Improving Turn around Performance through Operational Models and Value Stream Mapping on the Natuna Sea AG Platform of PT. X

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Abstract:- PT. X is one of the upstream oil and gas industry assets in Indonesia that produces natural gas and petroleum from production wells in Natuna Sea, with natural gas production capacity of 165 MMSCFD and 2000 BPD oil. The natural gas exported through a subsea pipeline to Singapore under a 30 years Gas Sales Agreement (GSA) contract. The issue of managing, planning and execution of facility maintenance activities is important to achieve high efficiency and performance. This study is intended to improve lean manufacturing of Turn Around Maintenance (TAM) with Value Stream Mapping and Operational mode methods. The current state mapping in flare tip inspection activities, can increased its Value Added Time (VAT) from 67% to 81% and increase the effect of Lead Time to 63% in the future state map. Research on operational modes using the PLS- SEM method with SmartPLS software provides results on the relationship between the influence of planning and improving lean manufacturing on operating performance. The result showed that there was a positive and significant influence of the scope of TAM, contractor's competency on TAM performance. It is also resulted in a positive and significant influence of TAM performance and maintenance performance on the operating performance of the AG platform. Meanwhile, the business planning process does not have a significant effect on TAM performance.

***Keywords*:-** *Lean Manufacturing, Turn Around Maintenance, Value Stream Mapping, PLS*

I. INTRODUCTION

The energy industry, especially in the oil and gas sector in Indonesia, is still the backbone of the country's economy through the Oil and Gas Non-Tax State Revenue (PNBP Migas) as an example of what is targeted in the 2020 State Budget (APBN) of IDR 192.04 trillion which was later revised to IDR 100.16 trillion due to the effects of the Covid19 pandemic which infected the whole world including Indonesia (Migas, 2020). The oil and gas governance used by the Indonesian government is a production sharing cooperation contract between the government and Cooperation Contract Contractors (KKKS) to manage oil and gas resources in the area of operation that has been tendered by the government. One of the PSC Contractors that operates and has a working area in the Riau Islands province is PT. X, a *Penanaman Modal Asing* (PMA) or Foreign Direct Investment (FDI) company that is a KKKS operator in the work area. Each PSC Contractor produces production results in the form of revenue and gets profit sharing according to the composition specified in the contract with the Special Task Force for Upstream Oil and Gas Business Activities (SKK Migas) as the controlling operator for upstream oil and gas activities in Indonesia. Profit sharing is net profit which is divided after the company calculates the profit from sales of oil and gas products minus production costs or lifting costs, these costs include operating costs and maintenance costs. High maintenance costs will certainly result in a decrease in revenue, so that the management of maintenance of oil and gas installations operated by PSC Contractors must be carried out as efficiently as possible.

One of PT.X's annual routine maintenance activities is Annual Turn Around Maintenance, a routine maintenance activity that requires operating facilities to stop completely to carry out high critical and high risk maintenance. Turn Around Maintenance or TAM, has the characteristics of a short-term project and uses a lot of resources, both in the form of materials, people and logistics (Wenchi et al., 2015). TAM activities generally require high costs and are usually followed by a shutdown. So if the management of TAM is not efficient it will cause high costs and wastage or wasted costs because of the inefficiency of its implementation. The problem of inefficiency in the implementation of TAM at PT. X will be analyzed so that the flow of activities that cause wastage, added value and non-added value can be mapped, so that the management of TAM management can be efficient following the principles of Lean Manufacturing with an empirical approach.

A. *Operational Problems that Occur in TAM Activities in the Operating Field of the AG Facility at PT. X Is as Follows:*

- Loss of planned potential production as a result of the cessation of operations from TAM and project activities.
- Oil and condensate amounted to 70,000 barrels in the 4 year observation period or 17,600 barrels per year.
- Gas of 8,400 BBTU (Billion Britsh Thermal Units) or around 67.5 million USD (16.9 million USD per year), assuming the natural gas price in the contract is USD 8.0 per mmBTU (million BTU).
- Down Time that occurred in the 2017-2020 period was 6,000 hours (1,500 hours per year).

- The ratio of planned work that is not carried out in the TAM execution phase is low, between 40-80%.
- There are defects in the work and quality of work in the TAM execution phase so that it requires rework and rescheduling.
- Waste that occurs during the execution phase which causes time inefficiencies, such as Change Over Time and delays in start-up time.

Research conducted by (Wenchi et al., 2015) conducted a case study of calculating cycle time and waiting time which were influenced by exchange time and the VA ratio towards an increase in the value of Takt time. Takt time will describe the efficiency of processing time as a TAM performance variable. In the following year (Shou, 2018) which explains lean manufacturing in Turn Around Maintenance activities by identifying waste in the form of NVA activities and VA activities will affect the effectiveness of TAM activities. The two studies conducted by Shou opened a new literacy about lean manufacturing in TAM activities, which so far have always been allowed to flow as high-cost and time-consuming activities due to the impact of production stoppages. This study provides another perspective on how management of TAM implementation is grouped into several classes, analyzing flow, time and communication, so that TAM management can achieve optimum efficiency using the lean management value stream mapping method.

B. To Determine the Quality of TAM Performance, it is Necessary to Know the Magnitude of the Influence of Each Supporting Factor in Order to Obtain Optimal TAM Performance in the Coming Period. In this Research, the Problem Faced by the Company is the Problem of Inefficiency From the Existing Waste During TAM Activities, Therefore the Authors Formulate the Research Problem as Follows:

- Do business processes affect TAM performance?
- Does TAM scope affect TAM performance?
- Does the competence of the Subcontractor affect the performance of TAM?
- Does TAM performance affect AG platform production operation performance?
- Does maintenance performance affect production operation performance?
- Does VSM's lean manufacturing contribute to TAM's performance improvement?

II. LITERATURE REVIEW

In the refinery industry, turn around is a planned work program that is usually carried out after the plant has been running for four to six year intervals and the turn around implementation time is between three to five weeks, for large- scale refinery complexes. Turn Around is a philosophy of planning shutdown scheduling to maximize plant efficiency and minimize down time (Sahoo, 2013). Reducing equipment down time so as to increase productivity and reliability of production equipment, as reported by (Milana et al., 2014). The successful implementation of the turn around will contribute to the company's profits because availability and reliability are very crucial in the business life cycle of the energy industry. In addition, the loss of production during the implementation of the turn around takes a high cost and will directly affect the company's profits. The turn around project is also not immune from the possibility of further losses such as schedule slips, cost overruns due to uncertainties (Shou, 2018).

Potential damage to process equipment due to corrosion, erosion, high pressure and fatigue, causing equipment reliability to gradually decrease so that the gas plant requires a shutdown to restore the performance of the equipment and maintain the safety capability of the operating facility. Shutdown can be divided into two types, namely planned shutdown and unplanned shutdown. Turn around is included in the planned shutdown category which is usually carried out with large financial support (Elwerfalli et al., 2019).

Turn Around projects are generally planned in several phases. 5 (five) phases that are often found in some literature, namely, scope of work planning, pre-shutdown activities, planning and organization, execution and termination (Al- Turki et al., 2013), in other literature Lenahan (1999, 2006) suggests simpler phases, namely, initiation, preparation, execution and closing.

Lean production is a systematic approach to identify and eliminate waste through a pull (pull) strategy in achieving perfection from the customer's perspective. This lean originates from the car industry, and was developed from Taiichi Ohno's idea of reducing costs by eliminating waste, which was originally known as the Toyota Production System (TPS) (Shou, 2018).

