THE INFLUENCE OF MATERIAL INVENTORY AND PREVENTIVE MACHINE MAINTENANCE ON THE EFFICIENCY OF PRODUCTION: THE CASE OF THE EMERGING ECONOMY

Jacky S. B. Sumarauw [*], Lucky O. H. Dotulong [**], Yunita Mandagie [**]

* Corresponding author, Sam Ratulangi University Manado, Indonesia
Contact details: Sam Ratulangi University Manado, Indonesia, Bahu link 8, Bahu, Malalayang, Kota Manado, Sulawesi Utara, Indonesia
** Sam Ratulangi University Manado, Indonesia

Abstract

Nowadays, development in the industrial sector is increasing and directed to become the driving force of efficient, competitive, and strong economy with advanced production patterns. Production is expected to develop from goods relying on productive labors with abundant natural resources into high-quality products having a competitive price. Further, it applies appropriate techniques in implementing the working plan in order to achieve the goals set by the organization or company. All enterprises, large, medium, or small, have one main goal that is continuity. Therefore, they expect their goods and services to be received by the consumers. One of the activities in production management is the production process. It needs to consider basic materials supplies and preventive maintenance of the machines used in the process. It is expected to result in the efficiency in the production to ensure continuity. The research applies descriptive and verification analysis methods. Descriptive analysis is used to describe and explain the data, while verification to see the correlation among the variables using the census sampling technique.

Keywords: Supplies, Maintenance, Efficiency, Production

1. INTRODUCTION

Development is gaining more attention in the globalization era, particularly in the economic sector because it supplies more resources for other sectors. Industrial development is one sector focused by the government to develop in order to support and increase the competitiveness in the global era.

Industrial development is increasing and directed to be the main driving force for efficient, competitive, and strong-structured economy with advanced production patterns. The activities are expected to develop from goods relying on productive labors with abundant natural resources into high-quality products with competitive price. It applies appropriate techniques and skills to implement the working plan in order to archive the goals set by the company or organization.

Improvement and development of an industrial enterprise is not easy because it is influenced by various activities in it. Hence, it requires human resources having the ability to solve the problems of the company, particularly in making the decision. A wrong decision may cause a loss to the company, leading to hampering the company in achieving the goal.

Each industry (large, medium, or small) has one main goal: production continuity. Thus, they expect that their products and services are received by the consumers. If they do not like the products, they tend to move to or find other products and services. It may influence the existence of the company,

especially the profit, maintenance cost, salary, which ends in harming the company.

One significant activity to note from company management is the production process to ensure continuity. More specifically, the company needs to emphasize the basic materials supplies. Appropriate use of materials and the preventive efforts during the storage are among the efforts taken by the company.

Basic materials as one of the components used in the production process of the company should be adequate. The suppliers usually estimate the amount of use for a particular period of time, such as a week, a month, a quarter, and so on. Each company needs to supply their materials in order to avoid any risk of being unable to fulfill the customers' demand. To ensure the continuity of production, basic materials become the sub-system. It is arranged in such a way that the materials are used in an appropriate amount and time.

The efficiency of a production process of a company can be assessed from the cost of production, or whether it is in line with the volume of products.

An efficient process is not only limited to a set of activities carried out by a company to ensure continuity, but also to cost efficiency. The company that neglects the time and cost of the production is likely to raise a problem.

In implementing the production process, either goods or services, the company needs equipment in order to ensure continuity. Thus, this equipment should be maintained. Machine maintenance is one function in the company that is equal to other functions within a company. It is expected to ensure the continuity of the company, particularly by preventing them from any damage. Besides, maintenance is also to ensure the safety and security of the labors who operate the machines.

Coconut is one agricultural product that has many advantages because we can use every part of the crop. For example, the fruit can be used to make coconut flour and the stem can be made into furniture. The latter has been popular among the customers.

In general, the research aims to analyze the management of materials supplies and machine maintenance in improving production efficiency as well as the continuity in coconut processing industry in North Sulawesi Province.

