Volume 1 Number 1 November 2026, Available online: November 20, 2026

Journal of Decision Support Systems and Multi-Criteria Decision Making

ISSN: 3164-7022

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Journal Homepage: https://research.pilar.or.id/index.php/jodesma

Decision Support System for Production Machine Maintenance Prioritization Using LOPCOW Weighting and SPOTIS

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Keywords:
Decision Support System;
Maintenance Prioritization;
LOPCOW;
SPOTIS;
Multi-Criteria Decision Making;

ABSTRACT

Maintenance of production machines is essential for maintaining production continuity and minimizing the risk of downtime and operational losses. However, limited maintenance resources, including budget, technician availability, maintenance time, and spare parts, require organizations to establish appropriate maintenance priorities. This study proposes a Decision Support System (DSS) for objectively prioritizing production machine maintenance using a Multi-Criteria Decision-Making (MCDM) approach that integrates the LOPCOW and SPOTIS methods. LOPCOW is applied to determine objective criterion weights based on the characteristics and variation of the maintenance data, while SPOTIS is used to rank production machines according to their distance from the ideal solution. The results show that C7 obtains the highest criterion weight of 0.2616, followed by C5 (0.2134) and C6 (0.1937), while C2 obtains the lowest weight of 0.0412. The SPOTIS results produce the maintenance priority sequence M4, M7, M2, M5, M1, M8, M3, and M6, with M4 achieving the highest priority with a final value of 0.0000, while M6 has the lowest priority with 1.0000. These findings demonstrate that the proposed LOPCOW-SPOTIS framework can provide a systematic, objective, and transparent basis for identifying maintenance priorities and supporting more consistent allocation of limited maintenance resources.

Publication Dates:
Online First Date:
August 29, 2026
Published Date:
November 20, 2026

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DOI: https://doi.org/10.67449/jodesma.1i1.1

Article Link: https://research.pilar.or.id/index.php/jodesma/article/view/1

Volume 1 Number 1 November 2026, Available online: November 20, 2026
Journal of Decision Support Systems and Multi-Criteria Decision Making
ISSN: 3164-7022
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I. Introduction

Maintenance of production machines is one of the important aspects in keeping the continuity and smoothness of the production process in a company[1]. Machines that are in optimal condition can support the achievement of production targets, maintain product quality, and reduce the risk of damage and downtime that can hinder operational activities. However, carrying out maintenance on all machines at the same time often faces various resource constraints, such as maintenance budgets, available time, the number and competence of technicians, and the availability of spare parts. These conditions make it necessary for companies to determine which machines should receive maintenance attention and action first. Not all machines have the same level of urgency and impact when they break down, so prioritizing maintenance becomes important so that limited resources can be allocated effectively and efficiently[2].

In the process of determining maintenance priorities, decisions that are still based on subjectivity, intuition, or technician experience can lead to different assessments between one decision-maker and another. This situation could cause maintenance priorities to be inconsistent, and machines with higher risk or importance levels might not necessarily get attended to first. Therefore, a Decision Support System (DSS) is needed to help companies set maintenance priorities objectively, measurably, and systematically, taking into account various relevant criteria, such as the level of damage, frequency of failure, downtime, machine age, maintenance costs, and their impact on the production process. With this system, decision-making can be done based on a more structured evaluation[3]–[5], so the use of maintenance resources becomes more optimal, maintenance priorities are more consistent, and the potential for disruptions to production process continuity can be minimized.

A DSS can objectively prioritize production machines for maintenance by integrating multiple maintenance-related criteria into a structured Multi-Criteria Decision-Making (MCDM) framework[6]–[8]. Each machine can be evaluated based on relevant criteria such as failure frequency, downtime, maintenance cost, machine age, failure severity, production impact, and spare-part availability. The criteria can be assigned objective weights based on the characteristics of the available data, reducing dependence on subjective judgments or individual technician experience. An appropriate MCDM ranking method can then be applied to calculate the priority score of each machine and generate a systematic maintenance priority ranking[9]–[11]. This approach enables companies to identify machines that require more immediate maintenance and allocate limited resources, including maintenance budgets, technician time, spare parts, and equipment downtime, more efficiently. Consequently, the DSS provides a transparent, consistent, and data-driven mechanism for supporting maintenance decisions and reducing the risk of inconsistent prioritization among production machines.

