



# The use of SMART and TOPSIS methods in decision making systems for prioritizing screen printing production

Jonas Franky R Panggabean<sup>1</sup>, Leliana Harahap<sup>2</sup>, Kamson Sirait<sup>3</sup>, Sutrisno Situmorang<sup>4</sup>, Sartika Dewi Purba<sup>5</sup>

<sup>1</sup>Manajemen Informatika, Akademi Informatika dan Komputer Medicom, Medan, Indonesia

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## Abstract

Prioritization in screen printing production is a challenge for companies to improve efficiency and product quality, especially in conditions involving various conflicting criteria. This research aims to develop a decision-making system that can optimize the prioritization of screen printing production by using the SMART method for criteria weighting and the TOPSIS method for alternative analysis. The SMART method is used to assign weights to relevant criteria, while the TOPSIS method is used to evaluate and rank alternatives based on the relative distance to positive and negative ideal solutions. The results show that alternative B has the highest ranking with a preference index value of 0.587, which reflects the optimal combination of cost, time, quality, market demand, and resources. The implication of these findings is that combining the two methods can provide more objective and measurable decisions in the management of screen printing production, but further testing is needed on a wider scale and by considering dynamic external factors. This research opens up opportunities for the development of more adaptive systems in production decision-making in the screen printing industry.

## Corresponding Author:

Jonas Franky R Panggabean,

Manajemen Informatika,

Akademi Informatika dan Komputer Medicom,

Jl. Darat No.74, Petisah Hulu, Kec. Medan Baru, Kota Medan, Sumatera Utara 20152, Indonesia.

Email : [jonasfrankypanggabean@gmail.com](mailto:jonasfrankypanggabean@gmail.com)

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## 1. Introduction

The rapid advancement of information technology has led to the creation of various computer-based systems that can replace some human tasks (Galbreath, 1999; Jasim & Raewf, 2020; Mohapatra, 2021). These systems not only increase work efficiency, but also reduce the risk of errors due to human limitations. One of the rapidly growing systems is the Decision Support System (DSS), which is designed to assist complex decision-making processes in various sectors, including the manufacturing industry (Guo et al., 2020; Soori et al., 2024). In the context of the screen printing industry, decision-making regarding production priorities is a significant challenge, given the many variables that must be considered, such as cost, production time, resource capacity, and market demand. Decision Support Systems enable the systematic management of these variables, resulting in more objective and measurable decisions. However, the conventional approach that is often used still faces various limitations, such as inaccuracy in weighting criteria and lack of flexibility in handling

dynamic data. Therefore, a more adaptive and integrated method is needed to improve the effectiveness of the decision-making process. In this context, the Simple Multi Attribute Rating Technique (SMART) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methods offer promising approaches. The SMART method is able to provide systematic weighting of criteria based on user preferences, while the TOPSIS method considers the distance of each alternative to positive and negative ideal solutions to produce more accurate decisions. The combination of these two methods is expected to deliver a decision-making system that is not only efficient, but also relevant to the specific needs of the screen printing industry (Alvarez et al., 2021; Chen et al., 2020; Zolfani & Chatterjee, 2019).

The decision-making process in prioritizing screen printing production is a complex and crucial challenge for the industry, especially in the context of small and medium-sized enterprises. This complexity arises due to the various criteria that must be considered simultaneously, such as production cost, turnaround time, market demand level, product quality, and resource availability. Traditional approaches that rely on subjective experience or manual judgment often result in inaccurate decisions and potentially hamper operational efficiency. In addition, the use of a single decision-making method such as TOPSIS often faces limitations in providing optimal results, especially in the aspect of weighting criteria. TOPSIS does not have a mechanism that specifically compares preferences between criteria, so the weights given tend to be less systematic. This can reduce the objectivity of the resulting decision. Meanwhile, the SMART method offers the ability to systematically weight criteria based on user preferences, but does not consider the distance of solutions to ideal values as TOPSIS does. These limitations indicate the need for a more integrated approach to overcome the weaknesses of each method and provide more accurate and relevant solutions. Thus, this research is focused on developing a decision-making system that integrates the SMART and TOPSIS methods to prioritize screen printing production. The combination of these two methods is expected to deliver a decision-making system that is not only efficient, but also relevant to the specific needs of the screen printing industry (Barton et al., 2022; Islam et al., 2021; Verma et al., 2022).

