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Measurement of Line Balance at PT. Krismasindo Printing Using the RPW Method to Improve Work Efficiency

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A B S T R A C T

Research on line balancing continues to develop as an effort to increase the productivity and efficiency of production systems in various industrial sectors, such as manufacturing, textiles, automotive, electronics, construction, printing, and even the craft industry. Based on the results of a review of various previous studies, the Ranked Positional Weight (RPW) method is one of the heuristic methods that is widely used because it is able to balance the workload between stations by arranging work elements based on position weights. Most studies show that the application of RPW can improve line efficiency, reduce balance delay, idle time, and smoothness index, so that production flows more smoothly and productivity increases. The results of the study indicate that the RPW method can be applied to various characteristics of the production process and provides a significant increase in line efficiency.

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INTRODUCTION

The advertising industry is a sector that continues to grow, driven by the increasing need for promotional media by companies, government agencies, educational institutions, organizations, and businesses. Sponsorship banners are one of the most widely used promotional media due to their relatively low production costs, ease of installation, and ability to reach a wide audience. This situation requires screen printing service providers to produce high-quality products, with fast turnaround times and high productivity to meet customer demand in a timely manner. (Hussalam et al., 2026).

Productivity is a crucial indicator in assessing the success of a production system. High levels of productivity can be achieved if a company's resources are utilized effectively and efficiently. One factor influencing productivity is line balancing. An imbalance in the workload between workstations can lead to bottlenecks, idle time, and low efficiency in the use of labor and production facilities, making it difficult to achieve production targets. (Wijaya et al., 2023)(Fauzi, 2025).

PT. Krismasindo Printing is a company engaged in the field of sponsor banner screen printing with a make-to-order production system. Based on observations, the production process consists of several sequential work elements starting from material preparation, ink mixing, screen making, screen printing, drying, and packaging. The results showed that the screen-printing process had the highest processing time, namely 1,793.8 seconds, making it a bottleneck point on the production line. This condition causes work queues and increased idle time at several work stations.

Production data from PT. Krismasindo Printing from January to May 2026 shows that the company continues to experience production shortages almost every month. The largest production shortages occurred in January, with 3,020 units, and in April, with 2,476 units. This situation indicates that production line capacity has not been able to keep up with increasing demand, requiring improvements in workload distribution between workstations to improve production efficiency.

One method that can be used to address this problem is Ranked Positional Weight (RPW). Before performing track balancing, work time measurements are first performed using the Time Study method to obtain the standard time for each work element. Next, the RPW method is used to rearrange the division of work elements based on position weights to achieve a more balanced workload distribution. Research (Putera & Abd, 2025) shows that the implementation of Time Study and RPW is able to increase the efficiency of the production line and reduce idle time., whereas (Apriani & Imtihan, 2024) reported an increase in line efficiency of up to 98.20% after implementing the RPW method.

Based on these conditions, this study aims to analyze the balance of the production line in the sponsor banner screen printing process at PT. Krismasindo Printing using the Time Study and Ranked Positional Weight (RPW) methods. The research questions proposed are: (1) what is the condition of the production line balance in actual conditions, (2) how is the proposed work station formed using the RPW method, and (3) how does the application of the RPW method affect the increase in line efficiency, decrease in balance delay, and smoothness index in the sponsor banner production process.

LITERATURE REVIEW

Line balancing is a method used to distribute work elements across multiple workstations to ensure a more balanced workload and ensure the completion time for each station does not exceed the cycle time. The implementation of line balancing aims to improve line efficiency, reduce idle time, minimize bottlenecks, and streamline production flow (Nazareth & Dewi, 2024; Nugrianto et al., 2020). One widely used method is Ranked Positional Weight (RPW), a heuristic that prioritizes work elements based on their positional weight, resulting in a more equitable workload distribution (Novarika et al., 2024).

Before implementing RPW, work time is measured using the Time Study method to obtain the standard time for each work element. This standard time is used as the basis for establishing workstations and evaluating line balance. Previous research shows that the combination of Time Study and RPW can increase line efficiency, as well as reduce balance delay, idle time, and smoothness index in various industrial sectors (Apriani & Imtihan, 2024; Putera et al., 2025; Fauzi & Saifuddin, 2025).

METHODOLOGY

This research uses a descriptive quantitative approach with a case study of the sponsorship banner production process at PT. Krismasindo Printing, Sukoharjo Regency, Central Java. The object of the study is the manual-based sponsorship banner production process, which consists of 12 work elements, from order receipt to packaging. The study aims to analyze the balance of the production line and develop a proposed work station allocation using the Ranked Positional Weight (RPW) method. The research stages include problem identification, data collection, data processing, analysis of the results, and drawing conclusions.

Data collection was conducted through direct observation, interviews, and documentation. Observations were conducted to observe the production process flow, the sequence of work elements, and the condition of each work station. Interviews were conducted with the company owner and production operators to obtain information about the production system and any challenges encountered. Documentation was used to obtain monthly production data, the sequence of production processes, and other supporting data. Additionally, work time was measured using the Stopwatch Time Study method on the 12 work elements, with 10 observations for each work element. Before being used in the analysis, the time data was tested using uniformity and data sufficiency tests to ensure that the observations were suitable for use as a basis for calculating standard time.

