Ergonomic Design of Durian Splitting Tool

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Abstract. The purpose of this research is to design a tool that can be used to facilitate the process of durian fruit splitting that is easy and comfortable to use with more efficient time. This research used an experimental method to determine the performance of durian splitting tool designed and to test the tool by comparing splitting using a durian splitter and using a knife. Test using durian splitter and knife were performed in two times with sample of a durian as many as 40 fruits tested by 10 people. The result of the design of the durian splitting tool is dimension of the stem length of 22 cm and size of the blade length of 7 cm with the width of 4 cm and the size of the pressing tool of 7 cm long with the height of 5 cm. Dimension of the stand has height of 9 cm with base width of 20x20 cm. In the first test the durian splitter produced the average splitting of 22 seconds / person and the second test was 17 seconds / person, while splitting the durian using the knife in the first test the average durian splitting was 123.1 seconds / person and the second test was 101.2 seconds / person. According to calculations and questionnaires distributed to 10 respondents who tested the durian splitting tool, it was obtained that the use of durian splitters is more efficient and comfortable when used than using a knife. From the results of this study can be concluded that the tool of durian splitting facilitates people in the process of splitting because it is more effective and efficient and more safety.

Keywords: Durian, Ergonomic, Splitter

1. Introduction

Durian is a plant that grows a lot in tropical regions such as Indonesia, one of which is in the Boven Digoel Regency of Mindiptanah District. This annual plant is a source of income for the people of Mindiptanah. Durian plants began to be developed in the Elikobel District of Merauke Regency in 2008, but not many planted durian like in the Mindiptanah District of Boven Digoel Regency, Durian in Papua experienced a harvest season once a year, from February to April.

Nationally, durian plants experience a non-simultaneous harvest season which runs from September to February and experiences less periods from April to July (Sinar Tani 2010) in (Rizal et al. 2015). In its natural habitat, durian plants can be aged up to approximately 200 years. Durian tree height ranges between 20-40 meters, can even reach 50 meters (Wirganta, 2001) in (Rizal, et al. 2015).

The size and shape of durian fruit varies, the fruit is round or ovoid, 15-30 cm long and sharp spiny. The color of the fruit when young is green and after dark is yellow. Durian fruit has oval seeds or oval brownish yellow, approximately 3 cm in diameter, coated with seed membrane and yellow (Setiadi, 2008) in (Harahap, 2016). To savor the durian fruit, first open the skin layer of the fruit,
where there is a hard skin layer and consists of sharp spines. In splitting durian, it is necessary to have a good concentration so that hand injuries do not occur during splitting.

As time and technology passes directly or indirectly will affect the power of human thought in developing creative ideas by increasing the technology that has been used. Improved technology to be used is accompanied by the ergonomic value of the tool or material comfort and safety for people who use the tool.

Therefore, the authors are motivated to design and create tools that can help and facilitate the splitting process of durian fruit that is easy and convenient when used. The purpose of this research is to design and make a tool that can be used to facilitate the process of splitting durian fruit that is easy and convenient to use with more efficient time.

2. Methodology
The study was conducted at the Agricultural Engineering Workshop of the Faculty of Agriculture, Musamus University in April 2018. This study used an experimental method to determine the performance of the durian splitting tool designed and tested the tool by comparing the durian splitting using a knife. Testing using a durian and knife splitter was carried out each of two replications with 40 durian samples tested by 10 people. The tools used in this study are the following stationery, wrenches, grinder, elbow ruler, welding tool, crimping, pocket measure tape, hammer, camera, stopwatch, electric drill. While the materials used are stainless steel plates, iron plates, solid stainless steel plates, handle covers, bolts and nuts, durian fruit electrodes.

2.1 Tool Making
The design of the durian splitting tool is expected to help and facilitate the process of splitting the durian fruit with a more secure level of work safety than using a knife to split, so that with this tool can accelerate the splitting process with the better results. The steps in the research of this durian splitting tool consist of several stages, namely preparing the necessary tools, then selecting the material to be used for making tools, then cutting the iron plate for the foundation and holder, making the durian fruit holder, after cutting the solid iron steel for stalks and cut stainless steel plates for blades, then weld stems with blades, and finally prepare a pressure device made of paralon pipes.

2.2 Research Procedure
In the research procedure the study of literature is carried out to obtain the basics knowledge about tool design, as well as the materials used in research. The procedures for researching the durian splitting tool are:

1. Literature study is used to obtain basic knowledge about durian fruit and durian splitting tools.
2. Sketching a tool that resembles a sping which works piercing then pushing the both stems in opposite directions.
3. Planning and drawing of a durian splitting tool are used so that the process of making the tool can be structured and the dimensions of the tool are adjusted to the anthropometry of the human body so it is comfortable to use.

![Figure 1. Design of a durian splitter](image-url)
4. Making durian splitting tool started from surveying the price of goods to be used then assembling durian splitting tool.
5. Testing the tool that is comparing the time of splitting using a knife and convenience in using the tool. If the equipment test does not succeed in splitting the durian properly, then the device is reassembled. If the tool splits durian well and comfortably when used, the device is successfully ready for use.
6. Interviews are used to obtain data or results of testing durian fruit splitting tools on work comfortability.
7. The result analysis is carried out The comparison process of splitting the durian by using a knife and the tools made. The results of comparison in the form of time and comfort are the results obtained from filling out the questionnaire.
8. Conclusions and suggestions indicate the answers to problems that exist in the research objectives.

