Available online at : http://josi.ft.unand.ac.id/

Jurnal Optimasi Sistem Industri

| ISSN (Print) 2088-4842 | ISSN (Online) 2442-8795 |

Research Article

How Organizational Culture Moderate the Effect of Total Productive Maintenance Practice on Operational Performance? Evidences from Indonesian Mining Industry

Nasar Buntu Laulita

Universitas Internasional Batam, Batam, Kepulauan Riau 29442, Indonesia

ARTICLE INFORMATION

Received : May 27, 2021
Revised : October 28, 2021
Available online : November 29, 2021

KEYWORDS

Organizational culture, Operational performance, Structural Equation Model, Total Productive Maintenance, Mining industry

CORRESPONDENCE

Phone : +62 812 70 05621

E-mail : nasar_bl@yahoo.com.sg

A B S T R A C T

The industry needed a system to support its operation when most of the processes were done by equipment or machines. Total Productive Maintenance (TPM) was a system to ensure all equipment or machines run in optimal performance for long period by fully supported by top management until the bottom level. Implementation of this system in the mining industry was still seldom due to some factors and organizational culture was one of the reasons. The purpose of this research was to analyze the influence of TPM implementation on operational performance by moderating the effect of organizational culture in the mining industry by using a two-step approach of structural equation model (SEM). The research type was under explanative research with hypothesis testing from primary data that was obtained from distributing questionnaires and direct interviews in the field which was analyzed by using Lisrel 8.7. This research showed that the construct of TPM has a significant impact to influence operation performance directly in the mining industry with a t-value of 3.54 and organization culture also increases the significance by moderating effect with t-value of interaction 5.28 was higher than 1.96 while organizational culture was not significant to influence operational performance directly that was showed by t-value 1.22. This research had a novelty for studying TPM practice in Indonesian mining by using SEM to analyze the moderating effect of organizational culture. The managerial implication of this research was a guideline for decision-makers to implement TPM by considering developing, group, hierarchical, and rationale culture to improve operational performance in the Indonesian mining industry.

INTRODUCTION

In the last few decades, maintenance of machines and production equipment has developed into one of the most important areas in the business environment because increased global competition has led to tremendous changes in the way of companies operation to compete and improve their quality, efficiency and productivity [1]. According to Modgil & Sharma [2], changing in the perspective of a company affects the way of machines and production equipment are maintained to support a business success in global competition and increase productivity and quality by minimizing operational costs. Rastegari & Salonen [3] further add that the application of lean concept is one of the significant changes in every company starting from the manufacturing industry in the form of just in time and demand flow technology to be successful in a competitive market. It is the reason for the company to optimize maintenance of production equipment as one of the key aspects in continuous improvement to achieve high availability of production equipment to be more effective and efficient. It similar with Hooi & Leong [4] who state that more companies are replacing reactive and repair strategies after a breakdown (Corrective Maintenance) with proactive strategies such as Preventive Maintenance and Predictive Maintenance as well as aggressive strategies such as Total Productive Maintenance (TPM) to achieve world-class performance. TPM was introduced since year 1971 in Japan where the implementation needed support from all employees [5]. The TPM is based on the principles of 5S [5] and best presented as a TPM house [6], as shown in Figure 1.

The 5S is an acronym of Japanese language which means *Seiri* (organization, removal of unnecessary things away from workplace), *Seiton* (systematization, ordering of things in the workplace for easy availability), *Seiso* (cleaning, keeping the workplace neat), *Seiketsu* (standardization, establishment of high level of cleanliness and order in the workplace and creation of graphical and written standards), and *Shitsuke* (self-discipline, to ensure that people cared for organizations, systematization, cleaning, and standardization), or in English means Short, Set, Shine, Standardize and Sustain [7]. The house of TPM contains 5S as a base and eight pillars, i.e quality maintenance,

DOI: 10.25077/josi.v20.n2.p93-103.2021

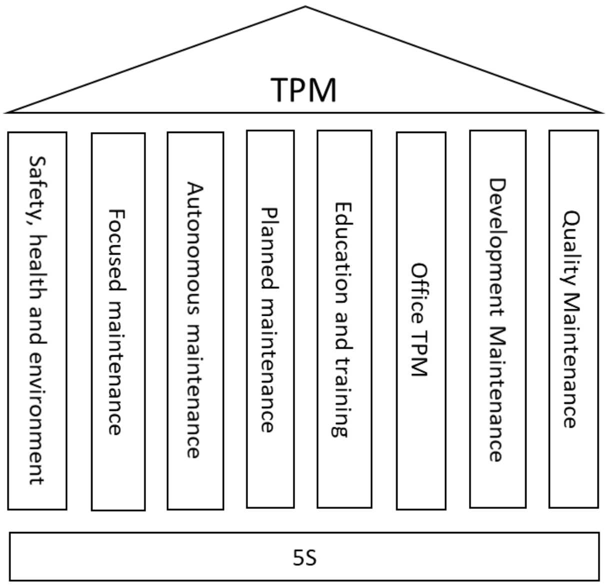

Figure 1. House of TPM

development maintenance, office TPM, education and training, planned maintenance, autonomous maintenance, focused maintenance, and SHE (safety, health and environment) [6]. Pačaiová & Ižaríková [6] also mention that Total means involvement of all the employees and elimination of all non-conformities, Productive means activities performed prior to problem origination and manufacturing problems are minimized continuously, and Maintenance means maintenance of equipment in good conditions and consistent performance of regular maintenance activities, such as repair, cleaning, greasing, checking, etc.

