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ANALYZING THE EFFECT OF 7 WASTE ELIMINATION FOR INCREASING COMPANY PROFITABILITY WITH SEM PLS METHOD STUDY CASE IN MANUFACTURING TURBINE COMPONENT COMPANY

RIKO MURI, ERRYRIMAWAN & SAWARNI HASIBUAN

Industrial Engineering, MercuBuana University, Jakarta, Indonesia

ABSTRACT

An effective and efficient process is one of the goals to be achieved in each production process, so that the company can reduce a number of costs arising from ineffective processes. The Lean approach makes it possible to eliminate activities when the production process has no value added to the customer, known as 7 waste or seven types of waste so as to increase productivity which will ultimately increase company profit. By using a structural model SEM-PLS can analyze whether there is a significant relationship on the application of lean methods to company performance. The results of this study can provide priority improvements that must be made by the company in an effort to increase productivity and make an effective and efficient process so that the company's profitability performance will increase.

KEYWORDS: Lean, 7 Waste, SEM-PLS, Productivity & Profitability

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Original Article

1. INTRODUCTION

According to [1] The manufacturing industry plays an important role in the Indonesian economy because of its ability to produce tradable products and create jobs, based on that The Indonesian government through the Ministry of Industry strongly supports the improvement of the manufacturing industry in Indonesia. Indonesia as one of the largest countries in the world apparently has a variety of important roles among the countries in Southeast Asia. The most prominent roles is the development of the manufacturing industry. In the national scale, this sector contributes in the form of an economic increase of 20.27% by shifting the role of Commodity Based to Manufacture Based. As a result in Southeast Asia, Indonesia has become the largest manufacturing base.

Indonesia's electricity consumption shows an increase with increasing access to electricity and changes in people's lifestyles. Indonesia's electricity consumption based on data from the Ministry of Energy and Mineral Resources in 2018 reached 1,064 KWH / capita, up 5% from the previous year. Based on this, the development of business in the field of electric power generation is very potential. In addition, the increase in electricity demand will trigger competition among companies engaged in power generation. These conditions require companies to be able to compete in carrying out the company's growth and operations. This requires the ability to compete in terms of producing quality products and competitive prices by increasing productivity and process effectiveness so that it can create more added value for customers. Competition in the manufacturing industry requires producers to be more productive and efficient to get quality and cheaper goods or products, among other manufacturing companies, each company is demanded to be more aggressive and creative in order to be able to compete in the manufacturing industry.

2. STUDY LITERATURE

Productivity and Profitability

According to [2] productivity is a measure that states how well resources are managed and utilized to achieve optimal results. Productivity is a term in production activities as a comparison between outputs and inputs. Productivity is a measure that states how well resources are managed and utilized to achieve optimal results. Productivity can be used as a benchmark for the success of an industry or type of business in producing goods or services. So the higher the ratio, means the higher the product produced. According to [3], Productivity is the relationship between inputs and outputs of a productive system. In theory, it is often easy to measure this relationship as the ratio of output divided by input. When more output is produced with the same number of inputs, productivity rises. Likewise, if less input is used for the same number of outputs, productivity also rises.

According to [4], profitability is the company's ability to make a profit in relation to sales. The profitability of a company is measured by using the difference between the sales price and cost of goods sold (HPP). All costs incurred in the production process in producing a product until it is ready for sale are Cost of Production. Cost of Production consists of the following fees:

- **Direct Material Costs**

Direct material costs it is all costs to obtain raw materials to ready-made materials which include: Price of raw materials, transportation costs, storage and others.

- **Direct labor costs**

Direct labor costs it is part of the wages or salaries of all workers involved in making products, the order of certain jobs, or the provision of certain services.

- **Over Head (OH) Factory Costs**

Over Head factory costs is defined as indirect raw materials, indirect labor and other factory costs that are not easily identified or charged directly to certain jobs, products, and final cost targets. OH costs consider two characteristics, which are related to the specific relationship between OH costs and the product itself and the volume of production. Based on the relationship between OH and the volume of production, OH costs can be fixed, variable or semi variable.

