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A PROPOSAL ON EFFICIENCY MEASURING OF RICE MILLING PROCESS BY USING AHP / DEA METHOD

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Abstract *Indonesia is a country which becomes the third largest producer of rice in the world. However, Indonesia still carries out rice importing and the rice is classified high-priced. One of the factors causing those problems is the lack of efficiency of rice milling process. Pandeglang Regency is a region which has the largest rice field in Banten. As the largest agricultural territory and a qualified rice producer, it must be possible to have rice-milling means. The rice-milling process does not always produce a constant output amounts, it can be increased or decreased, despite the use of a constant input amounts. Thus, efficiency measuring of rice-milling process is needed to find out the output increase or input decrease used in rice-milling process in order to reach an efficient point. Method applied in measuring the efficiency is AHP/DEA method. Based on acquired research results, the efficiency level at the research location was 90.01% in which from 11 rice-milling processes there was one inefficient rice-milling process which was the C rice-milling process.*

Keywords*: AHP/DEA; efficiency; inefficiency; rice milling process.*

1. Introduction

Rice is a staple food for most of people in the world especially in Indonesia [1]. In 2012, rice consumption in Indonesia was quite high, around 139 kilograms per capita per year [2]. Based on Food and Agriculture Organization (2015), Indonesia place third in the largest rice producer in the world with the amount of production of 75,6 million tons. However, rice imports in Indonesia is still on going to meet the need for rice consumption and rice price in Indonesia remains high [3]. One of the factors that caused it was lack of efficiency in rice milling process[1].

Pandeglang regency is the region that has the largest rice field in Banten. As a region that has the largest agricultural area and good quality rice producer, it is likely to find rice milling facility. This rice milling process does not always produce a fixed amount of output, either increasing or decreasing, although using a fixed number of inputs. Therefor it is necessary to measure the efficiency of the rice milling process [4] to determine the increase in output or reduction of inputs used in the rice mill to reach the efficient point. In this research, the efficiency was measured by using AHP/DEA method, whereas AHP method [5] was used to define the value of priority quality of each rice mill service criteria which then made one of the inputs to measure rice milling [4] process efficiency by using DEA method. If it is known that there is inefficiency, then factor analysis will be done by using cause-effect diagram which then the proposed improvement plan will be done by using 5W+1H tools and peer group comparison to indicate the increasing in output and reduction in input.

The aim of this research is to indicate the value of priority quality of service criteria in each rice mill, identifying input and output factors that affect efficiency level of rice mill, identifying efficiency level of rice mill in Pandeglang district, Majasari distrct, and Cimanuk district, and defining efficiency improvement proposal to inefficient rice mill.

2. Research Methodology

This research employs quantitative approach in survey method by using non-parametric statistic. The research took place in eleven rice mills located in Pandeglang regency especially in Pandeglang district. It was conducted on December 2016 until Februari 2017. The data used in this research were primary data

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obtained directly from the concerned parties by way of direct observation in the field, interviews, and questionnaires distribution to the expert, in this case, the owner of rice mills.

In this research, merging of two methods which is AHP and DEA was employed. Analytical Hierarchy Process (AHP) method [4] was employed to determine service criteria quality in rice mills which then used to measure efficiency in further method. Data Envelopment Analysis method was employed to determine efficient relativity [6] in defining efficient rice mill location.

The purpose of the hierarchy of problems above is to determine the highest priority in rice mil service with its predefined criteria. The criteria include [3] tangibility, responsiveness, reliability, assurance and empathy. The sub-criteria employed in the hierarchy of problems above are displayed in the table below.

Tabel 1. Criteria and Sub-Criteria in Rice-Milling Service

Criteria	Sub-Criteria
Reliability	a. Accurate Scales
	b. Opening / Closing of Rice Mill is on Schedule
	c. SOP accordance process
	d. Neat Packaging
	e. Work Agility
Assurance	a. Professional Skill
	b. Trustworthy Performance
	c. Treating customer fairly
Tangible	a. Spacious and comfortable workplace
	b. Strategic Location
	c. Production service supported machines
	d. Phone access service
Empathy	a. Periodical Bonus
	b. Price discount in case of complain
Responsiveness	a. FIFO
	b. Setting UP
	c. Responding to Complaint

After performing the matrix calculation stages of comparison of criteria and sub-criteria; determining priority quality and calculating the consistency (CR<0,1) [7] ; the priority quality of service criteria was gained from each rice mill. The following are values of priority quality which will be employed in measuring efficiency.

