

## Design of a Biomass Waste Shredding Machine Using the Quality Function Deployment (QFD) Method

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### Abstract

*This research aims to design a biomass waste shredder using the Quality Function Deployment (QFD) method to create a product that aligns with the needs and desires of users. The QFD method is employed to identify user requirements, translate them into technical specifications, and produce an optimal product design. The study involved 20 respondents from the Universitas Pahlawan Botanical Garden team as subjects to collect data on needs through closed questionnaires. The results indicate that consumers desire a shredder with key criteria, including speeding up the shredding process, high durability, safety in use, as well as ease of mobility and storage. The designed shredder product features several advantages, such as: An inlet feeder for biomass waste, six cutting blades with a bolt system, wheels for easy transportation. Through the House of Quality (HOQ) matrix, consumer needs were successfully translated into priorities for the development of the product's technical features. Compared to other shredders, this shredder has competitive advantages in functional aspects, user safety, and design. This demonstrates that the application of the QFD method is effective in producing an innovative, functional shredder design that meets user preferences. The findings of this study are expected to serve as a reference for the future development of shredder products.*

**Keywords:** Biomass Waste Shredder, Quality Function Deployment (QFD), Product Design, House of Quality.

### Abstrak

*Penelitian ini bertujuan untuk merancang mesin pencacah limbah biomassa menggunakan metode Quality Function Deployment (QFD) menciptakan produk yang sesuai dengan kebutuhan dan keinginan pengguna. Metode QFD digunakan untuk mengidentifikasi kebutuhan pengguna, menerjemahkannya menjadi spesifikasi teknis, dan*

*menghasilkan desain produk yang optimal. Penelitian ini melibatkan 20 responden yang berasal dari tim Kebun Raya Universitas Pahlawan sebagai subjek untuk mengumpulkan data kebutuhan melalui kuesioner tertutup. Hasil penelitian menunjukkan bahwa konsumen menginginkan mesin pencacah dengan kriteria utama meliputi mempercepat proses pencacahan, daya tahan tinggi, keamanan dalam penggunaan, serta kemudahan mobilitas dan penyimpanan. Produk mesin pencacah yang dirancang memiliki fitur unggulan seperti: Memiliki penarik masuk limbah biomassa, mata pisau pencacah berjumlah 6 dengan sistem baut, dan memiliki roda sehingga mudah untuk dipindahkan melalui matriks House of Quality (HOQ), kebutuhan konsumen berhasil diterjemahkan menjadi prioritas pengembangan fitur teknis produk. Dibandingkan dengan mesin pencacah lainnya, mesin pencacah ini memiliki keunggulan kompetitif dalam aspek fungsional, keamanan pengguna, dan desain. Membuktikan bahwa penerapan metode QFD efektif dalam menghasilkan desain produk mesin pencacah yang inovatif, fungsional, dan sesuai dengan preferensi pengguna. Hasil penelitian ini diharapkan dapat menjadi referensi bagi pengembangan produk mesin pencacah di masa mendatang.*

**Keywords:** *Mesin Pencacah Limbah Biomassa, Quality Function Deployment (QFD), Desain Produk, House of Quality.*

## 1. Introduction

The environment is an external system that serves as a habitat for various organisms and supports life and interactions between living things. However, in recent years, perceptions of the environment have been less positive and are considered to be capable of causing unexpected natural disasters. In fact, a healthy environment can be measured based on various aspects, including physical, chemical, biological, social, and psychological aspects. Examples of a healthy environment include clean air free from pollution, land and water free from waste, the availability of waste disposal facilities, and so on [1].

A campus is an area where individuals engage in various activities that require cleanliness and health. Therefore, a campus that supports environmental sustainability can effectively ensure the health and comfort of the entire campus community, and this is highly necessary. Mayasari, through Fachrudin, describes an environmentally conscious campus as a system encompassing education, research, community service, and an environmentally conscious environment. It involves all campus members in environmentally related activities that should have a positive impact on the environment, the economy, and society [2].

Pahlawan Tuanku Tambusai University (UP) is a campus that participates in the realization of an "Environmentally Friendly Campus" or Eco-Friendly Campus. The facilities owned by UP to support an environmentally friendly campus are the Universitas Pahlawan

botanical garden area which has an area that will be planned to be around 150 hectares, this botanical garden is the result of collaboration between Universitas Pahlawan and the National Research and Innovation Agency (BRIN) [3]. The botanical garden has a variety of biodiversity in it which produces biomass waste in the form of twigs and leaves, based on data obtained from the botanical garden team (2024), the estimated daily waste generation is 676.5 kg / day from approximately 451 trees.