There were many studies had discussed the application of TPM in various industries, such as manufacturing industry [4], [8], pharmaceutical industry [2] and construction [9]. According to Brodny & Tutak [10], the TPM strategy can be also applied in the mining industry but it's still limited. In addition, Pourjavad & Shirouyehzad [11] in their research explain that TPM is one of the most influential maintenance strategic management in the mining industry. TPM practice also has a direct impact on operational performance such as research from Modgil & Sharma [2], Nnabuife et al. [12], Xiang & Feng [13], Jain et al. [14], Hooi & Leong [4], and Wilson et al. [15]. Operational performance is a part of organizational performance under non-financial and it measures the output result from organizational process in the plant level [16]. Based on several studies from Ismail et al. [17], Asaad & Yusoff [18], and Attri et al. [19] who mention that the implementation of TPM is very risky for getting failure because it requires the awareness of all parties in machine maintenance, maintenance planning and support from top management in achieving the best productivity and quality. TPM focuses on participation and commitment from all stakeholder in the organization to achieve the target because organization commitment is one of the foundation to achieve performance as per expectation [20]. It means that the implementation of TPM need to be supported by organization culture which one country is different each other. Indonesia is one of the mining production source in the world and has a unique culture that is able to influence an organizational culture. Some scholars from Indonesia had done research that related to TPM practice such as Adiutama et al. [21] on manufacturing company, Priyono et al. [22] on sugar refinery, and Nuprihatin et al. [8] on food company. Most of the those researches result mentioned the effectiveness of TPM practice but the outcome was different each other depend on organization commitment to implement all values of TPM. Several scholars mentioned that it is necessary to change the organization culture to achive the best practice of TPM, such as Hoi & Leong [4], Nzewi [23], and Shabaan & Awni [24]. Another scholars, such as Sahoo [25] mentions the necessary to maintain a continues improvement culture, Sing and Ahuja [26] mention the necessary to promote the culture of acceptance and motivation in the organization, and Xiang & Feng [13] also mention the necessary to implement TPM as an organizational culture. Assad & Yusoff [18] mention in their research that organizational culture is a moderating effect in the relationship between TPM practices and operational performance. The moderating variable has a strong contingent effect in the relationship between independent variable and dependent variable [27]. Several researches have explained about organizational culture definitions, such as things that related to values in organizations [28], [29], shared beliefs and meanings [30], [31], forms of behavior, implementation, procedures and beliefs in an organization [32], [33]. Organizational culture is also reflected in the vision and mission, employee attitudes and behavior, as well as how the organization works as a glue for all members of the organization to lead to better performance [34], [35]. Some authors in their researches also mention that organizational culture has a direct impact on operational performance in certain country, such as Prajogo & McDermott who do research in Australia [36], and Al-tit who do research in Jordan [34]. It's different with Zao et al. who do research in China [29] and Yesil & Kaya [37] who did research in Turkey where they concluded not significant of organizational culture on operational performance. Organizational culture is classified in four dimensions, namely development culture, group culture, hierarchical culture and rational culture by referring to researches from Cao et al. [18], Paro & Gerolamo [38], Quinn & Rohrbaugh [39], [40]. These dimensions of organizational culture explains various cultural values in the organization, such as short-term or long-term orientation (development culture), the spirit of cooperation and groups (group culture), the existence of a reward system (rational culture), and the existence of centralized or decentralized control in decision-making (hierarchical culture).

There were several studies had analyzed the effect of organizational culture in the relationship between TPM and operational performance, such as Ismail et al. [17] who used qualitative analysis in their research by using descriptive approach and literature analysis comprehensively, and Asaad & Yusoff [18] who used Rasch model analysis that focuses on construction the measurement data to suit a measurement model with of errors. Hair et al. [41] mention that structural equation modeling (SEM) is one of the multivariate analysis method that allow separate relationships for each of a set of dependent variables. Hair et al. also mention that structural equation modeling provides the appropriate and most efficient estimation technique for a series of separate multiple regression equations estimated simultaneously. There is another method to analyze moderating effect in multiple regression, such as moderated regression analysis (MRA) but the estimates of regression coefficients in MRA are not consistent because of measurement

 DOI: 10.25077/josi.v20.n2.p93-103.2021

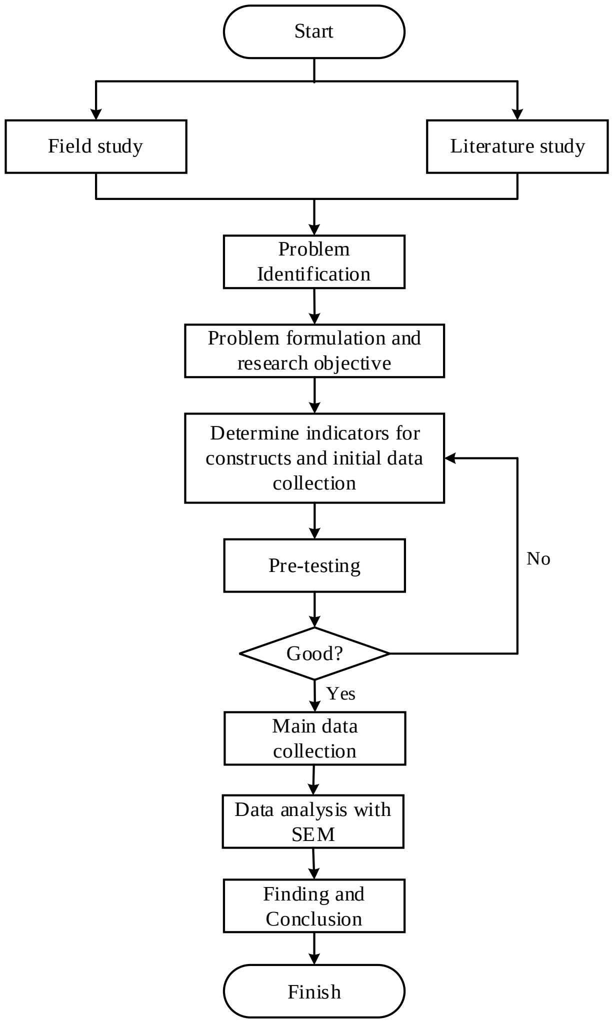

Figure 2. Flow of research method

error. There are several approaches to analyze interaction of a construct in a structural equation modeling, such as Kenny & Judd [42] who proposed a possible specification for modeling interaction effects under the SEM approach which assumed that both interacting variables are continuous, Jaccard and Wan's (1995) who proposed multiple product indicators approach, Jöreskog and Yang's [43] who proposed single product indicator approach, Ping's [44], [45] two-step single and multiple product indicators approach, and [46] who proposed two-stage least squares single indicator multiple instrumental variables approach. This research will use two-step approach from Ping's that is easier to be implemented in the analysis. Ping [44], [45] mentions that single indicator shall be used for moderating variable in the structural equation model, where single indicator is multiplication between indicators of exogenous construct and indicators of moderator construct.

Based on the research gap from previous researches, this study will develop the research from Assad and Yussof (2013) by focusing on the influence of TPM practices on operational performance in the mining industry in Indonesia by taking case study in Berau-East Kalimantan as one of the largest coal mining sources in Indonesia. There were some analysis to study the moderating effect of all aspects of organization culture in the relationship of two constructs, and this study will use SEM with two-step approach from Ping [44, 45].

METHOD

This research type was quantitative research in estimating the influential factors and the approach is used for testing objective theories by examining the relationship among variables [47].

This research adapted from the research from Modgil & Sharma [2] that implement in manufacturing industry to be adapted in mining industry which explained those dimensions of TPM practice were described in four dimensions with total of sixteen indicators, i.e discipline of maintenance (DM) with four indicators, information tracking (IT) with four indicators, housekeeping (HK) by four indicators and employee involvement (EI) with four indicators. Indicators statement of operational performance (OP) were also adapted from Modgil & Sharma [2] with seven indicators. This study also adapted the research from Cao et al. [30] that was implemented in manufacturing to be adapted in mining industry which explained that those dimensions of organizational culture (OC) were spelled out in four dimensions with total of fourteen indicators, namely development culture (DC) with four indicators, group culture (GC) with three indicators, rationale culture (RC) with four indicators and hierarchical culture (HC) with three statement of indicators (see Appendix 1). The flow of this research method as shown on Figure 2. It illustrates how the TPM practices in the mining industry were implemented and the importance of organizational culture to maintain the practice.

The conceptual framework of this research as shown on Figure 3. Based on the framework, there are two main hypotheses in this research:

H1 : TPM practices influence operation performance directly.