Lean

Lean Production is a production practice that considers all the expenditure of available resources to obtain economic value to customers without waste, and this waste is the target to reduce. The main purpose of implementing lean manufacturing is to increase productivity, reduce time and cost and improve quality so as to provide the highest value to customers [5]. Lean is a production practice that aims to minimize waste or waste with all value streams that create more value for customers. This is purely a customer-based strategy that focuses on value streams and optimization. According to the lean principle, the use of resources that do not provide consumer value is a target for change or elimination [5]. Lean always looks at product value from the customer's point of view, where the value is defined as value add or something that adds value to the customer or something the customer wants to pay. Womack and Jones continued their research in lean production and studied the conversion of other companies to lean crusade in their second book, Lean Thinking [6]. They explain that lean manufacturing is far more than technique, which is a way of thinking, and a system-wide approach that

creates a culture where everyone in the organization continues to improve operations. [7] Wrote the three books in this series with the title - The title of Becoming Lean - Inside Stories of US Manufacturers. The book about the Toyota system was also written by Liker in which he explained Toyota's management principles and he claimed to be the largest producer in the world. There are 5 main principles of Lean's philosophy [6]:

- Defining values from the customer's point of view
- Identify the flow of values
- Process flow
- Pull system
- Strive for perfection

Waste

Lean means manufacturing without waste. Waste is anything minimizing a number of: equipment, materials, parts, and working time that are absolutely essential for production. The concept of waste covers all possible defects of work / activities, not only defective products. In the Toyota Production System book written by [8] divides waste into seven categories:

- Transportation: the movement of products that do not add value.
- Inventory: more materials, components or products on hand from customers with needs.
- Motion Movement: the movement of people who don't add value.
- Waiting: idle time is created when material, information, people or equipment are not ready.
- Over-production: produce more than the current customer needs.
- Over-processing: effort that does not add value from the customer's point of view.
- Defect: work that contains a defect, error, rework error or does not have something needed.

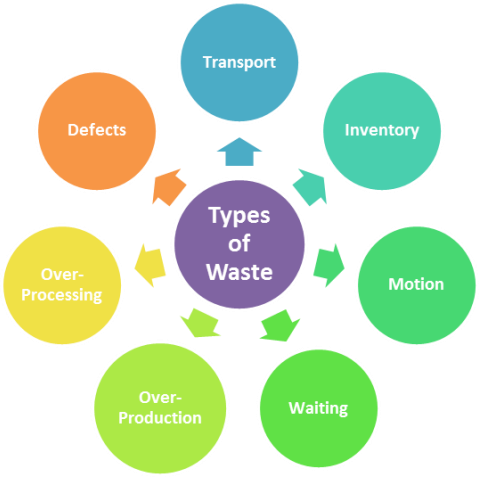

Figure 1. 7: Types of Waste.

Partial Least Square – Structural Equation Modelling

The use of structural equation modeling (SEM) that is used in complex modeling with various conditions that must be met. In some modeling these requirements are sometimes difficult to fulfill. An alternative that can be chosen while still applying complex modeling is Partial Least Square (PLS) [9]. SEM can also be used in solving problems for latent variables that cannot be calculated and difficult to measure [10].

Two approaches to SEM are: First approach is the widely applied covariance- based SEM (CB-SEM). During the past several decades CB-SEM has been widely applied in the field of social science, and is still the preferred data analysis method today for confirming or rejecting theories by testing of hypothesis, particularly when the sample size is large, the data is normally distributed, and most importantly, the model is correctly specified. That is, the appropriate variables are chosen and linked together in the process of converting a theory into a structural equation model [11].

PLS handle all types of data, from nonmetric to metric, with very minimal assumptions about the characteristics of the data [11]. Also it handles both reflective and formative constructs and all recursive models are identified. But, there are many industry practitioners and researchers note that, in reality, it is often difficult to find a data set that meets these requirements. Furthermore, the objective of the research may be exploratory, in which we know little about the relationships that exist among the variables. In this case, researchers can consider PLS.

