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Analysis of Improving Production Performance Based on Maintenance Management Including Process, Maintenance Workforce, and Quality Control (Case Study at Pt. XYZ)

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***Abstract*—** Maintenance of production facilities is an important part of supporting the production process. Maintenance Performance is one of the inputs for the production process. The production performance measurements need to be carried out to determine the effectiveness of the maintenance program has been implemented. This research aims to analyze the factors that influence maintenance performance consisting of Maintenance Process, Maintenance Workforce, and Maintenance Quality Control. Furthermore, the influence of Maintenance Performance on Production Performance was also analyzed. In this research, the data was collected by spreading questionnaires from 100 selected respondents, and then data was analyzed using the PLS-SEM method using SmartPLS 3.2.9 software. The analysis results show that Maintenance Process, Maintenance Workforce, and Maintenance Quality Control have a positive and significant effect on Maintenance Performance. Likewise, Maintenance Performance has a positive and significant effect on Production Performance.

***Keywords*—** Maintenance process, Maintenance Workforce, Maintenance Quality Control, Maintenance Performance, Production Performance, PLS-SEM, SmartPLS.

I. INTRODUCTION

This research was conducted at PT. XYZ is a company engaged in the exploration and production of petroleum and natural gas in Indonesia. The challenges faced by the company currently are decreasing their production from oil and gas wells, the age of production facilities, and the reliability of facilities starting to decline as indicated by an increase in the number of breakdown and maintenance backlogs, as well as PM/CM ratio and PPM compliance the low.

Maintenance backlog is a deferred maintenance activity and has not been completed according to plan. This could be due to the increasing number of corrective maintenance being carried out, the ratio of the number of workers and workload being unbalanced, the availability of materials, or being postponed because it needs to be aligned with the planned production facility maintenance schedule (planned shutdown).

Planned Plant Maintenance (PPM) compliance is an indicator used to measure the level of completion of the Planned Maintenance programs. PPM compliance data show achievement within the range of 70% - 90%, which is still below the company's target of above 90%. Based on Best Maintenance Practices (BMP), PPM compliance should be above 90% (R. Smith & Hawkins, 2004:221).

PM/CM Ratio is a comparison of the number of working hours used for preventive maintenance (PM) and corrective maintenance (CM). Smith & Hawkins (2004) stated that based on Best Maintenance Practices (BMP), the PM/CM ratio value is 6 PM:1 CM, or if converted to the ratio value it is 6. If the PM/CM ratio value is >6, the value indicates the maintenance function has done too much work in preventive maintenance. On the other hand, if the PM/CM ratio is <6 the program's preventive maintenance of the existing ones is not good enough, causing a lot of work corrective maintenance triggered by premature damage to production facilities (Smith & Hawkins, 2004).

Unplanned shutdown is the impact of problems with the reliability of production equipment and facilities which causes lost production opportunities (LPO). Maintenance record data for 2020-2021 shows that there have been several damages to production facilities including the serious damage classification category. Severe damage that occurs to production facilities has an impact on reducing production capacity (capacity impairment), increased repair costs, and loss of the

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opportunity to carry out production (lost production opportunity).

This research aims to determine the direction and magnitude of the influence of the Maintenance Process, Maintenance Workforce, and Maintenance Quality Control on Maintenance Performance. And what is the direction and magnitude of the influence of Maintenance Performance on Production Performance? Researchers developed a conceptual framework and research hypotheses as follows:

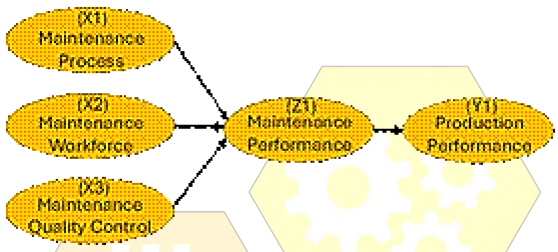

Figure 1. Conceptual Framework

Research Hypothesis:

H1: Maintenance Process has a positive and significant effect on Maintenance Performance

H2: Maintenance Workforce has a positive and significant effect on Maintenance Performance

H3: Maintenance Quality Control has a positive and significant effect on Maintenance Performance

H4: Maintenance Performance has a positive and significant effect on Production Performance

II. LITERATURE REVIEW

Assauri (2008:133) maintenance is an activity to be carried out to maintain production equipment or facilities and carry out repairs, adjustments, or replacements as necessary to obtain a production process activity that is satisfactory and by what was planned (Firmansyah, 2015).

