UNIVERSITAS MUHAMMADIYAH JAKARTA

FAKULTAS TEKNIK

KEPUTUSAN DEKAN

Nomor: 68 Tahun 2023

Tentang:

PELAKSANAAN PENELITIAN DAN PENGABDIAN MASYARAKAT DALAM UNSUR PENELITIAN DOSEN TETAP FAKULTAS TEKNIK UNIVERSITAS MUHAMMADIYAH JAKARTA SEMESTER GENAP 2022/2023

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NID: 20.773.

Engineering and Technology Journal

Website: http://everant.org/index.php/etj

ISSN (print): 2456-3358
DOI: 10.47191/etj

Impact Factor : 7.136
ASI Score : 1.3 , IPI Value: 2.68

Letter of Acceptance

Dear Author : Nurlaelah

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Engineering and Technology Journal e-ISSN: 2456-3358
Volume 08 Issue 08 August -2023, Page No.- 2515-2522
DOI: 10.47191/etj/v8i8.04, I.F. – 7.136

Analysis of NVA Waste in PT "XYZ" Warehouse Building Project, West Java, Indonesia

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ABSTRACT: Currently, construction waste remains a major concern for researchers and construction practitioners. Various efforts have been made to minimize waste during construction, aiming not only for the benefit of owners and contractors but also for the sustainable environment. Therefore, this research attempts to discuss construction waste related to Non-Value Added Activities (NVA) waste in the PT "XYZ" warehouse building project. The final results indicate the presence of 7 types of NVA waste along with various examples, and the most frequent occurrence is waste related to waiting.

KEY WORD: Construction Project, Construction Waste, Non Value Added

INTRODUCTION

The manufacturing sector is characterized by waste. Waste by definition is anything that does not add value or that customers do not want since it will detract from the desired end result. Waste is any activity that does not add value to the process of turning inputs into outputs along the value stream (processes for creating, producing, and delivering goods and or services to market), according to Vincent Gaspersz in his book "Lean Six Sigma" published in 2007. As time goes on, the construction sector, which seeks to improve the outcomes of construction projects, is also included in this waste discussion.

This is conceivable because there are still many construction projects that, both in terms of the final product (such as buildings, roads, bridges, etc.) and the construction process, do not meet the needs of the owner or user. Problems that frequently arise in construction projects include a number of building items that were affected (defective), failed (collapsed), delays in completion of work, protracted permitting process, and final conflict (dispute) between the owner and the contractor.

Koskela (2013) defined waste in the construction sector as anything that results in inefficiencies in the use of significant quantities of tools, materials, labor, or money required to construct a building. Furthermore, it was explained that waste in the construction sector is primarily classified into two categories: activity waste, or non-value-added activities (NVAs), and material waste, which takes the form of building trash. As a result of its connection to the three (three) primary limitations of construction projects, namely Cost, Quality, and Time, the category of activity waste is waste related to project performance. A construction project should ideally be produced with cheap cost (low budget), good quality, and a quick turnaround time, or at the at least, on schedule. It might be said that a construction project is not performing successfully if these three key restrictions are not met.

The warehouse building project at PT "XYZ" in the Cikarang district of West Java was one of the construction projects where the three constraints (Cost, Quality, and Time) were not met. This undertaking is a warehouse for the storage of processed foods and fresh foods like meat and chicken. This project ran into a number of issues while it was being completed, which led to cost and time overruns that cost both the contractor and the owner money. Preliminary information suggests that there was a significant amount of activity waste (NVA) during the construction process. Examples include the owner's selection of the contractor and subcontractor, the difficulty obtaining supplies from the building material stores, the length of the permit process, and others.

To enable contractors to input and take preventative action, it is therefore vital to identify and evaluate the NVA waste that happens in every building project, particularly in the Building Project at PT "XYZ."

DEFINITION AND TYPES OF CONSTRUCTION WASTE

In general, construction waste is divided into two main parts as expressed by Nagapan and Ismail (2011): 1. Physical waste and 2. Non-physical waste.