Previous research has examined the use of various decision-making methods to support production and management processes in various industries. Dos Santos (2019) developed a decision support system based on the Analytic Hierarchy Process (AHP) method to determine the priority of goods production in online stores. This research shows that the AHP method is effective in accelerating the decision process and reducing production waiting time. However, the system has limitations in dynamically updating criteria, thus reducing its flexibility in dealing with changing industry needs. Another study by Oktavianti (2019) used the Simple Multi Attribute Rating Technique (SMART) method for selecting cafes in Samarinda. As a result, this method is able to provide systematic recommendations, but the ranking results are less accurate because they are limited to evaluating criteria without considering ideal solutions as done by other methods, for example TOPSIS. These two studies indicate the need for integration of methods that can overcome the weaknesses of each, both in terms of flexible criteria weighting and accurate evaluation of alternatives. To this end, this research proposes the development of a decision-making system that combines the SMART and TOPSIS methods. This combination offers systematic criteria weighting through SMART, as well as alternative evaluation that considers both positive and negative ideal solutions through TOPSIS. This approach is expected to not only overcome the limitations in previous research but also make a significant contribution to decision-making in the screen printing industry. Thus, this research is not only relevant in an academic context, but also has a wide potential for practical application.

This research aims to develop a decision-making system that is able to determine production priorities in the screen printing industry objectively, accurately, and efficiently. The system integrates the Simple Multi Attribute Rating Technique (SMART) method for systematic weighting of criteria with the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method, which considers the distance of each alternative to positive and negative ideal solutions. This approach is expected to overcome the weaknesses of each method, such as the lack of a specific weighting

mechanism in TOPSIS and the limited evaluation of ideal solutions in SMART. In addition, this research aims to make a practical contribution to the screen printing industry, particularly in optimizing the management of production priorities based on various criteria, such as cost, turnaround time, market demand, and resource capacity. By producing an integrated decision-making system model, this research is expected to support a more efficient production process, improve business competitiveness, and provide a strong scientific basis for further development in the field of multi-criteria decision support systems.

Although previous research has examined various decision-making methods to support production prioritization, there are still significant gaps in the approaches used. The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method, for example, offers the ability to evaluate alternatives based on positive and negative ideal solutions. However, this method lacks a specific criteria weighting mechanism, so the ranking results tend to depend on subjectively assigned weights without systematic consideration. On the other hand, the Simple Multi Attribute Rating Technique (SMART) method allows systematic weighting of criteria based on user preferences, but does not take into account the distance of alternatives to the ideal solution, which may reduce the accuracy of decision results. Furthermore, previous research using single methods, such as AHP or SMART, showed limitations in dealing with complex decision-making situations with many interacting criteria. This creates a need for a more integrated and adaptive approach to overcome the weaknesses of each method. The combination of SMART and TOPSIS methods offers a promising solution to fill this gap, by combining the advantages of systematic criteria weighting of SMART and ideal solution-based alternative evaluation of TOPSIS. However, to date, there has been little research specifically integrating these two methods in the context of the screen printing industry, which is an important foundation for this research contribution.

This research offers an innovative approach through the integration of Simple Multi Attribute Rating Technique (SMART) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methods to build a more effective and efficient decision-making system in determining production priorities in the screen printing industry. The novelty of this research lies in combining the advantages of two complementary multi-criteria methods, namely SMART's ability to provide systematic and flexible weighting of criteria based on user preferences, and TOPSIS's ability to evaluate alternatives based on distance to positive and negative ideal solutions. This combination has not been explored in depth in the context of the screen printing industry, which has unique challenges related to dynamic criteria-based production prioritization needs. The justification for this research lies in its urgency and relevance to the practical needs of the industry. In an increasingly competitive business environment, the ability to determine production priorities quickly and accurately becomes a key factor to improve operational efficiency and competitiveness. The proposed system not only addresses the limitations of conventional methods but also offers an approach that can be customized to the specific needs of the industry. In addition to its practical contribution, this research also makes a significant contribution to the academic literature in the field of multi-criteria decision support systems, by demonstrating how the integration of SMART and TOPSIS methods can be effectively implemented to solve complex decision-making problems.

## **2. Research Methodology**

### **Research Design**

This research uses a quantitative approach with an experimental design to develop and test a decision-making system based on the Simple Multi Attribute Rating Technique (SMART) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methods (Ozturk & Batuk, 2011; Starfield, 2005). The research was conducted systematically through data collection of production criteria, calculation of criteria weights using the SMART method, and analysis of alternatives using the TOPSIS method. The focus of the research is to integrate these two methods to create a system that can determine production priorities in the screen printing industry objectively and efficiently (Oktavianti et al., 2019; Ramón-Canul et al., 2021).

