Product Design of Massage Cap by Using Nigel Cross Approach

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Abstract. The Massage Cap is a device to massage the acupuncture points on the user's head. This Massage Cap has the additional function of the eye patch as an additional. In the process of making the Massage Cap product using the Nigel Cross approach where the brainstorming technique is first used to determine the characteristics of the product to be made, then draw conclusions from the brainstorming that has been collected. Then the sampling technique is done by distributing open and closed questionnaires to determine the type of product. After the open and closed questionnaires are finished distributing, then a market survey is conducted using a sampling technique, as well as determining the validity and reliability of the main product and the competitors'. The problem steps to the sub problems are determined in order to classify the objectives that will be made in the design of massage caps. Sub problem steps to sub solutions are carried out to determine the Product Quality Function Deployment (QFD). The sub-solution step to the solution is determined to generate and evaluate alternatives by the sum of the paired matrix between attributes.

1. Introduction

Product Design, or commonly referred to as product design, is a set of product development that is a process in the work of marketing and business vision, which includes improving product vision or objectives into technical specifications, new development concepts, and the embodiment of new product engineering.

Design is the application of technical and scientific principles to regulate the components of a device that must be adjusted and realized to achieve certain results [1]. The product development process certainly starts from the manufacturer's understanding of consumers' perceptions and expectations of the product itself. Customer satisfaction assessment methods are used to assess consumer desires for existing products. The concept of customer satisfaction according to Parasuraman et al is used to measure the level of consumer satisfaction in the SERVQUAL method [2]. If the product must be made with special specifications desired by the customer, then here the product design will be very dependent or must be prepared by the customer himself, this can be found in the case of a job order [3]. The attributes of a product are basically very closely related to customer satisfaction, where the higher the customer assessment of a product attribute, the higher the customer satisfaction is felt. A development product can be said to be successful if it gets a positive response from consumers followed by the desire and actions to buy the product.

The purpose of this research is to design a massage cap product using the Nigel Cross approach.
2. **Background**

The hat is a type of head covering. The use of the hat is intended for several reasons. Generally used as a clothing accessory and as a protection from the sun. In some ceremonial and religious ceremony, the wearing of a hat can become mandatory. In the military world a hat can indicate the level and rank of an army. Brainstorming is usually a group activity that generates a large number of ideas. A group of people will not only complement each other in a broad experience, but also ensure the exchange of ideas and complementarity. In such a case, one's ideas will help stimulate other people's ideas and eventually become a real flow of ideas [4]. Brainstorming is a creative method for product design by spontaneously generating as many creative ideas as possible. For effective use Brainstorming is used in groups as a technique to increase creativity and generate a wide variety of ideas. Brainstorming can help a group of people (consisting of 7-8 people) to generate new ideas inspired by ideas that have been obtained previously [5].

3. **Methodology**

3.1. **Nigel Cross Approach Method**

Product design according to Cross is divided into seven steps which each have their own methods, namely:

- **Clarifying Object.** The first important step in designing is trying to clarify the design goals. In fact, it is very helpful in the results at each step until the results are as expected. The end of clarifying this goal is a set of object design goals that must be made even though the goals made may change in the next design process. The goal tree method provides the form and explanation of the purpose statement. This method shows the goals and objectives to be achieved with various considerations.

- **Defining Function.** From the objective tree method, it can be seen that the intent of the problem is that there are many levels of difference that are both general and detailed. Obviously, the level of each problem gives a very important meaning to or by the designer. The next step is to assign functions. The aim is to establish the necessary functions and the limits of the new product design system. In this step the functional analysis method is used with the black box model. Functional analysis methods offer such as considering the essential functions of tools, results or products or systems that are designed to be satisfactory, no matter what physical components they are supposed to use. The level of problem was decided by establishing boundaries in the laying sector of interrelated functions.

- **Setting Requirement.** After the function is determined, the next step is to arrange the requirements. This third step aims to create accurate manufacturing specifications that are necessary for the design / design. The method used in this step is the Performance Specification Model.

- **Determining Characteristic.** Next is the step called determining the characteristics, which aims to determine what targets will be achieved by the technical characteristics of a product so that it can satisfy the needs of consumers.

