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DESIGN OF A MANGO PICKING TOOL WITH USING QUALITY FUNCTION METHOD DEPLOYMENT (QFD) AND ERGONOMIC FOR DETERMINING STANDARD DIAMETER GRAND GALAH

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Abstract
Traditional mango pickers made from bamboo. The characteristics of the mango fruit picker tool can not be adjusted in short length so there are difficulties during use, such as reaching different tree heights. Long shapes make picking tools mango fruit difficult to carry. A fragile basket template. There is no standard handheld diameter galah so there are some users feel uncomfortable when grasping it because of smallness or greatness.he design of the mango fruit picker tool using Quality Function Deployment (QFD) can make the product based on the wishes and needs of the users of the mango pickers. Product Design With QFD This requires Customer Voices to compile House Of Quality primary needs for the users obtained from the Customer Voices this will be used as the basis for designing the picker tool mango fruit.
Designing the product by applying the hand anthropometry data of the handheld diameter (Maximum) using the P50 percentile. The use of the 50thpercentile is intended that users with larger or smaller handheld diameters may grasp it.

Keywords: *Quality Function Deployment (QFD), Anthropometry, Mango fruit picker*

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Introduction

The second largest mango producer in Indonesia is West Java in 2011 reaching 357,188 tons or about 16.8% of the national mango production. Majalengka Regency is one of the mango export centers in West Java with a mango production level of 43.21 tons in 2011 and is in the third rank of West Java's largest mango production or 12.12% of West Java's mango production. The focus of mango commodity development in Majalengka district. The focus of developing mango commodities for export was carried out around 1997 and has reaped the results as the largest exporter of the Gincu building variety mango. (Source: Gema Wibawa, 2013).

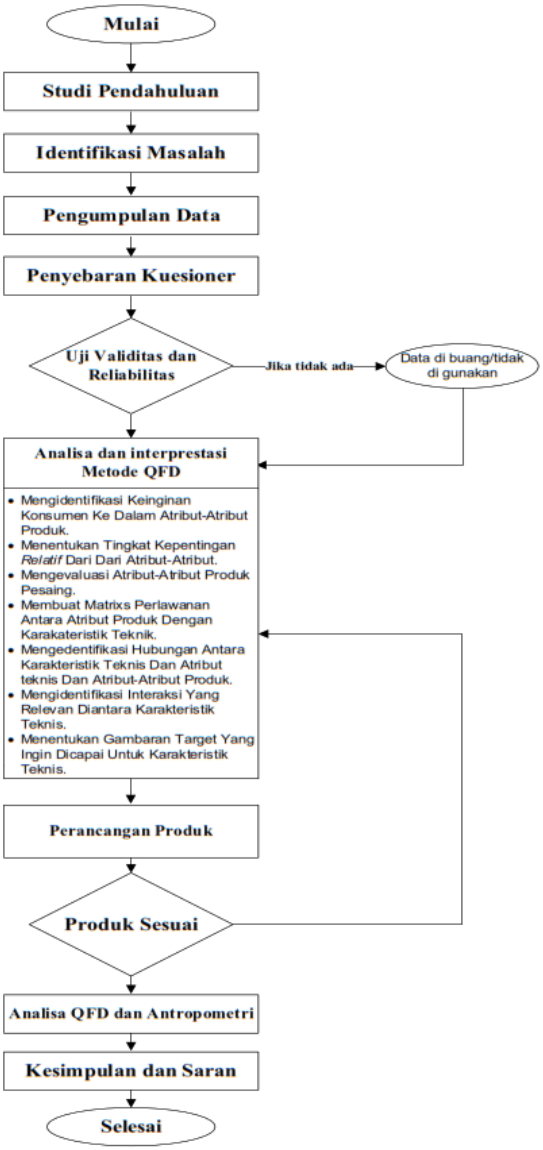
The purpose of harvesting is to get the appearance of mangoes that are uniform, smooth and clean. A mango picker equipped with a cutting knife and a basket when picking the fruit stalk is included +10 cm long to prevent the fruit skin from being exposed to sap and less sap being released. Make sure the sap from the stem does not contaminate the mango. The mangoes that are picked are placed from a basket made of plastic. The picking time is attempted from 09 to 15.00. The way of harvesting is still done with a traditional mango picker made of bamboo. The way this tool works is by directing the mango stalk you want to pick and then pulling it until it breaks and the mango will fall into the basket. The size of the mango picking tool varies from 2 meters to 6 meters which cannot be adjusted in short length so that there are some difficulties when using it, such as to reach different positions of the mango.

