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# Development of Batik an Environmentally Friendly

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## ABSTRACT

This study developed a batik products that are environmentally friendly. Product design and development begins with the needs and desires of consumers, environmentally friendly and economical. The results show that the attributes that should be corrected by the batik entrepreneur including the type and quality of cloth, the type and quality of the dye. The destruction of ecosystems is a high priority that contributes to environmental impacts. Alternative materials handling batik is by taking and reusing malan with lorod process, and reused as a mixture of malan. Batik products using a proven waste of malan could cut production costs and environmental impact.

Keywords: product design, consumer needs, consumer desires, reusing and environmentally friendly.

## INTRODUCTION

Industrial growth impact on social life and the environment. Humans have an important role in shaping a business environment that is friendly to the environment. Global warming issues has raise awareness of to pay more attention to the environment. Awareness on environmental problems triggered the industry to deliver products that promote the concept of environmental issues, or better known as the green. The green concept was born as a new lifestyle that is growing and recognized its existence by the public as consumers of products produced by the industry. Design for environmental or green design is an activity that is carried out by considering the environmental impacts caused by the product life cycle, in order to improve the competitive level, adding market value added, lower costs or preservation of environmental. (Karlson, 2001). Design for environmental has two main objectives, namely to prevent waste and to optimize the use of materials (Hundal, 2000). The application of green design to produce products that are environmentally friendly. Green product is a product that has a good quality which is able to support the health of the environment and to preserve resources.

Industry has a negative impact in the form of industrial waste. Type of waste generated comes from the production or non-production process. Wastewater derived from the production process and solid waste originating from the rest of the production process. Waste gases from combustion sources. Management of environmental impacts will affect the size of the charge. Nonetheless, there are advantages of efforts to optimize energy and material consumption (DeMendoca, 2001). These reasons lead to the rapid development of green industries. Successful product is a product that is able to provide benefits in accordance with perceived by consumers. (Ulrich, 2001). It is therefore necessary to consider the quality of the products based on the needs and desires of consumers are starting to lead to environmentally friendly products.

This study was conducted to evaluate product concepts that are part of the design and development of products using the Green QFD. Classic QFD not integrate environmental concerns and costs to the QFD matrix. In the design process and product development, QFD is used in evaluating the concepts of green products. The needs and desires of consumers of outlined in the phases of design and manufacturing. Cristophari make Green QFD is already considering environmental issues. Green QFD is still not efficient because it is not considering the cost in the QFD matrix. Continued development of QFD is able to integrate aspects of quality, environmental, and cost to the QFD matrix (Zhang, 1999). The purpose of this research is to design and development of products that address the needs and desires of consumers, environmentally friendly, quality and low cost.

**METHODS**

The initial phase of this study is data collect of product attributes based on the needs and desires of consumers . The attributes obtained from the literature and interviews with consumers and the industry. Determination of the products quality based on several theoretical frameworks, namely:(1) Performance or durability product is batik not easily torn. (2) Feature is colors and motifs of batik. (3) Conformance is precision measurement of batik. (4) Environmental is impacts of environmental and human. This attribute is added researchers as a consideration in determining the product quality. To raise the voice of the customer is done through a survey of consumers. The results of the consumer survey is a cheap price, not hot when worn, the color not easily fade, batik patterns interesting, colors are not the bright majority, cloth do not coarse, motive is not the market, cloth not easily torn and batik does not smell when worn.

The next stage is identify the information that is qualitative and structured hierarchically, source of ideas in the affinity diagram comes from internal and external sources. Internal data is data that support and lead to an understanding of the research issues. Data external is identifying the needs of consumers from the collection of attributes. Table 1 is a affinity diagram of the consumer demand for Batik.

**Table 1. Affinity Diagram**

| No. | Criteria | attributes |
|---|---|---|
| 1. | Strength | Color not easily fade |
| | | Cloth not easily torn |
| 2. | Aesthetics | Batik patterns interesting |
| | | Motive is not the market |
| 3. | Accuracy | Colors are not the bright majority |
| 4. | Simplicity | Cheap price |
| | | Cloth do not coarse |
| 5. | Environment potection | Not hot when worn |
| | | Batik does not smell when worn |

***House of Quality***

Attribute of product satisfaction will be improved and developed need to be determined priority weights. Priority development of product attributes, which are used determine the sequence of attributes that will be enhanced and developed. The weight of each attribute can be calculated by the formula:

$$\text{The weight ratio} = \text{degree of Interest } X \text{ improvement } ratio \; x \; Sales \; Poin$$

