DESIGN CONCEPT FOR THE DEVELOPMENT OF NATURAL PLANT FIBER EXTRACTOR AS A RAW MATERIAL FOR NATURAL FIBER COMPOSITES

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ABSTRACT

The design concept is used for the development of natural plant fiber extractors as raw materials for making natural fiber composites. The extractor is a tool used to extract natural plant fibers which are expected to produce natural fibers as raw materials for making natural fiber composites. In the previous tool, there are still several shortcomings that can be redeveloped, both for the sake of the tool itself and in terms of the fiber produced. In this journal, it is focused on making design concepts before the development of the extractor tool, including identifying problems in previous tools, determining the functional structure, finding solutions to existing problems, determining development specifications on the tool and also evaluating from the technical and economic side. In the process of this design concept, There are several things that are highlighted in the previous tools to be developed, including the mobility of the tool, the quality and quantity of fiber produced, production time and safety aspects and also environmentally friendly. Thus, in the end, all of it will be narrowed down to the choice of specifications needed to support this with the consideration of the objective tree.

Keywords *: Design concept, extractor tool, waste, composite*

1 INTRODUCTION

Indonesia is one of the countries that has very large natural resources (Rahmawaty et al., 2024). Farming is one of the livelihoods of most of the Indonesian population. The agricultural sector consists of several sectors, including horticulture, fisheries, food crops, forestry, and livestock (Filgantara et al., 2024)(LIMBONG, 2021). To support agricultural products, one of them is producing plant fiber for natural composite materials, which requires tools. The need for quality products increasingly demands the development of more complex product functions to meet the expectations and needs of the users of these products (Laetitia et al., 2020). The development of new products is a complex activity and is influenced by the internal and external conditions of the company. One of the issues in product development is timeliness and the ability to be flexible to speed up the process of developing new products(Hartanto & Subagyo, 2019). Design concepts can be interpreted as basic ideas that are the foundation in the design process. Without a good design concept, a design will seem less than optimal and ineffective in conveying the message you want to convey (Cahyadi, 2023).A design concept is the idea behind a design. A design can be said to be good if it starts with a good design concept. In solving design problems, a concept will lead the way to provide direction to design decisions by developing a small idea so that it becomes an interesting concept. The concept will underlie the logic, thinking, and reasoning of how the design will be made. In other words, the design concept becomes the framework for making design decisions. The design concept is the starting point to show the direction in the design. If a result of the design is not well formed, then the concept needs to be explored further to fit the concept. This is also the basis for determining the product design of natural plant fiber extractors as natural composite raw materials as in the previous tool (Azizi et al., 2024). Such as a tool developed by (Alfatah Dwi Putra, Sumarlin, 2001) o take fiber from pineapple. Waste is a waste material, both materials that are no longer used (used goods) and materials that have been taken as the main part which from an

economic point of view, waste is a waste material that has no value and in terms of the environment, waste is a useless waste material and causes many pollution problems and disturbances to environmental sustainability (Sunarsih, 2014). There is still a lot of plant waste that is not used effectively even though currently waste from plants can be used as raw materials for making natural compost. As well as (Alfatah Dwi Putra, Sumarlin, 2001) which makes pineapple fiber extractors to extract the fibers. Speaking of composites, when two are more physically and chemically different materials are combined with a distinct interface between the materials to form a single substance it can be called as composite (Shekar & Ramachandra, 2018). Recent trends in development of new materials are more focused on eco-friendly materials (Sarapure, 2018).Natural fibers, as a substitute for engineered fibers, have become one of the most researched topics over the past few years. This is due to its inherent properties, such as biodegradability, renewability and abundant availability when compared to synthetic fibers (Natanael Siagian & Sedo Putra, 2024). Composite materials are used in many applications such as aerospace, automotive, aerospace, and many more (Hassan et al., 2018). According to some previous researchers, what is commonly used as a reinforcing material in composite materials is a type of synthetic fiber that cannot be recycled. In fact, there are still many natural fibers that have not been utilized to the fullest to benefit humans (Fitri & Mahzan, 2016). Fibers derived from plants are generally grouped into 2 groups, namely non-wood fibers and wood fibers (Suryanto et al., 2013) . Based on the information above, it is necessary to make a design concept for the development of the natural plant extractor tool to increase the yield of fibers processed using this tool, this tool can later help the process of extracting natural plant fibers. It is hoped that from the design concept made for the development of natural plant fiber extractors, the right choice can be obtained from the side of the tool so that the expected output can be achieved.