The long shape also makes the mango picker difficult to carry. From the various diameters of the poles, some users of the mango picker feel uncomfortable when holding the mango picker. The knife of this mango picker is made of flattened rickshaw fingers. Basket rope made of woven rope. Customers of mango pickers also complained that the material was not strong enough.

After making direct observations to several customers of mango picking tools in Majalengka district. Primary, secondary, and tertiary attribute data that customers want are design, material, function and price. The Function Deployment (QFD) method is the right method when used in providing solutions to existing problems because in making a design, the Function Deployment

(QFD) method identifies the needs and desires of the user. QFD is a way to improve the quality of goods or services by understanding consumer needs and then connecting them with technical provisions for the manufacture of goods or services produced. Quality function deployment is a planning tool used to help businesses focus on the needs of their customers when compiling design and manufacturing specifications (Source: Rosnani Ginting, 2013).

Research Method



Results and Discussion

Identifying Consumer Desires into Attributes To determine consumer desires for mango picking tools, data collection was carried out by distributing questionnaires to 30 samples of mango picker users. The distribution of this questionnaire was carried out in 2 stages, namely stage I (open questionnaire) and stage II (closed questionnaire).

This open questionnaire was created with the aim of knowing the product specifications desired by consumers. The answers to the questions posed in this open-ended questionnaire are free, there is no limit to answering according to the wishes of the consumers.

So the answers obtained from the submission of the open questionnaire are the basis for the submission of the closed questionnaire which will be carried out later. The mode of each question contained in the results of the open questionnaire will be the attribute that will be asked in the closed questionnaire.

Table 4.1 Attribute Data for Mango Picking Tools that consumers want

No	ATRIBUT		
	PRIMER	SEKUNNDER	TERSIER
1	Desain	Bentuk galah slinder	Diameter Ø 38 mm
		Galah sambung	Bisa diatur panjang pendeknya
		Awet	Anti karat
		Panjang Galah	Panjang 4 meter
2	Material	Galah	Alumunium
		Keranjang	Tambang
3	Fungsi	Tambahan	Pisau pemotong
4	Harga	Terjangkau	Murah

Sumber : (Hasil kuisioner)

To test the validity and reliability of the instrument, the author uses SPSS 16.0 analysis. Validity testing is carried out with a significant level of testing by comparing the calculated r value with r table degree of freedom (df) = n-k in this case n is the number of samples and k is the number of constructs. In this case, the magnitude of df can be calculated as 30-2 or df 28 with an alpha of 0.05 obtained r table 0.374 if r count (for r each item can be seen in column r count is greater than r table, then the item or question is said to be valid The results of the validity analysis can be seen in table 4.3.

Table 4.3 Design Validity Test

Kebtuhan Pelanggan	R Hitung	R Tabel	Perhitungan	Keterangan
Ergonomi	0,806	0.374	r hit > r tab	Valid
Bisa diatur panjang pendeknya	0,658	0.374	r hit > r tab	Valid
Awet	0,469	0.374	r hit > r tab	Valid
Panjang galah 4 meter	0,546	0.374	r hit > r tab	Valid
Material galah almunium	0,398	0.374	r hit > r tab	Valid
Material keranjang tambang	0,451	0.374	r hit > r tab	Valid
Tambahan pisau pemotong	0,552	0.374	r hit > r tab	Valid
Terjangkau	0,646	0.374	r hit > r tab	Valid

Sumber : (Hasil Analisis SPSS 16.0)

The criteria for a research instrument are said to be reliable using the Cronbach alpha technique, if the reliability coefficient (r11) > 0.6.

