Journal of Positive School Psychology http://journalppw.com
2022, Vol. 6, No. 8, 2438-2452

An Hierarchical Latent Variable Model Of Reliability Centered Maintenance Using PLS-SEM And Its Impact On Productivity Of Gas Processing Companies

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Abstract

The role of maintenance management is vital, especially in companies with sustainable production; machines are forced to operate 24 hours a day without any breaks, which results in a greater risk of damage occurring. The exhibition is supported by various devices consisting of several process systems, including the refrigerant, hot oil, water plant, and WTP (water treatment plant). This study aims to determine what factors exist in the implementation of reliability centered maintenance that can reduce equipment downtime and increase productivity, as well as determine the design and development of a maintenance system model improvement based on a reliability centered maintenance system to obtain a good level of productivity in the gas processing industry. . The population in this study were employees of the operational and maintenance division of the Tambun LPG plant as many as 60 employees, with the number of samples using saturated samples where all populations were used as samples. The data analysis method in this study uses the Structural Equation Model-Partial Least Square (SEM-PLS) with hierarchical components with a reflective-reflective measurement model consisting of three lower-order constructs (preventive maintenance, predictive maintenance, and reactive maintenance) and three constructs higher-order (implementation of RCM, equipment downtime, and productivity). Reliability Centered Maintenance (RCM) was found to have a positive and significant effect on productivity. Reliability Centered Maintenance (RCM) was found to have a positive and significant impact on Equipment Downtime. Equipment Downtime is a mediating variable in the relationship between reliability-centered Maintenance (RCM) and productivity. Reliability-centered maintenance (RCM) with its lower order Preventive Maintenance construct was found to have a positive and significant effect on productivity. Reliability-centered maintenance (RCM), with its lower order Predictive Maintenance construct, was found to have a positive and significant impact on productivity. Reliability-centered maintenance (RCM), with its lower order Reactive Maintenance construct, was found to have a positive and significant effect on productivity.

Keywords: Realibility Centered Maintenance, Equipment Downtime, Productivity, SEM PLS

1. Introduction

The existence of limitations on production factors requires a way of managing these factors, namely by using a management system to manage all owned resources, both production management, distribution management, and maintenance management, to obtain maximum production results in various industrial lines the energy sector. One of the commodities that play an essential role in the national energy sector is oil and gas. The oil and gas sector is the government's main commodity in meeting domestic energy needs and is one of the industries contributing to the most considerable non-tax state revenue in Indonesia. The natural gas sector is one of the commodities that has experienced an increase in demand from year to year, especially since Indonesia implemented the kerosene to LPG conversion program in 2007. Sales of processed natural gas, especially LPG, have increased and are expected to cause LPG imports to increase in the next few years. In contrast to the amount of LPG production, imports are carried out because natural gas reserves and processing are decreasing from 2016 - to 2020. In contrast to the amount of LPG production, imports are carried out because natural gas reserves and processing are decreasing from 2016 - to 2020.

Based on the 2019 performance report of the directorate general of oil and natural gas at the Ministry of Energy and Mineral Resources, national natural gas reserves tend to stagnate and experience a slight decline; this can happen due to the shortage of raw materials that are running low, and the amount of production for downstream LPG refineries has decreased from previous years. The production achievement trend shows stagnant gas refineries. It tends to decline for the percentage of achievements based on predetermined targets. From the total existing LPG production of 1,394,804 million tons in 2016, it decreased to 1,063,499 million tons in 2020, and the capacity of the LPG refinery that can operate in 2020 is only 3.89 million tons per year. This happens because several upstream and downstream LPG refineries are not operating due to maintenance and repair of the refinery or other problems.

LPG is a natural gas product processed at the LPG Plant. This gas processing industry uses a multilevel fractionation system in its production process. The production activities are supported by several process systems, including the refrigerant, absorber, heating, fractionation, storage, air instrument, water treatment, power system, and several other processes. The Tambun LPG plant is one of the LPG processing industries in the West Java region, which has decreased production from year to year (Internal Data, 2021). This is related and directly proportional to the frequency of downtime that occurs, where downtime also increases from year to year.

