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# THE IMPACT OF CONSTRUCTION WASTE TO THE ENVIRONMENTAL ON PROJECT DEVELOPMENT IN ACEH

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## ABSTRACT

The development progress in construction industries have the great effects to the environmental especially in environmental change and waste produced. One of the causes of the construction waste is natural resources use exceeding what is required in construction process. Construction material waste refers to the materials from the construction location that cannot be used for construction purposes and must be removed for any reasons.In the implementation of a building construction project, it can be avoided the residual of construction material or commonlycalled construction waste.Beside effects on the cost, construction waste also affects to the environmental. This research aims to determine the type and quantity of dominant construction waste that is raised in construction project and analyzes the impact to the environmental.The location of this case study is DPU Banda Aceh Office Advanced Construction Project in Aceh Province. The methods used for data collection are field observation and interview. Data analysis using quantitative analysis examined descriptively.The results of the research mention that the screw steel reinforcement become the highest of the waste material found during the project construction which is 39.78% or Rp. 12,848,928.99. The dominant factors of the waste material are scattered/mixed with the soil, flow with the rainy, concrete waste still available in the mixer truck, less optimal of cutting process and lost due to the careless storage.

**KEYWORDS:** Construction Waste, Environmental, Sustainable Building, Consumable Material

## INTRODUCTION

Aceh Province still keeps on improving the area toward green city. The realization of this condition is not only to green the city but also to have more extensive activities.

One of the activities is the achievement of environmental friendly city by reducing the construction waste or waste material.

Construction project activity is long process activity in which we can find many problems and constraints during the implementation. The most common problem is waste material in construction project implementation.

The materials have the important roles in supporting the success of sustainable project development. Material procurement can absorbconsiderable cost of the total project cost. Therefore the material use is managed to be the most minimum to avoid any waste materials.

The materials become the main resources in the project implementation. Material procurement and allocation must be adjusted with the schedule determined. The delay of the material procurement will obstruct construction implementation process so that the work can not be finished on time. While excessive material procurement is also

uneconomic because the cost which is available should be allocated to other various work types. Construction material procurement and allocation must be managed well so that it can be utilized effectively and efficiently.

The materials waste of the project which has not been identified yet will cause the contractor cannot find out the losses percentage occurred because of the waste in the project location. The Excess losses can reduce income received by the contractor. The identification conducted to determine the potential material which can become the waste and to find out the how much loss cost because of the waste and to know the impact of the waste to the environment.

Related to the environmental, sustainable concept (sustainability) becomes the consideration in construction sector. Sustainability is human certainty in meeting the current needs by considering the capability of future generation to meet their needs.One of the implementations is sustainable building in which the policy application integrate to the environmental, economic and social occurring during planning, constructing and maintenance processes. Therefore, it is very important to create environmental friendly in construction project, because the issue of minimizing construction waste becomes the important issue for the community and construction waste management system should be developed in all construction projects to manage and reduce construction waste that has the negative effects to the environmental especially in construction location. Then the effort to analyze the environmental impact of the waste produced from the activity in construction location becomes very urgent.

## LITERATURE STUDY

### Construction Waste

There are often found large quality of waste material used in the field during the construction process phase, so that it is important to apply the efforts to minimize the waste material. The material used in the construction process can be classified into two major parts (Gavilan&Bernold, 1994) as below:

- Consumable material, the material that will become the part of building physical structures such as concrete, sand, gravel, stone, reinforced iron dam others.
- Non-consumable material, the supporting material used in the construction process, and not become the building physical part after the construction finish, such as scaffolding, formwork, whilst retaining walls, and others.

The existence of waste materials will increase along with the construction process being implemented. The types ofwaste materialscan be categorizedinto two parts as follows:

- Demolitionwaste is waste derived from the demolition material of the renovation process or old building demolition.
- Constructionwaste is waste derived from construction process or building renovation. The waste material cannot be reused in accordance withthe main function. Thewaste material consists of cement, brick, plaster, wood, pipeand others.

Construction wastecan be classified into two categories based on the type as the follow:

- Direct waste is waste material derived from the project because of damage, lost and cannot be used anymore.
- Indirect waste is the waste material derived from the project because the volume used exceeding volume planned, it does not cause the waste material physically in the field and it affects the cost physically in the field and affect

hidden cost, such as the thickness of the plastering in the implementation exceeds the thickness/volume planned caused by structural elements dimension deviation in the casting activities.