2. MATERIALS AND METHODS

2.1 Research Methodology

The following are the steps used can be seen in the following flow chart

1. Start
2. Clarification of the task
   (elaborate the specifications)
3. Specifications
4. Design Concept
5. Already Clear or Not
6. If already clear enough, continue to next step
7. Design concept accepted
8. Finish

For a better picture of the flow chart, we can see in figure.1

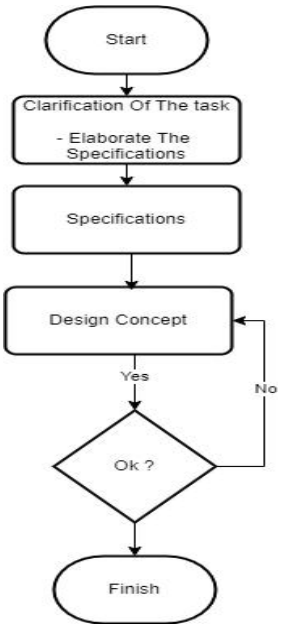

Figure 1. Research flow chart

The results of the development of the tool will be obtained as a percentage based on its function in accordance with the results of the development of the tool with a self-determined number or self-assessment

2.2 Input & Output Flow Diagram

The following is a flow chart to show the process from Input (waste) to Output (product)

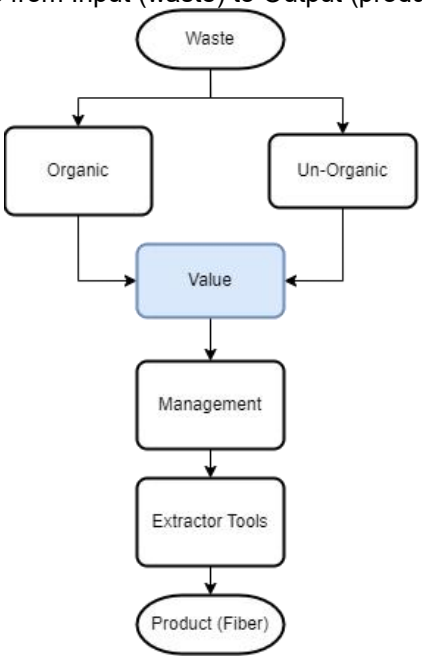

Figure 2. Flow Diagram of Input & Output of Waste

3. RESULTS AND DISCUSSION

3.1 Specifications of Previous Tools

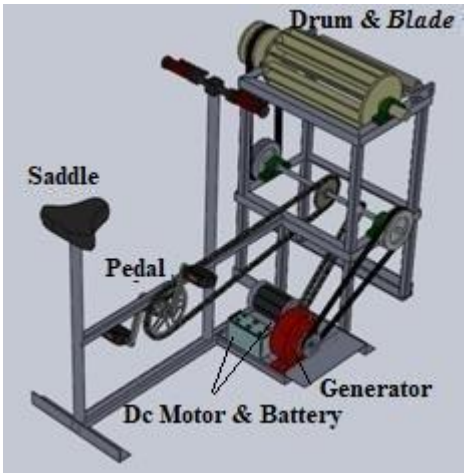

Figure 3. Previous Extractor Tools

The following are the specifications of the previous tool:

1. Saddle
2. Handlebar
3. Tool Frame
4. Pedal
5. Chain
6. Sprocket
7. Pulley
8. Belt
9. DC Motor
10. Spring
11. Drum Blade

3.2 Identify Previous Tool Problems

After knowing the specifications of the previous tool, then identify the problem of the previous tool, and the following problems were obtained:

1. Lack of mobility on the tool
2. Lack of Fiber Production Amount
3. Lack of Fiber Production Speed
4. Lack of quality of fiber produced
5. Lack of Safety & Environmentally Friendly Aspects

Next, Establish the principle of the solution that can be used for the next process

3.3 Finding the Solution Principle

After finding problems in the previous tool, then finding solutions to existing problems will then be continued in the next development

