Product design for cable waste peeler machine

B Cahyadi\textsuperscript{1,3} and Y Kurniawan\textsuperscript{2,4}

\textsuperscript{1} Department of Industrial Engineering, Pancasila University, Srengseng Sawah, Jagakarsa, Jakarta 12640, Indonesia
\textsuperscript{2} Mechanical Engineering Department, Pancasila University, Srengseng Sawah, Jagakarsa, Jakarta 12640, Indonesia
\textsuperscript{3} bambang.cahyadi@univpancasila.ac.id
\textsuperscript{4} yani.kurniawan@univpancasila.ac.id

Abstract. The design of the cable waste peeler is a product design that aims to reduce the impact of health losses. In general, this is due to the activity of taking the metal in a cable that is done by burning the cable. The design process begins with the identification of customer needs. The customer referred to in this study is the informal sector. Based on interviews that have conducted on several respondents obtained four primary needs that must be illustrated in product design. Then, to explain the four needs are available three types of design variants. The results showed weighting measurements and calculations on load values of approximately 4.15 for the second variant. The results of these calculations are higher than the other two types of design variants. Thus, the design of the variant is chosen for the next design process.

Keywords: wire waste peel design, customer need, design variants

1. Introduction
Cable plays a very important role in the electronic and electrical of product applications today. The use of cables has increased significantly in line with the increasing use of electronics and other electrical products such as computers, the internet, cable television and increased power services worldwide. The cable has the function to connect an electrical current from one component with other electrical and electronics components. Furthermore, the cable could consist of dimensions of size and material type. Generally, the cable consists of a core made of copper or fiber, insulators, and cable cover. The high use of cables in various electronic products has an impact on increasing electronics waste. This cable is one of the recyclable electronics wastes and still has material that has economic value. In developing countries, the waste recycling process still uses very simple methods such as burned or manually shelled to obtain the metal in a cable. Thus, this has the potential to have a negative impact on the environment and human health. For example, dioxins produced from the burning process of cables \cite{2}, a potential trigger for cancer \cite{1}. Therefore, in order to solve the problem, it is necessary to design an environmentally friendly waste cable stripper machine design and can meet the needs of the stakeholders of electrical wastewater management.

2. Methods
The Voice of Customer method is one of the product development techniques that used to describe the process of capturing customer needs arranged in a hierarchical structure and then set the priority requirement \cite{3}. The output and benefits of the VOC are able to recognize a detailed understanding of customer needs, as crucial inputs for setting the right design specifications for the product as well as a useful stepping stone for product innovation. There are three methods commonly used to obtain VOC,
for instance, interviews, focus groups discussion and product observations when operated [4]. However, the method used in this study was an interview to conduct the discussions with prospective customers such as the activists of the cable waste processing in the informal sector. Once the information is obtained, the next activity that can be done is to organize needs into hierarchies and then establish the relative importance of each need [4].

In general, the product development process is divided into six phases, such as phase 0 planning, is the process of determining what products and how to be made/developed. Product planning activities include the discovery of product ideas and policies of product. Phase 1 concept development, in this phase, has been done activities to identify the needs of the customer (activities of the voice of customer). As a result obtained alternatives product concepts and conduct evaluation or selection of one or more concepts to be developed and conducted further experiments. Phase 2 system level design, a phase that includes the definition of product architecture and product description into subsystems and components. Phase 3 system design, including complete the specifications of product models, materials, and tolerances of all components of the product and identification of all standard components purchased from suppliers. Phase 4 testing and repair, involves the construction and evaluation of various versions of initial product production. Phase 5 product launch, the product is made using the actual production system. [4].

The design process begins with the identification of customer needs by interviewing in two different places, namely Bekasi and Bojonggede in West Java. Once the needs are identified, the next activity is to create a hierarchy of consumer needs. Then, determine the specification matrix tool that will be designed and then terminated and give weight of interest assessment. In order to know the advantages and disadvantages of tools to be designed then benchmarking of similar products must be done. The final step is to assess several design variants including the components to be used. Variety of designs that have the highest scoring value will be chosen to be developed into a complete design form.

