The Detailed Description of Construction Waste in Low-Cost Housing Projects in Indonesia

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The Detailed Description of Construction Waste in Low-Cost Housing Projects in Indonesia

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Abstract

Developers construct low-cost housing specifically for the low-income demographic. While the number of people interested in this sort of home is growing in Indonesia, in practice, there is sometimes a delay in the development process due to waste. The goal of this research is to identify and describe the waste that occurs during the construction of low-cost dwellings. Field observations and interviews with 17 contractors working on four low-cost housing projects were used to gather data. The findings of the analysis demonstrate that various wastes arise throughout the construction process' flow, including waste Overproduction, Inventory, Defect, Motion, Transportation, Processing, and Waiting in each job, all of which stymie the development process. This study was not conducted at the level of the developer or material supplier, but rather at the project site, specifically on every job in the process of constructing a consumer's home. This study uses seven forms of waste that exist in a succession of manufacturing processes, namely Overproduction, Inventory, Defect, Motion, Transportation, Processing, and Waiting, which are rarely employed in construction projects.

Keywords: *Low Cost Housing, Construction Waste*

INTRODUCTION

Low-cost housing is a type of housing that is typically allocated for persons with limited purchasing power and low incomes. Because the developer cannot increase the selling price of structures and operational support facilities, unlike middle and luxury housing, where the cost of housing facilities and infrastructure is paid by customers, this form of housing offers little amenities. Low-cost housing is frequently found outside of the city limits. Because the cost of land in the inner city is prohibitively high, it cannot be passed on to consumers (Suparno et al, 2006). Affordable Housing Development is carried out for an area of no more than 5 (five) hectares and at least 5 (five) hectares in the Republic of Indonesia Government Regulation No. 64 of 2016 addressing the development of low-income community housing. A house that is affordable for low- and middle-income persons is known as an affordable dwelling. Low-income people will be able to live in a non-tiered house that is cheap.

However, there are significant issues that arise throughout the construction process, such as the delay, which is a delay in the start of work that causes the project to be completed late and in violation of the contract. According to the Indonesian Consumers Foundation, the development process was the most common complaint in the housing sector in 2018, accounting for 60 (sixty) complaints. The issue with the development process at hand is the construction of houses, which has an uncertain completion date.

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There have also been accusations that the development process has been delayed for an extended period of time and has failed to meet the developer's promises.

A project delay is defined as an event that causes the project's overall or partial completion to be delayed (D Chan, 2002). It indicates a loss of income for the owner due to underused facilities. Delays result in increased overhead expenses for contractors because a longer service life means higher material and labor costs (Assaf, 2006). Because of the longer service life, delays result in greater overhead expenses, higher material costs, and an increase in labor costs (Megha Desai, 2013). This delay is caused by the discovery of waste during the construction process.

In the context of lean thinking, the term waste refers to non-value-added (NVA) activities (PE Josephson, 2007). NVA is a component of the production flow, as well as activities that create value (Value Added / VA) (S Sarhan, 2013). Poor/inadequate product quality, rework, excess and waste materials, material handling, materials in stock, and working in less-than-ideal conditions are all examples of construction waste, according to (Koskela, 2013). Koskela associates waste with activities/businesses in building production that are related to time and money but do not generate added value. "Waste" is defined as "the use of more than is required, or unwanted consequences" throughout the manufacturing process, and not in agreement with the customer's wishes. Waste has been recognized as one of the issues that has a detrimental impact on design variants in the building industry. As a result, waste reduction efforts are extremely important opportunities for construction stakeholders to pursue (F Emuze, 2014). As a result, efforts are needed to determine the types of waste generated during the construction process, as well as when and where it occurs.

The purpose of this paper is to identify and explain the waste generated by the contractor during the low-cost housing development process in detail. This information is useful to contractors as input so that proactive measures can be implemented to prevent construction waste on future projects.

