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Pricing Decision System for Custom Design Batik

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***Abstract*— The process of determining costs and prices in Make-to-Order (MTO) companies is generally complex because they make products according to special orders. Speed, accuracy, and consistency are necessary for a successful pricing estimation. Custom batik price, along with anticipated production time, is still done manually at the moment. Integration of design and manufacturing with computer-based was needed to produce custom batik products. This paper aims to develop a pricing decision system model for CAD custom batik motifs and written batik CNC machines used in the production processes. Customers can adapt their budgets by changing the parameters to suit their requirements and capacities using various price options. This model helps the customers to make buying decisions. The data and information were gathered through interviews, observations, and a literature review. The pricing decision system has been determined using the job order costing method, where prices are collected for each order separately according to the demand's identity or the order's cost. The system was developed through the prototyping process. This research has created a framework for determining the price for custom design batik based on 4 (four) parameters: the motif, the number of colors used, the type of color used, and the type (size) of the fabric used. Also, incorporating more comprehensive parameters has improved the system (motif size, number of colors, color selection, coloring techniques, and fabric sizes). The outcome of the calculation simulation demonstrates that the constructed model successfully calculated the unit price of products with accuracy. It shows that the system can be used in practical situations.**

***Keywords*—Custom design batik; pricing; decision; job order costing; make-to-order; prototyping.**

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I. INTRODUCTION

The fashion industry, which includes the batik, has started to grow in response to the demand for designs in Indonesia. A particular batik designer first created batik, but it is now also producing designs created by customers, such as special orders or custom builds. This influences batik as well, which continues to evolve. Research by Rahadi et al. [1] states that batik consumers are starting to develop from conventional to contemporary fashion. The quality of batik products follows consumer desires to fulfill satisfaction in shopping for batik products. The trend of custom batik design products continues to increase, so the company must set a manufacturing strategy to determine the type of production that will be applied. A survey conducted by Fauziah [2] showed that consumers have many choices according to their character and taste of batik designs. The dominant variables influencing marketing performance are product, then price, distribution, and promotion [3].

According to the English Oxford Learner's Dictionaries [4], "custom" refers to customers' regular interactions with a store or company. Unlike custom, which denotes something manufactured or completed on demand. According to Cambridge Dictionary [5], "custom" is the support given to a company, mainly a shop, by the customers who purchase its products or services.

These various products lead to varying prices for each of these products. Thus, the company needs a system to calculate and determine the cost of the product. There are still many obstacles in the time of service and choosing the price in the current process. To determine costs, companies must have the necessary data in advance, such as data on the prices of raw materials and others. Still, these data are often not updated, so the decision-maker in determining the cost must first confirm it to the relevant sources. Fluctuations in raw materials and labor wages will make the products' prices vary.

According to Tersine [6], companies with a Make-to-Stock (MTS) system carry out production activities to meet the inventory of finished products in the warehouse. Meanwhile,

in companies with a Make-to-Order (MTO) system, new production activities will occur when there is a demand; the customer must be willing to wait until the product has finished. The cost estimation process in MTO companies is generally very complex because they make products according to special orders. The order process for custom batik design products is still manual, including determining costs, estimating production time, scheduling, and shipping goods.

Souza and Kingsman [7] believe successful price forecasting involves speed, accuracy, and consistency. As a result, pricing is a complicated task. MTO companies often have to prepare estimates quickly, risking making big mistakes. Tolerance requirements, for example, are a significant difficulty for MTO companies, as precise estimates of the time required are very time-consuming and open to error. Poor pricing decisions can cause a company to go bankrupt, so they must be made with extreme care.

Digitalization can assist businesses in generating data and gaining a better knowledge of processes [8]. Product pricing as decision-making by the owner can be assisted by using a DSS (Decision Support System). The right decisions, if timely folded in, can produce tremendous savings in a product's life-cycle cost. According to Turban [9], a DSS is a system that can assist in deciding a semi-structured problem. DSS aims to assist decision-making in determining costs and pricing. The DSS will help determine the best possible price.

The benefits of DSS design in determining costs and expenses for producers are automatic price estimates, and they can immediately find out the profit at the beginning. The DSS can also ease the owner's workload as the sole decision holder. Users have many price alternatives based on their financial capabilities, and they can modify the settings to change the budget. This DSS design seeks to determine the suitable selection of custom batik design items based on consumer wants and capabilities. According to Lee et al. [10], the features of Web 2.0 (e.g., decision aid) promote consumer participation in online shopping mall environments and customer relationships.

Research by Asmal et al. [11] has made CAD software on batik motifs with a batik character input system. However, the algorithms and systems that have been developed still have some limitations. Some of these problems make the CAD system imperfect, so it cannot be applied in real terms in Indonesia's batik industry and Small-Medium Enterprises (SMEs). This software must be developed with an algorithm to determine costs and prices and calculate production time.