Maintenance aims to ensure that the machine and all production equipment are ready for use, reduce or slow down the level of wear and damage to the machine, obtain the lowest possible maintenance costs by carrying out regular and planned maintenance activities, maintain quality at the right level to meet the requirements of the product, and so that production activities are not disrupted.

Production facility maintenance strategies can be carried out in several ways, they are preventive maintenance (PM), corrective maintenance (CM), and predictive maintenance (PdM).

PM is a maintenance strategy designed to carry out maintenance activities at predetermined intervals to reduce the possibility of failure or decreased performance (Ben-Daya et al., 2009). CM is maintenance performed after a functional failure occurs and is intended to return equipment to a state where it can perform its required function. This concept has weaknesses in the form of unplanned production process stops, excessive damage, spare parts problems, high repair costs, excessive waiting times, maintenance duration, and problem-solving times (Mohamed Ben-Daya et al., 2009). PdM is a maintenance activity that is initiated based on analyzing historical process data forecasting based on data trends, and predicting the right time to carry out maintenance tasks (Jimenez et al., 2020).

The maintenance management process is very important in determining the effectiveness and efficiency of Maintenance Performance. Wireman (1998) mentioned that maintenance effectiveness can represent overall company satisfaction with achieving production capacity and the availability of its assets. Palmer (1999), The effectiveness of maintenance can also be shown through the reduction in company costs obtained because production capacity is available when needed (Barberá et al., 2012). Efficiency is an action related to minimizing waste, expenditure, or unnecessary effort. Efficiency is then understood as performing better maintenance at the same cost as before (Barberá et al., 2012). The Maintenance Management Process consists of a plan, execution, evaluation, and control.

Furthermore, the composition and contribution of the Maintenance Workforce is important in carrying out maintenance tasks. Maintenance Workforce's capacity, competence, and motivation will greatly influence Maintenance Performance. Workforce size (Ighravwe & Oke, 2014), knowledge (Hariadi et al., 2020), skills and motivation (Maryulina, 2010), and work discipline (Haryadi et al., 2018)are several factors that influence workforce performance and productivity.

Quality maintenance provides a certain level of confidence that the equipment being repaired or maintained will function safely and reliably. Quality in maintenance is very important because poor quality maintenance can cause severe consequences in production facilities (Dhillon, 2006:140). The development of good maintenance quality control is essential to ensure high-quality repairs, accurate standards, maximum availability, and equipment life cycle as well as efficient equipment production levels (Ben-Daya & Duffuaa, 1995).

Maintenance quality control is responsible for ensuring that the quality objectives of resources, procedures, and standards used in the Maintenance Process are met. In addition, he carries out inspections of maintenance work and testing of equipment before it is accepted or put into operation. The quality of maintenance depends largely on the skills, motivation, and attitudes of maintenance personnel, the effectiveness of supervisors, and the level of compliance with work standards and instructions (Duffuaa & Raouf, 2015).

Maintenance performance (maintenance performance) is the company's ability to use all its resources to realize strategic plans and maintenance programs for production facilities to achieve a target level of effectiveness, efficiency, and productivity that has been determined and agreed upon. Meanwhile, according to Kadim (2017: 113), two factors are often used to measure production system performance, namely Utilization and Efficiency. Utilization is the percentage of utilization achieved against the design capacity (design capacity) from a production facility. Meanwhile, efficiency is the percentage of achieved utilization of effective capacity (effective capacity) from a production facility (Kadim, 2017).

III. METHOD

This research will explain the causal relationship between variables through hypothesis testing, namely testing research hypotheses based on previously formulated theories, then the data obtained calculating using a quantitative approach (Sugiyono, 2018).

Data collection was carried out by distributing questionnaires to a predetermined sample, involving 100 respondents who worked as core employees at PT. XYZ in the division maintenance, operation, planning & scheduling. After all the questionnaire data had been collected then continuing with the data processing and analysis using the SmartPLS Application Version 3.2.9 to obtain the results of the algorithm analysis (algorithm).

