THE USAGE OF EIGEN VALUE AND VECTOR TO DETERMINE THE PRIORITY OF FACTORS IN INDONESIAN BATIK PURCHASE

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Abstract

Modern batik is one of the fashion trends that are always in demand by the market. When choosing batik, many factors are considered including the type of batik (writing or stamp), fabric material, motif, quality, color, price, and design (model). Of all these factors, the most influencing people in buying batik are prices, motifs, colors, and designs (models). This study used Eigen Values and Vectors to determine the priority of factors that influence batik purchases. To find out the factors that are most in demand by the market among the four factors (price, motif, color, and design), the study was conducted by providing a questionnaire containing a comparison between one factor and another. Respondents write down which factors to choose and give weight to each choice. The next step is to calculate the eigen values and make a decision based on the normalized eigen vector.

Keywords: Modern batik, Eigen values, Eigen vectors.

1. INTRODUCTION

Batik is an original Indonesian handicraft product that is always in demand by people of various levels and ages. When buying batik, people will choose and tend to compare based on price, motif, color, and design. The survey in the form of a questionnaire was distributed to 30 people in the productive age range (30-40 years) regarding the comparison between the four factors, namely comparing prices against motifs, colors, and designs. Likewise, motifs are compared against color and design factors, and colors are compared to design. The purpose of this study is to find out the factors that influence the purchase of batik so that batik SMEs can increase their creativity and productivity. The questionnaire model distributed is as follows:

Table 1. Research Questionnaire

Determining the Order of Priority of Batik Selection Criteria Survey
Filling instructions: Mark criteria (A) or criterion (B) in the dominant column and code in the weight column that matches your opinion. Code definition: 1: Both criteria are equally dominant

2: Criterion (A) is slightly more dominant than (B)
3: Criterion (A) is clearly more dominant than (B)
4: Criterion (A) is very dominant than (B)

Table 2. Dominant Comparison and Weight Value between Price, Motif, Color, and Design

No	Code	Variable Factors	Dominant	Weight
1	A	Price		
	B	Motif		
2	A	Price		
	B	Color		
3	A	Price		
	B	Design		
4	A	Motif		
	B	Color		
5	A	Motif		
	B	Design		
6	A	Color		
	B	Design		

The results of the survey can be written as follows:

Table 3. Results of the Dominant Value and Weight Value Survey between Price, Motif, Color, and Design

No	Code	Variable Factors	Dominant	Weight
1	A	Price	A	2
	B	Motif		
2	A	Price		3
	B	Color		
3	A	Price	A	3
	B	Design		
4	A	Motif	A	2
	B	Color		
5	A	Motif	A	2
	B	Design		
6	A	Color	A	3
	B	Design		

The data is displayed in a matrix with important price criteria 2 times of the motif and the price criterion is more dominant 3 times than the color, so that in place the motif and color are filled 1/2 and 1/3.

Table 4. Assessment Of All Factors

	Price	Motif	Color	Design
Price	1	2	3	3
Motif	1/2	1	2	2
Color	1/3	1/2	1	3
Design	1/3	1/2	1/3	1

2. RESEARCH METHODOLOGY

A. Positive Matrix

A matrix A is dimensioned n x n with entries/elements of real numbers and is called a positive matrix if all its entries/elements > 0. (Getut, 2014)

B. Perron – Frobenius Theorem

If the matrix A is dimensioned n x n then the matrix A has a positip real Eigenvalue r with the properties of :
a. r is the simple root of the characteristic equation.
b. r has a positip Eigen Vector
c. If λ is any other Eigenvalue of A, then |λ| < r.