Table 2. Quality of Service Input

Rice Milling	Service Criteria	Value
A	Reliability	0,46
B	Reliability	0,39
C	Assurance	0,54
D	Empathy	0,3
E	Assurance	0,49
F	Responsiveness	0,47
G	Reliability	0,39
H	Assurance	0,41
I	Responsiveness, Assurance	0,31
J	Responsiveness, Assurance	0,27
K	Responsiveness	0,42

The data above are DMU determiner data whereas the quantity of rice milling process is used as DMU. There are eleven DMUs which mean there are eleven rice milling process in the mill. The following are grouping stage of input and output variable in measuring rice mill efficiency which includes eleven DMU, one output variable and eight input variables.

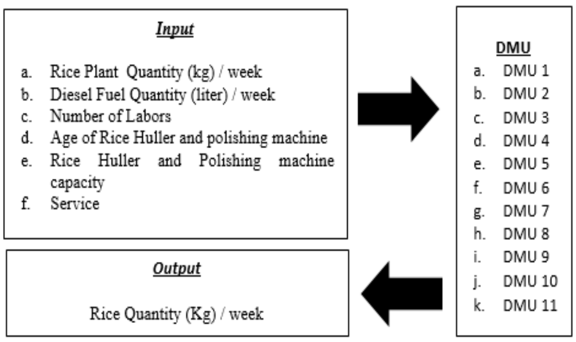

Fig 1 The Grouping of Input and Output Variable

1. Result and Analyze

Below are quantitative data of input and output variable which will be used in measuring rice mill efficiency by using Software Win4DEAP The next stage was determining DEA model. The model that was employed in measuring rice milling process efficiency was DEA with VRS model which is oriented to output value (output oriented). This model was chosen because the output of rice produced in each rice mill varied, sometimes fixed, decreases or increases indicating that the rice mill did not operate on an optimal scale.

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Table 3. Input and Output Data from DEA Method

Rice Milling Process	Rice Plant (Kg)/ Week	Diesel Fuel (Liter)/ Week	Number of Labor	PK Machine Age (Year)	Polishing Machine Age (Year)	PK Machine Capacity (Kg/hr)	Polishing Machine Capacity (Kg/hour)	Service	Rice (Kg) / Week
A	1000	20	1	5	5	1200	700	0,46	500
B	1000	20	2	10	10	1200	700	0,39	500
C	30000	600	18	10	10	1500	700	0,54	15000
D	6000	120	5	5	5	1200	700	0,3	3000
E	1000	20	3	2	2	1200	700	0,49	500
F	10000	100	3	30	30	1200	700	0,47	5500
G	2000	40	5	10	10	1200	700	0,39	1000
H	42000	360	8	10	10	1200	700	0,41	23000
I	5000	100	5	8	1	1200	700	0,31	2500
J	4000	120	4	1	1,5	1200	700	0,27	2000
K	5000	100	2	24	24	1200	700	0,42	2500

On the other hand, the output selection is oriented because the rice mill wants maximum output or increases by using fixed or decreasing inputs. Below is DEA mathematic model [8] to calculate the VRS technical efficiency value in DMU 1.

Function Purpose :

Max $q1 = \varphi + \varepsilon\ (s_1^+ + s_1^- + s_2^- + s_3^- + s_4^- + s_5^- + s_6^- + s_7^- + + s_8^-)$