2.3 Testing Tool
Testing is conducted by looking at the comparison percentage of splitting time and interviews about work comfortability. The procedures or work steps in this study are as follows:

2.3.1 Testing Tool
1. Take 40 durian samples
2. Split durian using a knife (calculating the start Time division) until the durian split.
3. Split durian using tools that have been made (counting time from division) until the durian parting.
4. Compare splitting times using knives and tools durian splitter.

Table 1. Testing Time

| Visual Aid | Splitting Using Knive | Using Durian Splitter |
|------------|-----------------------|-----------------------|

Table 3. Design of A Durian Fruit Stand
A.2.2 An Assessment of The Use of A Durian Splitter.
An assessment of the use of the durian splitting tool is conducted by distributing questionnaires to get data or the results of testing the durian splitting tool to work comfortably. The statement submitted to the respondent is as in Attachment 2. Each respondent gets a questionnaire consisting of 10 statements. Respondents are young men, women, and adults who are accustomed to splitting durian.

3. Results and Discussion

3.1 Durian Fruit Splitter
Durian fruit splitter is a tool designed specifically for splitting durian fruit easily and comfortably when used. The tool has 3 different components, namely the durian splitting tool, press tools, and the durian fruit holder each has a different way of working, but the first interrelated tool is the durian splitting tool, the operating system holds the tool shaft afterwards pushing the stem into the opposite direction, the blade will open the durian skin. This splitter has 2 sharp-pointed blades with the same size and 2 stems with the same length then the tip of the stalk is coated with a handle cover for hand comfortably while grasping the handle, then the second is a tool to press the blade to pierce the skin of durian fruit and the third that is, the holder is used to place the durian fruit, this holder has the same height and there are 4 holder positions namely each on the foundation, of the 4 stands which 2 have bolts under the base to adjust enlarge and reduce the holder to adjust the size of the durian.

The dimensions of the durian splitting tool are obtained from anthropometric measurements of the human body when sitting cross-legged and hands holding towards the front so that when working splitting durian with large amounts, the back and arms are not easily tired other than that to maintain health in the body not easily hurt or injury.

Anthropometry and ergonomic work for households or agriculture are interrelated. Worker's anthropometry data is very important when designing equipment because anthropometric data is needed to make work more functional and human, to increase worker productivity without additional input and physiological stress on workers.

3.2 Handle Tool
The tool shaft is designed with reference to the position of the person sitting cross-legged and in accordance with anthropometric measurements of the human body. For the length of the stems measured by using the position of the arm at an angle of 26° with an estimated height of the average durian 15-20 cm and a length of the stalk is 22 cm. Then the tool shaft is made of solid stainless steel solid steel which has a diameter of 3/8 mm which is curved at an angle of 10°, after that the tip of the stem is coated with a handle with a length of 8 cm for comfort when holding the stem when splitting durian.
3.3 Suppressor
The suppressor is designed with reference to the position of the person sitting cross-legged and in accordance with anthropometric measurements of the human body. For the height of the pressure device when placed in the middle of the stem is measured using the position of the arm with an angle of 46° with the estimated average height of durian 15-20 cm then this pressure device is made of atomic material or paralon T pipe which has a size of 3/4 inch length 7 cm and height 5 cm with a hole in the right and left U shape 1 cm the goal for the press is not missed from the stem and the size of the press is adjusted to the comfort of the palm when holding the tool.

3.4 Holder
The holder is used to place the durian fruit which is designed with the shape underneath. There is a platform, then on top of it, there are 4 holder positions. For durian fruit holder size is measured from the average fruit length of 20 cm, so that the foundation size with a width of 20 x 20 cm is obtained, if the size is too small then it is not balanced when the fruit is placed and if it is too large it is too heavy and takes up much space. For the thickness of the 3 mm base plate, then the 4 stands on top have the same size that is 9 cm high and the thickness of the 2 mm stand plate which has a slope of 35° and then has little space that is useful when the fruit is not restrained by the fruit skin with the holder.
3.5 Testing Tool

The time comparison test result of durian splitting design and splitting using a knife tested on 10 people are presented in the following table:

| Visual Aid (Person) | Splitting Using Knife (Sec) | Using Durian Splitter (Sec) |
|---------------------|-----------------------------|----------------------------|
|                     | Testing 1                   | Testing 2                   |
| 1                   | 150                         | 28                         |
| 2                   | 100                         | 26                         |
| 3                   | 156                         | 24                         |
| 4                   | 90                          | 21                         |
| 5                   | 107                         | 23                         |
| 6                   | 120                         | 19                         |
| 7                   | 102                         | 20                         |
| 8                   | 130                         | 18                         |
| 9                   | 140                         | 20                         |
| 10                  | 136                         | 21                         |

|                  | Average Testing 1: 123.1 sec/person | Average Testing 2: 101.2 sec/person |
|-----------------|-------------------------------------|-------------------------------------|
|                  | Testing 1: 22 sec/person             | Testing 2: 17.5 sec/person           |