DOI: https://doi.org/10.67449/jodesma.1i1.1

Article Link: https://research.pilar.or.id/index.php/jodesma/article/view/1

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Journal of Decision Support Systems and Multi-Criteria Decision Making
ISSN: 3164-7022
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LOPCOW is an objective weighting approach that determines criterion importance through the logarithmic percentage changes between the highest and lowest values of each criterion[12], [13]. Its main advantage is its ability to capture the magnitude of data dispersion without requiring subjective assessments from experts, making the resulting weights more reproducible and less dependent on individual preferences. In addition, the method provides a straightforward calculation procedure, can accommodate criteria with different value ranges, and highlights criteria that contain greater variations in the observed alternatives. These characteristics make LOPCOW advantageous for datasets in which the differences among alternatives contain important information for determining the relative significance of each criterion.

SPOTIS is a ranking method that evaluates alternatives according to their distance from an ideal solution, allowing the relative performance of each alternative to be measured across multiple criteria. One of its main advantages is its ability to provide a clear and stable preference order by directly comparing each alternative with the ideal reference point[14], [15]. The method also considers the direction of criteria, distinguishing between benefit and cost attributes, while normalization enables criteria with different measurement scales to be evaluated within a common framework. Furthermore, SPOTIS produces interpretable distance-based scores, making it easier to identify the alternatives that are closest to or farthest from the desired condition and supporting transparent comparison in multi-criteria decision-making problems.

Although research on maintenance prioritization has been conducted extensively, some studies still use subjective weighting methods, so the results of priority determination can be influenced by the decision-maker's perception and experience. In addition, the application of objective weighting methods combined with ranking methods based on ideal solutions is still relatively limited, especially in the context of production machine maintenance priorities. This situation shows that there is an opportunity to develop an approach that can determine criteria weights based on data characteristics while also producing alternative rankings in a systematic and measurable way. Therefore, this study proposes the integration of Logarithmic Percentage Change-driven Objective Weighting (LOPCOW) as an objective weighting method with Stable Preference Ordering Towards Ideal Solution (SPOTIS) to determine the priority of production machine maintenance. The LOPCOW-SPOTIS integration is expected to provide a more objective, consistent, and transparent approach in identifying machines that need maintenance priority based on various relevant maintenance criteria.

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II. Methodology

2.1. Research Stage

Research stages refer to a systematic sequence of activities conducted to achieve the objectives of a study, beginning with problem identification and continuing through data collection, data processing, analysis, and the interpretation of results to obtain valid and relevant conclusions[16]. A well-defined research process ensures that each stage is conducted systematically and that the results can be obtained in a structured and reproducible manner. In this study, the research stages are designed to support the development of a Decision Support System for production machine maintenance prioritization by integrating the LOPCOW weighting method and the SPOTIS ranking method. The research stages implemented in this study are presented in Figure 1.