The urgency of the research includes:
1. It becomes an aspiration to the coconut processing industry in order to improve the effectiveness and efficiency through supplies and maintenance management.
2. It is to improve the ability of industrial actors, both domestic and abroad, in ASEAN. It is ensured by the effectiveness and efficiency of performance, as well as by the added value of the company.
3. The results of the research become the main reference for similar research, either applied research or developmental research for the sake of public welfare.

The paper consists of six sections. The first one is Introduction. It highlights the research background. The second section is the literature review, which explains relation of this article to the previous research. The third section, research methods, explains the methods, variable operational and data source and determination, analysis tool and design. The fourth one, the result of this research, the fifth section provides discussion, and the last one is conclusion and suggestions.

2. LITERATURE REVIEW

2.1. The concept of basic materials supplies

All industries will always supply their basic materials. The difference between those large or small companies lies in the amount and condition. For large or medium companies, the materials are always made available, while the small ones are not. Even so, all of them always make efforts to suffice the production, which are caused by several things (Ahyari, 1999, p. 150; Tulung, 2017):
1. The materials cannot be purchased or imported in particular units or time.
2. In that case, the management may decide to supply the materials in large amount. However, big supplies in a company may results in the loss of the company, in that the higher the cost of the materials, the less the profits obtained by the company. Besides, damage to the materials may add to the advantage.

Richard (2002, p. 322) stated that basic materials include basic inputs from the production process of a company.

There are three systems in the procurements of basic materials:
1. Ideal procurement system.
2. Procurement System with a fixed number of orders.
3. Procurement System using similar time.

Raw materials supplies are intended to reduce the company's dependence in terms of quantity and time of delivery. Besides, the company encounters can anticipate the uncertainty of time and delivery and the demands of goods for a particular period. It means that the availability of the materials ensures the production process.

In developed countries, a comparison between the profits and the expenses are highly emphasized, while it is not so by the developing countries. In fact, the problem of scarcity is a common occurrence, in that they are likely to take great purchase while ignoring the cost.

2.2. The definition of maintenance

Maintenance is a function in a company that has equal importance with other functions, such as production. In the problems related to maintenance, a company often ignores the implementation, that leads to damages.

Reksohadiprojo et al. (2001, p. 157) define maintenance as activities to maintain the production tools in order to prevent defect components, and when it cannot be avoided, to substitute the damaged tools with the new ones.

Indonesian Dictionary (1997, p. 774) states that maintenance is a process, an act, a way of maintaining, taking care of, treating, or securing properties particularly productions tools to prevent it from damage.

Thus, it can be concluded that maintenance is an activity to maintain or take care of the facilities or manufacture's equipment and attempt for repair or necessary adjustment/substitution in order to smooth the production process.

2.3. The definition of production efficiency

To explain the definition and correlation of production process efficiency, the Indonesian Dictionary (1997, p. 250) mentions that efficiency comes from the word efficiency, which means accurate or an activity conducted to produce a product as well as ensuring accurate and proper accomplishment, usefulness, and time accuracy.

According to Salim and Salim (1995, p. 376), efficiency means:

1. Fixation, an effort to operate something by not wasting time, cost, and energy.
2. Quick use, in that it can accomplish a task quickly and accurately.

According to Stoner and Freeman (1996), efficiency means an ability to minimize the use of resources in achieving the goals of the organization by "doing the right thing."

Pass and Lowers (1996, p. 189) suggests efficiency as a relation among scarce input factors with the output of goods and services. The relation can be measured physically or financially. The concept is used as the criteria in the assessment research, about how well the market allocate the resources.

Meanwhile, Robbins (1998, p. 22) states that efficiency is the ratio between the effective output and input necessary to achieve.

Based on the definition, it can be concluded that efficiency of the production process is the methods and techniques to create or add the use of certain goods and services by minimizing/use the time/cost/energy in achieving the goals of the organization.

