

Improvement Recommendation Map Proposed (Future State Map) Housing Construction Process in Low-Cost Housing

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ABSTRACT: Based on the two (two) root causes of waste, it is suggested that improvements be made by implementing a more effective and efficient house construction procedure. The contractor will run the Pull System (Kanban System) for the projected development in question. Production Kanban, Withdrawal Kanban, and Signal Kanban are the three sorts of cards that can be used, and they are all kept in the contractor's office as Kanban Post. To deal with material supply difficulties, logistics operators might use Supermarket and FIFO (First In First Out) systems. All of these ideas are poured into a future state map (Future State Map) of the house-building process in Low Cost Housing.

A Focus Group Discussion was used to validate the suggested future state map, which led to the conclusion that the proposed change could be implemented. However, the Pull System, Supermarket System, and First in First Out (FIFO) presented in the process of creating houses in Low-Cost Housing still need to be improved.

KEYWORDS: *Low-Cost Housing Construction Process, Future State Map*

INTRODUCTION

In Indonesia, business developers and the government work together to build simple housing (Low Cost Housing). Meanwhile, the contractor is hired or an auction process is used to hand over the construction process at the site (site). According to the findings of a study conducted in housing I, II, III, and IV in the Bekasi area of West Java in 2018–2019, there were two major issues that arose during the construction process: Delay and Waste Overproduction, Inventory, Defects, Motion, Transportation, Processing, and Waiting. Delay happens when the first stages of construction work are not completed, and waste develops during the construction process.

These two major issues eventually caused delays in the construction process, delaying the important handover step to consumers. From the standpoint of the contractor, this delay in completion might result in a rise in the cost of the overall production process for building the house, as well as losses. From the developer's standpoint, this will result in a loss of public trust, causing housing unit sales to be impeded or even unsold.

To tackle the two main challenges, this study employs a Value Stream Mapping approach to map problems in the implementation of house construction via the Current State Map and give alternative solutions via the representation of the Future State Map. The Future State Map is based on brainstorming findings and input from parties who are directly accountable for development implementation, such as contractors, foremen, and field supervisors. This is necessary in order to generate more realistic input results that may be utilized as a basis for making decisions to improve the construction process.

LITERATURE REVIEW

1) The Definition of Low Cost Housing

Low Cost Housing, according to SNI 036981-2004, is a place to live that is affordable to low and middle income people. Simple dwellings are not designed to be ideal living quarters for low-income people. Low-Cost housing development is carried out for a land area of not more than 5 (five) hectares and at least 0.5 (zero point five) hectares in 1 (one) location designated for the construction of landed houses, according to Government Regulation No. 64 of the Republic of Indonesia concerning the construction of low-income community housing.

According to Sadana (2014), in Low-Cost housing, there are two main types of houses:

a. Coupled houses,

Also known as coupling houses, are two houses that are built next to each other and each have their own plot. One wall of the main structure merges at a home trailer or coupling house.

b. House in the Row

A row home is a group of dwellings that are connected to one another by a common wall. One or both of the main building's walls are merged with the walls of the other main buildings in a row house.

The row home system unites the housing units into a single entity. Each house in a row has its own land.

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2) The Definition of Future State Map

The Future State Map is the result of process optimization and the application of lean technologies to simplify the value stream by identifying waste, evaluating fundamental causes, and eliminating non-value generating activities (NVA). (Source: Wenchi, 2015). The Future State Map is created by focusing on the primary regions / concentrate on the Current State Map that need to be improved utilizing the ideal pull system (The Ideal Pull System) that we can achieve in the future (Wenchi, 2015).

The Future State Map, which is a one-page map illustrating the process needed to generate a product (Womack (2006) in Lim, et al., (2009)), is the most important aspect of Value Stream Mapping implementation. Meanwhile, VSM is a map that shows the current status of the production system and diagnoses it by evaluating the map and discovering waste causes (NVA). Following that, a road map for eliminating or reducing waste and optimizing value-adding activities (VA) is proposed, as well as an implementation development plan to achieve future conditions (Rother, et al., 2003). As stated in Table 1, the map is drawn using the key VSM principles:

