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The Improvement of Overhaul Desalination Plant Pltgu Duration in Pt. Pjb up Gresik Using Approach of Lean-Six Sigma Method

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Abstract: The Desalination Plant is a unit that processes seawater for raw water for electricity generation. This sea water will be converted into fresh water by using evaporation and condensation systems. Routine maintenance is needed for the readiness, reliability and efficiency of the generator equipment. Therefore an overhaul is needed to restore its performance. One of the problems in the overhaul project is the duration of project implementation that is not as planned. The purpose of this study is to identify Non-Value Added activities as well as the presence of waste that causes the overhaul process to not be completed on time. To identify and reduce waste, researchers use the Lean-Six Sigma method approach (Andarnis & Singgih, 2011; Li, Walton, & Apel, 2007). The Lean method is used to identify and reduce waste that arises while the Six Sigma Method is used to determine the research steps by utilizing DMAIC namely Define, Measure, Analyze, Improve and Control. With the Value Stream mapping method, a new work process design is stated in the form of Future State Mapping (FSM) by eliminating the 4 highest wastes, namely Defects, waiting, Extra processing, Non Utilized Talent. Then the FSM design was simulated with ARENA software. Based on the simulation results of the base model and FSM design, it was shown that the proposed activity improvements could reduce the duration of the desalination plant overhaul from 25.64 days to 22.85 days or 10.88%.

Keywords: Desalination plant, DMAIC, Lean-six sigma, Overhaul, Waste

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INTRODUCTION

In the UP Gresik PLTGU, fresh water is an important component in the generating cycle. This fresh water is used for the cooling process of generating equipment and as fillers of HRSG (Bore, 2008). This fresh water is produced at the Desalination Plant Unit. The Desalination Plant is a support unit that functions to process seawater into fresh water by evaporation to eliminate the salt content (George, Rowlands, Price, & Maxey, 2005). Overhaul is needed to restore the performance and condition of the unit so that it can operate optimally until the next period of overhaul. According to Moubray (1997), overhauls are maintenance activities in the form of replacing machine components simultaneously or in whole (also planned overhauls such as annual or biennial overhauls, or an expansion of production capacity). Frogera, Gendreauc, Mendozab, Pinsona, and Rousseauc (2016) also states that the major work that must be completed in the maintenance of the power plant is inspection, troubleshooting (setting), setting (adjustment), repair (repair), calibration, and function tests (functional test). Therefore, an overhaul project is planned for the desalination plant in the power plant unit. The overhaul project is planned to be completed within 25 days, but the realization of the overhaul project is completed within 27 days (Keith, 2002). The desalination plant unit is owned by UP Gresik and the overhaul project is carried out by UPHT (Eastern Maintenance Unit). This study aims to identify potential waste that arises so that this overhaul project is not completed on time (Schwalbe, 2004). Waste is defined as something that is not useful to the product, be it goods or services. Waste referred to in the field of maintenance (Hosban, 2016; Dasig Jr, 2017; Sumiarto, 2013; Willy, 2017) is: Defects, Overpproduction,

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waiting, transportation, inventory, motion, over processing, non utilizing employees. Work Breakdown Structure (WBS) overhaul projects can be seen in Figure 1. There are 3 (three) fields that will be identified, namely the Field of Mechanical, Electric Field, Control Instrument Field (Mobley & Higgins, 2008).

