

Raw Material Supplier Selection Information System Using Promethee Method on Batik Tulis Lasem

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ABSTRACT: The need for raw materials for the production of Batik Tulis Lasem, apart from the Batik Tulis cooperative, is also obtained through suppliers. Selection of raw material suppliers is one of the solutions to meet the needs of raw materials, thus supporting the performance and production process. The selection of raw material suppliers must also take into account the long term, PROMETHEE is an outranking method for a limited set of alternative actions to be ranked and chosen among criteria, which are often conflicting. The development of Information Systems to support decisions on determining suppliers of raw materials for written batik SMEs is the right solution to solve problems experienced by business actors.

Keywords: UMKM Batik Tulis Lasem, Supplier, PROMETHEE, Decision Support System.

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INTRODUCTION

Lasem Batik is one of the regional superior products in Rembang Regency. Lasem batik is one of the ancestral heritages which is an acculturation between Java and China (Roziqin et al., 2021). Currently, Batik Tulis Lasem is experiencing a fairly extensive marketing development and is even export-oriented (A. H. Abdullah & Samin, 2020). Some of Lasem's Batik Tulis MSMEs are members of the Sarwo Endah KUB with more than 20 Batik Tulis MSMEs members. The need for raw materials for the production of Batik Tulis Lasem, apart from the Batik Tulis cooperative, is also obtained through suppliers. The raw materials for the production of written batik include cloth, batik color reinforcement, canting, wax. The selection of raw material suppliers is one solution to meet the needs of raw materials, thus supporting the performance and production process (Hruška et al., 2014).

Supply chain management is one of the important supporting factors for industry in this competitive era (Chang et al., 2011). Suppliers have an important role in the supply chain to consumers (Mehmet Sevkli) in this case is the UMKM of Batik Lasem. The selection of suppliers is carried out through a review process, an evaluation process and the selection stage (Azadfallah, 2017). In the selection of suppliers, SMEs are expected to do it right so that there are no errors in determining the selection of raw materials.

The need for raw materials is a crucial requirement for the industry to support the continuity of the production process. The need for these raw materials requires quite a large cost, because part of the company's income is used for spending on these raw materials (Safari et al., 2012). The selection of raw material suppliers must also take into account the long term (Liu et al., 2020). Supplier selection is used to identify a decision-making problem so that it is able to meet the company's needs consistently and sustainably with appropriate financing according to the company's existence (Safari et al., 2012).

The PROMETHEE method is a flexible and simple method of determining automatic rankings in the decision-making process by analyzing various multi-criteria problems (Nasution et al., 2019). The PROMETHEE method is one of the MCDM (multi-criteria decision making) methods which is quite simple in its application (Behzadian et al., 2013). In the last few years the Promethee method has been used to solve problems in determining supplier selection (Safari et al., 2012), logistics supplier selection (Chen et al., 2010), suppliers of aroicultural products (Liu et al., 2020), comparisons and industry rankings. Competency-based (Veza et al., 2015). The decision-making process will not get accurate results if it does not use the right software to support decision-making (Behzadian et al., 2010).

PROMETHEE is an outranking method for a limited set of alternative actions to be ranked and selected among criteria, which are often conflicting (Alberti et al., 2011). There are more than 10 suppliers of written batik raw materials, most of whom come from outside the Rembang district. Making this Information System is one of the application frameworks in Supply Chain Management (SCM) to support decision making for companies (Kristianto et al., 2012).

THEORETICAL REVIEW

Supplier selection is one of the crucial factors for supporting the company's sustainability (Kristianto et al., 2012). The selection of suppliers becomes a reality that attracts attention for business owners but also for academics. The goal obtained from selecting the right supplier is the reliability of the supplier from the many alternative choices available (Liu et al., 2020). In the last few years, many researches have been carried out with case studies of supplier selection, which present comprehensive results that serve as a reference in solving decision-making problems.

Promethee Method

The PROMETHEE method was proposed by Brans, Vincke, and Mareschal in 1984. The Promethee method is a method of ranking, evaluating several alternative choices with specified criteria. Promethee is one of the models by determining the preference structure between alternatives by considering the preference function performed by the decision maker from each criterion so that it can perform partial ranking for each alternative (Moreira et al., 2021).