PLS-SEM analysis consists of two sub-models, namely: the outer model and the inner model. Testing the Outer Model or outer relation or measurement model defines the relationship between indicators and their latent variables. Testing in the outer model is a validity and reliability test. Validity testing consists of convergent validity and discriminant validity. Convergent validity is tested through parameters loading factor and value Average Variance Extracted (AVE). The measurement results are declared valid if the value loading factor is more than 0.7 and the AVE value is more than 0.5 (Hair et al., 2014). Discriminant validity is established when an indicator's loading on a construct is higher than all its cross-loadings with other constructs. The reliability test is seen based on the value Cronbach's alpha must be greater than 0.7 and the composite reliability value must be greater than 0.7 (Hair et al., 2014).

An inner model test was carried out to test the relationship between latent constructs. Inner models include inner relations, structural models and substantive theory describes the relationship between latent variables based on substantive theory.

The inner model is tested by looking at the R-square, Q-square, and path coefficient (path coefficient) to obtain information on how much the dependent latent variable is influenced by the independent latent variable, as well as a significance test to test the significance value of the relationship or influence between variables (Hair et al., 2014).

For the measurement of the significance of the hypothesis, a comparison of T-table and T-statistic values can be used. If the T-statistic value is greater than the T-table value, then it is significant. Conversely, if the T-statistic value is smaller than the T-table value, then it is not significant (Jogiyanto & Abdillah, 2009).

IV. PLS-SEM ANALYSIS RESULTS

4.1. Outer Model Analysis (Measurement Model)

Validity Test

a. Outer Loading

In the first iteration, the evaluation using 41 indicators produced 36 indicators with outer loading values >0.7 and 5 indicators <0.7.

Outer loading 36 indicators were declared valid, and 5 indicators were invalid, so they had to be eliminated from the model. The following are the results of the model used in the research model for further analysis:

Table 1. *Loading Factor*

Variable	Indicator	Value	Evaluation	Variable	Indicator	Value	Evaluation
X1 Maintenance Process	X1.1.1	0.817	Valid	X3 Maintenance Quality Control	X3.1.1	0.722	Valid
	X1.1.3	0.831	Valid		X3.1.2	0.782	Valid
	X1.1.4	0.812	Valid		X3.1.3	0.909	Valid
	X1.2.2	0.837	Valid		X3.2.1	0.784	Valid
	X1.2.3	0.828	Valid		X3.2.2	0.841	Valid
	X1.3.1	0.848	Valid		X3.3.1	0.817	Valid
	X1.3.2	0.848	Valid		X3.3.2	0.806	Valid
	X1.3.3	0.830	Valid		X3.3.3	0.804	Valid
	X1.3.4	0.850	Valid		X3.3.4	0.875	Valid
X2 Maintenance Workforce	X2.1.1	0.791	Valid	Y1 Production Performance	Y1.1.2	0.871	Valid
	X2.1.2	0.771	Valid		Y1.1.3	0.886	Valid
	X2.2.1	0.785	Valid		Y1.2.1	0.915	Valid
	X2.2.2	0.859	Valid		Y1.2.2	0.905	Valid
	X2.2.3	0.831	Valid		Y1.2.3	0.811	Valid
	X2.2.4	0.896	Valid	Z1 Maintenance Performance	Z1.2.1	0.764	Valid
	X2.2.5	0.802	Valid		Z1.2.2	0.820	Valid
	X2.2.6	0.838	Valid		Z1.3.1	0.885	Valid
	X2.3.2	0.825	Valid		Z1.3.2	0.876	Valid

b. Average Variance Extracted (AVE)

All latent variables including maintenance process, maintenance workforce, maintenance quality control, maintenance performance, and production performance have an AVE value greater than 0.5. Thus, it can be stated that each variable has good validity.