LITERATURE REVIEW

1) *Waste on Construction Projects*

Because a process involves a sequence of actions, it's likely that when we look at the waste in a process, we'll find a waste chain, or a chain of cause and effect where the first waste might lead to more waste. As a result, the harm is caused not just in one step, but in the entire process. Such a chain is referred to as a "vicious cycle of waste that begets waste" by Ohno, who differentiates between "primary and secondary garbage." The two words are then proposed to be replaced with core waste and lead waste. The core waste is the waste itself and at the same time it is the cause of other wastes. While the main waste is the dominant core waste causing a substantial negative impact in the production process. Thus, a waste can be caused by core waste or other waste that does not come from the waste itself (other root causes) (Koskela, 2013)

Waste is an obligation or activity that has no added value (NVA), and approximately 70% of design and construction activities have no additional value (Pinch, 2005). It's difficult to quantify waste. Several studies from various nations show that waste in building projects is significant in percentage, affecting project costs. The excessive amount of waste has an impact on the project's overall performance, so substantial steps must be taken to improve it (Goit, 2016).

NVA waste could account for up to 49.6% of construction activity time. Even overtime, which appears to be a common practice in the construction business, has a detrimental influence on productivity and can lead to increased weariness, incidents, and accidents, all of which raise the cost and duration of building projects. If left uncontrolled, this waste can have a significant influence on organizational competitiveness and industrial productivity growth (Abdulrazig, 2015).

The NVA wastes detected at the design stage (unnecessary redesign, poor design management, and insufficient design briefings) not only waste resources, but also have an impact on the construction supply chain's downstream activities (A O Ralph, 2012). As a result, waste reduction operations represent a huge potential for construction stakeholders to take advantage of (F Emuze, 2014). Eliminating waste will be one of the most effective strategies to boost earnings in any company. Profits can be enhanced while expenditures are reduced due to the removal of unneeded waste (Tersine, 2004).

2) *Type of Construction Waste Adopted from Ohno's Idea*

According to Ohno, the creator of the Toyota Production System philosophy (in (C Hicks, 2004) in a succession of manufacturing operations, there are seven categories of waste:

1. Excessive output of finished or semi-finished commodities is known as overproduction.

2. Waiting time (delay) is the time spent waiting for non-value-added materials, information, tools, and equipment to arrive.

3. Excessive transportation, which includes the movement of materials, information, equipment, and equipment that adds no value but incurs expenditures.

4. Inappropriate processing, i.e., activities that are not in accordance with the process/method of production operations owing to the use of instruments that are not in line with the functions or errors in procedures or operating systems.

5. Excess inventory, which refers to a stockpile of completed goods or raw materials in a warehouse.

6. Unnecessary motion is non-ergonomic movement caused by improper workstation design or work procedures.

7. Defect, the incidence of product flaws that necessitate rework, a large number of scraps, and repair.

Ohno's concept of identifying the above-mentioned waste kinds came to be introduced and embraced in the building sector over time. Excessive checks on the project site (Hamzah Abdul R, 2012), waiting for equipment repair, delays in starting activity, and handling excessive material (A O Ralph, 2012), poor vehicle and truck movements and excess material in project location (F Emuze, 2014), unnecessary and excessive material orders (J Arleroth, 2011) and excessive supervision (Modegh, 2013) are all examples of NVA waste, according to some researchers.

The debates illustrate that the traditional list of seven wastes is context specific, and that the critical wastes in the context of construction must be discovered and defined based on the features of this form of production. This understanding will be crucial in applying lean principles outside of the automotive industry. Indeed, it appears that there is a substantial need to conceptually explain the concept of waste from a context standpoint (Koskela, 2013).

METHODOLOGY

This research was conducted in 4 low-cost housing projects (housing I, II, III and IV) based on the following criteria to identify and describe the waste that occurs:

1. Setting an aim of constructing a subsidized, affordable home.

2. To create several dwelling units at simultaneously, the development process is carried out utilizing a system per work item.
3. The same labor sequence, beginning with excavation and ending with completion.
4. There are no works that have been subcontracted.