The decision-making process is prone to conflicts of interest, decision-making is a condition that often occurs at the top management level. PROMETHEE can assist top management in determining the best option from several available alternatives (Nasution et al., 2019).

The application of the promethee method begins with determining the criteria and then evaluating the alternatives that will be chosen (Peterková & Franek, 2018). In evaluating alternatives to this criterion, numerical data is needed by determining the relative importance and the function of decision-making preferences (Feng et al., 2020). Information is obtained in decision making by comparing the contributions of alternatives in each of the established criteria (L. Abdullah et al. ., 2019).

The PROMETHEE method is one of the methods used to make decisions with multiple criteria and is good at ranking. This method is very practical and is supported by a simple concept (Mehr et al., 2017). PROMETHEE can simultaneously handle qualitative and quantitative criteria, by ranking several alternatives (Ishak et al., 2019). A decision support system using the PROMETHEE method can be used as a framework for management in dealing with complex decision-making problems whose concepts can be applied to innovation management including ERP systems, information systems, technology, business models (Peterková & Franek, 2018).

The selection of raw material suppliers is carried out by identifying those with the highest potential, so that mamou fulfills the integrity of the company. Selection of the right supplier will be able to reduce operational costs and increase the company's competitiveness (Safari et al., 2012). In the ranking, the determination of suppliers is determined from the results of the netflow value from the lowest order to the best supplier (L. Abdullah et al., 2019).

Hand-drawn Batik SMEs

The Small, Micro, and Medium Enterprises (SME) sector has an important role in economic growth in a country, because it is able to create jobs and reduce poverty (Chimucheka et al., 2015). Small, medium, and micro enterprises (SMEs) are able to respond to challenges such as poverty alleviation and the unemployment rate can be overcome with policies that promote development and sustainability (Bvuma & Marnewick, 2020).

Written batik was officially confirmed as a list of intangible cultural heritage. Batik is a creative product made using traditional tools (Jakaria et al., 2018). The Lasem hand-drawn batik industry is a local and distinctive heritage of Rembang Regency (Roziqin et al., 2021).

In every business process, supply chain management is used to manage and organize plans from the acquisition of raw materials to finished goods that are distributed to consumers. Problems in supply chain management include determining suppliers or also the distribution process to end consumers according to the just-in-time concept. Batik Tulis Lasem is still facing problems, namely the application of the supply chain model (Tahwin et al., 2016). Suppliers of batik written raw materials include those from Yogyakarta, Solo and Pekalongan. Some of the criteria used in determining suppliers include the quality of the raw materials offered by the supplier, the delivery process, the price offered, the service, the capacity of the raw materials offered, the behavior and ethics of the supplier, technical implementation, information disclosure and the supplier's commitment to preserving the environment in relation to materials. standard offered (Saqdiah et al., 2022).

METHODOLOGY

This research data was obtained from 20 Lasem batik SMEs who are members of the Sarowo Endah KUB in 2021. The development of this decision support system uses the waterfall model. Implementation of a decision support system to determine suppliers of raw materials for Lasem batik uses the following approach:

1. Conducting interviews and observations to obtain variables in supplier selection to make decisions, as well as support for literature studies that are relevant to the research.
2. Identify the criteria used to determine suppliers of batik raw materials. Multi-criteria problem (Apriani et al., 2020). Meanwhile, according to (Brans et al., 1986) the purpose of using promethee analysis is to facilitate the decision-making process by grouping the types of decisions into six criteria functions (preferences).

a. General preference criteria (usual criterion)

The Usual type is the basic type, which has no threshold value or trend and this type is rarely used. Mathematically it can be written in the following notation:

$$p(x)=\{0\forall x\leq 0\ 1\forall x>0\}p(x)=\{0\forall x\leq 0\ 1\forall x>0\} \dots\dots\dots 1)$$

In this type, it is considered that there is no difference between alternative a and alternative b if $a=b$ or $f(a)=f(b)$, then the preference value is 0 (zero) or $P(x)=0$. If the value of the criteria for each alternative has a different value, then the decision maker makes an absolute preference of 1 (One) or $P(x) = 1$ for the alternative that has a better value.

b. Quasi .preference criteria

Quasi type is often used in assessing a data in terms of quality or quality, in which this type uses a predetermined threshold or trend, in this case the threshold is indifference. This indifference is usually denoted by the character m or q, and the indifference value must be above 0 (zero).

