Application of Value Engineering Principles in Developing Meat Grinding Machine with Zero-One Method and Matrices Evaluation Approaches

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***Abstract* - In this work, the value engineering principles are applied in order to enhance meat grinding machine performance. The one zero method and matrix evaluation approaches are used to analysis the product. Expected indicators of increased value, enriched a function of the product (not only for grinding but also enable for stirring the meat dough), and decreased production cost are expected from the developed machine. The machine is not only for expected enables. From three proposed alternatives, the selected product design is the meat grinding machine which operator position in semi-seated standing. The value of developed machine is 0.00028 performance/cost, which means the value increases 0.00004 from initial value. The performance of product also increases from 530 to 725, whereas production cost reduces from IDR. 2.900.000 to IDR. 2.572.890. The value of the revised grinding machine enhances up to 55.6%.**

Keywords:* *Value Engineering, Performance, Product, Value

1. INTRODUCTION

Due to rapid changed of customer desire, it is important to develop a product that meet the user requirement (Ulrich, 2001). For example, the customer want a meat grinding machine that enables not only for grinding but also for mixing a meat dough. Thus, product development have to be done in order to fulfill the user needs. In meat processing work, it is observed that meat grinding process and dough mixing are separated, thus high production cost and also low efficiency.

In order to enhance the grinding machine efficiency as well as the function, available meat grinding machine is redesign to develop a new dual-function machine (grinding and mixing). The development uses value engineering principle to increase the value of the machine whereas the production cost reduces. In this work, old grinding machine is redesigned to dual-function grinding-mixing machine. The development of the machine is based on the selected design from three alternative design. The alternative designs is analyzed with One-Zero method and matrix evaluation approaches (Ropik, 2006).

2. METHOD

2.1. Data collection

The data of meat grinding machine are collected from U.D. Umbul Rejeki at Pedan Klaten- Central Java-Indonesia. The collected data are tested of validity and reliability prior to data analysis. Validity test is performed with calculating scoring correlation every factor from all respondents. Meanwhile, reliability test aims to figure out the validity of measurement devices being used. Both testing calculations are executed with SPSS software.

2.2. Data analysis

The validated data is then analyzed using Zero-One method which employs value engineering principles. Sequences processes of the method as follows (Saaty Thomas, 1993): making of zero-one matrix; rank determination; factor rating (1-100) determination; alternative performance determination, and determination of the value for each alternative

Matrix evaluation is made based on decided criteria. The following steps are used in making matrix evaluation: determine alternative solution; decide affect criteria, scoring every criteria for each alternative; calculate total value of each alternative, and select the best alternative. The criteria of matrix evaluation are cost, accuracy, satisfaction, service time, and quality.

3. RESULT AND DISCUSSION

The principles of value engineering relates each other. The relation can be grouped in several stages as follows (Zimmerman and Hart, 1982).

3.1. Information stage

This stage contains information regarding old machine in terms of operating procedure, description, and cost.

3.1.1 Operating procedure

The process is started with slicing a meat before grinding process. The operator has to rotate handle box of the grinding machine and put the grinded meat into a container. The operator the go to mixing machine to blend the grinded meat with seasoning, to obtain meat seasoning dough. The next step is to overload the dough from container mixer. Eventually in the lass step, the operator have to package the dough based on order (Miles. L. D,1972).

3.1.2. Description of the machine

Figure 1 shows schematic diagram of meat grinding machine. Meanwhile, mixer is shown in Figure 2.

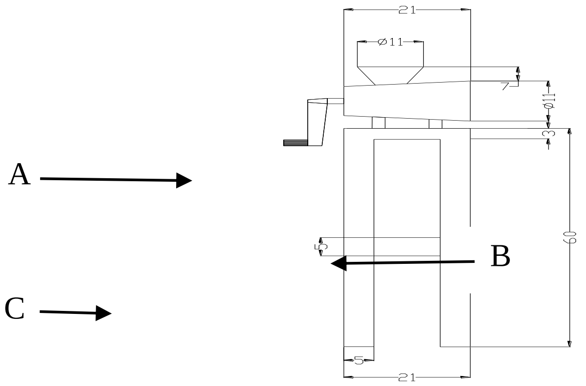

Fig. 1. Schematic diagram of meat grinding machine

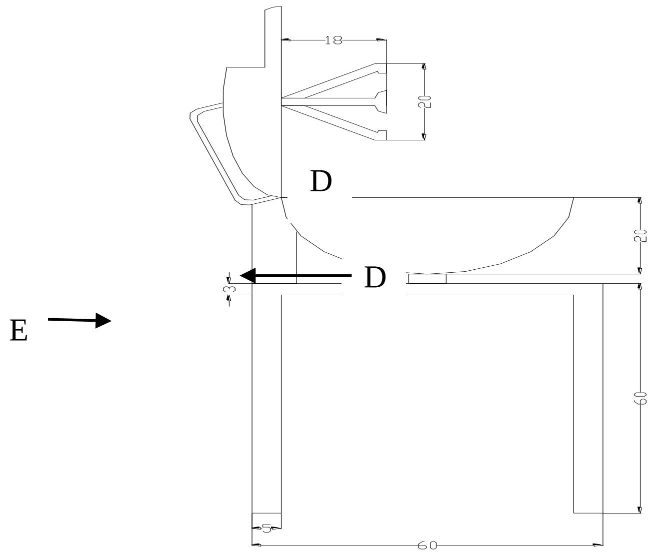

Fig. 2. Schematic diagram of meat-seasoning dough machine

Where A is the meat hopper, B is the dough outlet, C is the rotating handle, and D is mixer's container