One of the reasons for the decline in production capacity is the declining productivity of processing refineries, so turnaround (TA) activities and maintenance activities are needed to restore the performance of refineries operating in the upstream and downstream gas processing industries. In the natural gas processing industry, there are three main types of machines in the LPG production system: a gas compressor unit with a reciprocating model, a generator set engine, and a refrigerant compressor unit. Where for each unit of the station, several machines operate simultaneously, including the gas compressor unit, there are three units of equipment, the generator unit has three units of equipment, and the refrigerant screw compressor unit has three units of equipment, all of which are rotary engines with fuel. Natural gas.

Damage that often occurs in production machines will have a direct impact on the company's high maintenance costs and will result in the cessation of the production process, decreased machine effectiveness, and, most importantly, consumers are harmed, decreased trust in the company makes consumers less loyal to the product, will undoubtedly have a negative impact on the company. The application of maintenance management in the company is very influential in reducing losses caused by problems in repairing production machines, which directly affect the company's budget. The role of maintenance management is vital, especially in companies with sustainable production; machines are forced to operate 24 hours a day without any breaks, which results in a greater risk of damage occurring. Production is supported by various machines consisting of several processes, including the refrigerant system, hot oil system, water plant system, and WTP (water treatment plant).

The value of the OEE calculation on the tambun LPG plant from October to March 2020 for refrigeration machine tools is 72%, a decrease in the same period in 2021 by 69%. Based on the tabulation results of the average availability in the six significant losses analysis, it can be seen that the factor that most influences the low OEE is availability which shows that machine downtime is the main problem in the refrigeration system. The tambun LPG plant increases productivity and reduces the maintenance budget so that the impact on the company's operational costs decreases.

According to Dunn, S., budgeting for maintenance in medium and large-scale industries takes 30-50% of the overall operational costs, depending on the type of industry, from equipment investment to workforce needs. The distribution depends on the company's number of plants and equipment. In addition, indirectly implementing a flawed maintenance system will result in low machine reliability and increase the possibility of downtime. Equipment downtime that occurs directly impacts the loss of cessation of production activities, which can result in a decrease in quality and loss of both time and financial loss for the company. The increase in the cost of maintenance activities is getting higher, as well as the decrease in the quantity and quality of production, one of which can be caused by the decline in the reliability of production machines.

A common problem in the maintenance system is low machine reliability; this happens because of several factors related to one machine to another. One machine's low reliability can impact other machines; both performance and production activities are disrupted. The problems are directly related to low production efficiency and a decrease in production quality that often occurs; this is caused by a maintenance system that still needs improvement. Thus, in this case, disrupting production activities results in a decrease in product quality and quantity, which is very detrimental to the company. Meanwhile, the general problem experienced in the gas processing industry is a decrease in the amount of production from time to time and production problems that have not reached the set target; this can be caused by breakdowns of production machines that often occur due to the ineffectiveness of the production machine maintenance system applied in the company so that for this problem it is necessary to design a maintenance system improvement model that refers explicitly to preventive maintenance improvements.

Several methods can be used in developing care management, each with advantages and disadvantages. Reliability-centric maintenance (RCM) is the basic foundation of physical maintenance and a method for developing planned preventive maintenance (Hivarekar et al., 2020). The reliability and structure of the performance achieved is based on the principle that it is a function of the design. The quality that establishes effective preventive maintenance ensures a reliable design implementation of equipment with four key components in the RCM: post-maintenance, preventive maintenance, predictive testing and inspection, and preventive maintenance.