The degree of Interest attribute obtained by filling the questionnaire on the level of interest, respondents were asked to provide an assessment of product attributes according to their interest. The questionnaire on the level of interest, then made the degree of interest of each product attribute. The questionnaire on the Customer Satisfaction Performance, respondents were asked to provide an assessment of product attributes. Based The questionnaire on the Customer Satisfaction Performance, then made Customer Satisfaction Performance on each product attribute. Determination of improvement ratio must be in accordance with the strengths and weaknesses of management taking into account the internal and external conditions of management. Sales Point is information about the ability to sell products or services, based on how well each customer need is met. Value sales point is there is no point of sale, point of sale medium, strong selling point. Sales Point values are determined based on Importance to Customer. The most important attribute will have the highest value of sales point = 1.5. The improvement ratio aims to determine the value to be achieved by manejemen to achieve the targets set. If the performance value is greater than or equal with the target value then there should be no further improvement and if the performance is lower than the target value, it is necessary to repair.

The weight of each attribute is calculated to be normalized to determine development priorities attribute, to determine which one immediately gets development.

$$Normalized = \frac{Weight}{Weight\ Total}\ x\ 100$$

Furthermore, arranged in a quality home.

***Green House***

The initial phase of the preparation of the Green House is to identify Potential Waste Reduction. Based on the information that has been obtained, it is used to identify issues related to the presence of excess waste from the production process so that it has the potential to be reduced. LCA data processing with Software of SIMAPRO 7.1 and proceed with the preparation of the green house.

***Comparison house***

Starting with Life cycle Costin, in this calculation, calculated all the costs that occur during the life cycle of Batik products, ranging from upstream to downstream. Weight of product selection criteria made by the company valuation to criteria fulfilling the needs and desires of consumers. Furthermore, built the cost house and combined together in a comparison house.

## RESULTS AND DISCUSSION

### House of Quality

Attribute of product satisfaction will be improved and developed with to be determined priority weights. By knowing the development priority of product attributes, then can be determined the sequence attributes will be enhanced and developed. The weight of each attribute is calculated to be normalized. Normalize weights aims to facilitate the determining to priorities of attributes development.

**Table 3. Weight of Product Attributes satisfaction**

| No. | Attributes | Degree of interest | Improvement Ratio | Sales Point | Weight | Normalize weights |
|---|---|---|---|---|---|---|
| 1. | Cheap price | 3.91 | 1,088 | 1,2 | 5,0994 | 10,5364 |
| 2. | Not hot when worn | 4,36 | 1,011 | 1,2 | 5,2876 | 10,4545 |
| 3. | Color not easily fade | 4,39 | 1,107 | 1,2 | 5,8298 | 11,5264 |
| 4. | Batik patterns interesting | 4,56 | 1,411 | 1,2 | 7,7232 | 15,2699 |
| 5. | Colors are not the bright majority | 3,68 | 1,083 | 1,2 | 4,782 | 9,4547 |
| 6. | Cloth do not coarse | 3,80 | 1,036 | 1,2 | 4,7222 | 9,3364 |
| 7. | Motive is not the market | 4,16 | 1,025 | 1,2 | 5,1152 | 10,1136 |
| 8. | Cloth not easily torn | 4,35 | 1,066 | 1 | 4,6352 | 9,1645 |
| 9. | Batik does not smell when worn | 3,91 | 1,110 | 1,2 | 5,2037 | 10,2885 |
| | Total | | | | 48,398 | |

The house of quality matrix describes process needs and how to fulfill it. This matrix is made by merging the data processing of the determination of the weight to the prioritization of the development of quality procedures.

### Life Cycle Assessment (LCA)

The purpose of the LCA is to evaluate the concept of the product. The scope of this product LCA is throughout the product lifecycle from procurement of materials to the hands of consumers. Data processing lifecycle batik using softwhare of SIMAPRO 7.1. In figure 2 shows that the coloring

process contribute greatly to the environmental impact throughout the product life cycle of batik. Figure 3 shows some of the impact of the production process of batik. Figure 4. above, shows the process of coloring and washing process large berkonttribusi the waste generated. Figure 5 clearly visible given the greatest impact throughout the life cycle of batik is the coloring process. Life cycle of Batik product starting from taking material from the warehouse to product up in the hands of consumers. Product life cycle of batik from raw material to finished product, produces a lot of waste in every process.

