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Analysis of Production Efficiency: Comparison of Power Conversion Using Diode and Thyristor in Circular Saw

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ABSTRACT

This research aims to evaluate the comparison of two power conversion methods, utilizing diodes and thyristors, in circular saw machines used in the furniture industry. The research used a quantitative approach through controlled experiments, testing five machines from each method based on power consumption, cutting speed, and cutting productivity. The test results showed that machines with thyristor-based power conversion showed higher cutting speed and productivity compared to diode-based machines, although their power consumption was slightly higher. Statistical analysis using Welch's t-test indicated no significant difference in energy efficiency between the two methods. This study recommends the use of thyristor power conversion for industrial applications that require high speed and productivity, while the diode method is more suitable for low-power requirements.

Keywords: power conversion, energy efficiency, cutting speed, productivity, circular saw

INTRODUCTION

The furniture industry is one of the manufacturing sectors that continues to grow rapidly due to the increasing demand for high-quality furniture products. In its production process, the furniture industry heavily relies on various types of machines to cut, shape, and assemble raw materials into finished goods. The circular saw machine is one of the most important machines used in the furniture industry to enhance productivity in wood cutting. Power efficiency in the operation of these machines becomes a key factor in determining cost-effectiveness and production output. In practice, circular saw machines often require single-phase power sources, whereas industrial power supplies are generally based on three-phase systems. Therefore, an efficient and reliable power conversion method is necessary to convert from a three-phase to a single-phase system.

Power conversion models commonly used in the industry include diodes and thyristors. Diodes offer a simple rectification solution but are uncontrolled, making them less flexible to load and voltage variations. In contrast, thyristors allow control of the firing angle, providing greater flexibility in regulating output voltage and system efficiency[1][2][3]. The use of thyristors in power conversion can result in motor drive systems with higher efficiency and better speed control, although they involve greater circuit complexity[4]. Other studies have also shown that converters using thyristors provide better performance compared to diode-based converters, particularly in heavy industrial applications such as cutting machines[5].

Although various studies have discussed theoretical aspects, power conversion simulations, and general research related to the performance of circular saw machines, there is a significant gap in the literature regarding a direct empirical comparison between diode and thyristor power conversion methods in circular saw machines operated in actual furniture industry environments. This study presents novelty in terms of the testing context, which is conducted directly in the industrial field under real operational conditions, rather than solely relying on simulations or laboratory testing. In addition, the use of production efficiency parameters simultaneously, namely power consumption, cutting speed, and cutting productivity, provides a comprehensive overview that has not been widely addressed in previous studies.

The fundamental novelty of this research lies in its unique approach, namely, conducting direct controlled experiments by testing five circular saw machines with different specifications for each power conversion method using diodes and thyristors at actual production sites, rather than relying solely on simulations or limited laboratory tests. This study adopts comprehensive production efficiency parameters, including power consumption, cutting speed, and cutting productivity, to provide a holistic overview of machine performance that is relevant to industrial operational conditions. To ensure quantitative validity, inferential statistical analysis, specifically Welch's t-test, was applied to examine the significance of differences in energy efficiency between the two methods, an aspect that has been underemphasized in many previous studies. With this methodology, the research not only contributes to the academic literature with strong empirical data but also aims to provide practical and evidence-based recommendations for furniture industry practitioners in selecting the most optimal power conversion technology to improve operational efficiency and reduce production costs.

In the furniture industry, circular saw machines require a stable and efficient power supply to ensure production quality and speed [6]. Power conversion efficiency plays a crucial role in maintaining the operational stability of machines and reducing energy waste, which ultimately leads to cost reduction and increased productivity. Power conversion systems in the industry consistently demand efficient solutions to optimize energy use, which significantly contributes to cost-efficiency in production. The use of semiconductor devices such as diodes and thyristors in power conversion systems greatly determines the overall system performance, particularly in maintaining stability and power regulation in industrial equipment that requires continuous operation[7][8]. The use of more efficient technologies can enhance productivity and reduce energy waste across various industries[9]. The selection of an appropriate power conversion method will significantly affect production outcomes in the furniture industry, particularly for those relying on high-energy-consuming machines. Power system efficiency is directly related to the selection of proper components, which serve to improve performance and reduce wasted energy[10].