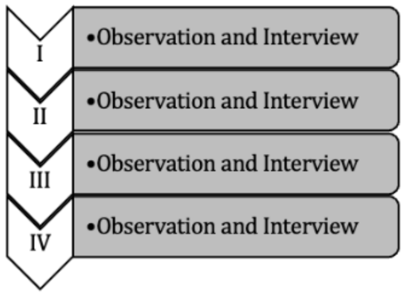

Figure 1. Research Method

Data collection methods were carried out as shown in Figure 1. In this study, observation meant watching construction workers in the four housing locations that were the subject of the study (housing I, II, III, and IV) every day from 8 a.m. to 17 a.m. WIB, from the first work (soil excavation) to the final work (finishing), for 3 to 6 months.

In addition, 22 research respondents (17 foreman and 5 field supervisors) who were accountable for and regarded knowledgeable about the house construction process were interviewed. According to observations and interviews, there is waste in the development process.

FINDINGS AND DISCUSSION

Based on observations in the field, Housing I built 35 units, Housing II 17 units, Housing III 26 units and Housing IV 21 units during the 2018/2019 period. Six contractors are participating in the construction of housing I, three contractors in housing II, four contractors in housing III, and four contractors in housing IV. All contractors follow the processes outlined in Figure 2 while constructing a house.

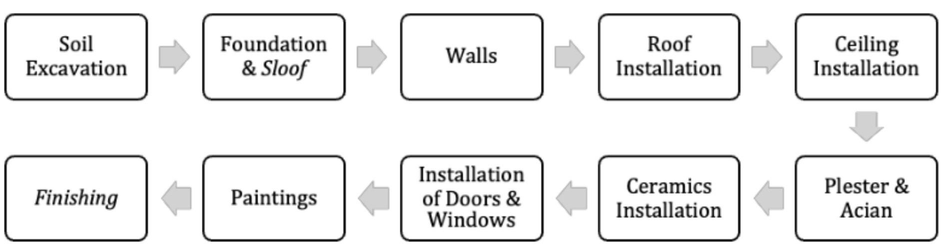

Figure 2. Sequence of House Construction Work in Low-Cost Housing

Figure 2 depicts a typical contractor's work flow, commencing with excavation and ending with finishing work. When a contractor is given a project with ten dwelling units, the process is carried out by employees excavating from the first to the tenth house. Workers also do foundation and roof work, from the first to the last house, and so on, until the final step is completed (finishing).

Data is collected in the form of delay data for each work that occurs early in the process at this stage. While the delay is a postponement in the completion of work caused by waste indicators such as defects (poor work results that need to be repaired and reworked), waiting (waiting for material to arrive from suppliers/ storage warehouses and waiting for previous work to be completed), motion (slow labor movement to complete work), and transportation (removal of construction materials that are not supported by adequate facilities, such as carts, so that tranportation can take place) (long work processes because workers involved are less skilled and experienced).

Furthermore, it is clear that there are two main obstacles to a smooth growth process including delays and construction waste as shown in Figure 3.

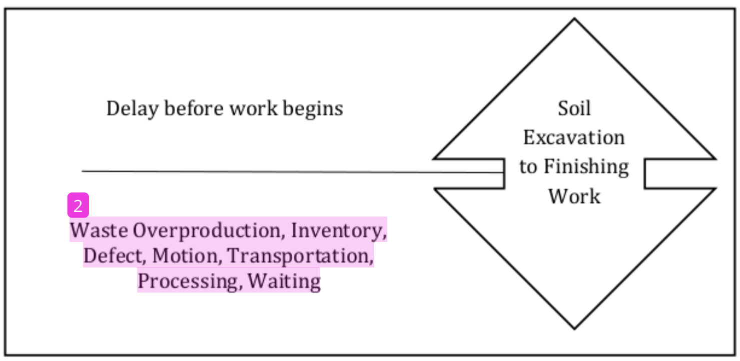

Figure 3. Two Main Issues in Low Cost Housing Projects

According to Figure 3, it can be explained that,

1) Delay before work begins.