- **Generating Alternatives.** The purpose of this step is to produce alternative design solutions. The method used is the Morphological Chart method. This method encourages designers to identify or look for new combinations of elements. The purpose of this method is to broaden the search for possible new solutions.

- **Evaluating Alternatives.** The alternatives that have been produced will then be evaluated to choose which one is the best. In this step, the Weighted Objective method is used which aims to compare the assistive values of each proposal based on the possibility of different objective weights.

- **Improving Details.** Much of the design work in practice is not associated with the creation of radical new design concepts, but making modifications to realize the design of a product. This
modification seeks to develop a product, improve its appearance, reduce weight, reduce costs, and enhance its appeal. All forms of modification can usually be divided into two types, namely modifications aimed at increasing the value of the product for buyers and reducing costs for producers.[6]

3.2. Sampling Method
Sampling (sampling) is a systematic method for selecting subjects to be studied. [7]. The sampling method used in this study is Nonprobability sampling, i.e. simple random sampling. Simple random sampling technique is one of the simple and commonly used sampling techniques. The selection of prospective respondents is based on random numbers until a number of prospective respondents are selected according to the sample obtained [8].

3.3. Questionnaire Method
The questionnaire is a research or survey instrument consisting of a series of written questions and is distributed to respondents accordingly, which aims to get responses from selected groups of people through personal interviews or by post in the form of a list of questions [9]. The questionnaire used in this study was an open questionnaire, a closed questionnaire, and the AHP questionnaire. Open questionnaire, is a question sheet that has been analyzed qualitatively that will produce suggestions given by the respondents so that it can be used in product planning to be developed, while a closed questionnaire in the form of a questionnaire validation of respondents and responses analyzed quantitatively [10].

Analytical Hierarchy Process (AHP) is a decision support model developed by Thomas L. Saaty. This decision support model will describe a complex multi-factor or multi-criteria problem into a hierarchical level, according to Saaty the hierarchy can be interpreted as a picture of a complex problem in a stratified structure where the first level is the goal, followed by the level of factors, criteria, sub criteria, and so on down to the last level of alternatives [11]. AHP is a structured method for solving problems that involves decision variables or attributes, some of which are qualitative and cannot be measured directly. AHP has an axiomatic basis [12]

3.4. Quality Function Deployment (QFD) Method
QFD is defined as a structured process or mechanism to determine customer needs and describe them into relevant technical needs. QFD uses a HoQ-shaped matrix that is used to provide a description of consumer desires and the technical ability of the company to design and produce goods and services according to customer desires [13]. QFD is a product development tool that can be used to improve product quality. QFD aims to fulfill consumer desires by creating and implementing consumer-oriented designs [14]. Quality Function Deployment is a technique utilizing to guarantee the quality in each creating items stages, beginning by the plan quality itself [15]. The QFD approach may likewise be extremely useful for scholastics intending to approve recuperation viability in the administration business [16].

This study aims to show the usefulness of the Massage Cap. Massage Cap works to massage two acupuncture points on the head. The research data were obtained from the distribution of open questionnaires, closed questionnaires and market surveys conducted in order to find the information needed related to the design of the Massage Hats product design. Then QFD is used to determine the characteristics of the product to be made. QFD is a structured methodology used in the process of product planning and development to determine the specifications of the needs and desires of consumers, and systematically evaluate the capabilities of a product or service in meeting the needs and desires of consumers. Then in order to find solutions to each problem that arises from the manufacture of the product, steps are determined to generate alternatives, evaluate, and improve details. From all of these steps, it can be determined the characteristics of making products at the appropriate cost.

4. Result and Discussion
The results of this study are the design of massage cap products using the Nigel Cross approach.
4.1. Classification of Purpose, Function, and Determination of Needs.

To find solutions to the problems above, there are 3 steps needed so that the problem will be divided into sub-problems, namely the classification of goals & functions, and determination of needs. The conclusion of the 3 steps in designing a Massage Cap product is:

The list of Objectives for the Massage Cap design is:

- Model of the cap is beanie model.
- The color of the cap is navy blue.
- Cap’s decoration is colored strap.
- The cap is striped and Has a plain pattern.
- Battery used is lithium battery.
- Additional function’s color is black.
- The cap is made by wool.
- Machine’s coating material is thin foam.
- Additional functions are made of wool.
- The additional functions is sleeping eyepatch.