Several previous studies examined how RCM implementation was able to increase performance productivity and reduce equipment downtime (Putri et al., 2020; Zakikhani et al., 2020; Chin et al., 2020; Szpytko & Duarte, 2019; Haq & Riandadari, 2019; Sembiring & Elvira, 2018; Cullum et al., 2018; Wibowo et al., 2021; Lagrada et al., 2018; Prasetya & Ardhyani, 2018), but not many previous studies have applied the SEM method to their analytical techniques. This is reinforced by research using the SLR (systematic literature review) method conducted by Poduval et al. (2015), finding that there is much literature on TPM, RCM, and its concepts. However, the available literacy on aspects that affect the application of TPM in the industry is limited. For this reason, there is enormous scope for conducting additional research on this issue using the SEM method, which is still not widely used. It is also seen that the researcher has not carried out statistical validation of the model developed in SEM, and there is an opportunity in this space for further research.

Several recent studies that apply the concepts of TPM and RCM with statistical validation using SEM (Structural Equation Modeling) have been applied by Talan & Bhattacherjee (2021), Díaz-Reza et al. (2018), Sasitharan et al. (2020) found that the implementation of RCM can increase productivity and reduce equipment downtime. The purpose of this study is to fill gaps in previous studies where researchers use statistical validation using SEM (Structural Equation Modeling) to see the effect of the implementation of Reliability Centered Maintenance (RCM) which is divided into three aspects, namely preventive, predictive and reactive maintenance to reduce the number of equipment downtime and increase the productivity of the company's performance by taking a case study on one of the gas processing companies, namely the tambun LPG plant.

2. Literature Review

2.1 Reliability Centered Managament (RCM)

Reliability-centric maintenance (RCM) is used to determine what needs to be done to enable a physical asset to continue to perform the expected functions in the context of current operations, The process to be done (Pranoto, 2015). According to Kurniawan (2013), reliability-centered maintenance (RCM) is a practical approach for developing PM (preventive maintenance) programs in minimizing equipment failures and providing industrial plants with practical tools and optimal capacity to meet customer demands and excel in competition. In addition, the impact of implementing RCM is an increase in reliability and a decrease in total maintenance costs for all components.

2.2 Preventive Maintenance

According to Assauri in Sudrajat (2016), preventive maintenance is a maintenance activity performed to prevent unexpected damage and identify conditions or situations in which production equipment may be damaged when used in the production process. Meanwhile, according to Ebeling in Sudrajat (2016), preventive maintenance is maintenance carried out on a scheduled basis, generally periodically, where several maintenance tasks such as inspection, repair, replacement, cleaning, lubrication, and adjustments are carried out.

2.3 Predictive Maintenance

According to Purba (2018), predictive maintenance is predictive maintenance, in this case an evaluation of regular maintenance (preventive maintenance). This detection can be evaluated from the indicators installed in the installation of a tool and also perform vibration and alignment checks to add data and further corrective actions. According to Purba (2018), predictive maintenance is carried out based on the current condition of a machine or system. Machine components that are damaged or indicated to be damaged will be replaced immediately. Predictive maintenance can optimize system constraints and save on parts inventory because not all parts must be provided.

2.4 Reactive Maintenance

Reactive maintenance is a maintenance mode in which everything is done until it fails. No action or effort is taken to keep the device in its original condition. So, reactive maintenance is a form of maintenance where equipment and facilities are repaired due to breakdown or failure. Reactive maintenance is performed in response to unplanned or unscheduled downtime, usually due to a failure, whether an internal or external failure. The advantages of reactive maintenance are lower initial costs than other maintenance methods. They require only a few staff in the repair process. The disadvantage of reactive maintenance is the increased cost of unplanned equipment downtime. This can increase the costs associated with repairing or replacing equipment, inefficient use of staff resources, and increased labor costs, especially if a time extension is required due to the replacement or replacement process. Repair of components that are not known in time.

2.5 Equipment Downtime

According to Agustin (2017), equipment downtime is the time a tool cannot operate due to a failure However, other equipment can replace that function, so the factory or company can continue to operate and the production process can continue to operate. Therefore, it is necessary to have a maintenance team in charge of providing maintenance on the machines and equipment used. Furthermore, according to Agustin (2017), downtime is the same as waste. Waste is anything that has no added value. Waste is not only in the form of wasted material but also other resources, including time, energy, and work area.