There is a pause before each stage of the project begins (from soil excavation to finishing) caused by:
1. The foreman has not yet received an order to start work from the contractor.
2. The contractor does not have sufficient beginning cash to use for material purchases and other operating costs.

Tables 1,2,3, and 4 below show the delay data for each housing.

Table 1. Housing I has been delayed by six contractors

No	Work Item	Contractor Delays (Days)						
		A	B	C	D	E	F	Average
1	Soil Excavation	2	1	1	3	3	2	2

2	Foundation & Sloof	3	2	2	4	3	4	3
3	Wallas	6	7	6	6	6	5	6
4	Roof Installation	8	6	6	8	7	7	7
5	Ceiling Installation	4	5	5	6	6	4	5
6	Plester & acian	5	4	4	6	4	6	5
7	Ceramics Installation	7	6	6	5	6	6	6
8	Installation of Doors & Windows	6	7	7	7	7	7	7
9	Paintings	5	4	5	5	5	5	5
10	Finishing	2	1	1	3	2	2	2
	Sum	48	43	43	53	49	48	48
	Constructed Housing Units	6	8	5	7	4	5	
	Total Houses Observed				35			

Contractor B, with 5.375 days per dwelling unit (43/8), has the shortest delay/waiting time duration, followed by contractor D with 7.57 days (53/7) and contractor A with 8 days (48/6), according to Table 1 Meanwhile, contractor F has been delayed for 9.6 days (48/5) and contractor E has been delayed for 12.25 days (49/4), the largest delay/waiting period among the other contractors.

Table 2. Housing II has been delayed by three contractors

No	Work Item	Contractor Delays (Days)			
		G	H	I	Average
1	Soil Excavation	2	2	2	2
2	Foundation & Sloof	2	2	2	2
3	Wallas	3	3	2	3
4	Roof Installation	3	3	3	3
5	Ceiling Installation	3	3	3	3
6	Plester & acian	2	2	2	2
7	Ceramics Installation	5	6	4	5
8	Installation of Doors & Windows	2	3	3	3
9	Paintings	3	4	2	3
10	Finishing	2	2	2	2
	Sum	27	30	25	28
	Constructed Housing Units	6	8	5	
	Total Houses Observed		17		

From Table 2, it can be seen that contractor I has a smaller delay/waiting time duration of 3.8 days per housing unit (25/7), followed by contractor G for 4.5 days (27/6) and the last is contractor H 7.5 days (30/4).

Table 3. Housing III has been delayed by four contractors

No	Work Item	Contractor Delays (Days)				Average
		J	K	L	M	
1	Soil Excavation	1	1	1	1	1
2	Foundation & Sloof	1	3	3	1	2
3	Wallas	3	3	2	5	3
4	Roof Installation	4	4	5	2	4

5	Ceiling Installation	3	3	3	4	3
6	Plester & acian	2	2	1	4	2
7	Ceramics Installation	2	5	3	6	4
8	Installation of Doors& Windows	3	2	3	3	3
9	Paintings	2	4	3	3	3
10	Finishing	2	1	1	1	1
Sum		23	28	25	30	26
Constructed Housing Units		5	8	7	6	
Total Houses Observed			26			

Contractor K has a shorter delay/waiting time than the other contractors, as shown in Table 3, with 3.5 days (28/8) per home unit, followed by contractor L with 3.6 days (25/7). Contractor J worked for 4.6 days (on the 23rd). Contractor M, on the other hand, is the most time-consuming, taking 5 days (30/6) each house unit.