Lean can be interpreted as a systematic and orderly approach to be able to find and eliminate inefficiencies (waste), or activities that do not have added value (non-value adding activities) through continuous improvement by smoothing product flow (materials, work) -in-process, output) and data using a pull system (pull system) from within and outside to achieve superiority and perfection. According to Gaspersz (2007) Lean is an ongoing effort to eliminate inefficiencies (waste) and increase the value (value added) of products, goods and services in order to provide value to consumers (customer value). Lean's goal is always to increase value for consumers (customer value) through increasing the ratio between value and waste (the value-to-waste ratio). In another study, Gaspersz (2007), describes Lean as a business philosophy based on minimizing the use of energy sources in various industrial activities.

Inefficiency or waste (waste), is all things that are not needed from the minimum requirements, both equipment, materials, processes and workers who are very important in the production process. Waste must be eliminated to increase product value and increase consumer value (Ahlstrom, 1998).

The definition of VSM historically was first known as Lean philosophy in 1995 which describes a group of activities that identify waste (waste) and then by Hines and Rich in 1997 it was enriched by a term known as the 'Seven VSM methods' (Shou, 2018).

Another definition of VSM according to (Yansen & Bendatu, 2013) is a lean manufacturing method that describes all VA and NVA activities to achieve product value according to consumer desires. Meanwhile, the purpose of VSM is to identify processes by describing all flows in order to eliminate waste. The general definition of VSM is closely related to the definition of lean manufacturing.

Visualization of the VSM process in its application will use a tool known as Big picture mapping, but in terms of process flow identification process, big picture mapping is similar to VSM. According to (Pradana et al., 2018) Big picture mapping is a tool for describing the system as a whole with its value stream, to find out the flow of physical information in the system. And the goal of Big picture mapping is to make the product flow to the end consumer.

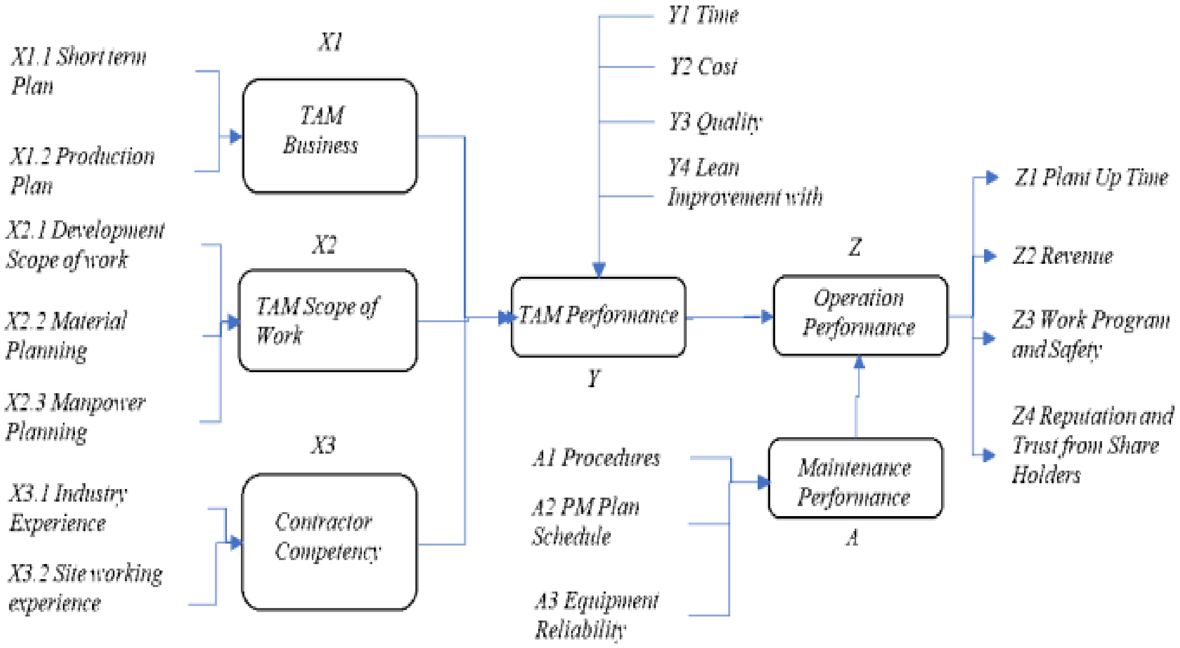

Fig 1 :- Framework The hypotesis of this study are

A. The Framework of this Research is as Follows:

- H1 : there is a positive and significant influence between business planning processes on TAM performance.
- H2 : there is a positive and significant influence between the scope of TAM on TAM performance.
- H3 : there is a positive and significant influence between contractor competency on TAM performance.
- H4 : there is a positive and significant influence between TAM performance on operating performance.
- H5 : there is a positive and significant influence between maintenance performance on operating performance.

III. RESEARCH METHOD

The research method is one of the scientific stages in managing valid and objective data with a specific purpose of use. Goals to be achieved and want to prove to solve the problem. One of the scientific references is to take the research method theory developed by Sugiyono (2019). So it can be concluded that the research method is guided by data grouping, data processing and proof of several assumptions scientifically by using logical ratios. The type of research used by researchers is descriptive quantitative.

The research variables that will be examined in this study are: planning quality (X), and maintenance performance (A) as independent variables and TAM performance (Y), operating performance (Z) as the dependent variable.

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Table- 1 Variable Measurement Indicators and Operational Definitions

Variable		Indicator	Scale
TAM Process Business (X1)	X1.1.1	Periodic shutdown plan planning	Ordinal
	X1.1.2	Work Program & Budgeting in the TAR financing scheme	
	X1.1.3	Material purchasing planning	
	X1.1.4	*Procurement Lead Time*	
	X1.1.5	*Carry over works in planning TAR*	
	X1.2.1	Forecasting sales to the market (Ghaithan, 2020)	
	X1.2.2	Production backup planning	
	X1.2.3	Buyer's approval of supply Reduction	
	X1.2.4	TAM duration planning	
	X1.2.5	Major equipment breakdown planning (Ghaithan, 2020)	
TAM Scope (X2)	X2.1.1	Data unplanned SD, Defect dan improvement proposal	Ordinal
	X2.1.2	Control progress with the Gantt Chart	
	X2.1.3	Shift planning time	
	X2.1.4	Specific work procedures	
	X2.1.5	Work order limit	
	X2.2.1	Job owner as the main executor of material planning	
	X2.2.2	Timely supply chain management	
	X2.2.3	Slow arrival of materials	
	X2.2.4	Slow loading of materials	
	X2.2.5	Identify offloading areas	
	X2.3.1	Availability of labor contracts	
	X2.3.2	Planning discipline expertise	
	X2.3.3	Selection of sub-contractors	
	X2.3.4	manhours plan	
	X2.3.5	Planning tools and equipment	
Subcontractor Competency (X3)	X3.1.1	Contractor certification and Expertise	Ordinal
	X3.1.2	Work experience in Industry	
	X3.1.3	Experience working in the AG field	
	X3.1.4	Working time in the AG field	
	X3.1.5	Understanding of the scope of the TAM by the contractor	
TAM Implementation Performance (Y)	**Y1.1.1**	Driver shutdown as a determinant of TAM lead time	Ordinal
	Y1.1.2	production ramp-up and ramp down planning	
	Y.1.1.3	VA ratio	
	Y1.1.4	Readiness of work procedures	
	Y1.1.5	Uptime	
	Y1.2.1	Flaring gas conversion	
	Y1.2.2	Industrial use of gas	
	Y1.2.3	Use of integrity test gasket as a substitute for inert gas	
	Y1.2.4	Expert mobilization	
	Y1.2.5	Use of logistical support (fixed wing, rotary wing & ships)	
	Y1.3.1	Work procedures	
	Y1.3.2	Pre-shipment inspection	
	Y1.3.3	FAT & SAT	
	Y1.3.4	Delivery time material	
	Y1.3.5	Competent inspector	
	Y1.4.1	Fixed downtime with the most critical equipment	
	Y1.4.2	Reduction of change over time	
	Y1.4.3	Overall lead time improvement	
	Y1.4.4	Improved uptime with 24 hours uptime	
Operation Performance (Z)	**Z1**	TAM total performance	
	Z2	TAM cost performance	
	Z3	Improved production and safety performance	
	Z4	Cost performance increases shareholder satisfaction	
Maintenance Performance (A)	**A1.1**	Detailed Maintenance Procedure Task List	
	A1.2	ramp-up planning Accurate details of specific equipment maintenance work	
	A.1.3	Achievement of Preventive Maintenance plan	
	A.2.1	Actualization of work orders with PM schedules	
	A.2.2	Periods of tool unavailability due to proper maintenance schedules	
	A.2.3	Good quality corrective maintenance	
	A.3.1	Increasing the value of equipment reliability (reliability)	
	A.3.2	Increased lifetime of equipment, MTBF above the company's target	
	A.3.3	Equipment breakdown intervals are shrinking	