**Causing Factors of the waste Material**

Many factors can cause the waste material in the field. The waste material can be caused by one factor or combination of several factors. Gavilan and Bernold (1994) differed the sources causing waste material into six categories; they are design, material procurement, material handling, implementation, residual and others.

**Previous Research**

Farmoso's research (2002) in Hong Kong conducted on 32 construction buildings since June 1992 to February 1993. The research aimed to reduce the higher waste material in the future and the impact to the environment, the waste material found was 2.4% to 26.5% of the material purchased. The research in the Netherland conducted on 5 house residential buildings since April 1993 to June 1994(Bossink and Browers, 1996). The research concluded that the waste material found was 1.0% to 10.0% of the material purchased, the waste material caused by mainly from the design phase, material supply, poor material handling and storage. The research also conducted in Australia on 15 residential buildings (Forsythe & Marsden, 1999). The waste material found was 2.5% to 22.0% of the material purchased; this research provided the cost model of waste material occurring in the project. The research in Brazil conducted on 3 residential buildings since 1986 to 1987 (Pinto &Agopayan, 1994). The research found that waste material was 11.0% to 17.0%.

Ridwan (2001) conducted the assessment to the waste material in housing construction in TanjungBunga Area, Makasar based on waste material resource criterias and works causing waste material. The analysis output showed that the cement material had the highest waste value which was the main resources came from the residual of the stucco work, the waste for the wood material came from the residual of the formwork, the waste for the ceramic especially came from the residual of tilling work size 30x30, the waste for the brick material mainly came from the mishandling in the wall construction work, the waste for the paint material come the mishandling in the basic painting work (*meni*), for the iron material wastecame from the measurement error. This research also gave the solution for the waste material reduction effort and the recommendation for the waste material coefficient that can be used in the next project phase.

Suryanto (2004) conducted the research on the analysis and evaluation of the waste material in store project construction in Surabaya. The research aimed to detect waste material quantity dan causing factors, then categorized the waste material into direct waste and indirect waste, and proposed a cost model for waste material in the store construction. The research data was obtained from questionnaire survey which was distributed to the construction actors, and also field observation in store project construction in Surabaya. The outputs of the research showed that: (1) waste material volume for the brick (12.51%) and the sand (11.39%) became the highest values, (2) cost model showed that the minimum value of the waste cost (good waste management practice) was 3.33%, and the maximum value of the waste cost (poor waste management practice) was 4.67% from the total cost of the store unit cost, so the potential waste saving cost became 1.34%.

Sari (2006) conducted analysis and evaluation of the waste material in store project construction in Malang. The outputs of the research showed that the highest quatity percentage of the waste materials were the brick (14.70%) and sand (8.20%). The most affecting causing factors were material procurement, residual, and field construction. Based on the waste material category, the percentage of the direct waste was (average) 72.52% and for the indirect waste (average)

27.48%. The average potential waste saving cost was 3.084% which wasRp 10,656,050.00.

Budiadi (2008) also conducted the research that aimed to evaluate the causing factors, quantity, and the effect and follow up of the waste materials in the housing project. The outputs showed that the quality, purchasing regulation and quantity became the most dominant factors related to the material management. While the work experience, commitment and loyality became the factors causing waste material and worker's behavior. The efforts that should be taken according to the respondents were that the material should be keptfor the next project or be discarded.The average of the respondents answered that the waste material quantity was 5% based on the case study.

The research of Widjaja (2008) aimed to detect the constructor handling to the direct waste material in the construction project in Surabaya. This research was conducted by distributing the questionnaire to 15 building construction projects in Surabaya to obtain the data about causing factors affected the waste material and the constructor handling to the waste material.The highest waste material causing factor was cutting waste which was 35.36%, the most handling carried out by the constructors was reducing the waste materialwhich was 35.64%. Based on volume comparation scale, the most waste material in the projects in Surabaya was residual packaging which was 2.47%.

## RESEARCH METHODOLOGY

### Research Location

The writer chooses the location of this case study is DPU Banda Aceh Office Advanced Construction Project. The project is constructed by PT. Flamboyant HumaArta with the budget cost Rp 3,568,570,000.00 (Three Billion Five Hundred Sixty Eight Million Five Hundred Seventy Thousand Rupiah) and located on T. P.NyakMakam Street, UleeKareng Sub District, and Banda Aceh.

