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Innovative Development of a Dual-Purpose Rattan Stripping and Splitting Machine

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Abstract - Introduction-This study focused on the development and performance evaluation of a rattan stripping and splitting machine designed to improve the efficiency and productivity of rattan processing operations. The study is significant in promoting mechanized processing methods that may reduce manual labor, improve operational efficiency, and support the increasing demands of the rattan industry. The study involved the design, fabrication, and experimental testing of the newly developed machine. Performance evaluation was conducted using different rattan samples under actual operating conditions. The machine was assessed on stripping efficiency, splitting efficiency, processing speed, operational consistency, and output quality. The performance of the newly developed machine was compared with that of an existing rattan processing machine.Results showed that the newly developed machine achieved an average stripping efficiency of 66.67%, while the existing machine achieved 100%. In terms of stripping speed, the newly developed machine recorded an average processing rate of 4.33 pieces per minute, whereas the existing machine achieved 5.00 pieces per minute. In the splitting process, the newly developed machine achieved an average splitting efficiency of 53.33%, compared to 88.33% for the existing machine. The findings further revealed that the machine experienced operational limitations when processing larger and thicker rattan materials due to insufficient cutting strength, aligner instability, and limited roller adaptability. In addition, some processed rattan products required further sanding to achieve a smoother, more refined surface finish. The study concludes that the newly developed rattan stripping and splitting machine can perform stripping and splitting; however, further improvements in motor capacity, blade and roller mechanisms, aligner stability, and overall machine design are necessary to enhance operational efficiency, consistency, and output quality. The findings of this study may serve as a basis for future improvements and further research on automated, sustainable rattan processing technologies.

Keywords: *Rattan Processing, Stripping Machine, Splitting Machine, Automation, Processing Efficiency*

INTRODUCTION

The rattan industry in Mandaue City, Cebu, is a significant contributor to the local economy, supporting small-scale producers, artisans, and their families. Despite its economic importance, the industry faces persistent challenges due to outdated machinery and labor-intensive manual processes. Cebu was historically a leading exporter of rattan furniture, maintaining a strong global market position from the 1950s to the 1980s. This dominance diminished as producers in Malaysia, China, and Vietnam adopted more efficient production methods (Philippine Institute for Development Studies [PIDS], 2008).

A major issue in the local rattan industry is the lack of efficient machinery that meets the needs of small-scale producers. Current machines, such as the Manually Operated Rattan Stripping Machine and Rattan Splitting Machine, are too expensive, difficult to maintain, and not designed to handle rattan of varying sizes. Their reliance on manual blade adjustments add to inefficiencies and increases labor intensity. These issues prevent small-scale producers from expanding operations, improving product quality, and meeting market demands (Department of Trade and Industry, 2021).

Continuing to depend on traditional methods makes these challenges worse. According to the Philippine Statistics Authority (PSA, 2022), over 40% of small-scale rattan processors in Cebu still use manual techniques. This leads to inconsistent quality and low production efficiency. Without affordable and efficient machinery, small-scale producers are at a disadvantage compared to larger manufacturers. This research aims to tackle these challenges by developing a dual-purpose rattan stripping and splitting machine specifically designed for Mandaue's rattan industry. The proposed machine will handle various rattan sizes through adjustable mechanisms, automate blade adjustments, reduce manual labor, and improve processing efficiency. It seeks to promote sustainability by minimizing material waste and maximizing resource use while remaining affordable for small-scale producers with a cost-effective design and low maintenance needs.

The innovation also aligns with Mandaue's commitment to eco-friendly practices. Studies show that better processing techniques can cut material losses by up to 30% (Snelder & Lasco, 2008). This will help artisans maximize the value of their materials while staying within environmental guidelines. Additionally, the machine's economic benefits go beyond improving production efficiency. By boosting productivity and

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lowering operational costs, the innovation could encourage business growth, create jobs, and increase household incomes in Mandaue's rattan-producing communities. According to the International Labor Organization (ILO, 2020), adopting technology in local economies can raise household incomes by 20-40%, underscoring its potential to drive change.

This study fills a significant gap in the rattan industry by introducing a cost-effective, adaptable, and sustainable solution. The dual-purpose rattan stripping and splitting machine aims to modernize traditional practices, support small-scale producers, and strengthen Mandaue City's place in the global rattan market. Through this innovation, the local rattan industry can achieve long-term sustainability, improve its economic impact, and ensure a brighter future for its artisans and stakeholders.