The large amount of organic waste per day can be utilized optimally and economically. Currently, the accumulated leaves and twigs end up being burned, causing negative impacts. Local communities remain indifferent to the issue of ineffective organic waste management, which can lead to air, water, and soil pollution. Yet, organic waste has significant potential to be utilized for useful and valuable purposes with proper processing, for example, by processing household waste into compost using the shredding method [4].

In general, a biomass waste shredder is a piece of equipment whose primary purpose is to shred biomass waste into smaller, finer pieces so that it can be used as raw material for composting. This machine will produce organic waste in a shape and size according to a predetermined design. Simply put, this tool consists of several important components, including the machine frame, machine body, drive, axle, transmission system, and blades for shredding the organic waste itself. In research conducted by Azriadi et al. [5], machine testing showed that for 6 kg of organic waste, it only took 88 seconds to complete the shredding process. Meanwhile, in research by Saparin et al. [6] with a similar subject, the number of samples tested was 2900 grams, and the average test time was recorded at 32.10 seconds. The tilt angle of the input hopper was set at 60°. The machine's production capacity can reach 293.93 kg per hour, and according to research by Romli et al. [7], the developed grass shredder is capable of cutting grass with a consistent size and capacity of up to 200 kg per hour, with the use of sharp blades for 10-12 hours per day.

Based on the explanation of the issues and previous research, to address the problem of biomass waste so that it does not cause negative impacts on the environment and public health, a sustainable waste processing process is needed that has economic value in the production of compost. This study developed the design of a biomass waste shredder using the Quality Function Deployment (QFD) method.

QFD is a structured methodology to be implemented in the product development process which includes specifying the needs and desires of users or consumers and conducting systematic evaluations of the advantages and disadvantages of a product or service [8].

## **2. Method**

This research was conducted at Pahlawan University, Kampar Regency, Riau, Indonesia. Data processing was carried out in several stages: the first stage included initial identification such as field observations, problem-solving, objectives, and literature studies. The second stage involved data collection from questionnaires and direct interviews with respondents from the Pahlawan Tuanku Tambusai University Botanical Gardens team. The third stage involved data processing using the QFD method to determine machine specifications that meet user needs

and create a design for a biomass waste shredding machine. The fourth stage involved analysis and discussion, including analysis of the results of the previous processing. The fifth stage involved conclusions and suggestions.

### 3. Results and Discussion

#### 3.1 Collection Data

The data collection conducted in this study aims to obtain the information needed to achieve the desired results in the research on the manufacture of a biomass waste shredding machine. The results of the data collection were obtained by distributing closed questionnaires to respondents who were staff and employees of the Pahlawan University Botanical Gardens. The data collection from distributing questionnaires to respondents aimed to obtain data on the specifications of the biomass waste shredding machine desired by users.

##### 3.1.1 Final Product Data

The shredding machine has a strong, durable, easy-to-use model and simplifies the shredding process.

##### 3.1.2 Respondent Data Recapitulation

The recapitulation of respondent data from the distribution of closed questionnaires to the botanical garden team consisting of 20 respondents can be seen in Table 1 below:

Table 1. Recapitulation of Respondent Data

| No  | Name               | Type Sex | Age | Position            |
|-----|--------------------|----------|-----|---------------------|
| 1.  | Ade                | Man      | 37  | Pertamanan UP       |
| 2.  | Andre              | Man      | 27  | Pertamanan UP       |
| 3.  | Azhar              | Man      | 46  | Pertamanan UP       |
| 4.  | Asril              | Man      | 35  | Pertamanan UP       |
| 5.  | Rendi              | Man      | 22  | Mahasiswa           |
| 6.  | Maulina Novita     | Women    | 38  | Dosen FIH           |
| 7.  | Putri Z.T          | Women    | 30  | Dosen FIH           |
| 8.  | Aan                | Man      | 48  | Pertamanan UP       |
| 9.  | Naldi              | Man      | 48  | Pertamanan UP       |
| 10. | Lailatul Syifa T.  | Women    | 28  | Dosen FT            |
| 11. | Riani              | Women    | 35  | PJ Medicine         |
| 12. | Syamsul Bachry     | Man      | 36  | PJ Kebun Raya UP    |
| 13. | Afrinaldi          | Man      | 23  | Mahasiswa           |
| 14. | Sri Mitha Agustien | Women    | 22  | Mahasiswa           |
| 15. | Ravi Hidayat       | Man      | 28  | Pengawas Kebun Raya |
| 16. | Askarani           | Man      | 53  | PJ Pembibitan       |
| 17. | Habibi             | Man      | 41  | Asisten PJ Medicine |
| 18. | Mahadir Johan      | Man      | 35  | KAJUBAG RT UP       |
| 19. | Bani               | Man      | 24  | Pertamanan UP       |
| 20. | Markino            | Man      | 77  | Pertamanan UP       |

