Development of 2 In 1 Back Support Tool Using the Quality Function Deployment Method

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Abstract

Back Support 2 in 1 product design is done to help relieve back pain and also improve one's posture. One of the diseases of the back that can occur is LBP (Low Back Pain). Lumbar back support is often used in low back pain pain and is also a common intervention effort in the industry to prevent back injuries. This product is equipped with an innovative TENS (Transcutaneous Electrical Nerve Stimulation) tool. TENS therapy has been shown to reduce various types of pain within 15-30 minutes. TENS is able to activate nerves of large and small diameter which will send various sensory information to the central nerve. The purpose of this research is as a method used in making 2

in 1 Back Support products that have good quality and have functions that can meet the expectations and needs of consumers or product users. The method used in obtaining data to design a 2 in 1 Back Support is the Nigel Cross method. The results of this study indicate that the technique is easy to work with. Where all the technical boundaries are important and detail for the product

Keywords
Back Support 2 in 1, NigelCross, TENS, Low Back Pain.

1. Introduction
Product design is the value contained in a product and is in the form of a distinctive and attractive product appearance and becomes a differentiator from competing products(Albert 2020) . In designing Back Support 2 in 1 products equipped with innovative TENS (Trancutaneous Electrical Nerve Stimulation) tools. TENS therapy is proven to reduce various types of pain within 15-30 minutes. TENS can activate large and small diameter nerves that will send various sensory information to the nerve center (Bayu 2015). Product design is a translation of industrial design. Some experts translate industrial design with product design. Product design is the key to the success of a product through the market as a basic bargaining marketing, designing a product means reading a market, market willingness, market ability, market mindset and many other aspects that will then be translated and applied in the design of a product.

QFD is a method that develops relationships between companies or institutions and consumers. Through QFD, every decision is made to meet the needs desired by customers. This approach uses a kind of matrix diagram to show data and information (Rosnani 2017). Quality Function Deployment (QFD) is a way to improve the quality of goods or services by understanding the technical requirements for producing a good or service to determine the specifications of consumer needs. QFD is defined as a structured process or mechanism for determining customer needs and meeting those needs, where each functional area and organizational level can understand. QFD is used to improve understanding of customers and to develop products, services and processes in a more customer-oriented way.

1.1 Objectives
The purpose of this research is as a method carried out in making Back Support 2 in 1 products that have good quality and have functions that can meet the expectations and needs of product users.

2. Literature Review
Product development produces products in accordance with what humans need is what the design process wants to achieve. One way is to design with an orientation towards customer wants and needs. The desires of each human being are made in product design through computer development and technical analysis, which can be processed in an organized manner, determining the time to consume it, and including marketing it (Ginting 2012).

Since ancient times, humans have been designing things. One of the most basic characteristics of humans is that they make various tools to suit their needs. As these needs change, people reflect on existing products and make improvements so that new types of products are formed. Thus, the desire to design objects is inherent in human life, and designing is not something that people always think requires a certain ability. In traditional societies, designing was not separated from making, meaning that there was no drawing or modeling prior to making. For example, a potter would make a pot by working directly and without first sketching or drawing the pot (Ginting 2010).

QFD is a way to improve the quality of goods or services by understanding the needs of consumers and then linking them with technical requirements to produce a good or service at every stage of making the goods or services produced. Quality function deployment is a planning tool used to help businesses focus on the needs of their customers when developing design and manufacturing specifications (Ginting 2021).

The steps of QFD using the House of Quality matrix are as follows:
- Identify consumer desires into product attributes
- Determine the relative importance of the attributes
- Evaluate the attributes of competing products
- Create a matrix of resistance between product attributes and characteristics

- Identify relationships between technical characteristics and product attributes
- Identify relevant interactions among technical characteristics
- Determine the target picture to be achieved for technical characteristics

3. Methods

The research method used in obtaining data to design Back Support 2 In 1 is the Nigel Cross method. Where there are 7 steps in the process, namely:

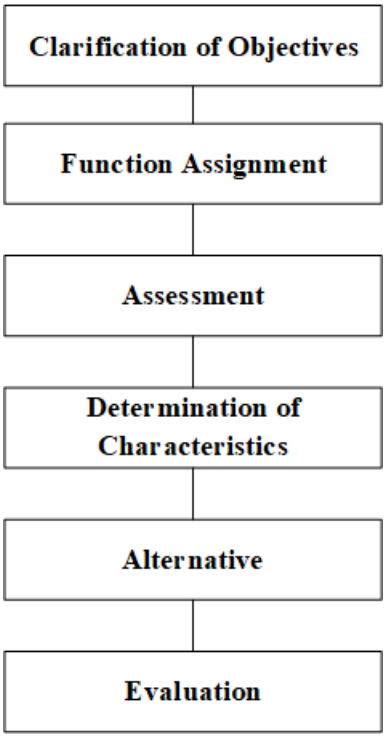


Figure 1. Research Method

3.1 Clarification of Objectives

Clarification of objectives is done to determine the purpose of the design. The method used is Objectives Trees. With this method, we will be able to identify the objectives and sub-objectives of designing a product and the relationship between the two in the form of a diagram that shows a hierarchical relationship between objectives and sub-objectives. The branching of the goal tree is a relationship that shows the way to achieve a particular goal. The steps taken in the goal clarification stage are as follows:

- List the design objectives.
- Arrange the list in order of objectives from higher-level to lower-level.
- Draw a goal tree diagram, to show the hierarchical relationships .

3.2. Function Assignment

This step aims to establish the necessary functions and limitations of the product design system. The functional analysis procedure is as follows:

- Organize the overall system function in the form of input/output transformation.
- Categorize sub-functions.
- Drawing a block diagram.
- Drawing system restrictions.
- Finding the appropriate components to produce sub-functions and the interaction between them.

3.3. Assessment

After determining the function, a requirement is determined to make the correct design specification. The implementation steps are as follows.

- Compile the overall system function in the form of input and output.
- Categorize the parts of the function.
- Draw a block diagram.
- Describing system constraints.

3.4. Determination of Characteristics

QFD is a way to be able to improve the quality of goods and services by understanding consumer needs and then linking them with technical determinations to produce a good or service at every stage of making goods and services produced. QFD (Quality Function Deployment) is a planning tool needed to help businesses focus on the needs of customers when compiling design and fabrication specifications.

3.5. Alternative

Alternative generation is a design process that serves to generate alternatives or solutions contained in design problems. The method used is to create a morphological chart which is a list of systematic shape change analysis to find out how the shape of a product is made.

3.6. Evaluation

Alternative evaluation is a process of determining the best solution or alternative from a collection of other alternatives, so that a good design is obtained and can fulfill consumer desires. The steps in making an alternative evaluation are to list the design objectives, compile a list of objectives and sub-objectives, create a relative weight on each objective, create parameters or implementation and calculate and compare the relative value of each design alternative.

4. Results and Discussion

4.1. Clarification of Objectives

Goal clarification is carried out to determine the purpose of product design. The method used is the goal tree, and the list of product design objectives for the Back Support 2 in 1 tool is black in color, made of cotton, weighs 500 g, the size of the waist circumference and height of the product is 75-85 cm, 160-175 cm, has a shoulder and waist model, is elastic, has the function of relieving pain and improving posture.

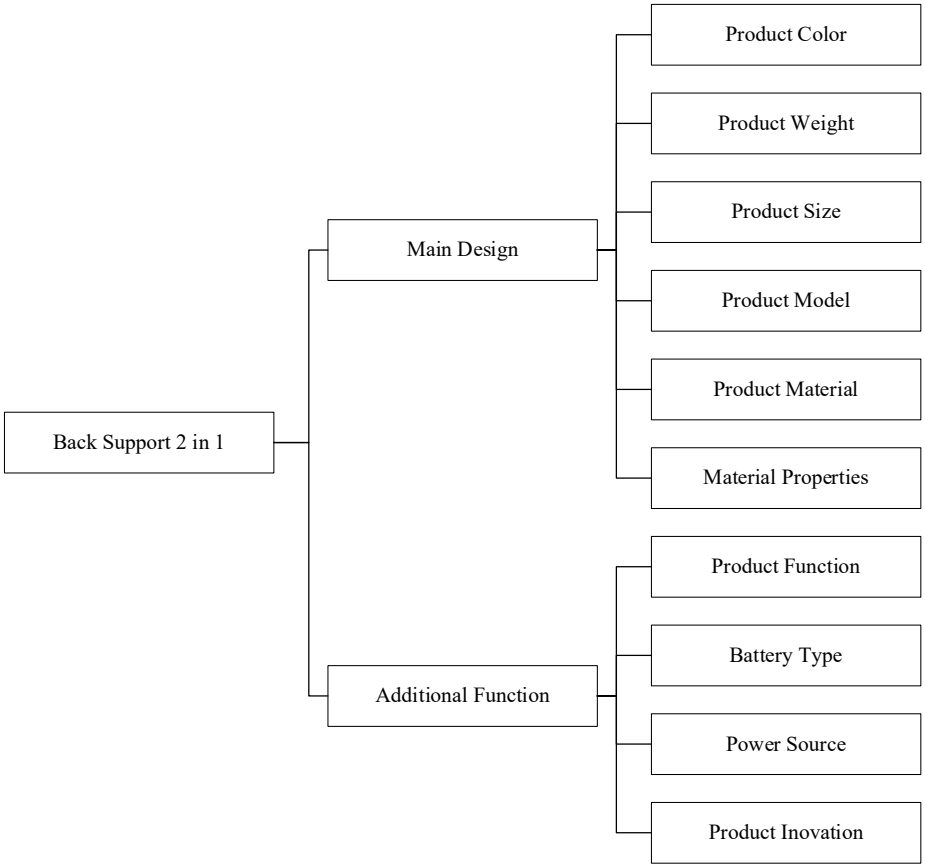


Figure 2. *Objectives Tree*

4.2. Function Assignment

The determination of these functions aims to determine the functions that occur in a design.