Table 4. Housing IV has been delayed by four contractors

No	Work Item	Contractor Delays (Days)				Average
		N	O	P	Q	
1	Soil Excavation	1	1	1	1	1
2	Foundation & Sloof	5	5	6	4	5
3	Wallas	8	7	7	10	8
4	Roof Installation	11	11	9	9	10
5	Ceiling Installation	5	4	6	5	5
6	Plester & acian	9	7	10	7	8
7	Ceramics Installation	6	6	6	6	6
8	Installation of Doors& Windows	4	6	5	5	5
9	Paintings	6	4	4	6	5
10	Finishing	1	1	1	1	1
Sum		56	52	55	54	54
Constructed Housing Units		4	7	6	4	
Total Houses Observed			21			

Contractor O has the shortest delay/waiting time, with 7.43 days (52/7) per dwelling unit, followed by contractor P with 9.2 days (55/6) and contractor Q with 13.5,5 days (54/4), as shown in Table 4. Contractor N, on the other hand, has the longest delay/waiting period, at 14 days per dwelling unit (56/4).

Delay is a wasteful action that occurs prior to the completion of labor. This waste can be found in a variety of projects, ranging from excavation to septic tanks to finishing work. According to (S.S. Assaf, 2006), a project's delay can be described as the completion time of work surpassing the contract or time that is not in accordance with what the parties engaged in the project agreed on. Because of the numerous production facilities that must be utilised at this time, a delay represents a loss of income for the owner. Delays result in increased overhead expenses due to longer service life, higher material costs due to inflation, and higher labor costs for contractors.

2) Waste that occurs in each item of construction work

At this stage waste is classified into seven categories: overproduction (O), inventory (I), defect (D), motion (M), transportation (T), processing (P), and waiting (W), and it occurs during the course of a work process.

1. Overproduction occurs when a product's supply exceeds demand, such as too much mortar and sand, too much iron for sloofs or columns / poles, and so on. Because material things are not cleanly stored, inventory builds up in a storage facility. Due to insufficient storage systems and storage conditions, this can result in material damage or a drop in material quality. As a result, if low-quality materials are still being utilized, the structure will suffer, necessitating repairs and rework.
2. Because there are no logistical operators in charge of the stuff available, inventory occurs. Regulation of material entry and exit to the housing unit to be built, checking the amount and condition of material originating from the supplier, regulation of material in the storage warehouse, checking the availability of material in the storage warehouse, and providing adequate facilities are just a few examples (carts). Furthermore, the logistics officer must communicate the availability of material to the contractor on a regular basis so that they can reorder if the material runs out and the work process can begin quickly.
3. Unexpected construction processes, such as broken walls, leaking roofs, peeling paint, and so on, result in defects. This occurs when the work techniques and materials employed do not fulfill the required parameters. As a result, employees must repair and rework so that the length of time work in process (WIP) for each phase can be reduced.
4. Because of the quality of workers who are less trained and experienced, motion is a slow movement of workers. As a result, the ongoing project is taking longer.
5. Transportation, on the other hand, is the action of transporting materials from insufficient storage warehouses. This is due to a lack of personnel and carts for transporting materials, as well as poor road conditions (muddy roads) surrounding the project site.
6. Processing is a work activity that does not meet the standards, such as manufacturing a cement and sand mixture with an incorrect composition, installing ceramic tiles that have not been immersed before being installed, excavating with insufficient depth, and so on. As a result, it will have an impact on building faults, necessitating additional repair and rework.
7. Both waiting for material from a storage warehouse to be used in a residential unit and waiting for material from a supplier are waiting activities. While the activity is awaiting the commencement of work, this is frequently due to a delay in the prior phase. All of this waste results in a longer cycle time, which causes work to be completed in a manner that is not in accordance with the contract.

The details of the types of waste in the low-cost housing construction process are listed in Table 5.