Table 2. *Average Variance Extracted (AVE)*

Variabel	AVE	Evaluation
X1. Maintenance Process	0.695	Valid
X2. Maintenance Workforce	0.677	Valid
X3. Maintenance Quality Control	0.668	Valid
Z1. Maintenance Performance	0.702	Valid
Y1. Production Performance	0.771	Valid

c. Cross loading

The cross-loading value is declared valid if the loading indicator on a construct is higher than all cross-loadings with other constructs. A measurement is categorized as having discriminant validity if it has a cross-loading value of 0.7. The loading value in the model can be seen in the following table:

Table 3. *Cross loading*

Indicator	X1 Maintenance Process	X2 Maintenance Workforce	X3 Maintenance Quality Control	Y1 Production Performance	Z1 Maintenance Performance	Evaluation
X1.1.1	**0.817**	0.555	0.611	0.570	0.569	Valid
X1.1.3	**0.831**	0.641	0.637	0.643	0.591	Valid
X1.1.4	**0.812**	0.645	0.595	0.592	0.574	Valid
X1.2.2	**0.837**	0.606	0.595	0.675	0.614	Valid
X1.2.3	**0.828**	0.555	0.679	0.594	0.623	Valid
X1.3.1	**0.848**	0.666	0.684	0.707	0.637	Valid
X1.3.2	**0.848**	0.616	0.695	0.650	0.573	Valid
X1.3.3	**0.830**	0.658	0.551	0.669	0.582	Valid
X1.3.4	**0.850**	0.648	0.671	0.742	0.659	Valid
X2.1.1	0.567	**0.791**	0.495	0.523	0.561	Valid
X2.1.2	0.660	**0.771**	0.613	0.678	0.591	Valid
X2.2.1	0.473	**0.785**	0.502	0.560	0.483	Valid
X2.2.2	0.600	**0.859**	0.547	0.614	0.553	Valid
X2.2.3	0.735	**0.831**	0.532	0.688	0.620	Valid
X2.2.4	0.684	**0.896**	0.635	0.725	0.646	Valid

X2.2.5	0.524	**0.802**	0.505	0.592	0.523	Valid
X2.2.6	0.622	**0.838**	0.544	0.625	0.581	Valid
X2.3.2	0.611	**0.825**	0.567	0.654	0.607	Valid
X3.1.1	0.634	0.564	**0.722**	0.564	0.599	Valid
X3.1.2	0.687	0.680	**0.782**	0.667	0.563	Valid
X3.1.3	0.788	0.625	**0.909**	0.688	0.663	Valid
X3.2.1	0.537	0.436	**0.784**	0.573	0.553	Valid
X3.2.2	0.573	0.557	**0.841**	0.643	0.613	Valid
X3.3.1	0.577	0.414	**0.817**	0.541	0.567	Valid
X3.3.2	0.611	0.538	**0.806**	0.659	0.590	Valid
X3.3.3	0.551	0.570	**0.804**	0.557	0.531	Valid
X3.3.4	0.626	0.529	**0.875**	0.571	0.571	Valid
Y1.1.2	0.686	0.669	0.654	**0.871**	0.711	Valid
Y1.1.3	0.687	0.716	0.654	**0.886**	0.726	Valid
Y1.2.1	0.691	0.671	0.713	**0.915**	0.784	Valid
Y1.2.2	0.697	0.700	0.699	**0.905**	0.670	Valid
Y1.2.3	0.674	0.617	0.541	**0.811**	0.605	Valid
Z1.2.1	0.545	0.533	0.608	0.658	**0.764**	Valid
Z1.2.2	0.552	0.465	0.517	0.574	**0.820**	Valid
Z1.3.1	0.651	0.720	0.677	0.741	**0.885**	Valid
Z1.3.2	0.667	0.600	0.584	0.691	**0.876**	Valid

Based on the table above, the loading indicator of a construct (which is printed in bold) has the highest value for the variable it forms, compared to the loading indicator with other variables (cross-loading), thus the cross-loading value of all indicators for each variable is declared valid.

d. Fornell-Larcker Criterion

The Fornell-Larcker Criterion states that the square root of the AVE value for each construct must be higher than the correlation value between constructs in a model. Sarwono (2007) states that the Fornell-Larcker Criteria is used to ensure discriminant validity, so the AVE for each latent variable must be higher than the R-square with all other latent variables.