Based on this background, research comparing these two power conversion methods is highly relevant for improving machine performance and production efficiency in the furniture industry. By analyzing the advantages and disadvantages of each method, it is expected to provide new insights for decision-making in the furniture industry, enabling the selection of a method that best meets operational needs and achieves cost efficiency. Specifically, the objective of this study is to empirically evaluate the energy efficiency, cutting speed, and cutting productivity of circular saw machines that use diode and thyristor power conversion methods in a real industrial environment.

RESEARCH METHOD

This study employed a quantitative approach with a controlled experimental design to objectively compare the production efficiency of circular saw machines using two power conversion methods: diode and thyristor. The research was conducted at CV. Surya Lestarindo Furniture Jepara, located at Bantengan–Bawu Street, RT 07/RW 02, Pekalongan Village, Batealit District, Jepara Regency, from January to April 2025. This approach enables systematic numerical measurement and statistical analysis, allowing for an in-depth understanding of the phenomenon under investigation.

The population in this study consists of all circular saw machines used by the company that implement power conversion from three-phase to single-phase. The samples were selected purposively, composed of five machines for each power conversion method, with the criterion that the machines were operating normally and actively used in the production process. Primary data were obtained through direct measurements using instruments such as a multimeter to measure voltage and electric current, a tachometer to measure saw blade rotation speed, and an oscilloscope to visualize electrical signals. Data analysis was performed using R Studio software.

The data collection techniques included direct measurement of power consumption and cutting speed, recording of cutting time to calculate productivity, and calculation of energy efficiency based on the ratio between productivity and power consumption. The obtained data were then analyzed using a mean difference test (t-test) with the Welch's t-test method to determine whether there was a significant difference in energy efficiency between machines using diode and thyristor power conversion. The overall research flow is presented as follows.

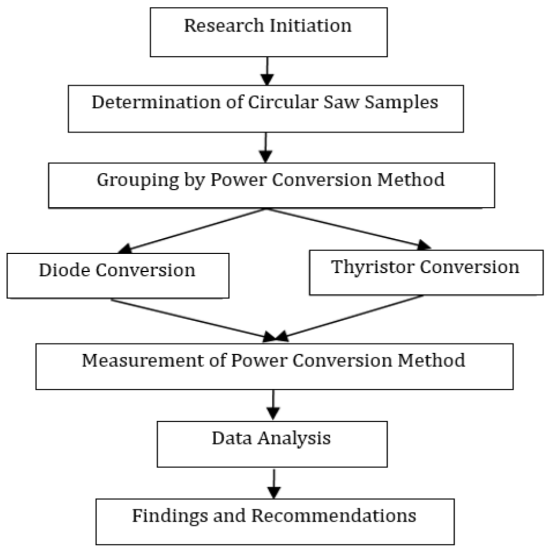

Figure 1. Research Flow Diagram

The data analysis technique used in this study was designed to systematically test the hypothesis and evaluate the impact of power conversion methods, utilizing diodes and thyristors, on various aspects of the production efficiency of circular saw machines. Energy efficiency was calculated as the ratio of cutting productivity to power consumption for each machine[11]:

$$Energy\ Efficiency = \frac{Cutting\ Productivity\ (m^3/_{hour})}{Power\ Consumption\ (Watt)}$$

To test the statistically significant difference in energy efficiency between machines using diode and thyristor conversion methods, a mean difference test (t-test) was used, specifically Welch's t-test for unequal variances[12]:

$$t = \frac{M_1 - M_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

Description:

a. M_1 and M_2
- M_1 is the mean of the first sample (average energy efficiency for the Diode conversion method).
- M_2 is the mean of the second sample (average energy efficiency for the Thyristor conversion method).

b. s_1^2 dan s_2^2
- s_1^2 is the variance of the first sample.
- s_2^2 is the variance of the second sample.