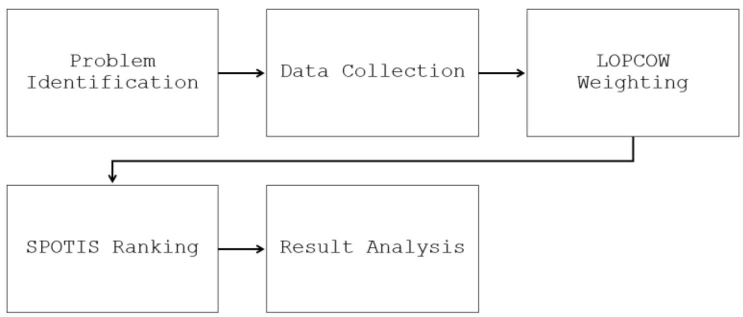

Figure 1. Research Stages

The research stages consist of several systematic steps. Problem identification is conducted to identify the challenges in determining maintenance priorities for production machines under limited maintenance resources. Data collection, preprocessing, and criteria determination involve gathering information related to production machines and their maintenance conditions based on the selected criteria, followed by checking the completeness, consistency, and suitability of the collected data for further analysis. The relevant maintenance criteria are then identified and classified as either benefit or cost criteria according to their influence on maintenance priority. LOPCOW weighting is applied to objectively determine the relative importance of each criterion based on the characteristics of the data. The resulting weights are subsequently used in the SPOTIS ranking process to calculate the performance of each production machine relative to the ideal solution and generate a maintenance priority ranking. Result analysis is conducted to identify machines requiring the highest maintenance priority and evaluate the implications of the obtained ranking for maintenance resource allocation.

2.2. LOPCOW Weighting

The LOPCOW method is an objective weighting technique used to determine the relative importance of decision-making criteria based on

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Journal of Decision Support Systems and Multi-Criteria Decision Making
ISSN: 3164-7022
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the variation of values within the decision matrix[17], [18]. The implementation of LOPCOW begins with the construction of the decision matrix, where the performance values of each production machine are organized according to the selected maintenance criteria, as presented in (1). Subsequently, the logarithmic percentage change for each criterion is calculated to measure the variation among alternatives, as shown in (2). The total logarithmic percentage change across all criteria is then determined according to (3). Finally, the objective weight of each criterion is obtained by normalizing its logarithmic percentage change against the total value, as presented in (4).

$$X = [x_{ij}]_{mxn} \tag{1}$$

$$n_{ij} = \frac{x_{ij}}{m + \sum_{i=1}^{m} x_{ij}^2} \tag{2}$$

$$PV_j = 100 * \left| \frac{\sqrt{\sum_{i=1}^{m} n_{ij}^2}}{\ln \frac{m}{\sigma_j}} \right| \tag{3}$$

$$w_j = \frac{PV_j}{\sum_{j=1}^{n} PV_j} \tag{4}$$

The LOPCOW method provides objective criterion weights based on the variation of maintenance-related data, allowing the relative importance of each criterion to be determined systematically without relying on subjective judgments. The resulting weights provide a quantitative representation of the importance of each criterion and can support a more objective, consistent, and transparent evaluation process in determining maintenance priorities.

2.3. SPOTIS Method

The SPOTIS method is an MCDM ranking method used to determine the preference order of alternatives based on their distances from an ideal solution[19], [20]. The method evaluates each alternative by considering its performance across multiple criteria and identifies the alternative that is closest to the ideal solution as the most preferred. In this study, SPOTIS is applied to determine the maintenance priority of production machines based on the criteria and objective weights obtained from the LOPCOW method. The implementation of SPOTIS consists of several stages, beginning with the determination of the ideal solution for each criterion, followed by the calculation of the normalized distance of each alternative from the ideal solution, the incorporation of criterion weights, and the calculation of the overall preference score. The resulting scores are then used to rank the production machines, where alternatives with lower distance scores indicate better preferences and consequently receive higher maintenance priority. The implementation of SPOTIS begins with the construction of the decision matrix, which contains the performance values of each production machine with respect to the selected maintenance criteria, as presented in (1). Next, the ideal distance for each criterion is determined by identifying the ideal value according to the type of criterion, as shown in (5). Subsequently, the normalized distance of each alternative from the ideal solution is

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calculated to obtain comparable values across different criteria, as presented in (6). The normalized values are then multiplied by the criterion weights obtained from LOPCOW to calculate the weighted distance, as shown in (7).

$$x_j^* = \begin{cases} \max x_{ij} \, ; benefit \\ \min x_{ij} \, ; cost \end{cases} \tag{5}$$

$$d_{ij} = \frac{|x_{ij} - x_j^*|}{\left|x_j^{*max} - x_j^{*min}\right|} \tag{6}$$

$$y_i = \sum_{j=1}^{n} d_{ij} * w_j \tag{7}$$

The SPOTIS method provides a systematic and stable approach for ranking alternatives based on their distance from the ideal solution. The resulting preference values enable each alternative to be compared objectively across multiple criteria, producing a clear priority order. Therefore, SPOTIS can support structured, consistent, and transparent decision-making by identifying alternatives that have the most favorable overall performance.