2.6 Productivity

According to Cahayani (2017), productivity is the relationship between a production system's input and output. In general, productivity can be interpreted as a measure of how optimally the resources are used together in a company. If more output is produced with the same input, it is called an increase in productivity. Likewise, productivity is said to increase if a lower input can produce a constant output. Productivity is a term that is often confused with the word production. Productivity and production have different meanings because when production is high, productivity is not necessarily high; it could be that productivity is even lower. High and low productivity is related to the efficiency of the resources (input) in producing a product or service (output). Thus, it can be said that productivity is related to the efficiency of user inputs in producing outputs (goods/services).

2.7 Structural Equation Modeling - Partial Least Square (SEM - PLS)

Sewal Wright developed this idea in 1934. to begin with known as route analysis, this approach changed into later narrowed down to a form of structural equation version analysis (Dachlan, 2014). SEM (Structural Equation Modeling) is a statistical technique that could examine the pattern of relationships among latent constructs and their signs, latent constructs with every different, and direct size errors. SEM lets in evaluation between several established and unbiased variables immediately. PLS is a part or variation-primarily based Structural Equation Modeling (SEM) equation, model according to Ghozali (2014), PLS is an opportunity method that movements from a covariance-primarily based SEM approach to a distribution-based method. Covariance-primarily based SEMs normally take a look at causality / principle, even as PLS is a more predictive model. PLS is a effective analytical method as it does not depend on many assumptions (Ghozali, 2014). as an instance, the information have to be usually distributed. The pattern isn't always critical. similarly to confirming the concept, PLS can also be used to explain whether or not there is a relationship among latent variables. PLS can simultaneously analyze the composition formed by means of reflexes and formative indicators.

Based on the literature review above, the hypotheses presented in this study are:

H1: Implementation of Reliability Centered Maintenance (RCM) Has a Positive and Significant Effect on Productivity

H1a: Implementation of Preventive Maintenance (Reliability Centered Maintenance (RCM)) Has a Positive and Significant Effect on Productivity

H1b: Implementation of Predictive Maintenance (Reliability Centered Maintenance (RCM)) Has a Positive and

Significant Effect on Productivity

H1c: Implementation of Reactive Maintenance (Reliability Centered Maintenance (RCM)) Has a Positive and Significant Effect on Productivity

H2: Implementation of Reliability Centered Maintenance (RCM) Has a Positive and Significant Effect on Equipment Downtime

H3: Equipment Downtime Mediates the Relationship Between Reliability Centered Maintenance (RCM) Implementation and Productivity