Variance describes how far the values in a sample deviate from the mean.

c. n_1 and n_2:
- n_1 is the number of elements or samples in the first group (amount of data for the Diode method).
- n_2 is the number of elements or samples in the second group (i.e., the amount of data for the Thyristor method).

Degrees of freedom (df) are calculated using the Welch–Satterthwaite equation, which is more appropriate for calculating variances that are unequal between groups.

$$df = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{\left(\frac{s_1^2}{n_1}\right)^2}{n_1 - 1} + \frac{\left(\frac{s_2^2}{n_2}\right)^2}{n_2 - 1}}$$

Description:

a. s_1^2 and s_2^2
- s_1^2 is the variance of the first sample.
- s_2^2 is the variance of the second sample.

Variance describes how far the values in a sample deviate from the mean.

b. n_1 and n_2:
- n_1 is the number of elements or samples in the first group (number of data points for the Diode method).
- n_2 is the number of elements or samples in the second group (number of data points for the Thyristor method).

This test was conducted to examine the null hypothesis (H_0), which states that there is no significant difference in production efficiency between circular saw machines using diodes and those using thyristors, and the alternative hypothesis (H_1), which states that a significant difference exists.

Cutting speed was measured in meters per second (m/s), and cutting productivity was measured in cubic meters per hour (m^3/hour). The analysis of cutting speed and cutting productivity was conducted descriptively by comparing the average values, performance range, and individual machine performance within both categories of power conversion methods. Although a t-test was used for the dependent variable, the comparative analysis results for cutting speed and cutting productivity are presented descriptively to illustrate trends and operational advantages without involving separate statistical significance tests for these individual variables.

This descriptive comparison aims to identify performance patterns, such as those of machines with thyristor power conversion, which tend to have higher cutting speeds and cutting productivity, indicating advantages in time efficiency and production volume. The entire process of data processing and analysis, including the calculation of energy efficiency and the t-test, was carried out using the R Studio software.

RESULTS AND DISCUSSION

The research findings on the comparison between diode and thyristor power conversion methods, concerning the production efficiency of circular saw machines, were based on direct measurements of power consumption, cutting speed, and cutting productivity from five machines for each conversion method. These measurements were then analyzed statistically.

1. Energy Efficiency Analysis

Energy efficiency in the context of this study is defined as the ratio between cutting productivity (in m^3/jam) and power consumption (in watts), which reflects the amount of production output generated per unit of energy. Based on the results of the Welch–Satterthwaite t-test, a t-value of -0.64 was obtained with degrees of freedom of 0.745 and a p-value of 0.5412. Since this value exceeds the significance threshold of 0.05, it can be concluded that there is no statistically significant difference in energy efficiency between machines using diode and thyristor power conversion.

These findings highlight that the theoretically more efficient performance of thyristors does not automatically result in higher system energy efficiency. In real-world applications, the increased speed and productivity achieved by thyristor-based systems are accompanied by greater power consumption, thereby maintaining an energy efficiency ratio equivalent to that of diode systems. The inductive motor load characteristics in circular saw machines are likely the dominant factor, where system efficiency is more influenced by the nature of the load rather than the type of power controller. This is supported by [13], which indicates that in cutting systems based on induction motors, variations in energy efficiency are more affected by load stability than by the conversion device.

Logically, this can be explained through a causal relationship between the technical features of the thyristor and the system output. Although the thyristor offers more precise firing angle adjustment and allows for better power control, in practice, this feature does not significantly reduce total energy consumption per unit of output when the load remains stable. In other words, adaptive power control does not necessarily lead to improved energy efficiency in systems with limited operational variability.