H2a : Organization culture has a positive impact on operational performance.

H2b : Organizational culture has a moderating effect in the relationship of TPM practices and operational performance.

The population of this research was those mining employees in Berau-East Kalimantan who related to maintenance department and permanent contract. Data was collected using an online survey method from August until November year 2020 with minimum samples size of 100 respondents as required for two to

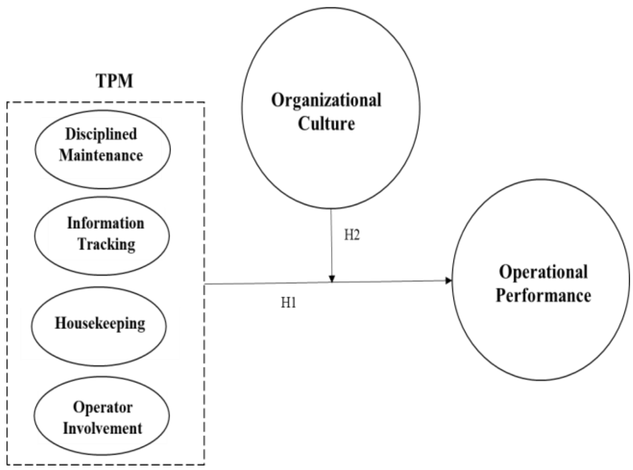

Figure 3. Conceptual framework of research

five latent variable [41]. This research will use three constructs in the analysis.

Preliminary test was needed to ensure all indicators representing those dimensions and there is no misunderstanding from respondents about those statements in the questionnaire. The result was accepted based on validity and reliability test for 35 respondents (see Appendix 1 and 2), then it could be continued to mass data collection. Validity is concerned with how well the concept is defined by the measure(s), whereas reliability relates to the consistency of the measure(s) [41].The questionnaire was distributed online to respondents by using Google forms and email. All statement items in the questionnaire which were distributed to respondents using 5-point Likert scale. A total of 110 questionnaires were collected during August until November year 2020 and after removing five samples with uncompleted data to answer the questions in the questionnaire included respondent profile, 105 data of respondents could be used for further analysis as representative of mining employees with permanent contract who working on maintenance department in Berau – East Kalimantan. Before doing SEM analysis, it was needed to do Confirmatory Factor Analysis (CFA), Discriminant Validity, Path Analysis, and Chi Square test by using SPSS 24.0 and Lisrel 8.7 software. Confirmatory factor analysis (CFA) was used in order to simultaneously validate the measures of TPM implementation to operational performance constructs as well as the moderating effect of organizational culture in the relationship. To measure the estimation of SEM, this research used latent variable score (LVS) of every construct. LVS is an individual score of latent variable or construct in the estimation of a SEM and this process is done after completing validity and reliability test [48].

Goodness of fit (GOF) test is used to measure indicating how well a specified model reproduces the covariance matrix among the indicator variables during CFA [41] and it is determined based on absolute fit indices that compare theoretical model fit and data collected, incremental fit indices that compare theoretical, relative and alternative model fit, and parsimonious fit indices that connect GOF's model and some coefficient of estimation

Table 1. Validity test for indicators

Latent Variable	Indicator	Estimation of Loading Factor	Critical Value of Loading Factor	Decision
TPM	DM1	0.54	0.5 or 0.7	Valid
	DM2	0.59	0.5 or 0.7	Valid
	DM3	0.98	0.5 or 0.7	Valid
	DM4	0.63	0.5 or 0.7	Valid
	IT1	0.83	0.5 or 0.7	Valid
	IT2	0.58	0.5 or 0.7	Valid
	IT3	0.82	0.5 or 0.7	Valid
	IT4	0.56	0.5 or 0.7	Valid
	HK1	0.65	0.5 or 0.7	Valid
	HK2	0.80	0.5 or 0.7	Valid
	HK3	0.77	0.5 or 0.7	Valid
	HK4	0.63	0.5 or 0.7	Valid
	EI1	0.69	0.5 or 0.7	Valid
	EI2	0.80	0.5 or 0.7	Valid
	EI3	0.60	0.5 or 0.7	Valid
	EI4	0.64	0.5 or 0.7	Valid
OC	DC1	0.94	0.5 or 0.7	Valid
	DC2	0.93	0.5 or 0.7	Valid
	DC3	0.63	0.5 or 0.7	Valid
	DC4	0.65	0.5 or 0.7	Valid
	GC1	0.85	0.5 or 0.7	Valid
	GC2	0.70	0.5 or 0.7	Valid
	GC3	0.83	0.5 or 0.7	Valid
	RC1	0.87	0.5 or 0.7	Valid
	RC2	0.83	0.5 or 0.7	Valid
	RC3	0.67	0.5 or 0.7	Valid
	RC4	0.75	0.5 or 0.7	Valid
	HC1	0.91	0.5 or 0.7	Valid
	HC2	0.89	0.5 or 0.7	Valid
	HC3	0.94	0.5 or 0.7	Valid
OP	OP1	0.69	0.5 or 0.7	Valid
	OP2	0.61	0.5 or 0.7	Valid
	OP3	0.63	0.5 or 0.7	Valid
	OP4	0.75	0.5 or 0.7	Valid
	OP5	0.68	0.5 or 0.7	Valid
	OP6	0.60	0.5 or 0.7	Valid
	OP7	0.95	0.5 or 0.7	Valid

DOI: 10.25077/josi.v20.n2.p93-103.2021

Table 2. Reliability test for dimensions

Latent Variable	Construct	CR	Critical Value	Decision
TPM	Disciplined Maintenance	0.8	0.7	Reliable
	Information Tracking	0.8	0.7	Reliable
	Housekeeping	0.8	0.7	Reliable
	Employee Involvement	0.8	0.7	Reliable
OC	Development Culture	0.9	0.7	Reliable
	Group Culture	0.8	0.7	Reliable
	Rationale Culture	0.9	0.7	Reliable
	Hierarchical Culture	0.9	0.7	Reliable
OP	Operational Performance	0.9	0.7	Reliable

that needed to achieve the model fit. Absolute fit indices are measured from chi-square ($\chi 2$), goodness of fit (GFI) and root mean square error of approximation (RMSEA). Incremental fit indices are measured from adjusted goodness of fit (AGFI), normed fit index (NFI), comparative fit index (CFI), incremental fit index (IFI) and relative fit indices (RFI). Beside that, parsimonious fit indices are measured from akaike's information criterion (AIC), consistent akaike information index (CAIC), expected cross validation index (ECVI) and parsimonious goodness of fit index (PGFI). This research uses 95% of confidence interval (CI), it means the significance of all construct is determined based on acceptance of t-value $\geq$ 1.96 or $\leq$ -1.96 in t-table with acceptance of P-value $\geq$ 0.05 [41].