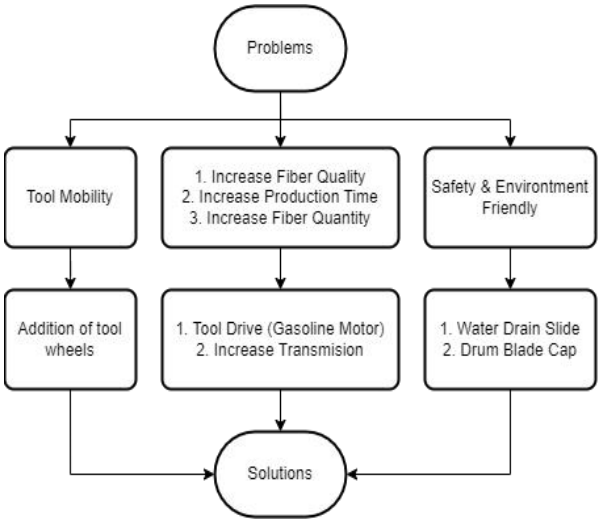

Figure 4. Solutions to Previous Tool Problems

From figure 4. above, the solution to the problem of the previous tool is obtained as follows:

1. Addition of Tool Wheels
2. Change of the main mover of the appliance to a gasoline motor
3. Addition of Tool Transmission
4. Addition of Extraction Waste Water Disposal Slide
5. Addition of Drum Blade Cap

Figure 5. Tool Wheel

Figure 6. Gasoline Motor

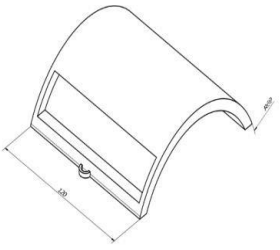

Figure 7. Drum Blade Cap

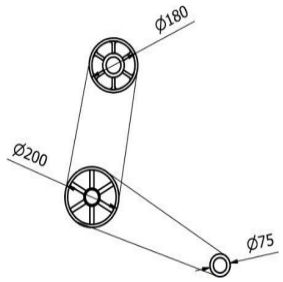

Figure 8. *Tool Transmission*

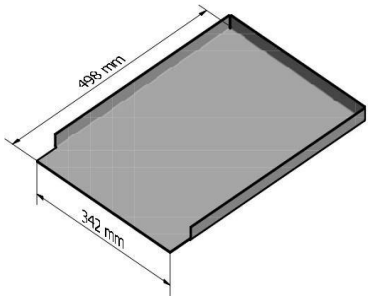

Figure 9. Water Drain Slide

3.4 Technical & Economic Aspects Evaluation

- Technical Study:
  1. The modified tool is expected to be faster to produce plant fiber due to the addition of transmission and the replacement of the main drive to the gasoline motor
  2. The modified tool is expected to be easy to mobilize
  3. The modified tool is expected to be able to cut production time
  4. The modified tool is expected to be able to meet the safety and environmentally friendly aspects with the addition of a lid

- Economic Study:
  1. By using the new tool, it is hoped that the cost for production to extract can be reduced.
  2. The modified tool is expected to be able to meet the expectations of the product produced (plant fiber) with good quality
  3. The new tool is expected to increase the selling value of natural plant fibers

3.5 Product Development

There are 2 approaches to product development seen in figure 10. Including:

- Fundamental Research
- Reverse Engineering

The product development for this plant fiber extractor uses the second approach (reverse engineering).

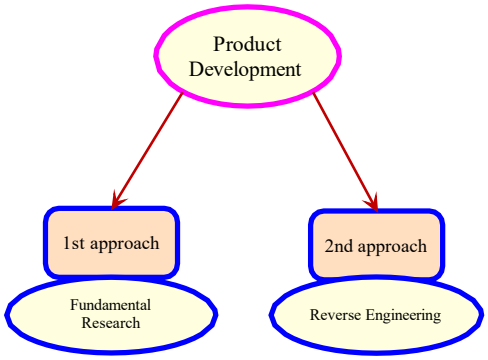

Figure 10. Product Development Approach

3.5.1 Reverse Engineering

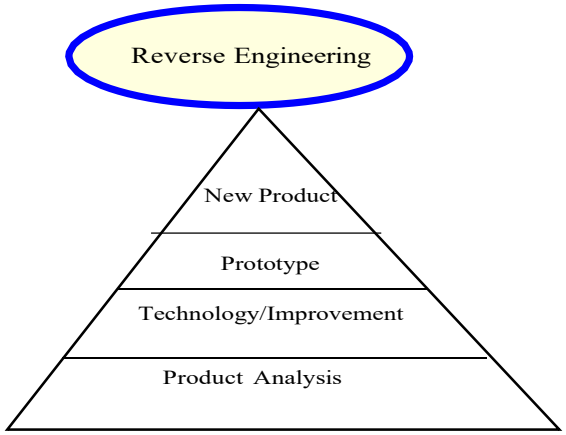

Figure 11. Reverse Engineering Approach

The points in reverse engineering are as follows:

- Detailed analysis of current products
- Discover the principles of technology
- Building new devices (different designs) with the same goal

3.5.2 Development of Technology Principles

In figure 12. It looks like a transmission principle in the previous tool when used manually

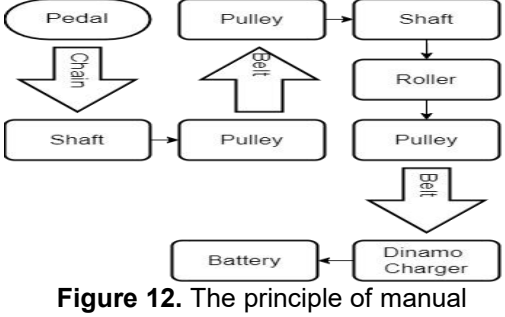

Figure 12. The principle of manual transmission

In figure 13. It can be seen that it is the transmission principle in the previous tool when used when using a DC motor.

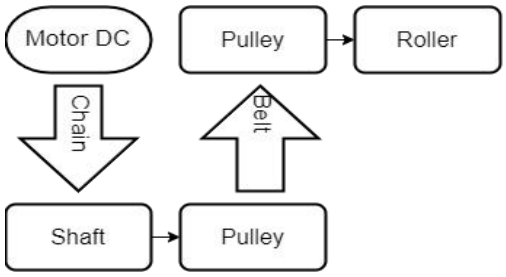

Figure 13. The principle of motor DC transmission

In figure 14. It can be seen that it is the transmission principle in the previous tool when used when using a gasoline motor.

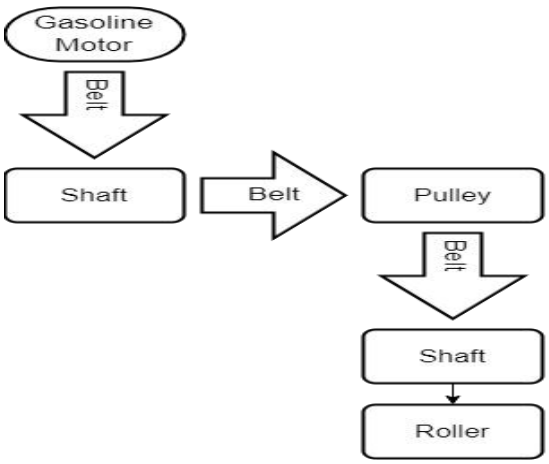

Figure 14. The principle of gasoline motor transmission

After going through the process stages of the previous thinking framework, the latest tool design concept is obtained as seen in figure 15.

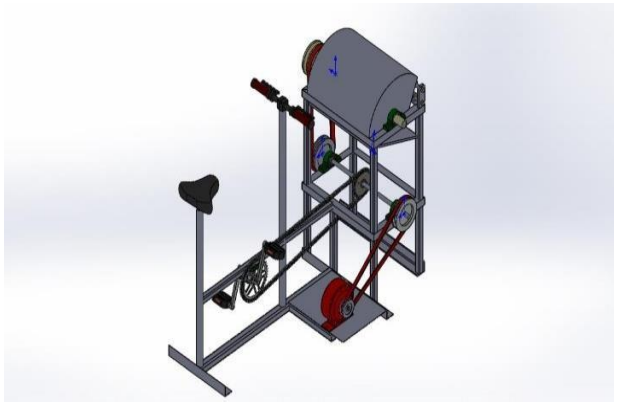

Figure 15. Latest Tool Design Concept

3.6 Morphology Chart

Next, create a Morphology Chart as seen in table 1. , The following list or in other words called a summary of the systematic deformation analysis to find out how this natural plant fiber extractor will then be made