### Research Data Analysis

Calculation done using Microsoft Excel including

- Material need calculation;
- Material purchasing calculation;
- Waste material calculation;
- Calculation of waste material quantity
  - Waste material = material purchasing – material stock – material need
- Calculation of waste material cost
  - Waste material cost = waste material x material unit price
- Calculation of waste material cost percentage
  - Waste material cost percentage = $\frac{waste\ material\ cost}{waste\ material\ total\ cost}\ x\ 100\%$
- Calculation of waste material cost percentage to project total cost
  - Total percentage = $\frac{Waste\ material\ total\ cost}{Project\ total\ cost}\ x\ 100\%$

### Research Phase

Research phases are steps order/procedures carried out sistimatically and logically based on basic problem theory in order to be analized accurately to achieve the research objectives. The phases of the research including:

- Preparation phase;
- Data collection phase;
- Data analysis phase; the steps done are:
  - Calculating the material needs based on asbuilt drawing
  - Calculating material purchasing based on project daily report
  - Calculating the waste material
    - Calculating the waste material quantity
    - Calculating waste material cost
    - Calculating waste material cost percentage
    - Calculating waste material total cost percentage to project total cost
- Research data analysis is quantitative descriptive analysis using Microsoft Excel program.
- Discussion Phase.

## RESULTS AND DISCUSSIONS

### Waste Material Identification

The waste material identified in DPU Banda Aceh Office Advanced Construction Project shown in Table 1. Based on the table 1, then identifying waste material cost percentage, it can be shown in Table 2. The highest waste material cost percentage during the project construction came from screw steel reinforcement which is 39.78% orRp12, 848, 928.99. The highest waste material cost percentage to project total budget cost is 1.00% or Rp 32,301,568.98.

The identification result of waste material amount to the ten material types commonly used in DPU Banda Aceh Office Advanced Construction Project showed that sand, concrete floor (K 100), ready mix concrete with the quality (K 175), ready mix concrete with the quality (K 250), ready mix concrete with the quality (K 275) are 0-5%; under floor cast concrete is 1-5%; plain steel reinforcement is 5-10%; formwork is 15-20 %; wire mesh steel is30-35%; and screw steel reinforcement is > 35%.

**Table 1: Waste Material**

| Material Type | Material Purchasing | Material Stock | Material Need | Waste Material |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) = (2)-(3)-(4) |
| Sand | 0.65 m3 | - | 0.60 m3 | 0.05 m3 |
| Concrete Floor (K 100) | 31.00 m3 | - | 30.18 m3 | 0.82 m3 |
| Ready Mix Concrete, the quality (K 175) | 8.50 m3 | - | 8.41 m3 | 0.09 m3 |

| Table 1: Contd., | | | | |
|---|---|---|---|---|
| Ready Mix Concrete, the quality (K 250) | 580.00 m3 | - | 579.65 m3 | 0.35 m3 |
| Ready Mix Concrete, the quality (K 275) | 8.50 m3 | - | 7.69 m3 | 0.81 m3 |
| Screw steel reinforcement | 47,000.00 kg | - | 46,046.78 kg | 953.22 m3 |
| Plain steel reinforcement | 12,500.00 kg | - | 12,334.92 m3 | 165.08 m3 |
| Formwork | 3,400.00 m2 | - | 3,375.59 m2 | 24.41 m2 |
| Under Floor Cast Concrete | 42.00 m3 | - | 41.38 m3 | 0.62 m3 |
| Wire mesh steel | 15,000.00 kg | - | 14,447.57 kg | 552.43 kg |

**Table 2: Waste Material Cost**

| Material Type | Waste Material | Unit Price (Rp) | Waste Material cost (Rp) | Material Cost Percentage |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) = (2)x(3) | (5) = (4)/Totalx100% |
| Sand | 0.05 m3 | 162,650.00 | 8,132.50 | 0.03% |
| Concrete Floor (K 100) | 0.82 m3 | 545,825.00 | 447,576.50 | 1.39% |
| Ready Mix Concrete, the quality (K 175) | 0.09 m3 | 715,000.00 | 64,350.00 | 0.20% |
| Ready Mix Concrete, the quality (K 250) | 0.35 m3 | 775,000.00 | 271,250.00 | 0.84% |
| Ready Mix Concrete, the quality (K 275) | 0.81 m3 | 825,000.00 | 668,250.00 | 2.07% |
| Screw steel reinforcement | 953.22 m3 | 13,479.50 | 12,848,928.99 | 39.78% |
| Plain steel reinforcement | 165.08 m3 | 10,592.00 | 1,748,527.36 | 5.41% |
| Formwork | 24.41 m2 | 211,917.50 | 5,172,906.17 | 16.01% |
| Under floor cast concrete | 0.62 m3 | 683,160.00 | 423,559.20 | 1.31% |
| Wire mesh steel | 552.43 kg | 19,275.00 | 10,648,088.25 | 32.96% |
| Waste material total cost | | | 32,301,568.98 | 100.00% |
| Total project cost | | | 3,244,162,547.27 | |
| Waste material total costpercentage to total project cost | | | | 1.00% |

