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Evaluation of Local Management System towards Application of Kaizen to Increase Productivity in the Precast Production Process

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Abstract— *PT. Merak Jaya Pracetak is one of the largest precast concrete industries in East Java, where to realize this vision, the company continues to develop products and increase productivity by improving service quality, production processes and product delivery to customers with minimum costs and the right delivery time. To achieve that goal, a kaizen method is needed to eliminate 3M (muda, mura, and muri) and manage activities that do not add value to the production process. Research begins with a description of the company using field observations. Waste was analyzed by questionnaires and check sheets, then analyzed with Pareto diagrams, then analyzed for causal analysis with five reasons for analysis and analyzed with fish bone diagrams. Next, do an evaluation using this brainstorming to improve and do the last with 5R or 5S in the work area. The results showed that 3M was the most critical which affected inventory productivity (29.00%), movement (19.00%), and transportation (17.00%). The effect of implementing kaizen in increasing savings, the presence of time savings in your production process u-ditch 800mm x 1000mm x 1200mm (t = 10cm) as many as 12 units amounting to 6000.90 seconds (100 minutes) or around (18.69%) and production processes square pile 20cm x 20cm x 4m as many as 120 units amounting to 7298.48 seconds (121 minutes) or around (18.61%).*

Keywords— *Kaizen, 3M, Five Why Analysis, Seven Tools of Quality, Brainstorming, 5R or 5S.*

I. INTRODUCTION

The construction industry is one of the important economic sectors in Indonesia which is growing rapidly. The growing construction industry has led to power competition to meet customer demand, so some important interests arise that require good management to improve effectiveness, efficiency and productivity.

The problem that often occurs is the existence of activities that do not provide added value, or what is called 3M (muda, mura, and muri). According to (Yudakusumah, 2012; Fakhurohman, 2016; Soesilo, 2017), waste in the construction industry such as poor equipment management, damage, defects, unnecessary shifts, overproduction, slow transportation processes, unnecessary preparation, procedural errors and information, and bad external conditions (environment and weather). Waste that occurs will affect the level of productivity. The decrease in productivity is generally caused by 7 waste / TIMWOOD which are not productive, such as transportation, inventory, motion, waiting, overprocess, overproduction, and defects.

PT. Merak Jaya Pracetak Wonorejo is one of the largest ready mix and precast concrete industries in East Java that has a vision to make a company that can be trusted in ready mix and precast and guarantee customer satisfaction is "Being the main in quality and service in the concrete and split industry" . In an effort to achieve this goal, a method is needed to increase product value added, reduce waste during production, and shorten production time requirements. One of them is by applying Kaizen. This term was first conceived by (Ohno, 1998) which states that Kaizen is a strategy that is used to continually improve towards better production processes, product quality, reduce operating costs, reduce waste to increase job security.

This research will identify and reduce 3M (muda, mura, and muri) that occur in the u-ditch and square pile production processes. Some of the things that need to be understood in this study are how the production process flows, what causes the emergence of waste, how the right improvements are proposed to minimize or reduce waste, and stimulate or conduct 5R or 5S experiments in the workplace, thereby increasing work productivity in the company.

II. LITERATURE REVIEW

A. *Indonesian work culture*

The Indonesian work culture needs to be maintained because the moment of independence day celebration reminded to appreciate the long journey of Indonesia to become a country known today. Amid the swift flow of change towards modernity, it does not mean that all Indonesian culture can be considered obsolete. As a young professional, it must be able to live up to the positive values of the Indonesian nation starting from the workplace. The following is a simple, but important, 'throwback' that can be done, namely mutual cooperation to encourage team spirit, mutual respect for building good cooperation, and deliberation so that the steps are more directed.

B. *Kaizen*

Kaizen is a term in Japanese which means "continuous improvement" (Imai & Heymans, 2000). According to (Ohno, 1998), Kaizen is a strategy that is used to continually improve towards better production processes, product quality, reduce operational costs, reduce waste to increase job security.