2.4. Dataset

The dataset is a collection of structured data containing information required to support the analysis and decision-making process in a research study. In this study, the dataset consists of production machine maintenance data containing the performance values of each machine based on several maintenance-related criteria. These data are used to represent the condition and maintenance requirements of each production machine and serve as the basis for evaluating and determining maintenance priorities. The dataset used in this study is presented in Table 1.

Table 1. Dataset

Machine	C1	C2	C3	C4	C5	C6	C7
M1	12	18.5	8.5	7	4	5	3
M2	8	12	6.2	5	3	4	4
M3	15	25.5	10.8	9	5	5	2
M4	6	9.5	5.4	4	3	3	5
M5	10	16	7.6	6	4	4	3
M6	18	30	12.5	10	5	5	2
M7	7	11.5	5.9	5	3	3	4
M8	13	21	9.2	8	4	5	3

The maintenance criteria are grouped into two categories based on their influence on maintenance priority. The cost criteria consist of Failure Frequency (C1), Downtime (C2), Maintenance Cost (C3), Machine Age (C4), Failure Severity (C5), and Production Impact (C6), where higher values indicate a greater need for maintenance attention. Meanwhile, the benefit criterion is Spare Part Availability (C7), where a higher value indicates better availability of spare parts and greater readiness to support maintenance activities. This classification ensures that each criterion is evaluated according to its appropriate direction when determining the maintenance priority of production machines.

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III. Result and Discussion

3.1. Problem Identification

Problem identification is the initial stage of the research process that aims to identify and clearly define the main problems occurring in the maintenance of production machines. Maintenance plays an important role in ensuring the continuity of production activities because machine failures can cause production stoppages, delays, additional maintenance costs, and reductions in productivity. In a production environment, machines generally have different operating conditions, failure frequencies, downtime levels, maintenance costs, ages, failure severities, and impacts on the production process. These differences indicate that each machine does not necessarily have the same level of maintenance urgency. However, limited maintenance resources, including budget, technician availability, maintenance time, and spare-part availability, make it difficult for companies to perform maintenance on all machines simultaneously. Therefore, an appropriate mechanism is required to identify which machines should receive maintenance attention first based on their actual conditions and their potential impact on production continuity.

The problem becomes more complex when maintenance priority decisions are determined primarily by the experience, intuition, or subjective assessment of maintenance personnel. Although the experience of technicians can provide valuable practical information, subjective assessments may produce different priority decisions for similar machine conditions and may lead to inconsistent maintenance prioritization. In addition, evaluating several maintenance-related criteria simultaneously requires a structured approach because improving one criterion may not necessarily correspond to an improvement in another criterion. For example, a machine with a high failure frequency may not have the highest downtime, while another machine with a lower failure frequency may have a greater impact on production when a failure occurs. This situation creates a need for a systematic decision-making approach capable of considering multiple criteria simultaneously and producing an objective priority order. Therefore, this study identifies the need for a Decision Support System (DSS) that can assist maintenance managers in evaluating production machines based on relevant maintenance criteria and determining which machines should receive priority for maintenance intervention.

3.2. Data Collection

Data collection is the stage of the research process conducted to obtain the information required for evaluating and determining the maintenance priorities of production machines. The data are collected from records and information related to the operational and maintenance conditions of each production machine, including Failure Frequency, Downtime, Maintenance Cost, Machine Age, Failure Severity, Production Impact, and Spare Part Availability. These criteria are selected because

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they represent different aspects of machine condition, maintenance requirements, operational risk, and the company's ability to perform maintenance activities. The collected data consist of quantitative values for each machine and criterion, allowing the condition of different production machines to be compared systematically. Data collection also considers the consistency of measurement units and the completeness of the information to ensure that the resulting dataset can be processed appropriately in the subsequent analysis stages.