Partial Least Squares (PLS) is the second approach, which focuses on the analysis of variance and can be carried out using PLS-Graph, Visual PLS, Smart PLS, and Warp PLS. Partial Least Squares is a soft modelling approach to SEM with no assumptions about data distribution. Thus, PLS-SEM becomes a good alternative to CB-SEM when the following situations are encountered [10]:

- Sample size is small.
- Applications have little available theory.
- Predictive accuracy is paramount.
- Correct model specification cannot be ensured.
- Definition of Normal Distribution is free.

It is also important to note that PLS-SEM is not appropriate for all kinds of statistical analysis. The researchers also need to be aware of some weaknesses of PLS-SEM, including:

- If the sample size is small high-valued structural path coefficients are needed.
- Problem of multi collinearity if not handled well.
- It cannot model undirected correlation since arrows are always single headed.
- The result in biased component estimation, loadings and path coefficients may occurred caused by a potential lack of complete consistency in scores on latent variables
- It is Possible create large mean square errors in the estimation of path coefficient loading.

Even though there are some limitations, PLS is useful for structural equation modelling including formative indicators in applied research projects especially when there are limited participants and that the data distribution is

skewed, e.g., surveying female senior executive or multinational CEOs [10]. PLS-SEM has been deployed in many fields, such as behavior sciences, marketing, organization, management information system, and business strategy.

3. METHODOLOGY

Based on the literature review presented, a research model is proposed where 7 Wastes (X1) variables are Transport (W1.1) indicator, Movement (W1.2) indicator, Waiting (W1.3) indicator, Over process (W2.1) indicator, Over Product (W2.2) indicator, Defect (W2.3) indicator and Inventory (W2.4) indicator. These 7 indicators are composed of 7 waste that effect Productivity (Y1) with production volume (P1) and yield production (P2), decreased production / cost (Y2) costs with indicators (C1-C5) and company profitability performance (Y3) with sales volume (Q1) and profit indicators (Q2) shown in figure 2.

The research hypothesis determines that there are important factors that influence the operational effectiveness of production, namely productivity which will affect the parameters of each cost item and the company's profitability performance. For that view, the research hypothesis is as follows:

- H1: Wastes1 elimination will have a positive effect on factory productivity performance.
- H1: Wastes2 elimination will have a positive effect on factory productivity performance.
- H3: Productivity will have a positive effect to reduce costs.
- H4: Lower total costs will have a positive impact on the company's profitability performance

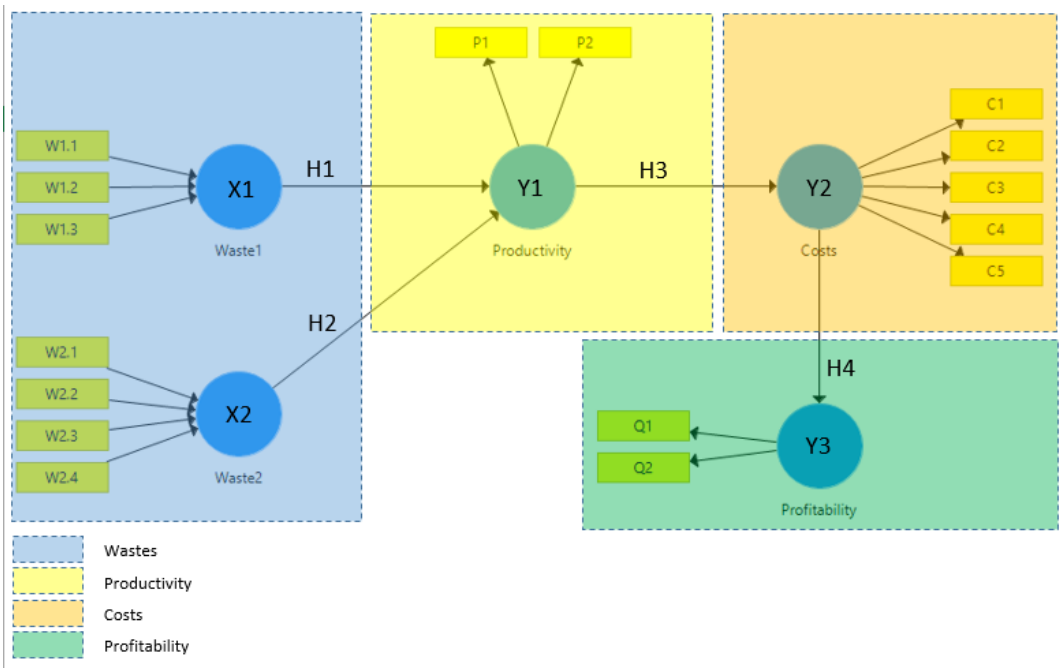

Figure 2: Research Model.