Limitation :

a. s_1^+ (*Rice Output*)
$y_{11}\lambda_1 + y_{12}\lambda_2 + y_{13}\lambda_3 + y_{14}\lambda_4 + y_{15}\lambda_5 + y_{16}\lambda_6 + y_{17}\lambda_7 + y_{18}\lambda_8 + y_{19}\lambda_9 + y_{110}\lambda_{10} + y_{111}\lambda_{11} - s_1^+ = \varphi y_{11}$

b. s_1^- (*Rice Input*)
$x_{11}\lambda_1 + x_{12}\lambda_2 + x_{13}\lambda_3 + x_{14}\lambda_4 + x_{15}\lambda_5 + x_{16}\lambda_6 + x_{17}\lambda_7 + x_{18}\lambda_8 + x_{19}\lambda_9 + x_{110}\lambda_{10} + x_{111}\lambda_{11} + s_1^- = x_{11}$

c. s_2^- (*Solar Input*)
$x_{21}\lambda_1 + x_{22}\lambda_2 + x_{23}\lambda_3 + x_{24}\lambda_4 + x_{25}\lambda_5 + x_{26}\lambda_6 + x_{27}\lambda_7 + x_{28}\lambda_8 + x_{29}\lambda_9 + x_{210}\lambda_{10} + x_{211}\lambda_{11} + s_2^- = x_{21}$

d. s_3^- (*Number of workers input*)
$x_{31}\lambda_1 + x_{32}\lambda_2 + x_{33}\lambda_3 + x_{34}\lambda_4 + x_{35}\lambda_5 + x_{36}\lambda_6 + x_{37}\lambda_7 + x_{38}\lambda_8 + x_{39}\lambda_9 + x_{310}\lambda_{10} + x_{311}\lambda_{11} + s_3^- = x_{31}$

e. s_4^- (*PK Machine Age Input*)
$x_{41}\lambda_1 + x_{42}\lambda_2 + x_{43}\lambda_3 + x_{44}\lambda_4 + x_{45}\lambda_5 + x_{46}\lambda_6 + x_{47}\lambda_7 + x_{48}\lambda_8 + x_{49}\lambda_9 + x_{410}\lambda_{10} + x_{411}\lambda_{11} + s_4^- = x_{41}$

f. s_5^- (*Polish Machine Age Input*)
$x_{51}\lambda_1 + x_{52}\lambda_2 + x_{53}\lambda_3 + x_{54}\lambda_4 + x_{55}\lambda_5 + x_{56}\lambda_6 + x_{57}\lambda_7 + x_{58}\lambda_8 + x_{59}\lambda_9 + x_{510}\lambda_{10} + x_{511}\lambda_{11} + s_5^- = x_{51}$

g. s_6^- (*PK Machine Capacity Input*)
$x_{61}\lambda_1 + x_{62}\lambda_2 + x_{63}\lambda_3 + x_{64}\lambda_4 + x_{65}\lambda_5 + x_{66}\lambda_6 + x_{67}\lambda_7 + x_{68}\lambda_8 + x_{69}\lambda_9 + x_{610}\lambda_{10} + x_{611}\lambda_{11} + s_6^- = x_{61}$

h. s_7^- (*Polish Machine Capacity Input*)
$x_{71}\lambda_1 + x_{72}\lambda_2 + x_{73}\lambda_3 + x_{74}\lambda_4 + x_{75}\lambda_5 + x_{76}\lambda_6 + x_{77}\lambda_7 + x_{78}\lambda_8 + x_{79}\lambda_9 + x_{710}\lambda_{10} + x_{711}\lambda_{11} + s_7^- = x_{71}$

i. s_8^- (*Services Input*)
$x_{81}\lambda_1 + x_{82}\lambda_2 + x_{83}\lambda_3 + x_{84}\lambda_4 + x_{85}\lambda_5 + x_{86}\lambda_6 + x_{87}\lambda_7 + x_{88}\lambda_8 + x_{89}\lambda_9 + x_{810}\lambda_{10} + x_{811}\lambda_{11} + s_8^- = x_{81}$

j. $\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 + \lambda_6 + \lambda_7 + \lambda_8 + \lambda_9 + \lambda_{10} + \lambda_{11} = 1$
$\lambda_1, \lambda_2, \lambda_3 l, \lambda_4, \lambda_5, \lambda_6, \lambda_7, \lambda_8, \lambda_9, \lambda_{10}, \lambda_{11}, s_1^+, s_1^-, s_2^-, s_3^-, s_4^-, s_5^-, s_6^-, s_7^-, s_8^- \geq 0$

A DMU is efficient if TEVRS value> SE. If TEVRS value < SE then the DMU is inefficient and improvement should be sought. SE (Scala Efficiency) value was gained from TECRS divided by TEVRS [9]. A DMU is efficient if TEVRS value> SE. If TEVRS value < SE then the DMU is inefficient and improvement should be sought. SE (Scala Efficiency) value was gained from TECRS divided by TEVRS [9]. The following are the result of DEA model calculation.