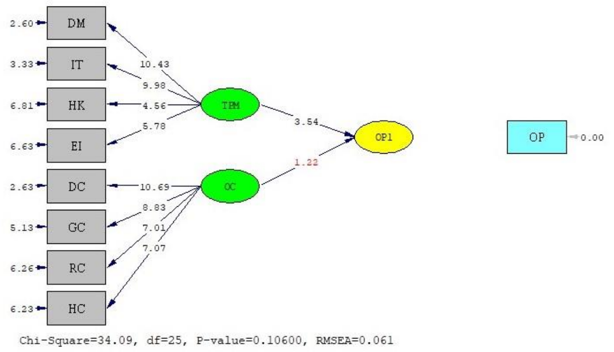

Figure 4. SEM of first step without interaction (t-value)

RESULT AND DISCUSSION

The normality test result was passed as shown by P-value for Skewness and Kurtois > 0.05 both uni-variate and multi-variate for confidence interval of 95%, so it was continued with Confirmatory Factor Analysis (CFA) to determine the validity and reliability of the first construct indicators and the second construct of TPM and organizational culture. The reliability of the latent variables was assessed by using loading factor (LF) and construct reliability (CR) values [41]. Both validity and reliability test were shown on Table 1 and 2.

Table 1 shows that all indicators are valid to measure the dimensions based on LF values that more than critical value of 0.5 or 0.7. The results from table 2 explain that all indicators are reliable to measure the dimensions based on CR value that more than critical value of 0.7.

By using two-step approached from Ping's [44], the structural equation modelling analysis with moderating effect was proceeded in two steps, i.e model estimation without interaction effect and with interaction effect. This analysis used latent variable score (LVS), then the structural equation model in the first step as shown in Figure 4 with t-value and coefficient of estimation in Figure 5.

Figure 5 shows the construct of TPM and OC have a positive impact to OP by showing positive value in the coefficient of estimation where construct of TPM had a significant effect by showing t-value of 3.54 in figure 4 is higher than 1.96, while OC is not significant to influence OP by showing t-value of 1.22 is less than 1.96. From the output of Lisrel 8.7 also, we can conclude that model without interaction effect has a acceptable good of fit (GOF) where a ratio of chi-square value to the degree

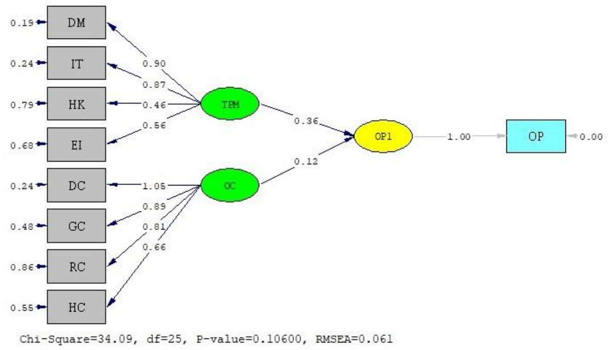

Figure 5. SEM of first step without interaction (coefficient of estimation)

of freedom (df) is less than 3 with a P-value of 0.106 > 0.05 and RMSEA < 0.08. Another GOF's criteria have also met the recommended ones such as GFI, NNFI, CFI, IFI, NFI, PGFI, ECFI, AIC and CAIC as shown at Appendix 3.

Before going to second step of analyzing in the second interaction, both validity and reliability test for all constructs of structural equation model in the first interaction are needed to check those values of estimation of loading factor (LF) and average variable extracted (AVE) and those results are shown on Table 3 and 4. Table 3 shows that all dimensions of constructs are valid to explain those constructs by referring to value of loading factor that is more than 0.5. Table 4 shows that all dimensions of constructs are reliable to explain those constructs by referring to all average variable extracted values that are more than 0.5.

Table 3. Validity test for first interaction model

Latent variable	Construct	Est. of LF	Critical value	Decision
TPM	Disciplined Maintenance	0.9	0.5	Valid
	Information Tracking	0.9	0.5	Valid
	Housekeeping	0.5	0.5	Valid
	Employee Involvement	0.6	0.5	Valid
OC	Development Culture	1	0.5	Valid
	Group Culture	0.9	0.5	Valid
	Rationale Culture	0.8	0.5	Valid
	Hierarchical Culture	0.7	0.5	Valid
OP	LVS Operational Performance	1	0.5	Valid

Table 4. Reliability test for first interaction model

Latent Variable	AVE	Critical Value	Decision
Total Productive Maintenance (TPM)	0.6	0.5	Reliable
Organizational Culture (OC)	0.7	0.5	Reliable
Operational Performance (OP)	1.0	0.5	Reliable

Table 5. Hypothesis summary

Hypothesis		Coefficient of estimation	t-value	Conclusion
H1	TPM practices influence operation performance directly	0.36	3.54	Significant
H2a	Organization culture has a positive impact to operational performance	0.12	1.20	Not significant
H2b	Organizational culture has a moderating effect in the relationship of TPM practices and operational performance	0.07	5.28	Significant

In the second step of moderating effect analysis, the structural equation model as shown in Figure 6 with t-value and coefficient of estimation in Figure 7.

From the estimation result in Figure 6, it can be seen that TPM selection has a direct effect on operational performance by showing the result of statistical t-value 3.54 that is more than 1.96, while organizational culture has a moderating effect in the relationship by showing the result of statistical t-value 5.28 is more than 1.96. The result in Figure 7 also shows all constructs have positive influence to operational performance, and we can estimate the influence level of all dimensions to variables based on the coefficient value of all dimensions of constructs.

The output model in the second interaction has also a acceptable good of fit (GOF) where a ratio of chi-square value to the degree of freedom (DOF) is less than 3 with a P-value of 0.118> 0.05 and RMSEA < 0.08 as referred to Joseph F. Hair et al. (2018). Other GOF criteria have also met the recommended ones such as GFI, NNFI, CFI, IFI, NFI, PGFI, ECFI, AIC and CAIC as shown in Appendix 4.

Based on all results above, the summary of hypothesis testing is shown in the Table 5. H1 is accepted that Total Productive Maintenance practice influence the operation performance directly. This research results supported Nnabuife et al. [12], Xiang & Feng [13], Jain et al. [14], Hooi & Leong [4] and Wilson et al. [15] who concluded the influence of Total Productive Maintenance on operational performance directly in certain industry, especially in mining industry [10]. The results are found the significance of Total Productive Maintenance practice that considered disciplined maintenance, information tracking,

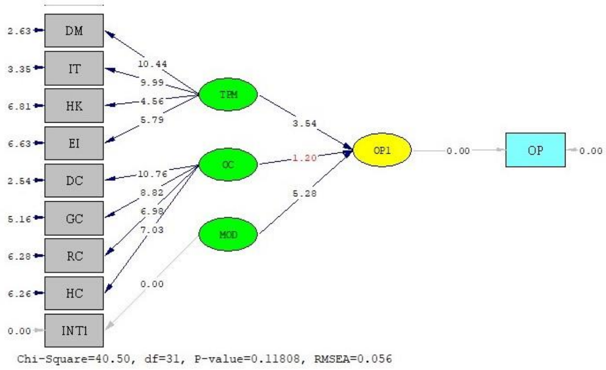

Figure 6. SEM of second step with interaction (t-value)