Kitipong et al. [12] researched establishing product prices for acquiring batik goods by identifying appropriate materials for the next products; two-stage clustering is suggested as a decision assistance system to boost productivity. Putri and Desi [13] researched price calculation using the task order costing approach to convert and process clothing materials into ready-made apparel. Prasetyowati et al. [14] determined Batik Madura's production cost with activity-based costing methods and linear regression analysis.

Leyesa et al. [15] created a system software to calculate and estimate each project job order for an electronics systems integrator. Using the job costing method, Jasim et al. [16] evaluated the cost, price, and organizational data for a bread production job from a renowned bakery store. Research by Alamia and ElMaraghya [17] assists manufacturing companies in achieving a competitive edge against their rivals through the reduction of labor hourly rates. Zahller [18] researched to find out the right price for premium business truffle business. Soualhi and Djafri [19] research investigates the Sharīʿah compliance of the pricing elements used in family takāful products. However, from an activity perspective, several journals discuss no other factors that affect production costs. There has not been much research on cost analyzed of production based on the job order costing method.

There is a revolution in manufacturing technology, where robots and machines have resulted in quantum leaps in productivity and quality [20]. The online platform-driven Customer-to-Manufacturer (C2M) strategy is an emerging business model to facilitate product customization [21]. Zhang and Zheng [22] look into how businesses should choose between multiple channels (online or offline) and the best-customized tactics. In a dual-channel retail environment, Chen et al. [23] consider two adoption instances of 3D printing, one of the technologies for mass customization, and assess how they may affect a company's product offering, price, and inventory decisions.

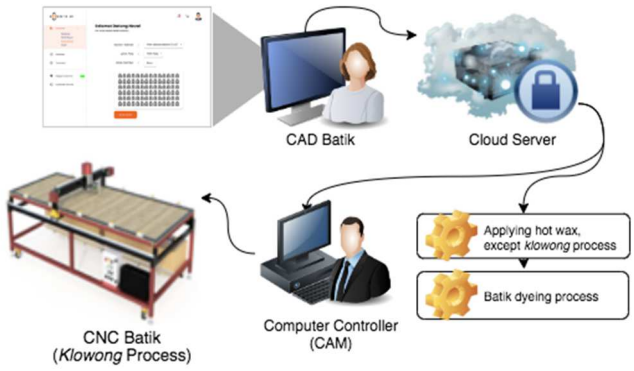

Fig. 1 Custom Batik Production (CAD and CNC System)

Furthermore, all batik manufacturing processes are carried out manually by human hands. There is no integration of design and manufacturing in batik using batik technology. In addition, shown in Fig.1., the production of custom batik designs uses a written batik CNC machine in one of the production processes. A written batik CNC machine and software provides benefits, especially for small and medium industries with many limited resources.

Research on the integration of design and manufacturing with computer-based has been carried out [24], [25], [26]. Research of integration in batik production equipment by Ridho [27], Dwinugroho et al. [28], Akhmad et al. [29], Muthi'ah [30], Sudiarso and Kusumawardani [31], increase the ability to produce batik using a CNC batik. As a result, several processes in batik are done faster with a CNC. A model must be made to calculate the processing time and determine the production costs. Calculations are carried out automatically based on the parameters of the batik motif design as a result of the CAD batik software.

II. Materials and Method

A. Research Object

This research was conducted at SMEs Butimo, one of the batik industries in Yogyakarta, the world's batik city. Butimo has complete production facilities and resources that support research. In addition to producing products with distinctive motifs designed by Butimo, they also accept custom batik designs according to customer designs. Butimo also researches Engineering technology and manufactures written batik CNC machines that assist in production.

B. Conceptual Model

According to Weygandt et al. [32], the two principal types of cost accounting systems are 1) job order cost system and 2) process cost system. Under a job order cost system, costs are assigned to each job or batch of goods; at all times, each job or batch of goods can be separately identified. A job order cost system measures costs for each completed job rather than for set periods. Manufacturing costs are classified as direct materials, labor, and overhead.

Job order cost system is most likely to be used by a company that receives special orders, custom builds, or produces heterogeneous items; that is, the product manufactured or the service rendered is tailored to the customer or client's requests, needs, or situation. Job order costing lends itself to specific, special-order manufacturing or servicing, while process costing is better suited to similar, large-volume products and continuous process manufacturing.

The concept of job order cost is the accumulated cost of each order in manufacturing a product. The value can be identified from ordering goods to costs until the product is ready for sale. Job order cost financing has three elements: direct costs of a job, indirect costs of a job, and general administrative costs [33].