I. STATEMENT OF THE PROBLEM

The research work is intended to design a cost-efficient, productive, and easy-to-operate rattan stripping and splitting machine to boost productivity and improve the quality of the final products in rattan manufacturing. The objectives of this research study are as follows:

1. Identify related studies on rattan processing and the development of efficient machines for stripping and splitting rattan.
2. Develop a dual-purpose rattan stripping and splitting machine that is easy to use and capable of processing various sizes of rattan.
3. Conduct testing and evaluation of the machine in terms of:
   - 3.1 Efficiency in stripping and splitting rattan
   - 3.2 Speed of processing
   - 3.3 Consistency and quality of output
   - 3.4 Adaptability to different rattan sizes and types
4. Evaluate user acceptance in the given machine using the TAM model:
   - 4.1 Perceived Usefulness
   - 4.2 Perceived Ease of Use
   - 4.3 Attitude Toward Use
   - 4.4 Behavioral Intention to Use

II. METHODOLOGY

A. Research Design

This study designed an efficient rattan stripping and splitting machine to overcome the constraints encountered with previous machines. The study adopted a mixed-methods research design, combining descriptive and experimental approaches. The current literature and existing machines were evaluated to identify weaknesses, including inefficient operations, poor output quality, and long operating times. The evaluation focused on mechanical adjustments and innovations to improve performance. A prototype of the machine was subsequently developed and tested in practical applications, with parameters such as operating time, output quality, and user satisfaction used to determine its effectiveness. The findings revealed that the designed machine not only operated efficiently but could also be modified to meet industrial requirement

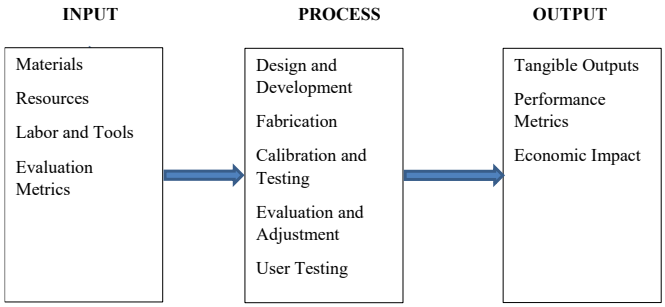

Figure 1:IPO

B. Research Environment

The study took place in Purok Orchid, Opao, Mandaue City, Cebu, known for its traditional handicraft industry, particularly rattan production. This area provided a real, tangible setting for the study because of the variety of crafts and businesses involved in furniture making and the manufacturing of rattan items. As the community was ideal for rattan processing, it served well for studying problems in rattan stripping and splitting, as well as for evaluating the potential advantages of adopting a mechanical technique. The selected environment facilitated direct communication with skilled individuals and business owners, ensuring the study met industrial needs.



Figure 2: Location Map

C. Research Respondents

These respondents were selected from a total of 10 people, including locals involved in rattan production, small-scale rattan producers, and workshop operators in Mandaue City, Cebu, specifically in Purok Orchid and Opao, where rattan processing was common. Respondents had to either manually or mechanically process the rattan because of their experience with the problems associated with conventional techniques. A purposive sampling technique was used to identify these

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respondents. It is considered to be the most appropriate non-probability sampling technique for this research. Selecting specific individuals with the necessary characteristics and skills would enable the collection of meaningful, relevant responses.

The selected respondents were a diverse group, ranging from veteran artisans to businesspeople—their diversity enabled the gathering of different views on the industry's difficulties and what is required. Moreover, certain demographics, such as years of experience, production capacity, and familiarity with current machines, were considered to gain a more complete understanding of the implications the invention may have. Thanks to their knowledge and practical experience, the selected respondents contributed significantly to assessing the machine's viability and its potential to address inefficiencies and improve productivity in the rattan industry of Mandaue City.

D. Research Instrument

Interviews were considered the main method of collecting data, along with the observational checklist technique, as far as the assessment was carried out based on the TAM principles and aimed at assessing the level of acceptance of the technology among rattan crafters. Interviews were held among local rattan craftsmen, manufacturers working on the micro-level and owners of workshops engaged in manufacturing goods from this material. The interview was dedicated to several main aspects of the TAM model such as the level of perceived usefulness how useful respondents think the introduction of the machine can be in terms of increasing efficiency, effectiveness and the quality of work and the level of perceived ease of use, meaning how user-friendly this machine can be. Moreover, there is an evaluation of certain barriers associated with the process of introduction of the machine in the production process. Besides interviews, the observations have been conducted to compare the efficiency and quality of manual labor in rattan processing.