This study has several strengths that support the validity of its findings. First, the experiments were conducted in an actual industrial environment rather than a laboratory simulation, thereby reflecting system performance under real operational conditions. Second, the measurement instruments used were industry-standard tools, such as multimeters, tachometers, and oscilloscopes, which enhanced the reliability of the data. However, the limitations of this study include the limited sample size (5 machines per method), as well as not considering other factors such as component lifespan, maintenance costs, and long-term system durability.

The results of this study align with several previous studies. For instance [14] stated that thyristor efficiency is superior in aluminum production systems, although in a different industrial context and with varying loads. Similarly, [15], concluded that thyristors outperform in power electronics applications. However, this study differs in that it focuses on overall system efficiency, not merely the efficiency of the power conversion device. This supports the findings of[16], which indicated that in metal cutting systems based on induction motors, the type of converter is not always the dominant factor in energy efficiency, especially when the load is constant. Therefore, although general literature supports the technical advantages of thyristors, the results of this study provide a "new narrative" that system efficiency in the context of the furniture industry must be assessed holistically, including the aspect of actual productivity.

The main contribution of this study is to enrich the academic literature with empirical data from the furniture industry, as well as to clarify that the selection of power conversion technology must take into account the application context. The implication is that for industries prioritizing high productivity, thyristors may be a more suitable choice. However, for pure energy efficiency with low initial costs, diodes remain an economical option. This output-based assessment approach is expected to encourage the development of a more practical efficiency evaluation framework, not solely based on electrical efficiency.

2. **Cutting Speed and Cutting Productivity Analysis**

Although energy efficiency did not show a statistically significant difference, the descriptive data analysis indicated that machines with thyristor power conversion consistently achieved higher cutting speed and cutting productivity compared to the diode method. For example, the TYRONE 2 HP machine with thyristor conversion recorded the highest cutting speed (16 m/s) and cutting productivity of 4.2 m^3/hour. Meanwhile, the best-performing diode machine (MONTOYA 1 HP) reached 15 m/s and 4.0 m^3/hour. The table comparing the average cutting speed and cutting productivity is presented in the figure below.

Table 1. Comparison of Average Cutting Speed of Circular Saws Based on Power Conversion Method

Power Conversion Method	Average Cutting Speed (m/s)	Standard Deviation (SD)
Diode	13.30	± 1.20
Thyristor	14.00	± 1.58

Table 1 shows that machines using the thyristor power conversion method have a slightly higher average cutting speed (14.00 m/s) compared to the diode method (13.30 m/s). However, the study also notes that, statistically, the energy efficiency between the two methods does not show a significant difference, although thyristor consistently achieves higher cutting speed and cutting productivity.

Table 2. Comparison of Average Cutting Productivity of Circular Saws Based on Power Conversion Method

Power Conversion Method	Average Cutting Productivity (m^3/hour)	Standard Deviation (SD)
Diode	3.56	± 0.34
Thyristor	3.74	± 0.40

Table 2 shows that machines using the thyristor power conversion method have a higher average cutting productivity (3.74 m^3/hour) compared to those using the diode method (3.56 m^3/hour). Although there is no statistically significant difference in energy efficiency between the two methods, the descriptive analysis indicates a clear advantage of thyristor machines in terms of cutting speed and productivity. In the context of the furniture industry, which heavily relies on operational speed and production volume, this advantage provides considerable strategic value.

The primary finding of this study is that circular saw machines with thyristor power conversion consistently show superior performance in terms of cutting speed and productivity. This indicates that although energy efficiency (the output/input power ratio) is relatively similar, thyristors provide functional advantages in terms of the actual output produced within a given time frame. For example, the thyristor-based TYRONE 2 HP machine achieved a cutting speed of up to 16 m/s and a productivity of 4.2 m^3/hour, whereas the diode-based SUMURA JY2A-4 machine reached only 12 m/s and 3.2 m^3/hour.

