DESIGN OF WATER GUAVA FRUIT PICKER USING OWAS METHOD

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ABSTRAK

Water guava is one of the fruits that is often found and is a typical fruit from Demak Regency. Many farmers in this city prefer to plant water guava from other fruits. The large potential of plantations in the city is interesting for our research material. This study aims to design fruit pickers using the Ovako Working Posture Analysis System (OWAS) method to assist the process of harvesting guava, and to make it easier for farmers not to climb trees and not damage guava fruit that has not been harvested. In addition, by climbing trees, allowing injury and disturbing the musculoskeletal system.

Using this developed tool there has been an increase in production capacity where by using old tools, each harvest only gets 24 pieces / minute / tree, while using a new fruit picking tool produces 34 pieces / minute / tree or an increase of 42%

Key Word: *Water Guava, Fruit Picker, OWAS Method, Musculoskeletal Injury*

1. INTRODUCTION

Market demand for water guava, made farmers to fulfill the demand. And encountering problems that often hinder the fruit picking process, there are still many guava fruit farmers harvesting the fruit by climbing trees, the risk is to make farmers tired and wasteful of time also the possibility of farmers falling from trees. The tools for harvesting guava fruit are still traditional, just combine 2 liter mineral water used bottle with a stick, the risk of the tool is to cause a lot of twig shocks so that un harvested fruit falls,

To overcome the limitations or weaknesses of manual harvesting, a fruit picker is made capable of picking fruit with high capacity and practically used. Based on the problems described earlier, research is needed to design a fruit picking tool for water guava fruit farmers by paying attention ergonomic aspects to increase the amount of fruit harvest and reduce fatigue. The design method for the tool uses the Ovako Working Posture Analysis System (OWAS) method, which is a method used in evaluating the body posture during work, by analyzing it based on a simple and systematic classification of work postures combined with observations from work activities.

Several previous studies that were used as references for this study included Mustaqimah (2012), with the title Designing and Testing Semi-Mechanical Papaya Picking Tools, discussing papaya picker designs. Jiken JJ et al (2012) designed a mangosteen picker published in the Mardi Technology Bulletin.

Suparian et al. (2006) engineered and evaluated the performance of mango pickers published in agricultural engineering journals and Faiz Syuaib et al. were check manual palm oil harvesting studies. From various studies there are differences in the fruit objects to be picked and designing analysis methods based on anthropometric

2. LITERATURE REVIEW

The feeling of comfort is expected by workers in carrying out their work and with the presence of such comfort, the work productivity is expected to increase. Broadly speaking, ergonomics in the world of work will pay attention to the following matters:

a. How do people do their jobs
b. What is the position and movement of the body used when working?
c. What equipment they use
d. What are the effects of the above factors for the health and comfort of workers.

Some ergonomic improvements that have been carried out by experts abroad, it is proven that the application of ergonomics is able to provide economic benefits, improve work safety and comfort. So it can be concluded that ‘good ergonomic is good economic’ (Hendrick, 2002).

Anthropometry as a study relating to the measurement of the dimensions of the human body that can be widely used as a consideration for designing products or work systems involving humans (Agus, 2005). Dimensions of body size to be applied in various product designs or work facilities, widely will be used as an ergonomic consideration in requiring human interaction. Anthropometric data that has been obtained will be applied widely in terms of designing work areas, designing work equipment, designing consumptive products, designing physical work environments. This data will determine the exact shape, size and dimensions relating to the product being designed and humans who will operate or use the product, then the limbs that need to be measured are as shown in the figure below (Wignjosoebroto, 2003) :

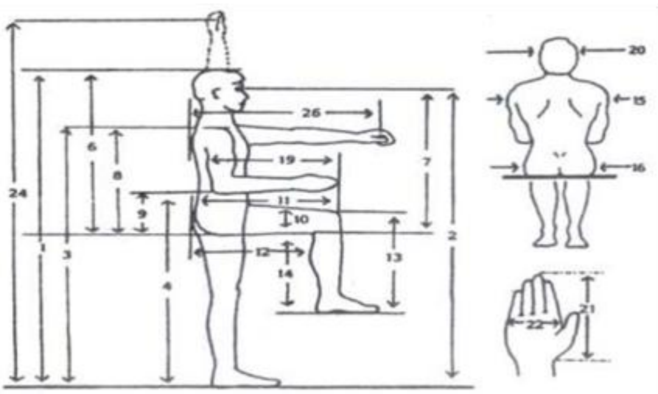

Figure 2.1. Body position of anthropometric measurements
(Source : Wignjosoebroto, 2003)