The measurement scale in this research is to use a Likert scale with several instruments, namely planning, VSM improvement and TAM performance. The Likert scale is used to measure the amount of influence, attitudes, opinions, and perceptions of a person or group about social phenomena (Sugiyono, 2012).

Table-2 Skala Likert

Code	Code Explanation	Score
SA	Strongly Agree (SA)	5
A	Agree (A)	4
N	Neutral (N)	3
D	Disagree (D)	2
SD	Strongly Disagree (SD)	1

The author took the population in this study in the form of permanent employees involved in TAR activities on the AG platform totaling 50 people which is a micro-sized saturated sample, under 100. In the book Research Method For Business by Roscoe, it provides a decent sample size for research with a minimum number of 30 up to 500 examples. Research conducted by Reinartz et al. (2009) indicated that PLS-SEM is a good choice when using small sample sizes, some researchers also believe that sample size does not play a major role in PLS- SEM applications, relying on the rule of thumb (Rules of Thumb) 10 times the number of variables used. widely used in social and business research. As an alternative, researchers can use the rule of thumb provided by Cohen (1992) with Power statistical analysis to model multiple regression (Hair Jr et al., 2021).

The sampling technique in this study used non-probability sampling in the form of purposive sampling, by only providing opportunities for members of the selected population as members of the sample. Then collect the sample by making a questionnaire and asking for the response of sample members to the questionnaire made.

Data collection techniques are the most important thing in research and the purpose of research is to process data. The authors in this study used 3 kinds of data collection techniques, namely documentation studies, questionnaires, and literature studies.

Methods of data analysis in this study using descriptive and inferential statistical analysis. In the descriptive statistical analysis, the research data is presented in the form of an average score, while inferential analysis uses the PLS-SEM (Partial Least Square-Structural Equation Modeling) analysis technique with SmartPLS software.

IV. DISCUSSION AND CONCLUSIONS

The stages of work from start to finish are presented in table 2 with the actual duration of work being 48 hours, specifically for this inspection work.

Table- 3 VSM Attribution to TAM Work Stages

	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9	Step 10
Work Steps	Platform depressurize & energy isolation				Inspection and repair				Reinstatement	
	Purging topside containments	Oil and Gas Well isolations	Nitrogen purging to Flare header	Positive isolation at 16 inch flare header	CVI inspection by RAT	Preventive Maintenance work	Scaffolding installation	Repair welding works	scaffolding dismantling	removal skillet at 16 inch flare header
Atribut										
CT	6	8	2	4	10	10	4	12	10	4
VAT	4	4	1	2	8	7	0	6	0	0
CO	0	6	1	2	2	4	4	2	2	2
Uptime	67%	50%	200%	100%	120%	80%	150%	100%	60%	75%
Actual working time	6	2	1	2	8	6	0	10	8	2

A. *Based on the Data, the Five Main Measurements of VSM are Calculated in Table 2*

- Cycle time (CT) is the duration required for a stage to complete its work;
- Lead time (LT) is the time required for activities between one stated task until the final task is completed. In TAM, in order to minimize project duration, stages are usually executed in parallel, therefore, the total cycle time is not equal to the lead time;
- Turnover time (COT) which is idle time that needs to be waited for one stage before the completion of the previous stage;
- Uptime is calculated by dividing actual working time by cycle time;
- The actual working time is calculated by subtracting the shift time from the cycle time.
- Furthermore, the data from table 2 is described in Stream Value Mapping to describe the current process (Current State Mapping) and the productivity values obtained.

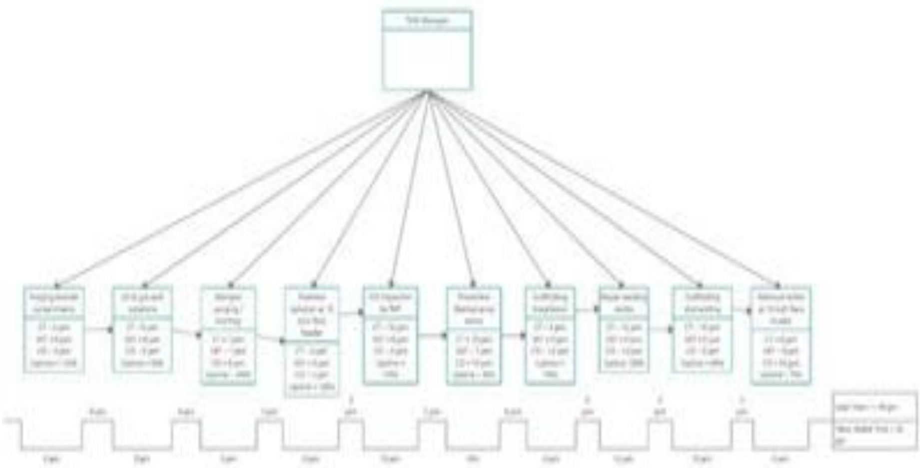

Fig 2 Current VSM Pekerjaan Flare Tip Inspection From

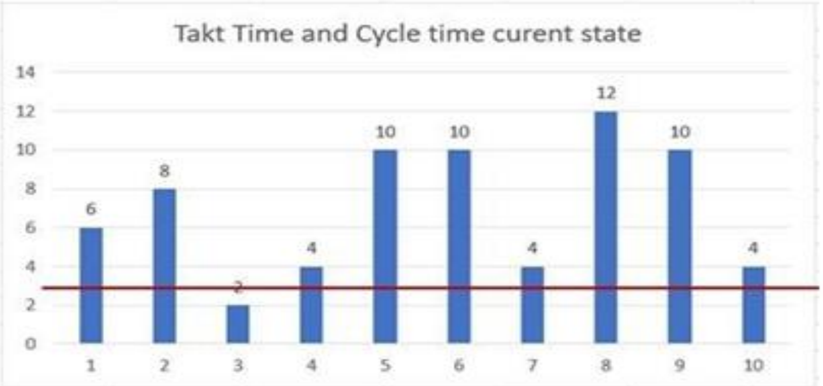

Fig 3 :- Graph Cycle Time against Takt Time

The future state map then needs to be built to reduce the Lead Time value to 36 hours with several possible jobs that can be carried out simultaneously.