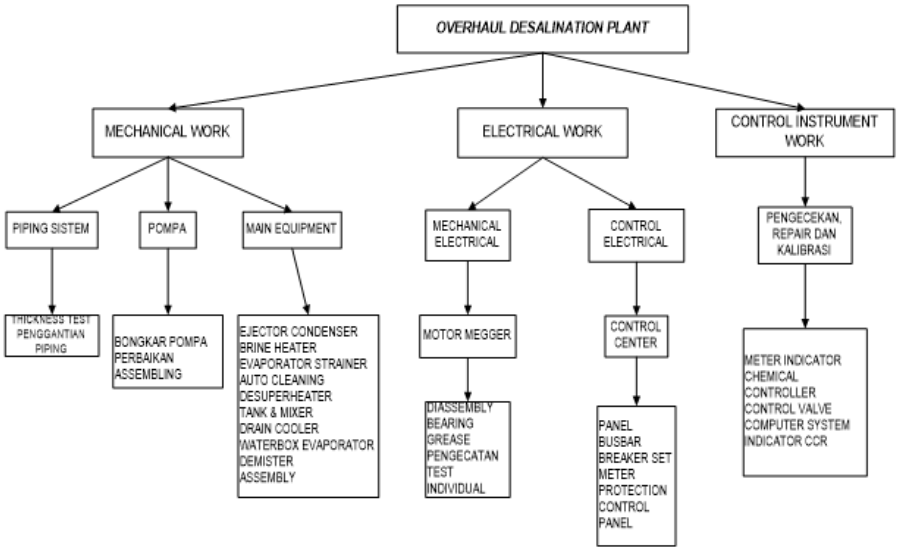

Figure 1. WBS project of overhaul desalination plant

METHOD

The research began with reference studies related to literature. Questionnaires were filled out to 25 respondents who were directly related to the desalination plant overhaul project (Esmemr, Ceti, & Tuna, 2010).

The main respondents are project managers, senior Supervisors and coordinators of each UPHT overhaul area, senior supervisors in each field in UP Gresik, Rendal UP Gresik QC team, desalination plant operators. Value stream mapping is carried out for overhaul activities and the identified waste is obtained. The waste is then repaired so that waste does not reappear in the FSM model. This FSM model is then simulated with ARENA software whether there is an improvement in activity. The research framework can be seen in Figure 2 below.

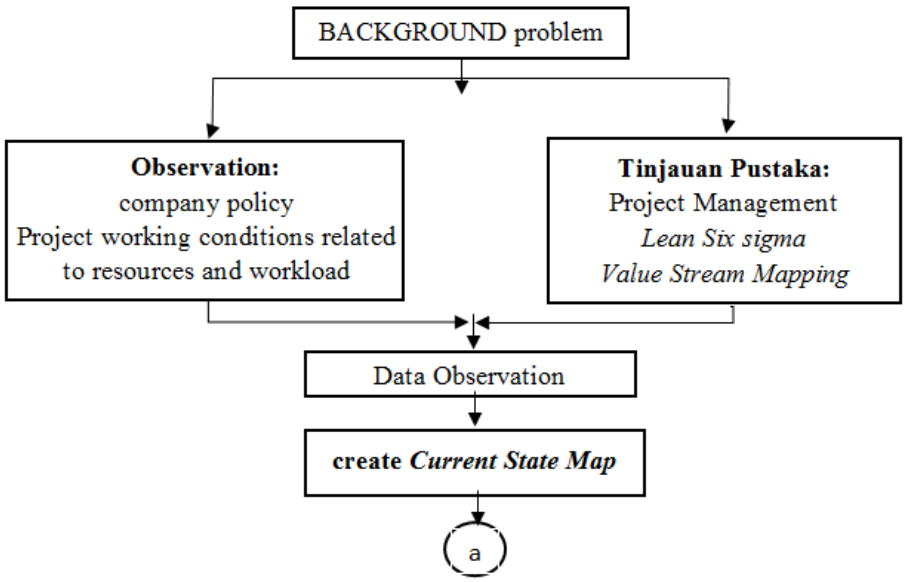

Figure 2. Research flow chart

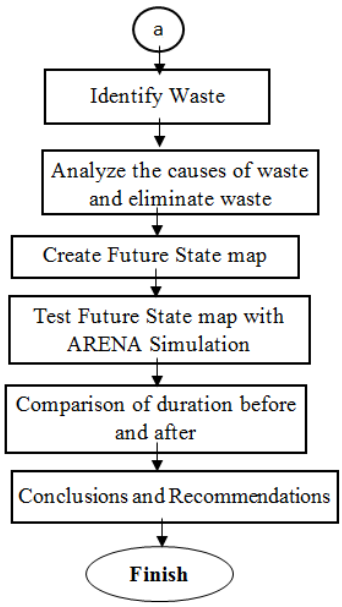

Figure 3. Research flow chart

CASE STUDY

This value stream mapping method is applied in the project desalination plant overhaul. This project has 3 main areas of activity. The target overhaul can be completed in a duration of 25 days, but in its implementation the project is completed in 27 days. So from that carried out an analysis of which activities contain waste which causes the target duration of 25 days is not reached. After taking the data in the form of direct observation in the field, distributing questionnaires and Focus Group Discussion with the PIC and senior employees in the Overhaul team in each field, a current state mapping of Overhaul activities can be formed that is thoroughly analyzed to ensure the forms and activities contained in it. The types of activities are then collected into three types, namely Value Added (VA), Necessary Non-Value Added (NNVA), Non Value Added (NVA). For NVA or NNVA activities, it is necessary to do a study to find out the main cause, so that it can be used as input for proposed improvements when making FSM. As a summary of activities can be seen in Table 1.