1. Physical waste

Construction projects generate a significant amount of solid waste. According to Bossink and Brouwer (1996), approximately 15 to 30% of the solid waste disposed of in landfills is construction waste. This waste comes from both

new building constructions and modifications to existing structures. A survey conducted by Wilson (2001) in 11 major European cities revealed that more than half of the managed solid waste originates from construction waste. Similar findings were reported by Ekayanake (2000) in his research, stating that the amount of solid waste produced from construction projects in the Netherlands is about 10% of the total waste generated.

According to Yahya and Boussabaine (2004), construction waste can be defined as materials that are not used and are a byproduct of the construction process. On the other hand, Defatta et al. (2003) and Hao et al. (2007) explain that construction and demolition waste refer to the residual materials arising from various activities such as construction, renovation, demolition, including excavation or earthworks, civil and building construction, site clearance, demolition activities, road works, and building renovations. This waste can consist of solid waste, including concrete debris, various types of bricks and blocks, various types of tiles, reinforcing steel, wood, plastic and paper materials, as well as gravel and soil. Research also identifies physical construction waste as the source of waste that is typically found at construction project sites.

2. Non Physical Waste

On the other hand, there are also types of waste known as Non-Value Added Activities (NVA). The term "not adding value" is used to distinguish physical construction waste found at project sites from other types of waste that occur during the construction process. This type of waste is also referred to by researchers as non-physical waste, non-tangible waste, or indirect waste.

According to Kutika, Saerang, & Gerunga (2018), NVA (Non-Value-Added) refers to activities that do not provide added value or are not efficient, and thus, can be improved to enhance value.

Previously, according to Womack and Jones (1996), waste can be defined as human actions that utilize resources without creating added value, such as errors requiring correction, production of unwanted goods, unnecessary process steps, unnecessary employee movements, and waiting for others to complete preceding activities. Upon further examination, it can be concluded that the viewpoint of Womack and Jones refers to non-physical waste (NVA).

Meanwhile, Koskela (1992) in the research by Formoso et al. (1999) explains NVA (Non-Value-Added) waste as any form of inefficiency that results in the use of equipment, materials, labor, or capital in larger quantities than necessary. In other words, waste in the construction industry is not only related to the quantity of materials wasted on-site but also encompasses various activities such as overproduction, waiting time, material handling, processing, inventory, and worker movements. Consistent with previous researchers, Alwi et al. (2002) interpret waste as not limited to material waste in the construction process but also includes other non-value-added activities, such as rework, waiting time, and delays.

In 2013, Koskela proposed the possibility of adopting the seven main wastes from The Toyota Way, which were introduced by Ohno and Shingo, in the context of the construction industry. These wastes are Overproduction, Inventory, Defects, Motion, Transportation, Processing, and Waiting.

In its development, the terminology of the seven wastes must be identified and defined according to the situation and conditions of each construction project. Several researchers have previously conducted studies related to the intended definitions. For example, Thanh (2011) provides a detailed explanation of his opinion as shown in the following Table 1.

Table 1. Seven types of Waste in the construction projects

No	Waste	Definition	Related Cause
1	Waste from defects	A defect is a shortfall in performance which manifests itself once the building is operational.	Value generation management, tasks management
2	Waste from delays	Delay is an act or event which extends required time to perform or complete work of the contract manifests itself as additional days of work.	Workflows management
3	Waste from overproduction	It is production of products earlier than specified by customers or greater quantity than required.	Tasks management, workflows management
4	Waste from overprocessing	It is arrangement or planning some unnecessary processes in work flow.	Workflows management

5	Waste from maintaining excess inventory	It is improper stored amount of resources, work-inprocess (WIP), finished products, and improper stored approaches	Workflows management
6	Waste from unnecessary transport	It is unsuitable transport approaches of resources or finished goods in the process flow or in the site.	Workflows management
7	Waste from unnecessary movement of people and equipment	It is activities of personnel or machine and equipment not to add value to work.	Workflows management

Source: Thanh (2011)

From the above waste definition, several types of NVA (Non-Value-Added) can be mentioned here based on various researchers.