3. Result and discussion
The research begins with the data collection activities of customer needs from the cable waste activist, especially informal sectors. Furthermore, the data is interpreted into the form of specifications and product design. There are some considerations of a shortage of existing cable stripper machine products such as less of secure due to the stripping process is not equipped with a safety cover. Furthermore, the existing machine is less of comfortable due to the equipment rotation speed cannot be changed. In addition, the machine is also not portable due to of its large and heavy dimensions. Therefore, the mission statement of the cable waste stripper to be developed comprises product descriptions, business objectives, primary and secondary markets and stakeholders related to the utilization of such tools.

Table 1. Cable wire peeler mission

| Mission Statement    | Cable wire stripper machine |
|----------------------|-----------------------------|
| Product description  | Stripper Cable Machine      |
| Business Target      | Middle and low Customer     |
| Primary Market       | Customer of cable waste collectors |
| Related Stakeholder  | Any user                    |

In the identification stage, especially the customer needs several stages are required to obtain data for the development of the tool, [4]:
1. Collecting raw data from customers or users, in this research, as a tool of data collection is used the interview process to the cable waste collectors, interviews are conducted in two places such as Bekasi and Bojonggede.
2. Interpretation of raw data into the needs of customers or users, the results of the interview process then translated into the table of a statement from the customer. Moreover,
interpreted to be the needs desired by consumers to be implemented into a tool that will be developed.

3. Organizing the needs into a hierarchy, this activity sequences the need for visible levels of needs, as summarized in Table 2. below:

| Level of needs | Needs                                                                 |
|----------------|----------------------------------------------------------------------|
| Hight          | The cable waste stripper is convenient to use                        |
|                | Rotation speed cannot be changed                                      |
| Moderate       | Machine is not portable due to of its large and heavy dimensions    |
| Hight          | Cable stripper machine components are easy to unload                 |
| Moderate       | An ergonomic form design of cable stripper                            |
|                | Waste Cable stripper is safe to use                                   |
| Hight          | The process of stripping cable equipped with a cover                 |
| Low            | The stripping cable is rolled automatically                          |
| Hight          | The stripping process can be done by using the motor and manually    |
| Moderate       | The stripping process is not noisy                                   |
| Low            | Vibration of machine is not large                                    |
|                | Durable stripping machine                                           |
| Hight          | Knife blades are not easily dulled                                    |
| Moderate       | Stripping blades are able to withstand axial loads                    |
| Hight          | Knife blades are able to withstand dynamic loads                      |
| Moderate       | Rust stainless blades                                                |
|                | Cable wire Striper is an affordable price                             |
| Moderate       | Using DC Motor                                                       |
| Moderate       | Cable wire stripper can be made easily                               |
| Moderate       | Cable wire stripper is made with simple technology                    |

There are several processes or stages in the manufacture of product specification targets to be developed [4]:

a. Prepare image metrics using the metric needs that have been previously obtained
b. Gathering information about competitors
c. Set an ideal and marginal target value that can be achieved for each matrix.

A good matrix is one that directly reflects the value of the product that satisfies the customer's needs [4]. The relationship between these needs and matrices is at the main of the process of defining specifications which the assumption is to translate customer needs into a set of precise and measurable specification values. Thus this will be able to produce satisfaction with customer needs. The cable stripper equipment design specification based on user needs is shown in the table below.
Table 3. The cable welder equipment design specification based on user needs