$$p(x)=\{0x\leq m\ 1x>m\}p(x)=\{0x\leq m\ 1x>m\} \dots\dots\dots 2)$$

An alternative has an equally important preference value as long as the difference or $P(x)$ value of each alternative does not exceed the threshold value. If the difference in the evaluation results for each alternative exceeds the value of m or q, then there is an absolute preference form, if the maker decides to use this criterion, the decision maker must determine the value of m or q, where this value can explain the significant effect of a criterion.

c. Linear preference criteria

Linear type is often used in quantitative or quantitative assessments, where this type also uses a predetermined threshold or trend, in this case the threshold is preference.

$$p(x)=\{xnx\leq n\ 1x>n\}p(x)=\{xnx\leq n\ 1x>n\} \dots\dots\dots 3)$$

This preference is usually denoted by the character n or p, and the preference value must be above 0 (zero). This criterion explains that as long as the difference value has a lower value than n or p, then the preference value of the decision maker increases linearly with the value of x, if the value of x is greater than the value of n or p, then there is an absolute preference.

d. Level preference criteria

This type is similar to the Quasi type which is often used in assessing a data in terms of quality or quality. This type also uses an indifference threshold (m or q) but is added one more threshold, namely preference (n or p).

$$p(x) = \begin{cases} 1 & \text{if } 0 \leq x \leq m \\ 0 & \text{if } m < x \leq n \end{cases} \quad p(x) = \begin{cases} 1 & \text{if } 0 \leq x \leq m \\ 0 & \text{if } m < x \leq n \end{cases} \dots 4)$$

- e. Linear and area preference criteria that do not differ

The Quasi Linear type is also similar to the Linear type which is often used in quantitative or quantitative assessments. This type also uses a threshold preference (n or p) but adds one more threshold, namely indifference (m or q).

$$p(x) = \begin{cases} 1 & \text{if } 0 \leq x \leq m \\ 0 & \text{if } m < x \leq n \end{cases} \quad p(x) = \begin{cases} 1 & \text{if } 0 \leq x \leq m \\ 0 & \text{if } m < x \leq n \end{cases} \dots 5)$$

The indifference and preference value must be above 0 (zero) and the indifference value must be below the preference value. Decision making considers preference increases linearly from no different to absolute preference in the area between two tendencies m and n (or q and p)

- f. Gaussian Criteria

Gaussian type is often used to find safe values or safe points in data that is continuous or running continuously

$$p(x) = \begin{cases} 1 & \text{if } 0 \leq x \leq 1 \\ 0 & \text{if } x > 1 \end{cases} \quad p(x) = \begin{cases} 1 & \text{if } 0 \leq x \leq 1 \\ 0 & \text{if } x > 1 \end{cases} \dots 6)$$

This type has a threshold value, namely the Gaussian threshold which corresponds to the standard deviation value or normal distribution in statistics

3. Design a decision support system for determining suppliers of Lasem batik raw materials using the PROMETHEE method, while for coding the system using PHP with MySQL database support.

4. Testing the decision support system using a black box system, by conducting direct trials from the research team and questionnaires for MSME actors.

RESULTS

System Implementation

Implementation of Information System for determining supplier of written batik with several views of the PROMETHEE method. User interface display as shown in Figure 1., is used for account creation for managers/admins and account creation for decision makers.