The Purpose Tree diagram can be seen in Figure 1. below.

![Figure 1. Destination tree diagram](image)

The division of functions into essential sub-functions.

- The sub-function of the Massage Cap design.
- Design the Eye Patch Feature design.

Determine the level of generality to operate.

- The product has a fashionable, comfortable and ergonomic design.
- The product can provide a relaxing massage.
- The product has the added function of a sleeping eyepatch.
4.2. Determining Characteristic.
In this section, the sub problem of the massage cap specifications will be found a sub solution with the steps of the Nigel Cross design, to determine the product characteristics. The result of quality function deployment of massage cap can be seen on figure 2.

![Quality function diagram of massage cap](image)

**Figure 2.** Quality function diagram of massage cap

Result of Quality Function Deployment are as follows:

Attributes of Massage Caps based on the results of the questionnaire in accordance with consumer desires are as follows:

- Cap’s Model : Beanie
- Cap’s Color : Navy Blue
- Cap’s Decoration : Colored Strap
- Cap’s Pattern : Stripe
- Battery Type : Lithium
- Additional Function’s Color : Black
- Cap’s Material : Wool
- Machine’s Coating : Thin Foam
- Additional Function’s Material : Wool
- Additional Function : Sleeping Eyepatch

| Attributes               | Value          |
|--------------------------|----------------|
| Cap’s Model              | Beanie         |
| Cap’s Color              | Navy Blue      |
| Cap’s Decoration         | Colored Strap  |
| Cap’s Patterns           | Stripe         |
| Battery Type             | Lithium Battery|
| Additional Function’s Color | Black         |
| Cap’s Material           | Wool           |
| Machine’s Coating        | Thin Foam      |
| Additional Function’s Material | Wool         |
| Additional Function      | Sleeping Eyepatch |

| Difficulties | 1 = Easy | 2 = Normal | 3 = Hard | 4 = Very Hard | 5 = Impossible |
|--------------|---------|------------|---------|---------------|---------------|
| Degree of Importance (%) | 14 | 25 | 21 | 22 | 17 |
| Cost Estimation (%) | 25 | 25 | 17 | 17 | 27 |

| Difficulties | 1 = Easy | 2 = Normal | 3 = Hard | 4 = Very Hard | 5 = Impossible |
|--------------|---------|------------|---------|---------------|---------------|
| Degree of Importance | 1-10 = Not Importance | 11-20 = Importance | 21-30 = Very Importance |
| Cost Estimation | 0-10 = Cheap | 10-20 = Average | 20-30 = Expensive |

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The comparison of Massage Cap with competitors for the same attributes based on customer perception is as follows:

- For cap models: Group IV products, competitors 2, and competitors 3 are in the same position superior to competitor 1’s products.
- For cap colors: Group IV products, Competitors 1, and competitors 2 are in the same position superior to competitor products 3. For hat decoration: Group IV products are superior to competitors 1 products, competitors 2 and competitors 3 who are in the same position.
- For cap patterns: Group IV and competitors 3 products are in the same position and are superior to competitors 1 and competitors 2 products in the same position.
- For battery types: Group IV products, competitors 1 and competitors 2 are in the same position and are superior to competitor 3’s products.
- For additional function colors: Group IV products, competitors 1 and competitors 2 are in the same position and are superior to competitors 3’s products.
- For cap material: group IV and competitor 1 products are in the same position and are superior to competitors 2 and competitor 3 products that are in the same position.
- For machine coatings: group IV products are superior to competitors 1, 2, and 3 competitors who are in the same position.
- For additional functional materials: Group IV and competitors 1 products are in the same position and are superior to competitors 2 and competitors 3 products that are in the same position.
- For additional functions: Group IV and competitors 3 products are in the same position and are superior to competitors 1 and competitors 2 products in the same position.