2.4. The definition of production process

Production process plays an important role because raw materials are turned into a product with usefulness and advantages. According to Ahyari (1998, p. 12), the production process is a method or technique to create new use or add usefulness. Gaspersz (2001, p. 4) states that the production process is a set of activates following a flow of materials and information transforming various input into useful or high added value output. Assauri (1994, p. 97) suggested that it is a way and method as well as technique on how resources (labors, materials, financial) are changed to create a product.

RESEARCH METHOD

3.1. Method

The research applies descriptive and verification analysis methods. Descriptive analysis is to describe and explain the data, while verification to see the correlation among the variables using the census sampling technique.

3.2. Variable operational

Table 1 shows the matrix of the variables operational, X_1 is raw materials. Basic materials supplies are the materials or goods that are stored and used to achieve particular goals. X_2 is machine preventive maintenance. Preventive maintenance is an activity to prevent any damage and find a condition or situation that may harm the production facilities during the usage, Y is production efficiency and Z is production process continuity.

Table 1. Matrix of variables operationalization

Variables	Concept	Indicator	Measurement	Scale
Raw materials supplies (X_1)	Basic materials supplies are the materials or goods that are stored and used to achieve particular goals, for example for the production process or assembly, for resale, for spare parts of particular pieces of equipment or machine.	The amount of raw materials to be used in the production process for one period.	Level of materials availability.	Ordinal
Machine preventive maintenance (X_2)	Preventive Maintenance is an activity to prevent any damage and find a condition or situation that may harm the production facilities during the usage.	Regular maintenance means the activity conducted on regular basis, for example, every day. Periodic maintenance means an activity conducted periodically or in a particular period of time, such as once a week, once a month, or once a year.	The level of Working hours or the level of Machine usage / the number of maintenance.	Ordinal
Production efficiency (Y)	Operational activity implemented by the company in accordance with the plan.	The ability to produce output that is in line with the input.	The level of comparison between the input and output.	Ordinal
Production process continuity (Z)	It is a production process that occurs continuously. The Company is able to keep operating.	Profit percentage.	The level of margin percentage between the expenses and revenues.	Ordinal

3.3. Data source and determination

The data source of the research is as follow:

- Primary Data

The data were obtained directly from the object of the research, that is the industry of coconut processing in North Sulawesi, either coconut flour, coconut oil, or coconut shell charcoal.

- Secondary data

It is the data obtained from literature or reference books as well as other information related to the concept of the research.

In collecting the data, the researcher applied the following methods:

a. The survey that is direct observation of the condition or situation of the company.
b. Interview that is the data collecting by conducting a communication or question and answer session with the head or employees of the company.
c. Library research, a stage of data collecting method done through reading literature or books in order to study the theories relevant to the problems being studied.
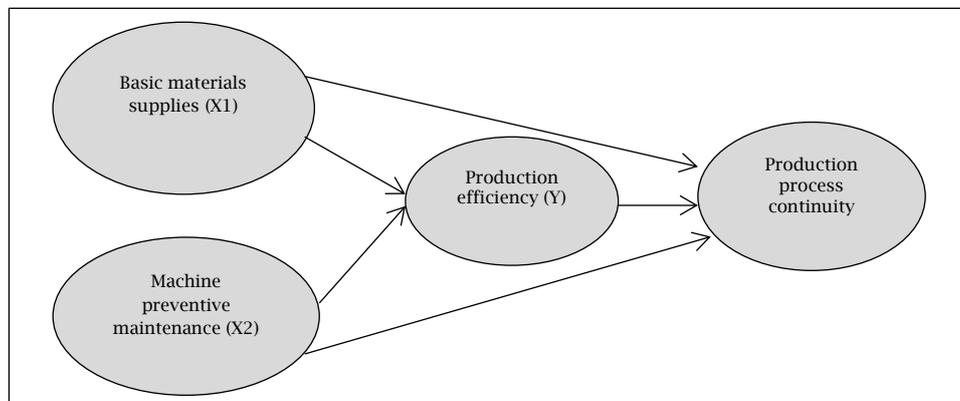
3.3.1. Analysis tool

To analyze the data, the path analysis method is applied using Software PLS-PM XL-Stat 2018.