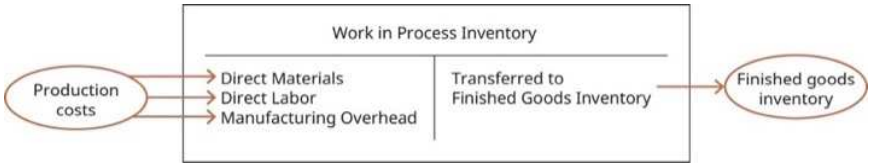

Fig. 2 Job Order Cost Production [34]

Fig. 2. shows the progression of these costs through the inventory of work in progress. Raw material, direct labor, and manufacturing overhead costs are job order cost financing components. In most production facilities, raw materials are transferred from the raw materials inventory to the work-in-progress inventory. One or more production divisions are involved in the work-in-progress, where labor and overhead turn raw materials into finished goods [34].

Pricing has been determined using the job order cost method, where prices are collected for each order separately according to the demand's identity or the order's cost. The framework for determining the price for custom design batik using the job order cost method is shown in Fig. 3.

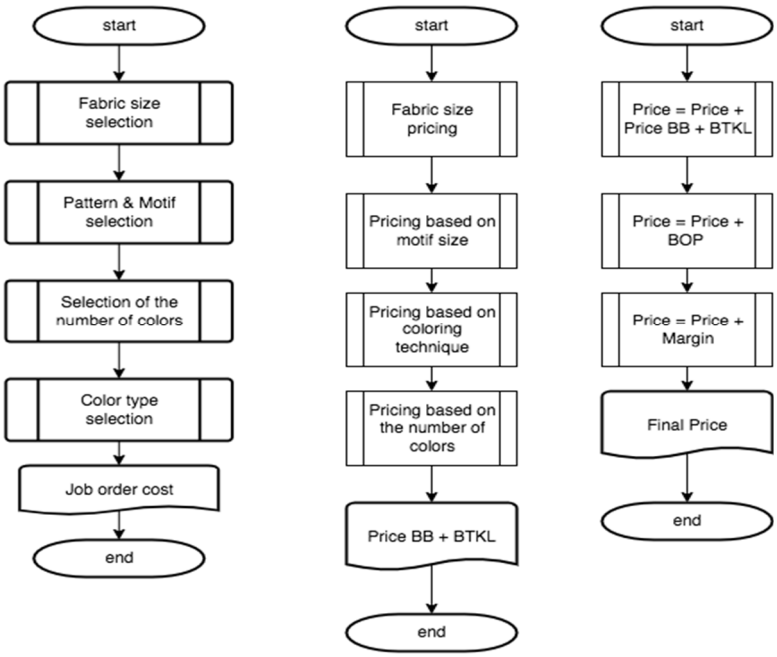

Fig.3 Conceptual Model

The price consists of material costs (BB), direct labor expenses (BTKL), and manufacturing overhead costs (BOP). This research has created a framework for determining the price for custom design batik based on 4 (four) parameters. The framework consists of the motif parameters (the density and the looseness of the motif), the number of colors used, the

type of color used, and the size of the fabric used. Some of the terms used in the model include:

- BB (*Bahan Baku*): direct materials cost
- BTKL *(Biaya Tenaga Kerja Langsung)*: direct labor cost
- BOP *(Biaya Overhead Pabrik)*: manufacturing overhead cost.

Several influential variables in determining costs using the job order costing method. Among them is the cost of raw materials, including fabrics, waxes, dyes, and chemicals. For direct labor costs, wages per production will be used for smudging, dyeing, washing, and drying. Factory overhead costs consist of machine, building asset, and maintenance costs. Machine costs consist of machine depreciation costs, machine maintenance costs, employee costs, and nights used for machines. The calculation of the value of assets can be assumed with the relevant value of the expert using personal property identification and the cost of *isen-isen* consisting of stoves, *canting*, pans, woks, brushes, and labor.

C. Stages of Prototyping Development

Researchers use the DSS development as a procedure in conducting research shown in Fig.4. According to Turban et al [9], most DSS are developed through the prototyping process. The terms "prototyping" and "evolutionary development" both refer to iterative design. Prototyping is the process of building a "quick and dirty" version of a system (e.g. user interface). The goal of the prototyping is to create a DSS in a series of quick steps while receiving rapid user feedback to confirm that the process is going well.

1) Planning: The evolutionary strategy begins with some analysis and broad DSS planning. Managers and users both need to be involved. Preliminary observations are used to know well the current situation and condition of Butimo. From this stage, we want to see how much business opportunity can be provided by solving the problem at hand. Therefore, initial observations were carried out directly as well as interviews to get a clear picture of the state. The data were obtained through a literature study and observations, and interviews with the owners and managers of Butimo Batik.