Mapping VSM with future state mapping, requires a review of all stages carried out. Re-mapping activities or stages that can be carried out effectively will reduce CT values and increase VAT values. Lean manufacturing has a philosophy of eliminating or reducing waste with more effective working methods. In the case of this flare tip inspection work, work is chosen which can be carried out simultaneously with other work which does not eliminate the steps of the work and does not increase the risk of the hazard posed. PM (Preventive Maintenance) work can be carried out simultaneously with positive isolation work, because PM work can be carried out at the location of the connection point (tie- in) in the electronic transmission box (Junction Box). By doing stage 4 and stage 6 work simultaneously, it can reduce the CT value from 14 hours to 10 hours. The second step is to use the RAT (Rope Access Technic) method, this method allows work at heights exceeding the height limit of the human body with aids in the form of straps and climbing, eliminating the need for scaffolding installation and removal. With this RAT method, the CT value can be reduced from 14 to 0.

Figure 2 it is found that the total lead time for this inspection activity is 48 hours obtained from the actual measurement of this work from start to finish. Furthermore, the total cycle time is 70 hours from the sum of all CT values. then the total Value Added Time (VAT) is 32 hours (*jam*) and the VAT ratio is 67% obtained from the total VAT divided by the total Lead Time.

The next calculation is to use Takt Time, where the definition of Takt Time is a unit of production/process rhythm according to the consumer's perspective (Wenchi Sou 20321). In this case the takt time measurement for flare tip inspection is the amount of lead time that can speed up the start-up time again, namely 48 hours minus 12 hours of slow down and ramp-up processes, which is a total of 36 hours of lead time. If in 1 day work during the day uses 12 hours, then the takt time required is 36 divided by 12 so that it becomes only 3 hours.

The overall achieve`ment of lean can reduce Lead time from 48 hours to 31 hours and increase the value of the VAT ratio from 67% to 81%.

Table- 4 Attribution of Future State VSM Flare Tip Inspection Work

	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
Work Steps	*Platform depressurize & energy isolation*				*Inspection and repair*		*Reinstatement*
	Purging topside containments	*Oil and Gas Well isolations*	*Nitrogen purging to Flare header*	*Positive isolation at 16 inch flare header*	*CVI inspection by RAT*	*Repair welding works by RAT*	*removal skillet at 16 inch flare header*
Atribut							
CT	6	8	2	4	10	12	4
VAT	4	4	1	2	8	6	0
CO	0	6	1	2	2	2	2
Uptime	67%	50%	200%	100%	120%	100%	75%
Actual working time	6	2	1	2	8	10	2
Atribut	*Combined works*			*Preventive Maintenance work*			
CT				10			
VAT				8			
CO				4			
Uptime				80%			
Actual working time				6			

From stage 6, which is 10 hours. In table 3 it can also be seen that stages 7 and 9 are unnecessary by replacing the altitude access method with RAT, this method can eliminate the CT value by 14 hours.

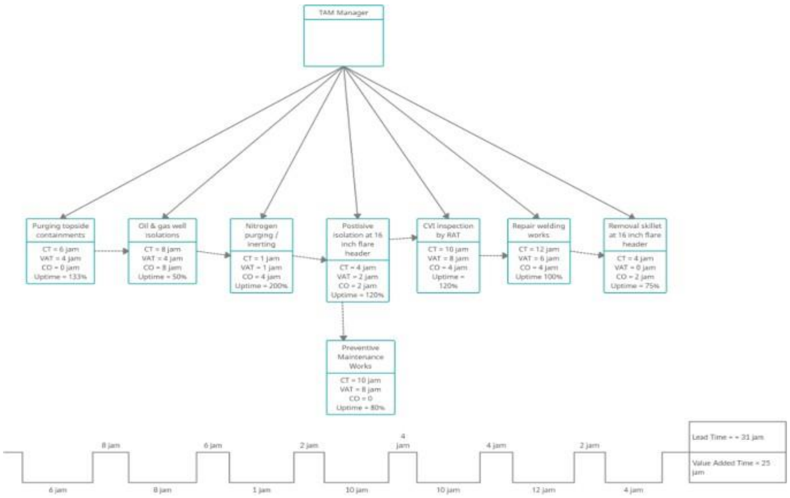

Fig 4 Future State VSM Flare Tip Inspection Work

In figure 4, the Value Stream map depicted has been streamlined from 10 stages to 7 stages. The total lead time needed to be 31 hours from the initial map is 48 hours (*jam*), there is a time saving of 17 hours.

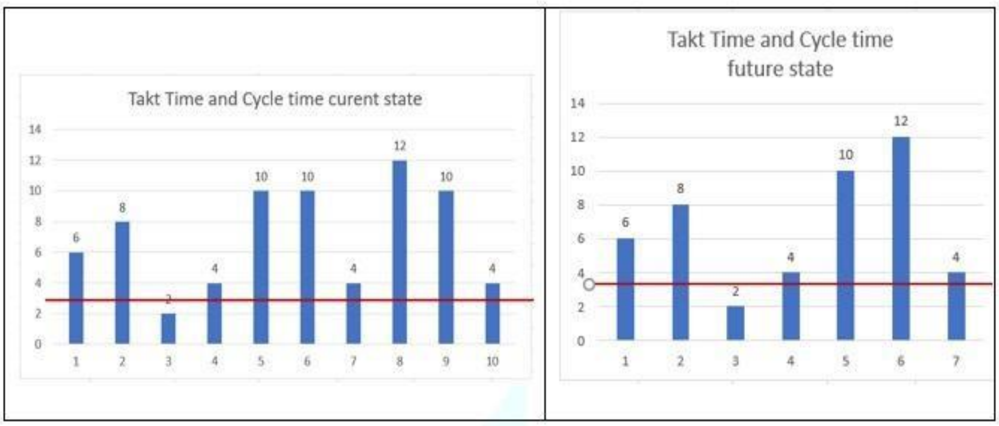

Fig 5 Comparison of Current VSM and Future VSM Cycle Time to Takt Time

Figure 5 shows a comparison of CT (Cycle Time) to Takt Time, the distribution of CT in the future state VSM is close to the Takt Time value on average, namely 4.42 hours, experiencing streamlining and an increase in effectiveness of 63%, calculated from the division of the average percentage of takt time in the future state to the current state.

The actualization of lean manufacturing in VSM in the TAM program is carried out mostly in the implementation phase in planning the use of manpower and the duration of TAM. Measurement of TAM's actual performance with VSM can be seen in the achievement of Key Performance Indicator (KPI) targets after the implementation of the TAM program.

Furthermore, this study will test the initial research hypothesis between the relationship between TAM management processes and TAM performance which is improved by the VSM approach to operating performance at PT.X. hypothesis testing will be analyzed using the Partial Least Square (PLS) - Structural Equation Modeling (SEM) statistical method.

Convergent validity is measured using the factor loading parameter which aims to measure the validity of the indicator. The loading factor is the path coefficient that connects a latentvariable with its indicator. An indicator is considered to have good reliability if the outer loading value is above 0.70 (Ghozali 2016).

The following table describes the results of the correlation between the indicators and their constructs with outer loading values > 0.7.