Tabel 4. *Fornell-Larcker Criterion*

Variable	**X1** Maintenance Process	**X2** Maintenance Workforce	**X3** Maintenance Quality Control	**Y1** Production Performance	**Z1** Maintenance Performance
X1. Maintenance Process	**0.833**				
X2. Maintenance Workforce	0.746	**0.823**			
X3. Maintenance Quality Control	0.763	0.670	**0.817**		
Y1. Production Performance	0.781	0.768	0.746	**0.878**	
Z1. Maintenance Performance	0.725	0.701	0.717	0.800	**0.838**

The table above shows that the square root value of AVE is higher than the correlation value between latent variables. Thus, all variables are declared valid based on the Fornell-Larcker criteria.

Reliability Test

Reliability tests are carried out to prove the accuracy, consistency, and precision of the instrument for measuring the construct. Cronbach's alpha provides an estimate of reliability based on the intercorrelation of observed indicator variables. To achieve good reliability, the composite reliability value and Cronbach's alpha must be greater than 0.70

Table 5. *Composite Reliability and Cronbach's alpha*

Variable	*Composite Reliability*	Cronbach's Alpha	Evaluation
X1. Maintenance Process	0.953	0.945	Reliable
X2. Maintenance Workforce	0.950	0.940	Reliable
X3. Maintenance Quality Control	0.947	0.937	Reliable
Z1. Maintenance Performance	0.904	0.858	Reliable
Y1. Production Performance	0.944	0.926	Reliable

Based on the table above, the composite reliability and Cronbach alpha values for all variables used in this study have composite reliability Cronbach alpha values of more than 0.7 (reliable). Thus, it can be concluded that each indicator of each variable is declared reliable, accurate, consistent, and appropriate for measuring the variables used in this research.

4.2. Outer Model Evaluation

Coefficient of Determination (R-Square)

Evaluation of the R-Square, determination coefficient is used to show how much effect or influence the independent variable has on the dependent variable. Chin (1998) states that R-square results of 0.67 and above for endogenous latent variables in the structural model indicate that the influence of exogenous variables on endogenous variables is in a good category. Meanwhile, if the result is 0.33 – 0.67 then it is included in the moderate category, and if the result is 0.19 – 0.33 then it is included in the weak category (Chin, 1998).

Table 6. *R-Square Value*

Variable	R Square	Evaluation
Z1. Maintenance Performance	0.624	Moderate
Y1. Production Performance	0.640	Moderate

Based on the table above, Maintenance Performance and Production Performance have a "Moderate" level of reliability.

In assessing goodness of fit or predictive relevance, it can be determined through the Q-Square value. Ghozali (2014:79), Q-Square can be used to measure how well the observation values are produced by the model and also the estimated parameters. A Q-square value >0 indicates that the model has good predictive relevance. The calculation of the Q-Square value is as follows (Hair et al., 2011):

$$\boldsymbol{Q^2} = 1 - (1 - R1^2)\,(1 - R2^2) \qquad \text{……………………(1)}$$

The calculation results show that the Q-square value is 0.865, meaning that the amount of diversity in the research data that can be explained by the structural model developed in this research is 86.5%. Based on these results, the structural model in the research has a large goodness of fit. The GoF value ranges from 0 to 1 with the interpretation of the values: 0.1 (small GoF), 0.25 (medium GoF), and 0.36 (large GoF) (Hair et al., 2014).

Hypothesis Test

The Hypothesis test in this research was carried out by comparing T-Statistics and T-Table, where the research hypothesis can be accepted if the T-Statistics > T table.

Table 7. *Hypothesis test results*

Hypothesis	Variable	Path Coefficient	T Statistic	P Value	Evaluation
H1	X1. Maintenance Process -> Z1. Maintenance Performance	0.263	2.190	0.029	Positive and significant effect
H2	X2. Maintenance Workforce -> Z1. Maintenance Performance	0.290	3.052	0.002	Positive and significant effect
H3	X3. Maintenance Quality Control -> Z1. Maintenance Performance	0.322	2.668	0.008	Positive and significant effect
H4	Z1. Maintenance Performance -> Y1. Production Performance	0.800	17.767	0.000	Positive and significant effect

Table 6 above shows that H1, H2, H3, and H4 have path coefficient values greater than 0.1 and are positive, thus all hypotheses have a positive influence. Meanwhile, the significance value can be seen from a p-value <0.05, based on the data above H1, H2, H3, and H4 have a p-value <0.05 which means it is significant. The T-statistic value for H1, H2, H3, and H4 is greater than the T-table, meaning that all hypotheses are "accepted".