Product’s Specification of Massage Cap are as Follows:

- Model of the cap is beanie model.
- The color of the cap is blue.
- Cap’s decoration is colored strap.
- The cap is striped and Has a plain pattern.
- Battery used is lithium battery.
- Additional function’s color is black.
- The cap is made by wool.
- Machine’s coating material is thin foam.
- Additional functions are made of wool.
- The additional function is sleeping eyepatch.

Difficulty: machine quality characteristics have a difficult level, the characteristics of the old assembly technique, foam thickness, material strength, and circuit strength are quite easy. Degree of Interest: assembly time, material strength, foam thickness and circuit strength are important, while the quality of the machine is quite important. Estimated Cost: all technical characteristics are expensive.

4.3. Sub Result
The sub-solution is the resolution of each problem that occurs, including among others the selection of attributes for the Massage Cap using the Nigel Cross steps, while maintaining the superiority that is already owned and improving the quality of the product.

In this section, there are 3 steps that are taken so that the sub-solution becomes a solution, namely generation of alternatives (Generating Alternatives), evaluation of alternatives (Evaluating Alternatives), and improving details (improving details). The following conclusions from the three steps in the process of designing the Massage Cap.
4.3.1 Generating Alternatives. The alternative generation stage aims to collect as many alternatives as possible that can be used to solve problems in the design of the Massage Cap product, to then find the best solution or alternative. This is done using the morphological map method (Morphological Charts) with the steps, which are:

- Make a list of functions or goals that are important to the product.
- Make ways to achieve essential functions.
- Identify a combination of design solutions that can be applied.
- Identify the feasibility of a combination of sub-solutions.

Morphological Chart shows all possible solutions or alternative relationships that can be used in the design of Massage Caps as in Table 2. Morphological Chart Massage Products are displayed in the form of a matrix of 10 x 3, where there are 10 functions that must be achieved and there are 3 alternatives that may be applied. So the total possible combinations to reach the alternative are 120 ways.

| No. | Characteristics                  | How to Achieve Function |
|-----|----------------------------------|-------------------------|
| 1   | Massage cap’s model             | Beanie                  |
| 2   | Massage cap’s color             | Baseball                |
| 3   | Massage cap’s decoration        | Colored Strap           |
| 4   | Massage cap’s pattern           | Plain                   |
| 5   | Massage cap additional function’s Color | Striped              |
| 6   |Massage cap’s Material           | Black                   |
| 7   | Massage cap Machine’s Coating   | Wool                    |
| 8   | Additional Function’s Material  | Foam                    |
| 9   | Battery Type                    | Lithium                 |
| 10  | Additional function             | Eye patch               |

4.3.2 Evaluating Alternatives. Alternative evaluation aims to compare the utility values of alternative product designs made or made on the basis of performance on the basis of weighting objectives, where the results of the alternative generation step will be evaluated by re-examining the alternative to be selected so that the best alternative is produced. The method used is the Weighted Objectives method with AHP scale. Rating ratings are performed using Pair Wise Comparison and AHP scale, with data obtained from the importance value for each attribute in QFD. Level I is a Paired Comparative Matrix between Primary Attributes, Level II is a Paired Comparative Matrix between Secondary Design Attributes, and Level III is a Paired Comparative Matrix between Secondary Attributes of Material and Additional Functions. After pairing the comparison matrix with the AHP scale then weighting is performed for each level. Weighting for each attribute is needed to know how the influence of these attributes in product design. Weighting is done by dividing the ranking value of each attribute to the total rating value itself. The results of the weighting of each comparison matrix can be seen in the table below.

| Element         | Main Design | Material | Multifunction |
|-----------------|-------------|----------|---------------|
| Main Design     | 1.0000      | 0.7649   | 2.3753        |
| Material        | 1.3073      | 1.0000   | 1.5219        |
| Multifunction   | 0.4210      | 0.6571   | 1.0000        |
| Total           | 2.7283      | 2.4220   | 4.8972        |