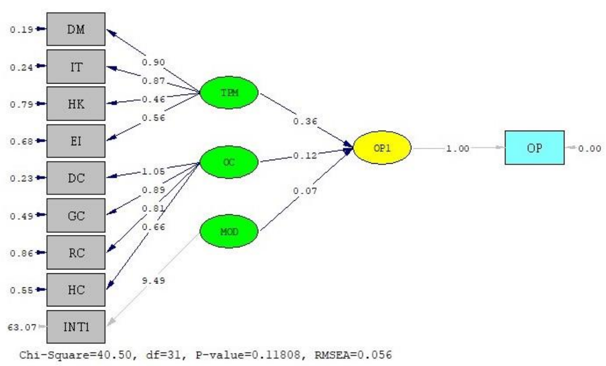

Figure 7. SEM of second step with interaction (coefficient of estimation)

DOI: 10.25077/josi.v20.n2.p93-103.2021

housekeeping, and employee involvement to influence operational performance where discipline maintenance has the highest contribution and followed by information tracking, employee involvement and housekeeping based on the loading factor's values. In the mining industry, most of the operations are supported by heavy-duty equipment that need a strategic maintenance management to ensure that all of them are running well as per expectation and Total Productive Maintenance is an aggressive strategic that involve all employees to maintain the equipment, machines and tools on top performance to support company operations. Loss time that is caused by some troubles in those assets will have a big impact to operation output and cost due to man hour rate and operational cost are quite high in mining industry. It means that the implementation of Total Productive Maintenance will support mining industry operation in Indonesia on high performance about productivity, quality, cost, and delivery. Total Productive Maintenance is one of the system in the maintenance management by involving all employees included top management to implement 5S as a foundation by supporting eight pillars, i.e quality management, development maintenance, office Total Productive Maintenance, education and training, planned maintenance, autonomous maintenance, focused maintenance, and safety, health and environment. Government controls all mining production and operation in Indonesia by certain contract and uses Law No 4/2009 about mineral and coal mining to ensure all organization which involved in the mining industry follow the standard of mining procedures to avoid unexpected happen during mining operation. The mining jobs are risks with accident, so the equipment and mobile heavy-duty need to be maintained properly by a specific maintenance to ensure no problem during operation and long life of running. A company in mining industry will produce certain amount of mines, production period, quality of mines and how to do the production based on the contract. Government will supervise all activities in mining operation because all mining products are controlled by countries to provide real added value to national economy in an effort to achieve prosperity and the welfare of the people fairly. Such kind of contract, regulation and law in mining make all organizations that involved in mining industry will operate efficiently with high quality, on time, and keep safety and health in their activities. Those companies in mining industry will get these results when implement the good system such as Total Productive Maintenance.

Hypothesis 2a is not accepted that organization culture has a direct effect on operational performance. This research also supported Zao et al. who did research in China [29] and Yesil & Kaya who did research in Turkey [37] which concluded not significant of organizational culture on operational performance, but it was different with Prajogo & McDermott who did research in Australia [36] and Al-tit who did research in Jordan [34] mentioned the significant effect of organizational culture in their country on operational performance. In Indonesia, mining schedules and production amount are controlled by government by referring to the contract All organizations will do their best to achieve the government target by operating efficiently and doing good management at all sectors included in the maintenance management. It means that all organization outcomes are not influenced by organizational culture directly but it is based on a system implemented in the organization to achieve the contract and maintain the company existence in mining industry because government will give sanction and punishment for those companies don't follow the law of No 4/2009 as clear mention on chapter XXII and XXIII. The organization in mining industry must implement a suitable system to achieve all directions in the law and most of those performance indicators are referred to the law contents It will cause organizational cultures adapt to follow the law as a part of organization habit and it will support the implementation of a system in the organizational to meet all requirements in the law as indicators of a performance.

Hypothesis 2b is accepted that organizational culture has a moderating effect in the relationship between Total Productive Maintenance practice and operational performance. This research supported Assad & Yusoff (2013) who mentioned that organizational culture is significant as moderating effect in the relationship between TPM and operational performance, also Ismail et al. [17] who mentioned the significance of organizational culture to influence all pillars of Total Productive Maintenance. This research also supported another researches that mentioned the importance of organizational culture in the Total Productive practice, such as Sahoo (2018) who mentioned the necessary to maintain a continues improvement culture, Sing and Ahuja (2014) who mentioned the necessary to promote the culture of acceptance and motivation in the organization, and Xiang & Feng (2021) who mentioned the necessary to implement Total Productive Maintenance as an organizational culture. It means that the organizational culture will strengthen the implementation of Total Productive Maintenance to improve operation performance in Indonesia mining industry. The term of organizational culture such as employee discipline, transparency, continues improvement, leadership and applying technology are very important to support Total Productive Maintenance in Indonesia mining industry. Those organization cultures will assist mining companies in Indonesia to follow all direction from government as mentioned in the law No.4/2009 to be able to manage and exploit potential minerals and coal independently, reliably, transparently, competitive, efficient, and environmentally friendly, and ensure sustainable national development.

This research will assist the decision-makers in Indonesia mining industry how to manage operational performance by implementing a strategic system such as Total Productive Maintenance and considering an organizational culture to support the system as a moderating effect to strengthen the implementation.

CONCLUSION

Most of the operation in mining industry uses heavy-duty equipment that need specific maintenance to maintain the performance. TPM is one of the maintenance management method used but it needs fully support from all stakeholder in the organization to ensure the success of implementation. Based on the study, it can be concluded that TPM practice is applicable in Indonesian mining industry and organizational culture in the certain modes will strengthen the implementation as a moderating effect, then structural equation modeling by using two-step approach from Ping's is applicable to analyze the moderating effect of the construct. For all factors that contributed in the TPM practice, discipline doing maintenance has the highest impact then continued by information tracking, employee involvement and housekeeping. To ensure that organizational culture will influence the TPM implementation, organization must focus on development culture as first priority then group culture, rationale culture and hierarchical culture. Managerial implication for improving the TPM practice in Indonesian mining based on this research results are as a guideline for decision makers in an organizational for the importance of TPM practice and ensure organizational culture with certain aspects will be implemented correctly in the company to improve operational performances. There are some limitations on this research because of data collection from certain organization and industry where all organizations have a different culture and the effect to TPM practice need further research in the different environmental. For the research methodology, the usage of two-step approach for analyzing moderating effect is one of the method in the structural equation modeling and the future research need to compare the result by using another methods such as two stage least square, maximum likelihood approach or quasi-maximum likelihood estimation.

ACKNOWLEDGMENT

The author would like to thank all mining employees in Berau-East Kalimantan who support data collection and Batam International University that supported the funding of this research.

REFERENCES

[1] F. Saleem, S. Nisar, M. A. Khan, S. Z. Khan, and M. A. Sheikh, “Overall equipment effectiveness of tyre curing press: a case study,” *J. Qual. Maint. Eng.*, vol. 23, no. 1, pp. 39–56, 2017. doi: 10.1108/JQME-06-2015-0021.