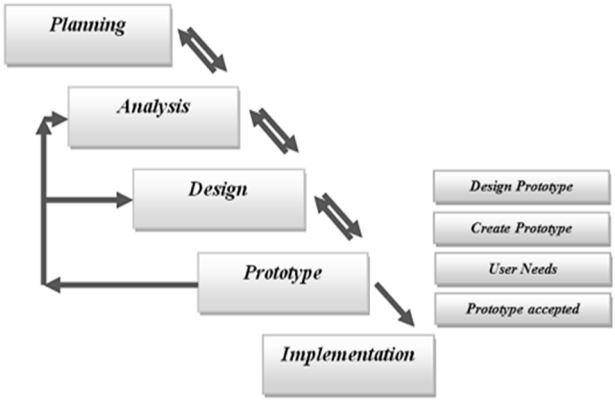

Fig. 4 Stages of Development Methodology [9]

2) Analysis (Problem identification and formulation): The next phases involve iterative analysis, design, and prototype implementation. After observing, it is necessary to know and identify the problems by making direct observations, literature studies and interviews with the people concerned in Butimo. It is a stage in research methodology that contains the information and knowledge needed to establish research conducted. Sources of literature review include books, journals, and reviews obtained through the internet. The analysis phase produces a logical model of the problem and its solution.

3) Design: Data collection was carried out to separate data and helpful information and use it in research from those that were not. The data collected will be adjusted to the DSS method used in the study. DSS will aim to assist decision-making in determining cost and pricing. Based on the DSS that will be formed, several data storage areas will be created, and the modules used in running the DSS. The data and modules are then used to run the DSS through stages that have been adapted to the current situation and conditions of batik production process. This stage transforms the logical model into a real model that is ready to be implemented.

4) Prototype: The data that has been processed will then be used as material to analyze the problems that have been set to provide answers and views of a problem. In this stage, the researcher communicates the DSS created to the user.

5) Implementation: This stage is only passed with user consent. Performed until a small prototype is ready (decided on jointly by the developers, managers, and users). Then, this system's implementation of this component takes place.

III. Results and Discussion

The following are the results of the DSS design process in the form of a flowchart or system model, which is divided into several discussions.

A. Planning

There will be a number of data storage locations set up that will hold data on Butimo Batik's prices and costs, production, and previous orders. The established data repository will also contain and store the rules that will be used in the DSS. It will be possible to save data on production, past orders, the prices and costs associated with Butimo Batik in a number of different places.

B. User Needs Analysis

Based on the respondents' observations and interviews in this study. Several areas for improvement of the old DSS model were identified to better inform the development of the new DSS model. These areas are listed in Table 1.

TABLE I
NEEDS ANALYSIS FOR PRICE ESTIMATION MODEL

No	Model	Shortage Constraint Model	Solution
1.	Fabric Types	Only Prima Sanforized fabric is used; there are no other kind (Quality 2)	Added Primisima Sanforized (Quality 1)
2.	Color	One new color option is indigosol	Added naptol and remasol
3.	Motif Size	Calculation based on previously completed layer measurements, producing an inaccurate estimation.	The new mathematical model improvements

C. Solution Design Making

A solution design is created at this point based on the analysis of user demands. The Turban approach is used in the solution design when considering the rules from the generalized DSS development process technique.

1) Design of the Fabric Price Model: Regarding the fabric type, there are sanforized prima (quality 1) and primisima (quality 2), each with varying costs per meter (m), as stated in Table 2 below.

TABLE II
FABRIC TYPE

No.	Fabric Name	Description	Price (IDR) / m
1.	Sanforized Primisima	Quality 1	25,000
2.	Sanforized Prima	Quality 2	20,000

According to the CAD program and the findings of Asmal's research [5] in Table 3., there are five options for the fabric size used.

TABLE III
FABRIC SIZE

No.	Variant	Size (cm)	Area (cm^2)	Area (m^2)
1.	*Kain Jarik* (Jarik Fabric)	250 x 100	25,000	2.5
2.	*Kain Sarung* (Sarong)	180 x 100	18,000	1.8
3.	*Kain Dodot* (Dodot Fabric)	400 x 200	80,000	8
4.	*Kain Selendang* (Shawl Fabric)	140 x 45	6,300	0.63
5.	*Kain Kemben* (*Kemben* Fabric)	250 x 50	12,500	1.25

According to the fabric pricing model (*Appendix 1.)*, the price of fabric is determined by (1) choosing the fabric type and (2) choosing the fabric size. The canvas size is multiplied by either price a or b, and these values are generated from the cost of the batik fabric you wish to use. Direct labor costs and the cost of raw supplies are included in the price.

2) Design of Color Pricing Model: The color pricing approach consists of (1) choosing the motif and background/ canvas coloring methods from three options: dip dyeing (*Teknik pewarnaan celup*), dabbling (*Teknik pewarnaan colet*), and combination, each with a different price. (2) The three types of dyes are Remazol, Naptol, Indigosol. (3) Enter the number of colors used (between 1 and 4), as shown in Table 4.

