Value Engineering of Coco Peat Product to Increase Productivity

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Abstract: Coco peat is a scrap from the process of sweeping coco fiber and coco bristle fibers in the form of fine granules. The selling value of coco peat block is more expensive compared to coco peat fine grain, hence why value engineering is needed. In this paper the process of making the coco peat block press machine is ergonomically described. Productivity of coco peat block fine grain and coco peat block will be compared. The method used for ergonomic design uses anthropometric data and Rapid Entire Body Assessment (REBA) analysis, while productivity measurement uses total productivity. The results obtained showed that the design using anthropometric data of workers resulted in an improvement of 4 points of work posture from conditions that needed to be improved to be safe. The total productivity of technological engineering changes carried out shows an increase in index of around 0,41. There is an increase in selling value between fine grain coco peat with 3 times coco peat block. These findings indicate that the procurement of press machines that are ergonomically designed to add the value of coco peat is a viable solution to increase the productivity of the company.

1 INTRODUCTION

Coconut is one of the most agricultural products has many derivatives. Not only from the flesh of the fruit, even coconut husk which is classified as scrap can be utilized as a product that is worth selling. The derivative of coconut husk can be divided into three, namely coco fibre, coco bristle, and coco peat.

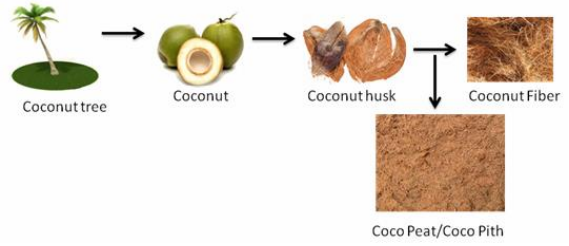

Figure 1: Industry Tree of coco peat

Coco fiber and coco bristle are fibers of coconut husk which has been combed to separate from one another (not sticking together). The granules resulting from the sweeping process is called coco peat. The difference in selling price of these three products are shown in Table 1.

Table 1: The selling price of the products.

No.	Product	Selling Price (Rp) / kg
1	*Coco Bristle*	14,000
2	*Coco Fibre*	2,700
3	*Coco Peat*	600

Coco peat has the lowest sales value. But if you consider the ratio of the proportion of the quantity produced by the coconut husk for each product, where the coco fiber, coco bristle, and coco peat in a row, namely 20%, 10% and 70%, then it would be very unfortunate if the coco peat not utilized. Mainly because of coco peat also has a good resale value because it can be used as a fertilizer and growing media such as hydroponics, vegetables, also flowers and trees nursery.

Coco peat has a mild nature, it can absorb large volumes of water, the acceptable pH, and have oxygention propertieswhich make coco peat suitable as planting media for root growth (Awang, 2009). Such properties make the coco peat to be one good alternative in lieu of the land, because the amount of land is increasingly limited.

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The compny that become the object of study has a production capacity of 4,500 kg per day. Coco peat, packed into 30 kg sacks, deposited into the warehouse and sold to the local market for Rp 18,000 per sack. Process undertaken to acquired coco peat products, namely:

1. Combing: Coconut coir parsed using a machine to separate Crasher coco fibers and CCO bristle fiber and coco peat granules.
2. Sieving: Beads of coco peat granules then filtered three times with sifting machine to obtain fine granules according to the standard of the company.
3. Packaging: Sieving results then packed into 30 kg sacks sized manually by workers.

Sales of coco peat in bulk form is the simplest way of selling. Generally coco peat is sold in the form of blocks, especially for countries that are more developed in their agribussiness like India, Europe, and America. The block form is easier to handle in terms of transportation because it has a smaller volume than the bulk form.

(a)

(b)

Figure 2: (a) Coco peat bulk in sacks (b) Coco peat pressed into block.

Value engineering (VE) is an organized effort to analyze the function of the product or service so that the company can find a way of generating the required functionality of the essential characteristics that users want while achieving the target set fee. Value engineering is widely used in target costing, product design and / or development, quality control, etc. In this research, value engineering done for product development. Value added activities carried out by changing the shape of the packaging of bulk into blocks which have a higher selling value, at Rp 23,000 / 10kg. Cost engineering is done on designing products by considering the option ofbuilding a new machine design with ergonomic principles or buy the machine available in the market.