Product design and development is a series of activities that start from analyzing perceptions and market opportunities, then ending with the stages of product production, sales, and delivery. Product design and development can also be interpreted as a sequence of steps or activities where a company seeks to compile, design, and commercialize a product. These products are not only limited to physical products but also products that are not physical, namely services (Ulrich and Eppinger, 2001). In designing a new product anthropometry must focus on ergonomic considerations in product planning processes and work systems that will involve human interaction.

The OWAS method is used to assess body posture at work, as well as the RULA and REBA methods. This method was first introduced by a Finnish writer Osmo Karhu, 1977. This method allows identification in several positions; namely the back, arms and legs by giving the code in each position. However, this method does not assess in detail the severity of each position. For example, this method identifies whether workers do work with knees bent or not, but does not distinguish between various flexion levels (Tarwaka, 2010).

OWAS basic posture is arranged with a code consisting of four digits, which are arranged sequentially starting from the back, arms, legs, and the weight of the load raised when handling material manually. The following is a classification of the attitudes of body parts observed for analysis and evaluation (Karhu, 1981)

The focus assessed is body posture, movement during work, frequency of work activity structure, position of work activities in a work process, need for intervention in work design and work environment, distribution of body movements, burden and energy needed when working.

Limb	OWAS Score	Body Posture Explanation
Back	1	Straight
	2	Bent Over
	3	Twist
	4	Bending and Twisting
Feet	1	Sit
	2	Stand with both legs straight
	3	Stand with one leg straight the other bend
	4	Stand with both knees slightly bent <1500
	5	Stand with both knees slightly bent> 1500
	6	Kneel
	7	Walk
Arm	1	Both arms are below shoulder height
	2	One of the arms is above shoulder height
	3	Both arms are above shoulder height
Force	1	Load weight <10 kg
	2	Load weight> 10 kg - 20 kg
	3	Load weight> 20 kg

Table 2.1 .Schematic Analysis System of the OWAS Method – Tarwaka 2010

3. RESEARCH METHODOLOGY

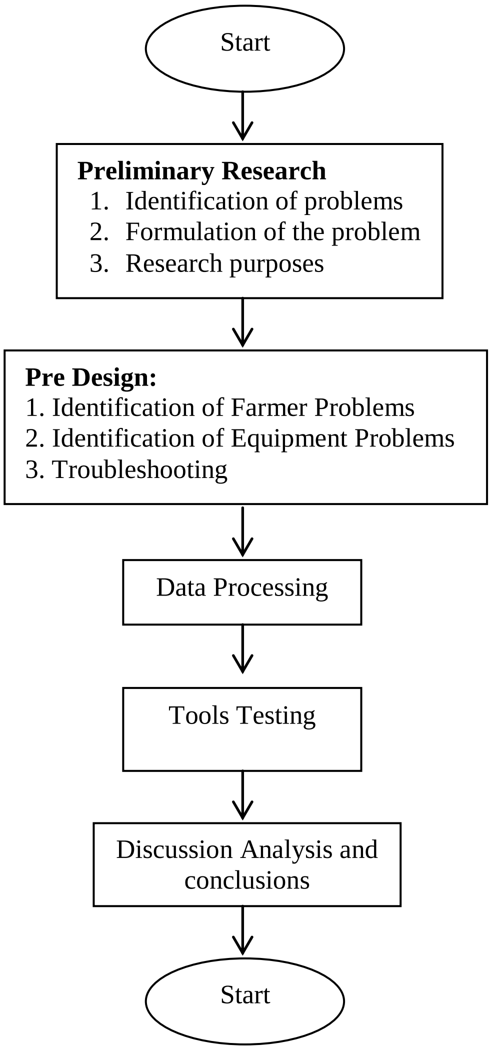

Figure 3.1 Research Methodology Flowcharts

3.1 Data Collecting and Processing

The subjects measured to obtain anthropometric measurement data were 30 guava farmers in Tempuran Village Demak Region. Field data capture is done with the purpose of obtaining primary data. The method of retrieving primary data is done by taking anthropometric data of the guava farmers' bodies and taking videos and photos of farmers doing the process of picking water guava fruit. Furthermore, observations and assessments were made using the OWAS method to farmers to find out the position of the body parts that are less comfortable

Some of the data processing to be performed on anthropometric data (Nurmianto, 1996 & Tayyari, 1997) as follows:

a. Determine the adequacy of data
b. Calculating data uniformity
c. Determine the 95% confidence level and the degree of accuracy of 5% or percentile.