Table- 5 Preliminary Outer Loading Testing

	A	**X1**	**X2**	**X3**	**Y**	**Z**
Indicator	**Maintenance Performance**	**Business Process**	**TAM**	**Contra Competence**	**TAM mance**	**Operati Performance**
A.1.1	0.739					
A.1.2	0.790					
A.1.3	0.844					
A.2.1	0.803					
A.2.2	0.799					
A.2.3	0.891					
A.3.1	0.725					
A.3.2	0.825					
A.3.3	0.795					
X1.1.1		0.628				
X1.1.2		0.578				
X1.1.3		0.692				
X1.1.4		0.741				
X1.1.5		0.774				
X1.2.1		0.832				
X1.2.2		0.777				
X1.2.3		0.746				
X1.2.4		0.514				
X1.2.5		0.546				
X2.1.1			0.735			
X2.1.2			0.709			
X2.1.3			0.661			
X2.1.4			0.711			
X2.1.5			0.698			
X2.2.1			0.619			
X2.2.2			0.871			
X2.2.3			0.582			
X2.2.4			0.825			
X2.2.5			0.821			
X2.3.1			0.528			
X2.3.2			0.820			
X2.3.3			0.765			
X2.3.4			0.852			
X2.3.5			0.762			
X3.1.1				0.859		
X3.1.2				0.858		
X3.1.3				0.839		
X3.1.4				0.736		
X3.1.5				0.809		
Y1.1.1					0.750	

Y1.1.2					0.844	
Y1.1.3					0.652	
Y1.1.4					0.806	
Y1.1.5					0.782	
Y1.2.1					0.631	
Y1.2.2					0.668	
Y1.2.3					0.701	
Y1.2.4					0.759	
Y1.2.5					0.681	
Y1.3.1					0.593	
Y1.3.2					0.741	
Y1.3.3					0.601	
Y1.3.4					0.826	
Y1.3.5					0.777	
Y1.4.1					0.829	
Y1.4.2					0.811	
Y1.4.3					0.755	
Y1.4.4					0.567	
Z1						0.747
Z2						0.877
Z3						0.849
Z4						0.866

- Combining all SEM components into a complete model from the measurement model and structural model, depicted in a Path Diagram to make it easier to see the causality correlation relationship being tested can be observed in the following figure:

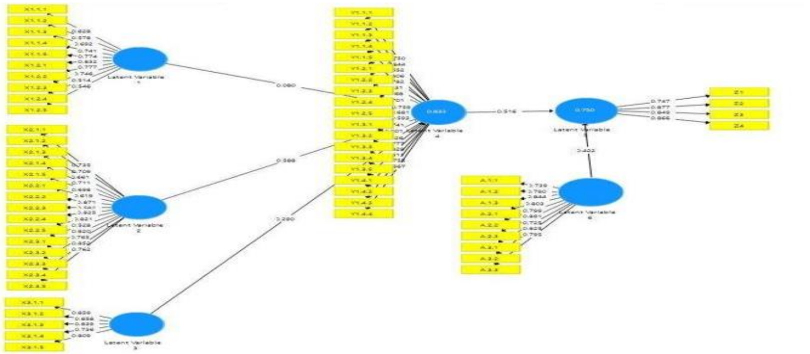

Fig 6 :- Initial Path Diagram based on Factor Loading

It can be seen that of the 62 indicators there are 17 indicators that have a lower outer loading value of 0.7 which means that the indicator does not have a good correlation with the construct, or is not valid. In order for the construct to have a good loading value from its indicators, it is necessary to test it by eliminating the 17 invalid indicators.

The new loading factor value will then be obtained from the calculation results with valid indicators and can be seen in the following Path Diagram image for loading factor improvements:

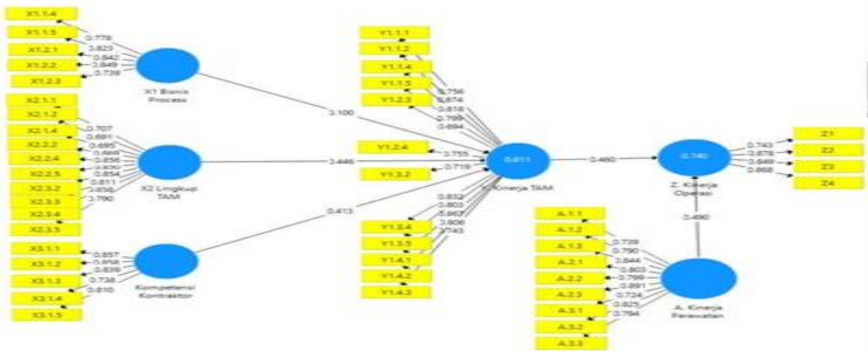

Fig 7 :- Repaired Path Diagram of Factor Loading

From the initial 62 indicators, there are 45 valid indicators that need further testing. The next step is to remove invalid indicators, then the loading factor correction data will be obtained as follows:

Table- 6 Corrected Loading Factor

Indicator	A Maintenance Performance	X1 Business Process	X2 TAM	X3 Contractor	Y TAM mance	Z Operation Performance
A.1.1	0.878					
A.1.2	0.885					
A.1.3	0.730					
A.2.1	0.803					
A.2.2	0.731					
A.2.3	0.891					
A.3.1	0.725					
A.3.2	0.825					
A.2.3	0.828					
X1.1.4		0.741				
X1.1.5		0.774				
X1.2.1		0.832				
X1.2.2		0.777				
X1.2.3		0.746				
X2.1.1			0.735			
X2.1.2			0.709			
X2.1.4			0.711			
X2.2.2			0.871			
X2.2.4			0.825			
X2.2.5			0.821			
X2.3.2			0.820			
X2.3.3			0.765			
X2.3.4			0.852			
X2.3.5			0.762			
X3.1.1				0.859		
X3.1.2				0.858		
X3.1.3				0.839		
X3.1.4				0.736		
X3.1.5				0.809		
Y1.1.1					0.750	
Y1.1.2					0.844	
Y1.1.4					0.806	
Y1.1.5					0.782	
Y1.2.3					0.701	
Y1.2.4					0.759	
Y1.3.2					0.741	
Y1.3.4					0.826	
Y1.3.5					0.777	
Y1.4.1					0.829	
Y1.4.2					0.811	
Y1.4.3					0.755	
Z1						0.747
Z2						0.877
Z3						0.849
Z4						0.866

From the outer loading data in the table above, it is found that the loading factor value for each indicator is above 0.7 with an average of 0.795 and the smallest value is 0.701 in indicator Y1.2.3. these results indicate that the 45 indicators have a good correlation with their constructs and are valid according to the terms of indicator validity.

Discriminant validity is the value of the cross loading factor which aims to find out whether the construct formed has sufficient discriminant by comparing the loading value of the construct that is the goal of greater value than the value of the other constructs. With the principle that different construct values should not be highly correlated. A measurement is said to have discriminant validity if it has a

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cross loading value of 0.7 (Jogiyanto, 2009). In addition to the cross loading value, discriminant validity measurement can be done by looking at the Fornell-Larcker criterion value. According to FL criteria, the square root of the AVE value of each construct must have a higher value than the correlation value between constructs.