Furthermore, Alwi et al. (2002) also explained other types of NVA (Non-Value-Added) activities, which include. 1) repair, 2) waiting time, 3) materials, 4) human resources, and 5) operational (operations). Haggard, et al. (2005) list six different types of supply chain inefficiency along with the following types of construction waste: 1) unnecessary material handling, 2) rework, 3) design flaws, 4) conflicts between buyers (conflict between buyers), 5) conflicts between contractors (conflict between contractors), and 6) ineffective supply chain. According to Senaratne et al. (2008), there are four different categories of construction waste: extra materials, delays, rework, and faults. According to Forbes et al. (2011), there are nine different categories of construction waste, including 1) overproduction, 2)idle time, 3)transportation, 4)processing, 5)inventory, 6)wasted operator motion, 7)producing defective goods, 8)satisfaction (making do), and 9)not talking and not listening. While waiting time and transportation time are the two categories of construction waste that Farrar, et al. (2004) characterize as being related to time.

Meanwhile Koskela, et al. (2002) go into greater depth about the many categories of building waste, citing:

1. A lack of resources or their unavailability, which causes delays.
2. Extraneous steps and tasks.
3. Unnecessary personnel, equipment, and material moves.
4. Having too many resources to complete a task (having too many resources).
5. Material inventories and associated statements regarding material conformance.
6. Excessive output brought on by the misuse of resources.
7. Lack of production but increased use of resources (production issues, resulting in adjustments, and increased use of resources as a result)

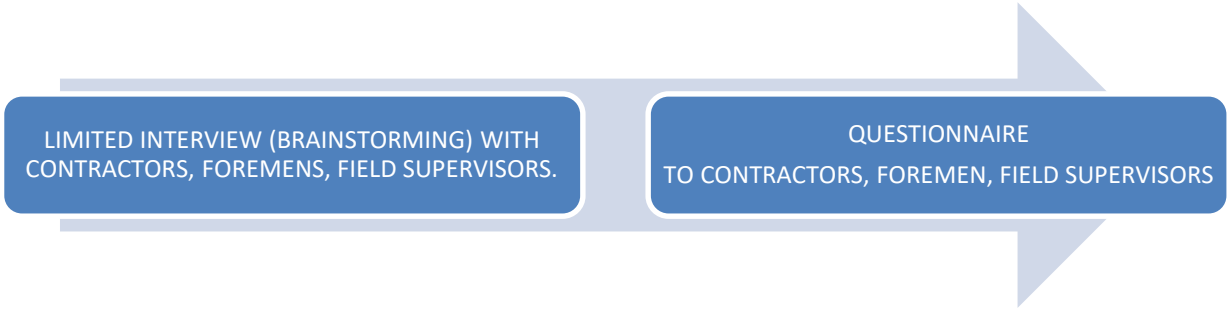
CAUSES OF WASTE OCCURANCE

People, professional management, design and documentation, materials, activities on building sites, and physical factors can all be characterized as causes of waste (Alwi et al., 2002). Inadequate trade skills, unequal labor distribution, incomplete inspection of work, a lack of qualified supervisors and foremen, subcontractors with insufficient abilities, and inexperienced inspectors are some of the causes of human-related waste. These issues seem to be particularly severe in Africa. South. Poor planning and scheduling, poor information management, poor coordination in the construction supply chain, and sluggish decision-making procedures are all sources of waste connected with professional management.

Poor site documentation, confusing requirements, ambiguous site drawings, a long response time to information requests, design revisions, and subpar design are all examples of sources of waste in the design and documentation process. Non-compliance with quality standards, delays in material delivery, inefficient material handling, and the use of improper resources are all sources of material waste. While deficient construction procedures, old equipment, equipment shortages, outdated site layouts, and an excessive reliance on overtime to complete work on schedule are among the sources of waste associated with site operations. In the meantime, design, procurement, material handling, site operations, and other related construction activities can be classified as the causes of construction waste in terms of material or time (Polat et al., 2004).