Based on Table 1, there were 20 respondents who were then grouped based on several criteria such as: gender consisting of men and women, there were 5 women and 15 men, different ages, and different positions.

### 3.1.3 Closed Questionnaire Statement

The summary of respondents' needs obtained from the results of interpreting user needs is as follows:

Table 2. 1Closed Questionnaire Questions

| No  | Survey User Needs                                |
|-----|--------------------------------------------------|
| 1.  | Biomass waste shredder driven by a dynamo engine |
| 2.  | Has a protective cover for the chopping blade    |
| 3.  | Easy to move with wheels                         |
| 4.  | Having a biomass waste inlet                     |
| 6.  | Can make the operator's work easier              |
| 7.  | The tool has a sturdy frame                      |
| 8.  | The blade can be maintained                      |
| 9.  | Easy to operate tool                             |
| 10. | Tools can be maintained periodically             |

Based on Table 2, the closed questionnaire was obtained from the question, "What kind of shredder machine do you want?" The closed questionnaire was conducted to be easier to understand and generally comprehend, meaning respondents did not experience confusion when filling out the questionnaire.

From the results of the closed questionnaire that has been distributed, the criteria for consumer needs for the shredding machine product that will be made were obtained. Users want a shredder driven by a dynamo engine, guaranteed user safety, a shredder that is easy to maintain, speeds up the shredding process, a tool with a sturdy frame, a tool that is easy to operate, a shredder that is lightweight and has wheels so it is easy to move.

### 3.1.4 Recapitulation of Respondents Needs

The recapitulation of the respondents' needs in this study is as follows:

Table 3. Summary of Respondents' Needs

| Product Attributes        | The Needs and Wants of Shredder Machine Users                                                                              |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------|
| <i>Performance</i>        | Biomass waste shredding machine<br>Dynamo-driven tools                                                                     |
| <i>Feature</i>            | The tool has a protective cover for the chopping blade.<br>Can be moved with wheels<br>Can make the operator's work easier |
| <i>Raliability</i>        | The tool has a sturdy frame<br>Speed up the enumeration process                                                            |
| <i>Service Capability</i> | The blade can be maintained<br>Easy to operate tool                                                                        |

### 3.2 Discussion

#### 3.2.1 Determining Importance to Customers, Goals, Sales Points, Improvement Ratio, Raw Weight, Normalized Raw Weight, and Determining Targets

##### a. Determining the Degree of Importance (Importance to Customer)

To find out the level of importance that is most considered by respondents (potential users), the higher the value, the higher the level of importance. To summarize the respondents' answers regarding the level of importance, see Table 4.

$$IC = \frac{\sum(\text{Skala tingkat kepentingan } i) (\text{Jumlah responden } i)}{\text{Total Jumlah Responden}} \quad (1)$$

Table 4. Summary of Respondents' Level of Interest Answers

| No  | Question                                         | STP | TP | CP | P  | SP | Total |
|-----|--------------------------------------------------|-----|----|----|----|----|-------|
| 1.  | Biomass waste shredder driven by a dynamo engine | 0   | 0  | 1  | 11 | 8  | 20    |
| 2.  | Has a protective cover for the chopping blade    | 0   | 0  | 0  | 4  | 16 | 20    |
| 3.  | Easy to move with wheels                         | 0   | 0  | 0  | 9  | 11 | 20    |
| 4.  | Having a biomass waste inlet                     | 0   | 0  | 1  | 13 | 6  | 20    |
| 5.  | Can make the operator's work easier              | 0   | 0  | 1  | 5  | 14 | 20    |
| 6.  | The tool has a sturdy frame                      | 0   | 0  | 0  | 6  | 14 | 20    |
| 7.  | Speed up the process of shredding biomass waste  | 0   | 0  | 0  | 11 | 9  | 20    |
| 8.  | The blade can be maintained                      | 0   | 0  | 1  | 6  | 13 | 20    |
| 9.  | Easy to operate tool                             | 0   | 0  | 1  | 10 | 9  | 20    |
| 10. | Tools can be maintained periodically             | 0   | 0  | 2  | 6  | 12 | 20    |