From table 4, it can be seen that there are ten efficient rice milling processes. Those are rice milling process A, B, D, E, F, G, H, I, J, K and one inefficient rice milling process which was rice milling process C. It can be concluded that efficiency level of rice milling process in Pandeglang was 90,91%. Rice milling process C had TEVRS value for 0,914 while SE value for 0,999. Therefore, it is concluded that the TEVRS in rice milling process C was smaller than the SE which means rice mill C was not efficient.

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Table 4. Efficiency Measure Result

Rice Milling Process	TE_{CRS}	TE_{VRS}	SE	Return to Scale	Indicator	Remarks
A	0,909	1	0,909	IRS	$TE_{VRS} > SE$	Efficient
B	0,909	1	0,909	IRS	$TE_{VRS} > SE$	Efficient
C	0,913	0,914	0,999	IRS	$TE_{VRS} < SE$	Inefficient
D	0,912	0,958	0,952	IRS	$TE_{VRS} > SE$	Efficient
E	0,911	1	0,911	IRS	$TE_{VRS} > SE$	Efficient
F	1	1	1	-	$TE_{VRS} > SE$	Efficient
G	0,909	0,954	0,953	IRS	$TE_{VRS} > SE$	Efficient
H	1	1	1	-	$TE_{VRS} > SE$	Efficient
I	1	1	1	-	$TE_{VRS} > SE$	Efficient
J	0,913	1	0,913	IRS	$TE_{VRS} > SE$	Efficient
K	0,909	1	0,909	IRS	$TE_{VRS} > SE$	Efficient

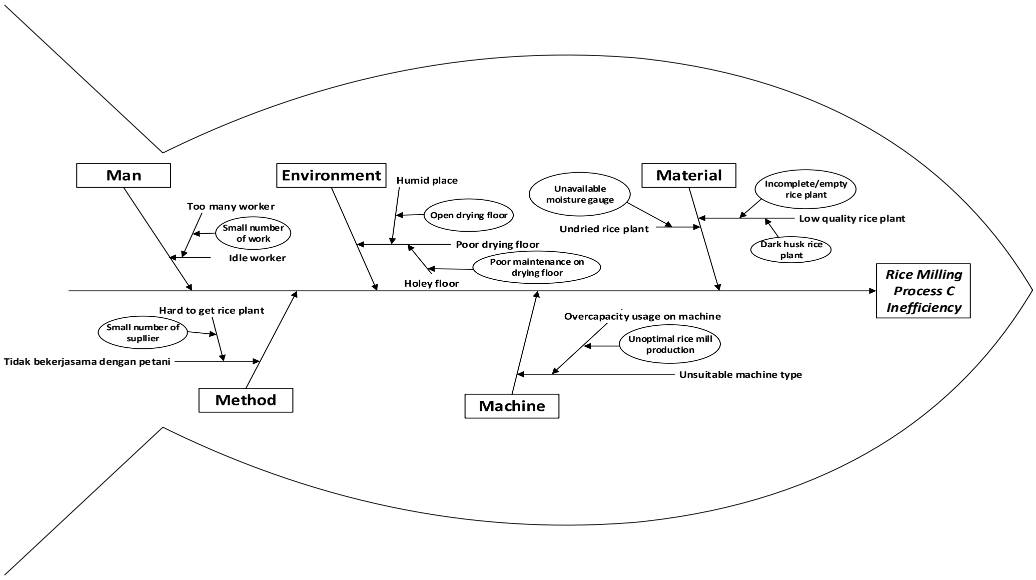

Fig 2. Cause and Effect Diagram of the Inefficiency in Rice Milling Process C

Thus, proposed improvement is necessary to find out the factors resulting in the efficiency of rice milling process C, the cause- effect diagram was employed. The following is the cause-effect diagram employed in the current research. After knowing the factor, the next stage was developing the draft improvement proposal using 5W+1H [10] .