Table 1. VSM principles

No	Principles	Meaning
1	<i>Push Flow</i>	A manufacturing system designed to create the greatest number of units possible while pushing output downstream regardless of client requests. Furthermore, optimization is local and occurs without respect for the broader value stream's effects.
2	<i>Pull Flow</i>	A manufacturing system in which each step only generates what is required for the next one. The procedure involves removing units from the manufacturing process's upstream.
3	<i>Inventory</i>	An activity generates work in progress
4	<i>FIFO Lane</i>	A production line in which the first units to enter the process also leave first. The maximum capacity for units processed is in the FIFO Lane. When this limit is reached, manufacturing must come to a halt.
5	<i>Kaizen Event</i>	Intensive efforts to resolve production difficulties and increase value flow
6	<i>Kanban Cards</i>	Signs used to communicate production requirements or unit recalls between activities
7	<i>Supermarket</i>	Work-in-progress storage that is both controlled and open. This permits a pull flow between the two activities to be formed without having to estimate production demand. It uses the Kanban card system to connect activities.
8	<i>Takt Time</i>	Customer demand determines the target manufacturing rate.

Sumber: Rother, et al., (2003) cit Rosenbaum, et al., (2014).

After a process has been thoroughly documented, it is decided which activities contribute value and which do not. VSM helps comprehend the true value of a process/system by identifying waste and areas for future improvement (Lean Construction Institute, 2015).

The Future State Map's primary goal is to remove waste's core causes and streamline value transfers. Variability is the fundamental issue in housing projects, resulting in swings in output flows. This means that the developer must keep a big number of staff on hand to ensure that the contractor's work flow remains consistent. It is important to develop a Future State Map in four steps to minimise variability: 1) Creating and syncing production flow to takt time, 2) Smoothing production flow, 3) Restructuring work, and 4) Improving operational reliability through standardization and TQM. When comparing the current and future state maps, it can be seen that overall performance is improving due to a stable product flow, task capacity in sync with takt time, and a quick response to changes (Yu, et al, 2009).

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RESEARCH METHOD

Green New Residence, Pondok Afi 1, Pondok Afi 2, and Pakubuwono Residence are four low-cost housing units in Bekasi, West Java, where this study was done. The procedure is depicted in Figure 1 below.



Figure 1. Research Stages

The research was divided into four sections, as shown in Figure 1:

1. Observations are made to ascertain the current state of the house construction process so that the Current State Map can be determined.
2. Following that, Brainstorming is conducted with the parties who are directly responsible for the development's implementation, such as the Contractor and the Field Supervisor. After that, a Future State Map is created, which is a potential solution to the delays and waste that occur.
3. Validation of the future state map created through focus group talks with the Foreman and the Builder's Head.

FINDINGS AND DISCUSSION

1) Current State Map Analysis

The descriptive analysis used to identify the waste generated is backed up by the outcomes of brainstorming sessions with the foreman and field supervisors. The analysis' findings reveal that various wastes arise along the development process' flow, including waste Overproduction, Inventory, Defect, Motion, Transportation, Processing, and Waiting in each job, all of which generate delays in the development process.

To illustrate the existing description of the simple housing development process, all work sequence data, cycle time and delay data, as well as waste identification are analyzed (Current State Map). Figure 2 depicts the findings of the Current State Map portrayal for four Low Cost Housing (Green New Residence, Pondok Afi 1, Pondok Afi 2 and Pakubuwono Residence).