The following is the calculation of the Importance to Customer (IC) for the first product attribute “Biomass waste shredder driven by a dynamo engine”.

$$IC = \frac{(0 \times 1) + (0 \times 2) + (1 \times 3) + (11 \times 4) + (8 \times 5)}{20}$$

$$IC = \frac{87}{20} = 4.35$$

The results of the overall IC calculation for each product attribute statement item can be seen in the Table 5.

Table 5. Summary of Importance Level Values

| No. | Needs Consumer                                   | Mark IC |
|-----|--------------------------------------------------|---------|
| 1.  | Biomass waste shredder driven by a dynamo engine | 4.35    |
| 2.  | Has a protective cover for the chopping blade    | 4.8     |
| 3.  | Easy to move with wheels                         | 4.55    |
| 4.  | Having a biomass waste inlet                     | 4.25    |
| 5.  | Can make the operator's work easier              | 4.65    |
| 6.  | The tool has a sturdy frame                      | 4.7     |
| 7.  | Speed up the process of shredding biomass waste  | 4.45    |
| 8.  | The blade can be maintained                      | 4.6     |
| 9.  | Easy to operate tool                             | 4.4     |

| No. | Needs Consumer                       | Mark <i>IC</i> |
|-----|--------------------------------------|----------------|
| 10  | Tools can be maintained periodically | 4.5            |

Based on Table 5. The recapitulation of the importance to customers value is "Has a protective cover for the chopping blade" with a score of 4.8.

### b. Relationship Between Customer Requirements and Technical Requirements

The relationship between customer requirements and technical requirements is as follows:

## 1. Target Technical Requirements

Target technical requirements are a set of technical specifications that must be met when designing a product, such as a Biomass Waste Shredder. The goal is to ensure that the resulting design meets functional, safety, and practical requirements. The target technical requirements for designing a biomass waste shredder are as follows:

[illegible]

Figure 1. Technical Requirements

## 2. Technical Requirement Relationship

The technical requirements in this study are interrelated. The symbols used are as follows:

VV = Strong positive relationship

V = Weak positive relationship

XX = Strong negative relationship

X = Weak negative relationship

|                                     |   |    |    |    |    |
|-------------------------------------|---|----|----|----|----|
|                                     |   |    |    |    |    |
|                                     |   |    | XX |    |    |
|                                     |   | XX |    | XX |    |
|                                     | V |    | X  |    | XX |
|                                     | X | VV |    | XX | X  |
| VV                                  |   | V  | X  | V  | VV |
| Has a security function             |   |    |    |    |    |
| Using an iron frame and steel plate |   |    |    |    |    |
| Equipped with wheels                |   |    |    |    |    |
| Affordable production costs         |   |    |    |    |    |
| Power supply from electricity       |   |    |    |    |    |
| Have varying speeds                 |   |    |    |    |    |

Figure 2. Relationship between Technical Requirements

### 3. Column Weight

The results of the column weighting in this study are as follows:

| Technical Requirement                            | Has a security function | Using an iron frame and steel plate | Equipped with wheels | Affordable production costs | Power supply from electricity | Have varying speeds |
|--------------------------------------------------|-------------------------|-------------------------------------|----------------------|-----------------------------|-------------------------------|---------------------|
| Biomass waste shredder driven by a dynamo engine |                         | ○                                   |                      | △                           | ●                             | ●                   |
| Has a protective cover for the chopping blade    | ●                       | ●                                   |                      |                             |                               |                     |
| Easy to move with wheels                         |                         |                                     | ●                    |                             |                               |                     |
| Having a biomass waste inlet                     | ●                       |                                     |                      |                             |                               |                     |
| Can make the operator's work easier              |                         |                                     | ○                    |                             |                               | ●                   |
| The machine has a sturdy frame                   | ○                       | ●                                   |                      |                             |                               |                     |
| Speed up the process of shredding biomass waste  |                         |                                     |                      |                             | ●                             | ○                   |
| The blade can be maintained                      | ○                       |                                     |                      |                             |                               |                     |
| Easy to operate tool                             | △                       |                                     |                      |                             |                               | ●                   |
| Tools can be maintained periodically             | ○                       |                                     |                      |                             |                               |                     |
| Absolute Importance                              | 127,3                   | 108,6                               | 54,9                 | 4,35                        | 79,2                          | 134                 |
| Prioritas                                        | 2                       | 3                                   | 5                    | 6                           | 4                             | 1                   |