C. 3M (muda, mura, and muri)

According to (Imai, 1998), there are 7 kinds of 3M categories (muda, mura, and muri), namely transportation, inventory, motion, waiting, overprocess, overproduction, and defect. muda means waste or a process that does not provide value added (non value add), mura means inequality or inconsistency that can cause waste, and muri is interpreted as excessive load or burden that exceeds the limits of the ability of resources (labor, machinery, processes) that can cause waste. The type of activity in the company is divided into three, namely value-added activities (VA), non-value-added activities (NVA), and activities not value added but needed (NNVA).

D. 5R or 5S movement

5R movement (ringkas, rapi, resik, rawat, and rajin) or 5S (seiri, seiton, seiso, shitsuke, and seiketsu). The concept of 5R or 5S is basically a process of changing attitudes by applying structuring, cleanliness and discipline in the workplace (Imai, 1998).

E. PDCA (Plan, Do, Check, and Action)

The first step of kaizen is to apply the PDCA cycle (plan, do, check, and action) some of the tools that guarantee the continuity of kaizen (Imai, 2005: 4). This is useful in realizing policies to maintain and improve or improve standards. This cycle is the most important concept of the process.

F. 5W + 1H (What, Who, Why, Where, When, and How)

5W + 1H is basically a method used to conduct investigations and research on problems that occur in the production process.

G. Five Why Analysis

Five why analysis is a method for finding the roots of a company. Usually what appears is symptoms are not a real problem.

H. Seven Tools of Quality

Seven tools of quality are 7 (seven) basic tools used to solve problems faced by production, especially on problems related to quality. 7 basic quality control tools were first introduced by (Ishikawa, 1968). The seven tools are check sheets, control charts, fishbone diagrams, pareto diagrams, histograms, scatter diagrams and stratification (Kalla, 2018).

III. RESEARCH CONCEPT FRAMEWORK

A. Research Conceptual Framework

The conceptual framework is the flow of research that shows the variables that influence and are influenced. In other words, this conceptual framework will show the factors that exist in the research variable. The framework of the research concept is a description of the relationship between the concept / variable one to the concept / other variables, from the problems that are being or will be studied.

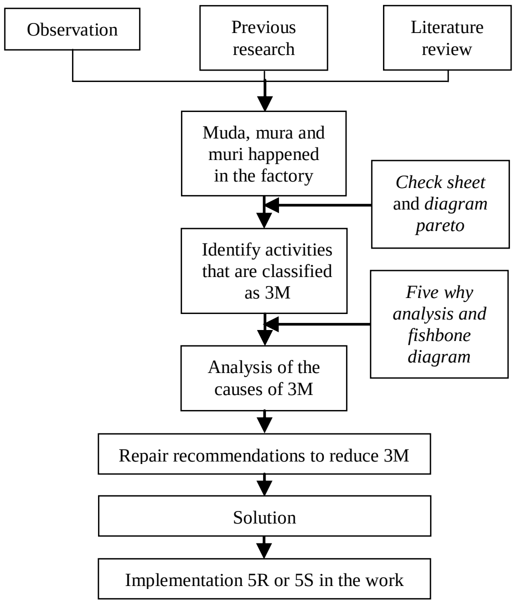

Fig. 1. Alghoritm conseptual framework of research

B. Research Hypotesis

- Non-value-added factors can affect the increase in productivity in the precast production process.
- The application of the Kaizen method can provide remedial solutions to reduce (muda) waste, differences (mura), and tension (muri) in the factory.
- Common mistakes in local management only see the quality of output, if you use the application of kaizen for input, it will increase productivity in the precast production process.

IV. RESEARCH METHOD

A. Data Collection Phase

The method of data collection is a process, where data is collected for research purposes. The data collection methods are as follows:

- Direct interview with related parties at PT. Merak Jaya Pracetak.
- Conduct direct observation / observation to obtain data relating to increased productivity.
- Disseminate questionnaires for identification of 3M in the precast production process.
- Conduct library research activities.