After developing cause-effect diagram and proposed improvement draft, the next stage was presenting the proposed improvement draft to increase the efficiency of rice mill in Pandeglang district, Majasari district and Cimanuk district.

According [9] suggestion for improvement of input and output variables on inefficient DMUs or those with excess inputs and outputs can be done by comparison with the peer groups (λ/DMU comparison). The peer group can be a reference for the inefficient DMU to be efficient [11]. The following are suggestions for improvement of input and output variables that must be achieved to be efficient.

In rice milling process C, the projected value which can be achieved to reach efficiency is 16420 Kg and the improvement percentage 6

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Tabel 5. Draft improvement proposal of the inefficiency of rice milling process C

Factor	Cause	*What* (what to do)	*Why* (Why to Do)	*Where* (*Where to Do*)	*When* (When to do)	*Who* (Who does it)	*How* (How to Do)
Material	Poor quality rice plant	Improve rice plant selection	To make high quality rice indicated by whole and white-colored rice.	Rice Milling Space.	When supplier deliver the rice plant	Person in charge or rice mill owner	By sample checking when supplier deliver the rice plant with 60.000 kg/2 weeks rice plant supplied in average and complaining when rice plant supply is in poor quality, also paying more attention to the drying process
	Undried rice plant	Optimal rice plant drying process to get an optimum dried rice plant and use a moisture gauge.	To make the rice not so easy to wrack during rice mill process	Lontar (Rice Mill location)	Plant rice drying process	Rice Mill worker	The layering thickness during drying process should be even and not too thick, flipping the rice plant in every hour, and if possible provide an oven room to make a faster process and gain an optimum dry.
Machine	Overcapacity usage of machine	Increase production in rice mill.	To maintain the production process with available machine capacity.	Rice milling space	Rice milling process	Rice mill worker	Increasing rice mill production by building cooperation between farmers and rice mill.
Environment	Poor drying floor	Fix/reconstruct the holey drying floor and build a drying space.	To make the drying rice not blended with rocks and pebble from the holey floor and to avoid a humid drying floor/space.	Lontar (Rice mill location)	Drying process	RiceMill worker	Covering the holey floor, cleaning the floor surface before rice plant drying process, build an oven room.
Method	Not cooperating with farmer	Build a cooperation between farmers and rice mill	To make supplier consistently supply rice plant to the mill	Rice Mill	In negotiation with supplier	Rice Mill owner	By investing money or fertilizer to farmer to make a permanent supplier to the rice mill, however the rice plant should have the same selling price with the market
Man	Idle worker	Hire a necessary number of worker that suit the amount of work available	So that there will be no idle worker during production	Rice Mill	During rice milling process and drying process	Rice Mill owner	By dividing the work fairly during rice milling process or drying process and hire the worker according to available work

Table 6. Evaluasion on Proposed Improvement Draft for Rice Milling Process C

Factors		Original Value	Projected Value	Improvement Percentage Suggestion
Output	Rice Quantity (Kg)	15000	16420,074	9,48%
Input	Diesel Fuel Quantity (Litre)	600	260,967	56,51%
	Number of Labour	18	7	61,11%
	Rice huller Capacity (Kg/jam)	1500	1200	20%

can be comparison for DMU 3 to achieve proposal is 9,477%. DMU 5, DMU 8 dan DMU efficiency. Reduction of input variable can be done by reducing the number of workers and reducing diesel fuel by increasing the rice mill production so that the machine capacity can be used optimally.

4. Conclusion

Based on this research, it can be concluded that:

1. The priority quality of service criteria in rice milling process in sequence was 0,46, 0,39, 0,54, 0,3, 0,49, 0,47, 0,39, 0,41, 0,31, 0,27, 0,42.
2. Input factors affecting rice mill efficiency are rice quantity, diesel fuel, labor, machine's age, machine's capacity, and service. While the output variable is rice quantity.
3. The efficiency level of rice mill in Pandeglang regency is 90,91%, whereas the efficiency level of rice milling process is categorized into high efficiency.
4. There was one inefficient rice milling process which was ice milling process C. Therefore, a proposal of efficiency improvement was done by increasing the quality of rice selection, utilizing moisture gauge, increasing rice mill production, doing maintenance, fixing the drying floor, cooperating with grain/rice supplier and work cooperation among labours.

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