To reach the minimum value of waste material handling, it is required to carry out material management system. Material management is integration from various activities applying integrated management in the implementation, which process starts from material procurement phase to processing process become one ready use material. In the construction project, material management generally includes procurement, storage, handling and material comsumption phases.

Material management is carried out by carefully calculating the material need will be used. Material procurement in the project location must meet the interest. The material arrival schedule based on the work volume can be calculated from the amount and type of material required so there is no material procurement which not needed. The material arrived must be checked by the supervisor whether the material volume is suitable with the volume planned. The logistic must be recorded every material purchased especially for the material amount purchased and cost amount expended. The material used should be kept as efficient as possible and no waste material excessively.

The current construction industry in Indonesia still runs with the problems of the inefficiencies in the construction process, there is still too much waste such as the activity using resources but no value expected can be achieved. Waste is the excess of the material quantity used in which cannot add work value. Waste can be always found whatever the reason is, therefore the realistic effort can be done is by reducing waste as low as possible.

The current assessment effort of thewastematerialis rarely performed in the project construction. It is because most of the contractorsconsider that waste material amount found is only a consequence ofthe construction process. Meanwhile by knowingthe source/cause ofwastematerial, we can reduce the waste material produced so that the cost can be reduced.

**The Waste Material Factors**

According to the interview with the contractor and directly observation in the field, we can find the causing factors of the waste material. For further information can be shown in Table 3 below.

**Table 3: Waste Material Factor**

| No. | Material Type | Waste Material Factor |
|---|---|---|
| 1 | Sand | Scattered/mixed with the soil |
| | | Flow with the rainy |
| 2 | Concrete Floor (K 100) | Scattered/mixed with the soil |
| | | Concrete waste still available in the mixer truck |
| 3 | Ready Mix Concrete, the quality (K 175) | Scattered/mixed with the soil |
| | | Concrete waste still available in the mixer truck |
| 4 | Ready Mix Concrete, the quality (K 250) | Scattered/mixed with the soil |
| | | Concrete waste still available in the mixer truck |
| 5 | Ready Mix Concrete, the quality (K 275) | Scattered/mixed with the soil |
| | | Concrete waste still available in the mixer truck |
| 6 | Screw steel reinforcement | Less optimal of cutting process |
| 7 | Plain steel reinforcement | Less optimal of cutting process |
| 8 | Formwork | Less optimal of cutting process |
| 9 | Under floor cast concrete | Scattered/mixed with the soil |
| 10 | Wire mesh steel | Less optimal of cutting process |
| | | Lost due to the careless storage |

In material handling and usage phases, the workers' behavior very affects the waste materials found in the field, because it is required not only the very careful attitude but also the experiencing workers in the construction sector. Guidance and training are required by the workers to realize and understand that the mistakes in material used in the field can result many waste materials, and this condition reduces the contractor profit.

## CONCLUSIONS

Due to the waste material calculation evaluation result in DPU Banda Aceh Office Advanced Construction Project can be summarized as below:

- The highest waste material cost percentage (waste cost) during the project construction is derived from Screw steel reinforcement which is 39.78% or Rp 12,848,928.99.
- Total waste material cost percentage (total waste cost) to the total project cost is 1.00% or Rp. 32,301,568.98.
- Dominant factors of the waste material are scattered/mixed with the soil, flow with the rainy, concrete waste still available in the mixer truck, less optimal of cutting process and lost due to the careless storage.

## SUGGESTION

The suggestions resulted from the research are below:

- The project location can be carried out in the other projects with the bigger scale project and the more complex work items.
- The additional of material type reviewed in order to find more complete material amount used in each work item.
- The output of the research should be used as the tool for the contractors in considering the waste material factor so that it can be minimized.

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