3.1.3. Cost of the machine

Table 1. Cost of the old machine

Product : Meat grinding machine (old)		
No	Unit	Price (IDR)
1	Grinding machine	750.000
2	Dough mixer	1.500.000
3	Dynamo 1pk	650.000
	Total price	2.900.000

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3.2. Creative stage

3.2.1. Alternative design

Due to ineffective operational of old machine (separated grinding and mixing), the dual function machine is designed in this stage. The machine is able for grinding and mixing in the same time, thus increases efficiency and deduces cost. Figure 3 to 5 show the alternative design of dual function machine.

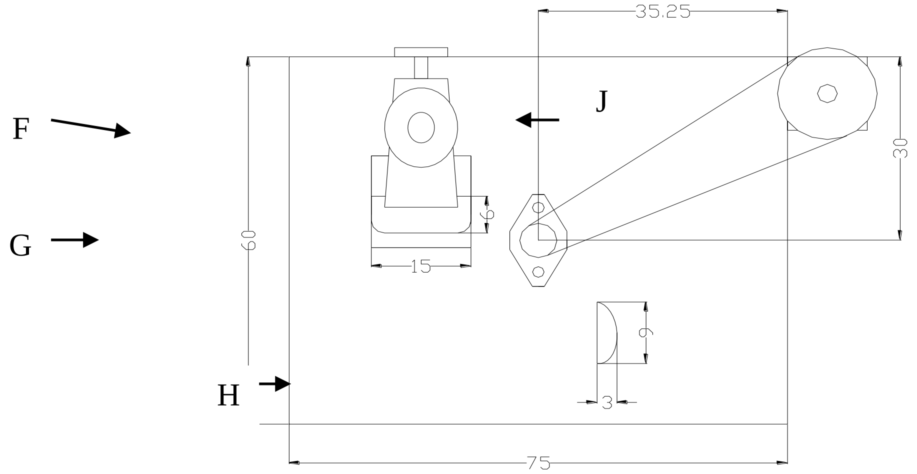

Fig. 3. Alternative design (top view)

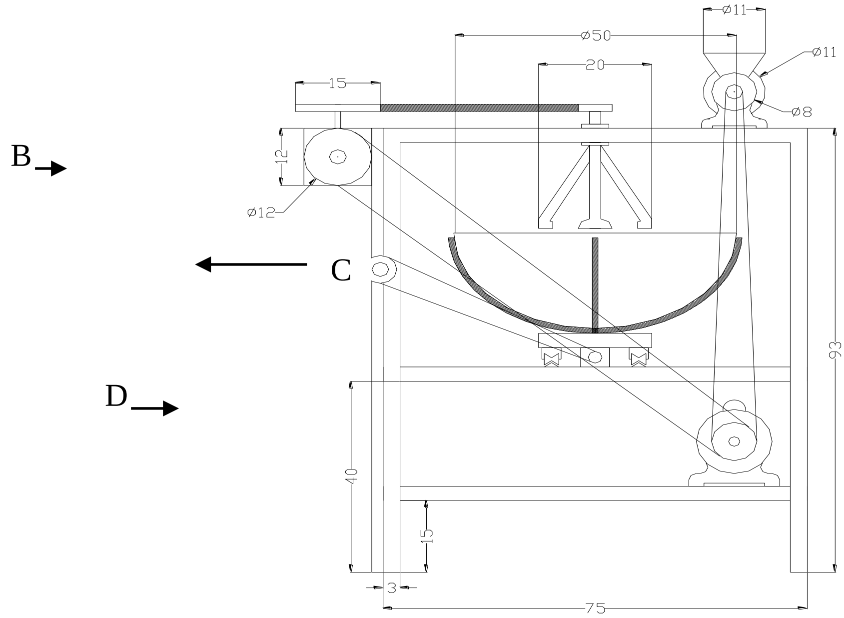

Fig. 4. Alternative design (front view)

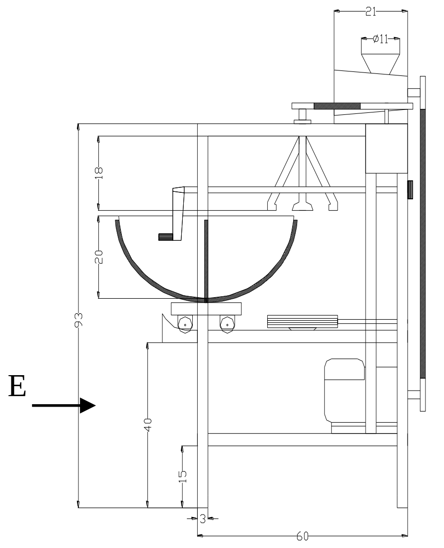

Fig. 5. Alternative design (side view)