To test the adequacy of the data is performed to determine whether the data have been obtained in the study is sufficient or not (Nurmianto, 1996 & Tayyari, 1997) using formula :

$$N' = \left[\frac{k/_s\sqrt{N.\sum x^2-(\sum x)^2}}{\sum xi}\right]^2$$

k: Level of confidence
If the confidence level is 99%, then k = 2.58 ≈ 3
If the confidence level is 95%, then k = 1.96 ≈ 2
If the confidence level is 68%, then k ≈ 1
s: Degree of accuracy
If N '<N, then the data is declared sufficient

The results of the calculation of the adequacy of anthropometric data are summarized in table form, can be seen in table 3.1 below.

Table 3.1.1Results of calculation of data adequacy test

No	Anthropometric	N	N'	Conclusion
1	Hand Diameter	30	22,421	N '<N sufficient data
2	Palm width	30	12,577	N '<N sufficient data
3	Hand Length	30	2,219	N '<N sufficient data

(Source: Data processing)

Uniformity test was conducted on the average price of class anthropometric data that has been obtained from the study. If the average price of those are outside the control limits that have been set (more than the upper control limit and lower control limits), it can be said that the anthropometric data are not uniform (Nurmianto, 1996 & Tayyari, 1997).

1. Standard deviation

$$\sigma x = \sqrt{\frac{\sum(xi - \bar{x})^2}{N - 1}}$$

2. Data uniformity

   Upper Class Limits = UCL = $\bar{x} + k\sigma$ + kσ

   Lower Class Limits = LCL = $\bar{x} + k\sigma$ - kσ

The uniformity test results are summarized in the table, can be seen in table 3.2

Table 3.1.2 Data from the data uniformity test

No	Anthropometric	Symbol	Std Dev	Data Uniformity		
				UCL	x	LCL
1	Hand Diameter	DGT	0.359	4.061	2.983	1.906
2	Palm width	LTT	0.718	10.122	7.967	5.811
3	Hand Length	PT	0.718	21.122	18.967	16.811

(Source: Data processing)

3.2 Work Posture Assessment with the OWAS Method

The OWAS method is a method that allows identification in several positions: back, arms and legs by coding the positions. The stages carried out during the coding of work postings can be described as follows (Tarwaka, 2010)

3.2.1 Recording of work position, there are 3 position: Pick fruit with traditional ladders and poles, Picking fruit with climbing stairs and Picking fruit with traditional poles

3.2.2 Calculating the average frequency - average working position,

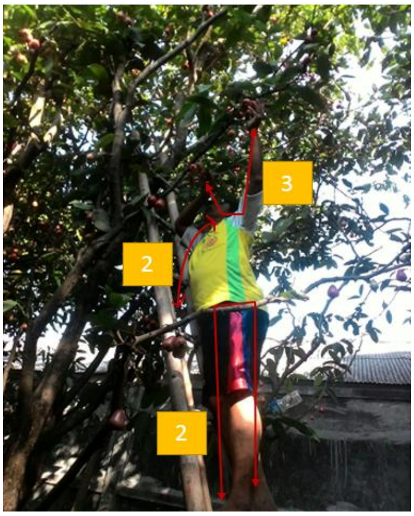

Figure 3.2 Picking fruit by climbing stairs

Figure 3.3 Picking fruit with traditional pole

Table 3.2.1 OWAS Code for Figure 3.2

1.	Back Position	:	Bending over backwards
	OWAS Code	:	2
2.	Arm Position	:	Both hands were above shoulder height level
	OWAS Code	:	3
3.	Feet Position	:	Stand with your legs straight
	OWAS Code	:	2
4.	Weight	:	Heavy load is less than 10 Kg
	OWAS Code	:	1