[2] S. Modgil and S. Sharma, “Total productive maintenance, total quality management and operational performance: An empirical study of Indian pharmaceutical industry,” *J. Qual. Maint. Eng.*, vol. 22, no. 4, pp. 353–377, 2016. doi: 10.1108/JQME-10-2015-0048.

[3] A. Rastegari and A. Salonen, “Strategic maintenance management: Formulating maintenance strategy,” *Int. J. Cond. Monit. Diagn. Eng. Manag.*, pp. 1–9, 2015.

[4] L. W. Hooi and T. Y. Leong, “Total Productive Maintenance and manufacturing performance improvement,” *J. Qual. Maint. Eng.*, vol. 23, no. 1, pp. 2–21, 2017. doi: 10.1108/JQME-07-2015-0033.

[5] S. Nakajima, *Introduction to TPM: total productive maintenance.(Translation).* Portland, OR: Productivity Press, 1988.

[6] H. Pačaiová and G. Ižaríková, “Base Principles and Practices for Implementation of Total Productive Maintenance in Automotive Industry,” *Qual. Innov. Prosper.*, vol. 23, no. 1, pp. 45–59, 2019. doi: 10.12776/qip.v23i1.1203.

[7] M. F. Harun, N. F. Habidin, and N. A. M. Latip, “5S Lean Tool, Value Stream Mapping and Warehouse Performance: Conceptual Framework,” *Int. J. Supply Chain Manag.*, vol. 8, no. 3, pp. 605–608, Jube 2019.

[8] S. Nuprihatin, M. Angely, and H. Tannady, “Total Productive Maintenance Policy to Increase Effectiveness and Maintenance Performance Using Overall Equipment Effectiveness,” *J. Appl. Res. Ind. Eng.*, vol. 6, no. 3, pp. 184–199, 2019.

[9] M. Darade, P. Khare, and P. Desai, “Overall Equipment Effectiveness in Construction Equipment’s (Implementation of OEE for Improving Performance and Quality Output of the Equipment),” *Int. J. Res. Appl. Sci. Eng. Technol. IJRASET*, vol. 5, no. 7, pp. 1808–1811, 2017.

[10] J. Brodny and M. Tutak, “Application of Elements of TPM Strategy for Operation Analysis of Mining Machine,” *IOP Conf. Ser. Earth Environ. Sci.*, vol. 95, pp. 1–7, 2017. doi: 10.1088/1755-1315/95/4/042019.

[11] E. Pourjavad and H. Shirouyehzad, “Selecting maintenance strategy in mining industry by analytic network process and TOPSIS,” *Int. J. Ind. Syst. Eng.*, vol. 15, no. 2, pp. 171–192, 2013. doi: 10.1504/IJISE.2013.056095.

[12] E. Nnabuife, O. P. Itua, and E. I. Chimezie, “Total Productive Maintenance and Performance of Bottling Company Plants in Edo State.,” *Int. J. Sci. Res. Manag.*, vol. 7, no. 12, pp. 1449–1458, 2019. doi: 10.18535/ijsrm/v7i12.em03.

[13] Z. T. Xiang and C. J. Feng, “Implementing Total Productive Maintenance in a Manufacturing Small or Medium-Sized Enterprise,” *J. Ind. Eng. Manag.*, vol. 14, no. 2, pp. 152–175, 2021. doi: 10.3926/jiem.3286.

[14] A. Jain, R. Bhatti, and H. Singh, “Total productive maintenance (TPM) implementation practice: A literature review and directions,” *Int. J. Lean Six Sigma*, vol. 5, no. 3, pp. 293–323, 2014. doi: 10.1108/IJLSS-06-2013-0032.

[15] E. O. Wilson, D. K. Uko, S. A. Etok, and E. J. Awaka-Ama, “Implementation of Total Productive Maintenance (TPM) In Nigerian Manufacturing Industries (Brewery),” *Int. J. Eng. Sci. Invent. IJESI*, vol. 9, no. 6, pp. 29–41, 2020.

[16] S. Sharma and S. Modgil, “TQM, SCM and operational performance: an empirical study of Indian pharmaceutical industry,” *Bus. Process Manag. J.*, vol. 26, no. 1, pp. 331–370, 2020. doi: 10.1108/BPMJ-01-2018-0005.

[17] M. Ismail, N. A. Sari, D. P. M. Putra, and E. Rimawan, “The Influence of Organizational Culture on Total Productive Maintenance (TPM) Practices in Manufacturing Companies,” *Int. J. Innov. Sci. Res. Technol.*, vol. 3, no. 6, pp. 549–553, 2018.

[18] M. N. M. Asaad and R. Z. Yusoff, “Organizational Culture Influence on Total Productive Maintenance (TPM) and Operational Performance Using RASCH Model Analysis,” *Asian J. Technol. Manag.*, vol. 6, no. 2, pp. 72–81, 2013.

[19] R. Attri, S. Grover, N. Dev, and D. Kumar, “Analysis of barriers of total productive maintenance (TPM),” *Int. J. Syst. Assur. Eng. Manag.*, vol. 4, no. 4, pp. 365–377, 2012, doi: 10.1007/s13198-012-0122-9.

[20] A. Winarno and D. Hermana, “How to encourage lecturer performance in research through servant leadership, organizational commitment, and tacit knowledge sharing,” *J. Manaj. Dan Pemasar. Jasa*, vol. 14, no. 1, pp. 35–48, 2021. doi: 10.25105/jmpj.v14i1.8541.

[21] A. Adhiutama, R. Darmawan, and A. Fadhila, “Total Productive Maintenance on the Airbus Part Manufacturing,” *J. Bisnis Dan Manaj.*, vol. 21, no. 1, pp. 3–15, Mar. 2021. doi: 10.24198/jbm.v21i1.280.

[22] S. Priyono, Machfud, and A. Maulana, “The Application of Total Productive Maintenance (TPM) in Sugar Refinery in Indonesia (A Case Study of PT. XYZ),” *J. Apl. Manaj. Dan Bisnis*, vol. 5, no. 2, pp. 265–277, Mei 2019. doi: 10.17358/jabm.5.2.265.

 DOI: 10.25077/josi.v20.n2.p93-103.2021

[23] H. N. Nzewi, O. M. Chiekezie, and A. E. Arachie, “Total productivity maintenance and performance of selected aluminium manufacturing companies in Anambra State,” *J. Bus. Manag.*, vol. 18, no. 1, pp. 67–73, 2016.

[24] M. S. Shaaban and A. H. Awni, “Critical success factors for total productive manufacturing (TPM) deployment at Egyptian FMCG companies,” *J. Manuf. Technol. Manag.*, vol. 25, no. 3, pp. 393–414, 2014. doi: 10.1108/JMTM-09-2012-0088.

[25] S. Sahoo, “An empirical exploration of TQM, TPM and their integration from Indian manufacturing industry,” *J. Manuf. Technol. Manag.*, vol. 29, no. 7, pp. 1188–1210, 2018. doi: 10.1108/JMTM-03-2018-0075.

