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# Selection of Machine Tools using Topsis and Entropy Methods

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**Abstract:** This study is conducted to select the best machine tool among available alternatives. The machine tool considered in this paper is a wood planer. The problem focuses on selecting the best wood planer among six available alternatives. Six parameters, referred to as six criteria, are used to characterize each machine, including planing width, maximum planing depth, maximum no-load speed, total machine length, weight, and price. The weights of the criteria are calculated using the Entropy method, while the ranking of machines is performed using the TOPSIS method.

**Keywords:** Machine tool selection, TOPSIS, Entropy

## 1. Introduction

Machine tools play a fundamental role in determining productivity and product accuracy in manufacturing processes. A suitable machine tool system not only improves economic efficiency by optimizing machining time but also ensures high product consistency. However, selecting an optimal machine is a challenging problem, as investors must simultaneously consider numerous technical parameters such as speed levels, speed range, accuracy grade, and level of automation. These criteria often conflict with each other. For example, a highly precise and automated machine usually comes with a high cost, leading to longer payback periods. Conversely, minimizing initial investment costs may result in machining inaccuracies or limited speed ranges. Therefore, analyzing and balancing technical and economic factors is essential. Multi-Criteria Decision-Making (MCDM) methods are widely used to address this complexity. Among them, TOPSIS is one of the most commonly used methods. In addition, determining criteria weights is necessary, and the Entropy method is adopted in this study due to its effectiveness and popularity.

## 2. Entropy Method

The determination of criteria weights using the Entropy method is carried out according to the following steps [12].

**Step 1:** Construct the decision matrix consisting of *m* rows and *n* columns as shown in Equation (1). Here, *m* and *n* represent the number of alternatives to be ranked and the number of criteria used to characterize each alternative, respectively. Let yij denote the value of criterion *j* for alternative *i*. The symbols *B* and *C* represent benefit criteria (the larger, the better) and cost criteria (the smaller, the better), respectively.

$$Y = \begin{bmatrix} y_{11} & y_{12} & \cdots & y_{1n} \\ y_{21} & xy_{22} & \cdots & y_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ y_{m1} & y_{m2} & \cdots & y_{mn} \end{bmatrix} \quad (1)$$

**Step 2:** Determine the normalized values of the criteria according to Equation (2).

$$p_{\text{ij}} = \frac{y_{\text{ij}}}{m + \sum_{i=1}^{m} y_{\text{ij}}^2} \quad (2)$$

**Step 3:** Calculate the entropy measure value for each criterion according to Equation (3).

$$e_{\text{j}} = -\sum_{i=1}^{m}\left[p_{\text{ij}} \times \ln(\text{p}_{\text{ij}})\right] - \left(1-\sum_{i=1}^{m} p_{\text{ij}}\right) \times \ln\left(1-\sum_{i=1}^{m} p_{\text{ij}}\right) \quad (3)$$

**Step 4:** Determine the weight of each criterion according to Equation (4).

$$w_j = \frac{1 - e_j}{\sum_{j=1}^{m}(1 - e_j)} \quad (4)$$

## 3. Topsis Method

The steps involved in the TOPSIS method are described as follows [13].

**Step 1:** Same as Step 1 of the Entropy method.

**Step 2:** Determine the transformed values according to Equation (5).

$$y'_{ij} = \frac{y_{ij}}{\sqrt{\sum_{i=1}^{n} y_{ij}^2}} \quad (5)$$

**Step 3:** Construct the normalized decision matrix according to Equation (6).

$$Y = w_j . y'_{ij} \quad (6)$$

Here, $w_j$ denotes the weight of criterion ***j***.

**Step 4:** Determine the ideal best solution $A^+$and the ideal worst solution $A^-$for the criteria according to Equations (7) and (8).

$$A^+ = \{y_1^+, y_2^+, \dots, y_j^+, \dots, y_n^+\} \quad (7)$$

$$A^- = \{y_1^-, y_2^-, \dots, y_j^-, \dots, y_n^-\} \quad (8)$$

Here, $y_j^+$and $y_j^-$represent the best and worst values of criterion ***j***, respectively.