Value addition of coco peat bulk into blocks can be done with the procurement of a press machine. Thus in this study will be a comparison of productivity of sales coco peat with a bulk form and block. They will also do a comparison of productivity between the use of the press machine individually designed with ergonomic considerations with engines purchased from the market.

2 METHODS

Stages of the research conducted in this study include the ergonomic design of the press machine, productivity calculations, and the analysis of the value added.

Manually packing Method is analyzed by using Rapid Entire Body Assessment (REBA) to look at risk due to work postures that are not good. This method is chosen because the workers use almost entire body part to work. Then the machine will be designed with consideration of workers anthropometry so that in addition to having better productivity, health and work comfort is also obtained in the presence of the press machine.

Productivity calculation method used in this study is total productivity. This method compares the magnitude of the overall output of the input used. Input factors are taken into account include labour, materials, capital, energy, and others while the output factor is the revenue earned from the sale (Sinulingga, 2014). Productivity on the conditions before and after value engineering is compared to see which options are most profitable productivity. The formula used to calculate the total productivity, namely:

$$\text{Total productivity} = \text{Output} / \text{Input} \quad (1)$$

An option with the best productivity index is submittedas the best proposal of this study. To find out how much value is actually done in the

engineering of this value then the calculation of added value is done. This calculation is performed in a way to calculate the necessary costs (materials, labour, packaging, depreciation, etc.) to make one kilo of product. Then the value of the product sales will be reduced by the value of the production cost. The result of these reductions is actual profit earned by the manufacturer.

Calculation of profit per kilo product is done for the condition before and after engineering. Then the difference of thevalue of the two is the added value that has been done. The larger the value, the better the added value that has been done.

3 RESULTS

3.1 Ergonomic Design Press Machine

Packaging method performed before the value engineering is manually done by workers. Activity of manual packaging is done by using a shovel to move the coco peat located on the production floor into the sack.

Figure 3: Method of manual packaging.

Figure 3 shows that the worker bent to 95^{o} repeatedly for a long time. The manual method is then analyzed posture using REBA method (see Figure 4). REBA assessment results show the value of nine which indicated that necessary action as soon as possible. This means that the procurement of a new working method or an ergonomic press machine is required in terms of packaging.

The design of the press machine is done by using the worker's body dimensions (five workers) as consideration of the dimensions of the press machine. Body dimensions used were High Standing Elbow, Hand Reach and Height Upright.

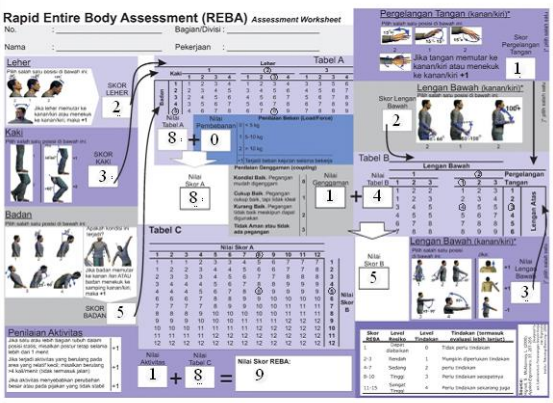


Figure 4: REBA sheet assessment before value engineering.

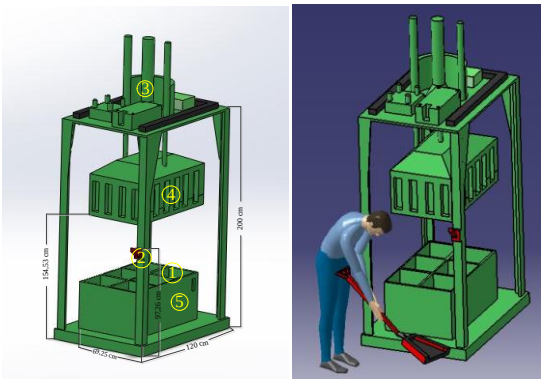
Theresults of the collected anthropometric data are then processed statistically by calculating the average, standard deviation, and uniformity test. Then the dimensions used is the 95th percentile results in accordance with the principle of upper extreme.