[26] K. Singh and I. S. Ahuja, “Effectiveness of TPM implementation with and without integration with TQM in Indian manufacturing industries,” *J. Qual. Maint. Eng.*, vol. 20, no. 4, pp. 415–435, 2014. doi: 10.1108/JQME-01-2013-0003.

[27] U. Sekaran and R. Bougie, *Research methods for business: a skill-building approach*, 7th ed. Chichester, West Sussex, United Kingdom: John Wiley & Sons, 2016.

[28] L. Guiso, P. Sapienza, and L. Singales, “The value of corporate culture,” *J. Finance Econ.*, vol. 117, no. 1, pp. 60–76, 2015. doi: 10.1016/j.jfineco.2014.05.010.

[29] H. Zhao, H. Teng, and Q. Wu, “The effect of corporate culture on firm performance: Evidence from China,” *China J. Account. Res.*, vol. 11, pp. 1–19, 2018. doi: 10.1016/j.cjar.2018.01.003.

[30] Z. Cao, B. Huo, Y. Li, and X. Zhao, “The impact of organizational culture on supply chain integration: a contingency and configuration approach,” *Supply Chain Manag. Int. J.*, vol. 20, no. 1, pp. 24–41, 2015. doi: 10.1108/SCM-11-2013-0426.

[31] J. Gochhayat, V. N. Giri, and D. Suar, “Influence of Organizational Culture on Organizational Effectiveness: The Mediating Role of Organizational Communication,” *Glob. Bus. Rev.*, vol. 18, no. 3, pp. 1–12, 2017. doi: 10.1177/0972150917692185.

[32] S. Ghosh and B. K. Srivastava, “Construction of a reliable and valid scale for measuring organizational culture,” *Glob. Bus. Rev.*, vol. 15, no. 3, pp. 583–596, 2014. doi: 10.1177/0972150914535145.

[33] N . T. D. Nguyen and A. Aoyama, “Impact of corporate culture on he relationship between efficient technology transfer and business performance,” *Glob. Bus. Rev.*, vol. 15, no. 4, pp. 637–661, 2014. doi: 10.1177/0972150914543420.

[34] A. A. Al-Tit, “Factors affecting the organizational performance of manufacturing firms,” *Int. J. Eng. Bus. Manag.*, vol. 9, pp. 1–9, 2017. doi: 10.1177/1847979017712628.

[35] S. Bag, “Supplier Management and Sustainable Innovation in Supply Networks: An Empirical Study,” *Glob. Bus. Rev.*, vol. 19, no. 3, pp. 176–195, 2018. doi: 10.1177/0972150918760051.

[36] D. Prajogo and C. McDermott, “The relationship between multidimensional organizational culture and performance,” *Int. J. Oper. Prod. Manag.*, vol. 31, no. 7, pp. 712–735, 2011, doi: 10.1108/01443571111144823.

[37] S. Yesil and A. Kaya, “The effect of organizational culture on firm financial performance: evidence from a developing country,” *Procedia – Soc. Behav. Sci.*, vol. 81, no. 1, pp. 428–437, 2013, doi: 10.1016/j.sbspro.2013.06.455.

[38] P. E. P. Paro and M. C. Gerolamo, “Organizational culture for lean programs,” *J. Organ. Change Manag.*, vol. 30, no. 4, 2017. doi: 10.1108/JOCM-02-2016-0039.

[39] R. E. Quinn and J. Rohrbaugh, “A competing values approach to organizational effectiveness,” *Public Product. Rep.*, vol. 5, no. 2, pp. 122–140, 1981. doi: 10.2307/3380029.

[40] R. E. Quinn and J. Rohrbaugh, “A spatial model of effectiveness criteria: towards a competing values approach to organizational analysis,” *Manag. Sci.*, vol. 29, no. 3, pp. 363–377, 1983. doi: 10.1287/mnsc.29.3.363.

[41] J. F. Hair, B. J. Babin, R. E. Anderson, and W. C. Black, *Multivariate Data Analysis*, 8th ed. Boston: Cengage, 2019.

[42] D. A. Kenny and C. M. Judd, “Estimating the non-linear and interactive effects of latent variables,” *Psychol. Bull.*, vol. 96, pp. 201–210, 1994. doi: 10.1037/0033-2909.96.1.201.

[43] K. Jöreskog and F. Yang, *Advanced Structural Equation Modeling*. Mahwah, NJ: Lawrence Erlbaum Associates, 1996.

[44] R. A. Ping, “A parsimonious estimating technique for interaction and quadratic latent variables,” *J. Mark. Res.*, vol. 32, no. 3, pp. 336–347, 1995, doi: 10.1177/002224379503200308.

[45] R. A. Ping, “Latent variable interaction and quadratic effect estimation: A two step technique using structural equation analysis,” *Psychol. Bull.*, vol. 119, pp. 166–175, 1996. doi: 10.1037/0033-2909.119.1.166.

[46] K. A. Bollen and P. Paxton, “Interactions of latent variables in structural equation models,” *Struct. Equ. Model.*, vol. 5, pp. 267–293, 1998. doi: 10.1080/10705519809540105.

[47] J. W. Creswell, *Research Design: Qualitative, Quantitative, and Mixed Method Approaches*, 4th ed. California: Sage Publications, 2014.

[48] K. G. Joreskog, D. Sorbom, S. Du Toit, and M. Du Toit, *LISREL 8: New Statistical Features*. Lincolnwood, IL: Scientific Software International, 1999.

APPENDIX

Appendix 1. Validity test for indicators on preliminary test

Latent Variable	Indicator	Est. of Loading Factor	CV of Loading Factor	Decision
Total Productive Maintenance (TPM)	Employees spend all days doing maintenance on machines/equipment (DM1)	0.63	0.5 or 0.7	Valid
	Employees perform good machine/equipment maintenance to achieve the expected product quality and meet production targets (DM2)	0.68	0.5 or 0.7	Valid

Appendix 1. (continued)