Table- 7 Cross Loading Value

Indicator	Cross Loadings					
	Business Process	Operation Performance	Maintenance Performance	TAM Performance	Contractor Competence	TAM Scope
A.1.1	0.556	0.755	0.739	0.767	0.762	0.738
A.1.2	0.601	0.761	0.790	0.521	0.535	0.677
A.1.3	0.311	0.634	0.844	0.346	0.210	0.380
A.2.1	0.275	0.548	0.803	0.442	0.306	0.387
A.2.2	0.404	0.635	0.799	0.534	0.380	0.390
A.2.3	0.468	0.716	0.891	0.598	0.517	0.578
A.3.1	0.377	0.386	0.724	0.322	0.148	0.339
A.3.2	0.404	0.470	0.825	0.434	0.344	0.376
A.3.3	0.416	0.548	0.794	0.498	0.384	0.491
X1.1.4	0.778	0.365	0.453	0.539	0.431	0.589
X1.1.5	0.823	0.509	0.422	0.631	0.599	0.661
X1.2.1	0.842	0.499	0.527	0.560	0.592	0.622
X1.2.2	0.849	0.545	0.517	0.576	0.431	0.614
X1.2.3	0.739	0.467	0.272	0.556	0.555	0.615
X2.1.1	0.638	0.424	0.437	0.666	0.555	0.707
X2.1.2	0.685	0.622	0.508	0.598	0.480	0.691
X2.1.4	0.519	0.662	0.576	0.614	0.644	0.695
X2.2.2	0.664	0.775	0.567	0.745	0.769	0.869
X2.2.4	0.638	0.559	0.447	0.768	0.681	0.856
X2.2.5	0.664	0.565	0.440	0.732	0.702	0.850
X2.3.2	0.625	0.531	0.448	0.706	0.733	0.854
X2.3.3	0.591	0.547	0.530	0.701	0.743	0.811
X2.3.4	0.603	0.674	0.583	0.743	0.758	0.858
X2.3.5	0.547	0.636	0.537	0.677	0.643	0.790
X3.1.1	0.619	0.693	0.615	0.788	0.857	0.769
X3.1.2	0.630	0.651	0.509	0.712	0.858	0.781
X3.1.3	0.521	0.552	0.338	0.649	0.839	0.678
X3.1.4	0.283	0.448	0.293	0.617	0.738	0.493
X3.1.5	0.572	0.677	0.381	0.718	0.810	0.706
Y1.1.1	0.494	0.662	0.367	0.756	0.727	0.724
Y1.1.2	0.551	0.681	0.437	0.874	0.768	0.786
Y1.1.4	0.524	0.550	0.477	0.818	0.617	0.649
Y1.1.5	0.421	0.624	0.587	0.799	0.630	0.749
Y1.2.3	0.661	0.459	0.452	0.694	0.612	0.587
Y1.2.4	0.535	0.552	0.520	0.755	0.528	0.683
Y1.3.2	0.673	0.680	0.516	0.719	0.632	0.642
Y1.3.4	0.614	0.561	0.469	0.832	0.624	0.670
Y1.3.5	0.617	0.524	0.509	0.803	0.712	0.712
Y1.4.1	0.536	0.701	0.493	0.867	0.787	0.687
Y1.4.2	0.542	0.610	0.596	0.806	0.699	0.618
Y1.4.3	0.601	0.671	0.653	0.743	0.703	0.718
Z1	0.357	0.743	0.549	0.587	0.378	0.431
Z2	0.540	0.878	0.775	0.672	0.620	0.681
Z3	0.567	0.849	0.522	0.727	0.827	0.702
Z4	0.506	0.868	0.749	0.604	0.645	0.664

By looking at the high cross loading value, which is >0.7 which ranges from 0.701 to 0.891, it can be said that all indicators have met the criteria and can be continued for further analysis.

Furthermore, from the convergent validity test, the AVE value must be > 0.5, so the latent variable (Z) has met the requirements and is declared convergently valid.

Table- 8 AVE value

	Average Variance Extracted (AVE)
Business Process	0.652
Operation Performance	0.699
Maintenance Performance	0.644
TAM Performance	0.625
Contractor Competence	0.675
TAM scope	0.642

Then the Fronell-Larcker criterion is used as a discriminant validity test, so the AVE for each latent variable must be higher than R2 with all other latent variables. So thus, each latent variable shares more variance with each of its indicator blocks than with other latent variables that represent a different block of indicators.

Table- 9 Fronell-Larcker Criterion Value

Variable	A Maintenance Performance	X3 Contractor Competence	X1 Business Process	X2 TAM scope	Y TAM Performance	Z Operation Performance
A : Maintenance Performance	0.802					
X3 : Contractor Competence	0.530	0.821				
X1 : Business Process	0.543	0.649	0.807			
X2 : TAM scope	0.631	0.842	0.770	0.801		
Y : TAM Performance	0.640	0.853	0.711	0.870	0.791	
Z : Operation Performance	0.785	0.743	0.593	0.747	0.774	0.836

In formative constructs, the collinearity of indicators can be tested by calculating the variance inflator factor (VIF), a VIF value below 5 indicates that the indicator has no correlation problems with other indicators in one construct (Hair, 2011).

Table- 10 Inner VIF value

	Maintenance Performance	Contractor Competence	Business Process	TAM scope	TAM Performance	Operation Performance
Maintenance Performance						1.695
Contractor Competence					3.429	
Business Process					2.457	
TAM Scope					4.881	
TAM Performance						1.695
Operation Performance						

Table 9 shows that all independent variables have a VIF value of <5, so they don't have a multi-collinearity problem.

Table- 11 Composite Reliability and Cronbach's Alpha values

Variable	Composite Reliability	Cronbach's Alpha
Maintenance Performance	0.942	0.931
Contractor Competence	0.912	0.879
Business Process	0.903	0.866
TAM scope	0.947	0.937
TAM Performance	0.952	0.945
Operation Performance	0.903	0.855

Based on table 10, it can be concluded that the composite reliability and Cronbach's Alpha values of the latent variable meet the requirements, namely > 0.7. So it can be concluded that the indicators on all variables are declared reliable and consistent.

Evaluation of the inner model or test of the structural model is needed to see the direct or indirect effect between variables. In this study testing with PLS-SEM to see the results of the path coefficient test, goodness of fit test and hypothesis testing. R2 results above 0.67 for endogenous latent variables in the structural model, showing the effect of exogenous variables on endogenous variables are included

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in the good category, while results between 0.33-0.67 are included in the moderate category and 0.19-0.33 are included in weak category (Ghozali, 2005).

The R-square value on the TAM performance variable and Operational performance is 0.811 and 0.740. This informs that the magnitude of the percentage influence of business processes, TAM scope and workforce planning on TAM performance is 81.1%, while the remaining 19.9% is influenced by other factors outside the research model between TAM performance (Y) to Operations performance (Z).

In the operating performance response variable, the value of the influence of TAM performance on operating performance is 74% and the remaining 26% is influenced by other factors outside the research model between operating performance (Z) on plant availability & reliability, TAM cost performance, safety performance and company reputation.

In the goodness of fit assessment, it can be seen through the average value of communality and the average R2. This value is almost similar to the R2 function in the regression analysis, with the higher the GoF value, the more fit the model is with the data. GoF calculation according to (Fornell and Larcker 1981), as follows:

$$GoF = \sqrt{ØComx\ ØR2} \quad \text{…………………………………………………...} \quad (4.1)$$

$$GoF = \sqrt{0{,}514 \times 0{,}776}$$

$$GoF = 0{,}631$$

With a GoF calculation result of 0.631, it means that the variance of the research data in this structural model is 65.8%, which means that the goodness of fit of this structural model is good. GoF values range from 0 to 1, with interpretations of 0.1 (small), 0.25 (moderate), and 0.36 (large) (Zali and Latan, 2012).