Data is collected from the operational performance of the Blade Ring Product company PT. XYZ for 3 years 2017 - 2019 will be examined using SmartPLS 3.0 to evaluate the reliability and validity of the research model and also to assess the research hypothesis.

4. RESULTS

Evaluation of Measurement Reflective Model (Outer Model)

Internal Consistency Reliability, has been fulfilled with value *Composite Reliability (CR)*> 0,7 according to table 1.

Table 1: Composite Reliability

Variable Manifest	CR	AVE
Costs	0,98	0,926
Productivity	1	1
Profitability	1	1

Indicator Reliability, has been fulfilled according to Table 2 with value of *outer loading*> 0.7

Table 2: Indicator Reliability

Indicator	Outer Loading	Explanation
C1	0,986	> 0,7
C2	0,961	> 0,7
C3	0,949	> 0,7
C4	0,952	> 0,7
P1	1,000	> 0,7
Q1	1,000	> 0,7

- Convergent Validity, has been fulfilled according to Table 1 with value of AVE > 0,5
- Discriminant Validity, Based on the data presented in Table 3, it is known that Fornell-Larcker Criterioneach indicator in the research variable has the greatest value on the variables it forms compared to the values on other variables.

Table 3: Fornell-Larcker Criterion

Variable Manifest	Costs	Productivity	Profitability
Costs	0,962		
Productivity	0,868	1,000	
Profitability	0,988	0,877	1,000

Evaluation of Measurement Formative Model (Outer Model)

- Convergent Validity, has been fulfilled based on Table 4 R-square value between 0.64 - 0.81

Table 4: R-Square

Variable Manifest	R-Square	Explanation
Costs	0,753	> 0,64
Productivity	0,182	< 0,64
Profitability	0,977	> 0,64

- Collinearity Issue, has been fulfilled based on Table 5 values of VIF <5

Table 5: Outer VIF

Indicator	VIF	Explanation
W1.1	1,057	< 5
W1.2	1,02	< 5
W1.3	1,06	< 5
W2.1	1,191	< 5
W2.2	1,242	< 5
W2.3	1,146	< 5
W2.4	1,078	< 5

- Significance and relevance of the formative indicators could be measured with using P-value outer weight. The indicators could be used if P-value outer weight > 0,05 and if the P-value < 0,05 need to re check P-value outer loading > 0,5 can be use and if P-value outer loading < 0,5 is consider to deleted [12].

Table 6: P-Value Outer Weight

Indicator	Outer Weights	Explanation	Outer Loading
W1.1	0,472	< 0,5	0,789
W1.2	0,287	< 0,5	0,251
W1.3	0,310	< 0,5	0,294
W2.1	0,369	< 0,5	0,292
W2.2	0,714	> 0,5	0,327
W2.3	0,290	< 0,5	0,261
W2.4	0,869	> 0,5	0,657

Evaluation of Structural Measurement (Inner Model)

- Collinearity Assessment, has been fulfilled based on table 7 VIF inner model value <5

Table 7: VIF Inner Model

Variable	Cost	Productivity	Profitability
Cost			1,000
Waste1		1,000	
Waste2		1,000	
Productivity	1,000		

- Structural Path Coefficient Model, based on figure 3 and Table 8 the value of the T-statistic variables are greater than 1,96 and the value of P-value < α(0.05), but for independent variable waste1 to productivity is less than 1,96 and the value of P-value > α(0.05) so that we can say that the inner model is very significant for costs to profitability, productivity to cost, and waste2 to productivity but not significant for waste1 to productivity.