Table 1: Mechanical activities

No		Activities	Type	Labor	Duration (day)
1	Main Equipment	Open manhole and inspection Ejector Condenser	VA	3	15
		Diassembly and inspection Evaporator strainer	VA	3	
		Diassembly and inspection Brine heater	VA	3	
		Cleaning Waterbox Evaporator	NVA	3	
		Assembly Desuperheater	VA	3	3
		Diassembly and inspection Tank & Mixer	NVA	2	5
		Cleaning Drain cooler	VA	2	3
		Diassembly and inspection and repair Desuperheater	VA	3	6
		Diassembly dan cleaning demister	NVA	3	6

Table 1. Continue...

No		Activities	Type	Labor	Duration (day)
		Assembly demister,waterbox, tank mixer,evaporator strainer, brineheater,ejector condenser, close manhole	VA	4	5
2	Pump	Disassembly pump	NVA	3	7
		Repair damage	VA	3	11
		Assembling and finishing	VA	3	3
3	Piping System	Thickness test and replace Piping	NVA	3	20
			Duration	Total	26

Table 2: Electrical activities

No		Activities	Type	Labor	Duration (day)
1	LV Motor & Megger	Disassembly and cleaning part motor	NVA	4	8
		Check visual bearing conditions and bearing replacement	NVA	4	8
		Replace grease/bearing lubricant	VA	2	1
		Assembling motor	VA	3	4
		Cleaning and painting body motor	VA	2	1
		Individual run test and measure the vibration voltage current	VA	2	2
2	Control Center	Cleaning panel and calibration	VA	2	6
		Cleaning busbar and calibration	VA	2	3
		Cleaning breaker set NFB and calibration	VA	2	5
		Protection meter cleaning motor and calibration	VA	2	5
		Test performance	VA	2	27
		Cleaning control panel fire protection and calibration	VA	2	1
			Duration	Total	24

Table 3: Control instrument activities

No		Activities	Type	Labor	Duration (day)
1	Check, repair dan kalibrasi	Meter dan indicator chemical inst (check dan kalibrasi PI,TI,DPI)	NNVA	2	3
		Controller (check dan kalibrasi SV,LX,FX,PX,LS,DPIS,FIS)	NNVA	2	6
		Control valve steam (test open-close, disassembly valve, check inner part, cleaning, repair, and calibration, assembling valve)	NVA	4	7

Table 3. Continue..

No	Activities	Type	Labor	Duration (day)
	Computer system (check PLC system fan filter module, calibration signal conditioner and loop test, running test fan switch lampu; check terminal, test program, check interrupt function; check and test I/O)	VA	3	5
	Indicator Control Room (cleaning panel,check monitor display,looptest,cleaning)	VA	2	3
		Duration	Total	24

Potential for waste

Waste identification is carried out by distributing and filling out 25 questionnaires to experts in their fields. Of the 8 waste (DOWNTIME) found 4 waste with the top position that occurred in the implementation of an overhaul namely defects, waiting, extra processing, non-utilized talent. Can be seen in Table 4.

Table 4: Results of identification of waste

Waste	Frequency						Ranking
	NEVER (0)	RARELY (1)	EVEN (2)	USUAL(3)	OFTEN (4)	VERY OFTEN (5)	
1 Defect	0	2	2	6	13	2	3
2 Over production	0	15	10	0	0	0	8
3 Waiting	0	0	0	3	4	18	1
4 Non-Utilized Talent	0	1	1	5	10	2	4
5 Transportation	0	7	13	5	0	0	7
6 Inventory	0	5	13	6	1	0	6
7 Motion	0	8	9	4	3	1	5
8 Extra Processing	0	0	1	2	5	17	2

Respondents were asked to fill out the answers with the highest score of 5 for the category where there was always waste (> 8 times overhaul), 4 for frequent occurrence (5-6 times overhaul, 2 rare (1-2 times overhaul), and 0 never (did not occur) , from 2007 to 2017. The discussion about improving improve the duration of the overhaul was carried out by analyzing waste and then the existing problems will be obtained in accordance with Table 5.