V. DISCUSSION

H1: The Effect of Maintenance Process on Maintenance Performance

H1 obtained T-Statistics (2.190) > T table (1.985), meaning that there is a positive and significant influence Maintenance Process on Maintenance Performance. The path coefficient of Maintenance Process (X1) to Maintenance Performance (Z1) is 0.263 (positive). The coefficient value shows a direct influence, namely if the other variables are constant, then Maintenance Performance (Z1) is influenced by Maintenance Process (X1) by 26.3%. This explains that the better the Maintenance Process, the performance of maintenance performance will also be better or increased. Likewise, if the Maintenance Process is lower, the Maintenance Performance will be lower or decrease. This is in line with research conducted by Muchiri, (2011) which stated that the Maintenance Process is a determining factor for success that drives Maintenance Performance (Muchiri et al., 2011).

H2: The Effect of Maintenance Workforce on Maintenance Performance

H2 obtained T-Statistics (3.052) > T table (1.985), This means that there is a significant positive influence of Maintenance Workforce on Maintenance Performance. The path coefficient of Maintenance Workforce (X2) to Maintenance Performance (Z1) is 0.290 (positive). The coefficient value shows a direct influence, namely if the other variables are constant, then Maintenance Performance (Z1) is influenced by Maintenance Workforce (X2) by 29.0%. This explains that a higher Maintenance Workforce value leads to higher Maintenance Performance. Likewise, if the Maintenance Workforce value is lower, Maintenance Performance will be lower or decrease. According to Groote (1995), the competence of the maintenance team is an important factor that impacts maintenance performance. This means that maintenance performance depends on the expertise and knowledge of the team in completing maintenance tasks (Fatoni et al, 2018). Peach et al, (2016) in their research revealed that competence (skill level) and motivation are the most important human maintenance factors that affect the performance of the maintenance function (Peach et al., 2016).

H3: The Effect of Maintenance Quality Control on Maintenance Performance

Maintenance Quality Control has a positive and significant effect on Maintenance Performance. The obtained T-Statistics value (2.668) > T table (1.985). This means that Maintenance Quality Control has a significant positive influence on Maintenance Performance. The path coefficient of the Maintenance Quality Control (X3) on Maintenance Performance (Z1) is 0.322 (positive). The coefficient value shows a direct effect, namely if the other variables are constant then Maintenance Performance (Z1) is influenced by Maintenance Quality Control (X3) by 32.2%. This explains that a higher Maintenance Quality Control value leads to higher on Maintenance Performance. Likewise, if the Maintenance Quality Control value is lower, the Maintenance Performance value will be lower or decrease. This is in line with research conducted by Maletič (2014) which states that maintenance quality has a significant effect on Maintenance Performance (Maletič et al., 2014).

H4: The Effect of Maintenance Performance on Production Performance

The Maintenance Performance has a positive and significant effect on The Production Performance measured in terms of facility utilization and production efficiency. The obtained T-statistics value (17.767) > T-table (1.985). This means Maintenance Performance has a significant positive effect on Production Performance. The path coefficient of the Maintenance Performance (Z1) on Production Performance (Y1) is 0.800 (positive). The coefficient value shows a direct influence, namely if the other variables are constant then Production Performance (Y1) is influenced by Maintenance Performance (Z1) by 80.0%. This explains that the higher the Maintenance Performance value, the higher or increased Production Performance will be. Likewise, if the Maintenance Performance value is lower, Production Performance will be lower or decrease. These results are in line with research conducted by Jasasila (2017), Iqbal (2017, and Anggraeni et al. (2016); maintenance activities have a significant and influential effect on the production process and Production Performance (Jasasila, 2017), there is an influence of preventive maintenance and breakdown maintenance activities on the smoothness of the production process and Production Performance (Iqbal, 2017), maintenance has a positive and significant effect on product quality and production performance (Anggraini & Maulana, 2016).