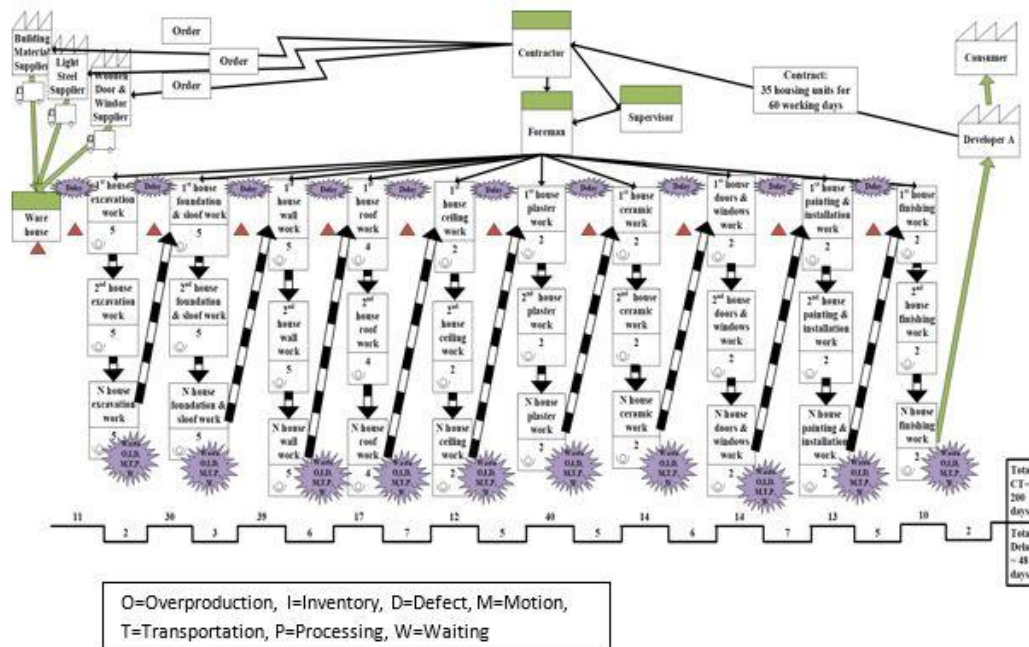


Figure 2. Current State Map

The Low Cost housing's Current State Map clearly demonstrates that there is waste delay and waste OI DMTPW at every step of construction. As a result, effort must be taken to decrease or eliminate the two major wastes.

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2) Depiction of Future State Map

The Future State Map is the result of process optimization and the application of lean technologies to simplify the value stream by identifying waste, evaluating fundamental causes, and eliminating non-value generating activities (NVA). (Source: Wenchi, 2015). The Future State Map is created by focusing on the primary regions / concentrate on the Current State Map that need to be improved utilizing the ideal pull system (The Ideal Pull System) that we can achieve in the future (Wenchi, 2015).

As a result, the Future State Map was created in this study based on the findings of the previous root cause analysis (RCA), which were related to the money factor and the human factor (man). Both of these core problems must be addressed by developing a more efficient and effective work system at the project site utilizing a Pull System to eliminate waste such as overproduction, inventory, defect, motion, transportation, processing, and waiting.

The Pull System is a Lean method for reducing waste in any manufacturing process. By implementing a pull system, we can only start new jobs when a client requests them, lowering overhead and decreasing storage costs. Implementing a pull system essentially means manufacturing things based on actual demand rather than expectations. We can then concentrate on minimizing waste processes, optimizing resources, and reducing the risk of surplus inventory. Furthermore, using a pull system will ensure that work is finished on time (Kanbanize, 2019).

The Pull system that will be implemented will take the following forms:

- (1) Information flow, which will be controlled by the Kanban system, which is a communication system for controlling the flow of activities in the project area.
- (2) Material flow, which entails stationing logistics people in the storage warehouse to control and monitor material availability during the construction process. Personnel in charge of logistics are also expected to put in place:
 - a. a "supermarket" system for storing and controlling inventories.
 - b. The "FIFO" (First In, First Out) system, which regulates material entry and exit.

Figure 3 depicts a description of the planned Future State Map.