After the data are collected, the information is organized into a structured decision matrix, in which each row represents a production machine and each column represents a maintenance criterion. The dataset is then examined to identify missing, inconsistent, or abnormal values that may affect the evaluation results. Each criterion is also classified according to its characteristic as either a benefit or cost criterion to ensure that the direction of preference is correctly represented during the MCDM analysis. The resulting dataset provides the primary input for the subsequent weighting and ranking processes and serves as the basis for objectively evaluating the relative maintenance priority of each production machine.

3.3. Determining Weights Using the LOPCOW Method

Determining weights using the LOPCOW method is performed to establish the relative importance of each maintenance criterion based on the characteristics and variation of the collected data. The LOPCOW method uses an objective weighting mechanism, allowing the importance of each criterion to be determined directly from the decision matrix without relying on subjective judgments from maintenance personnel or decision-makers. The resulting weights represent the relative importance of the maintenance criteria and are used to distinguish criteria that provide greater information for the maintenance prioritization process. Through this procedure, LOPCOW produces criterion weights in a systematic and data-driven manner, providing an objective basis for the subsequent evaluation of production machine maintenance priorities.

The first stage of the LOPCOW method is the construction of the decision matrix, which contains the performance values of each production machine according to the selected maintenance criteria. The decision matrix is presented in (1), and the decision matrix results correspond to the assessment data in Table 1.

The second stage calculates the logarithmic percentage change for each maintenance criterion to measure the magnitude of variation among the production machines. This calculation is presented in (2), with the resulting values shown in Table 2.

Table 2.Normalization Value of the LOPCOW Method

Machine	C1	C2	C3	C4	C5	C6	C7
M1	0.0107	0.0062	0.0142	0.0173	0.0301	0.0316	0.0300
M2	0.0071	0.0040	0.0104	0.0124	0.0226	0.0253	0.0400
M3	0.0134	0.0086	0.0181	0.0223	0.0376	0.0316	0.0200
M4	0.0054	0.0032	0.0090	0.0099	0.0226	0.0190	0.0500
M5	0.0089	0.0054	0.0127	0.0149	0.0301	0.0253	0.0300

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M6	0.0161	0.0101	0.0209	0.0248	0.0376	0.0316	0.0200
M7	0.0063	0.0039	0.0099	0.0124	0.0226	0.0190	0.0400
M8	0.0116	0.0071	0.0154	0.0198	0.0301	0.0316	0.0300

The third stage determines the total logarithmic percentage change by aggregating the logarithmic percentage change values obtained for all maintenance criteria. The calculation is presented in (3), and the resulting total value is reported in Table 3.

Table 3. Logarithmic Value of the LOPCOW Method

C1	C2	C3	C4	C5	C6	C7
0.3847	0.2247	0.5329	0.6660	1.1647	1.0576	1.4280

The final stage determines the objective weight of each maintenance criterion by normalizing its logarithmic percentage change against the total value. The weight calculation is presented in (4), while the final criterion weights are presented in Table 4.

Table 4. Criteria Weight Value of the LOPCOW Method

C1	C2	C3	C4	C5	C6	C7
0.0705	0.0412	0.0976	0.1220	0.2134	0.1937	0.2616

Table 5 presents the criterion weight values obtained using the LOPCOW method, with the weights reflecting the relative importance of each criterion in the maintenance prioritization process. C7 has the highest weight of 0.2616, indicating that it contributes the most to the decision-making process, followed by C5 with a weight of 0.2134 and C6 with 0.1937. Meanwhile, C4 has a weight of 0.1220, while C3 has a weight of 0.0976. The lowest weights are obtained by C1 and C2, with values of 0.0705 and 0.0412, respectively. These results indicate that the importance of the maintenance criteria varies according to the characteristics and information contained in the dataset, with C7 providing the greatest contribution to the overall evaluation.

3.4. Alternative Ranking Using the SPOTIS Method

The SPOTIS is a MCDM method designed to rank alternatives by evaluating their distance from an ideal solution. The method provides a structured approach for comparing multiple alternatives that are assessed using different criteria with varying characteristics and measurement scales. SPOTIS determines an ideal value for each criterion according to whether the criterion represents a benefit or a cost, and subsequently evaluates how far each alternative is from these ideal values. By incorporating the performance of alternatives across all criteria, SPOTIS produces a preference value that represents the overall distance of each alternative from the ideal solution. Alternatives with smaller distance values are considered more preferable because they demonstrate performance that is closer to the desired condition. This approach enables the ranking process to consider multiple criteria simultaneously and provides a clear, systematic, and transparent basis for determining the relative priority of alternatives.