Table 8: Coefficient and Effect Evaluation of Structural Model

Effect	Standard Dev	T Statistics	P Value
Costs -> Profitability	0,006	153,37	0,000
Productivity -> Costs	0,087	9,937	0,000

Waste1 -> Productivity	0,187	0,717	0,473
Waste2 -> Productivity	0,164	2,266	0,024

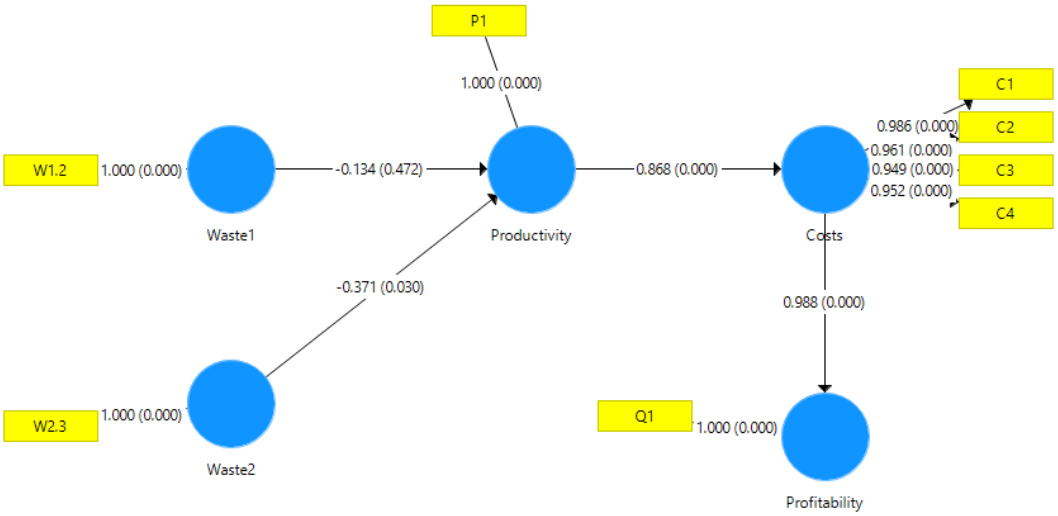

Figure 3: Result of Structural Model.

- Coefficient of Determination, based on Table 9, the R^2 value of 0.75 is considered to have a large prediction accuracy.

Table 9: Determination Coefficient

Variable Manifest	R-Square
Costs	0,753
Productivity	0,182
Profitability	0,977

Based on R^2 values in table 9 above, it can be seen that the value of R^2 for the construct variable Cost is 0.753, the value explains that the magnitude of the Cost can be explained by its indicators of 75,3%. Then for the value of R^2 obtained by the productivity construct of 0.182, the value explains that the magnitude of the effect of productivity can be explained by the indicators of production volume and yield of 18.2%. And for the value of R^2 obtained profitability construct of 0.977, this value explains that the amount of profitability can be explained by profit and sales of 97.7%.

- Effect Size, Based on f^2 value in table 10 it can be seen that the Cost to Profitability and Productivity to Cost has a large effect size. Whereas Waste to Productivity has a small effect size.

Table 10: Effect Size

Variable Manifest	Costs	Productivity	Profitability
Costs			42,305
Productivity	3,044		
Waste 1		0,021	
Waste 2		0,157	

- Predictive Relevance, Q^2 value is obtained by using a blindfolding procedure to evaluate the value of R^2 as a criterion of prediction accuracy where according to table 11, a value above 0.35 has a large predictive relevance.

So that the predictive relevance for the variable Cost, and Profitability is large but for variable Productivity is small.

Table 11: Predictive Relevant

Variable	Q^2
Costs	0,753
Productivity	0,182
Profitability	0,977

5. CONCLUSIONS

Four (4) hypotheses proposed: Waste1 to Productivity (H1) not accepted because not significant gives negative effect and P-values >0,05, Waste2 to Productivity (H2) accepted and gives negative effect but P-values <0,05, Productivity to Cost (H3) and Cost to Profitability (H4) in this study, all can be accepted because each of them gives a significant positive effect which is shown to have a P-values <0,05.

Profitability can increase with reducing costs (C1-C5) by increasing productivity with reducing waste2 with indicator defect (W2.3).

To increase the profitability manufacturing blade ring at PT. XYZ, the priority improvements that must be made to reducing defects (W2.3), and for another waste have no significant effect to profitability.

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