B. Data Processing Phase

Based on the data that has been collected, the next step is to do data processing. The steps are as follows:

- This check sheet is done to check the precast production process, making it easier to collect data in the precast production process.
- Data on waste, difference, and tension were obtained from the results of questionnaires that were filled out by competent production actors.

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C. Analysis and Evaluation Phase

This stage is a stage, where an analysis and evaluation process is carried out from the results of data collection and processing that have been obtained. This stage is the stage of improvement of the precast production process after 3M is identified. The following are the stages of the improvement process carried out, namely:

- Identification of the root causes of 3M generated based on the results of mapping with 7 (seven) tools (seven tools) of quality, check sheet, histogram, pareto diagram, fishbone diagram, scatter diagram, stratification, and chart control chart. After that, an analysis was conducted to find out the cause of 3M.
- Recommendations for improvement, namely by formulating proposed improvements to reduce 3M to achieve the desired improvement.

V. RESULTS AND DISCUSSION

A. Current Time Flow

In addition to direct interviews with relevant parties to obtain information data and total time requirements for ordering, and field observations by observing and recording the time needed for each process with the help of a stopwatch and taken from different days for 30 days, where in 1 day do 2 -3 observations for 8 hours, then taken the total average of each average per day.

TABLE I. U-ditch and square pile production process times

JOB ACTIVITIES	h	m		s		ms
RECAPITULATION OF U-DITCH WORK TIME						
A. U-Ditch Reinforcement Iron Fabrication Work	1 hour	36	:	29	.	19
B. U-Ditch Reinforcement Componen Assembly Work		32	:	44	.	12
C. U-Ditch Casting Work	1 hour	41	:	36	.	97
D. Appointment Work, Repair, and Stockyard		32	:	43	.	91
Total (6 unit)	4 hour	21	:	31	.	29
Total (12 unit)	8 hour	43	:	2	.	58
RECAPITULATION OF SQUARE PILE WORK TIME						
A. Middle Spiral Crossing Work (4 m 50 Rounds)		44	:	36	.	12
B. Spiral Crossing Work for Embed Plate (4 m = 7 Rounds)		45	:	25	.	76
C. Angkur Embed Plate Reinforcemer Work (40cm)	1 hour	36	:	10	.	44
D. Embed Plate Reinforcement Component Assembly Work		54	:	34	.	48
E. Square pile casting work	4 hour	32	:	48	.	96
F. Product Lifting, Product Repair, an Stockyard jobs	2 hour	14	:	37	.	53
Total (120 unit)	10 hour	45	:	47	.	29

Description: h = Hours
m = Minutes
s = Seconds
ms = Milliseconds

B. 3M identification (muda, mura, and muri)

The next step after mapping is identification of 3M by check sheet and distributing questionnaires filled out by respondents who are directly involved in the u-ditch and square pile production processes. This questionnaire is given 3M's understanding in general and filling is accompanied by the researcher, so that the respondent understands the purpose of the questionnaire.

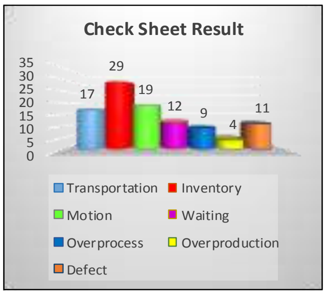
TABLE III. Seven waste identification results from the check sheet

Waste	*Branistorming Area* I	II	III	IV	V	*Score*	*Cumulative Score*
Transportation	4	4	2	4	3	17	17
Inventory	6	5	5	6	7	29	46
Motion	6	3	3	3	4	19	65
Waiting	1	1	1	4	5	12	77
Overprocess	1	2	1	2	3	9	86
Overproduction	2	0	0	1	1	4	90
Defect	1	2	2	3	3	11	101