E. Research Procedure

A quantitative analysis experiment was conducted to assess the efficiency and effectiveness of the rattan stripping and splitting machine. This involved observations and assessments on how effectively the machine was operating. Operations included setting up and adjusting the machine to its proper position and function and cleaning the raw rattan in preparation for processing. The rattan was set on the machine stall and pushed by the pusher into the splitting blade, where it is split evenly and systematically. Split rattan is then routed to the stripping station, where the outer layer is stripped with the stripper, leaving polished material ready for production. Stripped rattan is collected at the quality control station, where the material is checked for size conformity. The machine's metal parts were checked for wear and tear, while the efficiency of operation and ease of use were assessed as well.

F. Gathering of Data

Data collection was conducted through interviews, observation checklists, and a literature review. Structured interviews with local rattan manufacturers and small manufacturers were conducted to gather qualitative data on their current processes, challenges, and expectations regarding the rattan stripping and splitting machines. At the same time, observation checklists were used during site visits to record and quantify the efficiency, quality, and safety of the manual process. Secondly, secondary data were collected by analyzing peer-reviewed journal articles and industry research reports to provide background on rattan manufacturing. This approach enabled the collection of credible, reliable data on the industry, which informed the development of a useful rattan stripping and splitting machine.

G. Treatment of the Data

The data collected in this study—from structured interviews, observational checklists, and survey questionnaires—was systematically analyzed using both quantitative and qualitative methods. Quantitative data, including performance metrics such as processing time, output consistency, and operator satisfaction, were summarized using descriptive statistics (e.g., frequencies, percentages, and weighted means). Meanwhile, qualitative responses were coded and thematically analyzed to identify common challenges and requirements within the rattan processing industry. This integrated approach ensured a comprehensive understanding of existing inefficiencies and guided the evaluation of the proposed rattan stripping and splitting machine, thereby supporting robust, evidence-based conclusions.

III. RESULTS AND DISCUSSIONS

Table 1: New Stripping Machine Efficiency Analysis

TRIAL	1	2	3	4	5	6	7	8	9	10	EFFICIENCY
1	PASSED	PASSED	PASSED	FAILED	PASSED	PASSED	PASSED	PASSED	FAILED	PASSED	80%
2	FAILED	PASSED	PASSED	PASSED	PASSED	FAILED	PASSED	FAILED	FAILED	FAILED	50%
3	FAILED	PASSED	PASSED	PASSED	PASSED	PASSED	PASSED	FAILED	PASSED	PASSED	70%
NEW STRIPPING MACHINE AVERAGE:											66.67%
OLD STRIPPING MACHINE AVERAGE :											100%

Table 1 summarizes the overall performance of the new stripping machine and the old stripping machine in terms of efficiency. The results show that the new stripping machine achieved an average efficiency of 66.67%, which is interpreted as Marginal Operating Efficiency. This indicates that the machine was generally capable of processing rattan pieces but was affected by operational issues such as waste buildup around the blades and roller misalignment, resulting in intermittent interruptions during operation.

In comparison, the old stripping machine achieved a perfect average efficiency of 100%, indicating Highly Efficient Performance. This shows that the old machine was able to process all rattan pieces successfully without failure, demonstrating stable and uninterrupted operation under the same testing conditions.

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In summary, the consistent difference in efficiency between the two machines indicates that the old stripping machine performs more reliably. In contrast, the new stripping machine still requires further improvements to achieve stable and continuous operation.

Table 2: New Splitting Machine Efficiency Analysis

Trial	1	2	3	4	5	6	7	8	9	10	Efficiency
1	Failed	Failed	Failed	Passed	Passed	Passed	Passed	Failed	Failed	Passed	50%
2	Passed	Failed	Passed	Passed	Passed	Failed	Failed	Passed	Failed	Failed	50%
3	Passed	Passed	Failed	Passed	Passed	Passed	Failed	Passed	Failed	Failed	60%
New Splitting Machine Average:											53.33%
Old Splitting Machine Average:											88.33%

Table 2 summarizes the overall performance of the new splitting machine and the old splitting machine in terms of efficiency. The results show that the new splitting machine achieved an average efficiency of 53.33%, which is interpreted as Low Efficiency and Requires Improvement. This indicates that the machine was only moderately effective in splitting rattan pieces but was frequently affected by blade resistance, fiber difficulty, and inconsistent splitting performance, resulting in repeated interruptions during operation.

In comparison, the old splitting machine achieved an average efficiency of 88.33%, which is interpreted as Efficient and Acceptable Operation. This shows that the old machine was able to process a higher number of rattan pieces successfully with fewer interruptions and more stable performance under the same testing conditions.