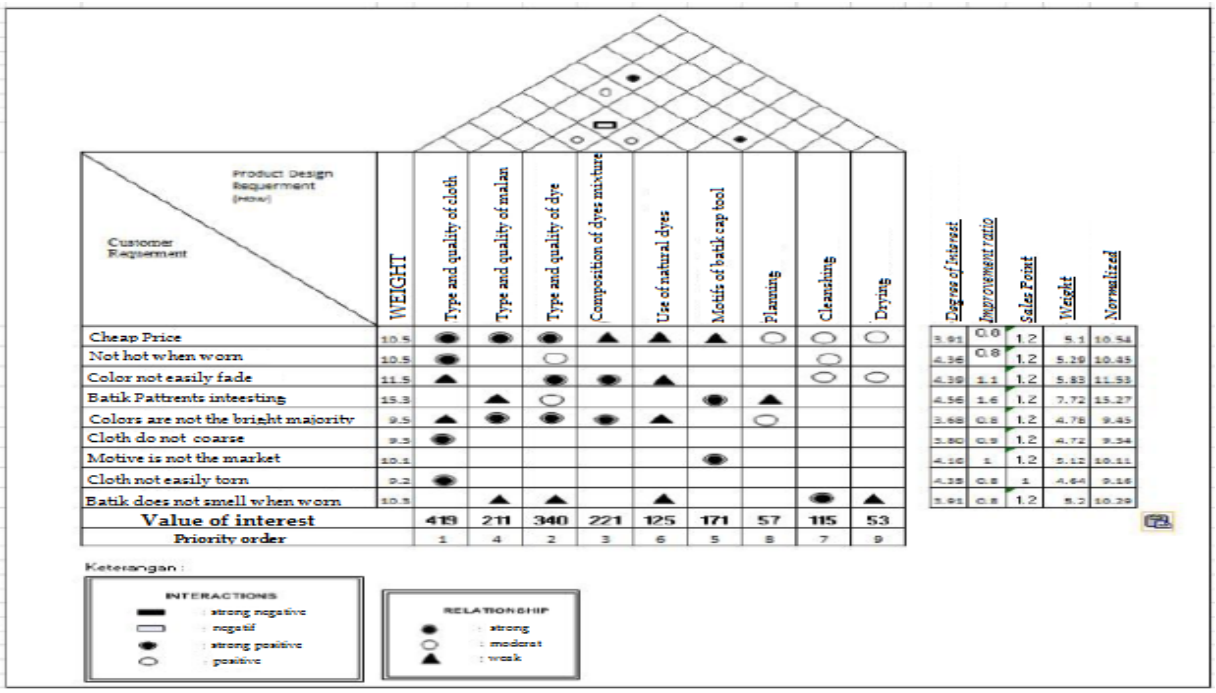


**Figure 1. House of Quality**

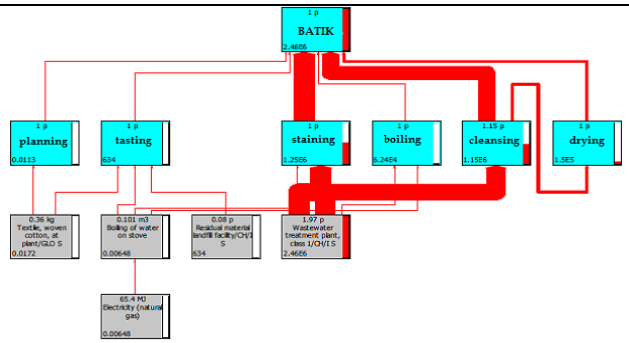


**Figure 2. Life cycle of Batik**

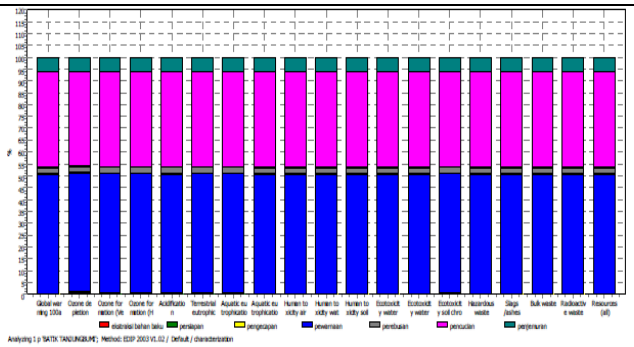

**Figure 3. Batik *Characterization***

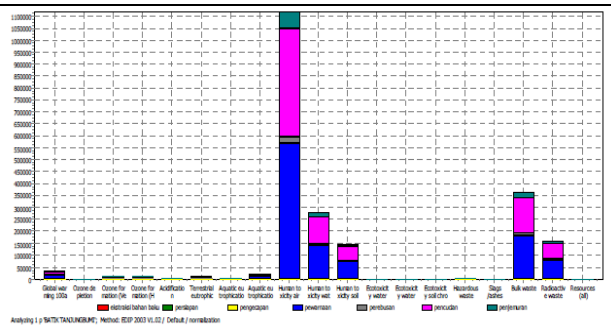

**Figure 4. *Normalized of* batik**

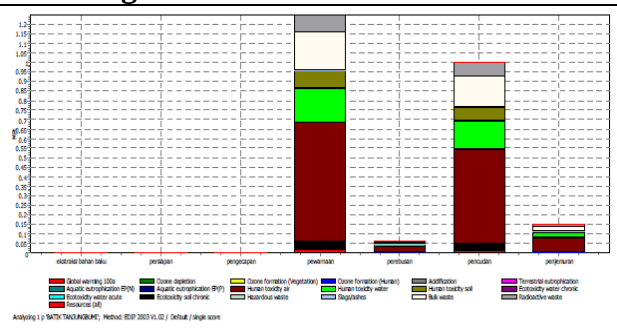

**Figure 5. Single Score Impact of Batik**

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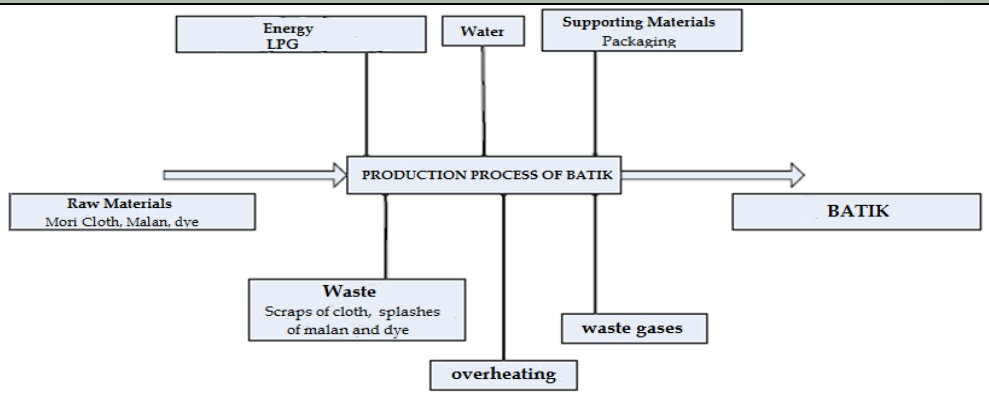


**Figure 6. Input-output flow of batik**

Identification of waste generated in each production process, namely: (1) Extraction, performed for raw materials such as mori cloth, malan and prophecy can have an impact on the balance of the ecosystem if done continuously, because the raw materials derived from chemicals or non- natural. (2) Preparation of raw materials, the waste of small pieces of cloth derived from the residual cloth cutting. Wastes generated from the process of heating the water to release malan. (3) Tasting, pasting Malan to cloth produce waste on the floor that night droplets and print table. (4) Staining, waste generated in the form water of residual staining is usually dumped on the ground, there is also the pickings dye on the wall. (5) Boiling, the release of malan with boiling water produce waste the boiling water rest and dumped around of the house production. (6) Cleansing, waste comes from used water rinse dye batik. (7) Drying, there are droplets of water used to wash on the ground and the smell of gas around drying.

**Product Life Cycle Impact**

Grouping environmental impact based on the method of Environmental Design Industrial Product (ENDIP). The criteria are: (1) Gobal Warming is the increase in the average temperature of the atmosphere, ocean and land on earth. (2) The formation of ozone photochemistry that occurs when primary pollutants (NO 2 is formed from fossil fuel combustion) interact under the influence of sunlight to produce a mixture of various different substances and dangerous. (3) Acidification is air contamination and water of chemical mixtures that make up the acid the metal or decrease the natural ability to neutralize acid resulting in a decrease in the pH of water or soil. (4) Nutritient enrichment derived from nitrogen and phosphorus. Pollutants in the form of nitrogen can cause problems for health. (5) Ecotoxicity and Human Toxicity are chemicals of released into the environment that are giving negative impact on the ecosystem. (Wenzel, 1997).