TABLE IV
COLOR PRICES

No	Parameters	Group	Price (IDR)
1.	Coloring technique	Dip dyeing	30,000
		Dabbling	70,000
		Combination coloring	50,000
2.	Types of Indigosol Dye	Group 1: Red, green, and purple	25,000
		Group 2: Yellow, blue, brown, orange, gray	15,000
3.	Types of Naptol Dyes	Group 1: Red, yellow, blue, purple, orange	25,000
		Group 2: Black and brown (*soga*)	30,000
4.	Types of Remasol Dye	Group 1: Light blue/ turquoise, yellow, black, gold yellow	25,000
		Group 2: Dark blue, red, brown, orange	30,000

The model of a color pricing plan is based on technique, type, and amount of coloring (*Appendix 2.*).

- The color technique will be calculated per piece, IDR 30,000 if using the dip dyeing technique (*celup*); IDR 70,000 for the dabbling coloring technique (*colet)*; and IDR 50,000 for the combination technique.
- There are two groups for choosing color types for *Indigosol*, Group 1 being red, green, and purple, and group 2 being yellow, blue, brown, orange, and gray. There are two groups of *Naptol* color types: Group 1 includes red, yellow, blue, purple, and orange, while group 2 includes black and brown (*soga*).
- There are two groups in the *Remasol* color type: group 1 composed of light blue/turquoise, yellow, black, and golden yellow, while group 2 composed of dark blue, red, brown, and orange. grouping since, as shown in Table 3. above, the cost is the same for each group.
- Quantities are computed using 1, 2, 3, and 4 colors, and if each motif has the same color, a single price is determined. The motif's color and the fabric's primary color make up the paint itself (background).
- The price includes the cost of raw materials and direct labor costs.

3) Design of Motive Pricing Model: Creating a mathematical model framework, which includes integrating the pricing mechanism, comes next. The DSS model is designed to support the decision-maker's judgment regarding the selling price, specifically estimating costs based on the quantity of work using a CNC machine for writing batik. This study looked at some aspects of the custom batik system, including the size of the formed motif, the number of colors, color choice, coloring methods, and the size of the fabric. These aspects will influence the price of the DSS model being developed; the machine needs a lot of time to work on larger motifs, which affects the manufacturing cost based on the total image (a factor that affects the working time of the machine based on the size of the motif from the circumference of the vector line). The machine's working time is divided into 1 to 15 hours intervals.

TABLE V
WORK TIME RESULTS FOR BATIK CNC MACHINES

Total Image	Working Time	Total Image	Working Time
0 - 15	1 Hour	281 - 335	9 Hours
16 - 40	2 Hours	336 - 390	10 Hours
41 - 65	3 Hours	391 - 465	11 Hours
66 - 90	4 Hours	466 - 540	12 Hours
91 - 115	5 Hours	541 - 615	13 Hours
116 - 170	6 Hours	616 - 680	14 Hours
171 - 225	7 Hours	681 - 780	15 Hours
226 - 280	8 Hours		

Based on Table 5., 15 groups are producing hand-drawn batik on a written batik CNC machine, and each hour will be computed at IDR 15,000 for new members and IDR 12,500 for old members. Direct labor costs and the cost of raw supplies are included in the price. This computation was made based on the Butimo Batik operators already in use. The following equation determines the total image that appears:

$$\sum vertical\ image = \frac{LK-BAB}{UM+JM+JV} \quad (1)$$

where LK is canvas width ($Lebar\ Kanvas$), BAB is upper- lower limits ($Batas\ Atas\ Bawah$), UM is pattern size ($Ukuran\ Motif$), JM is pattern distance ($Jarak\ Motif$), JV is vertical distance ($Jarak\ Vertikal$).

$$\sum horizontal\ image = \frac{PK-BKK}{UM+JM+JH} \quad (2)$$

where PK is canvas length ($Panjang\ Kanvas$), BKK is right- left border ($Batas\ Kanan\ Kiri$), JH is horizontal distance ($Jarak\ Horizontal$).

$$\sum total\ image = \sum vertical\ image * \sum horizontal\ image \quad (3)$$

In the above Eq. (1), (2), and (3), there is a price determination flow that will be displayed on the calculation of hours determined by the company operator at Butimo Batik, and the size of the image determines the time parameter. These variables include motif size, motif distance, canvas border right-left, up-down, vertical space, and horizontal distance. This is because, up until this point, the longest image and canvas size distance was 15 hours, and the quickest working time with a written batik CNC machine was 1 hour. Fig. 5 displays a method for calculating the circumference of vector graphics. Finding the total images on the screen canvas comes after determining the vector image's perimeter. Calculating the total number of motifs (*Appendix 3.).*

4) Design of Estimated Production and Delivery Time Model: Computation of production time based on the duration of machining, the method of coloring, and the number of colors used. Fig. 6. depicts a flowchart for calculating production and delivery times. The customer orders through the system and selects his preferred color. The subsequent steps depend on how long it takes to create the batik motif. When employing dye with a single color, the process can be completed in a day if the dab technique is utilized, which can add a half-day to the process if fewer than 24 hours have passed. Delivery times range from 2 to 5 days, depending on the destination city.