TABLE III. The results of identification of 7 waste from the questionnaire

Waste	Respondent Score: Arif	Agus	Suparno	Estu	Suwarno	Chalid	Gatot	Zainal	Aris	Harianto	*Score*	*Cumulative Score*
Transportation	3	4	1	5	3	2	2	2	2	2	26	26
Inventory	4	3	1	2	2	2	4	5	4	5	32	58
Motion	4	4	1	1	3	0	1	5	4	5	28	86
Waiting	1	4	2	1	1	1	2	3	4	4	23	109
Overprocess	4	3	1	2	0	2	1	2	1	1	17	126
Overproduction	1	3	1	2	1	1	0	1	0	0	10	136
Defect	4	1	1	3	4	2	3	1	1	1	21	157

Based on the results of identification of waste from the check sheet and questionnaire in the table above, a histogram can be drawn.



a) check sheet results

b) questionnaire results

Fig. 2. Seven waste identification results with a check sheet and questionnaire

C. Analysis of Pareto Charts

This concept is used to create diagrams that show the most dominant wastage. The waste percentage formula is as follows:

TABLE IV. Percentage of waste check sheet

Waste	*Score Percent*	*Cumulative Score Percent*	Ranking
Transportation	17%	17%	3
Inventory	29%	46%	1
Motion	19%	64%	2
Waiting	12%	76%	4
Overprocess	9%	85%	6
Overproduction	4%	89%	7
Defect	11%	100%	5

TABLE V. Percentage of waste questionnaire

Waste	*Score Percent*	*Cumulative Score Percent*	Ranking
Transportation	17%	17%	3
Inventory	21%	37%	1
Motion	18%	55%	2
Waiting	15%	70%	4
Overprocess	10%	80%	6
Overproduction	6%	87%	7
Defect	13%	100%	5

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Based on the weighting results in the table above, it can be described the ranking with the pareto chart.

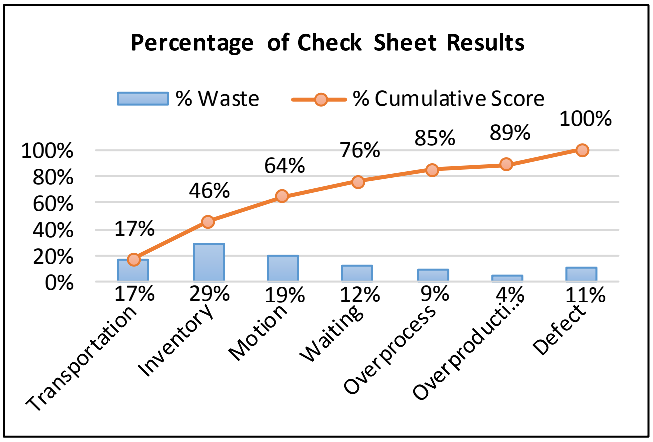

Fig. 3. Pareto diagram results of the check sheet

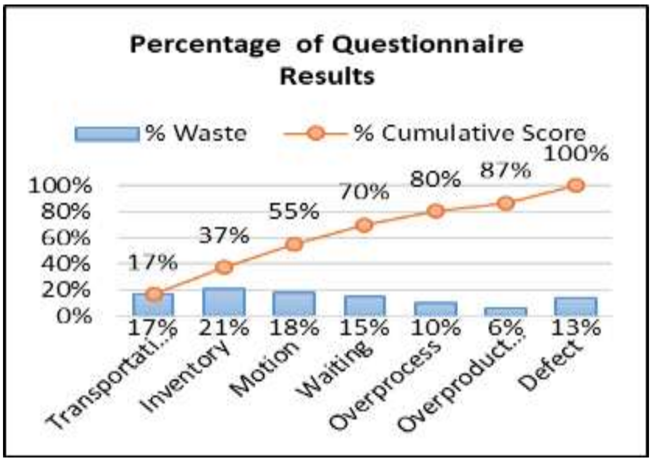

Fig. 4. Pareto diagram of the results of the questionnaire

Based on the results of the identification of 7 waste from the check sheet in the tables and figures above, there were 3 highest scores, namely inventory (29.00%), motion (19.00%), and transportation (17.00%).