Based on the data in table 5 shows that the comparison of the average value is different between using a knife and a splitter. In the first test splitting using a knife has an average 123.1 seconds/person and the second test is 101.2 seconds/person, the difference in testing time is due to the first test not yet finding the groove of fruit skin when splitting, so it requires quite a long time, compared to the second test where the division has been thorough or already has a strategy in finding the path. So that more quickly the time needed in the division of durian. Then the first test of the durian splitting tool is 22 seconds/person and the second testing is 17.5 seconds/person, the difference in testing time of the splitting tool is caused that in the first test the person splitting using the tool is not accustomed to using the tool, so the time is longer, whereas in the second test the splitting time was faster, it was due to the fact that the person understood the use of the splitter. From the comparison of testing durian splitting tool, this tool is able to split durian with a faster time than splitting using a knife. Besides the factors that cause the durian splitting tool can be faster than using a knife are:

1. The durian splitter can split in two or more directions while the knife can only split in one direction.

2. Durian splitting tool is plugged into the flashlight by pressing and the splitting process is immediately carried out, while splitting using a knife is needed to find the groove then the lever process is usually carried out and usually not immediately split.

The advantage of the durian splitting tool is that it does not involve bending position when splitting the durian, then it is comfortable to use and avoid the durian skin prick.
3.6 Interview Result

To find out whether the durian splitting tool is better and is ergonomically designed, the testing result of this tool are based on the interview results with 10 respondents who tested the durian splitter. Based on the results of the interview the following data are obtained:

| No. | Question                                                                 | Score (%) | Score Interpretation Criteria |
|-----|---------------------------------------------------------------------------|-----------|-------------------------------|
| 1   | This durian splitter is difficult to use                                  | 32%       | Weak                          |
| 2   | Durian splitter feels comfortable when used                               | 90%       | Very Strong                   |
| 3   | The right position when using this durian splitting tool is hard to find  | 32%       | Weak                          |
| 4   | Feeling pain in the hand when using a durian splitter                    | 28%       | Weak                          |
| 5   | It takes extra energy when using a durian splitter                       | 34%       | Weak                          |
| 6   | Durian splitters are not dangerous when used                              | 90%       | Very Strong                   |
| 7   | Durian splitting tool still has weaknesses when used                      | 44%       | Average                       |
| 8   | Durian splitting tool is easy for women to use                           | 88%       | Very Strong                   |
| 9   | The durian splitter is easily mobilized                                  | 86%       | Very Strong                   |
| 10  | Durian splitting tool makes it easy to divide durian                      | 99%       | Very Strong                   |
From the results of the questionnaire statement of 10 respondents presented in the form of a percentage that is the lowest score of 28% - 34% states that the statement is weak or 10 respondents expressed strongly disagree with the statement, while a score of 44% stated that the statement was classified as sufficient. For a score of 86% - 99% states that the statement is very strong or the respondents strongly agree. From the 10 statements above which show that statements relating to the level of comfort and safety in using the durian splitter get a very strong response or agree that is a score of 86% - 99%, while the statement stating the durian splitter is difficult to use or a very small percentage is the score 28 % - 44%, by this response states the durian splitter is easy and convenient to use.

4. Conclusion
The results of the design of the durian splitting tool have dimensions of the stem length 22 cm and the size of the blade length 7 cm with a width of 4 cm and the size of the press tool length 7 cm with a height of 5 cm. With the dimensions of the durian splitting tool that has been designed and tested by 10 people, the durian splitting tool is very helpful and facilitates the process of splitting the durian fruit by comparing splitting time using a knife and splitting tool. In the first splitting test using a knife has an average splitting durian fruit is 123.1 seconds/person and the second test is 101.2 seconds/person, the difference in testing time is due to the first test not yet finding the groove of fruit skin when splitting, so it required quite a long time, compared to the second test where the division has been thorough or already has a strategy in finding the path. So that more quickly the time needed in splitting the durian. Then the first test of the durian splitting tool is 22 seconds/person and the second testing is 17.5 seconds/person, the difference in testing time of the splitting tool is caused that in the first test the person splitting using the tool is not accustomed to using the tool, so the time is longer, whereas in the second test, the splitting time was faster, it was due to the fact that the person understood the use of the splitter. Besides the factors that cause the durian splitting tool can be faster than using a knife are:
   a. The durian splitting tool can split in two or more directions while the knife can only split in one direction.
   b. Durian splitting tool is plugged into the flashlight by pressing and the splitting process is immediately carried out, while splitting using a knife is needed to find the groove then the lever process is usually carried out and usually not immediately split.

The advantage of durian splitting tool is that it does not involve bending position when splitting durian and is comfortable in use and avoiding durian skin prick, so the results of the durian splitting test, the durian splitter is more efficient than splitting using a knife. The durian splitting tool is easily mobilized and the 10 respondents stated that splitting the durian using the splitter felt comfortable by not involving a bent body position and more secure work safety.

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