|   |        |
|---|--------|
| ● | Strong |
| ○ | Medium |
| △ | Weak   |

Figure 3. Column Weight

### 4. Analysis and Selection of Priority Item in The Matrix

The analysis and selection of priority items in the matrix consists of Goal values, Sales points, Improvement Ratio (IR), Row Weight (RW) values, and Normal Row Weight (NRW) values. The Goal values are as follows:

Goal: This section is used to indicate the level of importance expected to meet each attribute of the shredder, according to the user's objectives. This section provides several points to fill in the priority values, including:

- (1) Very unimportant
- (2) Not important
- (3) Quite important
- (4) Important
- (5) Very important

Table 6. Target Values (*Goal*) for each Attribute

| No | Question                                         | Goal |
|----|--------------------------------------------------|------|
| 1. | Biomass waste shredder driven by a dynamo engine | 4    |
| 2. | Has a protective cover for the chopping blade    | 5    |
| 3. | Easy to move with wheels                         | 5    |
| 4. | Having a biomass waste inlet                     | 4    |
| 5. | Can make the operator's work easier              | 5    |
| 6. | The tool has a sturdy frame                      | 5    |

| No  | Question                                        | Goal |
|-----|-------------------------------------------------|------|
| 7.  | Speed up the process of shredding biomass waste | 4    |
| 8.  | The blade can be maintained                     | 5    |
| 9.  | Easy to operate tool                            | 4    |
| 10. | Tools can be maintained periodically            | 5    |

Next, the sales point describes the shredder's ability to meet the user's desired attributes. This section provides several points to fill in, including:

1.2 : Medium sales point

1.5 : Strong sales point

Table 7. Sales Point

| No  | Question                                         | Sales Point |
|-----|--------------------------------------------------|-------------|
| 1.  | Biomass waste shredder driven by a dynamo engine | 1.5         |
| 2.  | Has a protective cover for the chopping blade    | 1.5         |
| 3.  | Easy to move anywhere with wheels                | 1.5         |
| 4.  | Having a biomass waste inlet                     | 1.2         |
| 5.  | Can make the operator's work easier              | 1.5         |
| 6.  | The tool has a sturdy frame                      | 1.5         |
| 7.  | Speed up the process of shredding biomass waste  | 1.5         |
| 8.  | The blade can be maintained                      | 1.5         |
| 9.  | Easy to operate tool                             | 1.5         |
| 10. | Tools can be maintained periodically             | 1.2         |

Improvement Ratio is a measure of how much work needs to be done to improve product quality. Calculated using the formula:

The Improvement Ratio (IR) value is as follows:

$$IR = \frac{\text{Goal}}{IC}$$

$$IR\ 1 = \frac{4}{4.35} = 0.9$$

Table 8. Recapitulation of IR of the Developed Shredding Machine

| No  | Question                                         | Sales Point |
|-----|--------------------------------------------------|-------------|
| 1.  | Biomass waste shredder driven by a dynamo engine | 0.9         |
| 2.  | Has a protective cover for the chopping blade    | 1.04        |
| 3.  | Easy to move anywhere with wheels                | 1.1         |
| 4.  | Having a biomass waste inlet                     | 0.9         |
| 5.  | Can make the operator's work easier              | 1.07        |
| 6.  | The tool has a sturdy frame                      | 1.06        |
| 7.  | Speed up the process of shredding biomass waste  | 0.88        |
| 8.  | The blade can be maintained                      | 1.08        |
| 9.  | Easy to operate tool                             | 0.9         |
| 10. | Tools can be maintained periodically             | 1.11        |