3.3.2. Analysis design

The data were analyzed using path analysis method. The model can be seen in the following chart.

Figure 1. Research model

4. RESEARCH RESULTS

4.1. The research objects

The research was conducted in the coconut processing company in North Sulawesi. Geographically, North Sulawesi is located on 00˚15'51" - 05˚34'06" North Latitude and 123˚07'00" - 127˚10'30" East Longitude. The area expands to 15.273, 10 km2, with a population of 2.208.012 people (according to the data of 2012). The potential commodity in this province is coconut, clove, nutmeg, coffee, and chocolate. Based on the data obtained from the Board of Plantation, the area of coconut plantation is 272.137, 22 Ha, clove 74.383, 00 Ha, nutmeg 13.774, 93 Ha, coffee 9.271,43 Ha, and chocolate 13.048,50 Ha. The highest production was obtained from coconut, which reached 362.84,82 tons. In North Sulawesi, there are 17 companies operating the coconut processing industry. It spreads in five regencies/cities. Since it is only 17 in number, the sampling technique used is census, where all the population becomes the sample of the research. Meanwhile, to obtain the data, a questionnaire is distributed to the head or the equal.

4.2. The correlation between the latent variable and each indicator (outer model)

Measurement model (outer model) is basically used to measure the correlation between the indicator and the construct. In other words, the model describes how the indicator explains the constructor the latent variables. According to Chin (1998), the correlation between the construct and the latent variable (convergent validity) can be seen from the loading factor. If the loading factor is more than 0.5, then the hypothesis is accepted, while if it is below, the indicator can be excluded from the model. After evaluating the validity, the internal consistency reliability can be seen through the score of Cronbach Alpha and D.G. rho. If the score exceeds 0.7, the hypothesis is accepted. The score above 0.8 and 0.9 are considered satisfying and highly satisfying, respectively (Nunnally & Bernstein, 1994).

The table shows that all indicators are valid because the value of the loading factors is above 0,5. As for reliability, the values of Cronbach Alpha and D.G. rho are above 0.7. It means that all variables are accepted.

Table 2. The correlation between variable and the indicators

Variables	Indicator	Loading factor	Cronbach's Alpha	D.G rho	Note
Basic material supplies (X1)	X1.1	0.612	0.803	0.865	Valid and reliable
	X1.2	0.641			
	X1.3	0.740			
	X1.4	0.863			
	X1.5	0.757			
Machine preventive maintenance (X2)	X2.1	0.709	0.709	0.807	Valid and reliable
	X2.2	0.758			
	X2.3	0.683			
	X2.4	0.644			
	X2.5	0.572			
Production efficiency (Y)	Y1	0.764	0.818	0.874	Valid and reliable
	Y2	0.702			
	Y3	0.827			
	Y4	0.824			
	Y5	0.673			
Production process continuity (Z)	Z1	0.683	0.784	0.853	Valid and reliable
	Z2	0.806			
	Z3	0.688			
	Z4	0.751			
	Z5	0.714			

Source: Research results, 2018

4.3. Correlation among latent variables in the research

Basic Materials Supplies (X1) and Machine Preventive Maintenance (X2) are tested on the Production Efficiency (Y) as well as on the Continuity of the Production Process (Z) in coconut processing industry in Norty Sulawes. It applies the structural model (inner model) in PLS> the model describes the correlation among the latent variables based on the substantive theory. Compatibility test between the model and the data proves that the research describes the phenomena being studied. The results using PLS XLStat 2018 are shown in the following chart.

Table 3. Goodness of fit value

	GoF	GoF (Bootstrap)	Standard error
Absolute	0.560	0.594	0.106
Relative	0.742	0.765	0.107
Outer model	0.959	0.913	0.082
Inner model	0.774	0.835	0.060

Source: Research result, 2018

From the calculation, it is evident that the goodness of fit (GoF) – absolute, relative, outer or inner model – are more than 0, 5 or almost 1. It means that the theory used in this research can represent the phenomena being studied.