RESEARCH METHOD

This study was conducted on the warehouse building project of PT "XYZ" located at Jl. Sungkai 2, Cikarang Pusat, Bekasi, West Java, Indonesia. through 2 (two) main stages as shown in Figure 1 below:



1. The limited interview (brainstorming) aims to explain definitions related to waste NVA terms that have been formulated through literature studies. Additionally, data related to examples of NVA (Non-Value-Added) waste that occurred in the "XYZ" warehouse project were also collected.
2. Questionnaire, is an activity to find data related to the frequency of occurrence of waste NVA during the construction process. Data analysis was carried out using SPSS statistics to find out how often NVA activity waste occurs in the PT "XYZ" warehouse building project.

FINDINGS AND DISCUSSION

Following the research stages mentioned above, this study was conducted through two phases: 1. Limited interviews (brainstorming) and 2. Questionnaires provided to research respondents. The respondents in this study consisted of 15 individuals directly involved in the construction process of the warehouse building, including 4 Contractor Heads, 7 foremen, and 4 field supervisors.

1. Examples of NVA (Non-Value-Added) waste that occurred

Based on the results of limited interviews (brainstorming) and direct observations on-site, the following examples of NVA (Non-Value-Added) waste are presented in Table 2.

Table 2. Examples of waste NVA in PT. XYZ Warehouse Building Project

No	Waste NVA	Examples of waste NVA
1	Overproduction (Producing in larger and faster quantities than needed).	• Many wasted iron pieces for the construction of beams, poles/columns. • Wasted cement, sand, and gravel mix for the foundation, poles, and beams.
2	Inventory (Excess testing, equipment, data storage, process inventory, and material and supplies more than needed).	• Accumulation of excavated soil in some corners, causing the project site to be untidy. • Piling up construction materials in the warehouse without proper organization.
3	Defect (Products produced not according to specifications).	• Some parts of the building are damaged, such as cracked walls, peeling paint, and others. • Cracked and lifted floor tiles in several locations. • Wooden and aluminum doors and windows are dragging. • Damaged door and window accessories.
4	Motion (Unnecessary movement of operators from one task to another, or from one place to another).	• Endless meetings by owner and contractor. • Errors and delays in ordering materials from the supplier. • Workers taking excessively long breaks. • Workers Using mobile phones excessively during work.
5	Transportation (Unnecessary movement of materials or equipment).	• The transfer of excavated soil to another location is hindered due to insufficient equipment. • The transfer of foundation and beam materials (blocks, cement, sand, gravel, iron) is hindered due to inadequate equipment and lack of logistics personnel managing the inflow and outflow of materials in the warehouse.

6	Processing (Non-value-added processing activities on the product).	• Slow progress of work. • Incorrect or delayed exchange of information. • Inaccurate measurements were made for constructing beams, poles/columns, resulting in numerous wasted iron or steel pieces. • Design changes requested by the owner. • Inaccurate measurements were taken for the casing and plywood used for temporary formwork. • Rework in several parts of the building.
7	Waiting (Waiting due to weak management, planning, and monitoring of materials and workflow).	• Administrative issues originating from the owner. • The foreman waiting for information from the contractor, and the contractor waiting for information from the owner. • Workers waiting for work instructions from the foreman. • Workers waiting for materials from the storage warehouse.

With the occurrence of various types of NVA (Non-Value-Added) waste in this project, it is essential to take elimination and prevention measures. As stated by Ismail, et al. (2016), Waste can directly impact the construction process and projects but can be avoided by executing the work properly, maintaining strict monitoring, control, and planning. Everyone involved in the construction process has the potential to generate waste as they influence the process Therefore,, (Tersine, 2004) explained waste must be removed from a construction process as it can proliferate and multiply if left unaddressed, leading to reduced operational effectiveness. The elimination of waste can enhance the company's profits by reducing resource utilization and improve overall performance and quality.

2. The frequency of NVA (Non-Value-Added) waste occurrence.

Based on the previously outlined definition of the 7 NVA (Non-Value-Added) wastes and explanations provided to the 15 research respondents, the following 7 questions were formulated regarding the frequency of NVA waste occurrences in this project. Each question has a rating scale consisting of 1 (Always), 2 (Often), 3 (Seldom), and 4 (Never).