The costs necessary to make the press machine is shown in Table 2.

Table 2: Cost of each component machine press.

No.	Component	Unit price (Rp 000)	Quantity (Unit)	Total Price (Rp 000)
1	Iron Plate 8-10 mm	8,750 / m	15	8.242
2	Iron Plate 12-20 mm	8,750 / m	15	16.485
3	diesel engines	4.770 / unit	1	4.770
4	hydraulic Valve	123 / unit	1	123
5	hydraulic Pump	950 / unit	1	950
6	Working cylinder	9,000 / unit	1	9,000
7	oil Filter	428 / unit	1	428
		Total		39.998

The costs in Table 2 was obtained by interviews with experts of construction machinery. This machine is able to suppress the bulk 4 kg coco peat coco peat into one unit block. The cost of construction of this machine is much cheaper when compared to the cost of purchasing the press machine of the market for Rp 65,000,000 per unit with the same capacity. Figure 5 shows the appearance of the proposed draft press machine.



(a) (b)

Figure 5: (a) Draft of the press machine (b) How to use.

Information:

1. Container as a place to put coco peat
2. Control valve as a means of controlling the lowering and raising the working cylinder.
3. Cylinder as a means to lower and raise the mould presses.
4. Mold presses as a tool that puts pressure on coco peat into blocks.
5. Door as a place to put out the coco peat that has been printed.

In Figure 5 (b) is shown posture coco peat bulk of workers when inserting bulk coco peat into the machine. Posture thus already looks much better when compared with the posture before the press machine. Posture assessment work on the use of the press machine shown in Figure 6.

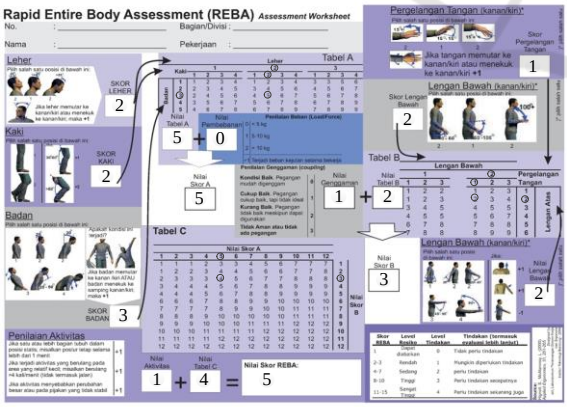


Figure 6: REBA sheet assessment after value engineering.

REBA assessment results show the value of five, which indicates that the working posture is safe to do in the long term.

3.2 Calculation of Productivity

Productivity calculations carried out for before and after value engineering. Factors taken into account the inputs and outputs include:

1. Raw material costs namely the costs required in the acquisition of raw materials (Rp 7 / kg)
2. Telaborcost which consist of salaries to employees (five workers with a salary of Rp 50,000 / day / person before value engineering and Rp 75,000 / day / person after value engineering).
3. The energy cost which consist of electric power costs for machinery and other production purposes.
4. Transportation cost is the transportation cost to the consumer (Rp 283 / kg prior to value engineering and Rp 373 / block after value engineering).
5. The cost of packaging ie the cost of procurement of sacks for bulk coco peat or plastic / cardboard for products coco peat block (Rp 1,500 for sacks and an assumed amount of Rp 6,708,000 for plastic and cardboard)
6. Depreciation costs of equipment and machinery.
7. Machinery maintenance costs.
8. The output is the result of revenues from product sales (Rp 600 / kg for bulk and Rp 2,300 / kg for the block). Each of the coco peat block is made of 4 kg of coco peat bulk.

To see a comparison of productivity of prior to value engineering and after value engineering, then a simple simulation is done using historical data. The production data with press machine designed ergonomically and the ready to use purchased machine is considered the same as the specification is also considered as the same engine capacity. Coco peat production data 2016-2017 period are shown in Table 3.