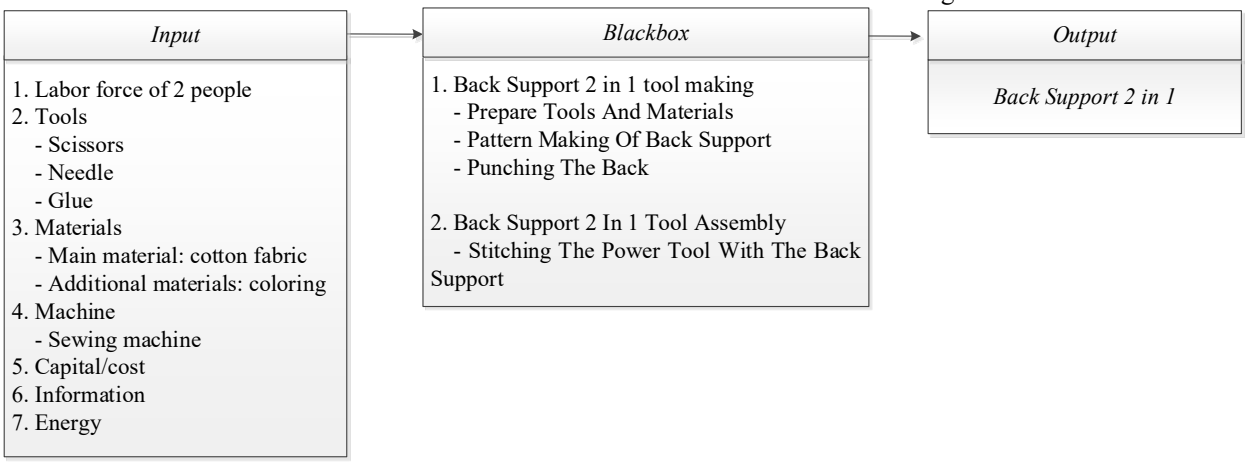
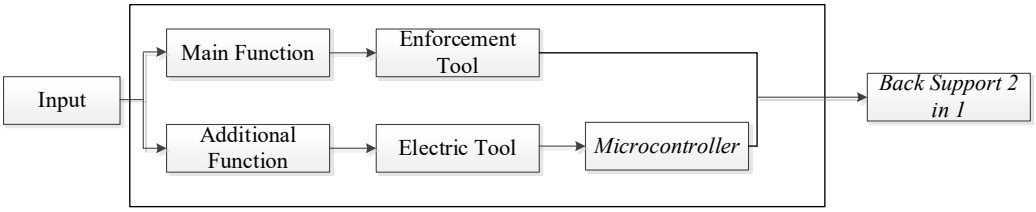


Figure 3. *Black Box*

The following is the interaction of the sub-functions of the 2 in 1 back support design

Figure 4. Interaction Sub-Sub Function



The following is the limiting system for the 2 in 1 back support design

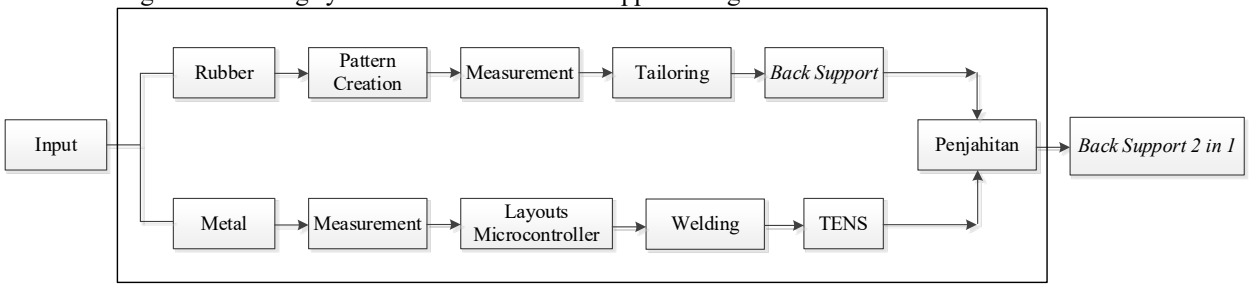


Figure 5. Limiting System

4.3. Determination of Demand

The steps in determining needs include making different levels of generality from the design solutions that can be applied, such as the product alternative is Back Support 2 in 1, and the product type is designed to be multifunctional, made of comfortable and quality materials and ergonomic, which has the characteristics of a black product, made of cotton fabric, weighs 500 g, has a waist circumference and height of 75-85cm, 160-175cm, has a shoulder and waist model and is elastic.