The superior performance of thyristors can be technically explained by their ability to regulate the firing angle, which enables more precise control of voltage and current. Thyristor systems are capable of adjusting the power supply in real-time in response to fluctuations in cutting load, thereby providing better torque and speed stability [17]. This advantage has been proven to offer significant operational benefits, particularly in maintaining production rates and reducing cutting time per unit of raw material.

The primary contributing factor to this result is the adaptive capability of thyristors to variations in inductive motor loads, which are commonly found in industrial saw machines. The fluctuating nature of loads in the field necessitates power conversion systems with high response speeds to maintain motor performance. A study by Hartono and Siregar reported that thyristors can improve the motor system's response speed by up to 27% compared to diode systems, making them more responsive to changing working conditions [18].

The strength of this study lies in its approach, which was directly applied in a real production environment with direct observation of five machines for each method. In addition, the use of industrial measuring instruments such as multimeters, tachometers, and oscilloscopes, as well as the application of inferential statistical testing (Welch's t-test), reinforces the validity of the results. However, limitations remain, such as the small sample size and the study being conducted at only one industrial site. Long-term aspects, such as system durability, maintenance costs, and component lifespan, were not evaluated; therefore, the results should be interpreted within the specific context of furniture applications.

From a literature perspective, these results show both alignment and differentiation. A study by Tandioga et al. indicated that thyristor converters provide better system efficiency in large-scale electrolysis processes [19], and Jhajharia stated that thyristors are more efficient in power electronics systems[20]. However, both studies emphasized the technical efficiency of the device, not system efficiency based on actual productivity, as in this study. Therefore, this research provides a "new narrative" in the discourse on industrial efficiency by shifting the focus from merely energy consumption to output productivity per unit of energy.

These findings are also supported by Wibowo and Nugroho, who stated in their study that in metal cutting systems based on induction motors, the difference in efficiency between thyristors and diodes is not significant when tested under constant load conditions [21]. Meanwhile, Haryanto and Fadhillah concluded that in linear cutting systems, efficiency is more influenced by load characteristics than by the type of power controller [22]. Thus, this study not only confirms previous findings but also contributes to differentiation by emphasizing the importance of actual output as an indicator of efficiency.

The practical implications of these findings are highly significant for the furniture industry. For companies seeking to expand production capacity without investing in additional machines, the thyristor system can serve as a strategic option. On the other hand, industries with budget constraints or lower production demands can still rely on diode systems. For academics and technology developers, the actual productivity-based evaluation approach used in this study can serve as a methodological foundation for measuring industrial system efficiency in a more comprehensive and applicable manner.

The table comparing the average values and performance ranges of circular saws, based on the power conversion method, is presented below.

Table 3. Average Values and Performance Ranges of Circular Saws Based on Power Conversion Method

Variable	Diode Conversion Method (Average ± SD)	Thyristor Conversion Method (Average ± SD)
Power Consumption (Watt)	816.00 ± 59.41	850.00 ± 79.06
Cutting Speed (m/s)	13.30 ± 1.20	14.00 ± 1.58
Cutting Productivity (m^3/hour)	3.56 ± 0.34	3.74 ± 0.40
Energy Efficiency (m^3/hour/Watt)	0.00436 ± 0.00011	0.00440 ± 0.00007

Table 3 presents a comparison of the average performance of circular saw machines between two power conversion methods: diode and thyristor. In general, machines with thyristor-based power conversion demonstrate superior operational performance. The average power consumption of thyristor machines is 850.00 ± 79.06 Watts, slightly higher than that of diode machines, which recorded 816.00 ± 59.41 Watts. However, this power consumption is compensated for by output performance: thyristor machines have an average cutting speed of 14.00 ± 1.58 m/s and cutting productivity of 3.74 ± 0.40 m^3/hour, which is higher than that of diode machines, with 13.30 ± 1.20 m/s and 3.56 ± 0.34 m^3/hour.