Table 3: Comparison of production data before and after value engineering.

Month	Raw material (Kg)	Prior to Value Engineering		After Value Engineering	
		(A) (Ton)	(B) (Rp 000)	(A) (000 Blocks)	(B) (Rp 000)
2016 Aug'	99.400	71	2.3	17.75	6,708
2016 Sept'	105,000	75	2.5	18.75	6,708
2016, Oct'	106.400	76	2.5	19:00	6,708
2016, Nov'	105,000	75	2.5	18.75	6,708
2016 Dec’	96,600	69	2.3	17:25	6,708
2017, Jan'	96,600	69	2.3	17:25	6,708

Table 4: Comparison of production data before and after value engineering (continued).

Month	Raw material (Kg)	Prior to Value Engineering		After Value Engineering	
		(A) (Ton)	(B) (Rp 000)	(A) (000 Blocks)	(B) (Rp 000)
2017, Feb'	109,200	78	2.6	19:50	6,708
2017, Mar'	105,000	75	2.5	18.75	6,708
2017, Apr'	105,000	75	2.5	18.75	6,708
2017, May	109,200	78	2.6	19:50	6,708
2017, June '	109,200	78	2.6	19:50	6,708
2017 July '	100,800	72	2.4	18:00	6,708
Total	1,247,000	891	29.7	223	80,496

Information:
(A) The raw material is processed and sold
(B) Costs incurred for packaging

Based on production data on Table 3 the productivity of each condition can be calculated. Comparison of productivity before and after value engineering can be seen in Table 4.

Table 5: Productivity comparison before and after value engineering.

No	Description	(A) (Rp 000)	(B) (Rp 000)	(C) (Rp 000)
1	Output (Income) (Rp)	534.600	683.100	683.100
2	Input (Rp)			
	Raw material	8.731	8.731	8.731
	Labor	74.250	111.375	111.375
	Energy	16.375	60.106	60.106
	Packaging	44.550	80.496	80.496
	Transportation	252,000	110.820	110.820
	Depreciation	1,450	5,050	7,300
	Maintenance	60	1,800	2,400
	Total Cost of Production	397.958	378.379	381.230
3	Gross Revenue (Rp)	136.641	304.720	301.869
4	Corporate Income Tax 15%	20.496	45.708	45.280
5	Net income	116.145	259.012	256.589
6	Productivity Total (D)	1:34	1.81	1.79

Information:
(A) Prior to the engineering value
(B) After engineering value with the press machine design results
(C) After engineering value with the press machines purchased in the market
(D) Calculated by a formula (1)

Total productivity index for the condition before value engineering and after value engineering with designed machine and purchased machine successively 1.34, 1.81, and 1.79. This figure means that every US $ 1 generate Rp 1.34 to conditions prior to engineering, and so on for the other options. This means the condition after the value engineering with designed machine is the best option because it has the highest index value.

3.3 Added Value

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Added value calculation is performed to see how much profit is obtained by producers as compared to prior to value engineering. This calculation will be done by comparing the value of profits after value engineering using the press machine which is ergonomically designed, with the profit before value engineering. The option of after value engineering with designed machine is chosen to be analyzed because this option has the highest value. Tables 5 and 6 respectively show the cost of production and the selling value of the condition before and after value engineering.

Table 6: Production cost and income before value engineering.

No.	Production description	Amount (kg)	Price (Rp)	Total (Rp)
1	Income	1	2,300	2,300
2	Production cost			
	Raw material	4	7	29
	Labor			375
	Energy			202
	Packaging			271
	Depreciation			17
	Transportation			373
	Maintenance			6
	Total Production Costs			434
	Profit per kg (Rp)			166

Table 7: Cost of production and income after value engineering.