Table 3.2.2 OWAS Code for Figure 3.3

1.	Back Position	:	Bending over backwards
	OWAS Code	:	2
2.	Arm Position	:	Both hands were above shoulder height level
	OWAS Code	:	3
3.	Feet Position	:	moving
	OWAS Code	:	7
4.	Weight	:	Heavy load is less than 10 Kg
	OWAS Code	:	1

3.2.3 Analysis of OWAS work posture

Picking fruit by climbing stairs for analyzing figures 3.2 summarized in Table 3.2.3

Table 3.2.3 OWAS Table

BACK	ARMS	1			2			3			4			5			6			7			LEGS
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	USE OF FORCE
1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1	
	2	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1	
	3	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1	
2	1	2	2	3	2	2	3	2	2	3	3	3	3	3	3	3	2	2	2	2	3	3	
	2	2	2	3	2	2	3	2	3	3	3	4	4	3	4	4	3	3	4	2	3	4	
	3	3	3	4	2	2	3	3	3	3	3	4	4	4	4	4	4	4	4	2	3	4	
3	1	1	1	1	1	1	1	1	1	2	3	3	3	4	4	4	1	1	1	1	1	1	
	2	2	2	3	1	1	1	1	1	2	4	4	4	4	4	4	3	3	3	1	1	1	
	3	2	2	3	1	1	1	2	3	3	4	4	4	4	4	4	4	4	4	1	1	1	
4	1	2	3	3	2	2	3	2	2	3	4	4	4	4	4	4	4	4	4	2	3	4	
	2	3	3	4	2	3	4	3	3	4	4	4	4	4	4	4	4	4	4	2	3	4	
	3	4	4	4	2	3	4	3	3	4	4	4	4	4	4	4	4	4	4	2	3	4	

Table 3.2.4. Results of OWAS data processing Farmers pick fruit by climbing stairs

Risk	**Effects on the Musculoskeletal System**	**Corrective action**

category		
2	Positions that could potentially cause damage to the musculoskeletal system (medium risk).	Repairs may be needed..

Picking fruit with traditional pole for analyzing figures 3.3 summarized in Table 3.2.5

Table 3.2.5 OWAS Table

BACK	ARMS	1			2			3			4			5			6			7			LEGS
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	USE OF FORCE
1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1	
	2	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1	
	3	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1	
2	1	2	2	3	2	2	3	2	2	3	3	3	3	3	3	3	2	2	2	2	3	3	
	2	2	2	3	2	2	3	2	3	3	3	4	4	3	4	4	3	3	4	2	3	4	
	3	3	3	4	2	2	3	3	3	3	3	4	4	4	4	4	4	4	4	2	3	4	
3	1	1	1	1	1	1	1	1	1	2	3	3	3	4	4	4	1	1	1	1	1	1	
	2	2	2	3	1	1	1	1	1	2	4	4	4	4	4	4	3	3	3	1	1	1	
	3	2	2	3	1	1	1	2	3	3	4	4	4	4	4	4	4	4	4	1	1	1	
4	1	2	3	3	2	2	3	2	2	3	4	4	4	4	4	4	4	4	4	2	3	4	
	2	3	3	4	2	3	4	3	3	4	4	4	4	4	4	4	4	4	4	2	3	4	
	3	4	4	4	2	3	4	3	3	4	4	4	4	4	4	4	4	4	4	2	3	4	

Table 3.2.5. Results of OWAS data processing farmers pick fruit by traditional pole

Risk category	Effects on the Musculoskeletal System	Corrective action
2	Positions that could potentially cause damage to the musculoskeletal system (medium risk).	Repairs may be needed

3.3 Design and manufacture of tools

Design and manufacture of the tool is obtained based on anthropometric data processing and data-related tools as well as work with the attitude measurement OWAS method of collecting data 30 guava growers. Following is the determination of the design size or design of the tool in table 3.3.1