4.4. Characteristic Determination

The steps for determining characteristics with the QFD method for the design of Back Support 2 in 1 are identifying product attribute data. Then determine the relative importance of the product (Table 1).

Table 1. Tingkat Kepentingan Produk

No.	Attribute			Interest Level
	Primer	Sekunder	Tersier	
1	Desain Utama	Color	Black	4
		Weight	500 g	4
		Size	75-85 cm, 160-175 cm	4
		Model	Hips and Shoulder	3
		Material	Cotton	4
		Material's Characteristics	Elastic	4
2	Fungsi Tambahan	Function	Relieving Pain and Correcting body Posture	3
		Type of Battery	A2	4
		Energy Source	Electric	4
		Innovation	TENS	4

4.5. Alternative Generation

At this stage, several design solutions are applied as alternative choices of the Back Support 2 in 1 product and the solution search area will be expanded using morphological charts (Table 2).

Table 2. Morphological Chart

Function	How To Reach The Function		
	1	2	3
Color	Black	Red	Yellow
Weight	300 g	500 g	600 g
Size	70-80, 150-160	75-85, 160-175	50-60, 145-155
Model	Hips	Shoulder	Hips and Shoulder
Material	Cotton	Elastic	Rubber
Material's Characteristics	Stiff	Elastic	Hard
Function	Relieve Pain	Correcting body posture	Relieving Pain and Correcting body Posture
Type of Battery	A1	A2	Baterai jam
Energy Source	Electric	Manual	Solar System
Innovation	TENS	Buckle	Heater

4.6. Alternative Evaluation

From the alternatives sought in the previous step, the AHP questionnaire will be weighted and the performance parameters of each attribute will be determined from the AHP questionnaire. After obtaining the importance value of the alternative weights of each attribute for each alternative, the value of each alternative and alternative 3 is obtained which is the closest value to the value of group 1 shown on this Gantt chart..

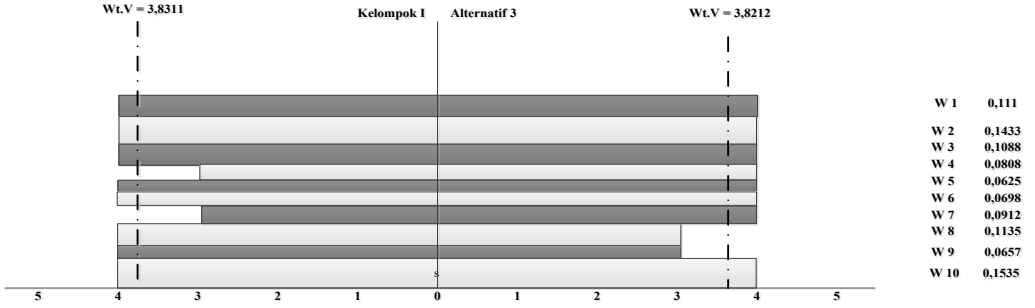


Figure 6. *Gantt Chart*

From the calculation of the area of the gap between group I and alternative 3, it can be concluded that the area of the gap in group I (0.4289) is smaller than the area of the gap in alternative 3 (1.3236) so that the selected product is the product of group I. From the gantt chart it can be seen that the greatest weight is found in W10, which is the additional function of product innovation. While the smallest weight is W5, namely product material design.

6. Conclusion

Based on the results of the discussion above, several conclusions can be drawn in the manufacture of Back Support 2 in 1 products have inputs in the form of a workforce of 2 people, have scissors, needles and glue equipment, have the main material of cotton cloth and dye, in the black box prepared tools and materials and made back support patterns and hollowed out the back, then sew the electrical devices or TENS with Back Support. Back Support has a main function and additional functions, the main function is in the form of an enforcement tool, while the additional function is in the form of electrical therapy. On the needsetter, the 2 in 1 back support is made of comfortable and quality materials and ergonomics, which has the characteristics of a black product, made of cotton cloth, weighs 500 g, has a waist circumference size and height of 75-85 cm, 160-175 cm, has a shoulder and waist model and is elastic. And on the gantt chart the selected product is group I product or Back Support 2 in 1. And it can be seen that the greatest weight is on W10, which is the additional function of product innovation. While the smallest weight is W5, which is the product material design.

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