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Designing Pepper Peeler Machine with Crusher System to Support Pepper Processing in Archipelago

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***Abstract*— Designing pepper peeler machine with crusher system is the steps of designing tool to assist the process of peeling pepper to replace the system pepper peeler manually at Bangka Belitung. This system uses 2 dishes mounted horizontally with a certain distance and slope of a particular dishes. The design uses the Pahl and Beitz method with the distance of two dishes can be adjusted. The top of the dishes is fixed where the lower dish slow rotates and the peel process be quickly without decay process of the skin of pepper with low power. The design results obtained 600 x 600 x 800 mm in dimension engine, 400 mm dimeter dish with distance settings, rotation speed of 15 rpm, peeling peeper skin without decay process, the peeling process uses water, engine power 735 Watt with 1:60 reducer. Test results, this machine can reduce the process of peeling skin pepper with the input capacity of 1 kg/hour.**

Keywords— crusher, disk, pepper, peeling

I. INTRODUCTION

The Province of Bangka Belitung Islands is an archipelago province which is a major producer and exporter of white pepper in Indonesia [1]. Based on data from the Province of Bangka Belitung Islands, the total area is 81,725.14 km2. One of the commodities produced by this province is pepper that began to develop in Bangka Belitung since the 18th century. The production of Bangka pepper in the 1920s until 1931 was a golden era, where Bangka pepper production reached 12,000 tons, while the Dutch East Indies pepper exports reached 14,000 tons [2]. But since 2002, production of pepper decreased in both production and price.

In 2017, the Province of Bangka Belitung Islands refocused on the development of the agricultural sector by restoring the glory of pepper and establishing the Provisions of Bangka Belitung Islands as a pepper province [3]. To support the development of pepper glory in the Province by accelerating and facilitating the post-harvest process of pepper.

The post-harvest pepper is still using traditional systems. Starting from the picking process, the process of peeling pepper, the process of threshing pepper seeds from the stalk, peeling the pepper skin until the drying process of pepper. The traditional processing of white pepper is through the processing of immersion of pepper in water for 7-10 days [4]. After that, peeling the pepper skin by being trampled and then cleaned and dried for 3-4 days in the sun.

The longest time in the process of post-harvest pepper is the process of peeling the pepper skin [5]. For this reason, it is necessary to design a pepper skin peeler in support of the acceleration of the production of pepper which would eventually facilitate the work of farmers and shorten the processing time of pepper harvest.

Traditionally, the stripping of pepper skin is done by pepper which has been soaked in water in a sack and then trampled until the pepper skin is peeled off. In addition to being trampled, pepper can also be peeled by hand. The process of stripping pepper like this requires a long time and workers experience various kinds of complaints. The stripping process causes the wrists and shoulders to move around, so that they are directly in contact with the pepper in a state of pressing pepper that has sap without using gloves[6].

To replace the contact between hands and pepper, a machine is made that adopts hand movements. The system was designed using 2 dishes that pushed each other on the pepper seeds where one dish was fixed dish and the other is in a rotating dish. Among the 2 dishes, it is made slope with a distance not exceeding the average diameter of the pepper seeds. To help soften the pepper seeds, the water would flow continuously through the process of pressing the pepper by the dish [7].

For this reason, the working principle of the tool designed is that by entering the pepper in an inlet funnel, then it is moving to two dishes. The dishes were assembled with a particular slope towards the rotating dish to aim the pepper out of the dish. While moving towards the edge of the dish, the dish press the pepper when turning so that friction between the pepper skin and the disk causes the pepper skin to be scratched and peeled off.

II. ENGINEERING DESIGN METHOD

Engineering design is an activity that requires a knowledge-intensive where knowledge is in the head of each individual who can give them the ability to make decisions and take action [8]. To be generally accepted, the design method is very important. The using of design methods for creating innovative products is being pushed on companies[9]. The design method of this research use comprehensive method that has been in use by Pahl & Beitz. This method aimed to improve the product design technically

and economically in developing strategies for the development of solutions [10]. The design method of Pahl and Beitz have four main phases [11], planning and clarifying the task, conceptual design, embodiment design and detail desain, as shown on fig. 1.

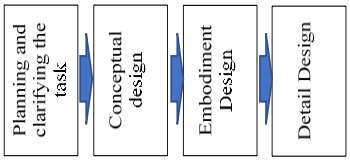

Fig. 1. Main Stage Defined for Design Procedure[10]

A. Planning and Clarifying Task

The biggest impact of the products characteristics that been studied earlier. Consider these characteristics that are determined during the initial design process– that is, clarification of the task and conceptual design. Because the one of greatest impact is on this stage, so the aim of this task is to replace the role of feet and floor to two dishes that push each other (crusher system) where the crusher would flake pepper peel. The dishes consist of fixed dishes and rotating dishes where the position of dishess is horizontal as shown on fig. 2.