| User needs | Matrices                                | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------------|-----------------------------------------|---|---|---|---|---|---|---|---|---|----|
| Dimension of machine | Machine model | Total weight of machine | Sharpness knife to split cable | Strength to withstand dynamic loads | Corrosion resistant material | Device lifespan | Production cost | Precision manufacturing technology | Energy saving |
| 1          | Rotation speed can be change             | ● |   |   |   |   |   |   |   |   |    |
| 2          | The dimensions of the cable waste       | ● | ● |   |   |   |   |   |   |   |    |
|            | stripper can be moved                   |   |   |   |   |   |   |   |   |   |    |
| 3          | The components are easy to uninstall    | ● | ● |   |   |   |   |   |   |   |    |
| 4          | Stripper machine is ergonomic            |   | ● | ● |   |   |   |   |   |   |    |
| 5          | The process of stripping the cable      |   |   | ● | ● |   |   |   |   |   |    |
|            | using a safety cover                    |   |   |   |   | ● | ● |   |   |   |    |
| 6          | The stripping cable is rolled by        |   |   |   |   |   | ● |   |   |   |    |
|            | automatically                           |   |   |   |   |   |   |   |   |   |    |
| 7          | The stripping process can be done by    | ● |   |   |   |   |   | ● | ● |   |    |
|            | using the motor and manually            |   |   |   |   |   |   |   |   |   |    |
| 8          | The stripping process is not noisy      |   | ● |   |   |   |   | ● |   |   |    |
| 9          | Vibration of machine is not large       |   |   | ● |   |   |   |   |   |   |    |
| 10         | Knife blades are not easily dulled      | ● |   |   |   |   |   |   | ● | ● |    |
| 11         | Stripping blades are able to withstand  |   |   |   | ● |   |   |   |   |   |    |
|            | axial loads                            |   |   |   |   |   |   |   |   |   |    |
| 12         | Rust stainless blades                   | ● | ● | ● | ● | ● | ● |   |   |   |    |
| 13         | Using DC Motor                          |   |   |   |   |   |   |   |   | ● |    |
| 14         | Cable wire stripper is made with simple |   |   |   |   |   |   |   |   | ● |    |
|            | technology                             |   |   |   |   |   |   |   |   |   |    |

After the cable stripper design specification matrix had been completed, then the next activity was ranking the weight of metrics. The process of assessment was performed by the researcher.

Table 4. Cable welding equipment design specifications

| Matrices | Needs | Metrics | Interest |
|----------|-------|---------|----------|
| 1        | 2,3,4 | Dimension of machine | 4 |
| 2        | 2,3,4,5,6,7 | The model of machine | 4 |
| 3        | 2,3,4 | Total weight of machine | 4 |
| 4        | 8,10,12 | Sharpness knife to split cable | 4 |
| 5        | 8,9,11 | Strength to withstand dynamic loads | 4 |
| 6        | 10,12 | Corrosion resistant material | 4 |
| 7        | 10,12 | Device lifespan | 4 |
| 8        | 2,3,4,7,10,12,13,14 | Production cost | 4 |
| 9        | 3,14 | Precision manufacturing technology | 4 |
| 10       | 7,13 | Energy saving | 4 |
The next stage is to collect data specifications of competitors or products that already exist. This becomes the basis of the target product specification that will be developed.

**Table 5.** Specification data from competitors of cable wire peeler

| Matrices | Need | Matrices | Interest | Competitor |
|----------|------|----------|----------|------------|
| 1        | 2,3,4| Dimension of machine | 4 | 120 x 40 x 120 mm |
| 2        | 2,3,4,5,6,7 | Model of machine | 4 | There is > 1 knife that can be used in any different cable dimensions |
| 3        | 2,3,4 | Total weight of machine | 4 | > 50 Kg |
| 4        | 8,10,12 | Sharpness knife to split cable | 4 | Less sharp |
| 5        | 8,9,11 | Strength to withstand dynamic loads | 4 | Yes |
| 6        | 10,12 | Corrosion resistant material | 4 | Yes |
| 7        | 10,12 | Device lifespan | 4 | > 3 years |
| 8        | 2,3,4,7,10,12, 13,14 | Production cost | 4 | > 50 million |
| 9        | 3,14 | Precision manufacturing technology | 4 | Yes |
| 10       | 7,13 | Energy saving | 4 | Yes |

Designing of product concept is an activity of developing ideas into a concept of the design solution. This stage is part of the design concept and design detail [4]. The product concept is done by first categorizing design specifications that have been determined in the previous stage. This stage is a step where all the needs and desires of customers can be documented, this is the result of the determination of the customer [3]. In this study used a simple information system that can be compiled by using a list of needs. Based on this information will be obtained the right data in order to determine the specifications of new or developed products. The product specifications should be different with competing products and should be feasible in technically and economically. Highlights the clarity of technical specifications can be obtained after knowing the presence of competitors and similar products [3]. In addition, this steps also to find out the problems and weaknesses of the product. Therefore, it is expected that this design can modify existing products and closer to the needs of users. In addition, user satisfaction is expected to be fulfilled and provide solutions to all complaints and problems. Based on the specified specifications, it can be made the concept of the solution. From that point, alternative parts design and part of the cable stripper to be selected can appear.
Based on several concepts of existing solutions, then to find the best solution concept must develop a judgment for each concept that exists. The criteria used to assess the concept of the shape, size, and the ability to split the cable. Selection criteria obtained from the need metrics are assigned weighting assessments based on interview results or survey results obtained from cable stripper consumer [4]. The stage of selection or determination of product concept consists of several stages, for example:

1. Preparing a selection matrix, some results of product concept ideas that have been obtained based on the identification of needs, target specifications and concepts that have been created using tables.
2. Assess the concept, the assessment stage of the results of existing concepts conducted by the team or experts.
3. Ranking the concept, after an assessment of the existing concepts, then the next stage is to rank or rank of the concepts from the highest to the lowest.
4. Combining and refining concepts, concepts with the highest ranking value (one or more concepts) are re-analyzed to ascertain whether the concept is appropriate, if not yet fixed until the concept can be realized.
5. Choosing the concept, from the stage of improvement of the concept with the highest ranking has been done, the next stage is to choose or determine a concept that is really convincing and has fulfilled aspects or specifications that have been predetermined.
6. Reflecting on results and processes, the final step of the concept selection stage is to reflect it with agreement and consolidation of the chosen concept.

By using the selection criteria of the final product specifications that have been obtained previously, then a concept screening metric is made of the components of the cable stripper that has been generated. The method quantifies or weighs the criteria of the target specification to be achieved from each of the design alternatives. The weighting is evaluated using the assumption that the alternative can meet the final product specifications and in this study, the assessment is performed by experts in the field of wire stripping. The assessment criteria used in this study are shown in Table 7 below.

Table 7. Scale weighting assessment

| Relative performance                                      | Score |
|----------------------------------------------------------|-------|
| Very bad compared to references                          | 1     |
| Poor than reference                                      | 2     |
| Equal as references                                      | 3     |
| Better than references                                   | 4     |
| Very much better than reference                          | 5     |

Based on the weighting and calculation of the load values of the design variant for the waste of cable stripper, it was concluded that the second variant of the 2nd waste of cable stripper has the highest value approximately 4.15. Thus, this will be the design chosen and will be developed for the waste of cable stripper.

Table 8. An appraisal matrix of the concept of a wastewater peeler component

| No | Criteria Selection | Load Reference | Model Variants of waste of cable stripper |
|----|--------------------|----------------|------------------------------------------|
|    | Weight Load Value  | Weight Load Value | Weight Load Value | Weight Load Value |
|----|--------------------|-----------------|-----------------|-----------------|
| 1  | Easy to operate    | 15% 4 0.6       | 4 0.6           | 5 0.75 3 0.45   |
| 2  | Easy to move       | 15% 3 0.45      | 3 0.45          | 4 0.60 3 0.45   |
| 3  | The storage space is small | 10% 4 0.4 | 4 0.4           | 4 0.40 4 0.4    |
| 4  | Result chunks      | 20% 3 0.6       | 4 0.8           | 4 0.80 4 0.8    |
| 5  | Ease of manufacturing | 20% 3 0.6   | 3 0.6           | 4 0.80 3 0.6    |
| 6  | Ease of assembly   | 10% 3 0.3       | 3 0.3           | 4 0.40 3 0.3    |
| 7  | Cost production    | 10% 3 0.3       | 4 0.4           | 4 0.40 4 0.4    |
|    | Total value        | 3.25 3.55 4.15  | 3.40           |
|    | Level              | 4 2 1 3        |
|    | Continue?          | No No Yes No    |

From the chosen design variant is then drawn in such a way that the components can simultaneously create a cable stripper machine in the motion of each component does not collide with each other. Thus, the resulting product can perform its function properly as expected.
4. Conclusion

In the process of designing the wastewater peeler, this cable consists of six different stages of activity performed. However, these activities are interconnected. The process begins with the identification of customer needs and ends with a tool design. The design of the developed tool is that has a weighted value and calculation of the load value of the highest variant. The highest value weighs around 4.15 is the second design concept variant. The success of a design is the suitability of the design made with what is required by the customer.

5. References

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