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The first stage is the construction of the decision matrix, which contains the performance values of each production machine for all selected maintenance criteria, as presented in (1) , and the decision matrix results correspond to the assessment data in Table 1.

The second stage is the determination of the ideal solution, where the ideal value for each criterion is determined according to its classification as a benefit or cost criterion, as presented in Equation (5). The calculation results at this stage are presented in Table 5.

Table 5. Ideal Solution Value of the SPOTIS Method

C1	C2	C3	C4	C5	C6	C7
6	9.5	5.4	4	3	3	5

The third stage is the calculation of the normalized distance, which determines the relative distance of each production machine from the ideal solution for each criterion, as presented in (6). The calculation results at this stage are presented in Table 6.

Table 6. Normalization Value of the SPOTIS Method

Machine	C1	C2	C3	C4	C5	C6	C7
M1	0.5000	0.4390	0.4366	0.5000	0.5000	1.0000	0.6667
M2	0.1667	0.1220	0.1127	0.1667	0.0000	0.5000	0.3333
M3	0.7500	0.7805	0.7606	0.8333	1.0000	1.0000	1.0000
M4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
M5	0.3333	0.3171	0.3099	0.3333	0.5000	0.5000	0.6667
M6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
M7	0.0833	0.0976	0.0704	0.1667	0.0000	0.0000	0.3333
M8	0.5833	0.5610	0.5352	0.6667	0.5000	1.0000	0.6667

The fourth stage is the calculation of the weighted distance, where the normalized distance values are multiplied by the corresponding criterion weights to account for the relative importance of each criterion, as presented in (7). The calculation results at this stage are presented in Table 7.

Table 7. Final Value of the SPOTIS Method

Machine	Final Value
M1	0.6318
M2	0.2322
M3	0.9296
M4	0.0000
M5	0.4854
M6	1.0000
M7	0.1243
M8	0.6726

The final results of the evaluation are used to determine the ranking of production machine maintenance priorities based on the preference values obtained from the SPOTIS method. Each production machine is compared according to its overall performance across the selected maintenance criteria, allowing the alternatives to be ordered from the highest to the lowest maintenance priority. A machine with a more favorable preference value is positioned accordingly in the ranking,

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providing a clear basis for identifying machines that require maintenance attention first. The resulting ranking serves as a structured reference for evaluating maintenance priorities and supporting the allocation of available maintenance resources. The final ranking of the production machines is presented in Table 8.

Table 8. Alternative Ranking

Machine	Final Value	Rank
M4	0.0000	1
M7	0.1243	2
M2	0.2322	3
M5	0.4854	4
M1	0.6318	5
M8	0.6726	6
M3	0.9296	7
M6	1.0000	8

Table 1 presents the final ranking of production machines based on the preference values obtained from the SPOTIS method. M4 achieves the highest priority with a final value of 0.0000, placing it in rank 1, indicating the closest position to the ideal solution. It is followed by M7 with a value of 0.1243 in rank 2 and M2 with 0.2322 in rank 3. The subsequent positions are occupied by M5 with 0.4854 (rank 4), M1 with 0.6318 (rank 5), M8 with 0.6726 (rank 6), and M3 with 0.9296 (rank 7). Meanwhile, M6 obtains the highest final value of 1.0000, placing it in rank 8. These results indicate that M4 should receive the highest maintenance priority, while M6 has the lowest priority relative to the other evaluated machines.