The main finding from this section is that thyristor machines provide improved functional performance, although they do not significantly enhance energy efficiency. The calculation of energy efficiency (m^3/hour/Watt) shows a value of 0.00440 for thyristor machines and 0.00436 for diode machines. The difference is minimal, and the result of the Welch's t-test ($p = 0.5412$) confirms that there is no statistically significant difference between the two methods. This means that the increase in productivity in thyristor machines is proportionally offset by the increase in power consumption, resulting in an almost identical efficiency ratio.

The contributing factor to this finding originates from the technical characteristics of the thyristor. The thyristor's ability to control the firing angle enables more precise and adaptive power regulation in response to variations in cutting load [23]. This results in improved torque and motor speed stability, particularly when the machine operates under fluctuating load conditions. A study by Hartono and Siregar showed that the use of thyristors in industrial motor systems increased dynamic response by 27% compared to diode-based systems [24]. This more flexible power adjustment is the underlying reason for the increased machine output.

The strength of this study lies in its approach, which is based on direct experimentation in an actual production environment, rather than relying on laboratory simulation. Data were collected from five machines per group, using industrial measurement instruments, and analyzed using inferential statistics. However, this study also has limitations, including a small sample size, a single industrial site, and non-technical variables (such as component lifespan and maintenance costs) that were not examined. These aspects open opportunities for further research with a broader scope and a multivariate approach.

In comparison to previous studies, these findings provide a new perspective. Tandioga et al. reported that thyristor converters are more efficient in industrial electrolysis processes due to their ability to reduce power losses under heavy loads [25]. Jhajharia also emphasized that thyristors are technically superior in power electronics systems [26]. However, unlike those studies that focused on internal electrical efficiency, this research measures efficiency from the perspective of actual industrial output. Therefore, these results enrich the scientific narrative with a more comprehensive system efficiency approach.

This study aligns with the findings of Wibowo and Nugroho [27], who reported that in metal cutting systems based on induction motors, no significant efficiency differences were observed between thyristor and diode systems when tested under constant load conditions. Furthermore, Haryanto and Fadhillah concluded that energy efficiency is more influenced by load characteristics than by the type of power controller [28]. This reinforces the notion that in environments with fluctuating loads, system performance depends more on the compatibility between load characteristics and power control capabilities, rather than merely on the type of converter used.

The practical implications of these findings are highly significant for the manufacturing sector, particularly the furniture industry, which relies on high productivity. The use of thyristor machines offers the opportunity to increase production capacity without the need to add more machines, although it involves higher initial costs and more complex control systems. On the other hand, for medium-scale production needs with limited budgets, diode systems remain a viable option. The academic contribution of this study lies in strengthening the output-based efficiency assessment approach, which can serve as a framework for evaluating other industrial sectors.

3. Research Hypothesis Testing

This study was designed to test two main hypotheses related to production efficiency in circular saw machines using two different power conversion methods, namely diode and thyristor. The null hypothesis states that there is no significant difference in production efficiency between the two power conversion methods. Conversely, the alternative hypothesis states that there is a significant difference. Production efficiency in this study is comprehensively defined as a combination of energy efficiency, cutting speed, and cutting productivity.

Based on the statistical test results for energy efficiency, a p-value of 0.5412 was obtained, which is greater than the significance level of 0.05. This finding indicates that there is no statistically significant difference between circular saw machines using diode and thyristor power conversion methods in terms of energy efficiency. Therefore, the null hypothesis cannot be rejected, which means that both conversion methods have equivalent performance in terms of the output-to-input power ratio.

However, the descriptive analysis revealed that machines with thyristor power conversion consistently showed superiority in terms of cutting speed and productivity. This indicates that although energy efficiency (output/input) does not differ statistically, the functional performance or actual output of thyristor-based machines is at a higher level. This finding represents a key point in this study, namely that thyristors excel not because they consume less power, but because they can optimize output within the same amount of time.

This superior performance is affected by the technical characteristics of the thyristor, which allows precise control of the firing angle. With this capability, the system can dynamically regulate the voltage and current supplied to the motor in response to variations in the cutting load. In the context of the furniture industry, which frequently faces fluctuations in material load, such adaptive power control becomes highly crucial. The thyristor's ability to maintain torque and motor speed stability not only increases productivity but also reduces the potential for machine damage due to load surges, thereby contributing to long-term operational efficiency.