**Table 4. The weight of the impact characteristics to batik products**

| | Priority Impact | weight of Priority Impact |
|---|---|---|
| Global | Global Warning | 0,067 |
| Regional | Adification | 0,131 |
| | The formation of ozone photochemistry | 0,13 |
| | Nutritient enrichment | 0,07 |
| | Human Toxicity Water | 0,196 |
| | Human Toxicity (Soil) | 0,055 |
| | Chronic Ecotoxicity (Water) | 0,155 |
| | Chronic Ecotoxicity (Soil) | 0,1 |
| Lokal | Human Toxicity (Air) | 0,095 |

**Table 5. Product costs for 1 unit of batik**

| No. | Type | Price (Rp/Kg) | Material requirement (gr) | Price |
|---|---|---|---|---|
| **1.** | **Material** | | | |

| | | | | |
|---|---|---|---|---|
| | Mori cloth | 210,000 | 2.15 x 1.30 | 14,000 |
| | Malam | 22,000 | 250 | 8,800 |
| | prophecy | 80,000 | 15 | 1,200 |
| **2.** | **Suporting Material** | | | |
| | LPJ | 14,000 | 7 | 100 |
| | Water | 500 | 2,000 | 1,000 |
| **3.** | **Labour** | | | |
| | Plannng | 15,000 | 0,01 | 150 |
| | tasting | 25,000 | 0,01 | 250 |
| | Staining | 20,000 | 0,01 | 200 |
| | Boiling | 15,000 | 0,01 | 150 |
| | Cleansing | 17,500 | 0,01 | 175 |
| | Dryin | 15,000 | 0,01 | 150 |
| | Finishing | 17,500 | 0,01 | 175 |
| | Total | | | 26,350 |

The impact characteristics serve as the basis for assessment on the impact of priority to be addressed. Value of the impact characteristics placed in the priority column impacts. Consideration of the potential impact obtained from the life cycle of the product of batik and from interviews with experts in the Chemical Laboratory - University of Trunojoyo Madura. Analysis of AHP with Expert Choice software obtained weighting of impact characteristic to batik product as Table 4. Life Cycle Costing of Batik products are the costs that occur during the life cycle of Batik products ranging from upstream to downstream, as Table 5. Product selection criteria are the needs and desires of consumers, environmental impact, and product costs. Product selection criteria are the needs and desires of consumers, the impact of produk to the company's and product costs. Companies need to assess these criteria. The data is then searched the priority weighting of each criterion using expert choice software. The output of the expert choice as Table 6.

**Table 6. Weights Criteria**

| Criteria | Priority weighting |
|---|---|
| The needs and desires of consumers | 0.443 |
| Environmental impact | 0.387 |
| Product costs | 0.17 |

There are 9 criteria of impact based on the EDIP method (Environmental Design of Industrial Products) (Wenzel, 1997) which incorporate elements into the environmental impact of green house. The data in the green house obtained from the interview and exchange ideas with experts.

