

The Identification of Waste Construction at Construction Project Life Cycle

Mochammad Agung Wibowo¹, Naniek Utami Handayani^{2,*}, Asri Nurdiana¹, and Moh Nur Sholeh¹

¹*Civil Engineering Department, Faculty of Engineering, Diponegoro University, Semarang 50275, Indonesia*

²*Industrial Engineering Department, Faculty of Engineering, Diponegoro University, Semarang 50275, Indonesia*

The implementation of environmentally production process is an interesting issue on some decades. In construction industry, the research on green building and green construction become an interesting subject. The construction project is generally based on the Project Life Cycle (PLC), consisting the steps of ideas, planning, construction, and operational/maintenance with the various stakeholders involved. The process of construction of environmentally buildings could not be separated from the activities of the supply chain, that impacted to construction waste. Waste in the construction process has impact on increasing the project cost. Waste reduction needs to be done to improve the effectiveness and efficiency to minimize costs. In order to reduce construction waste, the studies on the types of waste and strategy to minimize waste must be investigated. The research in waste construction is usually examined in the construction phase (PLC). There is rarely study about construction waste on the other phases of the Project Life Cycle (PLC). The aim of this study is to identify the construction waste in each phase of PLC from the stakeholders perspective. This research method uses survey, questionnaires, and brainstorming (FGD) with the experts to determine the waste at each phase of the PLC. The output of this study, there are different types of waste at each phase of the PLC and from different stakeholders perspective. The results of this study will be used as a strategy to reduce construction waste.

Keywords: Waste Construction, Project Life Cycle, Supply Chain.

1. INTRODUCTION

In order to accelerate the economic growth in various regions, the Government of Indonesia encourage the development of infrastructure with the target of investment is 2.000 trillion rupiah in 2025. Planning of infrastructure development includes the technical and management matters such as cost, quality, time, safety and environment. Project is a set of interrelated activities and requires skills from different professions, and also project is involved the various of stakeholders in each phase of the Project Life Cycle (stage idea/ideas, planning phase, construction phase, and operation and maintenance phase).

The construction industry impact on the environment in the form of natural resources that are used as well as the solid waste that is generated, and they could harm the surrounding environment. The previous research states that the sheer number of solid waste generated by the construction is 20–30% of construction projects in Brazil, and 1–10% in the Netherlands.¹ To anticipate the issues related to environmental impacts, it is necessary to use waste management as part of the construction project management.

Waste divided to solid waste and non-solid waste. Solid waste is waste in the form of solid and liquid wastes that make work inefficiently. While non-solid waste is waste that is not in the form of solid or liquid waste, but can be shaped as wasted time, high costs, and poor quality that makes the job is not efficient as well.

The problems in the construction project is how to build an environmentally friendly project so it can reduce waste in every phase of the project life cycle. Previous research shows that the application of environmental concepts occurs only in the construction phase. The objective of the study is to identify of waste at the construction project life cycle. The scope of this study is focus on non-solid waste, there are time, cost, and quality.

2. LITERATURE REVIEW

2.1. Project Life Cycle

Projects on the construction industry are temporary and following a certain cycle called the project life cycle. This cycle occurs from pre project to post project. Generally, this cycle consists of stages of idea, the planning phase, the construction phase, and the operation and maintenance phase. Project life cycle generally describes the technical work to do in each phase and who should

* Author to whom correspondence should be addressed.

be involved in each phase. Wibowo has conducted several studies related to Construction Project Life Cycle are as follows: attempted to define the knowledge management maturity on construction companies.² How the application of risk management in project performance based contracts on the terms of the Project Life Cycle has analyzed.³ Other studies about project life cycle in construction projects have also been carried out in build operate transfer.⁴

2.2. Waste Construction

Waste is the movement of workers that do not provide the added value and are not needed in a process.⁵ Waste can also be described as any human activity which absorbs certain number of resources but do not produce added value, such as errors requiring repair, the unwanted production, processes or processing not necessary, the useless movement of labor and waiting for the results of previous activities.