3.5. Result Analysis

The results of this study demonstrate that the proposed maintenance prioritization approach is able to produce an objective and systematic ranking of production machines based on multiple maintenance-related criteria. The LOPCOW weighting results show that the seven criteria have different levels of importance in the evaluation process. C7 obtains the highest weight of 0.2616, followed by C5 with 0.2134, C6 with 0.1937, C4 with 0.1220, C3 with 0.0976, C1 with 0.0705, and C2 with the lowest weight of 0.0412. These results indicate that C7 provides the greatest contribution to the maintenance prioritization process, while C2 contributes the least based on the characteristics and variation of the available data. The differences in criterion weights demonstrate that the importance of maintenance criteria is not uniform, and therefore the evaluation of production machines should consider the relative contribution of each criterion rather than assigning equal importance to all criteria.

Based on the SPOTIS ranking results, the evaluated production machines demonstrate different levels of maintenance priority. M4 obtains the most favorable position with a final value of 0.0000 and is ranked first, indicating that it has the closest position to the ideal solution. The second position is occupied by M7 with a final value of

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0.1243, followed by M2 with 0.2322, M5 with 0.4854, M1 with 0.6318, M8 with 0.6726, M3 with 0.9296, and M6 with 1.0000. The ranking demonstrates that M4 is the machine requiring the highest maintenance priority, while M6 has the lowest priority among the evaluated alternatives. The resulting order provides a clear differentiation between machines and enables maintenance personnel to identify which equipment should receive attention first based on the overall evaluation.

The position of M4 as the highest-priority machine is an important finding of this study because it indicates that the machine has the most critical overall position when all maintenance criteria are considered simultaneously. Its final value of 0.0000 represents the ideal reference position in the SPOTIS evaluation, making M4 the primary candidate for maintenance intervention. Meanwhile, M7 and M2, with final values of 0.1243 and 0.2322, respectively, also demonstrate relatively high maintenance priority and should be considered in the subsequent maintenance schedule. The intermediate alternatives, particularly M5, M1, and M8, have progressively higher final values, indicating lower priority relative to the machines positioned above them. This result illustrates the advantage of multi-criteria evaluation because the final priority is determined from the combined performance of each machine across all criteria rather than from a single maintenance indicator.

From a practical perspective, the resulting ranking can support maintenance managers in allocating limited resources more effectively. The priority sequence M4 → M7 → M2 → M5 → M1 → M8 → M3 → M6 provides a structured reference for determining the order of maintenance intervention. Machines with higher priority can be scheduled for earlier inspection, preventive maintenance, corrective maintenance, or other appropriate interventions, while lower-priority machines can continue to be monitored and maintained according to routine maintenance schedules. The results therefore indicate that the proposed approach can convert diverse maintenance-related information into an interpretable priority ranking, reducing dependence on individual judgment and supporting more consistent and transparent maintenance planning. Overall, the study identifies M4 as the highest-priority production machine for maintenance, while the remaining machines can be addressed sequentially according to their obtained ranking and available maintenance resources.

IV. Conclusion

This study demonstrates that the LOPCOW–SPOTIS approach provides a systematic and objective framework for prioritizing production machine maintenance based on multiple maintenance-related criteria. The LOPCOW method produces criterion weights ranging from 0.0412 to 0.2616, with C7 obtaining the highest weight of 0.2616 and C2 the lowest weight of 0.0412, indicating that the contribution of each criterion differs in the evaluation process. Using these weights, the SPOTIS method generates the maintenance priority sequence M4 → M7 → M2 → M5 → M1 → M8 → M3 → M6, where M4 achieves the highest priority with a final value of 0.0000, while M6 obtains the lowest priority with 1.0000. These findings confirm

DOI: https://doi.org/10.67449/jodesma.1i1.1

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that the proposed approach can transform multiple maintenance indicators into a clear and measurable priority ranking, providing a practical basis for maintenance managers to allocate limited resources and determine the order of maintenance interventions.

CRediT Authorship Contribution Statement

Very Hendra Saputra: Writing – review & editing, Writing – original draft, Validation, Software, Methodology, Conceptualization. **Agung Deni Wahyudi:** Writing – original draft, Formal analysis, Data curation, Investigation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Funding Statements

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Declaration of Generative AI and AI-assisted Technologies in The Writing Process

The authors used Generative AI to improve the writing clarity of this paper. They reviewed and edited the AI-assisted content and take full responsibility for the final publication.

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