Table 2. Weighting of pairwise comparative matrices between level II primary attributes

| Element               | Model   | Main Color | Decoration | Pattern | Additional Function’s Color | Weight |
|-----------------------|---------|------------|------------|---------|-----------------------------|--------|
| Model                 | 0.2032  | 0.2687     | 0.1668     | 0.2060  | 0.1750                      | 0.2039 |
| Main Color            | 0.1531  | 0.2027     | 0.3542     | 0.2040  | 0.1412                      | 0.2111 |
| Hiasan                | 0.3270  | 0.1536     | 0.2684     | 0.3902  | 0.3526                      | 0.2984 |
| Pattern               | 0.0714  | 0.0719     | 0.0498     | 0.0724  | 0.1200                      | 0.0771 |
| Additional Function’s Color | 0.2452 | 0.3031     | 0.1608     | 0.1274  | 0.2112                      | 0.2096 |
| Total                 | 1.0000  | 1.0000     | 1.0000     | 1.0000  | 1.0000                      | 1.0000 |
After that, the performance parameters of each attribute are determined. Performance parameters can be seen in Table 4. below.

| Characteristics          | Parameters | Value 5 | Value 4 | Value 3 | Value 2 | Value 1 |
|--------------------------|------------|---------|---------|---------|---------|---------|
| Model                    | Quality    | Very Good | Good    | Quite Good | Deficient | Not Good |
| Main Color               | Contrast   | Very Contrast | Contrast | Quite Contrast | Not enough | Not Contrast |
| Decoration               | Quality    | Very Good | Good    | Quite Good | Deficient | Not Good |
| Pattern                  | Quality    | Very Good | Good    | Quite Good | Deficient | Not Good |
| Additional Function’s Color | Contrast | Very Contrast | Contrast | Quite Contrast | Not enough | Not Contrast |
| Main Material            | Quality    | Very Good | Good    | Quite Good | Deficient | Not Good |
| Machine’s Coating        | Quality    | Very Good | Good    | Quite Good | Deficient | Not Good |
| Additional Function’s Material | Quality       | Very Good | Good    | Quite Good | Deficient | Not Good |
| Additional Function       | Quality    | Very Good | Good    | Quite Good | Deficient | Not Good |

4.4. Result and Solution

The final stage of the design process aims to increase the value of the product for consumers and reduce costs that must be incurred by producers. The solution that has been obtained from the alternatives that are then communicated to consumers through products with all the advantages of its attributes compared to competitors' similar products, this can be done by using the Value Engineering method. The steps in improving details are as follows:

- Make a list of product components and identify the functions of each component as in Table 5. below.

| Component          | Function                                                                 |
|--------------------|---------------------------------------------------------------------------|
| Beanie Cap Model   | Used as main material in the massage cap production                      |
| Lithium Battery    | Used as energy source for massage cap                                      |
| Switch             | Used as opener and Closer for Electric Current in the machine Frame       |
| Cable              | Used to flow electric current to the machine’s components                  |
| Vibrator           | Used as vibrating source at massager machine                               |
| Plastic            | Used as main material for massager machine’s case                          |
| Buckle strap       | Used as machine’s base at the user’s head                                 |

- Determine the value of the function identified. Based on the functions that have been identified, the values are determined based on consumer perception. The values of each function are assessed based on the suitability of the design to the consumer's desire for is as shown in Table 6.

| Fungsi          | Value | Information                                                                 |
|-----------------|-------|-----------------------------------------------------------------------------|
| Design          | Good  | The massage cap has a good design because it can adjust to the wearer's head shape without feeling uncomfortable, this hat design makes the wearer more confident and is not disturbed in carrying out daily activities. |
| Material        | Good  | This massage cap is made of wool, which is very soft so that it can be comfortably used on your head, this material is also not hot when used and can absorb sweat |
| Additional Function | Good   | This massage cap has an additional function, namely as an eye patch that can be used for sleeping |

- Calculate the cost of each component. The price of the main raw material, supplementary material, and supporting material for the manufacture of the product has been estimated in advance to determine the selling price of the product produced. Component prices are assumed as shown in Table 7.