The results of the statistical analysis using SPSS are as follows:

1. Question 1

How often do you encounter overproduction in this project?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always	8	53.3	53.3	53.3
	Often	6	40.0	40.0	93.3
	Seldom	1	6.7	6.7	100.0
	Total	15	100.0	100.0	

2. Question 2

How frequently do you observe excess inventory of materials or supplies?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always	7	46.7	46.7	46.7
	Often	7	46.7	46.7	93.3
	Seldom	1	6.7	6.7	100.0
	Total	15	100.0	100.0	

3. Question 3

How often do you notice unnecessary movement of workers or equipment between tasks or locations?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always	2	13.3	13.3	13.3

	Often	12	80.0	80.0	93.3
	Seldom	1	6.7	6.7	100.0
	Total	15	100.0	100.0	

4. Question 4

How frequently do you come across defects in the final products?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always	3	20.0	20.0	20.0
	Often	9	60.0	60.0	80.0
	Seldom	2	13.3	13.3	93.3
	Never	1	6.7	6.7	100.0
	Total	15	100.0	100.0	

5. Question 5

How often do you witness excess waiting time for instructions or materials?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always	2	13.3	13.3	13.3
	Often	6	40.0	40.0	53.3
	Seldom	6	40.0	40.0	93.3
	Always	1	6.7	6.7	100.0
	Total	15	100.0	100.0	

6. Question 6

How frequently do you observe non-value-added processing activities in the production process?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always	1	6.7	6.7	6.7
	Often	13	86.7	86.7	93.3
	Seldom	1	6.7	6.7	100.0
	Total	15	100.0	100.0	

7. Question 7

How often do you encounter unnecessary transportation of materials or equipment?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Often	14	93.3	93.3	93.3
	Seldom	1	6.7	6.7	100.0
	Total	15	100.0	100.0	

Graphically, the average responses of the respondents are as follows:

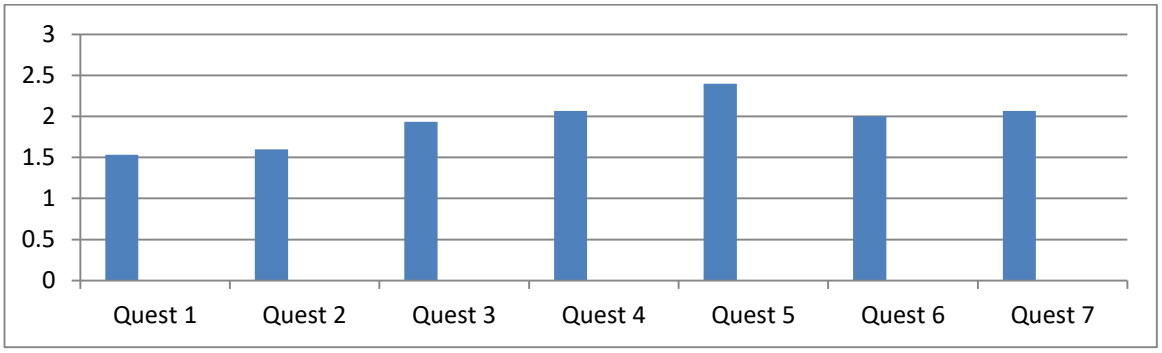


Fig. 1 The average responses of the respondents.

In Figure 1, It is evident that for question 5 (How often do you witness excess waiting time for instructions or materials?), it ranks first with a score of 2.4. This means that this NVA waste should be the primary concern for both the contractor and the owner during the construction process. It is followed by questions 4 and 7 (How frequently do you come across defects in the final products? And How often do you encounter unnecessary transportation of materials or equipment?), respectively. Next is question 6 (2.0), followed by question 3 (1.9), question 2 (1.6), and question 1 (1.53). However, overall, it can be observed that the average responses are between 1.5 to 2.4, indicating that this NVA waste occurs "Often." Therefore, this can serve as valuable input for both the contractor and the owner of the warehouse project at PT "XYZ."

CONCLUSION

Based on the frequency of NVA waste occurrences above, it can be concluded that for the warehouse project at PT "XYZ," the "Waiting" factor is the main constraint during the construction process. The waiting referred to consists of:

- Administrative issues originating from the owner.
- The foreman waiting for information from the contractor, and the contractor waiting for information from the owner.
- Workers waiting for work instructions from the foreman.
- Workers waiting for materials from the storage warehouse.