Waste that occurs in activities such as those listed in the previous chapter is carried out further analysis by researchers to look for proposed improvements in every activity known to be waste. Determination of proposed improvements is done by forum group discussion when daily meeting Overhaul. Proposed improvements to minimize activity wastage are shown in Table 6.

In the previous sub-chapter, FSM has been formed in each field and a simulation with ARENA Software version 4.0 was conducted. All activities, labor and duration of activities are included as input into the software. In this simulation phase, running simulation is carried out by directly combining all activities. This is done to determine the total duration of the Overhaul Desalination Plant project after

elimination of Non Value Added in each field. Figure 3 is the initial CSM model in ARENA software. While Figure 4 is the model after the removal of waste.

Table 5: Table of waste and problems

No.	Waste	Problem
1	Defect	In the process of repair and calibration of the control valve in the field of control instrument, it requires several times the calibration/rework setting is related to the accuracy of its performance. And often after the start unit causes a Work Order from the Desalination Plant operator
2	Waiting Process	Thickness test awaits predictive and replacing Piping is waiting for the welding department to arrive The process of giving motor grease is done waiting for all the motors to do a visual check and replace the bearings finished The visual check process of bearing conditions and replacement of bearings begins waiting for the process of all loading and cleaning of the motor parts to be completed. Tank&mixer inspection activities await brine and superheater assembly activities In the activity process, repair and calibration of the control valve in the control instrument field have 4 technicians (7 days).
3	Extra Processing	Unloading the pump is done to all pumps and is not seen from the history of pump damage. Cleaning the pump strainer is done separately for too long (6 days) The duration of the Cleaning Waterbox Evaporator activity is too long (15 days) because the technician is careful in cleaning so as not to injure the wall and remove the coating Meter activity and chemical inst indicator (check and calibrate PI, TI, DPI) are carried out on all parts. Controller activity (check and calibrate SV, LX, FX, PX, LS, DPIS, FIS) is done on all parts.
4	Not Utilized	Talent In the process of repair and calibration of the control valve in the field of control instrument, it requires several times the calibration/rework setting is related to the accuracy of its performance. The welding process awaits the certified person

Table 6: Waste and proposed improvements

No.	Waste	Problem	Proposed Improvements
1	Defect	In the process of repair and calibration of the control valve in the field of control instrument, it requires several times the calibration/rework setting is related to the accuracy of its performance. And often after the start unit causes a Work Order from the Desalination Plant operator	SOP and QC Checklist for control valve calibration program.

Table 6. Continue...

No.	Waste	Problem	Proposed Improvements
2	Waiting Process	Thickness test awaits predictive and replacing Piping is waiting for the welding department to arrive	Thickness test is done when taking data before overhaul. An agreement was made with the welding team to standby at local level so that it could immediately execute
		The visual check process of bearing conditions and replacement of bearings begins waiting for the process of all loading and cleaning of the motor parts to be completed.	When 1 motor has been disassembled and motor part cleaning is carried out, it can be continued immediately by visually inspecting the bearing condition and based on the vibration/work order trend data where the indicated bearing is damaged. Perform replacement bearings only on abnormal motors.
		The process of giving motor grease is done waiting for all the motors to do a visual check and replace the bearings finished	Can start giving grease when 1 motorbike has been declared to have no bearing damage.
		Tank & mixer inspection activities await the desuperheater installation activity	Tank mixer inspection activities are carried out in parallel with disassembly cleaning demister activities because it is a process and has an early schedule.
		In the repair and calibration process, the control valve in the control instrument field has	4 technicians (7 days) 4 technicians are needed when installing the control valve. When repairing, only 2 technicians are needed. 2 other technicians can perform Indicator Control Room activities (panel cleaning, check monitor display, looptest, cleaning) which only takes 3 days
3	Extra Processing	Unloading the pump is done to all pumps and is not seen from the history of pump damage.	Based on the history of damage data when the operating unit and normal can be directly parallel, check alignment is done with the motor
		Cleaning the pump strainer is done separately for too long	There is a 3-month PM schedule for strainer cleaning. So that when overhauling the condition of the strainer is not too much dirt.
		Duration of Cleaning Waterbox Evaporator activity is too long (15 days) because it uses workers to be careful in cleaning so as not to injure and remove the coating	Using grinding tools with softer material. So that the coating layer is not peeled off when in contact with the grinding eye.