VI. CONCLUSION

Based on the results of the research that has been carried out, the following can be concluded:

1. The Maintenance Process which consists of planning, execution, monitoring, and control, has a positive and significant effect on Maintenance Performance by 26.3%. This explains that the better the implementation of the Maintenance Process, the better the Maintenance Performance will be, and vice versa.

2. Maintenance Workforce Maintenance (maintenance workforce) which consists of capacity, capability, and motivation has a positive and significant effect on Maintenance Performance by 29.0%. This means that the better the quality of the Maintenance Workforce as assessed by capacity, capability, and work motivation, the better the Maintenance Performance will be, and vice versa.
3. Maintenance Quality Control consists of methods, work equipment (tools), and improving the quality of the Maintenance Workforce has a positive and significant effect on Maintenance Performance by 32.2%. This explains that the better the choice of work methods, the use of standardized work equipment, and the improvement in the quality of the Maintenance Workforce, the better the Maintenance Performance will be, and vice versa.
4. Maintenance Performance which is influenced by three independent variables, namely Maintenance Process, Maintenance Workforce, and Maintenance Quality Control has a positive and significant effect on Production Performance by 80.0%. This explains that the better the Maintenance Performance, the better the Production Performance, and vice versa.

VII. SUGGESTION

Based on the limitations of this research, the researcher suggests improvements for further research as follows:

1. It is hoped that further research can develop this research or further explore the influence of the independent variables used in this research on Maintenance Performance, especially in companies engaged in the exploration and production of petroleum and natural gas (oil & gas companies) more broadly, or by using other independent variables such as to get a more complete picture of Maintenance Performance and the independent variables that influence it.
2. This needs to be done considering that currently, the development of information technology is increasingly rapid, which can have a direct and indirect impact on the strategies and work methods used by companies to achieve optimum results more effectively and efficiently.
3. Campaigns by government agencies and community organizations throughout the world that are concerned about sustainability and the use of green energy to prevent uncontrolled global installations will have an impact on government policies towards companies operating in these countries, in particular companies engaged in the exploration and production of petroleum and natural gas. With this policy, of course, companies are required to adjust their company strategy immediately so that they can run their operation effectively and efficiently.
4. Further research using a larger sample, more complete independent variables, and involving more companies operating in the oil and gas business sector in Indonesia. Of course, this research will have a bigger and broader impact, both for oil and gas companies operating in Indonesia and for the government as the owner and manager of natural resources, especially oil and natural gas in Indonesia.

REFERENCES

[1] Anggraini, M., & Maulana, R. (2016). Pengaruh Pemeliharaan Mesin Terhadap Kualitas Sepatu Pada PT. Nikomas Gemilang. Sains: Jurnal Manajemen Dan Bisnis, 9(1), 59–74. https://doi.org/10.35448/jmb.v9i1.5356

[2] Barberá, L., Crespo, A., Viveros, P., & Stegmaier, R. (2012). Advanced model for maintenance management in a continuous improvement cycle: Integration into the business strategy. International Journal of Systems Assurance Engineering and Management, 3(1), 47–63. https://doi.org/10.1007/s13198-012-0092-y

[3] Ben-Daya, M., & Duffuaa, S. O. (1995). Maintenance and quality: The missing link. Journal of Quality in Maintenance Engineering, 1(1), 20–26. https://doi.org/10.1108/13552519510083110

[4] Ben-Daya, Mohamed, Duffuaa, S. O., Knezevic, J., Ait-Kadi, D., & Raouf, A. (2009). Handbook of maintenance management and engineering. In Handbook of Maintenance Management and Engineering. https://doi.org/10.1007/978-1-84882-472-0

[5] Chin, W. (1998). The Partial Least Squares Approach to SEM chapter. Modern Methods for Business Research.

[6] Dhillon, B. . (2006). Maintainability, Maintenance, and Reliability for Engineers. In Maintainability, Maintenance, and Reliability for Engineers. Taylor & Francis Group. https://doi.org/10.1201/9781420006780

[7] Duffuaa, S. O., & Raouf, A. (2015). Planning and control of maintenance systems: Modelling and

analysis. In Planning and Control of Maintenance Systems: Modelling and Analysis. https://doi.org/10.1007/978-3-319-19803-3

[8] Firmansyah, A. (2015). Pengaruh Pemeliharaan Mesin Terhadap Kualitas Produk Pada Perusahaan Haryati Bordir Tasikmalaya. Jurnal Manajemen Ekonomi.