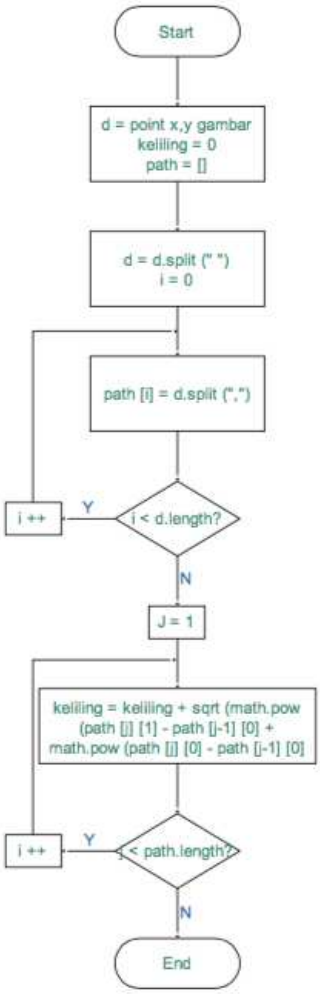

Fig. 5 Path for Determining the Circumference of Vector Images

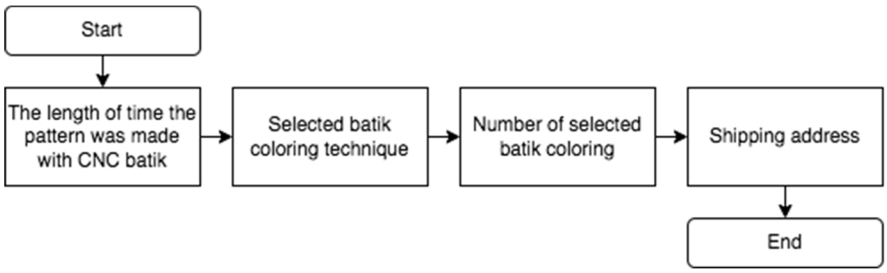

Fig. 6 Flowchart of Estimated Production and Delivery Time

D. Prototype

At this stage, the results in Fig. 5. and some of the necessary parameters are used to realize the design created with CAD custom batik motif software. The DSS will automatically determine the anticipated amount to be paid based on the model calculations in this prototype stage, after the user has finished creating the design. The production and delivery times will show up, after the user selects the batik design he wants to purchase. The Kawung and Fauna motifs are two instances of made-up motifs in Fig. 7. in the system prototype.

E. Model Implementation

This implementation step is carried out following user approval of the prototype design. Currently, the validation approach involves comparing the calculations made by the

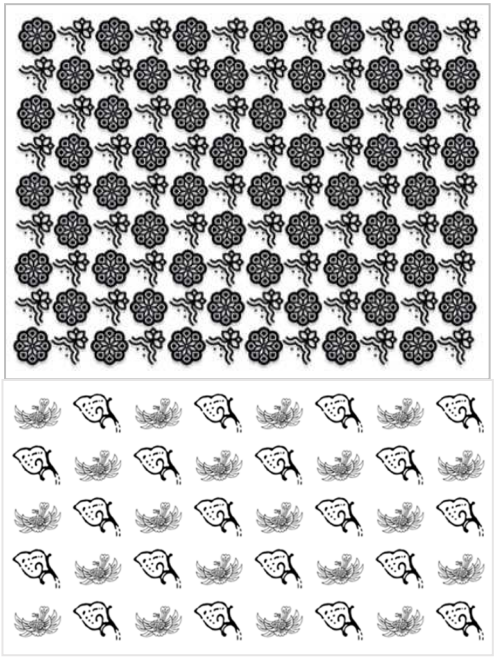

Fig.7 Example of Batik Design Result (Kawung and Fauna Motifs)

DSS model with those manually performed. The parameters for the first alternative simulation of the "Fauna" batik motif have been found and shown in Table 6. Next, the user wants to update the fabric section's settings for alternative 2, to quality 2 and color 2, respectively.