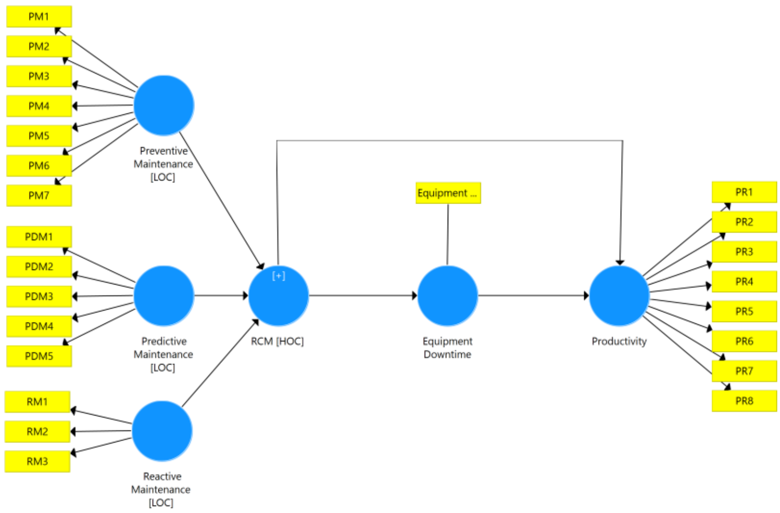

Figure 1. Conceptual Model

3. Methodology

This research refers to the background and is oriented to the implementation design of Reliability Centered Maintenance (RCM) and the formulation of the problem. The methodology that will be used in this research is descriptive quantitative analysis research to discuss a problem by researching, processing data, analyzing, interpreting what is written with an orderly and systematic discussion and for next reserch can analyzing the root of the problem and making improvements, then closing with conclusions and giving advice as needed. Quantitative data is from a survey given to employees of the Tambun LPG Plant operational division. The population in this study were employees of the operational and maintenance division of the Tambun LPG plant, with as many as 60 employees. This study uses a saturated sample where the samples were taken are employees of the Tambun LPG plant operational division, as many as 60 employees consisting of the maintenance division as many as 21 employees (35%), the Operations division as many as 31 employees (52%), and the Engineering & Logistics division as many as eight employees. (13%), as well as sample trouble/breakdown on machines in the 2020 period.

The data analysis was performed using SEM PLS (a structural equation that models partial least squares), an evaluation of the measurement model (external model). Convergent validity, discriminative validity and reliability. Another test, the evaluation of the structural model (internal model), is performed by examining the values of the R-squared (R2), Q-squared, and fitting models. In addition, the final test is a hypothetical test performed by the resampling bootstrap method. The test statistic used is a t-statistic or a t-test. The data was collected using a pre-made questionnaire. In addition, the partial least squares-structural equation modeling (PLS-SEM) application system is used to validate the study results, which is expected to yield accurate data on the impact of implementing reliability centered maintenance (RCM). increase. Reduce plant downtime and improve productivity. The variables or constructs in this study are divided into two, namely the higher-order construct (HOC) and the lower-order construct (LOC). The HOC represents a more general construct similar to the reflective measurement model, simultaneously explaining all the underlying LOC. Operational variables in this study are shown in table 1.

Table 1. Measurement Scales

Construct		Indicators
Higher Order	**Lower Order**	
Implementasi RCM	Preventive maintenance Diadaptasi dari Kalir, Rozen dan Morrison (2017); Duenckel,Soileau dan Pittman (2017); Reza et al (2018)	Preventive upkeep as a exceptional method
		Preservation branch committed to prevention and operator support
		Record the renovation movements done at the equipment
		Disclose data of the renovation statistics
		Clean get right of entry to to equipment upkeep records
		Report the best generated by using the device
		Become aware of reasons of device screw ups and record the facts
	Predictive maintenance Diadaptasi dari Sasitharan et al. (2020)	Minimizing deliberate downtime
		Maximizing system lifespan
		Optimizing worker productiveness
		Monitoring control or equipment performance for early detection
		locate defects and removal of gadget defects
	Reactive maintenance Diadaptasi dari Parida dan Kumar (2002)	Breakdown maintanance
		Run-to-failure maintenance
		Repair maintance
Equipment Downtime Diadaptasi dari Talan dan Bhattacherjee (2021)		Downtime of equipment system (minutes) = Repair time of equipment (minutes)+Forced ideal time (minutes)
Productivity Diadaptasi dari Shen (2015); Ma et al. (2011); Reza et al (2018)		Removal of productiveness losses
		Extended gadget reliability and availability
		Discount of preservation expenses
		Advanced final product first-rate
		Decreased spare elements stock charges
		Advanced company generation
		Progressed response to market modifications
		Development of company aggressive capabilities

4. Results

The model design in this study uses a hierarchical component approach with a reflective-reflective measurement model consisting of three lower-order constructs (preventive maintenance, predictive maintenance, and reactive maintenance) and three higher-order constructs (RCM implementation, equipment downtime, and productivity). Data analysis in this study used the Partial Least Square Structural Equation Modeling (PLS-SEM) method.

4.1 Analysis of Confirmatory Factor Analysis

Confirmatory Factor Analysis The second-order construct has been carried out by testing the values of convergent validity, VIF collinierity, discriminant validity and construct reliability.