Table 4.4 Reliability Test

			Perhitungan	Keterangan
Kebutuhan pelanggan	0,735	0,6	r 11 > 0,6	Realibel

Sumber : (Hasil Analisis SPSS 16.0)

From the table above, it can be seen that the value of customer needs has a Cronbach alpha value > 0.6, thus it can be said to be reliable.

Determining the Relative Importance Of Product Attributes

Determination of the relative importance of these attributes is done by assigning a percentage weight to each attribute using a priority scale, which can be seen in table 4.2.

Table 4.5 Data of Importance of Product Attributes

No	ATRIBUT		
	PRIMER	**SEKUNNDER**	**TERSIER**
1	Desain	Bentuk galah slinder	Diameter Ø 38 mm
		Galah sambung	Bisa diatur panjang pendeknya
		Awet	Anti karat
		Panjang Galah	Panjang 4 meter
2	Material	Galah	Alumunium
		Keranjang	Tambang
3	Fungsi	Tambahan	Pisau pemotong
4	Harga	Terjangkau	Murah

Sumber : (Hasil kuisioner)

Evaluating Competitor's Product Attributes

The level of importance of attributes and competitors obtained from the results of the questionnaire can be seen in table 4.6.

Table 4.6 Attribute Evaluation Data from competitor products

No	Atribut			Tingkat Kepentingan	
	Primer	**Sekunder**	**Tersier**	**Pesaing 1**	**Pesaing II**
1	Desain	Bentuk galah slinder	Diameter Ø 38 mm	4	4
		Galah sambung	Bisa diatur panjang pendeknya	4	3
		Awet	Anti karat	3	3
		Panjang galah	Panjang galah 4 meter	4	4
2	Material	Galah	Alumunium	2	2
		Keranjang	Tambang	4	4
3	Fungsi	Tambahan	Pisau pemotong	4	4
4	Harga	Terjangkau	Harga Murah	4	4

Sumber : (Hasil kuisioner)

Identifying the Relationship Between Product Attributes and Product Characteristics

In this case, it is done by using the highest score indicating the highest level of convenience for the design team to identify the technical characteristics that affect customer satisfaction. The matrix between product attributes of mango pickers and technical characteristics can be seen in table 4.12.

Table 4.12 Matrix Between Product Attributes and Technical Characteristics

	Diameter galah	Panjang galah	Bobot	Usia pakai	Fungsi produk
Bentuk galah slinder Ø 38 mm	V	x	√	X	√
Galah sambung	x	√	√	√	V
Awet	x	X	x	V	V
Panjang galah 4 meter	x	V	√	x	V
Galah alumunium	X	X	V	V	x
Keranjang tambang	X	X	x	V	V
Fungsi tambahan pisau pemotong	X	√	x	X	V
Harga terjangkau	X	x	x	V	V

Sumber : (Data Diolah)

Identifying Relationships Between Technical Characteristics

This step aims to identify the relationship between the characteristics of one another, can be seen in Figure 4.1.

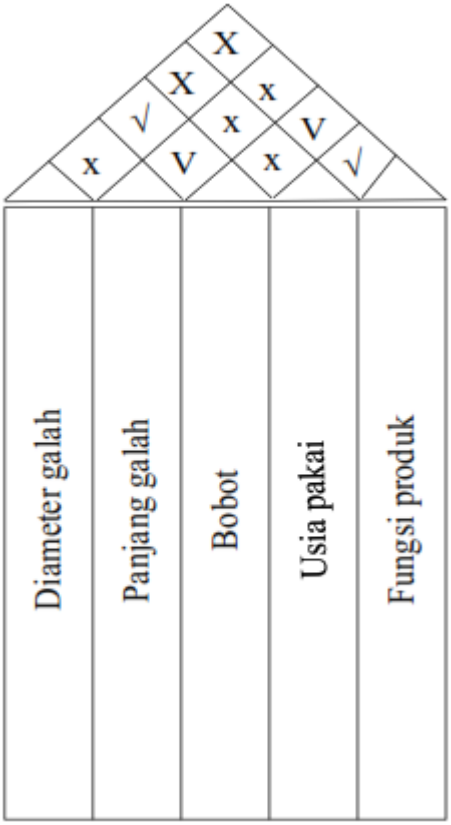


Figure 4.1 Relationship Between Technical Characteristics

Determining Achievement Targets For Each Technical Characteristic

In this step, the target to be achieved is determined for each technical characteristic, the level of difficulty in making the product, the level of importance and the estimated cost of each technical characteristic. Customer Perception Consumer perception data can be seen in table 4.13.