TABLE VI
CALCULATION OF ALTERNATIVE PRICES (FAUNA MOTIF SIMULATION)

Parameters	Alternative 1	Price 1 (IDR)
Price of Fabric	Quality 1 (Jarik 2,5m)	62,500
Price of Color	Celup (Dip)	30,000
	Indigosol 3 (Purple, red, yellow)	65,000
Price of Motive	Number of Images 40 (2 hours)	30,000
Total Price		187,500
Overhead (10%)		18,750
Margin (25%)		46,875
Selling Price		**253,125**

TABLE VII (A)
CALCULATION OF ALTERNATIVE PRICES

Parameters	Alternative 2	Price 2 (IDR)
Price of Fabric	Quality 2 (Jarik 2,5m)	50,000
Price of Color	Celup (Dip)	30,000
	Indigosol 2 (Yellow, gray)	30,000
Price of Motive	Number of Images 40 (2 hours)	30,000
Total Price		140,000
Overhead (10%)		14,000
Margin (25%)		35,000
Selling Price		**189,000**

TABLE VII (B)
VALIDATION TIMES AND PRICES COMPARISON

Calculation	Production Time (minutes)	Price (IDR)
DSS Model Calculation	780	253.125
Manual calculation	818	250.000
Difference comparison	**4.65%**	**1.25%**

A comparison of the costs and times for using the DSS system and the manual is shown in Table 7. below. In this validation, the manual calculation requires 818 minutes and costs IDR 250,000, whereas the DSS model estimates 780 minutes at a cost of IDR 253,125. compares the 1.25 percent difference. Based on these calculations, the manual computation and the DSS model only differ by a minimal amount or 1.25%. This DSS model, therefore, has an acceptable level of accuracy. Users can adapt their budgets by changing the parameters to suit their requirements and capacities by using various price options, shown in Fig. 8., Fig. 9., Fig. 10. in order to facilitate quicker decision-making when getting ready to order products with a custom batik design.

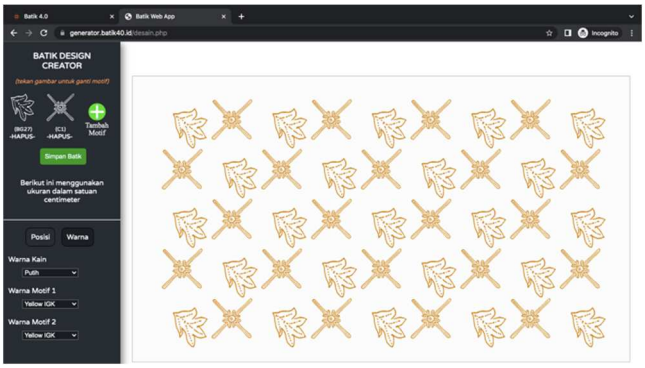

Fig. 8 Motifs Design in Prototype Example

Fig. 9 Changing the design parameters.

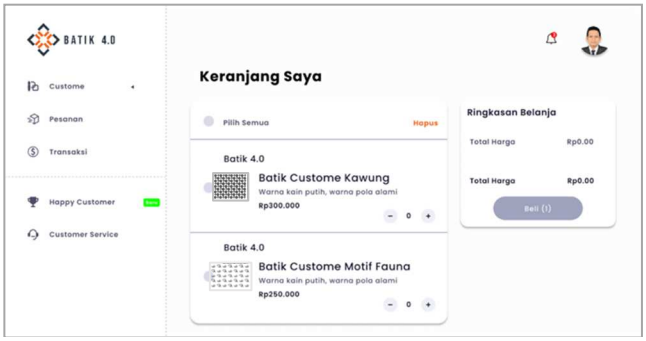

Fig. 10 Custom batik design products order

IV. Conclusion

DSS plays an essential role for producers in helping the decision-making process to determine costs and prices. DSS strongly emphasizes adaptation and flexibility so that it may be quickly tailored to the demands of the user. Before beginning production, a manager or other DSS decision-maker will collect reports, such as profitability reports, from the pertinent reporting system. Moreover, DSS can provide customers with alternative pricing by modifying the budget and criteria to their requirements and capacities. to facilitate quicker decision-making when ordering products with a custom batik design.

The design is the outcome of a DSS model on a custom-made batik employing CAD batik, with a written batik CNC machine being used in part of the production process. The developed mathematical model may precisely determine the production costs by calculating the processing time with a CNC batik machine. Additionally, the system has been enhanced by adding characteristics like the fabric type and the dye employed. Later, it can support Small and medium-sized companies (SMEs) in Industry 4.0.

This study's limitation is that the projected production time model didn't account for the queue when there were a lot of incoming orders, as the company's resources will undoubtedly be involved. Future research ideas can enhance these restrictions and compute the required or estimated production time and schedule until the delivery of goods, all of which are still handled manually.