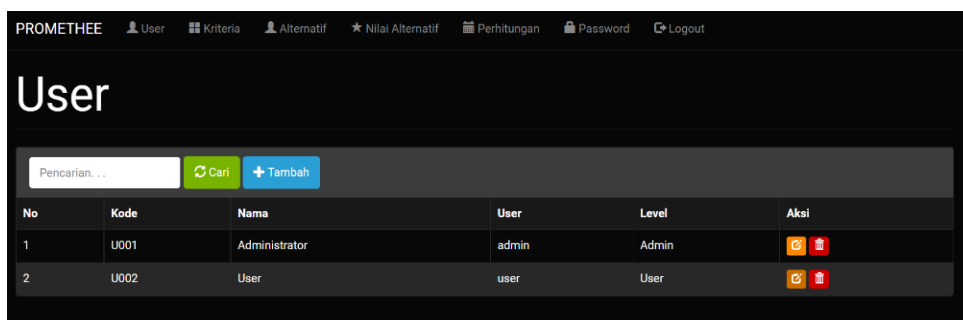
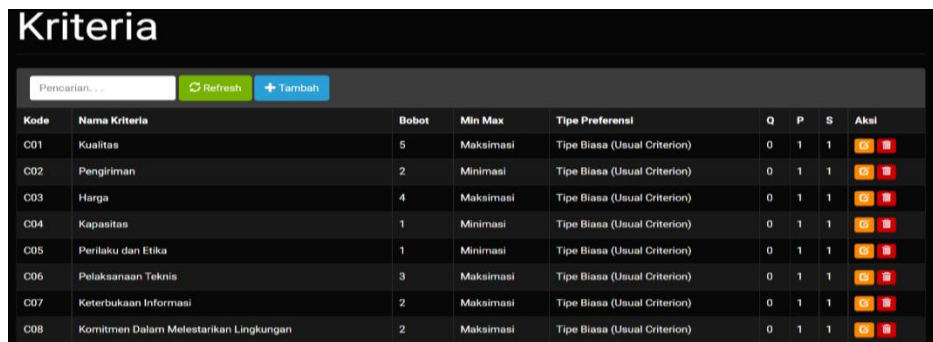


Figure 1 : User View

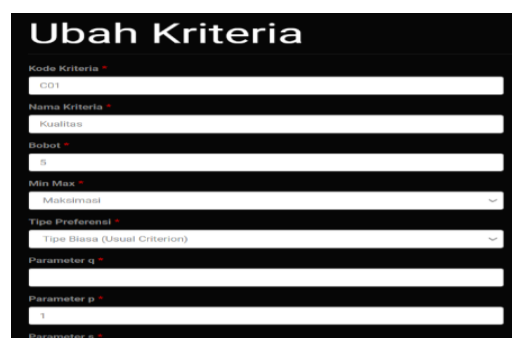
After creating users for admin and decision makers / management, the next step is to determine the criteria used for determining suppliers. The criteria used are: C01: Quality, quality is the criterion of the quality of the raw materials offered by the supplier, C02: Delivery, delivery is one of the criteria for batik SMEs to determine the delivery period from the time the order is received until it is received. C03: Price, price is the criterion variable offered from the raw materials offered from each raw material item, C04: Capacity: capacity is the sum of the supplier's ability to provide supply materials, C05: Behavior and Ethics, behavior and ethics are an important variable from suppliers to determine the value of the criteria from suppliers, C06: Technical Implementation, the process of determining suppliers related to technical implementation related to activities carried out from the supply chain management (SCM) process, C07: Information Disclosure, one of the important factors from suppliers is the disclosure of information provided by the supplier to the UMKM Batik Tulis, C08: Commitment in preserving the environment, this commitment is shown by the raw materials offered by the supplier. The criteria used to determine the supplier of raw material for Batik Tulis Lasem are as shown in Figure 2.



Kode	Nama Kriteria	Bobot	Min Max	Tipe Preferensi	q	p	s	Aksi
C01	Kualitas	5	Maksimasi	Tipe Biasa (Usual Criterion)	0	1	1	[Edit] [Delete]
C02	Pengiriman	2	Minimasi	Tipe Biasa (Usual Criterion)	0	1	1	[Edit] [Delete]
C03	Harga	4	Maksimasi	Tipe Biasa (Usual Criterion)	0	1	1	[Edit] [Delete]
C04	Kapasitas	1	Minimasi	Tipe Biasa (Usual Criterion)	0	1	1	[Edit] [Delete]
C05	Perilaku dan Etika	1	Minimasi	Tipe Biasa (Usual Criterion)	0	1	1	[Edit] [Delete]
C06	Pelaksanaan Teknis	3	Maksimasi	Tipe Biasa (Usual Criterion)	0	1	1	[Edit] [Delete]
C07	Keterbukaan Informasi	2	Maksimasi	Tipe Biasa (Usual Criterion)	0	1	1	[Edit] [Delete]
C08	Komitmen Dalam Melestarikan Lingkungan	2	Maksimasi	Tipe Biasa (Usual Criterion)	0	1	1	[Edit] [Delete]

Figure 2 : Display Criteria

In determining the criteria, the data that must be inputted are the criteria code, criteria name, weight, Min/max, preference tip with a choice of ordinary type (usual criterion), quasi type (quasi criterion/u-shape, linear type (linear criterion/v-shape) , type level/level criterion, type linear quasi/linear criterion with indifference, type gaussian, other input data is the determination of parameters q, p and s, as shown in Figure 3.