Table 4.13 Consumer Perception Data

Atribut	Perancangan	Pesaing 1	Pesaing 2
Bentuk galah Ø 38 mm	4	4	4
Galah sambung	4	4	3
Awet	4	3	3
Panjang galah 4 meter	4	4	4
Galah alumunium	3	2	2
Keranjang tambang	4	4	4
Fungsi tambahan pisau pemotong	4	4	4
Harga terjangkau	4	4	4

Sumber : (Hasil kuisioner)

Table 4.14 Relationship between Technical Characteristics and Difficulty Level,

Degree of Interest, and Estimated Cost

	Diameter galah	Panjang galah	Bobot	Usia pakai	Fungsi produk
Tingkat Kesulitan	1	1	1	1	1
Derajat Kepentingan	12	18	14	14	15
Perkiraan Biaya	14	14	14	14	14

Sumber : (Data Diolah)

Furthermore, it can be described House Of Quality which is a combination of all technical characteristics, attributes that consumers want, the position of competing mango pickers and designs for the same attributes. Everything is made in a quality house using the QFD method (can be seen in Figure 4.2)

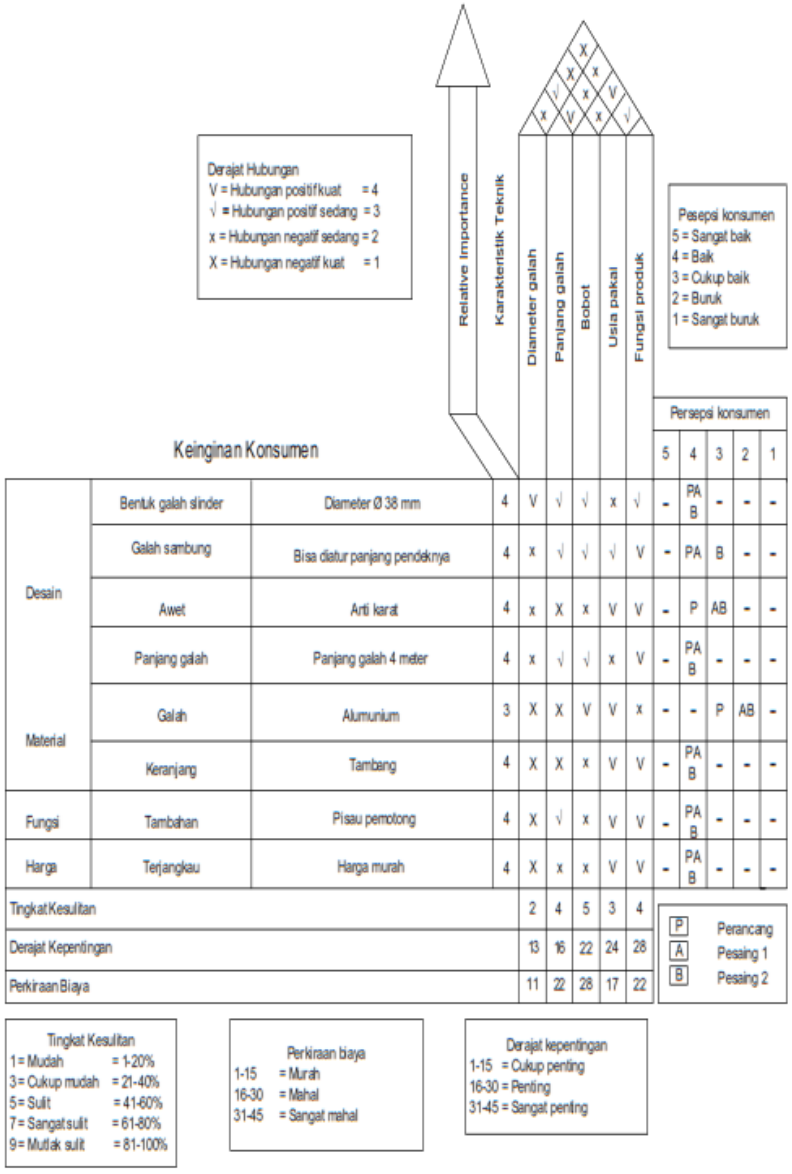


Figure 4.2 House Of Quality Magga Picker Tool Design

The discussion of the QFD image above is:
1. The attributes of the mango picking tool from the questionnaire results are:
a. Mango picker tool that has a cylindrical pole shape
Diameter 38 mm.
b. A mango picker with an adjustable pole
short length (connection pole).
c. Mango picker tool that has anti-rust.
d. A mango picker with a length of 4 meters.
e. A mango picker tool that has a pole material from
aluminum.
f. A mango picker that has a basket material from
mine.
g. A mango picker with a cutting knife.
h. An affordable mango picker.
2. Comparison of Mango Picking Tools as a result of distributing questionnaires
with competing products are:
a. For the shape of the cylindrical pole diameter 38 mm: product design,
competitor 1, and competitor 2 have the same level of advantage.
b. For pole characteristics: product design and competitors 1 more
superior to competitors 2.
c. For durability: product design is superior to competitors 1
and 2.
d. For the length of the pole: design product, competitor 1, and competitor 3
have the same level of excellence.
e. For pole material: the design product is superior to competitors
1 and 2.
f. For basket materials: design product, competitor 1, and
competitor 3 has the same level of advantage.
g. For additional cutting blades: design product, competitor 1,
and competitor 3 has the same level of advantage.
h. For affordable prices: design product, competitor 1, and
