on the results of the volume calculation above, it is known that the largest volume is 24 m^2 in architectural work, namely “the ceiling of the corridor seeps and detaches”. This occurs due to less than optimal supervision so it violates the established working method which causes the bolt bond between the ceiling frame lock and the roof truss to be not strong. The repairs carried out of course removed all the ceiling components that were detached and reinstalled.

3.3 Determination of the Cause of Damage

The determination of cause of damage is determined by conducting interviews with project implementers based on the list of damage that has been obtained during field observation and measurement surveys. The cause of the damage is shown in Table 3.

Table 3. Causes of building damage

Num	Types of Damage	Cause
1	Corridor ceiling seeps and detaches	Roof leaks
2	Demolition of plaster and wall plastering	The cable line has not yet been installed
3	Peeling inner wall paint	The base paint is not suitable
4	Corrugated and cracked granite floors and less specular	Fewer species
5	Pairs of rocks in random area landscape	Poor specs
6	Peeling exterior wall paint	Rough wall surface
7	The roof of the corridor has a leak	Waterproofing is not optimal
8	Peeling paint on door and window frames	Waterproofing is not optimal
9	Landslide drainage channel	Waterproofing is not optimal

In general, the causes of damage are divided into two, namely miscoordination and lack of supervision during the work. Coordination errors occurred between mechanical, electrical, and plumbing (MEP) subcontractors and the executors where the wall work had been completed but new cables and pipes were installed so that the walls were dismantled so that the cables could be installed. The lack of supervision causes the work methods carried out by the workers to be less than optimal which causes inappropriate work results, including leaks due to the lack of waterproofing layers, the specimen used not following the provisions, the granite floor is not soaked first so that the floor absorbs heat from the specimen.

3.4 Damage Handling

The handling of building damage is determined by interviewing the field implementer and the project site manager. The handling to be carried out is shown in Table 4. The handling provided is all minor repairs to the disaster that occurred so that reconstruction is not carried out like the beginning of the implementation of the work. The handling provided is a repair of damaged areas through rework by dismantling part of the area and reinstalling. So repairs are not carried out only at the point of damage but in some areas within the range of the point of damage.

3.5 Damage Cost Analysis

The cost analysis of the damage to the building that occurred was carried out by multiplying the unit price by the amount of damage volume resulting from the previous calculation. The unit price used is the 2023 Badung Regency Work Unit Price Analysis (AHSP) because the project that is the location of the study is located in Badung Regency. The results of the calculation are shown in Table 5.

Table 4. Building damage handling

No.	Types of damage	Handling
1	Corridor ceiling seeps and detaches	Corridor ceiling repair work due to seepage
2	Demolition of plaster and wall plastering	Shaft plaster wall repair work
3	Peeling inner wall paint	Repair of shaft finish walls and painting
4	Corrugated and cracked granite floors and less specular	Granite floor repair work due to wavy and broken and lack of spec
5	Pairs of rocks in a random area landscape	Repair of random times stone pairs
6	Peeling exterior wall paint	Exterior wall painting
7	The roof of the corridor has a leak	Waterproofing of corridor roofs
8	Peeling paint on door and window frames	Repainting
9	Landslide drainage channel	Drainage channel repair

Table 5. Damage cost analysis

No.	Types of damage	Vol	Unit	Unit price (Rp)	**Total price (Rp)**
1	Corridor ceiling seeps and detaches	24	m^2	636,333.00	15,271,992.00
2	Demolition of plaster and wall plastering	1.5	m^2	1,053,852.00	1,580,778.00
3	Peeling inner wall paint	5	m^2	1,053,852.00	5,269,260.00
4	Corrugated and cracked granite floors and less specular	9.5	m^2	977,821.00	9,289,299.50
5	Pairs of rocks in random area landscape	3	m^2	460,350.00	1,381,050.00
6	Peeling exterior wall paint	8	m^2	884,273.00	7,074,184.00
7	The roof of the corridor has a leak	9	m^2	533,186.00	4,798,674.00
8	Peeling paint on door and window frames	2	Unit	511,742.00	1,023,484.00
9	Landslide drainage channel	2.8	m'	963,281.00	2,697,186.80
	Total				48,385,908.30

Based on the calculation above, the contractor must spend a surcharge of Rp 48,385,908.30 (Forty-Eight Million Three Hundred Eighty-Five Thousand Nine Hundred Eight Point Thirty Rupiah) to handle the damage that occurs. The amount of cost to handle damage to architectural components is Rp 40,890,047.50 (Forty Million Eight Hundred Ninety Thousand Forty-Seven Point Fifty Rupiah) or 84.51% of the total repair cost. The roof component requires a cost of Rp 4,798,674.00 (Four Million Seven Hundred Ninety-Eight Thousand Six Hundred and Seventy Four Rupiah) or 9.92% of

the total value of the repair. The landscape component requires a cost of Rp 2,697,186.80 (Two Million Six Hundred Ninety-Seven Thousand One Hundred Eighty-Six Point Eighty Rupiah). The money is issued through the contractor's internal cash so that the contractor's profit is automatically reduced. If the contractor has completed maintenance and made repairs to the damage, the contractor will be paid a retention value of 5% of the contract value.

4 Conclusion

The damage that occurred amounted to 9 (nine) damages with the division of architectural components amounting to 7 (seven) damages or 77.78%, roof and landscape components each amounting to 1 (one) damage or 11.11%. The amount of damage volume is the corridor ceiling seeping and detached 24 m^2, demolition of plaster and wall plastering 1.5 m^2, peeling inner wall paint 5 m^2, corrugated and broken granite floor and less mortar 9.5 m^2, Batu Kali Random Area Landscape Couple 3 m^2, peeling exterior wall paint 8 m^2, the roof of the corridor leaks 9 m^2, peeled door and window frame paint 2 units and landslide drainage channel 2.8 m'. The cost that must be incurred to handle the damage that occurred is Rp 48,385,908.30.

Acknowledgment

The researcher expressed his gratitude to the contractor and hotel management for giving permission to carry out the research so that the research could run smoothly.

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