Row Weight (RW) or attribute priority weight is useful for knowing the priority of product development, so that it can be determined in which order the attributes will be improved and developed. The Row Weight (RW) value search is as follows:

$$RW = IC \times SP \times IR$$

$$RW 1 = 4.35 \times 1.5 \times 0.9$$

$$RW 1 = 5.8$$

Table 9. Recapitulation of RW of The Developed Shredding Machines

| No  | Question                                         | Sales Point |
|-----|--------------------------------------------------|-------------|
| 1.  | Biomass waste shredder driven by a dynamo engine | 5.8         |
| 2.  | Has a protective cover for the chopping blade    | 7.48        |
| 3.  | Easy to move anywhere with wheels                | 7.5         |
| 4.  | Having a biomass waste inlet                     | 4.6         |
| 5.  | Can make the operator's work easier              | 7.46        |
| 6.  | The tool has a sturdy frame                      | 7.47        |
| 7.  | Speed up the process of shredding biomass waste  | 5.87        |
| 8.  | The blade can be maintained                      | 7.45        |
| 9.  | Easy to operate tool                             | 6           |
| 10. | Tools can be maintained periodically             | 6           |

The weight of each attribute that has been calculated requires normalization of the weight of each attribute desired by the user, which is useful for making it easier to determine the priority of improving the biomass waste shredding machine. Calculated using the formula:

$$NRW 1 = \frac{RW}{\sum RW} \times 100\%$$

$$NRW 1 = \frac{5.8}{65.63} \times 100\%$$

$$NRW 1 = 8.83\%$$

The search for the Normal Row Weight (NRW) value carried out in this study is as follows:

Table 10. Recapitulation of RW of The Developed Shredding Machines

| No    | Question                                         | NRW    |
|-------|--------------------------------------------------|--------|
| 1.    | Biomass waste shredder driven by a dynamo engine | 8.83%  |
| 2.    | Has a protective cover for the chopping blade    | 11.39% |
| 3.    | Easy to move anywhere with wheels                | 11.42% |
| 4.    | Having a biomass waste inlet                     | 7%     |
| 5.    | Can make the operator's work easier              | 11.36% |
| 6.    | The tool has a sturdy frame                      | 11.38% |
| 7.    | Speed up the process of shredding biomass waste  | 8.94%  |
| 8.    | The blade can be maintained                      | 11.35% |
| 9.    | Easy to operate tool                             | 9.14%  |
| 10.   | Tools can be maintained periodically             | 9.14%  |
| Total |                                                  | 100%   |

## 5. House of Quality (HOQ)

|                                                                  |  |                         |                                     |                      |                             |                               |                     |                        |      |             |                   |            |                   |
|------------------------------------------------------------------|--|-------------------------|-------------------------------------|----------------------|-----------------------------|-------------------------------|---------------------|------------------------|------|-------------|-------------------|------------|-------------------|
|                                                                  |  |                         |                                     |                      |                             |                               |                     |                        |      |             |                   |            |                   |
| <div>Technical Requirement</div> <div>Customer Requirement</div> |  | Has a security function | Using an iron frame and steel plate | Equipped with wheels | Affordable production costs | Power supply from electricity | Have varying speeds | Importance to Customer | Goal | Sales Point | Improvement Ratio | Row Weight | Normal Row Weight |
|                                                                  |  |                         |                                     |                      |                             |                               |                     |                        |      |             |                   |            |                   |
| Biomass waste shredder driven by a dynamo engine                 |  |                         | ○                                   |                      | △                           | ●                             | ●                   | 4.35                   | 4    | 1,5         | 0,9               | 5,8        | 8,83%             |
| Has a protective cover for the chopping blade                    |  | ●                       | ●                                   |                      |                             |                               |                     | 4.8                    | 5    | 1,5         | 1,04              | 7,48       | 11,39%            |
| Easy to move with wheels                                         |  |                         |                                     | ●                    |                             |                               |                     | 4.55                   | 5    | 1,5         | 1,1               | 7,5        | 11,42%            |
| Having a biomass waste inlet                                     |  | ●                       |                                     |                      |                             |                               |                     | 4.25                   | 4    | 1,2         | 0,9               | 4,6        | 7%                |
| Can make the operator's work easier                              |  |                         |                                     | ○                    |                             |                               | ●                   | 4.65                   | 5    | 1,5         | 1,07              | 7,46       | 11,36%            |
| The machine has a sturdy frame                                   |  | ○                       | ●                                   |                      |                             |                               |                     | 4.7                    | 5    | 1,5         | 1,06              | 7,47       | 11,38%            |
| Speed up the process of shredding biomass waste                  |  |                         |                                     |                      |                             | ●                             | ○                   | 4.45                   | 4    | 1,5         | 0,88              | 5,87       | 8,94%             |
| The blade can be maintained                                      |  | ○                       |                                     |                      |                             |                               |                     | 4.6                    | 5    | 1,5         | 1,08              | 7,45       | 11,35%            |
| Easy to operate tool                                             |  | △                       |                                     |                      |                             |                               | ●                   | 4.4                    | 4    | 1,5         | 0,9               | 6          | 9,14%             |
| Tools can be maintained periodically                             |  | ○                       |                                     |                      |                             |                               |                     | 4.5                    | 5    | 1,2         | 1,11              | 6          | 9,14%             |
| Absolute Importance                                              |  | 127,25                  | 108,55                              | 54,9                 | 4,35                        | 79,2                          | 133,95              |                        |      |             |                   |            |                   |
| Prioritas                                                        |  | 2                       | 3                                   | 5                    | 6                           | 4                             | 1                   |                        |      |             |                   |            |                   |