No.	Production description	Amount (kg)	Price (Rp)	Total (Rp)
1	Income	1	600	600
2	Production cost			
	Raw material	1	7	10
	Labor			83
	Energy			15
	Packaging			50
	Depreciation			1
	Transportation			283
	Maintenance			1

Total Production Costs	434
Profit per kg (Rp)	166

It can be concluded that by using the system of bulk sales, manufacturers have lost Rp 860 per kg or Rp 766,260,000 per year. This figure is quite large because the value has exceeded the value of sales of bulk per year that is Rp 534,600,000. In other words there is an increase of 143% of income compare to prior of value engineering.

4 DISCUSSION

There are three options on this study to be considered. Option 1 is the condition without VE, option 2 is VE with the designed machine, and option 3 is VE with purchased machine. Productivity values of the three options can be seen on Figure 7.

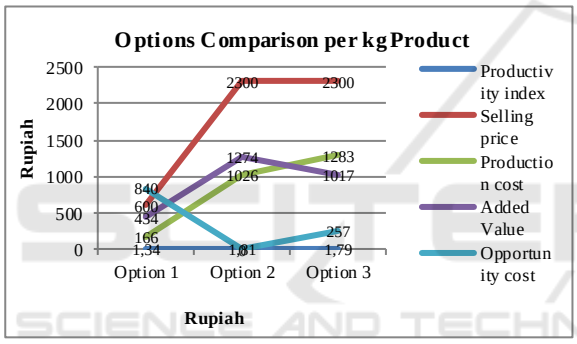

Figure 7: Options comparison.

From productivity point of view, the added value for option 1 and 2 are above the production cost which means both option is giving better cost to income ratio than option 3. From the opportunity cost which means the loss that gain by choosing other option, the base value is the option 2 because it has the best added value. If option 1 is chosen company would lost the income of Rp 840 per kilogram and if option 3 is chosen then company will lost Rp 257 per kg.

Basically the option 2 is the best option to choose. But there is also some disadvantage of it such as a necessary of an expert machine constructor to deliver the design into real life in the right way. This option will need some adjustment for the workers to get used to it. The period of adjustment, there will be a slight deviation in the productivity due to learning curve. A sensitivity analysis also has not been done. So we cannot make sure the reliability of the investment against various scenarios.

Generally this method of value added is not something new in the development of coco peat. But there is still limited study which discussed about the economic value of coco peatfor most of them are discussing about the usage of coco peat as growing media such as done in (Yahya, A, 1997 and Trivedi, Darshini R., 2014)

The kind of coco peat discussed in this study is the kind that needs a further treatment before use. Especially if it is to be used as growing media. Coco peat has a chemical property name tanin which is harmful for plants for it can prevent them to grow. Hence why, coco peat need to be soaked in water for several hours before used. This process is meant to reduce or eliminated the tanin in the coco peat by rinsing it off with water (Ramadhan, Dimas, 2018, Arif, 2014).

This study is only discussing the press machine because for now it is the only required condition to fulfil the market demand. The current local market preferred a low cost rather than a quality product. If needed, a further research can be done to develop further the value of coco peat such as making a ready to use coco peat which has already labelled and standardized quality parameters such as weight, size, impurities, moisture, electrical conductivity, pH, phytosanitary test (Plant Quarantine Certificate), salinity, fibre content, cation exchange capacity (CEC), etc.

This standardization is necessary if we want to expand our business internationally. In Netherland, there are already many coco peat producers which has been certificated by *European Certification body for Agricultural Sector* (ECAS). These companies not only provide a standardized coco peat, they are also selling a customized coco peat-based media mixtures for each type of plant. So buyer can buy the most suitable type to increased the success rate in growing plants (trubus online, 2009).

In India, they even have a Coir Board which has a lot of information about coconut derivatives products and control the regulations and the development of coco peat industry. Not only for growing media coco peat even used for a living lawn that can be rolled up, as a raw material to make briquettes, bio oil, insulator, production of vanillin, activated carbon, even textiles (Ministry of MSME India, 2016).

5 CONCLUSIONS

In conclusion, this study indicates that the value engineering done by transforming the form of coco peat from bulk to block can increase the productivity and income to the company. The added value is not only the increase of productivity, but also the healthy and comfort while working for the chosen option is to make the ergonomically designed press machine rather than the ready to use machine that can be purchased from the market.

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