**Step 5:** Determine the values of $S_i^+$and $S_i^-$according to Equations (9) and (10).

$$S_i^+ = \sqrt{\sum_{j=1}^{n} \left(y_{ij} - y_j^+\right)^2} \qquad i = 1, 2, \dots, m \quad (9)$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} \left(y_{ij} - y_j^-\right)^2} \qquad i = 1, 2, \dots, m \quad (10)$$

**Step 6:** Determine the values of $C_i^*$according to Equation (11).

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-} \qquad i = 1, 2, \dots, m; \ 0 \le C_i^* \le 1 \quad (11)$$

**Step 7:** Rank the alternatives based on the principle that the alternative with the highest $C_i^*$ value is considered the best option.

## 4. Machine Tool Selection

Table 1 summarizes the data of six wood planers to be ranked, which are denoted as WP1, WP2, WP3, WP4, WP5, and WP6. The six criteria for each alternative include planing width (C1), maximum planing depth (C2), maximum no-load speed (C3), total machine length (C4), weight (C5), and price (C6). The units of the criteria are also presented in the second row of the table.

It should be noted that the unit of criterion C6, “Thousand”, refers to a Vietnamese monetary unit, where one US dollar is approximately equivalent to 24 “Thousand”. The first three criteria are benefit criteria, whereas the remaining three are cost criteria.

Table 1: WP machines [14]

| Machine | C1 | C2 | C3 | C4 | C5 | C6 |
|---|---|---|---|---|---|---|
| Unit | mm | mm | m/min | mm | kg | Thousand |
| WP1 | 82 | 2 | 16000 | 285 | 3 | 1.586 |
| WP2 | 82 | 2.6 | 16500 | 300 | 2.8 | 1.529 |
| WP3 | 82 | 1.8 | 16000 | 290 | 2.5 | 1.390 |
| WP4 | 102 | 1 | 17000 | 280 | 2.7 | 2.430 |
| WP5 | 82 | 2 | 11500 | 280 | 2.7 | 1.135 |
| WP6 | 82 | 3 | 18000 | 390 | 4.6 | 2.218 |

Based on the data presented in Table 1, it can be observed that the maximum value of criterion C1 is 102 (mm), corresponding to alternative WP4; the maximum value of criterion C2 is 3 (mm), corresponding to alternative WP6; and the maximum value of criterion C3 is 18,000 (m/min), which also belongs to alternative WP6. The minimum value of criterion C4 is 280 (mm), corresponding to alternatives WP4 and WP5; the minimum value of criterion C5 is 2.5 (kg), corresponding to alternative WP3; and finally, the minimum value of criterion C6 is 1.135 (Thousand), corresponding to alternative WP5.

These observations indicate that, based solely on the raw data in Table 1, it is not possible to determine the best alternative among the six machines. In order to identify the optimal alternative, the Entropy method is first employed to calculate the weights of the criteria, followed by the TOPSIS method to rank the machines.

The decision matrix is given by the data in Table 1. By applying Equation (2), the normalized values of the criteria using the Entropy method are obtained, as summarized in Table 2.

Table 2: Normalized values in the Entropy method

| Machine | C1 | C2 | C3 | C4 | C5 | C6 |
|---|---|---|---|---|---|---|
| WP1 | 0.0019 | 0.0588 | 0.0000 | 0.0005 | 0.0463 | 0.0637 |
| WP2 | 0.0019 | 0.0765 | 0.0000 | 0.0005 | 0.0432 | 0.0614 |
| WP3 | 0.0019 | 0.0529 | 0.0000 | 0.0005 | 0.0386 | 0.0558 |
| WP4 | 0.0023 | 0.0294 | 0.0000 | 0.0005 | 0.0416 | 0.0976 |
| WP5 | 0.0019 | 0.0588 | 0.0000 | 0.0005 | 0.0416 | 0.0456 |
| WP6 | 0.0019 | 0.0882 | 0.0000 | 0.0007 | 0.0710 | 0.0891 |

By applying Equations (3) and (4), the weights of the criteria are calculated as summarized in Table 3.