Waste is divided to solid waste and non-solid waste. Solid waste is. Non solid waste is Waste in the construction and manufacturing can be a delay of time, lack of security, rework, excessive costs, unnecessary travel or transfer, long distances, imprecision in the selection of operation methods or management tools and capacity building that are bad.⁶ Waste is unavoidable in the construction work, because material is the main contribution of the project costs. Material control and material storage management can improve profitability, minimize waste, improve efficiency of work and others. Through the work efficiency, material control system can also improve the productivity in global competition with a stable system of rules, regulations and procedures at a high level of initiative.⁷

Waste of construction is defined as a material except the material of the earth that are transported to another place on the project site or used on the project site that does not conform to the specifications of the project because of the damage, excess and unused or unusable or production of the construction process that is not according to plan.¹ In other studies also has conducted several studies related to the construction waste such as identifying the influence level of the waste in construction management.³

3. METHODOLOGY

The step of data analysis in this is identification of waste from literature, questionnaire, and focus group discussion as Figure 1.

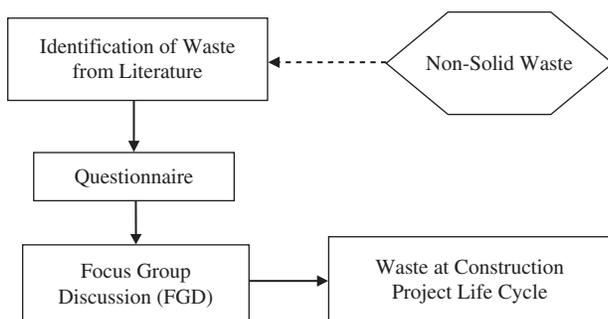


Fig. 1. The methodology of research.

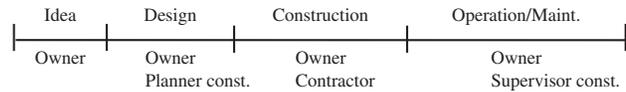


Fig. 2. Project life cycle.

3.1. Identification of Waste from Literature

To get the waste at each phase of the project life cycle is obtained from the literature study. The literature study from journals earlier. Each waste at this phase of the project life cycle which will be asked to the respondents by a questionnaire.

3.2. Questionnaire

The questionnaire asked to the respondents. The respondents of this study is are owner, contractor, planner consultant, and supervising consultant. Owner will fill out a questionnaire at the phase of idea, design, construction, and operation maintenance about waste that normally exist at the project life cycle phase and which are not. The design phase is filled by owner and planner consultant. The construction phase is filled by owner and contractor. The operation and maintenance phase is filled by owner and supervisor consultant. The phase of project life cycle and the stakeholders as Figure 2.

3.3. Focus Group Discussion

Focus group discussion (FGD) is a discussion by several peoples on a certain topic to make decisions together. FGD will be conducted by expert peoples in the construction with the researcher. The waste that has identified to the respondents will be discussed for further identification. FGD could also result in decisions and other views that add new knowledge.

The analysis of data by qualitative methods. The results of questionnaires and focus group discussion analyzed into waste that occurs in the project life cycle.

4. DISCUSSIONS

The results of the questionnaire to respondents that filled by owner, planner consultant, contractor, and supervisor consultant as Table I.

In Table I below, it can see how the respondent’s opinion about the waste in the project life cycle. Each waste also see how it impacts to the cost, time, and quality. Waste at the idea phase according to owner is the length of the execution time for many stakeholders involved and a lot of interest. The impact of this waste is to the cost and quality.

Waste at the design phase according to owner and planner consultant perspective. According to owner is waiting time from the design planner and unskilled expert planner. Meanwhile, according to the planner consultant is unskilled expert planner, primary data and secondary data are not match, the waiting time for a long survey process, and Scope of work is unclear.

Waste at the construction phase according to the owner is the work is not within specifications, inefficient meeting, delay the progress of work, labor competencies promised not met, one of the parties is bad performance, and frequent design changes. Meanwhile, according to the contractor is excessive production, damage output of the work are not within specifications, unnecessary processes, the waiting time of arrival of materials and tools, the waiting time caused by previous work, unnecessary

Table I. Identification waste at construction project life cycle.