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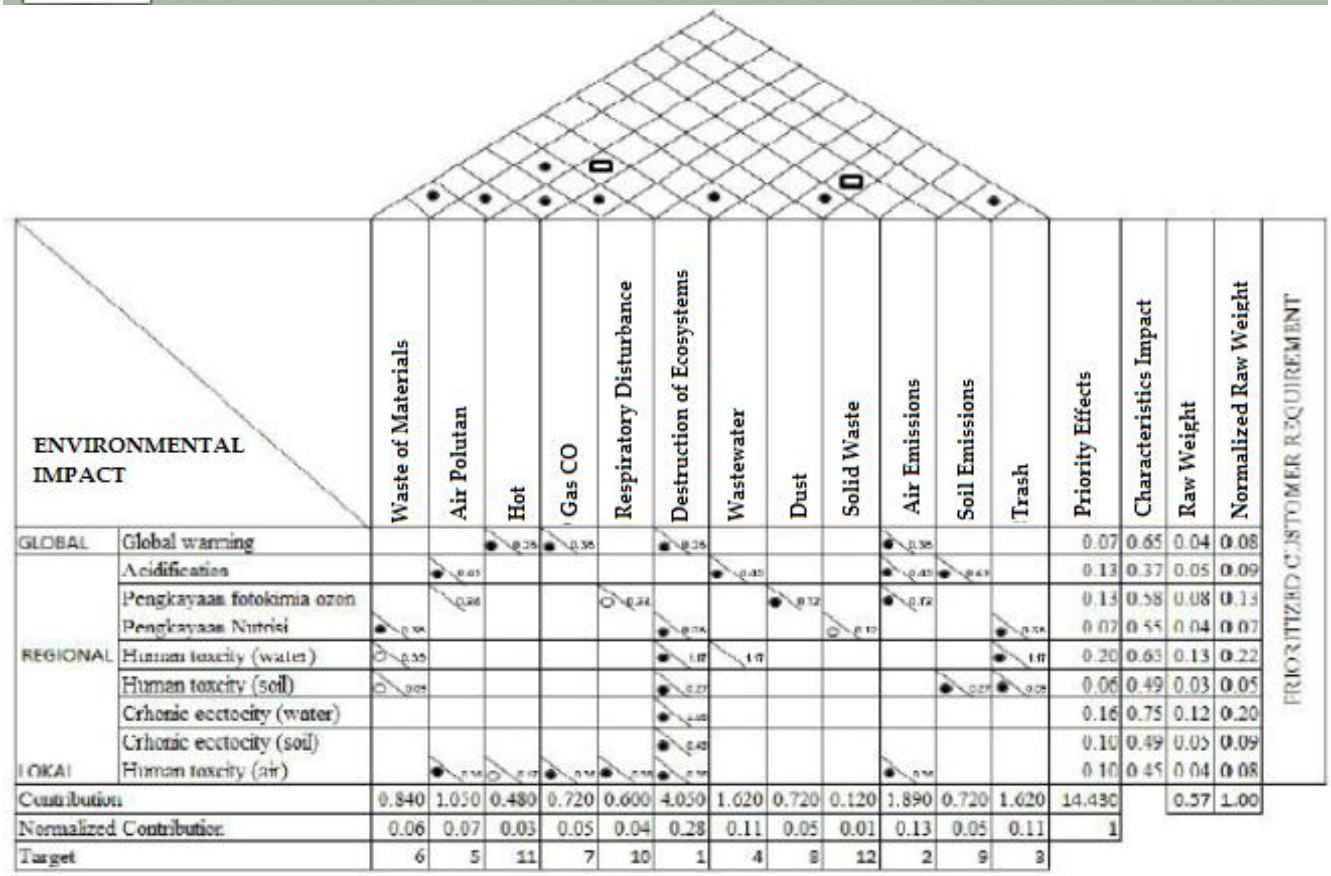


**Figure 7. Green House Batik**

In the process of making batik, throughout their life cycle produce a lot of environmental impact, especially in the process of staining, washing and drying. Therefore require analysis of green house for determine the impact of environment parameters.

**Table 8. Waste management of batik industry**

| waste | Waste management |
|---|---|
| Waste of material | - Recycling<br>- Reuse |
| Air Pollution | - Me Reduce combustion<br>- Me Selecting a source of energy used |
| Hot | |
| CO gas | |
| Air Emission | Do the optimization process |
| Water waste | - Optima Optimization of the process<br>- Reuse<br>- Recycling |
| Solit waste | Closure Maintenance and Warehouse |
| Trash | Utilization of trash / recycling |

The destruction of ecosystems is a high priority impacts that contribute to environmental impact. Technical response to the destruction of ecosystems important to consider in the determination of repair. Costs that exist in each life cycle of batik, input into cost house matrices.

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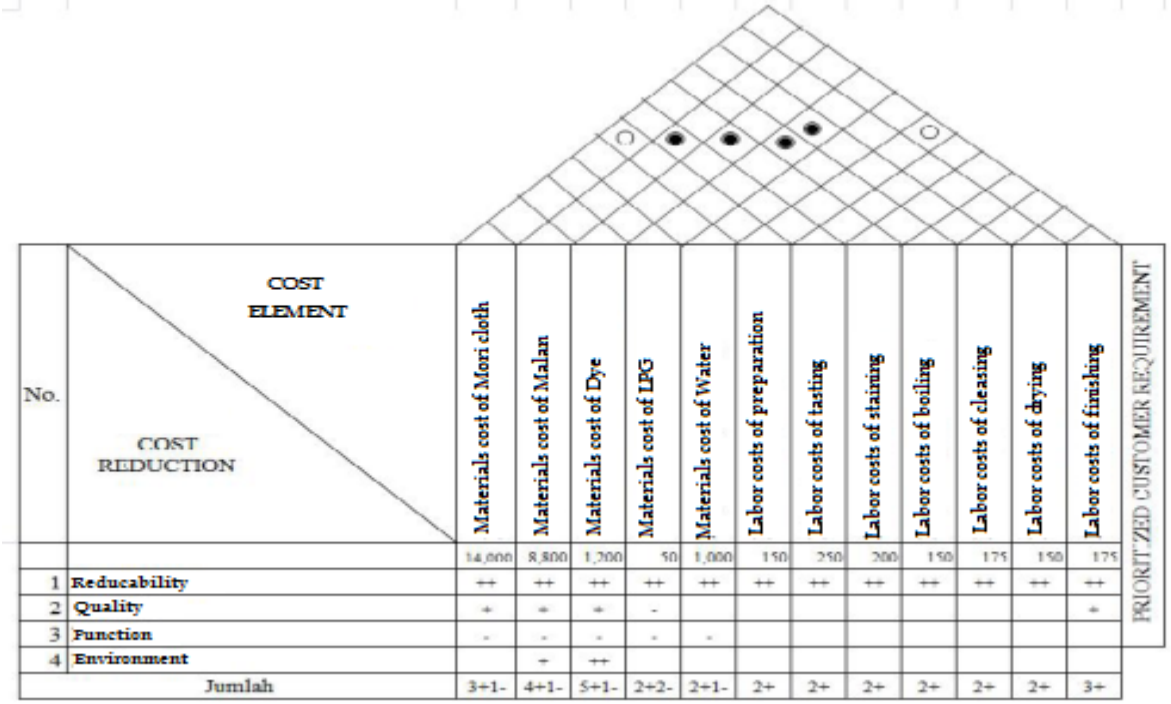