Table 2. Evaluation of Second-Order

Higher Order Construct			Lower Order Construct		
Item	**Loading**	**Decision**	**Item**	**Loading**	**Decision**
PDM1	0.773	Valid	**PDM1**	0.831	Valid
PDM2	0.795	Valid	**PDM2**	0.809	Valid
PDM3	0.836	Valid	**PDM3**	0.888	Valid
PDM4	0.694	Valid	**PDM4**	0.765	Valid
PDM5	0.874	Valid	**PDM5**	0.861	Valid
PM1	0.718	Valid	**PM1**	0.804	Valid
PM2	0.741	Valid	**PM2**	0.808	Valid
PM3	0.718	Valid	**PM3**	0.776	Valid
PM4	0.768	Valid	**PM4**	0.827	Valid
PM5	0.751	Valid	**PM5**	0.787	Valid
PM6	0.866	Valid	**PM6**	0.915	Valid
PM7	0.863	Valid	**PM7**	0.819	Valid
RM1	0.849	Valid	**RM1**	0.880	Valid
RM2	0.856	Valid	**RM2**	0.902	Valid
RM3	0.796	Valid	**RM3**	0.907	Valid

Hair et al to analyze the reflection model. An external load of over 0.6 is recommended. (2017). However, if the external load is less than 0.4, you will need to remove the reflection indicator. If the external load is between 0.4 and 0.7, it is recommended to keep or remove the item depending on the external load (height) of other items (Hair et al., 2017; Avkiran & Ringle, 2018). Based on this theory, the researchers took a value of 0.6. In addition, the extracted mean variance (AVE) must be greater than 0.5. Rather recommended. This ratio means that latent variables account for more than 50% of the variance of the reflectivity index. Based on the test results, you can see that all the measures meet the requirements for testing the value of the external exposure and extract an average variance (AVE) above 0.50. Therefore, they are called valid and latency variables. For VIF co-linearity tests, the VIF value is less than 10 in all predictor configurations. Therefore, co-linearity is not a problem between design dimensions. In the discriminant validity test, the 2.5% and 97.5% confidence interval (CI) values for each dimension of the variable value are less than or equal to 1.00. In contrast, the first step in running the HMTinference test is to bootstrap with 5000 resamplings to get the confidence interval values. (CI) is 1.00 or less to identify that there is no problem with the validity of the identification (Henseler et al., 2015). As a result, there are no identification validity issues with the supporting metrics. In the construct reliability test, the values for all latent variables are 0.70, and the Cronbach's alpha and rho_A values are 0.60. By testing the importance of the relationship between dimensions (LOC) and variables (HOCs), you identify the dimensions of the structure and determine the extent to which each dimension can explain each variable. If the p-value is less than 0.05 in 1.96, we can conclude that all lower dimensional configurations are components that make up the higher variable constructs.

4.2 Measurement Model Evaluation

The test examines the external stress and the extracted mean variance to validate the convergence. Here, the test results show that all measures meet the requirements for testing extreme stress values, as there are no questions below 0,6. In this case, we can conclude that the measurement target has a measurement capacity of more than 60% for each variable.

Table 3. Loadings

Item	Loadings	Decision	Item	Loadings	Kesimpulan	Item	Loadings	Decision
Equipment Downtime	1	Valid	**PM1**	0.804	Valid	**PR1**	0.744	Valid
PDM1	0.83	Valid	**PM1**	0.713	Valid	**PR2**	0.777	Valid
PDM1	0.77	Valid	**PM2**	0.808	Valid	**PR3**	0.86	Valid
PDM2	0.809	Valid	**PM2**	0.735	Valid	**PR4**	0.801	Valid
PDM2	0.797	Valid	**PM3**	0.776	Valid	**PR5**	0.854	Valid
PDM3	0.888	Valid	**PM3**	0.715	Valid	**PR6**	0.799	Valid
PDM3	0.836	Valid	**PM4**	0.827	Valid	**PR7**	0.845	Valid
PDM4	0.764	Valid	**PM4**	0.766	Valid	**PR8**	0.836	Valid
PDM4	0.691	Valid	**PM5**	0.787	Valid	**RM1**	0.88	Valid
PDM5	0.861	Valid	**PM5**	0.753	Valid	**RM1**	0.851	Valid
PDM5	0.876	Valid	**PM6**	0.915	Valid	**RM2**	0.902	Valid
PDM1	0.83	Valid	**PM6**	0.866	Valid	**RM2**	0.858	Valid
PDM1	0.77	Valid	**PM7**	0.82	Valid	**RM3**	0.907	Valid
PDM2	0.809	Valid	**PM7**	0.866	Valid	**RM3**	0.798	Valid
PDM2	0.797	Valid				**Equipment Downtime**	1	Valid
PDM3	0.888	Valid						
PDM3	0.836	Valid						