Table 3.3.1 Determining the size of the design tool guava fruit pickers

No.	Design Size	Size	Description
1	High pole	Average height of guava trees	The height of the pole adjusts the average height of the guava tree, for the length of the pole it can be flexible and the pole can be shortened or extended
2	Pole diameter	Hand diameter with 50th percentile	The diameter of the pole so that it can be held comfortably when used
3	Basket diameter	Customizing design	Basket diameter adjusts one stalk per kilogram of guava fruit
4	Basket volume	Design balance	Basket volume is designed for a maximum of five kilograms of guava fruit
5	Distance scissors to basket	Design alignment	The distance between the scissors and the basket is not too close, so the basket does not hit the guava fruit and minimize fruit defect
6	Wire length	Adjust the length of the pole	The length of the wire cable for the brake lever adjusts the length of the pole, with the average corresponding length of the bicycle brake cable
7	Brake lever height	Hand length with 95th percentile	The height of the brake lever from the bottom is not too close to the grip of the pole because it adjusts the length of the wire cable and is comfortable to operate
8	The distance of the brake lever with the pole grip	Hand width with 95th percentile	The distance of the brake lever is not too close
9	Brake lever	Hand length with 5th	The brake lever used is a bicycle brake lever

		percentile	

Based on the characteristics of table 3.3.1, the specifications of the guava fruit picker from the design are as follows:

Tabel 3.3.2 Fruit Picker Characteristics

No	Part Name	Size (cm)
1.	High pole	200
2	Pole diameter	3
3	Basket diameter	17,5
4	Basket volume	3 liter
5	Scissor distance with basket	19
6	Wire length	176
7	Brake lever height	20
8	The distance of the brake lever with the pole grip	9
9	Brake lever	7

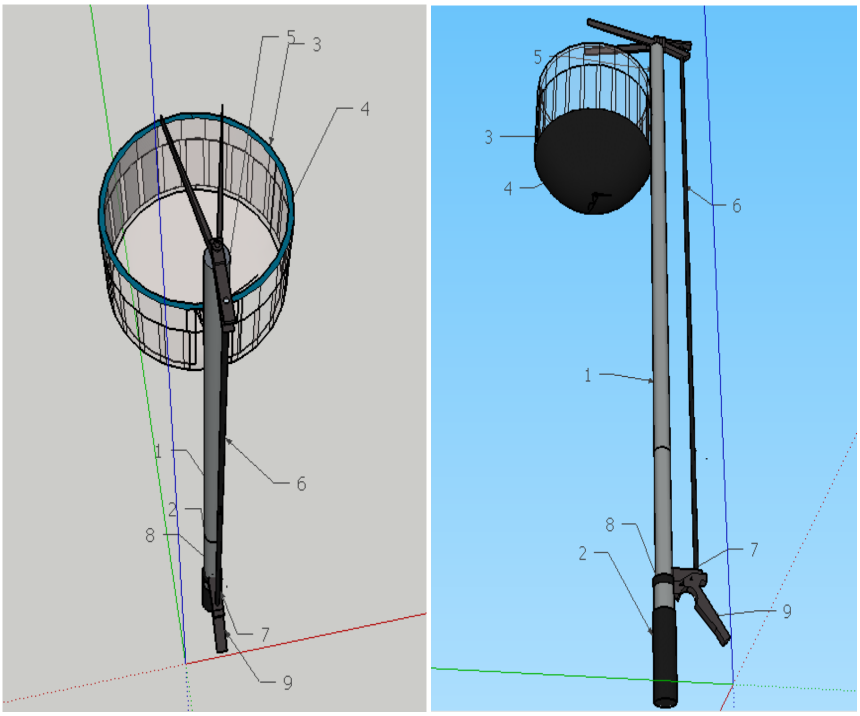

Figure 3.4 Fruit Picker Design

New pole is equipped with a lever to operate the scissors and clippers fruit to be neater and easy slaughtering and reduce fruit loss.

4. RESULTS AND DISSCUSION

1. Farmer picking fruit with a new pole, and picking fruit with a new pole and climb stairs can be explained in the following table

Table 4.1

Risk category	Effects on the Musculoskeletal System	Corrective action
1	Normal position without effects that can disrupt the musculoskeletal system (low risk).	No Need to Repairs

2 There are an increase in production capacity compared to the use of a long pole = 24 pieces / min / tree, whereas with the new pole = 34 units / min / tree or an increase of 42%

5. CONCLUSION

1. Yields of fruit produced did not have disabilities or loss, because redamnya shocks and reduced loss of fruit trees.
2. In the traditional pole the yield obtained for each harvest in 1 tree is only 24 pieces / minute, while using a new fruit picker produces 34 pieces / minute in each harvest in 1 guava fruit tree.
3. Reducing the level of fatigue and injury to farmers who previously climbed guava trees.
4. Increase the effectiveness and efficiency of production time with traditional pole replacements with redesigned poles.

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