It means that the source of the issues is not solely attributed to the contractor but can also originate from the owner. Therefore, there is a need for intensive discussions between both parties (owner and contractor) mainly during the before construction, construction, and after construction phases. This is crucial to minimize miscommunication, errors, or delays in information exchange between them.

FURTHER RESEARCH

Further research is highly necessary due to the unique nature of each construction project. As a result, definitions, explanations, and examples of NVA waste will become more varied. Consequently, contractors, consultants, and owners will receive valuable inputs regarding NVA waste and can take preventive measures before commencing their construction projects.

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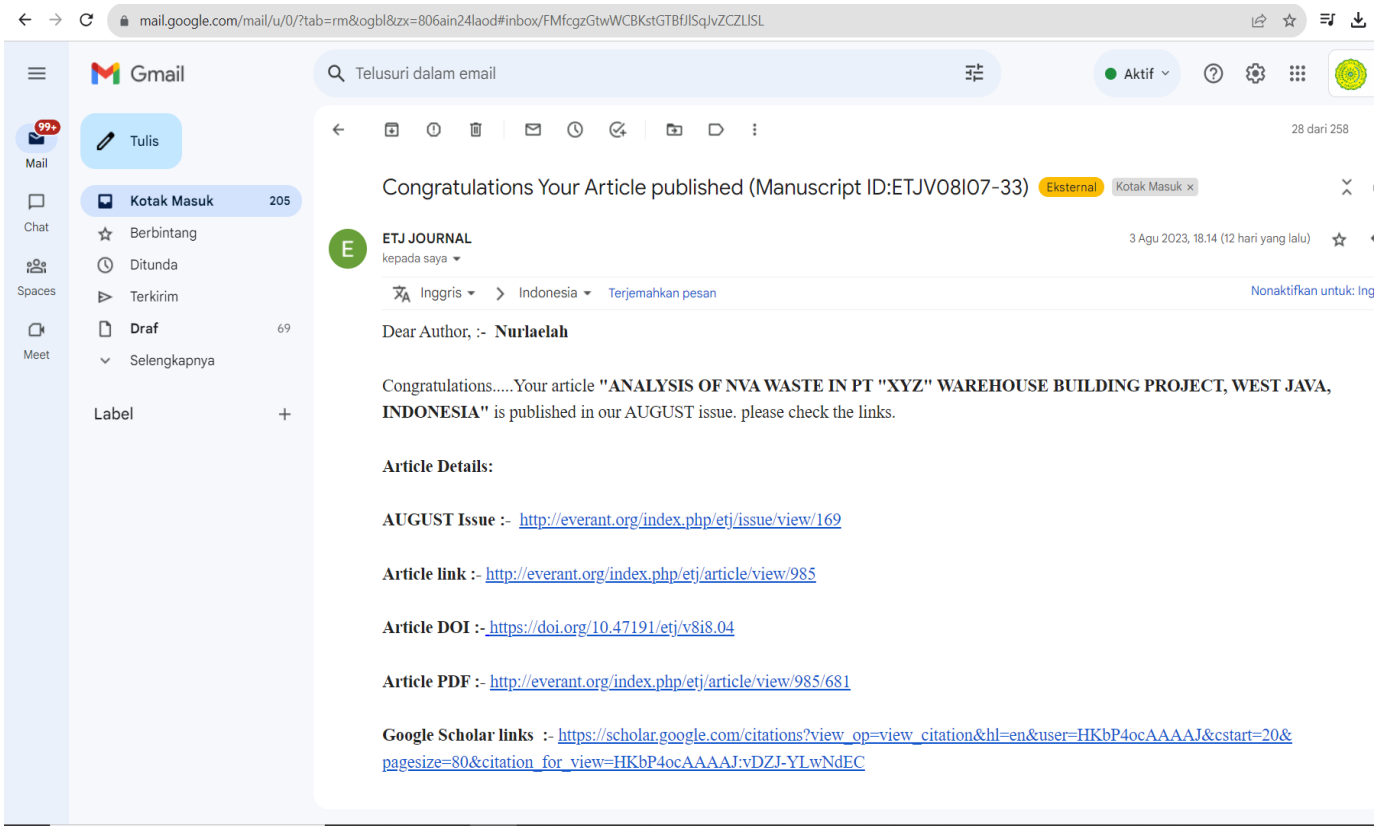
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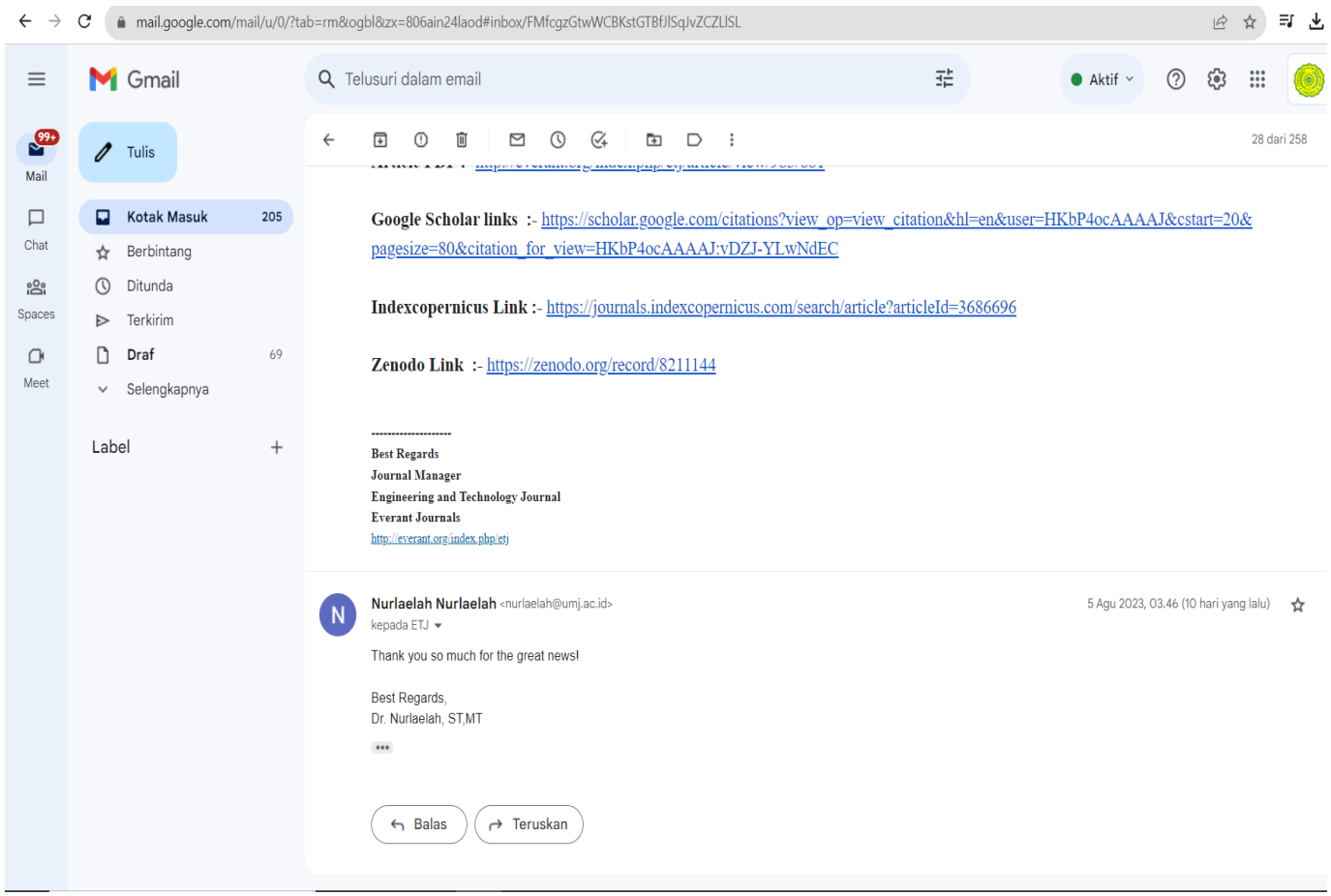
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