In addition, the extracted mean variance (AVE) must be greater than 0.5. Rather recommended. This ratio means that the latent variable accounts for more than 50% of the variance of the reflection indicator. To run the discriminant validity (CI) test, we bootstrapd 5000 resamps to get a confidence interval (CI) value of 1.00 or less and identified that there were no discriminant validity issues (Henseler et al., 2015). This study found that both 2.5% and 97.5% confidence intervals (CIs) for each dimension of the variable were 1.00 or less. Mutual load testing has revealed that the value of the external load in each configuration of interest is more important than the value of the external load in other configurations. The configuration reliability test in the analysis of this measurement model shows the results of the combined reliability test. This shows that all latent variable values have a value of 0.70 and Cronbach's alpha and rho_A values have a value of 0.60.

4.3 Structural Model

After the anticipated version meets the standards of the dimension model (outside version), the subsequent step is to check the structural version (inner model). in keeping with Ghozali (2015), the evaluation of structural fashions (inner fashions) objectives to expect relationships among latent variables. Haare et al. (2017) Ramaya et al. (2017) We advise to recollect the coefficient of determination (R2), the cost of impact length (f2), version suit, and predictive relevance (Q2) to evaluate the structural (inner version). The coefficient of determination test was performed using the R-square value or the coefficient of determination 0.470 (47%) from the device downtime configuration. In contrast, the coefficient of determination for productivity composition is 0.810 (81%). After analyzing the value of the coefficient of determination, further analysis is carried out by looking at the effect size, where the results show that all paths have a value range of 0.000 to 637.758. It was found that six relationships had a large (strong) influence. The predictive relevance (Q2) of the structural version measures how properly the observations are generated. in this have a look at, all values show values above 0.000, so we are able to finish the applicable predictions of the version. in the meantime, the in shape model evaluation for this have a look at became completed the usage of three take a look at models, which include Chi2, a standardized root imply rectangular (SRMR), and a normalized in shape index (NFI). Standardized root suggest rectangular. Residual (SRMR) is identical to 0.1 (0.097). but, other adjustment standards are not accumulated by way of the SmartPLS 3.0 software program. that is due to the fact a few goodness-of-fit standards aren't defined because this observe uses an iterative index version.

4.4 Hypothesis Testing

To test the proposed hypothesis, you can see it from the path factor, the bootslap t-statistic, and the p-value.

Table 3. Outer Weight, Outer Loading and Outer Loading

Path		Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Decision
H1	**Realibility Centered Maintenance (RCM) (X1) -> Productivity (Y2)**	0.6	0.6	0.1	6.2	**0**	Accepted
H1a	Preventive Maintanance -> Realibility Centered Maintanance (RCM) (X1) -> Productivity (Y2)	0.5	0.5	0	20	**0**	Accepted
H2b	Predictive Maintanance -> Realibility Centered Maintanance (RCM) (X1) -> Productivity (Y2)	0.3	0.3	0	19	**0**	Accepted
H3c	Reactive Maintanance -> Realibility Centered Maintanance (RCM) (X1) -> Productivity (Y2)	0.3	0.3	0	15	**0**	Accepted
H2	**Realibility Centered Maintenance (RCM) (X1) -> Equipment Downtime (Y1)**	0.7	0.7	0.1	13	**0**	Accepted
H3	**Realibility Centered Maintenance (RCM) (X1) -> Equipment**	0.3	0.3	0.1	4	**0**	Competitive Mediation