Table 6. Continue...

No.	Waste	Problem	Proposed Improvements
		Meter activity and chemical inst indicator (check and calibrate PI, TI, DPI) are carried out on all parts.	Calibrated on abnormal parts based on work order data damage during the operation unit. Whereas the normal calibration measures are not carried out.
		Controller activity (check and calibrate SV, LX, FX, PX, LS, DPIS, FIS) is done on all parts.	Calibrated on abnormal parts based on work order data damage during the operation unit. Whereas the normal calibration measures are not carried out.
4	Not Utilized	in the process of repair and calibration of the control valve in the field of control instrument, it requires several times the calibration/rework setting is related to the accuracy of its performance.	A mentoring program was held for members of the new control instrument team
		The welding process is waiting for a certified welding technician	Welding certification is held for the mechanical field team

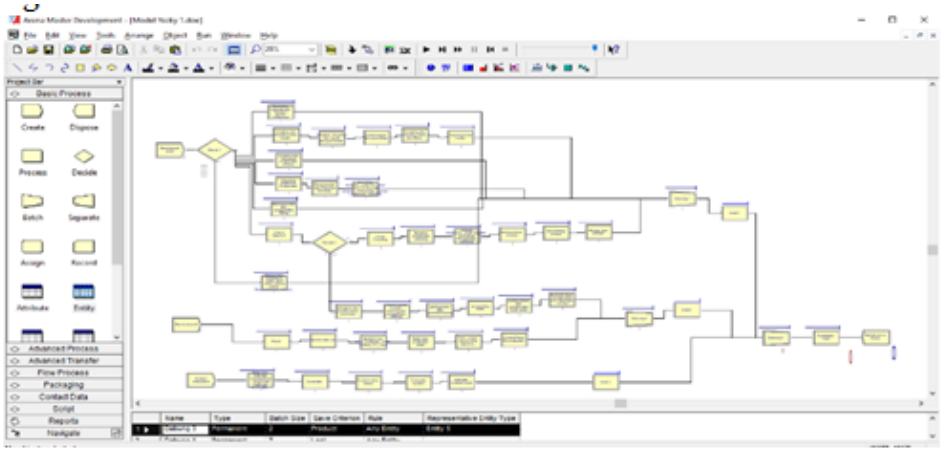

Figure 4. Initial model (CSM) in ARENA Software

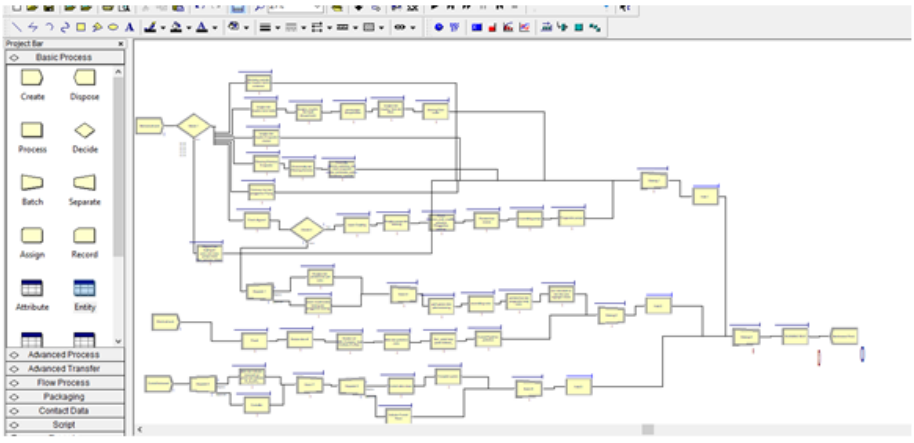

Figure 5. Proposed model in ARENA Software

The comparison of the simulation results of the duration of the overhaul before the reduction of waste is carried out by reducing waste can be seen the difference. Figure 5. shows the change in duration before and after waste elimination. In the model before analyzing elimination of waste, the total time needed is 25.64 days. After analyzing and eliminating the existing waste then simulating and obtaining a duration of 22.85 days. Overall there was an improvement in the duration of the overhaul compared to the previous 10.88%. Figure 5 is a comparison of the results of the Current State Mapping (left) and FSM (right) simulations.