| No. | COST ELEMENT / COST REDUCTION | Materials cost of Mori cloth | Materials cost of Malan | Materials cost of Dye | Materials cost of LPG | Materials cost of Water | Labor costs of preparation | Labor costs of tasting | Labor costs of staining | Labor costs of boiling | Labor costs of cleasing | Labor costs of drying | Labor costs of finishing | PRIORITIZED CUSTOMER REQUIREMENT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 14,000 | 8,800 | 1,200 | 50 | 1,000 | 150 | 250 | 200 | 150 | 175 | 150 | 175 | |
| 1 | Reducability | ++ | ++ | ++ | ++ | ++ | ++ | ++ | ++ | ++ | ++ | ++ | ++ | |
| 2 | Quality | + | + | + | - | | | | | | | | + | |
| 3 | Function | - | - | - | - | - | | | | | | | | |
| 4 | Environment | | - | ++ | | | | | | | | | | |
| Jumlah | | 3+1- | 4+1- | 5+1- | 2+2- | 2+1- | 2+ | 2+ | 2+ | 2+ | 2+ | 2+ | 3+ | |

**Figure 8 . Cost House of Batik**

The increasing demand for batik products, causing demand for raw materials increases. Another alternative is needed to add to the composition of the raw materials into materials batik with a relatively low price without compromising the quality of batik. Nurdalia (2006), provides an alternative raw materials of batik with capitalize waste of malan. Observations in the field, batik entrepreneurs yet utilizing waste of lorod process. Alternative materials handling of malan is take and reuse malan from process lorod, and reused as a mixture of batik malan. Capture of malan is done by using a combination of two stages malan traps. Residual water of lorot mixed with batik malan flowed into the sink trap consisting of two tubs are related to each other. The working principle of the trap tup same as vessel -related systems. Malan will separate with water and float above surface. Recovery process of malan is expected to be 60%.

Here are the advantages in the cost and the environment if batik entrepreneurs utilizing the waste of malan. Malan price for 1 piece batik shirt is IDR 8,800 while 60 % of malan can be reused. Malan in use only 40 % of IDR 8,800 or approximately IDR 3,520. Greater use of waste causes batik production costs become cheaper. When viewed in terms of the environment, the use of waste in the production of batik is very good because it can minimize the environmental impact of liquid and solid waste and adding value to the waste . Substitute or reuse of dyes, researchers have yet to get a favorable solution. The use of natural dyes are still very expensive and the result of natural dyeing not as much and as good as synthetic dyes. The use of natural dyes only have a positive impact on the environment, while the quality and costs have a negative impact.