C. Eigen Values and Eigen Vectors

If the matrix A is n x n dimensions, then the non-zero vector x ϵ Rⁿ is called the characteristic vector (eigen vector) of the

matrix A. (Leon, 1998)
If Ax = λx applies to a scalar λ, then λ is called the characteristic value (eigen value) of the matrix A. (Anton, 2000)

$$Ax = \lambda x \dots (1)$$
$$Ax - \lambda x = 0 \dots (2)$$
$$(A - \lambda I)x = 0 \dots (3)$$

The characteristic vector is a non-trivial solution (a solution that is not all zero) of (A - λ I)x = 0.
In order to obtain a non-trivial solution, then:

$$Det (A - \lambda I) = 0 \dots (4)$$

where Det (A - λ I) = 0 is called the characteristic equation. (Yess24, 2010)

Example: Determine the eigen values and eigen vectors of the matrix $A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$

Settlement:
$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix} - \begin{bmatrix} \lambda & 0 & 0 \\ 0 & \lambda & 0 \\ 0 & 0 & \lambda \end{bmatrix} = \begin{bmatrix} 1-\lambda & 0 & 0 \\ 0 & 1-\lambda & 0 \\ 0 & 0 & -\lambda \end{bmatrix}$$

$$\begin{bmatrix} 1-\lambda & 0 & 0 \\ 0 & 1-\lambda & 0 \\ 0 & 0 & -\lambda \end{bmatrix} = 0$$

(1-λ) (1-λ) (-λ) = 0
So the characteristic equation: (1-λ) (1-λ) (-λ) = 0.
Characteristic polynomial roots: λ1 = 0, λ2 = λ3 = 1
So the eigenvalues of the matrix A are 0 and 1.
For λ=0, the eigen vector corresponding to λ=0 is :

$$A-\lambda I = \begin{bmatrix} 1-\lambda & 0 & 0 \\ 0 & 1-\lambda & 0 \\ 0 & 0 & -\lambda \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

(A-λI) x = 0
$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

So $x_1 = 0$, $x_2 = 0$, $x_3 = a$, $a \neq 0$, $a \in R$

So that x = $\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$ is an eigen vector that

corresponds to λ = 0
In the same way, for λ = 1, the eigen vector

corresponding to λ = 1 is: $\begin{bmatrix} b \\ c \\ 0 \end{bmatrix}$

D. Simple Additive Weighting Method

Simple Additive Weighting Method is to calculate the weighted summation of the performance rating on each alternative across all attributes (Prasetyo, 2010). The greatest value will be chosen as the best alternative. This method requires the process of normalizing the decision matrix (X) to a scale that can be compared with all existing alternative ratings :

$$r_{ij} = \frac{x_{ij}}{Maxx_{ij}} \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(5)$$

r_{ij} = normalized performance rating value
x_{ij} = the value of the attribute that each criterion has
$Maxx_{ij}$ = the value of the sum of attributes against the sum of all attributes in the corresponding column

Table 5. Data Table Example

Alternative	X	Y	Z
A	4	5	2
B	2	3	4
C	5	1	3
D	3	2	5

Then the nominalized rating is as follows:

$r_{AX} = 4/14 \quad r_{AY} = 5/11 \quad r_{AZ} = 2/14$

$r_{BX} = 2/14 \quad r_{BY} = 3/11 \quad r_{BZ} = 4/14$

$r_{CX} = 5/14 \quad r_{CY} = 1/11 \quad r_{CZ} = 3/14$

$r_{DX} = 3/14 \quad r_{DY} = 2/11 \quad r_{DZ} = 5/14$

So that the normalized rating results are:

Table 6. Normalized Rating Results

Alternative	X	Y	Z
A	0.286	0.455	0.143
B	0.143	0.273	0.286
C	0.357	0.091	0.214
D	0.214	0.182	0.357

To search the Eigen Vector of each alternative is the same as looking for the average value of each row:
- Row A : (0.286 + 0.455 + 0.143) / 3 = 0.295
- Row B : (0.143 + 0.273 + 0.286) / 3 = 0.234
- Row C : (0.357 + 0.091 + 0.214) / 3 = 0.221
- Row D : (0.214 + 0.182 + 0.357) / 3 = 0.251

So that an Eigen Vector table can be created:
Table 7. Eigen Vector

Alternative	X	Y	Z	Eigen Vector
A	0.286	0.455	0.143	0.295
B	0.143	0.273	0.286	0.234
C	0.357	0.091	0.214	0.221
D	0.214	0.182	0.357	0.251
	1	1	1	1

The greatest value is alternative A so alternative A is the best choice.
For the price row and price column, obtained:

3. RESULT AND DISCUSSION

From Table 4 will be searched for eigen values in a way that the values in each column are divided by the sum of all the values in the corresponding column (normalization):
1. For the price row and price column, obtained:
$$\frac{1}{1+\frac{1}{2}+\frac{1}{3}+\frac{1}{3}} = 0.463$$
2. For the price row and motif column, obtained:
$$\frac{2}{2+1+\frac{1}{2}+\frac{1}{2}} = 0.50$$
3. For the price row and color column, obtained:
$$\frac{3}{3+2+1+\frac{1}{3}} = 0.474$$
4. For the price row and design column, obtained:
$$\frac{3}{3+2+3+1} = 0.33$$

5. For the motif row and price column, obtained:

$$\frac{\frac{1}{2}}{1+\frac{1}{2}+\frac{1}{3}+\frac{1}{3}} = 0.231$$

6. For the motif row and motif column, obtained:

$$\frac{1}{2+1+\frac{1}{2}+\frac{1}{2}} = 0.250$$

7. For the motif row and color column, obtained:

$$\frac{2}{3+2+1+\frac{1}{3}} = 0.316$$

8. For the motif row and design column, obtained:

$$\frac{2}{3+2+3+1} = 0.222$$

9. For the color row and price column, obtained:

$$\frac{\frac{1}{3}}{1+\frac{1}{2}+\frac{1}{3}+\frac{1}{3}} = 0.153$$

10. For the color row and motif column, obtained:

$$\frac{\frac{1}{2}}{2+1+\frac{1}{2}+\frac{1}{2}} = 0.125$$

11. For the color row and color column, obtained:

$$\frac{1}{3+2+1+\frac{1}{3}} = 0.158$$

12. For the color row and design column, obtained:

$$\frac{3}{3+2+3+1} = 0.333$$

13. For the design row and price column, obtained:

$$\frac{\frac{1}{3}}{1+\frac{1}{2}+\frac{1}{3}+\frac{1}{3}} = 0.153$$

14. For the design row and motif column, obtained:

$$\frac{\frac{1}{2}}{2+1+\frac{1}{2}+\frac{1}{2}} = 0.125$$

15. For the design row and color column, obtained:

$$\frac{\frac{1}{3}}{3+2+1+\frac{1}{3}} = 0.052$$

16. For the design row and design column, obtained:

$$\frac{1}{3+2+3+1} = 0.111$$

The calculation above can be classified as follows:

Table 8. Normalized Eigen Values

	Price	Motif	Color	Design
Price	0.463	0.50	0.474	0.33
Motif	0.231	0.250	0.316	0.222
Color	0.153	0.125	0.158	0.333
Design	0.153	0.125	0.052	0.111

The eigen vector is obtained from the average of each row:
- For the price row obtained the eigen vector:
  (0.463+0.50+0.474+0.33) / 4 = 0.442
- For the motif row obtained the eigen vector:
  (0.231+0.250+0.316+0.222) / 4 = 0.255
- For the color row obtained the eigen vector:
  (0.153+0.125+0.158+0.333) / 4 = 0.192
- For the design row obtained the eigen vector:
  (0.153+0.125+0.052+0.111) / 4 = 0.110

The results of the eigen vector calculation above can be labeled as follows:

Table 9. Normalized Eigen Vector

	Price	Motif	Color	Design	Eigen Vector
Price	0.463	0.50	0.474	0.33	0.442
Motif	0.231	0.250	0.316	0.222	0.255
Color	0.153	0.125	0.158	0.333	0.192
Design	0.153	0.125	0.052	0.111	0.110
	1	1	1	1	1

From the calculations in Table 9 above, it shows that the price criterion is the most dominant criterion with a weight value of 0.442 or 44.2%, then followed by the motif criteria in the second place with a weight value of 0.255 or 25.5% while the third order is the color criterion with a weight value of 0.192 or 19.2% and the last order is the design criterion with a weight value of 0.110 or 11.0%.

4. CONCLUSION

From the discussion above, the price is the dominant / most important factor for choosing batik at 44.2%, followed by the motif factor in the second place with a weight value of 25.5% while the third order is the color factor with a weight value of 19.2% and the last order is the design factor with a weight value of 11.0%.

5. ACKNOWLEDGMENTS

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