D. Root Cause Analysis (RCA) with Five Why Analysis and Fishbone Diagram

In this study, the method used for root cause analysis was five why analysis and fishbone diagram. The basic function of this method is to identify the causes that might occur, which then separates the root cause. The first step in this method is the identification of the main problems based on the biggest critical waste of waste identification results. The main problems identified (a1) are inventory, motion, and transportation. The second step (a2) is to identify the factors that cause inventory, motion and transportation problems, including material, machinery, people, methods, and the environment. After identifying the causes of the problem, then the third step (a3) is finding the root cause of each factor using the 5 why analysis method.

TABLE VI. Results of five why analysis inventory

Causative factor	*Why 1*	*Why 2*	*Why 3*	*Why 4*	*Why 5*
Material	Lack of material and product handling	Material and product storage is not suitable	Material and product storage methods do not yet exist	Materials and products are mixed in the work area & stockyard	Messy materials and products in the work area & stockyard
Machine	Placement of the machine is not in place	Where the tool is not in place			
Man	Works not optimally in the production process	Less skills in structuring materials and products	Workers work at will	Lack of direction in work	
Method	Material and product arrangement methods do not yet exist	There are no work procedures on materials and products	Work methods have not been maximized in improving performance		
Environm ent	The workplace is less comfortable at work	Hot and rainy weather at work			

TABLE VII. Results of five why analysis motion

Causative factor	*Why 1*	*Why 2*	*Why 3*	*Why 4*	*Why 5*
Material	Workers have difficulty taking raw materials that are piled up	Retrieving raw materials and old products	The worker path is blocked by material	Lack of material and product handling	
Machine	Works not according to engine capacity	The work of cutting, bending and gantry cranes is slow	Cutting, bending and gantry cranes stop		
Man	Works not optimally in the production process	Less skill in producing	Workers work at will	Lack of direction before work	Freelance rs / bulk workers
Method	Job information is unclear and late	There are no work procedures in the production process	Work methods have not been maximized in improving performance		
Environme nt	The workplace is less comfortable at work	Hot and rainy weather at work	Small work area		

TABLE VIII. Results of five why analysis transportation

Causative factor	*Why 1*	*Why 2*	*Why 3*	*Why 4*	*Why 5*
Material	*Forklift difficulties in lifting raw materials*	The layout of material and product layout is bad	*Forklift difficulties in lifting materials*		
Machine	Machine placement is less efficient and less effective	Leaking forklift tires	*Broken / stopped vibrator*	*Broken / stopped Gantry crane*	
Man	Workers' ability to work is lacking	Works not according to work procedures	Works not optimally in the production process		
Method	There are no work instructions	Lift square pile with a forklift	Manual material removal		
Environment	Narrow line of workers and forklifts	The amount of waste on the forklift line	The forklift lane is flooded		

The next step is to make fishbone diagrams for inventory, motion, and transportation.

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Fig. 5. Fishbone diagram for waste of inventory

Fig. 6. Fishbone diagram for waste of motion

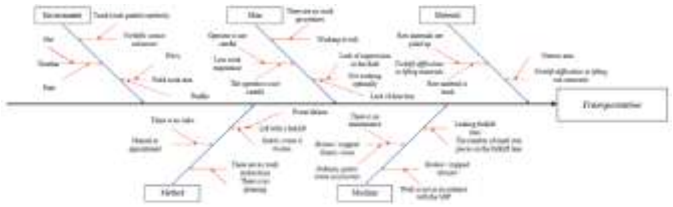

Fig. 7. Fishbone diagram for waste of transportation

E. Evaluation and Improvement

Proposed improvement recommendations are expected to reduce or eliminate the waste that occurs. Following are the proposed recommendations for improvements that are related to the problems of waste inventory, motion, and transportation