In line with the hypothesis of the research, the data were examined using path analysis. Since the data were in the form of the census, significance testing was not taken. According to Cooper and Schindler (2006), significance testing is carried out to determine the hypothesis accuracy based on the facts obtained from the samples, instead of from the census data. Therefore, to answer the hypothesis, the path coefficient is compared to zero.

In the partial examination, if the coefficient of the tested variable is not zero, *H0* is rejected.

Conversely, if the result is zero, *H0* is accepted. The concept also applies to simultaneous examination.

Table 4. The influence in the first structure

	Machine preventive maintenance (X2)	Basic materials supplies (X1)
Correlation	0.755	0.319
Path coefficient	0.835	-0.144
Correlation * path coefficient	0.631	-0.046
Contribution to R² (%)		
Cumulative %		

The equation of the first structure is:

*Production Efficiency (Y) = -0.14 * Basic Material Supplies (X1) + 0.83 * Machine Preventive Maintenance (X2)* (1)

Table 5. The influence in the second structure

	Machine Preventive Maintenance (X2)	Production Efficiency (Y)	Basic Materials Supplies (X1)
Correlation	0.722	0.656	0.574
Path coefficient	0.310	0.326	0.298
Correlation * path coefficient	0.224	0.214	0.171
Contribution to R² (%)	36.813	35.149	28.037
Cumulative %	36.813	71.963	100.000

The equation of the second structure is:

*Production Process Continuity (Z) = 0.29 * Basic Materials Supplies (X1) + 0.31 * Machine Preventive Maintenance (X2) + 0.32 * Production Efficiency (Y)* (2)

Table 6. Contribution of basic materials supplies and machine preventive maintenance to the continuity of the production process through production efficiency

Relation			Contribution		
			Direct	*Indirect*	*Total*
Raw material supply	→	Production efficiency	-0.144	-	-0.144
Preventive machine maintenance	→	Production efficiency	0.835	-	0.835
Raw material supply	→	Production process continuity	0.298	-0.047	0,251
Preventive machine maintenance	→	Production process continuity	0.310	0.273	0,779
Production efficiency	→	Production process continuity	0.326	-	0.583

Source: Research result in 2018

Table 6 shows the influence of each variable, both directly and indirectly, as well as their simultaneous influence. The biggest influence is from machine preventive maintenance on production efficiency, while materials supplies have a negative influence on it.

5. DISCUSSION

Based on the data, basic materials supplies have a negative influence on the production efficiency of the coconut processing industry in North Sulawesi. In other words, if the materials are increased, the efficiency decreases. It is normal because adding the amount means increasing the cost. It may lead to inefficiency of the production, especially in the company using the just-in-time method. However, materials supplies do not influence the continuity of the production process because the scarcity of materials is not uncommon, which leads to fluctuating production cost. The inexistence of materials will stop production.

Preventive maintenance has a positive influence on production efficiency and continuity. The company understands that any damage will harm the production process. Besides, since the machines are purchased from other countries, the damage will cost them a lot more, in terms of money and time. They have to invite experts and spare part from where the machine is purchased.

Meanwhile, production efficiency influences the production continuity. It helps to maintain the continuity of the production process of the company.

6. CONCLUSION AND SUGGESTIONS

Coconut industry in the North Sulawesi, there was a negative influence from the raw material on production efficiency, while the raw material supply to the sustainability of the production process had a positive effect. Basic materials supplies influence the production efficiency on the coconut processing industry in North Sulawesi province, but it has no influence on the production process. Meanwhile, preventive maintenance has a positive influence on production efficiency and the continuity of the production process, either directly or indirectly. Further, it is found that product efficiency influences the continuity of production.

The limitation of this research is the sample that only includes North Sulawesi coconut industry, further research on the topic should take the sample in Indonesia coconut industry or add several central coconut industries

Based on the conclusion, it is suggested that the manager of coconut industry companies pay attention to the preventive maintenance of the machines, for it has great influence.