Table- 12 Hypothesis Test Results

Hypothesis	Relationship Explanation	Path Coefficient	T Statistics	P Values	Keterangan
H1	Business Process to TAM Performance	0.122	0.820	0.414	Positive influence and insignificant
H2	TAM Scope to TAM Performance	0.135	**3.305**	0.001	Positive influence and significant
H3	Kompetensi kontraktor to TAM Performance	0.094	**4.400**	0.000	Positive influence and significant
H4	TAM Performance to Operation Performance	0.134	**3.440**	0.001	Positive influence and significant
H5	Maintenance Performance to Operation Performance	0.133	**3.685**	0.000	Positive influence and significant

The hypothesis test in this study was carried out by looking at the T-Statistics value where the research hypothesis can be declared accepted if the T-Statistics value > T table.

B. Hypothesis:

- H0 : There is no influence between the independent variables on the dependent variable partially
- H1 : There is an influence between the independent variables on the dependent variable partially

C. Kriteria Keputusan :

- If T-Statistics value < T table (t(0.05, 44) = 2,017), so H0 will be accepted.
- If T-Statistics value > T table (t(0.05, 44) = 2,017), then H1 will be accepted.

Table- 13 Hypothesis Testing Results

No.	Hypothesis	Conclusion
1	H1 : There is a positive and significant influence between Business Process (X1) on TAM Performance. (Y)	Rejected
2	H2 : There is a positive and significant influence between TAM Scope (X2) on TAM Performance. (Y)	Accepted
3	H3 : There is a positive and significant influence between contractor competence (X3) on TAM Performance. (Y)	Accepted
4	H4 : There is a positive and	Accepted
	significant influence between TAM Performance (Y) on Operational Performance (Z)	
5	H5 : There is a positive and significant influence between Maintenance Performance (A) on Operational Performance (Z)	Accepted

D. Hypothesis 1: Effect of Business Process on TAM Performance

Based on the hypothesis testing presented in table 12 that the proposed H1 is rejected, this means that the business processes carried out by PT. X have no significant effect on the performance of the TAM program. Resulted from a positive path coefficient value of 0.122, which means it has an effect, but it also produces a T-statistic value (0.820) < T table (2.017), so the relationship value is not significant. This is not in line with research conducted by (Akbar & Ghazali, 2016) that there is a significant influence and relationship between planning and TAM performance and in another study conducted by (Vichich, 2006) which states that the characteristics of TAM and the level of definition and planning can provide a measurable influence on the success of TAM. However, even this can be said to be in line with research conducted by (Obiajunwa, 2012) which suggests that, one of the arguments is that organizations tend to be interested in adopting factors to achieve TAM program success, such as methodology, tools, knowledge and skills, but continue to measure TAM results use the wrong criteria. In the case of TAM business process planning at PT.X it was found that the organization has a framework to run the TAM program but has not consistently implemented it. The determination of the shutdown driver is determined based on management decisions (executive decisions) from various departments, such as engineering, reliability, maintenance, in terms of determining critical work criteria and TAM duration, in other cases also determining TAM intervals of a year, two years or more. The inconsistency of determining success criteria will affect the planning process and TAM performance at the implementation stage. The person in charge of work (Job Owner) must re-manage the scope of work, work contracts and material procurement to adjust to changes in the shutdown driver based on management decisions.

E. Hypothesis 2: Effect of TAM Scope on TAM Performance

Based on the hypothesis testing presented in table 12, the proposed H2 is accepted. This means that the scope of TAM has a positive and significant effect on TAM performance. This is in line with research conducted by (Vichich, 2006) that the scope definition and planning practices are one of the important indicators of the success of the TAM program. The path coefficient value of 0.135 was obtained and the T-statistic value (3.305) > T-table (2.017) was also obtained, which meant a positive and significant effect. This shows that the determination of the scope of work in its implementation significantly affects TAM performance. In the case study at PT.X the TAM planning function does not stand alone, but becomes an operational planning function. This can be an obstacle as well as another challenge in determining the priority and performance of work programs for the TAM program in particular. Limitations on accommodation and safety plans with a high number of workers when TAM activities become a bottle neck in implementing all TAM scope plans, time and manpower allocation becomes unequal due to scope planning conflicts.

F. Hypothesis 3: Effect of Contractor Competence on TAM Performance

Based on the hypothesis test presented in table 12 that the proposed H3 is accepted. This means that contractor competence has a positive and significant effect on TAM performance. This is in line with research conducted by (Al-Marri et al, 2020) that workforce expertise has a positive influence on the performance of TAM projects in the oil and gas industry. It is known that the path coefficient value is positive by 0.094 and the T-statistic value (4.400) > T table (2.017), in the sense that it has a positive and significant effect. In the case of PT.X TAM's workforce planning is a contractor who has worked at AG facilities and is familiar with the structure and work procedures that are applied, so TAM's scope adjustment in terms of expertise and specialization is supportive. The use of contractor labor is obtained by using labor procurement contracts with a duration of 3 years to 5 years, so that the continuity of the use of contractors with competence according to company standards is always guaranteed as long as the contract is running.

G. Hypothesis 4: Effect of TAM Performance on Operational Performance

Based on the hypothesis testing presented in table 12 that the proposed H4 is accepted, which means that TAM performance has a positive and significant influence on operating performance. This is in line with research conducted by (Elwerfalli et al., 2018) that the chosen methodology can increase the uptime associated with the TAM interval in order to improve operational performance in terms of availability and reliability. It is known that the positive path coefficient value is 0.134 and the T-statistic value (3.440) > T-table (2.017), which means a positive and significant effect. For the case study at PT.X determining TAM performance based on quality, time and cost during the implementation of the TAM program can increase the value of "operating days without unplanned shutdown" as a measurement of the final performance of an oil and gas field process operation. Continuous plant availability will increase the volume of production sold and reduce costs due to un-planned shutdowns. SKK Migas as part of consumers as well as regulator of upstream oil and gas business activities in Indonesia, monitors the target of achieving maintenance performance every month in PT.X's monthly report to SKK Migas. The minimum plant availability target of 98% must include production and availability loss plans when TAM activities are carried out every year.

H. Hypothesis 5: Effect of Maintenance Performance (Maintenance) on Operational Performance

Based on the hypothesis testing presented in table 12 that the proposed H5 is accepted, which means that maintenance performance has a positive and significant effect on operating performance. Operational performance as measured by plant uptime, revenue, achievement of work and safety programs and company reputation, gets a significant influence from the implementation of a good equipment maintenance program. It is known that the path coefficient value is positive by 0.133 and the T-statistic value (3.685) > T-table (2.017) thus indicating a significant influence of the two variables. In the case study at PT.X, the maintenance program is one of the implementation categories under plant online or plant shutdown conditions. The activity planner will sort out the equipment maintenance schedule by utilizing online conditions and un-planned shutdown events as effectively as possible, so that the TAM scope and TAM performance control function can be optimized. Availability and reliability of good production operation tools will improve operational performance by reducing equipment breakdown rates.

In VSM data processing, the case study of TAM Flare Tip Inspection work implementation, a lean manufacturing approach is carried out by eliminating 14 hours of change over time waste by substituting work steps with Rope Access Technic (RAT) and streamlining the Total Lead Time by 17 hours . These two lean rework results succeeded in increasing the Value Added Time (VAT) value from 67% to 81% and increasing lead time effectiveness by 63%, which means that the VSM method can increase the TAM performance improvement ratio in addition to the variables of time, quality and cost. In indicators Y.1.1, Y.1.2 and Y.1.4., where the lean manufacturing element in TAM performance gets a mean value in the range between 4.27 – 4.32, which means that 85.4% to 86.4% of respondents agree that improvements lean manufacturing can improve TAM's overall performance.