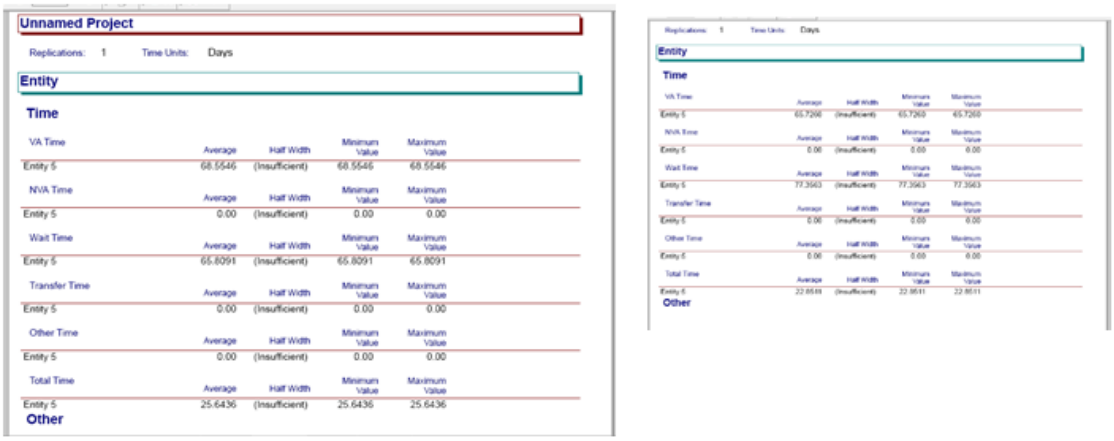

Figure 6. Comparison of duration before (left) and after removal of waste (right)

CONCLUSION

Based on the data obtained and analyzed, it was concluded that the transformation of the duration of the Overhaul Desalination Plant process with the Lean-Six Sigma method approach and suggestions for further research (Ayeni, Baines, Lightfoot, & Ball, 2011).

1. Waste analysis is carried out on activities in three fields, namely the fields of Mechanical, Electrical, and Control Instrument. Obtained as follows:

• In the mechanical field, it is identified as waste waiting on the Thickness test piping activity waiting for the results of the test in the predictive field, tank & mixer activities that await the brine assembly's accuracy and the superheater is complete. Waste Extra Processing was identified in the activities of demolition and repair of pumps which were carried out to all pumps, cleaning pump strainer activities, cleaning waterbox activities (Mossman, 2009).

• In the electricity field, waste is identified in the form of waste waiting on the activity of giving grease, which waits for all motors to be checked and replacement of bearings on all motors.

• In the Control Instrument field, waste is identified in the form of waste defect in the activities of Control Valve repair, the calibration process is not standard and causes unstable performance. Waste waiting was also identified in the repair valve repair activity where there were 4 technicians with a duration of 7 days while requiring 4 technicians when just uninstalling, when the repair process was only 2 technicians, the rest remained idle. Waste Extra Processing is also identified here in the activity of meter indicators and controllers where both activities are carried out by prioritizing parts that have work order improvements.

2. By applying the Value Stream Mapping, the FSM design from the Desalination Plant overhaul design is then simulated by using ARENA software. Based on the simulation results of the base model overhaul and simulation of the proposed improvement design using ARENA software, it is indicated that the proposed activity improvement can reduce the duration of the desalination plant overhaul from 25.64 days to 22.85 days or 10.88%.

3. In this study, researchers focused on improving the duration of the implementation of overhauls in the fields of mechanics, electricity, and control instruments. For further research it is recommended to

conduct research on the potential of waste in other fields such as OHS and the procurement/procurement sector in order to support the progress of this research and to obtain a more effective way of working.

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