REFERENCES

1. Ahyari, A. (2002). Manajemen produksi perencanaan sistem produksi. Jakarta: Edisi Empat Penerbit Erlangga.
2. Assauri, S. (2003). Manajemen produksi dan operasi. Jakarta: Edisi Revisi, Lembaga Penerbit FEUI.
3. Bell, G. F., & Balkwill, J. (2003). Management in engineering principles and practice. USA: Prentice Hall.
4. Basu, S. (2004). Pengantar bisnis modern. Yogyakarta: Edisi III, Penerbit Liberty.
5. Buffa, E. S. (1995). Modern production/operation management (8th ed.).New York: MC Graw-Hill Book Company Inc.
6. Chin, W. W. (1995). Partial least square is to LISREL as principal components analysis is to common factor analysis (University of Calgary, Canada, Technology Studies). Retrieved from https://pdfs.semanticscholar. org/3173/663806d878ddc6305c6c14c115cd1c1a46ac.pdf
7. Cooper, D. R., & Schindler, P. S. (2006). Business research method (9th ed.). New York, Irwin /McGraw-Hill.
8. Gasperz, V. (2001). Production planning and laventory control. Jakarta: PT. Gramedia Pustaka Utama.
9. Handoko, H. T. (2000). Dasar-dasar manajemen produksi dan operasi. Yogyakarta: BPFE.
10. Herjanto, E. (2003). Manajemen produksi dan operasi. Yogyakarta:.Edisi Pertama, Fakultas Ekonomi UGM, BPFE.
11. Hill, T. (2000). The essence of operation management. UK: Prentice Hill, Inc.
12. Heizer, J., & Render, B. (2001). Operation management. New Jersey: Prentice Hall Inc, UP Per Saddle.
13. Husein, U. (1999). Studi kelayakan bisnis manajemen metode dan kasus. Jakarta: Penerbit PT. Gramedia.
14. Kamus Besar Bahasa Indonesia (1998). Edisi III, Penerbit Balai Pustaka.
15. Ma'arif, S., & Tanjung, H. (2003). Manajemen operasi. Jakarta: PT. Grafindo.
16. Prawiro, S. (2001). Manajemen operasi analisis dan studi KA S9. Jakarta: Edisi ke 3, Bumi Aksara,
17. Reksohadiprojo, S., & Gito S. I. (2001). Manajemen produk. Yogyakarta: Edisi ke empat BPFE.
18. Riggs, J. (2001). Production system planning analysis and control. New York: John Willy and Sons,
19. Robbins, R. S. (1998). Manajemen produksi perencanaan fasilitas produksi dan lingkungan kerja perencanaan standar produksi Yogyakarta: Penerbit BPFE UGM.
20. Render, B., & dan Jay, H. (2005). Operations management. Buku Satu, Edisi Ketujuh, Penerbit Salemba Empat.
21. Riggs, J. L. (1995). Production systems: Planning, analysis, and control (4th ed.). USA: John Wiley & Sons, Inc.
22. Shcroder, R. (2004). Manajemen operasi. Jilid Satu, Edisi Ketiga, Penerbit Erlangga.

23. Sofyan, A. (2004). Manajemen produksi dan operas (Edisi Revisi, Penerbit Fakultas Ekonomi, Universitas Indonesia).
24. Stoner, J. A. F. (2003). Management. Jakarta: Edisi ke 8 terjemahan, Penerbit Erlangga
25. Tulung, J. E. (2017). Resource availability and firm's international strategy as key determinants of entry mode choice. *Jurnal Aplikasi Manajemen-Journal of Applied Management 15(1).* http://jurnaljam.ub.ac.id/index.php/jam/article/view/916
26. Winston, W. L. (2004). Operations research: Applications and algorithm (4th ed.) Indiana University. Retrieved from https://fac.ksu.edu.sa/sites/default/files/books_3337_0.pdf
27. Yamit, Z. (1996). Manajemen Kuantitatif Untuk Bisnis. Operation research. Yogyakarta: Edisi I, Penerbit BPFE.