Phases	Perspective	Waste	The impact of		
			Cost	Time	Quality
Idea	Owner	The length of the execution time for many stakeholders involved and a lot of interest	✓		✓
Design	Owner	Waiting time from the design planner	✓		✓
		Unskilled expert planner		✓	✓
	Planner consultant	Unskilled expert planner	✓	✓	✓
		Primary data and secondary data are not match	✓	✓	✓
		The waiting time for a long survey process		✓	✓
Construction	Owner	Scope of work is unclear	✓	✓	✓
		The work is not within specifications	✓	✓	✓
		Inefficient meeting	✓		✓
		Delay the progress of work	✓		✓
		Labor competencies promised not met		✓	✓
		One of the parties is bad performance			✓
	Contractor	Frequent design changes	✓		✓
		Excessive production	✓	✓	
		Damage output of the work are not within specifications			✓
		Unnecessary processes	✓	✓	
		The waiting time of arrival of materials and tools		✓	
		The waiting time caused by previous work		✓	
		Unnecessary inventories	✓	✓	
		Unnecessary transportation	✓	✓	
		Unnecessary movement	✓	✓	
		Improper design	✓	✓	✓
		The waiting time because the design has not been completed		✓	
		Design changes	✓	✓	
Operation/maintenance	Owner	One of the parties is bad performance	✓		✓
		The building's performance is not suitable with the planning	✓	✓	
	Supervisor consultant	Quality building is not in accordance with specifications		✓	
		The waiting time jobs from contractors			✓
		Unnecessary movement		✓	✓
		One of the parties is bad performance		✓	✓

inventories, unnecessary transportation, unnecessary movement, improper design, the waiting time because the design has not been completed, design changes, and one of the parties is bad performance.

Waste at the operation and maintenance phase according to owner and supervisor consultant. According to the owner is the building's performance is not suitable with the planning and quality building is not accordance with specifications. Meanwhile, according to the supervisor consultant is the waiting time jobs from contractors, unnecessary movement, and one of the parties is bad performance.

This study is still in the scope of non-solid waste consisting of cost, time and quality. So that in future studies can be analyzed in solid waste. In addition, the increase in the number of respondents will make data analysis more valid.

5. CONCLUSIONS

The phase of construction project life cycle have different waste. These waste are according to different stakeholders. For future research these waste can be used as a reference for stakeholders to work on construction projects. So it can be anticipated that waste can be minimized. Owner as the main stakeholders involved in all phases of the project life cycle to be able to

anticipate the waste to be handled properly. While the contractor is the case of waste during the construction phase should be better in working on the project for waste reduced.

This study is still in the scope of non-solid waste consisting of cost, time and quality. So that in future studies can be analyzed in solid waste. In addition, the increase in the number of respondents will make data analysis more valid.

References and Notes

1. L. L. Ekanayake and G. dan Ofori, *Journal Building and Environment* (2001).
2. M. A. Wibowo and R. dan Waluyo, *Procedia Engineering* 125, 89 (2015).
3. Elizar, M. A. Wibowo, and P. dan Koestalama, Identification and analyze of influence level on waste construction management of performance, *The 5th International Conference of Euro Asia Civil Engineering Forum (EACEF-5)*, *Procedia Engineering* (2015), Vol. 125, pp. 46–52.
4. S. Menherree and S. N. dan Pollalis, Case Studies On Build Operate Transfer, Project Management and Real Estate Development Delft University of Technology (1996).
5. C. T. Formoso, L. Soibelman, C. D. Cesare, and E. L. dan Isatto, *Journal of Construction Engineering and Management* 128 (2002).
6. O. O. Faniran and G. dan Caban, Minimizing Waste on Construction Project Sites, Engineering, Construction and Architectural Management, Blackwell Science Ltd. (1998).
7. T. S. Ping, A. Omran, and A. H. K. dan Pakir, Material Waste In The Malaysian Construction Industry, *The International Conference on Economics and Administration*, Faculty of Administration and Business, University of Bucharest, Romania (2009).

Received: 12 October 2016. Accepted: 2 November 2016.