A : Box of meat grinding
B : Grinded meat output
C : Bearing of mixer shaft
D : Inlet port for seasoning
E : Gear box of mixer shaft
F : Inlet port of meat
G : Electric motor
H : Dough mixer
I : Container pan
J : rotating handle of container pan

3.2.2. Production cost

Table 2. Production cost of alternative dual function machine

Product description : Dual function (grinding-mixing) machine Number : 1 unit					
No	Description	Dimension/ capacity	Quantity	@ Price (IDR)	Total (IDR)
1	Component cost				
	Mild steel plat	2 cm x 2 cm	12 rods	16.250	195.000
	Grinder	22 mm	1 pcs	160.000	160.000
	Electric Motor	1 Pk	1 unit	600.000	600.000
	Gear Box)	50 : 1	1 unit	425.000	425.000
	V-belt	50cm	3 pcs	15.000	45.000
	Pully	D= 16cm	1 pcs	40.000	40.000
	Pully	D=15cm	3 pcs	35.000	105.000
	Bearing	3205	4 units	30.000	120.000
	Shaft (ST 37)	D=19mm	1 rod	45.000	45.000
	Bolt & Nut	15mm	30 pcs	1.000	30.000
	Betonezer	12 m	1 rod	30.000	30.000
	Wood board	P=75,L=60, T= 3	1 pcs	20.000	20.000
	Hydraulic jack	1 Ton	1 unit	75.000	75.000
	Sprocket	D=15cm	2 units	13.000	26.000
	Chain	1M	1 unit	15.000	15.000
	Castor wheel	D=3cm	2 units	27.500	55.000
	Chain adjustor	Standard	1 pcs	160.000	160.000
2	Overhead cost				234.390
3	Labor cost				192.500
				Total Cost	2.572.890

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3.2.3. Analysis stage

After all required data are obtained and have been validity and reliability testes, the next step is analysis with zero-one method. Procedure for zero-one method as follows (Saaty Thomas, 1993).

a. Making Zero-One matrix

Based on calculation of an average value of every criteria, Zero-One matrix is formatted as shown in Table 3.

Table 3. *Zero-One matrices*

Kriteria	Desain	Harga	Keawetan	Kenyamanan	Total	Ranking
Design	*	1	0	0	1	3
Cost	0	*	0	0	0	4
Durability	1	1	*	0	2	2
Comfort	1	1	1	*	3	1

Note : * = no criteria
0 = less important criteria
1 = more important criteria

b. Determination of rank

The rank of the criteria is shown in Table 4. The rank is obtained from zero-one matrices calculation

Table 4. Determination of rank

Criteria	Rank	Weight
Design	3	2
Cost	4	1
Durability	2	3
Comfort	1	4

c. Determination of Rating Factor

Rating factor in the range of 0 to 100 based on information from the owner of UD. Umbul Rejeki. Table 5 shows the rating factor for each alternative

Table 5. Rating factor for each alternative

Alternative	Criteria			
	Design	Cost	Durability	Comfort
Initial	50	40	70	45
I	63	70	75	76
II	55	75	50	68

Note :
0-25 = Worse
26-50 = Fairly
51-75 = Good
76-100 = Excellent

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d. Determination of performance

The performance is determined by multiplying weight criteria with rating factor. Table 6 shows the performance.

Tabel 6. Determination of performance

Criteria	Design	Cost	Durability	Comfort	Total	Rank
Weight	2	1	3	4		
Initial	50	40	70	45		
	100	40	210	180	530	3
Alternative I	63	70	75	76		
	126	70	225	304	725	1
Alternative II	55	75	50	68		
	110	75	150	272	607	2

e. Calculation of Value of alternatives

The value is obtained from subtraction of perfromance by cost as depicted in Table 7.

Table 7. Performance, cost, and value of the design

Alternative	*Performance*	Cost (IDR)	*Value*
Initial	530	2.900.000	0.00018
I	725	2.572.890	0.00028
II	607	2.540.390	0.00023

3.3. Development and Presentation

With the use of Zero-One method, initial design has value of 0.00018, performance of 530, and cost of IDR. 2.900.000. Meanwhile the value, performance and cost are 0.00028, 725, and IDR 2.572.890, respectively for alternative design I and 0.00023, 607, and IDR 2.540.390 for the alternatives II. The alternative design I is selected due to the highest its value (0.00028). The design II is the design which operator position of semi-seated sitting. The developed design is displays in Figure 6

Fig. 6. Photo of the new grinding-mixing machine

4. CONCLUSION

Based on the analysis, it can be concluded that:

1. The value of initial design, alternative I (operator position is semi-seated standing), and alternative II (operator position is sitting) are 0.00018, 0.00028, 0.00023, respectively
2. Due to alternative design I has higher increased value than alternative II (0.00004 compared with 0.000005), hence alternative design I is selected.
3. The value of the alternative design I increases 55.6 %. It is due to the used of Zero-One method and matrix evaluation.

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