Table 3: Weights of the criteria

| C1 | C2 | C3 | C4 | C5 | C6 |
|---|---|---|---|---|---|
| 0.1295 | 0.2093 | 0.1221 | 0.1246 | 0.1974 | 0.2170 |

By applying Equation (5), the normalized values of the criteria using the TOPSIS method are obtained, as summarized in Table 4.

Table 4: Normalized values in the TOPSIS method

| Machine | C1 | C2 | C3 | C4 | C5 | C6 |
|---|---|---|---|---|---|---|
| WP1 | 0.3908 | 0.3780 | 0.4091 | 0.3794 | 0.3911 | 0.3648 |
| WP2 | 0.3908 | 0.4914 | 0.4219 | 0.3994 | 0.3651 | 0.3517 |
| WP3 | 0.3908 | 0.3402 | 0.4091 | 0.3861 | 0.3259 | 0.3197 |
| WP4 | 0.4861 | 0.1890 | 0.4347 | 0.3728 | 0.3520 | 0.5590 |
| WP5 | 0.3908 | 0.3780 | 0.2941 | 0.3728 | 0.3520 | 0.2611 |
| WP6 | 0.3908 | 0.5669 | 0.4603 | 0.5192 | 0.5997 | 0.5102 |

By applying Equation (6), the weighted normalized values of the criteria are calculated, taking into account the criteria weights, as summarized in Table 5.

Table 5: Weighted normalized values of the criteria in the TOPSIS method

| Machine | C1 | C2 | C3 | C4 | C5 | C6 |
|---|---|---|---|---|---|---|
| WP1 | 0.0506 | 0.0791 | 0.0500 | 0.0473 | 0.0772 | 0.0792 |
| WP2 | 0.0506 | 0.1028 | 0.0515 | 0.0498 | 0.0721 | 0.0763 |
| WP3 | 0.0506 | 0.0712 | 0.0500 | 0.0481 | 0.0644 | 0.0694 |
| WP4 | 0.0629 | 0.0396 | 0.0531 | 0.0465 | 0.0695 | 0.1213 |
| WP5 | 0.0506 | 0.0791 | 0.0359 | 0.0465 | 0.0695 | 0.0567 |
| WP6 | 0.0506 | 0.1187 | 0.0562 | 0.0647 | 0.1184 | 0.1107 |

By applying Equations (7) and (8), the values of $A^+$ and $A^-$ are obtained, as summarized in Table 6.

Table 6: Values of $A^+$ and $A^-$ in the TOPSIS method

| Machine | C1 | C2 | C3 | C4 | C5 | C6 |
|---|---|---|---|---|---|---|
| $A^+$ | 0.0629 | 0.1187 | 0.0562 | 0.0465 | 0.0644 | 0.0567 |
| $A^-$ | 0.0506 | 0.0396 | 0.0359 | 0.0647 | 0.1184 | 0.1213 |

By applying Equations (9), (10), and (11), the corresponding values of $S^{+}_{i}$, $S^{-}_{i}$and $C_i$ are calculated, as summarized in Table 7. The final column of this table also presents the ranking of the alternatives based on their CiC_iCi values.

Table 7: Selected parameters in TOPSIS and ranking of alternatives

| Machine | $S^{+}_{i}$ | $S^{-}_{i}$ | $C_i$ | Rank |
|---|---|---|---|---|
| WP1 | 0.0493 | 0.0744 | 0.6016 | 4 |
| WP2 | 0.0297 | 0.0930 | 0.7579 | 1 |
| WP3 | 0.0511 | 0.0842 | 0.6224 | 3 |
| WP4 | 0.1023 | 0.0563 | 0.3550 | 6 |
| WP5 | 0.0464 | 0.0920 | 0.6647 | 2 |
| WP6 | 0.0796 | 0.0824 | 0.5086 | 5 |

Based on the data in Table 7, the ranking of the machines in descending order is as follows: WP2 > WP5 > WP3 > WP1 > WP6 > WP4. Among the six alternatives considered, WP2 is identified as the best option.

WP2 has the following specifications: planing width of 82 (mm), maximum planing depth of 2.6 (mm), maximum no-load speed of 16,500 (m/min), total machine length of 300 (mm), weight of 2.8 (kg), and a price of 1.529 (Thounsand).