Path		Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Decision
	Downtime (Y1) -> Productivity (Y2)						

Direct Path

Based on the hypothesis test, the reliability-centric maintenance (RCM) coefficient did not affect productivity. Based on test results on the direct impact of reliability-oriented Maintenance (RCM) on productivity, the path coefficient value is 0.587, close to the +1 value, and the t-statistic value is 6.161 (> 1.96), Cohen. Since the effect value (f2) is 0.959 (strong) and the p-value is 0.000 (<0.05), the first hypothesis (H1) is accepted and it can be concluded that it is a reliability-centric maintenance (RCM). I can do it. It has a positive effect and has a great impact on productivity. Reliability-centric maintenance (RCM) factors have been found to impact asset downtime. This is because we can conclude that the higher the reliability-centric maintenance (RCM) operated by an enterprise, the more directly the asset downtime. Not all trust-centric maintenance (RCM) is supported. Based on test results on the direct impact of reliability-centric maintenance (RCM) on equipment downtime, the path factor value is 0.685, close to the +1 value, and the t-statistic value is 13.072. (> 1.96). The Cohen effect value (f2) is 0.424 (strong) and the value is 0.424 (strong). Since the P-value is 0.000 (<0.05), we can conclude that the second hypothesis (H2) was accepted. Equipment downtime factors have been found to affect their role as a partial intermediary between reliability-centric maintenance (RCM) and productivity.

Indirect Path

Based on test results on the indirect impact of reliability-centric maintenance (RCM) on productivity due to equipment downtime, the pass factor value is 0.267, close to +1. The t-statistic is 4.028 (> 1.96) and the p-value is 0.000 (<0.05). So it can be concluded that the third hypothesis (H3) is accepted. In the analysis using Variance Accounted For (VAF), the results found partially mediating with a magnitude of 31% (partial) as follows:

VAF = ((a*b))/((axb)+c)

VAF = ((0.685*0.390))/((0.685*0.390) + 0.587)

VAF = (0.267)/(0.854)

VAF = 0.312 (31% or partial mediation)

When referring to the theory development carried out by Hair et al. (2017), equipment downtime was found to have a complimentary mediation mediating effect. Either directly or indirectly, equipment downtime can affect reliability-centered maintenance (RCM). Productivity is an essential variable between the two variables.

5. Conslusion

Based on the results of the hypothesis test and the discussions in the previous chapters, some conclusions can be drawn. Trust-centric maintenance (RCM) has been found to have a significant positive impact on productivity. Reliability-centric maintenance (RCM) has been found to have a positive and significant impact on equipment downtime. Asset downtime is a parametric variable in the relationship between trust-centric maintenance (RCM) and productivity. Reliability-centric maintenance (RCM) with preventive maintenance subconstructs has a significant positive impact on productivity. Reliability-centric maintenance (RCM) with subordinate predictive maintenance structures has a significant positive impact on productivity. Reliability-centric maintenance (RCM) with low-order retroactive maintenance structures has been found to have a significant positive impact on productivity. The reliability-centric maintenance (RCM) coefficient affects the productivity factor with a path coefficient value of 0.587, a t-statistic of 6.161 (> 1.96), an f2 value of 0.959 (significant), and a p-value of 0.000 (<0.05) out. Moreover, the reliability-centered maintenance (RCM) factor can increase the productivity factor with preventive maintenance as the most influential factor because it has the largest original sample-path coefficient value with a value of 0.453 and T statistics of 19.863. The results of this study can be used as material for consideration and evaluation of reliability-centered maintenance (RCM), equipment downtime, and workers' productivity in maintaining the sustainability of the LPG (liquefied petroleum gas) industry. The various benefits of reliability-centered maintenance (RCM) in the LPG (liquefied petroleum gas) industry are expected to increase motivation to start a business.

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