Table 1. Morphology Chart Extractor Tool

No	Components	Items	Alternatives		
1	Drive Motor	Type	Motor DC	Gasoline Motor	Motor Series Wound
2	Transmission	Type	Belt & Pulley	Chain & Sprocket	
		Type	Belt & Pulley	Chain & Sprocket	
3	Wheel	Type	Trolley Wheels	Reguler Wheels	Flower Rubber Wheels
		Shape	Circle	Elipse	Square
		Load	Soft Duty	Medium Duty	Hard Duty
		Size	3 Inch	4 Inch	5 Inch
4	Water Drain Slide	Material	Steel	Iron Plate	Zinc
		Type	Base Iron	Flower Iron	Bordes
		Shape	Rectangle	Circle	Elipse
		Thickness	5 mm	10 mm	15 mm
5	Drum Blade Cap	Material	Steel	Iron Plate	Zinc
		Shape	Rectangle	Circle	Elipse

3.7 Objective Tree

The Objective Tree in this tool is used to trace from the beginning of the concept so that finally the reason for choosing materials/specifications in the development of the tool that has been packaged can be seen

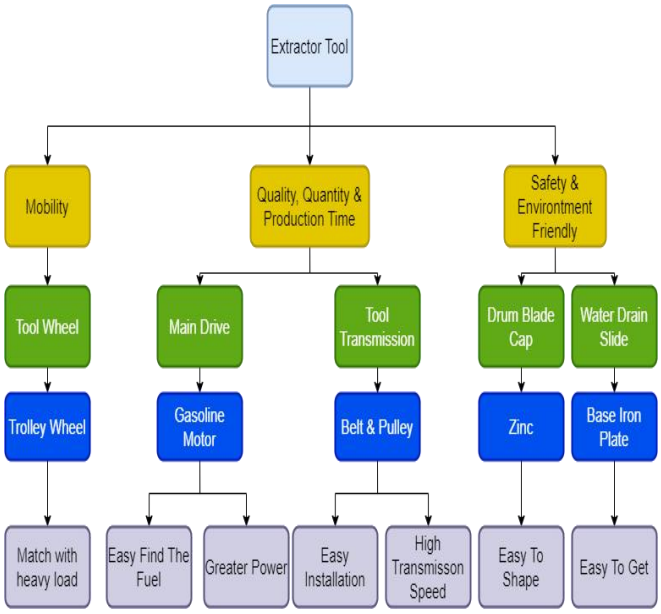

Figure 16. Objective Tree Extractor Tool

3.8 Weighting the Impact of Tool Development

Furthermore, the weighting value on the impact of tool development is determined as follows in table 2.

Table 2. Weighting Figures for the Impact of Tool Development

Percentage of Impact of Plant Fiber Extractor Development				
No	**Function Name and Development Item**	**Manual Mode (%)**	**DC Motor Mode (%)**	**Gasoline Motor Mode (%)**
1	Tool Mobility	0	0	100
2	Fiber Quality	70	50	85
3	Fiber quantity	50	70	85
4	Production Time	60	50	85
5	Safety and Environmentally Friendly	0	0	100

And if it is created, the graph will look like in figure 17. It can be seen in the graph that the significant impact caused during the development of the tool will occur on the mobility of the tool because wheels are added and also in terms of safety because a drum blade cap is added where the drum blade cap is very crucial because when the fiber extraction process gets a very high rotation than the main drive of the gasoline motor which is then passed to the transmission

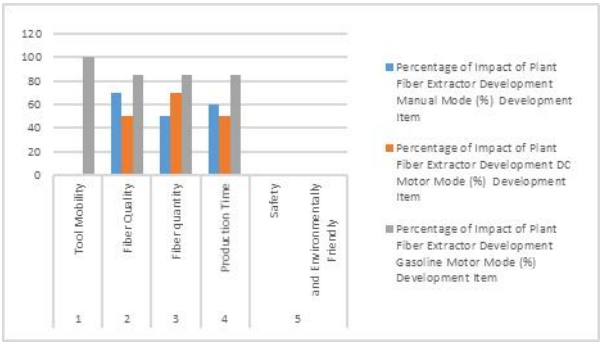

Figure 17. Tool Development Impact Percentage Chart

4. CONCLUSION

Some of the problems that occur in natural plant fiber extractors can be minimized with new additions that are very useful for this tool so that it has an impact on the problems of previous tools that can be minimized. The following conclusions can be drawn from the design concept of the development of this extractor tool aims to improve problems in the previous tool before modification is made.

In the design concept that has been made, solutions are obtained and the selection of parts and specifications of the tool to be used with the considerations and reasons that have been written in the objective tree.

In the end, from the design concept that has been made, it can be passed on to the next stage of the process in the development of this natural plant fiber extractor.

5. ACKNOWLEDGMENT

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