## 5. **Conclusion**

This study applied the Entropy method to determine the weights of the criteria for wood planers, followed by the TOPSIS method to rank the alternatives. Accordingly, the weights of the criteria—planing width, maximum planing depth, maximum no-load speed, total machine length, weight, and price—were determined to be 0.1295, 0.2093, 0.1221, 0.1246, 0.1974, and 0.2170, respectively.

The best wood planer selected has the following specifications: 82 (mm), 2.6 (mm), 16,500 (m/min), 300 (mm), 2.8 (kg), and a price of 1.529 (Thounsand).

## References

[1]. Hagag, A.M.; Yousef, L.S.; Abdelmaguid, T.F. (2023). Multi-Criteria Decision-Making for Machine Selection in Manufacturing and Construction: Recent Trends, Mathematics, 11, 631

[2]. Vinicius M.: Brito Alves A. L.:, Hluszko, C.: Kovaleski, J. L.: Colmenero, J. C. (2024). Multi-criteria decision-making for equipment selection: A review, Conference: Congresso Brasileiro de Engenharia de Produção (CONBREPRO).

[3]. İç, Y.T.; Yurdakul, M. (2023). Selecting MCDM Criteria for Machining Center Ranking Decisions Using Design of Experiments and TOPSIS Approaches, In: Mirzazadeh, A., Erdebilli, B., Babaee Tirkolaee, E., Weber, GW., Kar, A.K. (eds) Science, Engineering Management and Information Technology.

[4]. Hai L.: Wei W.:, Lei F.: Qingzhao L.:, Xuezhen, C. (2020). A novel hybrid MCDM model for machine tool selection using fuzzy DEMATEL, entropy weighting and later defuzzification VIKOR, Applied Soft Computing, 11, 106207

[5]. Trung, D. D.; Dudić, B.: Bao, N. C.; Thinh, H. X.: Duc, D. V.; Ašonja, A. (2025). Applying Probability Method for Battery Electric Vehicle Selection, *24th International Symposium INFOTEH-JAHORINA (INFOTEH)*, East Sarajevo, Bosnia and Herzegovina.

[6]. Trung, D.D., Ašonja, A., Van Duc, D., Bao, N.C., Son, N.H. (2025), Comparison of RAWEC and AROMAN Methods in Material Selection for Manufacturing or Maintenance, In: Glavaš, H., Hadzima-Nyarko, M., Ademović, N., Hanák, T. (eds) 33rd International Conference on Organization and Technology of Maintenance.

[7]. Trung, D. D. (2021). A combination method for multi-criteria decision making problem in turning process, Manufacturing review, 8, 26.

[8]. Trung, D. D. (2021). Application of TOPSIS and PIV methods for multi-criteria decision making in hard turning process, Journal of Machine Engineering, 21, 4.

[9]. Rani, R.; Goyal, V.; Gupta, D. (2025). Optimizing multi-level decision-making: M-TOPSIS approach for quadratic fractional multi objective problems, Int J Syst Assur Eng Manag, 16.

[10]. Vimal, J.; Badhoutiya, A. (2023). Composite Material Selection using GRA MCDM Method, *1st International Conference on Cognitive Computing and Engineering Education (ICCCEE)*, Pune, India.

[11]. Sharma V.; Zivic F.; Adamovic D.: Ljusic P.; Kotorcevic N.; Slavkovic V.; Grujovic N. (2022), Multi-Criteria Decision Making Methods for Selection of Lightweight Material for Railway Vehicles, Materials (Basel), 16,1.

[12]. Li, F.; Su, M.; Li, D. (2021). Combination Evaluation Model Based on Entropy Weight Method, *2nd International Conference on Machine Learning and Computer Application*, Shenyang, China.

[13]. Ren: Peng; Zhang; Ran; Luo; Shuhang. (2023). Multipath Route Optimization with Multiple QoS Constraints Based on Intuitionistic Fuzzy Set Theory, Wireless Communications and Mobile Computing, 6318433

[14]. Trung, D. D.; Diep, M. T.; Duc, D. V.; Bao, N. C.; Son, N. H. (2024). Application of probability theory in machine selection, Applied Engineering Letters, 9, 4.