Thus, this study not only shows the statistical equivalence of energy efficiency but also introduces a new perspective that the effectiveness of power conversion systems in industry should not be measured solely by power savings, but also by the actual production output that can be achieved within the same unit of time. This represents an important contribution to assessing system efficiency in a more holistic and practical manner.

The factors supporting these results include the thyristor's ability to maintain a more stable motor speed and power, as well as its capacity to adapt to dynamic operational conditions. The strength of this study lies in its experimental design, which was conducted directly in the field using five machines for each power conversion group. Data were collected using standard measuring instruments and analyzed using inferential statistical methods to ensure the validity of the findings. However, the limitations of this study include the relatively small sample size and the focus limited to a single industrial site, which means the results cannot yet be generalized to other industrial sectors.

Compared to previous studies, the results of this study reveal both alignment and key differences in understanding the efficiency of power conversion systems. The studies by Jhajharia [29] and Tandioga et al. [30] concluded that the use of thyristors generally provides higher energy efficiency compared to diodes, particularly in electrical systems with high energy demands, such as metal electrolysis. Their findings focused on the technical efficiency of converters, specifically the extent to which each method minimizes power losses.

However, the approach used in this study is broader, as it assesses efficiency not only from an electrical aspect but also from the actual productivity within the operational context of the furniture industry. This means that efficiency is not only viewed in terms of the electrical input-output ratio, but also in consideration of the volume of production output per unit of energy consumed. This approach enriches the definition of system efficiency and offers a new perspective in evaluating power conversion performance, particularly in motor-based industrial applications.

In addition, these findings are also consistent with the studies by Hartono and Siregar [31] and Wahyudi et al. [32], which showed that thyristors offer advantages in providing more flexible and stable power control, particularly in induction motor systems. More precise control over voltage and current enables thyristors to respond more quickly to load changes, ultimately enhancing productivity and overall system performance, although it does not always result in a significant reduction in power consumption.

Thus, the main contribution of this study is the presentation of an output-based efficiency evaluation approach, rather than focusing solely on electrical efficiency. This is important to consider in industrial decision-making, especially when production efficiency and process speed are prioritized over mere energy savings.

The implications of this study are highly significant for industry practitioners, particularly in the furniture industry, which requires high speed and production volume. The use of thyristors offers the opportunity to increase productivity without compromising energy efficiency. Scientifically, this study enriches the literature on power conversion system efficiency in real industrial contexts and opens opportunities for further research with a broader range of variables and industrial sectors. Its practical contribution lies in supporting decision-making regarding the selection of technology that best aligns with the industry's needs and priorities, both in terms of technical efficiency and production productivity.

CONCLUSION

Based on the research results and analysis, it can be concluded that there is no statistically significant difference in energy efficiency between circular saw machines using diode and thyristor power conversion methods. Energy efficiency, measured as the ratio between cutting productivity and power consumption, shows relatively comparable values for both methods. Therefore, from the perspective of pure energy efficiency, both conversion methods can be considered to have equivalent performance.

However, the results of the descriptive analysis indicate that machines employing the thyristor-based power conversion method show advantages in terms of cutting speed and productivity. Thyristor machines consistently show higher performance in processing materials within a unit of time, despite slightly higher power consumption. This advantage has a positive impact on overall production efficiency, particularly for industries that emphasize high output and faster work processes.

Considering these results, it can be concluded that the selection of power conversion methods should be aligned with the specific needs of the industry. For industries that prioritize system simplicity and energy savings, the diode method remains relevant. However, for industries that emphasize production speed and output volume, the use of thyristors becomes a more advantageous option. This study is expected to provide practical insights for furniture industry practitioners in determining strategies to improve operational efficiency through the appropriate selection of power conversion technology.

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