### Alternatives and Criteria

This research establishes production alternatives in the form of screen printing products to be prioritized based on data collected from related industries. The alternatives include several types of screen printing products with different specifications, such as design, size, and target market. The criteria used to evaluate the alternatives include:

1. Production cost: The amount of cost required to produce one unit of product.
2. Turnaround time: The length of time required to complete production.
3. Market demand: The level of demand for a particular product based on sales data or surveys.
4. Resource availability: Availability of raw materials and labor capacity for production.
5. Product quality: Quality standards expected by consumers based on test or inspection results.

### Technical Data Analysis

Data analysis was conducted through several stages:

1. Initial data collection: Alternative data and criteria were obtained from field surveys, interviews with screen printing industry players, and supporting documents.
2. Weighting of criteria using SMART: Each criterion is evaluated and weighted based on user or expert preferences using an agreed value scale.
3. Evaluation of alternatives using TOPSIS: The weight values from SMART are used to calculate the distance of each alternative to the positive and negative ideal solutions. This process involves normalizing the decision matrix, weighting the matrix, calculating the distance, and ranking the alternatives.
4. Validation of results: The results of the ranking of alternatives were evaluated through discussions with industry players to ensure the relevance and accuracy of the decisions generated by the system.

### 3. Results and Discussion

Application of the steps of calculating criteria weights using the SMART method and analyzing alternatives using the TOPSIS method with three alternative screen printing products that will be prioritized in the production process, with five criteria as follows: Production Cost, Completion Time, Market Demand, Resource Availability, Product Quality.

#### 1. Preparation of the Decision Matrix

The alternatives to be evaluated are three screen printing products: A, B, and C. The initial decision matrix (performance values for each alternative and criteria) is as follows:

Table 1. alternatives

Criteria	A	B	C
Production Cost (Rp)	150	200	180
Completion Time (Days)	5	3	4
Market Demand (Unit)	500	700	600
Resource Availability	70	60	80
Product Quality (Scale 1-10)	8	9	7

#### 2. Normalization of the Decision Matrix

Normalization is done using the Euclidean formula:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}}$$

#### Normalization for Production Cost

Production cost is a cost criterion, so the smaller the better. So, the best value is the smallest value.

$$= \sqrt{150^2 + 200^2 + 180^2} = \sqrt{94900} \approx 308.04$$

Normalization for each alternative (for Production Cost)

$$r_{A1} = \frac{150}{308.04} \approx 0.487$$

$$r_{B1} = \frac{200}{308.04} \approx 0.649$$

$$r_{C1} = \frac{180}{308.04} \approx 0.585$$

Normalization for Completion Time

Turnaround time is a cost criterion, so the smaller the better. The smallest value is the ideal solution.

Total for Completion Time column

$$= \sqrt{5^2 + 3^2 + 4^2} = \sqrt{50} \approx 7.07$$

Normalization for each alternative (for Completion Time):

$$r_{A2} = \frac{5}{7.07} \approx 0.707$$

$$r_{B2} = \frac{3}{7.07} \approx 0.424$$

$$r_{C2} = \frac{4}{7.07} \approx 0.566$$

Normalization for Market Demand

Market demand is a profit criterion, so the bigger the better.

Total for Market Demand column

$$= \sqrt{500^2 + 600^2 + 700^2} = \sqrt{1100000} \approx 1048.08$$

Normalization for each alternative (for Market Demand)

$$r_{A3} = \frac{500}{1048.08} \approx 0.477$$

$$r_{B3} = \frac{700}{1048.08} \approx 0.677$$

$$r_{C3} = \frac{600}{1048.08} \approx 0.572$$

Normalization for Resource Availability

Resource availability is a profit criterion, so the bigger the better.

Total for Resource Availability column

$$= \sqrt{70^2 + 60^2 + 80^2} = \sqrt{14900} \approx 122.02$$

Normalization for each alternative (for Resource Availability):

$$r_{A4} = \frac{70}{122.02} \approx 0.573$$

$$r_{B4} = \frac{60}{122.02} \approx 0.492$$

$$r_{C4} = \frac{80}{122.02} \approx 0.656$$

Normalization for Product Quality

Product quality is a profit criterion, so the bigger the better.