- Look for ways to reduce costs without reducing value. From the results of the evaluation conducted, value engineering can only be done by finding replacement components whose prices are relatively cheaper than before. After the survey, a replacement component with a price is obtained as shown in Table 8.
The product can be divided into several sections. The primary function of the cap is striped and has a plain pattern. Battery color, cap material, engine coating material, additional function materials, and additional functions of the Massage Cap product are model, color, decoration, motif, type of battery, additional functions, and additional function material, and additional functions. Secondary attributes of Massage Caps products are design, materials and additional functions. The attributes advantages compared to the competitors are as follows: For cap models: Group IV products, competitors 2, and competitors 3 are in the same position superior to competitor 1’s products. For cap colors: Group IV products, Competitors 1, and competitors 2 are in the same position superior to competitor products 3. For hat decoration: Group IV products are superior to competitors 1 products, competitors 2 and competitors 3 who are in the same position. For cap patterns: Group IV and competitors 3 products are in the same position and are superior to competitors 1 and competitors 2 products in the same position. For battery types: Group IV products, competitors 1 and competitors 2 are in the same position and are superior to competitor 3’s products. For additional function colors: Group IV products, competitors 1 and competitors 2 are in the same position and are superior to competitors 3’s products. For cap material: group IV and competitor 1 products are in the same position and are superior to competitor products 3. For hat decoration: Group IV products are superior to competitors 1 products.

Additional funtion materials: Group IV and competitors 1 products are in the same position and are superior to competitor 3’s products. For cap colors: Group IV products, Competitors 1, and competitors 2 are in the same position and are superior to competitor 3’s products. For battery types: Group IV products, competitors 2 and competitors 3 are in the same position and are superior to competitor 3’s products. For additional function colors: Group IV products, competitors 1 and competitors 2 are in the same position and are superior to competitors 3’s products. For cap material: group IV and competitor 1 products are in the same position and are superior to competitor products 3. For hat decoration: Group IV products are superior to competitors 1 products.

Evaluate alternatives and select change. The way to reduce costs is through replacement of materials from the Vibrator to a larger vibrator that can be searched for at a lower price than the estimated price, so that the initial price is estimated at around IDR 224,000 to IDR 228,000.

5. Conclusion

Attributes of Massage Caps based on the results of the questionnaire in accordance with consumer desires are as follows: Cap’s Model is Beanie, Cap’s Color is Navy Blue, Cap’s Decoration is Colored Strap, Cap’s Patterns are Stripe, Battery Type used is Lithium Battery, Additional Function’s Color is Black, Cap’s Material is Wool, Machine’s Coating is using Thin Foam, Additional Function’s Material is Wool. Additional Function is Sleeping Eyepatch.

For the attributes of the Massage Cap product can be divided into several sections. The primary attributes of Massage Caps products are design, materials and additional functions. Secondary attributes of the Massage Cap product are model, color, decoration, motif, type of battery, additional function color, cap material, engine coating material, additional function material, and additional functions.

| Component      | Price (IDR) | Components Needed | Total Price (IDR) |
|----------------|-------------|-------------------|-------------------|
| Beanie Cap Model | 85.000/ Piece | 1 piece            | 85.000            |
| Lithium Battery  | 40.000 / piece | 1 piece            | 40.000            |
| Switch          | 8.000 / piece  | 1 piece            | 8.000             |
| Cable           | 4.000 / Meter  | 2 meters           | 8.000             |
| Vibrator        | 8.000 / piece  | 6 piece            | 48.000            |
| Plastic         | 2.500 / Meter  | 10 meters          | 25.000            |
| Buckle Strap    | 35.000 / 150 cm | 40 cm              | 35.000            |
| Total           |              |                   | 241.000           |

| Component      | Price (IDR) | Components Needed | Total Price (IDR) |
|----------------|-------------|-------------------|-------------------|
| Beanie Cap Model  | 90.000/ Piece | 1 piece           | 90.000            |
| Lithium Battery  | 40.000 / piece | 1 piece          | 40.000            |
| Switch          | 8.000 / piece  | 1 piece          | 8.000             |
| Cable           | 2.000 / Meter  | 2 meters         | 4.000             |
| Vibrator        | 5.000 / piece  | 6 piece          | 30.000            |
| Plastic         | 2.500 / Meter  | 10 meters        | 25.000            |
| Buckle Strap    | 31.000 / 150 cm | 40 cm         | 31.000            |
| Total           |              |                   | 228.000           |