TABLE IX. Proposed improvement in inventory

Waste	Category	Repair Recommendations
Inventory	Material	Effective and efficient material area arrangement with 5R or 5S implementation
		Making label boards for material areas
		Making work procedures
	Machine	Making a layout with the concept of 5R or 5S
		Making toolbox tools
	Man	Increase worker motivation
		Hold job training
		Making work procedures
	Method	Making procedures with the concept of 5R or 5S
	Environment	Implement 5R or 5S in the work environment area

TABLE X. Proposed improvement in motion

Waste	Category	Repair Recommendations
Motion	Material	Making insulation between raw materials
		Making a layout with the concept of 5R or 5S
	Machine	Making information about the maximum engine power
		Hold regular maintenance
	Man	Increase worker motivation
		Hold job training
		Making work procedures
	Method	Making clear and easy to understand information
		Making procedures with the concept of 5R or 5S
	Environment	Implement 5R or 5S in the work environment area

TABLE XI. Proposed improvement in transportation

Waste	Category	Repair Recommendations
Transportation	Material	Effective and efficient material area arrangement with 5R or 5S implementation
	Machine	Cleaning the remaining material at the forklift lane area
		Hold regular maintenance
	Man	Increase worker motivation
		Hold job training
		Making work procedures
	Method	Hold routine maintenance on gantry cranes
		Making transportation equipment (arko) to move material
		Making work SOP
	Environment	Flatten the area with landfill or casting transportation lines
		Implementation 5R or 5S in the work environment area

Proposed recommendations for improvement with the 5R or 5S given are expected to help companies overcome the waste that occurs and become a reference for companies in developing continuos improvement.

F. VA, NVA and NNVA activities

Analyze the proportion of each activity that adds value (VA), does not add value (NVA), and does not add value but is needed (NNVA). Based on observations in areas I, II, III, IV, and V.

TABLE XII. Percentage of VA, NVA, and NNVA

Activity Type	VA	NVA	NNVA
Area (I) Iron fabrication	10 (48%)	3 (14%)	8 (38%
Area (II) Warehouse Roll Bender	10 (53%)	5 (26%)	4 (21%)
Area (III) Reinforcement Assembly	4 (33%)	5 (42%)	3 (25%)
Area (IV) Casting, Stockyard, and U-ditch Molding	13 (48%)	7 (26%)	7 (26%)
Area (V) Casting and Stockyard Square Pile	18 (51%)	9 (26%)	8 (23%)
Total	55 (49%)	29 (25%)	30 (26%)

G. 5R / 5S Implementation Guide

The implementation of 5R / 5S in a company is carried out using a guide asking 5W + 1H.

TABLE XIII. Guide to implementing 5R / 5S using 5W + 1H

No.	Question	Result
1	*Who*	Employees and workers
2	*What*	Improving the work environment based on the 5R or 5S concept, ringkas (seiri), rapi (seiton), resik (seiso), rawat (seiketsu), dan rajin (shitsuke)
3	*Where*	PT. Merak Jaya Pracetak Wonorejo
4	*When*	1 December 2018 - 31 March 2019
5	*Why*	Creating an optimal work culture with the aim of increasing effectiveness and increasing work productivity so that the satisfaction of Merak Jaya Precast companies can be maintained continuously
6	*How*	Implement kaizen based on 5R / 5S cultural guidelines through sorting materials and goods based on the level of need, organizing the work environment functionally, conducting periodic cleaning, being responsible and disciplined in carrying out work activities continuously

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H. 5R or 5S Evaluation Stages

This evaluation phase is done by designing 5R or 5S and comparing the result photo before and after implementation.

R1-RINGKAS-S1-Seiri

- Criteria for selecting materials and goods.
- Collecting material and goods data in areas I, II, III, IV, and V.
- Determine actions taken for each group of materials and goods.