Table 5. Details of Types of Waste in the Low-Cost Housing Development

No	Projects	Overproduction (O)	Inventory (I)	Defect (D)	Motion (M)	Transportation (T)	Processing (P)	Waiting (W)
1	Soil Excavation	-	Stacking up excavated soil in several corners which makes the project location not arranged neatly	• Soil excavation is slanted. • The excavation depth for septic tank is only 1 m (should be 2 m) • Septic tank wall is not plastered	Slow movement of workers to dig soil and make septic tank	The transfer of ex-excavated land to other places is hampered because the number of wagons is lacking.	Excavation of foundation & septictank soil not properly measured	Workers are waiting for direction for excavation from the foreman.
2	Foundations & Sloof	• Many pieces of iron for sloof are wasted • Wasted soil, mix cement for pair foundation	Stacking up of unorganized foundation & sloof material: ✓Cement in the warehouse. ✓Sand, gravel, concrete brick outside the warehouse.	• Sloping foundation & sloof • Foundation depth only 40 cm	Workers rest for too long, play phone while working	The transfer of foundation & sloof materials (brick, cement, sand, gravel, iron) is hampered because the number of wagons and logistical workers is absent	• No measurements of the length of foundation & sloof. • Using rusty iron material. • Incorrect technique of mixing cement, sand & gravel. • Using bricks for foundation	• Workers await the foundation & sloof work instructions from the foreman. • Workers are waiting for foundation & sloof material from the storage warehouse

Table 5. Details of Types of Waste in the Low-cost Housing Development Process (Continuation)

4

No	Projects	Overproduction (O)	Inventory (I)	Defect (D)	Motion (M)	Transportation (T)	Processing (P)	Waiting (W)
3	Walls	• Stir in the cement & sand to attach the wasted bricks. • Pieces of iron for wall poles / columns are wasted.	Stacking up materials: ✓Cement inside the warehouse. ✓Sand, gravel, concrete brick outside the warehouse.	• Sloping wall & not elbow	Workers rest for too long, play phone while working	The transfer of wall material (brick, cement, sand, gravel, iron) is hampered because the number of carts and logistics workers is not available	• Does not make the wasterpass to be straight and flat against the wall. • Not using centilever for the corner of the room so as not to tilt. • No accurate measurements are taken to make a wall pole / column.	• Workers are waiting for work directions from the foreman wall. • Workers are waiting for wall material from the storage warehouse
4	Roof Installation	-	Stacking materials for lightweight steel roofs is unorganized neatly outside the warehouse	Leaning	Workers rest for too long, playing mobile while working	The transfer of lightweight steel roof material is hampered because the vehicle and logistic workers are limited	Not using cantilever/ elbows	• Workers are waiting for light steel roof work instructions from the foreman. • Workers are waiting for lightweight steel roof material from the storage warehouse

Table 5. Details of Types of Waste in the Low-cost Housing Development Process (Continuation)

No	Projects	Overproduction (O)	Inventory (I)	Defect (D)	Motion (M)	Transportation (T)	Processing (P)	Waiting (W)
5	Ceiling Installation	Pieces of rafters and plywood for wasted ceiling.	Stacking up of unorganized ceiling material: ✓4x6 plywood, nails in the warehouse	Perforated ceiling	Workers rest for too long, play phone while working	The transfer of ceiling material (wood rafters and plywood) is hampered because the number of wagons and logistical workers is not available	• No accurate measurements are carried out on the rafters and plywood to be used. • Do not use compound for ceiling grout.	• Workers are waiting for ceiling work instructions from the foreman. • Workers are waiting for ceiling material from the storage warehouse
6	Plaster & Acian	Stir in wasted cement & sand.	Stacking up of neatly arranged plaster & accesible material: ✓Cement inside the warehouse. ✓Sand outside the warehouse.	• Fracture	Workers rest for too long, play phone while working	Transfer of plaster and acian material (cement & sand) is hampered because the number of carts and logistics workers is absent	• Does not make the waterpass so that it does not tilt. • Wrong technique of making mortar & sand. • Making acian with the wrong composition of cement and water.	• Workers are waiting for the direction of plaster work & the guidance from the foreman. • Workers are waiting for plaster material & acian from the storage warehouse
7	Ceramics Installation	• Mix cement & sand to remove wasted ceramics	Stacking of ceramic materials that are not arranged neatly: ✓30x30 cement & ceramics inside the warehouse. ✓Sand outside the	• Ceramics broke • Ceramics lifted	Workers rest for too long, play phone while working	The transfer of ceramic materials (ceramics 30x30 uk, cement & sand) is hampered because the number of carts and logistics workers is	• Ceramic tiles are not soaked first. • Do not use waterpass to flatten tiles. • There is no even filling of grout.	• Workers are waiting for work instructions on installing ceramics from the foreman. • Workers are waiting for ceramic mounting materials from the storage