competitor 3 has the same level of advantage.
3. Difficulty level: All the characteristics of the technique are quite easy
to be done.
4. Level of importance: All technical characteristics are considered important
only the diameter of the pole is considered to be of sufficient importance.
5. Estimated cost: the estimated cost of the design product is classified as
in the expensive category except for the diameter of the pole which is relatively cheap.

Anthropometric Data Used

The design of the mango picker must be adjusted to the anthropometry of the user. Anthropometric data used in the design of the mango picker tool is adjusted to the design needs. The data required is anthropometric data of the handheld diameter (maximum) used as a measure of the thickness of the handle on the mango picker.

Table 4.15 Hand Anthropometry Data Grip Diameter (Maximum)

Data diameter genggam (maksimum)															
Data	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	53	48	50	48	48	51	49	47	46	53	53	48	51	48	52
Data	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	48	52	47	46	53	53	51	49	47	52	53	48	47	46	50

Sumber : (Hasil pengukuran)

Grip Diameter Data Normality Test (Maximum)

Using a 95% confidence level, 0.05 then tested whether the data are normally distributed are as follows:

a) Hypothesis Test

Ho : Data is normally distributed

H1 : Data is not normally distributed

b) Statistical Test with Kolmogorov-Smirnov . Test

If sig. > , then H0 is accepted

If sig. < , then H1 is rejected

c) Conclusion

Because significant count > significant , then Ho accepted means that the data is normally distributed which means that the data can be processed.

Table 4.16 Calculation of Data Normality Test

No.	Pengukuran	N	Sign.	α	Keterangan
1	Diameter gengam (maksimum)	30	0,098	0,05	Data Normal

Sumber : (Hasil Analisis SPSS 16.0)

Grip Diameter Data Uniformity Test (Maximum)

The data uniformity test is carried out so that the data that we will use are within the specified control limits.

Table 4.17 Calculation of Data Uniformity Test

No.	Pengukuran	Simbol	$\overline{X}$	σ	BKA	BKB	Keterangan
1	Diameter gengam *(maksimum)*	Dgm	49	2	53	45	Seragam

Sumber : (Data Diolah)

Grip Diameter Data Sufficiency Test (Maximum)

The data adequacy test was carried out with the aim that the data used in this study used a 95% confidence level and 5% accuracy degree.