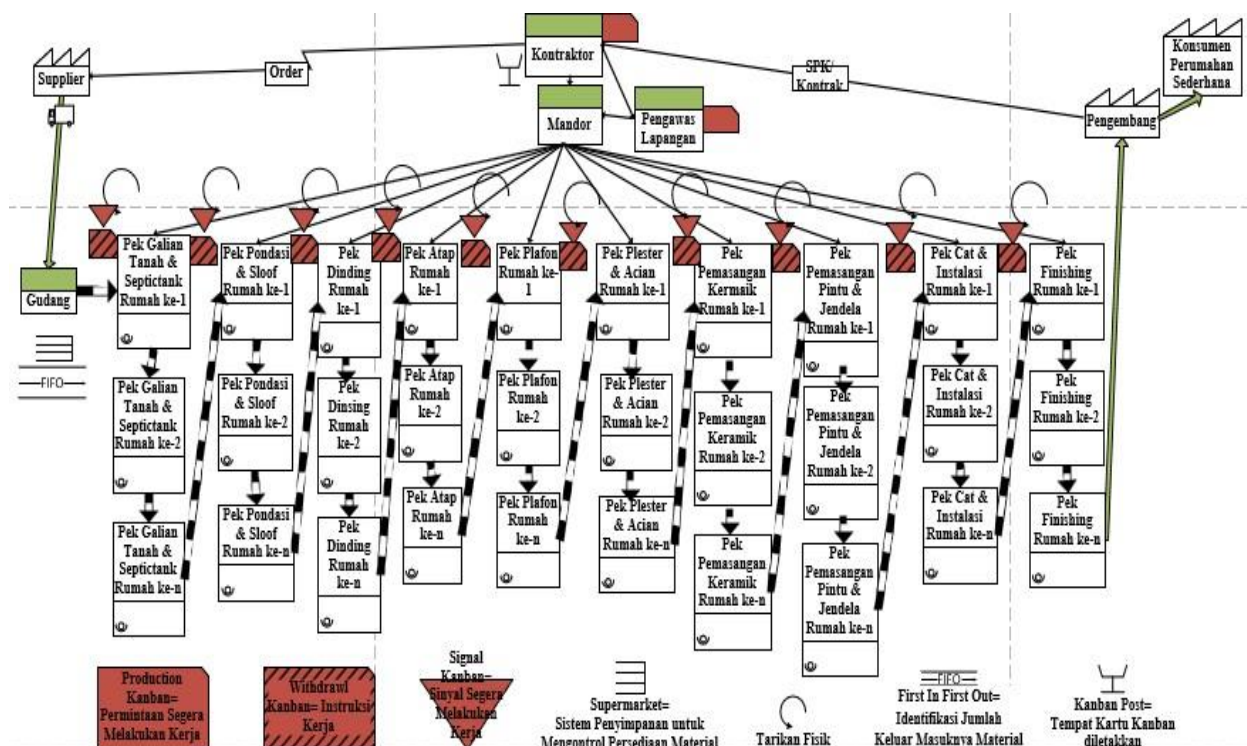


Figure 3. Future State Map of House Construction Process in Low-Cost Housing

Contractors and field supervisors create Kanban in the form of a card for the foreman, with the goal of controlling the progress of building by workers. Kanban cards are created based on work planning and scheduling and are customized for each job (earth excavation through completing) (Figure 3). There are three types of kanban cards:

1. Production Kanban, which is supplied to the field supervisor by the contractor and is used to supervise the house construction process by construction workers headed by the foreman.
2. Withdrawal Kanban is a sort of work implementation instruction card supplied to the foreman by the contractor to quickly guide the task execution.
3. Make a signal Kanban is a signal card that the

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contractor gives to the craftsman's head for each project. As a place to put the kanban card, these three sorts of cards will be pasted on the contractor's office wall (Kanban Post). Every weekend, the contractor must analyze the cards placed by the field supervisor, foreman, and chief handyman each day to determine the challenges that arise throughout the construction process.

It is suggested to install logistics operators in storage warehouses in various locations who are responsible for goods, including storage, availability, distribution to housing units, ordering, reporting to contractors, and reviewing materials received from suppliers, among other things. It is also planned to construct a supermarket system in this warehouse, notably as a location for storing and controlling material inventory, as well as a FIFO (First In First Out) system to govern material admission and leave. So that it is known when the material is running low and needs to be ordered again right away.

3) Validation of Future State Maps Through Focus Group Discussion (FGD)

(1) FGD participant characteristics

A Focus Group Discussion (FGD) was held to validate the proposed Future State Map that had been created. Contractors, field supervisors, foremen, and chief handymen in the Green New Residence, Pondok Afi 1, Pondok Afi 2, and Pakubuwono Residence are among the participants in this focus group. Participants in the focus group who can contribute information from the four housing estates include:

Table 2. Characteristics of FGD Participants

No	Housing	Participants	Position	Education	duration of labor
1	Green New Residence	1	Foreman	S1 Ekonomi	6
		2		SMA	3
		3	Field Supervisor	SMA	5
		4		SD	2
2	Pondok Afi 1	5	Foreman	S1 Ekonomi	5
		6		SMA	3
		7	Field Supervisor	SMP	4
		8		SD	1
3	Pondok Afi 2	9	Foreman	S1 Ekonomi	6
		10		SMP	2
		11	Field Supervisor	SD	4
		12		SD	3
4	Pakubuwono Residence	13	Foreman	S1 Ekonomi	3
		14		SMA	1
		15	Field Supervisor	SD	2
		16		SD	1