Ubah Kriteria

Kode Kriteria : C01

Nama Kriteria : Kualitas

Bobot : 5

Min Max : Maksimasi

Tipe Preferensi : Tipe Biasa (Usual Criterion)

Parameter q : 0

Parameter p : 1

Parameter s : 1

Figure 3 : Change Criteria Menu

In the alternative change menu, the PROMETHEE method is used to input data on alternative raw material suppliers who submit bids to MSMEs, as shown in Figure 4.

Figure 4 : Alternative Input Menu

Determination of weights and calculations begin with weight conversion as shown in Table 1.

Table 1 : Weight Conversion

Score	Weight
8.1 – 10.0	5
6.1 – 8.0	4
4.1 – 6.0	3
2.1 – 4.0	2
1.0 – 2.0	1

The menu for determining weights is as shown in Figure 5.

Figure 5 : Alternative Weight Input Menu

The ranking menu display as Figure 6 shows the ranking of alternative suppliers, the value of leaving flow, entering flow, net flow, from the previous calculation process, the ranking display shows a list of sequences.

Hasil Akhir				
Alternatif	Leaving Flow	Entering Flow	Net Flow	Urutan
PT D	13.1111	2	11.1111	1
PT C	9.7778	4.1111	5.6667	2
PT A	9.6667	4.5556	5.1111	3
PT I	9.3333	4.6667	4.6667	4
PT H	7.1111	7.4444	-0.3333	5
PT B	7.6667	8.5556	-0.8889	6
PT J	5.8889	9.6667	-3.7778	7
PT F	6.1111	10	-3.8889	8
PT G	4.1111	12	-7.8889	9
PT E	3.8889	13.6667	-9.7778	10
Alternatif produk terbaik adalah PT D dengan total: 11.1111				
Cetak				

Figure 6 : Ranking

System Test

Application testing using the PROMETHEE method in determining suppliers of Lasem batik raw materials using the Black Box method and comparison testing. Test results with black box as Table 2

Table 2 : Test Result System

No.	Test Step	Desired Result	Test Result	Program Response
1.	Login	Successfully	Succeed	Succeed
2,	User	Successfully Logged In	Succeed	Succeed
		Successfully Added User And Setting User Password	Succeed	Succeed
3	Criteria Menu	Successfully Added And Saved Data	Succeed	Succeed
4	Alternative Menu	Successfully Added And Saved Data	Succeed	Succeed
5	Alternative Value Menu	Successfully Added And Saved Data	Succeed	Succeed
6	Calculation Menu	Successfully Display The Calculation Results	Succeed	Succeed
7	Changed Password Menu	Successfully Changed Password	Succeed	Succeed

DISCUSSION

This scientific article has produced references in determining the supplier of raw material for Lasem's hand-drawn batik. Various preferences have been widely used, preferences using the usual criteria (usual criterion) are considered as the simplest criterion function. The combination of linear preference and level preference is used for net outflows, which are selected based on the order of their respective criteria. The ranking results show that PT D's supplier consistently ranks first. On the other hand, the supplier of PT E has the weakest preference of the two preference functions.

CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis and testing that has been done, several conclusions can be drawn, including:

1. The implementation of the PROMETHEE method in determining supplier priorities has been successfully applied. Produce a system that can display the ranking of each supplier against the final assessment results in accordance with predetermined criteria.
2. The assessment criteria consist of Quality, Delivery, Price, Capacity, Behavior and Ethics, Technical Implementation, Information Disclosure, Commitment. The output of the system is a ranking of each customer supplier based on the highest value to the lowest value.
3. The application of the PROMETHEE method in determining suppliers makes it easier for MSMEs with written batik to make decisions and become an alternative way to avoid differences of opinion between MSMEs who are members of the Joint Business Group (KUB).
4. The application of the PROMETHEE method uses a preference type of 1 usual criterion (usual criterion) and has a very good level of accuracy, namely the accuracy value reaches 100% and the error rate is 0%.

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