Table 4.18 Calculation of Data Sufficiency Test

No.	Pengukuran	Simbol	N	N'	Keterangan
1	Diameter gengam (maksimum)	Dgm	30	1	Data Cukup

Sumber : (Data Diolah)

Percentile Calculation

Then the next step is to determine the size of the mango picker based on the percentile size that will be used in this study, namely P5 for the small percentile size, P50 for the average percentile measurement and P95 for the large size.

Table 4.20 Percentile Calculation

No.	Pengukuran	Simbol	Persentil		
			P_5	P_{50}	P_{95}
1	Diameter genggam *(maksimum)*	Dgm	46	49	52

Sumber : (Data Diolah)

After the percentile calculation is obtained, the next step is to determine the diameter of the pole, which can be seen in table 4.21.

Table 4.21 Diameter of pole grip

No	Bagian Alat	Ukuran (mm)
1	Diameter genggam galah	49

Sumber : (Data Diolah)

To determine the diameter of the pole, the hand dimension used is the grip diameter (maximum). The percentile chosen for this design is the middle percentile P50. The use of the P50 percentile is intended so that users who have a larger or smaller handheld diameter can hold a mango picker.

Mango Picking Tool Design

After determining the design of the mango picker using the Quality Function Deployment (QFD) and anthropometric methods, the next step is to design a mango picker with the help of solid work 2013 software. 5:1 unit using (mm) can be seen in Figure 4.4.