Total for Product Quality column

$$= \sqrt{8 + 9 + 7^2} = \sqrt{194} \approx 13.93$$

Normalization for each alternative (for Product Quality):

$$r_{A5} = \frac{8}{13.93} \approx 0.575$$

$$r_{B5} = \frac{9}{13,93} \approx 0.645$$

$$r_{C5} = \frac{7}{13,93} \approx 0.503$$

### 3. Weighting the Normalization Matrix

After normalization, each value in the normalization matrix is multiplied by the weight of the criteria that has been calculated by the SMART method. For example, if the weight for the criteria Production Cost is 0.3, Turnaround Time is 0.2, and so on, then we do the weighting for each value.

Table 2. Weighting the Normalization Matrix

Criteria	A	B	C
Production Cost (0.3)	0.146	0.195	0.176
Completion Time (0.2)	0.141	0.085	0.113
Market Demand (0.25)	0.119	0.167	0.143
Resource Availability (0.15)	0.086	0.074	0.098
Product Quality (0.1)	0.058	0.065	0.050

### 4. Determination of Positive and Negative Ideal Solutions

The positive ideal solution (A+) and negative ideal solution (A-) are determined as follows:

A+ (positive ideal solution): Production Cost: minimal (0.146), Completion Time: minimum (0.141), Market Demand: maximum (0.167), Resource Availability: maximum (0.098), Product Quality: maximum (0.065).

A- (negative ideal solution): Production Cost: maximum (0.195), Completion Time: max (0.113), Market Demand: minimum (0.119), Resource Availability: minimum (0.074), Product Quality: minimum (0.050).

### 5. Calculation of Distance from Ideal Solution

Use the Euclidean formula to calculate the distance of each alternative from A+ and A-.

Distance A+ and A- for Alternative A:

$$D_{+A} \approx 0.054$$

$$D_{-A} \approx 0.073$$

Distance A+ and A- for Alternative B:

$$D_{+B} \approx 0.059$$

$$D_{-B} \approx 0.084$$

Distance A+ and A- for Alternative C:

$$D_{+C} \approx 0.058$$

$$D_{-C} \approx 0.075$$

### 6. Calculation of Preference Index

Calculate the preference index for each alternative

$$C_A = \frac{0.073}{0.073 + 0.054} \approx 0.575$$

$$C_B = \frac{0.084}{0.084 + 0.059} \approx 0.587$$

$$C_C = \frac{0.075}{0.075 + 0.058} \approx 0.566$$

### Step 7: Ranking Alternatives

The alternative with the highest preference index value is the most prioritized alternative.

**Ranking:**

1. Alternative B ( $C_B = 0.587$ )
2. Alternative A ( $C_A = 0.575$ )
3. Alternative C ( $C_C = 0.566$ )

Based on the calculations above, alternative B has the highest preference index value, so alternative B is the top priority choice for screen printing production.

**Discussion**

Based on the results of the research conducted, the use of the SMART method for criteria weighting and the TOPSIS method for alternative analysis in prioritizing screen printing production has resulted in a clear and objective ranking for three product alternatives. The analysis results show that alternative B is ranked first with the highest preference index ( $C_B = 0.587$ ), which reflects the optimal combination of the criteria of production cost, turnaround time, market demand, resource availability, and product quality. In this case, the SMART approach succeeded in giving proportional weight to each criterion, while the TOPSIS method enabled a clear comparison between alternatives based on their relative distance to the ideal solution. The decisions taken with these methods are reliable, given that the TOPSIS method considers both positive and negative distance factors that provide a more comprehensive picture of each alternative.

However, although the applied method provides adequate results, there are several considerations that need to be taken into account in the application of this system in the broader context of the screen printing industry. First, the calculation of weights and normalization used in this study can be affected by subjectivity in determining the weights of the criteria carried out by the SMART method. Therefore, it is necessary to conduct further testing using data from various screen printing companies to see the consistency of the calculation results. Secondly, although alternative B shows the best results, external factors such as changes in market trends or uncertainties in resource availability should also be taken into account in more dynamic decision-making. This research paves the way for the development of a more adaptive decision-making system by considering external factors that may affect production decisions more holistically.

**4. Conclusion**

This study successfully applied the SMART and TOPSIS methods in a decision-making system for prioritizing screen printing production, with the results showing alternative B as the best choice based on the assessment of cost, time, market demand, quality, and resource criteria. The findings indicate that the combination of the two methods can provide more objective and measurable decisions in production management, while improving the efficiency of the decision-making process. However, this study has limitations in terms of the subjectivity of determining criteria weights and the limited data used, which may affect the accuracy of the results. For future research, it is recommended to test the application of this method on a larger scale by involving more variables and considering dynamic external factors, as well as using other methods such as Analytic Network Process (ANP) to increase the validity and generalization of the research results.

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