**Tabel.9 Cost of new produk for 1 unit of batik with waste materials**

| No. | Type | Price (IDR/Kg) | Material requirement (gr) | Price |
|---|---|---|---|---|
| **1.** | **Material** | | | |
| | Mori cloth | 210,000 | 2.15 x 1.30 | 14,000 |
| | Malam | 22,000 | 250 | 3,520 |
| | prophecy | 80,000 | 15 | 1,200 |
| **2.** | **Suporting Material** | | | |
| | LPJ | 14,000 | 7 | 50 |
| | Water | 500 | 2,000 | 100 |

| | | | | |
|---|---|---|---|---|
| **3.** | **Labour** | | | |
| | Plannng | 15,000 | 0,01 | 150 |
| | Tasting | 25,000 | 0,01 | 250 |
| | Staining | 20,000 | 0,01 | 200 |
| | Boiling | 15,000 | 0,01 | 150 |
| | Cleansing | 17,500 | 0,01 | 175 |
| | Dryin | 15,000 | 0,01 | 150 |
| | Finishing | 17,500 | 0,01 | 175 |
| | Total | | | 20,120 |

**Comparison House**

Based on the analysis of the quality of the environmental impact and costs, then the development of batik products through comparison Concept house. Based on the analysis of quality, environmental impact and cost of batik product development done by Concept comparison house. The method of selecting the best products obtained from the matrix of Comparison House . This matrix is obtained from development of the third the previous matrix is quality matrix, environment matrixs and cost matrix. The results of previous evaluations incorporated into matrix of concept comparison matrix house. To decide which products are selected then do brainstorming with experts and batik entrepreneurs itself. Scale scores were used a scale of 1, 3 and 9. Scale 9 is the number for a good quality score, as well as to the cost and the environment. The results of Concept comparison house is known that the satisfaction for the concept of new product is very significant in some parameters of good quality, cost and the environment.

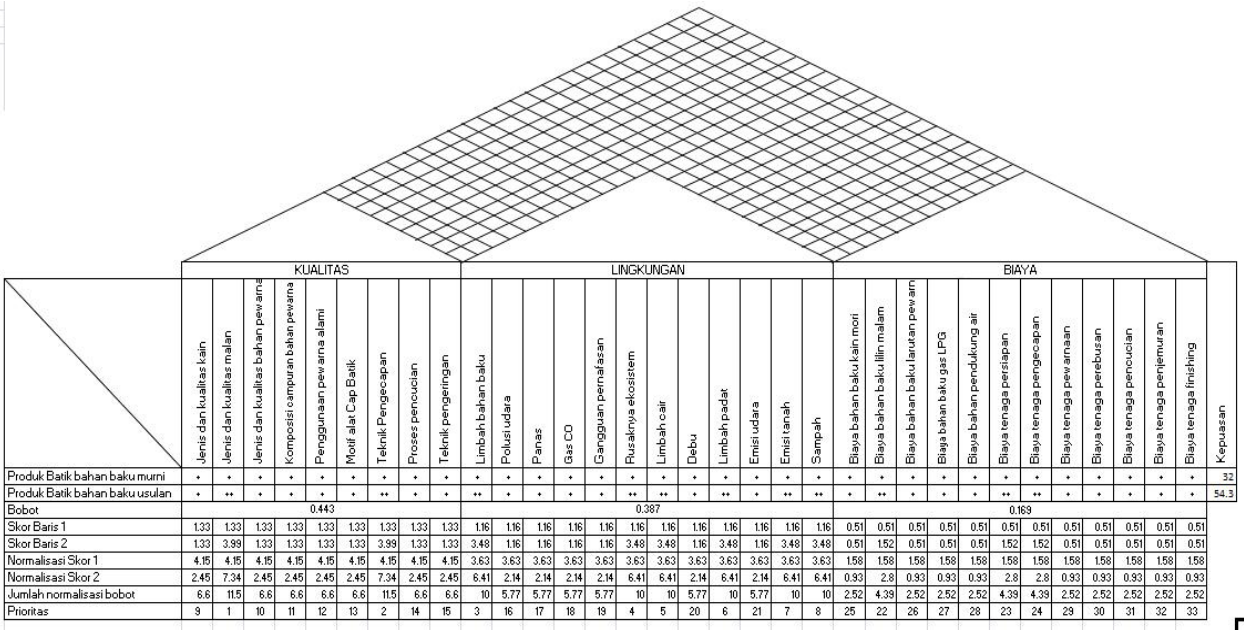


**Figure 9. Comparison House**

**CONCLUSION**

Attributes that should be corrected batik entrepreneurs are the type and quality of the cloth, the type and quality of the dye, the dye mixture composition, motif batik stamp tool, the type and quality of the evening, the user's natural coloring, washing process, tasting techniques, drying techniques. The destruction of ecosystems is a high priority impacts that contribute environmental impact. technical response to the destruction of ecosystems important to consider in the determination of repair. Alternative products are in accordance with the wishes of consumers, is environmentally friendly and economical products that wear batik or utlize waste of a malan or wax, because it could cut production costs and environmental impact.

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