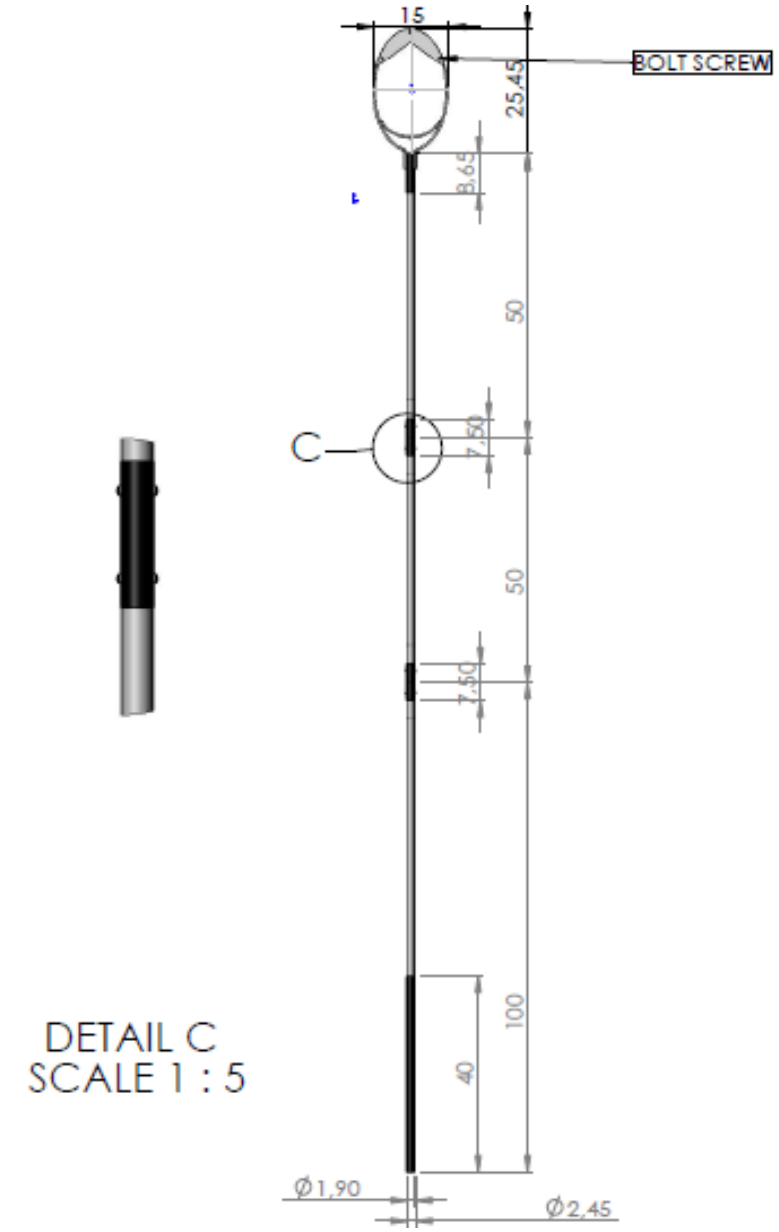


Figure 4.4 Technical Drawing of Mango Picking Tool

Analysis of Design Results Using Quality Function Deployment Method

Quality Function Deployment (QFD) can explain things that become the needs and interests of consumers and how to fulfill them. House of quality can describe the relationship between consumer desires with technical factors and evaluate competitors in terms of meeting customer satisfaction. Identified 8 attributes of consumer requirements (Customer Requirements) that determine the level of satisfaction with these products, including: pole shape, pole characteristics, durability, pole length, pole material, basket material, additional functions (cutting knives) and affordable prices.

From the results of the design of the mango picker, several differences were obtained, including: The previous pole material was bamboo, now aluminum for durability, the characteristics of the pole can now be adjusted in short length, which is intended to overcome differences in tree height and easy to carry. Cutting blades that are easy to sharpen because they can be disassembled.

Analysis of Design Results With Ergonomics (Anthropometric Data)

From the results of the design of the mango picker tool, it is obtained that there is a difference in the size of the diameter of the current handheld pole with the designed manga fruit picker. The dimensions of the diameter of the handheld pole currently do not have a size according to the average anthropometric size of the user, this will have an impact on discomfort when gripping. In the mango picker tool currently available, the diameter of the handheld pole is 38 mm, this can make it uncomfortable when holding it for those who have a large grip diameter because the fingers are too circular.

Meanwhile, the mango picker tool designed has been adjusted to the anthropometric data size of the maximum handheld diameter of the user, which is 49 mm, using the P50 percentile or middle percentile so that users who have a larger or smaller handheld diameter can grip the mango picker.

Conclusion

1) The concept of designing a mango fruit picker using Quality Functon Deployment using a weighted value order with the desires and needs of consumers, namely: cylindrical pole shape, pole characteristics, durable and not easily damaged when dropped, pole length size, pole and basket material, function additional cutting blades and affordable prices.

2) Of the several components desired by consumers, there are several components which are advantages that have been designed with existing tools, namely: Handheld diameter according to hand anthropometric data, maximum grip diameter, pole characteristics that can be adjusted in short length, durable, not easily damaged if dropped , easy to maintain the cutting blade and easy to carry.

3) The technical characteristics of mango picking tools are; Pole diameter, pole length, weight, service life and product function.

4) The diameter of the handle of the pole as a result of the design using anthropometric data, the maximum grip diameter of the P50th percentile or the middle percentile is intended so that those who have small or large handheld diameters can hold it, namely

49mm.

Reference

Chan, L.K. and Wu, M.L., 2002. Quality function deployment: A literature review. *European journal of operational research*, *143*(3), pp.463-497.

Chan, L.K. and Wu, M.L., 2002. Quality function deployment: a comprehensive review of its concepts and methods. *Quality engineering*, *15*(1), pp.23-35.

Govers, C.P., 1996. What and how about quality function deployment (QFD). *International journal of production economics*, *46*, pp.575-585.

Lam, K. and Zhao, X., 1998. An application of quality function deployment to improve the quality of teaching. *International Journal of Quality & Reliability Management*.

Wang, J., Thornton, J.C., Kolesnik, S. and Pierson Jr, R.N., 2000. Anthropometry in body composition: an overview. *Annals of the New York Academy of Sciences*, *904*(1), pp.317-326.

Norton, K., Whittingham, N., Carter, L., Kerr, D., Gore, C. and Marfell-Jones, M., 1996. Measurement techniques in anthropometry. *Anthropometrica*, *1*, pp.25-75.

Cameron, N., 1978. The methods of auxological anthropometry. In *Human growth* (pp. 35-90). Springer, Boston, MA.