Table 2 shows the responses of 16 (sixteen) participants to the suggested Future State Map. This FGD included 6 (six) different types of questions, including 4 (four) questions about Kanban Cards and 2 (two) questions about logistics operators' engagement. The following is a brief description of the question:

A. In the case of Kanban Cards (Production Kanban for field supervisors, Withdrawl Kanban for foreman, and Signal Kanban for head builders), the following is to be noted:

- What are your thoughts on this Kanban Card?
- How would you react if this Kanban Card were used to manage the construction of houses at the housing estate where you work?
- What challenges will you face if you use this Kanban Card?
- Can this Kanban Card help you focus your house-building efforts?

B. It has to do with the logistics operators' engagement.

- Do you understand the role of logistics operators in a construction project?
- Do logistics operators play a role in the construction of modest housing?

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The projected improvement condition map (Future State Map input)'s or input is a supporting element in achieving the desired aims. Clear communication from the Focus Group Discussion implementation is expected to provide a clear image or even useful input for improving the Kanban system's implementation and the proposed engagement of logistics operators.

(2) Future state map validation results

Inputs were received as indicated below based on the outcomes of the Focus Group Discussion (FGD).

A. Concerning the application of Kanban Cards.

- Kanban Cards-related questions.

Table 3. FGD Findings on Kanban Cards

Question	FGD responses			
What are your thoughts on this Kanban Card?	Participant 1	excellent, need to give it a go	Participant 9	excellent, need to give it a go
	Participant 2	excellent	Participant 10	excellent, need to give it a go
	Participant 3	It's good, although it's a little inconvenient.	Participant 11	excellent, need to give it a go
	Participant 4	I'm not sure	Participant 12	I'm not sure
	Participant 5	excellent	Participant 13	excellent, need to give it a go
	Participant 6	excellent	Participant 14	excellent, need to give it a go
	Participant 7	I'm not sure	Participant 15	Excellent
	Participant 8	I'm not sure	Participant 16	I'm not sure
Conclusion	On average, FGD participants responded to Kanban Cards pretty well.			

The Kanban Card was judged to be fairly good based on the findings of the FGD, and some of the participants even suggested trying it out at the project site.

- Questions about implementing Kanban Cards.

Table 4. Results of the Focus Group Discussion on Kanban Card Implementation

Question	FGD responses			
How would you react if this Kanban Card was used to implement house development at the housing complex where you	Participant 1	must be applied in stages	Participant 9	must be applied in stages
	Participant 2	must be applied in stages	Participant 10	must be applied in stages
	Participant 3	must be applied in stages	Participant 11	must be applied in stages
	Participant 4	I'm not sure	Participant 12	I'm not sure

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worked?	Participant5	wonderful, but must be implemented gradually	Participant13	must be applied in stages
	Participant6	wonderful, but must be implemented gradually	Participant14	must be applied in stages
	Participant7	must be applied in stages	Participant15	must be applied in stages
	Participant8	I'm not sure	Participant16	must be applied in stages
Conclusion	The FGD participants, on average, stated that they would need to deploy the Kanban Card in stages.			

According to the FGD's findings, when asked about implementing Kanban Cards in project locations where participants work, they typically provide answers that must be adopted gradually. Because the characteristics of the project location and developer policies in each housing are relevant.

- Concerns concerning the Kanban Card's implementation complexity.

Table 5. Results of the Focus Group Discussion on Kanban Card Difficulty

Question	FGD responses			
What challenges will you face if you use this Kanban Card?	Participant1	It's a little challenging for me because I'm not used to it.	Participant9	It's a little challenging for me because I'm not used to it.
	Participant2	It's a little challenging for me because I'm not used to it.	Participant10	It's a little challenging for me because I'm not used to it.
	Participant3	A little challenging	Participant11	difficult to implement
	Participant4	complicated	Participant12	difficult to implement
	Participant5	It's a little challenging for me because I'm not used to it.	Participant13	It's a little challenging for me because I'm not used to it.
	Participant6	It's a little challenging for me because I'm not used to it.	Participant14	It's a little challenging for me because I'm not used to it.
	Participant7	It's a little challenging for me because I'm not used to it.	Participant15	It's a little challenging for me because I'm not used to it.