The data processing stage begins by calculating cycle time, performance rating, allowance, normal time, and standard time for each work element. Next, cycle time is calculated as the basis for establishing the actual work station. Evaluation of actual conditions is carried out by calculating idle time, work station efficiency, line efficiency, balance delay, and smoothness index. The next stage is the application of the Ranked Positional Weight (RPW) method. This involves constructing a precedence diagram, determining the predecessor and successor relationships, calculating the positional weight of each work element, determining the minimum number of work stations, and then allocating work elements to work stations based on the highest positional weight value, while still considering the precedence relationship and cycle time limits.

The proposed work station formation results are then evaluated using the same indicators as the actual conditions: idle time, work station efficiency, line efficiency, balance delay, and smoothness index. A comparison is then made between the actual and proposed conditions to determine the level of improvement in production line efficiency after implementing the RPW method. The results of this analysis serve as the basis for developing recommendations for improving production line balance at PT. Krismasindo Printing.

RESEARCH RESULT

Actual Condition of Production Line

PT. Krismasindo Printing produces sponsorship banners using a make-to-order system. Based on production data from January to May 2026, the company still experiences production shortages almost every month. The largest production shortages occurred in January, with 3,020 units, and in April, with 2,476 units. This situation indicates that available production capacity is insufficient to meet customer demand, necessitating a production line balance analysis. Working time measurements were conducted on 12 work elements using the Stopwatch Time Study method, with ten observations for each work element. The observation data met uniformity and adequacy tests and can therefore be used as a basis for calculating standard time. The measurement results showed that the screen-printing process had the longest standard time, at 1,793.8 seconds, making it a potential bottleneck on the production line.

Under actual conditions, the twelve work elements were grouped into eight work stations. The evaluation results showed a line efficiency of 63.03%, a balance delay of 36.97%, and a smoothness index of 2,955.70. This value shows that the distribution of workload between stations is not yet even, so there is still quite a lot of idle time.

Table 1. Actual Condition Evaluation Results

Parameter	Mark
Number of work stations	8
Line Efficiency	63,03%
Balance Delay	36,97%
Smoothness Index	2.955,70

Results of the Application of the Ranked Positional Weight (RPW) Method

The path balancing was performed using the Ranked Positional Weight (RPW) method. The analysis phase began with the preparation of a precedence diagram, determination of predecessor and successor relationships, calculation of the positional weight of each work element, and then grouping the work elements into work stations based on the highest positional weight, while still considering the precedence relationship and cycle time limits. The analysis resulted in seven proposed work stations. The regrouping of work elements resulted in a more even workload between stations compared to actual conditions. Consequently, idle time was reduced and line efficiency was increased.

Table 2. RPW Method Evaluation Results

Parameter	Mark
Number of work stations	7
Line Efficiency	72,03%
Balance Delay	27,97%
Smoothness Index	1.853,60

Comparison of Actual and Proposed Conditions

The results showed that the implementation of the RPW method improved the performance of the production line. The number of work stations was reduced from eight to seven. The line efficiency value increased by 9.00%, while the balance delay decreased by 9.00%. In addition, the smoothness index value decreased from 2,955.70 to 1,853.60, indicating that the workload variation between stations was reduced.

Table 3. RPW Method Evaluation Results

Parameter	Aktual	Usulan	Perubahan
Number of work stations	8	7	↓ 1
Line Efficiency	63,03%	72,03%	+9,00%
Balance Delay	36,97%	27,97%	−9,00%
Smoothness Index	2.955,70	1.853,60	−1.102,10

The increase in line efficiency indicates that the division of work elements using the RPW method is able to utilize work time more optimally. The decrease in balance delay indicates that idle time on the production line is reduced, while the decrease in smoothness index indicates that the workload between stations is more balanced. The results of this study are in line with the research of Putera et al. (2025), Fauzi and Saifuddin (2025), and Apriani and Imtihan (2024) which stated that the application of the RPW method is able to increase the efficiency of the production line through equalizing the workload and reducing idle time. Thus, the RPW method is worthy of being implemented as a proposed improvement in the sponsor banner production process at PT. Krismasindo Printing.

DISCUSSION

The research results show that the application of the Ranked Positional Weight (RPW) method can improve production line balance in the sponsorship banner screen printing process at PT. Krismasindo Printing. Restructuring workstations based on positional weights results in a more even workload distribution, thereby reducing bottlenecks and idle time on the production line. This results in increased line efficiency and more optimal resource utilization. The findings of this study align with those of Apriani and Imtihan (2024), Putera et al. (2025), and Fauzi and Saifuddin (2025), which found the RPW method to be effective in increasing line efficiency by equalizing workloads and reducing idle time. Therefore, the RPW method can be a suitable alternative for improving production system performance, particularly in companies with sequential production processes such as PT. Krismasindo Printing.

CONCLUSIONS AND RECOMMENDATIONS

The application of the Time Study and Ranked Positional Weight (RPW) method has been proven to improve production line balance at PT. Krismasindo Printing by establishing more effective work stations. This method results in increased line efficiency, reduced idle time, and improved workload distribution between stations. Further research is recommended to combine the RPW method with other line balancing methods or production simulations to obtain more optimal line improvement alternatives while considering implementation costs.

ADVANCED RESEARCH

This research is limited to the application of the Time Study and Ranked Positional Weight (RPW) methods to one type of product and one production line at PT. Krismasindo Printing. Further research is recommended to combine RPW with other line balancing methods, such as COMSOAL, Largest Candidate Rule (LCR), or production simulation, and apply them to various types of products to obtain more optimal and comprehensive results.

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