Fig. 8. Before and after ringkas (seiri)

R2-RAPI-S2-Seiton

- Make a grouping of raw materials, semi-finished goods, and finished goods according to frequency.
- Designing layout areas I, II, III, IV, and V
- Providing storage space for the remaining pieces of material.
- Providing spiral storage / semi-finished goods.
- Giving a line
- Give identification / label board

Fig. 9. Before and after rapi (seiton)

R3-RESIK-S3-Seiso

- Record the number of cleaning equipment that is available and functioning.
- Cleanliness criteria.
- Responsibility in each area.
- Method of resik (seiso).

Fig. 10. Before and after resik (seiso)

R4-RAWAT-S4-Seiketsu

- Make standards in the work area.
- Daily inspection.
- Inspection by management.
- This inspection is carried out by management.

Fig. 11. Before and after rawat (seiketsu)

R5-RAJIN-S5-Shitsuke

- Habit of the 5R / 5S procedure.
- Carrying out "10 minutes 5R / 5S" activities

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Fig. 12. Banner 5R or 5S rajin (shitsuke)

I. Comparison of Time Before and After Kaizen Implementation

TABLE XIV. Comparison of time before and after 5R / 5S implementation

Production process	Before Kaizen Implementation	After Kaizen Implementation	Difference
U-ditch (12 units) 800x1000x1200mm t = 10cm	32112.38 (s)	26111.48 (s)	6000.90 (s)
Square pile (120 units) 20cmx20cmx4m	39217.83 (s)	31919.35 (s)	7298.48 (s)

Description: s = Seconds

VI. CONCLUSION

Based on the results of research on evaluating the local management system towards the application of kaizen to increase productivity in the precast production process, the following can be concluded:

1. Dominant factors that can affect productivity increase are inventory (29.00%), motion (19.00%), and transportation (17.00%).
2. The way to improve to reduce 3M that occurs is:
   a. Repair recommendations for inventory
   Stimulus 5R or 5S in the work area, making layouts with the concept of 5R or 5S, making label boards for material areas and product areas, making work procedures, making toolboxes for equipment, increasing work motivation, and conducting job training.
   b. Repair recommendations for motion
   Stimulus 5R or 5S in the work area, making insulation between raw materials, making layouts with the 5R or 5S concept, making information about the maximum power of the machine, conducting routine maintenance of the machine, increasing workers' motivation, conducting job training, and making work procedures.
   c. Repair recommendations for transportation
   Stimulus 5R or 5S in the work area, clean up the remaining material in the forklift lane area, carry out routine maintenance, increase workers' motivation, conduct job training, make work procedures, make transportation equipment to move material, and flatten the area with urug or casting ground on the lane transportation.
3. The effect of applying kaizen in increasing productivity achievement in the precast production process is:
   a. The time before the implementation of kaizen in the production process of u-ditch 800mm x 1000mm x 1200mm (t = 10 cm) as many as 12 units is 32112.38 seconds and after the implementation of kaizen is 26111.48 seconds, there is a time savings in the production process of 6000.90 seconds (100 minutes) or around 18.69%.
   b. The time before the implementation of kaizen in the production process of square pile 20cm x 20cm x 4m as many as 120 units is 39217.83 seconds and after the implementation of kaizen is 31919.35 seconds, there is a savings in production process time of 7298.48 seconds (121 minutes) or around 18.61%.

VII. SUGGESTION

From the results of the research, the suggestions that can be conveyed by researchers are as follows:

1. There needs to be a review in the selection of equipment accessories, in this case the gantry crane where this tool is a vital tool that serves as the lifting of square pile products or by carrying out routine maintenance on gantry cranes, there by reducing damage to the gantry crane.
2. Provision of provisions on productivity to employees and labor will support the achievement of an effective and efficient production system.
3. In stimulus 5R or 5S, it should be noted, how the concept of 5R or 5S continues to run in the company until so on, so it is known how much influence the application of 5R or 5S on the company in the long term.

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