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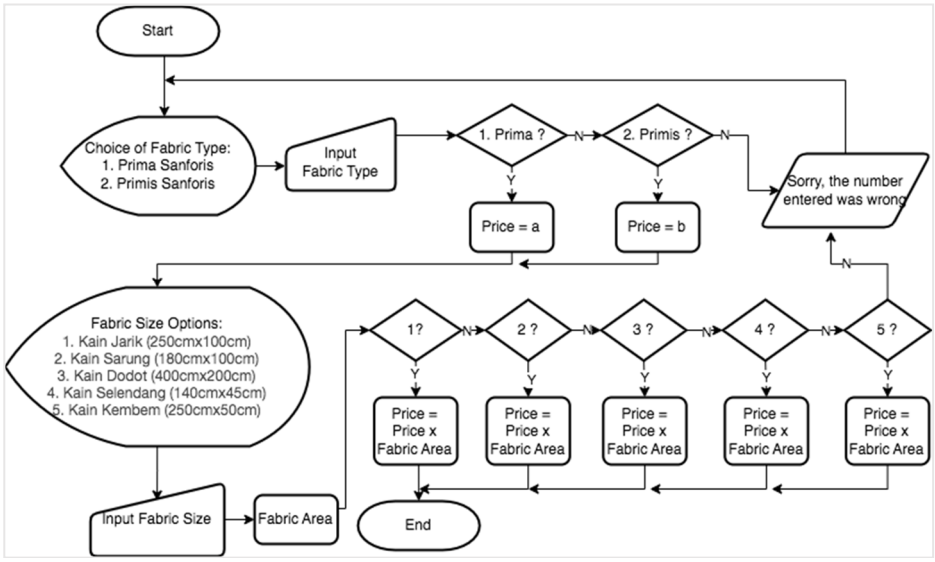
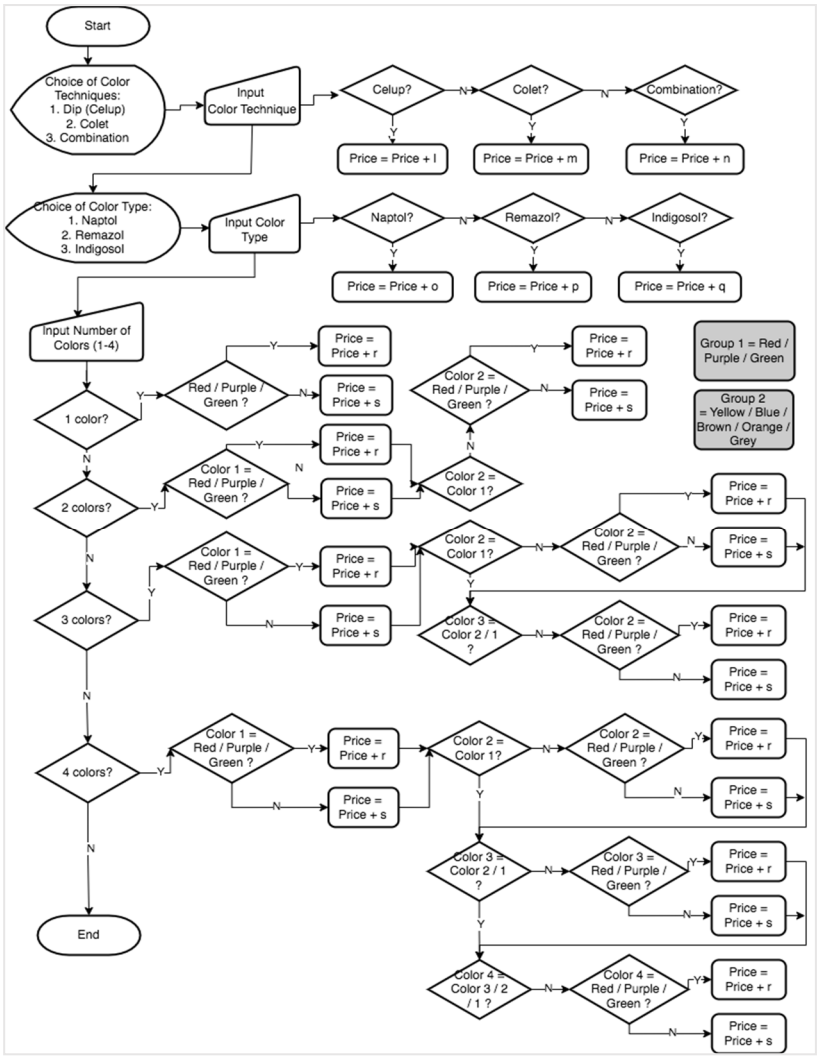
APPENDIX

Appendix. 1: Diagram of Fabric Pricing Model Based on Type and Size



Appendix. 2: Color Pricing Scheme Based on Technique, Type and Quantity



Appendix. 3: Determining the Total Number of Motifs

Finding the total images on the screen canvas comes after determining the vector image's perimeter. Figure below. illustrates the process for calculating the total number of motifs.