I. Based on the Results of the Research that has been done, it can be Concluded the Following Things:

- In the practice of implementing lean manufacturing with the VSM method, it is found that the overall achievement of lean in the implementation of planned shutdown flare tip inspection, future state VSM can increase the value of the VAT ratio (value added time) from 67% to 81% and increase in effectiveness by 63% , calculated from the percentage division of the average takt time in the future state to the current state.
- TAM business process planning has a positive but not significant effect on TAM performance, this indicates that there is no relationship. Good or bad TAM performance is not influenced by the TAM planning process. So to improve the planning process so that it affects TAM performance, companies need to improve TAM management governance in accordance with the literature and TAM research results in the same industry.
- TAM scope has a positive but not significant effect on TAM performance, this indicates that there is no relationship. Good or bad TAM scope planning does not affect TAM performance. So to improve TAM performance so that it can carry out all TAM supporting plans properly, companies need to improve TAM management time management so that preparation and planning can be managed insufficient time.
- Contractor competence has a positive and significant effect on TAM performance. This explains that the higher the contractor's competency value, the higher the TAM's performance value. Vice versa if the value of the contractor's competence is low, TAM's performance will be even lower.
- TAM performance has a positive and significant effect on operating performance. This explains that the higher the TAM performance value, the higher the operating performance value. Vice versa if the TAM performance value is low, the TAM performance value will be even lower.
- The effect of improving lean manufacturing with the VSM method on the TAM performance variable was well received by the respondents. Lean improvements in lead time and change over time can improve TAM performance as value added from performance measures other than time, cost and TAM quality.
- Maintenance performance (maintenance) has a positive and significant impact on operating performance. This explains that the higher the maintenance performance value, the higher the operating performance value. Vice versa if the maintenance performance is low then the operating performance value will be lower.

J. Some of the Limitations and Weaknesses in this Study are as Follows:

- The number of samples is small, in this study the number of samples is only 44 from the core workforce on the AG platform which is the object of research, limited availability of workers who are directly involved in the planning and implementation phases of TAM on the AG platform, only 50 workers. A good number of samples can increase the value of the validity and reliability of research. Respondents' positions could be further expanded into the fields of production management and project management, so that the questionnaire responses could represent the field of planning.
- VSM data processing as an effort to improve business processes is only limited to TAM flare tip inspection activities which have a relatively short duration. Selection of a TAM event with a longer duration will improve the quality of VSM data processing and recommendations for the future state of VSM for companies.

K. Based on the Conclusions of the Research Results Above, the Following Suggestions can be Given to Related Parties Including:

- For Companies

For the company's top management to be able to focus on planning the TAM program by strengthening the organization and creating a framework that is in accordance with the nature of the oil and gas business in Indonesia, so that plant uptime can be maintained at the highest level with good TAM performance quality. In order for improvement objectives to be achieved, it must be supported by the development of the capabilities of personnel involved in TAM planning management and by using project management techniques as the governance of TAM management. VSM can be the main tool for determining the optimum time for implementing the TAM program by making maps of the current state and future state as well as streamlining takt time to achieve TAM performance efficiency targets.

➢ *For Future Researchers*

For future researchers who will research the same problem topic in order to expand the VSM lean manufacturing analysis by adding a larger TAM scope and adding several factors in statistical analysis that can affect the company's operating performance.

REFERENCES

[1] Akbar, J. U. D., & Ghazali, Z. B. (2016). The mediating influence of team alignment on the relationship between plant turnaround maintenance planning and plant turnaround maintenance performance. International Journal of Economics and Financial Issues, 6(3), 76–82.

[2] Al-Marri, A. N., Nechi, S., Ben-Ayed, O., & Charfeddine, L. (2020). Analysis of the performance of TAM in oil and gas industry: Factors and solutions for improvement. Energy Reports, 6(November 2018), 2276–2287. https://doi.org/10.1016/j.egyr.2020.08.012

[3] Al-Turki, U. M., Duffuaa, S. O., & Ben-Daya, M. A. (2013). A holistic system approach for turnaround performance management. Maintenance Performance Measurement and Management,MPMM, September. https://doi.org/10.13140/2.1.2805.0886

[4] ELWERFALLI, A. A., KHAN, M. K., & MUNIVE-HERNANDEZ, J. E. (2018). a New Methodology To Optimize Turnaround Maintenance (Tam) Scheduling for Gas Plants. 104–117. https://doi.org/10.1142/9789813230774_0008

[5] Elwerfalli, A., Khan, M. K., & Munive-Hernandez, J. E. (2019). Developing Turnaround Maintenance (TAM) Model to Optimize TAM Performance Based on the Critical Static Equipment (CSE) of GAS Plants. International Journal of Industrial Engineering and Operations Management, 01(01), 12–31. https://doi.org/10.46254/j.ieom.20190102

[6] Ghaithan, A. M. (2020). An optimization model for operational planning and turnaround maintenance scheduling of oil and gas supply chain. Applied Sciences (Switzerland), 10(21), 1–20. https://doi.org/10.3390/app10217531

[7] Hair Jr, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S. (2021). Partial least squares structural equation modeling (PLS-SEM) using R: A workbook. In Springer. https://link.springer.com/content/pdf/10.1007/978-3-030- 80519-7.pdf

[8] Hines, P., & Rich, N. (1997a). The seven value stream mapping tools. International Journal of Operations and Production Management, 17(1), 46–64. https://doi.org/10.1108/01443579710157989

[9] Hines, P., & Rich, N. (1997b). The seven value stream mapping tools. International Journal of Operations & Production Management, 17(1), 46–64. https://doi.org/10.1108/01443579710157989

[10] Milana, M., Khan, M. K., & Munive, J. E. (2014). A framework of knowledge based system for integrated maintenance strategy and operation. Applied Mechanics and Materials, 564(February 2015), 619–624. https://doi.org/10.4028/www.scientific.net/AMM.564.619

[11] Obiajunwa, C. C. (2012). A framework for the evaluation of turnaround maintenance projects. Journal of Quality in Maintenance Engineering, 18(4), 368–383. https://doi.org/10.1108/13552511211281543

[12] Pradana, A. P., Chaeron, M., & Khanan, M. S. A. (2018). Implementasi Konsep Lean Manufacturing Guna Mengurangi Pemborosan Di Lantai Produksi. Opsi, 11(1), 14. https://doi.org/10.31315/opsi.v11i1.2196

[13] Sahoo, T. (2013). Process Plants Shutdown and Turnaround Management. In Process Plants.

[14] Shou, W. (2018). Enhanced Value Stream Mapping for Improving Turnaround Process Efficiency in Oil and Gas Industry. March.

[15] Shou, W., Wang, J., Wu, P., & Wang, X. (2021). Lean management framework for improving maintenance operation: development and application in the oil and gas industry. Production Planning and Control, 32(7), 585– 602. https://doi.org/10.1080/09537287.2020.1744762

[16] Vichich, B. (2006). Leading indicators of turnaround performance outcomes. NPRA 2006 Reliability and Maintenance Conference and Exhibition - Technical Papers, 2006.

[17] Wenchi, S., Wang, J., Wang, X., & Chong, H. Y. (2015). An application of value stream mapping for turnaround maintenance in oil and gas industry: Case study and lessions learned. Proceedings of the 31st Annual Association of Researchers in Construction Management Conference, ARCOM 2015, September, 813–822.

[18] Yansen, O., & Bendatu, L. Y. (2013). Perancangan Value Stream Mapping dan Upaya Penurunan Lead time pada Bagian Procurement-Purchasing di PT X. Titra, 1(2), 9– 16.