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	Participant 8	A little challenging	Participant 16	It's a little challenging for me because I'm not used to it.
Conclusion	Because they were unfamiliar with the situation, the participants delivered a somewhat convoluted response on average.			

After modeling the usage of Kanban Cards at the project site, participants on average said it was difficult to use them, according to the results of the FGD. However, they usually explain that this occurs because they are not used to utilizing it.

- Concerns about Kanban Cards' advantages.

Table 6. Results of a Focus Group Discussion on the Advantages of Kanban Cards

Question	FGD responses			
Can this Kanban Card help you focus your house-building efforts?	Participant 1	Yes	Participant 9	Yes
	Participant 2	Yes	Participant 10	Yes
	Participant 3	Yes	Participant 11	Yes
	Participant 4	I'm not sure	Participant 12	Yes
	Participant 5	Yes	Participant 13	Yes
	Participant 6	Yes	Participant 14	Yes
	Participant 7	Yes, however it's a little tough to put into practice.	Participant 15	Yes, however it's a little tough to put into practice.
	Participant 8	I'm not sure	Participant 16	Yes, however it's a little tough to put into practice.
Conclusion	Kanban Cards, on average, participants said may help them focus their work.			

According to the findings of the focus group, Kanban Cards can help them do a better job, however they are challenging to deploy.

- B. It has to do with the logistics operators' engagement.
- It has to do with the involvement of the logistics operators.

Table 7. The Findings of the FGD on Logistic Operators and Their Functions

Question	FGD responses			
Do you understand the role of logistics	Participant 1	Yes	Participant 9	Yes

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operators in a construction project?	Participant 2	Yes	Participant 10	Yes
	Participant 3	Yes	Participant 11	Yes
	Participant 4	Yes	Participant 12	Yes
	Participant 5	Yes	Participant 13	Yes
	Participant 6	Yes	Participant 14	Yes
	Participant 7	Yes	Participant 15	Yes
	Participant 8	Yes	Participant 16	Yes
Conclusion	On average, participants said that they were aware of logistics operators.			

Table 7 shows that all participants understood logistics operators, based on the results of the focus group. Furthermore, they comprehend the role of logistics operators in a construction project.

- Concerns about the need for logistics operators to be involved.

Table 8. Results of the FGD on the Need for Logistics Operator Involvement

Question	FGD responses			
Are logistics operators required in a modest dwelling construction project?	Participant 1	Yes	Participant 9	there's no necessity
	Participant 2	Yes	Participant 10	Yes
	Participant 3	Yes	Participant 11	Yes
	Participant 4	Yes	Participant 12	Yes
	Participant 5	Yes	Participant 13	Yes
	Participant 6	Yes	Participant 14	Yes
	Participant 7	there's no necessity	Participant 15	Yes
	Participant 8	Yes	Participant 16	Yes
Conclusion	Involving logistics operators was deemed necessary by the majority of participants.			

According to Table 8, the majority of participants agreed that logistics operators should be included. Given the high quantity of materials required in the construction of dwellings, particularly when many housing units are constructed at the same time.

Based on the findings of the focus group discussion about the use of Kanban Cards in the construction of simple housing, it is possible to infer that Kanban Cards can be used in general, but only gradually. This means that the developer must assess the

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condition of the contractor who will implement the Kanban Card, as well as whether or not he has prior expertise building houses. Furthermore, all FGD members decided to include logistics operators in the implementation of consumer house development in general. Mostly concerned with material placement on the job site.

CONCLUSION

Based on the two (two) root causes of waste, it is suggested that improvements be made by implementing a more effective and efficient house construction procedure. The contractor will run the Pull System (Kanban System) for the projected development in question. Production Kanban, Withdrawl Kanban, and Signal Kanban are the three sorts of cards that can be used, and they are all kept in the contractor's office as Kanban Post. To deal with material supply difficulties, logistics operators might use Supermarket and FIFO (First In First Out) systems. All of these ideas are poured into a future state map (Future State Map) of the house-building process in basic housing (Low Cost Housing).

FURTHER RESEARCH

The findings of this study are quite valuable, particularly for contractors who will be involved in the development of low-cost homes. Because it implements the Pull System (Kanban System), a cost-effective and efficient building approach, the process of constructing consumer homes becomes smoother and is predicted to be completed on time (according to the SPK provided by the developer). Other effects of implementing the Pull System are also predicted to have an impact on the quality of the final housing structures.

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