Product’s Specification of Massage Cap are as follows: Model of the cap is beanie model. The color of the cap is blue. Cap’s decoration is colored strap. The cap is striped and has a plain pattern. Battery
used is lithium battery. Additional function’s color is black. The cap is made by wool. The machine’s coating material is thin foam. Additional functions are made of wool. The additional functions are sleeping eyepatch. Difficulty: machine quality characteristics have a difficult level, the characteristics of the old assembly technique, foam thickness, material strength, and circuit strength are quite easy. Based on the value engineering step through improving details, it is found that from the alternatives available there are the best alternatives with a total cost of IDR. 228,000.00.

References
[1] Ginting, Rosnani 2018 Perancangan dan Pengembangan Produk (Medan: USUPress)
[2] Hariastuti, N L P and Lukmandono 2016 Analisis Peracangan Deskripsi Produk Gadukan Guna Meningkatkan Daya Saing Industri Kecil Menengah Industrial Engineering Scientific Journal, 16 (1)
[3] Ginting, Rosnani 2007 Sistem Produksi (Yogyakarta: Graha Ilmu)
[4] Darniati and Sinambela, Yusnia 2018 Desain Kursi dengan Metode Brainstorming di Fakultas Teknik Universitas Quality Medan Juitech 2 (2)
[5] Roberta Z S and Rosliana 2020 Brainstorming Business Model Canvas pada Formulasi Strategi “Rabuk Diyang” Sebagai Produk Khas Kabupaten Indragiri Hilir Jurnal Selodan Mayang 5 (1)
[6] Gentha O D 2018 Perancangan Ulang Headset dan Penutup Mata Untuk Tidur Menggunakan Metode Nigel Cross, Jurnal OPSI, pp 65-77
[7] Nuridiani N 2014 Teknik Sampling Snowball dalam Penelitian, Jurnal ComTech, pp 1110-1118
[8] Arieska P K and N H 2018 Pemilihan Teknik Sampling Berdasarkan Perhitungan Efisiensi Relatif Jurnal Statistika, 166-171
[9] Wibawa G N 2019 Peningkatan Kompetensi Pendidik Melalui Evaluasi Pembelajaran Berbentuk Kuesioner Online Jurnal Pengabdian Masyarakat Ilmu Terapan, 181-186
[10] Hariadi D 2017 Pengembangan Modul Akuntansi Berbasis Kontekstual Sebagai Pendukung Implementasi Kurikulum 2013 Pada Materi Pengkodean Akun dan Pencatatan dan Pencatatan Transaksi Keluaran Jurnal Jurnal Pendidikan Akuntansi (JPAK) pp 1-6
[11] Arian F 2017 Sistem Penunjang Dalam Penentuan Prioritas Pemilihan Percetakan Media Promosi Menggunakan Metode AHP Jurnal Informatika, pp 214-221
[12] Haramaini, Tasliyah, Nasution, Khairudin and Sulaiman O K 2018 Penerapan Metode Analytical Hierarchy Process (AHP) dalam Menentukan Tingkat Kemacetan Lalulintas di Kecamatan Medan Kota, Jurnal Ilmiah, 12 (1) pp 8-19
[13] Aji E R, Yuliawati E 2016 Pengembangan Produk Lampu Meja Belajar Dengan Metode Kano dan Quality Function Deployment (QFD) Journal of Research and Technology pp78-86
[14] Lukman M, Wulandari and Wahyu 2018 Peningkatan Kualita Produk Coklat dengan Integrasi metode Kano dan QFD, Jurnal Teknik Industri, 19 (2), pp 190-204
[15] Wurjaningrum F 2008 Design of education service quality improvement of Airlangga university by applying Quality Function Deployment (QFD) model International Conference on Service Systems and Service Management pp 1-6
[16] Wu W Y, Qomariyah, A, Sa, N T T and Liao, Y 2018 The integration between service value and service recovery in the hospitality industry: An application of QFD and ANP International Journal of Hospitality Management, 75 48-57