Figure 4. HOQ

### 3.2.2 Biomass Waste Shredding Machine Design

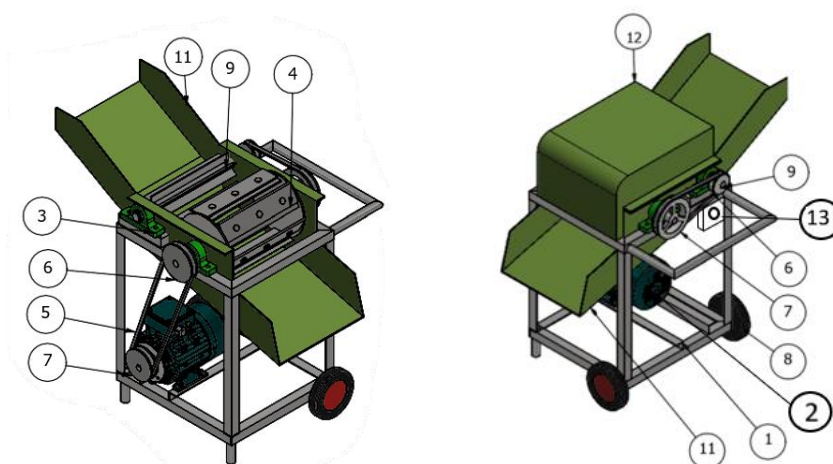


Figure 5. Design 3D

Table 11. Components of a Shredder Machine

| No. | Amount | Component               | Information                                              |
|-----|--------|-------------------------|----------------------------------------------------------|
| 1.  | 1      | Frame Assembly          | <i>Hollow</i> iron and L iron                            |
| 2.  | 1      | Dynamo/Electric Motor   | 5hp electric motor                                       |
| 3.  | 4      | UCP 205                 | -                                                        |
| 4.  | 1      | Enumerator              | -                                                        |
| 5.  | 2      | V-Belt                  | -                                                        |
| 6.  | 2      | Pulley A                | -                                                        |
| 7.  | 2      | Pulley B                | -                                                        |
| 8.  | 2      | Wheel                   | Static wheel                                             |
| 9.  | 1      | Rotary                  | -                                                        |
| 10. | 1      | Blade                   | <i>insert</i> material (a combination of iron and steel) |
| 11. | 1      | Bottom Cover            | 4 mm steel plate                                         |
| 12. | 1      | Top Cover               | 4 mm steel plate                                         |
| 13. | 1      | Speed Controller/Dimmer | -                                                        |

#### 4. Conclusion

Based on the results of the House of Quality (HOQ), the priority attributes obtained starting from the most priority include; 1) Having a variety of speeds in the machine rotation, 2) having a safety function, 3) using an iron frame and steel plate, 4) power supply from electricity, 5) equipped with wheels, 6) having affordable production costs.

The machine specifications designed in this research are in the form of an organic waste shredding machine with a blade drive from an electric motor, has a bottom cover and a top cover as a shredding blade protector, rotary as a biomass waste puller, made of iron and steel plate, has 2 static wheels, and uses a speed controller or contact to control the rotation speed of the shredding machine.

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