III. DISCUSSION

A. Conceptual Design Phase

This phase determines the solution of the task that be solved. The solution must be clearly requirment. In conceptual design, there are two stages needed to determine the requirements needed. First is the initial activity of capturing them by interpreting the customer's needs. The second is To aim supporting the improvement of products that are suitable for design processes, management is needed for the long term [12]. In this research, the requirement would be divided 2 requirments, that is main demand and additional demand, that shown on table 1.

1) Abstract the task to identify the essential problem

At this stage, the overall function of the machine should be clarified [9]. In order to state the function of machine, an adequate criterion are very needed by determining the hierarchical level or boundary in the hierarchy of functions of the product [13]. The abstraction level of reseacrh is shown on table 2 when the stages state the relationship between part functions and needs. Roth suggested that was connection function of the part in the list of needs was formulated explicitly and arranged in the order of importance [14].

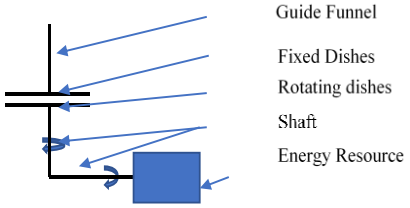

Fig. 2. Planning of machine system

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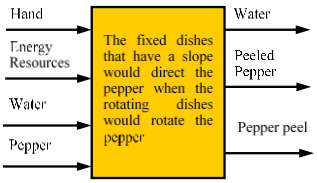


Fig. 3. The function of structures

TABLE I. THE DEMANDS OF RESEARCH

Main Demands	Additional Demands
Use electrical energy The dimension of machine is not more than 600x600x800 The rotating dish rotates around 15 rpm The capacity of machine is only 1 kg/hour Rigid Horizontal dishes Adjustable height of horizontal dishes Slope of fixed dishes Safe and easy operation Easy to move	Cheap Easy production proccess Easy maintenance

2) Establish the functional structures

The relationship between an objective, an activity and a task should be clearly as a structure function[15]. It is the boundaries of the articulation solution and the functional solution to fulfill specification requirement way in which energy, materials and signals flowing into the output structure [10]. To develop the functional structures, it is needed relation between input and output abstract of the task as shown on fig. 3.

Process improvement of main function would be derived using parametric oriented [15] and divided to sub function as shown on fig. 4. The function of machine has one or more sub functions.

The sub functions consist of:

- Sub- function of guide funnel
- Sub-function of transmission element
- Sub-function of pepper peeling

TABLE II. THE ABSTRACTION LEVEL OF RESEARCH

Stages	Results
1	The energy source is electrical energy Machine have dimension is not more than 600x600x800 The rotating dish rotates around 15 rpm The capacity of machine is only 1 kg/hour Horizontal dishess distance around 2-4 mm Slope of fixed dishes Function is peeling pepper Cheap Easy maintenance
2	The energy source is electrical energy Machine have dimension is not more than 600x600x800 The rotating dish rotates around 15 rpm The capacity of machine is only 1 kg/hour Dishess distance around 2-4 mm Function is peeling pepper
3	The dimension of machine is not more than 600x600x800 The capacity of machine is only 1 kg/hour Adjustable dishes distance

	Function is peeling pepper
4	The rotating dish rotates around 15 rpm The capacity of machine is only 1 kg/hour Adjustable dishes distance Function is peeling pepper
5	The capacity of machine is only 1 kg/hour Function is peeling pepper

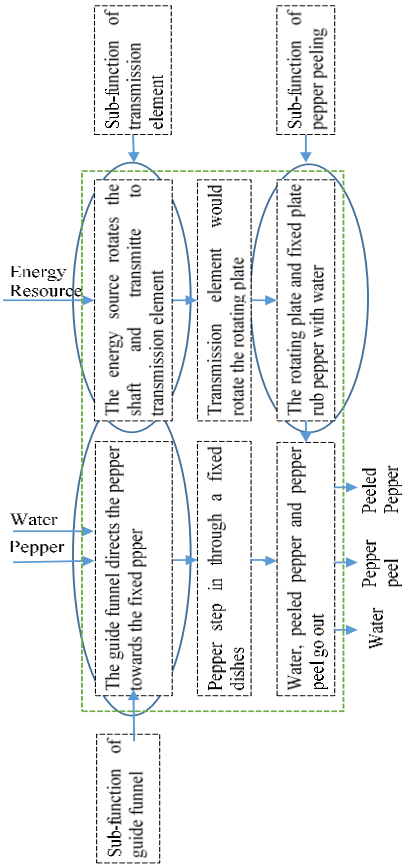


Fig. 4. The sub function of structures

3) Search for solution principles

The solution for each sub function would be explained as follow:

- Sub- function of guide funnel, The funcion of guide funnel is to get in pepper from the top of machine regarding to dishes placed horizontally. There are two alternatives, vertical funnel and inclined funnel as shown on table 3.
- Sub-function of transmission element, The convertion horizontal rotating to vertical rotating only use bevel gear as shown on table 3.
- Sub-function of pepper peeling, Pepper would be peeled by two dishes placed horizontally where the plate consists of a fixed dish and a rotating dish. The plate has a specified slope and has a certain distance to rotate the dish as shown on table 3.