			warehouse.			absent		warehouse

Table 5. Details of Types of Waste in the Low-Cost Housing Development Process (Continuation)

No	Projects	Overproduction (O)	Inventory (I)	Defect (D)	Motion (M)	Transportation (T)	Processing (P)	Waiting (W)
8	Installation of Doors & Windows	-	Stacking wooden door and window piles and doors and accessories in a neatly arranged warehouse	• Doors and windows drag • Doors and windows tilt • Door & window accesories broke	Workers rest for too long, play phone while working	The transfer of wooden door frames and doors is blocked because the number of carts and logistical workers is absent	Installation of door and window frames does not use waterpass.	• Workers are waiting for work directions on the installation of doors & windows from the foreman. • Workers are waiting for door frames and doors & windows from the storage shed
9	Painting & Installation	-	Stacking of paint material, electric cables, NCB, etc.) untidily in a werehouse	• The paint is peeled and bubbled. • Paint has water spots. • Installation of a wall outlet, an untidy switch.	Workers rest for too long, play phone while working	The transfer of paint & installation materials (paint, cables, sockets, NCB, etc.) is hampered because the number of carts and logistics workers is not there	• Do repainting with a fast duration of time. • The wall is not cleaned before painting. • Do not use electric pipes to plant cables in the walls.	• Workers are waiting for work instructions on painting & installation from the foreman. • Workers are waiting for paint & installation materials from the storage warehouse

Table 5. Details of Types of Waste in the Low-cost Housing Development Process (Continuation)

No	Projects	Overproduction (O)	Inventory (I)	Defect (D)	Motion (M)	Transportation (T)	Processing (P)	Waiting (W)
10	Finishing (Paving the front yard of the house)	• Pour the cement & sand for the pavement of the wasted front yard.	Stacking of finishing materials (cement & sand) in a neatly arranged warehouse	Pavement of the yard is not neat	Workers rest for too long, play mobile	The transfer of finishing material (cement & sand) is delayed because the carrier and the logistic workers are unavailable	Wrong technique of mixing cement and sand	• Workers are waiting for the direction of finishing work from the foreman. • Workers are waiting for pavement material for the yard (cement and sand) from the storage warehouse

Table 5 shows that not all types of waste are present in all building activity items. There is no overproduction waste for soil excavation, roof installation, door and window installation, and painting and installation tasks, as can be shown. However, there are various sorts of waste generated by all construction projects (Inventory, Defect, Motion, Transportation, Processing and Waiting). A study conducted by (S Alwi, 2002) on the construction industry in Australia and Indonesia found that waste is caused by many things, such as design changes, lack of trade trade skills, slow decision making, poor coordination between project partners, poor planning and scheduling. poor quality, delays in material delivery to the project site, inappropriate construction methods, poor design, poor quality site documentation, slow revision and distribution of drawings, unclear site drawings, unclear specifications, and individual and collective weather conditions.

According to the findings of a study done by researchers using the Waste Assessment Model (WAM), A waste recapitulation for all waste that happens in each work, as indicated in Figure 4 below.