Latent Variable	Indicator	Est. of Loading Factor	CV of Loading Factor	Decision
Total Productive Maintenance (TPM)	Employees have different shifts or parts of shifts in carrying out machine/equipment maintenance activities (DM3)	0.95	0.5 or 0.7	Valid
	Machine/equipment maintenance division focuses on helping employees carry out preventive maintenance at their place of work (DM4)	0.74	0.5 or 0.7	Valid
	There is a graph that illustrates the frequency of machine breakdowns in the workshop or workplace (IT1)	0.87	0.5 or 0.7	Valid
	Information about machine productivity is available to employees (IT2)	0.63	0.5 or 0.7	Valid
	Most of the equipment or processes in today's workshops or workplaces are statistically quality controlled (IT3)	0.86	0.5 or 0.7	Valid
	Employees use charts to determine whether the production process is controlled as expected (IT4)	0.64	0.5 or 0.7	Valid
	The company emphasizes placing all tools and equipment in their place (HK1)	0.72	0.5 or 0.7	Valid
	Employees are proud to keep the workplace neat and clean (HK2)	0.83	0.5 or 0.7	Valid
	The workplace is always clean at all times (HK3)	0.79	0.5 or 0.7	Valid
	Employees are always easy to find the tools they need (HK4)	0.64	0.5 or 0.7	Valid
	Operators receive training to multi-task (EI1)	0.71	0.5 or 0.7	Valid
	Operators in this factory learn how to perform various tasks/jobs (EI2)	0.82	0.5 or 0.7	Valid
	The longer an operator is in this factory, the more tasks or jobs they learn to do (EI3)	0.63	0.5 or 0.7	Valid
	Operators are cross-trained in this factory so they can fill in for others if needed (EI4)	0.67	0.5 or 0.7	Valid
Organizational Culture (OC)	The company carries out a long-term program to achieve the company's capabilities before it is needed (DC1)	0.96	0.5 or 0.7	Valid
	The company tries to anticipate the potential of new processes and technologies in the company (DC2)	0.91	0.5 or 0.7	Valid
	The company remains at the forefront of new technology in its industry (DC3)	0.66	0.5 or 0.7	Valid
	Companies are constantly thinking about the next generation of technology used by them (DC4)	0.70	0.5 or 0.7	Valid
	Superiors encourage people to work as a team (GC1)	0.83	0.5 or 0.7	Valid
	Superiors encourage employees to exchange opinions and ideas (GC2)	0.72	0.5 or 0.7	Valid
	Superiors often hold meetings with subordinates to discuss work problems in the company (GC3)	0.86	0.5 or 0.7	Valid
	The company's incentive system encourages employees to pursue company targets with passion (RC1)	0.84	0.5 or 0.7	Valid
	The company's incentive system is fair in rewarding employees who achieve company targets (RC2)	0.86	0.5 or 0.7	Valid
	The company's incentive system actually recognizes the people who contribute the most to the company (RC3)	0.71	0.5 or 0.7	Valid
	The incentive system in the company encourages employees to achieve company targets (RC4)	0.73	0.5 or 0.7	Valid
	Even small things must be referred to superiors for final answers (HC1)	0.88	0.5 or 0.7	Valid
	Any decisions made must be approved by superiors (HC2)	0.91	0.5 or 0.7	Valid
	There are very few actions taken in the company without the approval of the leadership (HC3)	0.92	0.5 or 0.7	Valid
Operational Performance (OP)	Production of machinery/equipment has increased in the past year (OP1)	0.72	0.5 or 0.7	Valid
	The level of spare parts inventory has decreased in the past year (OP2)	0.64	0.5 or 0.7	Valid
	The rate of damage to machine parts/equipment has decreased in the last one year (OP3)	0.64	0.5 or 0.7	Valid
	The quality of products produced by machines/equipment has improved in the past year (OP4)	0.78	0.5 or 0.7	Valid
	Machine/equipment utilization has increased in the past year (OP5)	0.72	0.5 or 0.7	Valid
	More efficient machine/equipment operating costs in the past year (OP6)	0.64	0.5 or 0.7	Valid
	Machine/equipment innovation has increased in the past year (OP7)	0.89	0.5 or 0.7	Valid

DOI: 10.25077/josi.v20.n2.p93-103.2021

Appendix 2. Realibility test for dimensions on preliminary test

Latent Variable	Dimension	CR	Critical Value	Decision
TPM	Disciplined Maintenance	0.78	0.7	Reliable
	Information Tracking	0.82	0.7	Reliable
	Housekeeping	0.84	0.7	Reliable
	Employee Involvement	0.81	0.7	Reliable
OC	Development Culture	0.86	0.7	Reliable
	Group Culture	0.85	0.7	Reliable
	Rationale Culture	0.92	0.7	Reliable
	Hierarchical Culture	0.90	0.7	Reliable
OP	Operational Performance	0.89	0.7	Reliable

Appendix 3. Goodness of fit for first interaction model

GOF Meas.	Estimation Result	Criteria	Conclusion
χ^2 statistic	df = 25 χ^2= 34.09	$0\leq \chi^2 \leq 2df$ $2df< \chi^2 \leq 3df$	Fit
P-value	0.106	$0.05<P\leq 1$ $0.01<P\leq 0.05$	Fit
RMSEA	0.061	≤ 0.08 ≤ 0.05	Fit
ECVI	0.75	<ECVI for saturated model (0.91)	Fit
AIC model	74.09	< Saturated AIC (90.00)	Fit
CAIC model	146.19	< Saturated CAIC (252.23)	Fit
NFI	0.91	NFI>0.9 0.8≤NFI≤0.9	Fit
TLI or NNFI	0.95	NNFI>0.9 0.8≤NNFI≤0.9	Fit
PNFI	0.63	small	Fit
CFI	0.97	CFI≥0.97 0.90≤CFI<0.97	Fit
IFI	0.97	IFI≥0.90 0.80≤IFI<0.90	Fit
RFI	0.87	RFI≥0.90 0.80≤RFI<0.90	Fit
SRMR	0.055	SRMR≤0.05 0.05<SRMR≤0.1	Fit
GFI	0.93	GFI>0.9 0.8≤NFI≤0.9	Fit
AGFI	0.87	AGFI>0.89 0.8≤NFI≤0.89	Fit
PGFI	0.52	near 1	Fit

Appendix 4. Goodness of fit for second interaction model

GOF Meas.	Estimation Result	Criteria	Conclusion
χ^2 statistic	df = 31 χ^2= 40.5	$0\leq \chi^2 \leq 2df$ $2df< \chi^2 \leq 3df$	Fit
P-value	0.118	$0.05<P\leq 1$ $0.01<P\leq 0.05$	Fit
RMSEA	0.056	≤ 0.08 ≤ 0.05	Fit
ECVI	0.89	<ECVI for saturated model (1.11)	Fit
AIC model	88.5	< Saturated AIC (110.00)	Fit
CAIC model	175.05	< Saturated CAIC (308.28)	Fit
NFI	0.91	NFI>0.9 0.8≤NFI≤0.9	Fit
TLI or NNFI	0.96	NNFI>0.9 0.8≤NNFI≤0.9	Fit
PNFI	0.63	small	Fit
CFI	0.97	CFI≥0.97 0.90≤CFI<0.97	Fit
IFI	0.97	IFI≥0.90 0.80≤IFI<0.90	Fit
RFI	0.87	RFI≥0.90 0.80≤RFI<0.90	Fit
SRMR	0.057	SRMR≤0.05 0.05<SRMR≤0.1	Fit
GFI	0.92	GFI>0.9 0.8≤NFI≤0.9	Fit
AGFI	0.87	AGFI>0.89 0.8≤NFI≤0.89	Fit
PGFI	0.52	near 1	Fit

AUTHORS BIOGRAPHY

Nasar Buntu Laulita

The author has almost 25 years of experience as a professional in several industries and graduated his Bachelor Degree on Mechanical Engineering from Petra Christian University, Master Degree from Batam International University and Doctoral Degree from Trisakti University on Strategic Management. Currently, the author is a professional lecturer in Batam International University at Management Study Program and UKI Toraja on Mechanical Engineering. The author also had published several article in international journal and national journal under Sinta accreditation. At the beginning of April 2021, the author published his book with title “The basic concept of Machinery Maintenance: Strategic Management”.