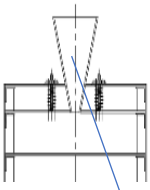
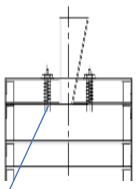
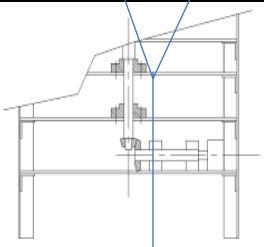
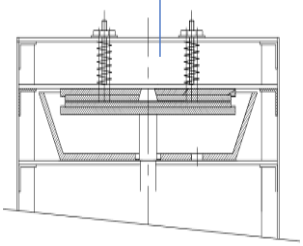
4) Combine the solution principles into concept variants

The sub function would be divided to one or more alternatives. The alternative is as shown table 3.

5) Evaluation of concept variants using technical and economic criteria

The evaluation of criteria must be set of by designer. For this research, designer use technical criteria which has assessment quality of 60% and economic criteria which has assessment quality of 60% to choose solution for sub function. The technical criteria evaluation of concept this research is based on:

TABLE III. THE CONCEPT VARIANTS

No	Sub Function	Alternatives	
		1	*2*
1	Guide funnel		
2	Transmission element		
3	Pepper peeling		

- Function achievement. This criteria is main assessment aspect and have an assessment quality of 50% of the total assessment.
- Manufacturing process. The criteria have assessment quality of 20% of total assessment.
- Assembly process. The criteria have assessment quality of 10% of total assessment.
- Efficiency and effectiveness. Inputs, outputs and resources are related to efficiency, while the relationship between output and goal are related to effectiveness . The criteria have assessment quality of 10% of total assessment.
- Maintenance aspect. The criteria have assessment quality of 5% of total assessment.

TABLE IV. THE ASSESSMENT ASPECT

No	Assessment Aspects	Quality (%)	Alternative	
			1	*2*
Technical criterias (60%)				
1	Function achievement	50	50	40
2	Manufacturing process	20	15	15
3	Assembly process	10	10	10
4	Efficiency and effectiveness	10	10	7,5
5	Maintenance aspect	5	5	5
6	Safety	5	5	5
Grade			95	82,5

Economic criterias (40%)				
1	Manufacturing cost	50	50	40
2	Maintenance cost	50	50	40
Grade			100	80
Total Grade			97	81,5

The technical criteria evaluation of concept this research is based on:

- Manufacturing cost is a cost plan in the process of machinery. This criteria have an assessment quality of 50% of the total assessment.
- Maintenance cost is a cost plan in the maintenance process during the usage process. This criteria have an assessment quality of 50% of the total assessment.
- The result of assesment is as shown on table 4 where the total of assessment technical criterias and economic criterias is 100%. The score of evaluation for two alternatives are shown on table 4.
- Safety. The criteria have assessment quality of 5% of total assessment.

B. Embodiment Design

Result based on evaluation criteria, the first alternative has choosed by designer. The embodiment of alternative is as shown on fig. 5.

C. Carry Out A Detail Design

A design detail is the conceptual solutions that needed to realize the physical form of the products. The choice of appropriate components, materials, forms and finishes must apply the systematic design principle [10].

D. RESULT

Machine is made based on the detail design as shown on fig. 6. The specsification of machine are:

- The total dimension of machine is 600x600x800 mm
- The diameter of inlet is 30 mm
- The machine use 735-watt electric motor and rotate in 1400 rpm
- To reduce the rotation from electric motors, the machine use reducer that has a ratio of 1:60
- Horizontal motion is converted to vertical motion that be transmitted by a bevel gear andt the ratio of bevel gear is 1:1.5
- The dimensions of the dishes are 400 mm in diameter with a slope of 0.68° and coated with rubber both on the fixed dish and rotated dish where the rotated dish rotates of 15 rpm.

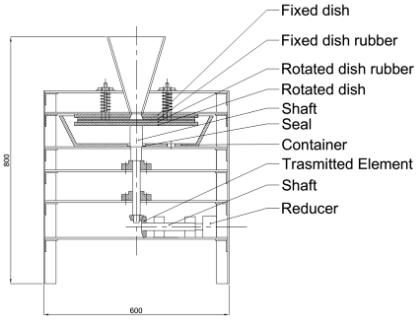


Fig. 5. The embodiment design of machine [7]

Fig. 6. The embodiment design of machine [7]

- Experiment were done in freshly picked pepper without soaking and carried by the water. From the results of the machine, the input capacity of machine is 1 kg / hour, the pepper is completely peeled off by 89% and the pepper is not exfoliate peel off by 11% [7].

IV. CONCLUSION

The research is about process design of pepper peeling machine based on Pahl and Beitz method. The result of design show that guide funnel uses vertical funnel, transmission element uses bevel gear and pepper peeling process uses 2 dishes that placed horizontally. The both of dishes is coated by rubber. Based on result of design, input capacity of machine can achive 1 kg kg/hour.

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