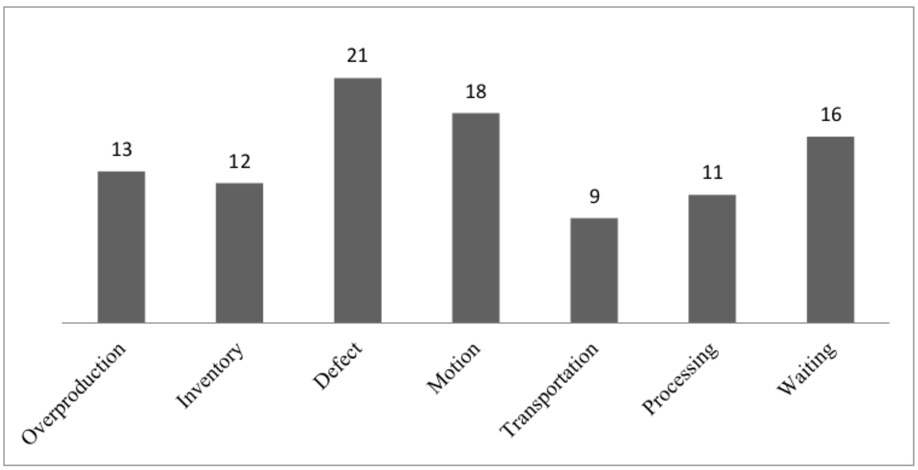

Figure 4. The Amount of Waste Produced During The Construction of Low-Cost Houses

Figure 4 shows that for all works, the kind of waste Defect ranks first with a percentage of 21%, followed by Motion with 18%, Waiting with 16 percent, Overproduction with 13 percent, Inventory with 12 percent, Processing with 11 percent, and Transportation with 9 percent. Defect, Motion, and Waiting are the three categories of waste with the highest proportions throughout the entire process of basic housing creation, according to this data. As a result, contractors should prioritize these three wastes in their evaluations with foremen and field supervisors, and find the best approach to eliminate them. The other four wastes (overproduction, inventory, transportation, and processing) should not be overlooked, as they are incorporated in practically all activities and have the potential to cause project delays.

This occurs owing to two factors: 1. the use of low-quality construction materials that do not satisfy specifications, and 2. insufficient construction worker abilities. Contractors are attempting to minimize the cost of the consumer house construction process in each of these ways. This has a negative impact on the quality of this low-cost dwelling, making it less appropriate for habitation. Consumers typically modify the homes that they have acquired.

CONCLUSION

In the process of creating Low Cost Housing in housing I,II,III, and IV, there are two major issues: a. Delays that occur before each step of construction work, and b. Waste Overproduction, Inventory, Defect, Motion, Transportation, Processing, Waiting that occurs during each stage of construction work. Both have a significant impact on the time it takes to create modest residences for consumers. From the standpoint of the consumer, it will have an impact on the handover process, which is currently experiencing delays. Meanwhile, from the developer's standpoint, this will lead to a loss of consumer confidence and a halt in the construction of houses elsewhere. Meanwhile, it will have an impact on the expenditures incurred by the contractor, particularly labor costs. As a result, efforts to identify and classify building debris are critical. Contractors, foremen, and field supervisors will be able to use it as input. So that preventative actions can be implemented to ensure that all sorts of waste are avoided or minimized in the future.

Preventive steps can be implemented in a variety of methods, beginning with analyzing the work that has been completed and determining why delays and waste may arise through regular observations by field supervisors. This preventive measure must be made by the developer as part of an effort to improve the quality of consumer home development in order for them to have a positive image and their property items to sell successfully in the market.

LIMITATION & FURTHER RESEARCH

This study was not conducted at the level of the developer or material supplier, but rather at the project site, specifically on every job in the process of constructing a consumer's home. Although this study is limited to the process of contractors performing construction work on the site, it can be utilized as a resource for developers, particularly those who would create consumer homes, both low-cost and luxury. Furthermore, this research can be utilized as an input for the central government, allowing it to be evaluated and turned into a legislation that governs the development of low-income housing.

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