[9] Hair, J., Hult, T., Ringle, C., & Sarstedt, M. (2014). A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM). In Long Range Planning (Vol. 46, Issues 1–2). SAGE Publications. https://doi.org/10.1016/j.lrp.2013.01.002

[10] Hariadi, D. P. A., Muhammad, M. N., & Falefi, R. P. (2020). Effect of Talent Management and Knowledge Management on Company Reputation With Employee Performance As an Intervening Variable: Case Study of Employees At Pt Taspen (Persero). International Journal of Organizational Innovation (Online), 13(2), 160–177. https://www.ijoi-online.org/attachments/article/278/1105 Final.pdf

[11] Haryadi, A., Parashakti, R. D., & Nashar, M. (2018). Effect of Styles and Leadership Work Discipline on Employee Performance (Case Study of PT. Telecommunication Indonesia Tbk Dki Jakarta). KnE Social Sciences, 3(10), 419–429. https://doi.org/10.18502/kss.v3i10.3392

[12] Ighravwe, D. E., & Oke, S. A. (2014). A Non-Zero Integer Non-Linear Programming Model for Maintenance Workforce Sizing. International Journal of Production Economics, 150, 204–214. https://doi.org/10.1016/j.ijpe.2014.01.004

[13] Iqbal, M. (2017). Pengaruh Preventive Maintenance (Pemeliharaan Pencegahan) dan Breakdown Mainteannce (Penggantian Komponen Mesin) terhadap Kelancaran Proses Produksi di PT.Quarryndo Bukit Barokah. Manajemen Dan Bisnis (Almana), 1(3), 321–330.

[14] Jasasila. (2017). Peningkatan Mutu Pemeliharaan Mesin Pengaruhnya Terhadap Proses Produksi Pada Pt. Aneka Bumi Pratama (Abp) Di Kabupaten Batanghari. Jurnal Ilmiah Universitas Batanghari Jambi, 17(3), 96–102.

[15] Jimenez, V. J., Bouhmala, N., & Gausdal, A. H. (2020). Developing a predictive maintenance model for vessel machinery. Journal of Ocean Engineering and Science, 5(4), 358–386. https://doi.org/10.1016/j.joes.2020.03.003

[16] Kadim, A. (2017). Penerapan Manajemen Produksi dan Operasi Di Industri Manufaktur (N. Sunardi & A. Sutarman (eds.); Pertama). Mitra Wacana Media.

[17] Maletič, D., Maletič, M., & Gomišček, B. (2014). The Impact of Quality Management Orientation on Maintenance Performance. International Journal of Production Research, 52(6), 1744–1754. https://doi.org/10.1080/00207543.2013.848480

[18] Maryulina, A. (2010). Analisis Pemeliharaan Mesin Produksi Pada PT. P&P Bangkinang di Desa Simalinyang. In Universitas Islam Negeri Sulthan Syarif Kasim Riau (Vol. 15, Issue 40). Universitas Islam Negeri Sulthan Syarif Kasim Riau.

[19] Muchiri, P., Pintelon, L., Gelders, L., & Martin, H. (2011). Development of Maintenance Function Performance Measurement Framework and Indicators. International Journal of Production Economics, 131(1), 295–302. https://doi.org/10.1016/j.ijpe.2010.04.039

[20] Peach, R., Ellis, H., & Visser, J. K. (2016). A Maintenance Performance Measurement Framework that includes Maintenance Human Factors: A Case Study from The Electricity Transmission Industry. South African Journal of Industrial Engineering, 27(2), 177–189. https://doi.org/10.7166/27-2-1492

[21] Smith, R., & Hawkins, B. (2004). Lean maintenance: reduce costs, improve quality, and increase market share. In Plant Engineering CN - TS155 .S635 2004. files/723/Ricky Smith-Lean Maintenance _ Reduce Costs, Improve Quality, and Increase Market Share (Life Cycle Engineering Series) (2004).pdf