In summary, the results indicate that the old splitting machine performs significantly better in terms of stability and efficiency. In contrast, the new splitting machine still requires improvements in blade design, resistance handling, and operational consistency to achieve better performance.

Table 3: New Stripping Machine Speed Analysis

Trial	Operating Time	Successfully Processed	Defective	Effective Processing Speed
1	1 Minute	3 Pieces	1 Piece	3 Pieces/Min
2	1 Minute	4 Pieces	1 Piece	4 Pieces/Min
3	1 Minute	6 Pieces	1 Piece	6 Pieces/Min
New Stripping Machine Average:				4.33 Pieces/Min
Old Stripping Machine Average:				5.00 Pieces/Min

Table 3 summarizes the overall performance of the new splitting machine and the old machine in terms of processing speed. The results show that the new splitting machine achieved an average effective processing speed of 4.33 pieces per minute, indicating moderate performance across all trials. This suggests that the machine was able to process rattan at a consistent rate, although its output was still affected by splitting errors and occasional material resistance during operation.

In comparison, the old machine recorded a higher average processing speed of 5.00 pieces per minute, indicating more efficient and stable performance with fewer interruptions and defects under the same testing conditions.

In summary, the results indicate that the old machine performs slightly better in terms of processing speed and stability. In contrast, the new splitting machine still requires improvements to increase output efficiency and reduce processing interruptions.

Table 4: New Splitting Machine Speed Analysis

TRIAL	OPERATING TIME	SUCCESSFULLY PROCESSED	DEFECTIVE	EFFECTIVE PROCESSING SPEED
1	1 minute	3 pieces	2 pieces	3 pieces/min
2	1 minute	5 pieces	2 pieces	5 pieces/min
3	1 minute	4 pieces	1 piece	4 pieces/min
NEW SPLITTING MACHINE AVERAGE:				4 pieces/min
OLD MACHINE SPLITTING AVERAGE				4 pieces/min

Table 4 summarizes the overall performance of the new splitting machine and the old splitting machine in terms of processing speed. The results show that the new splitting machine achieved an average effective processing speed of 4 pieces per minute, indicating moderate and consistent performance across the three trials. This suggests that the machine was able to maintain a stable processing rate despite variations in output and occasional defective products during operation.

In comparison, the old splitting machine also recorded an average processing speed of 4 pieces per minute, indicating that both machines performed equally in terms of processing speed under the same testing conditions.

In summary, the results indicate that both the new and old splitting machines have comparable processing speed,

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suggesting that while differences may exist in efficiency and consistency, their overall throughput capacity is the same.

CONSISTENCY OF STRIPPING AND SPLITTING RATTAN

This documentation presents a comparison of the outputs from the old and newly developed machines during the rattan stripping and splitting process, using images. The pictures show the actual appearance, smoothness, and consistency of the processed rattan produced by both machines. The comparison highlights visible differences in the output quality, including surface finish and defects observed after processing. The purpose of these images is to visually evaluate and compare the effectiveness of the old and newly developed machines in processing rattan.



Figure 3: New Stripping Machine Consistency

Figure 3 shows the stripping consistency of the newly developed machine during rattan processing. Based on the output presented, some portions of the rattan still have small remaining skin or surface residue after the stripping process. However, the output is still considered acceptable by the workers for processing purposes. It was also observed that the stripped rattan requires additional sanding with sandpaper to achieve a smoother, more refined surface finish. Despite these minor imperfections, the machine still produced functional, usable rattan output.



Figure 4:New Splitting Machine Consistency

Figure 4 shows the splitting consistency of the newly developed machine during rattan processing. Based on the output, the machine successfully split the rattan; however, slight variations in size, surface finish, and uniformity were observed in some processed pieces. Some outputs appeared slightly rough and uneven due to inconsistencies during the splitting process. These variations may have been influenced by the machine's operational stability and the conversion from a 3-phase to a 1-phase power supply. Despite these observations, the split rattan produced by the newly developed machine remains acceptable for further processing and use by the workers. However, some pieces still require sanding with sandpaper to achieve a smoother, more refined finish.



Figure 5: Old Stripping Machine Consistency

Figure 5 shows the stripping consistency of the old machine during rattan processing. Based on the output shown, the old machine produced smoother, more uniform rattan surfaces with fewer visible defects and interruptions during processing. The consistency of the stripped rattan indicates that the machine maintained stable operation throughout the process. The output also required minimal adjustment and finishing, indicating that the old machine provided reliable, consistent stripping performance.



Figure 6: Old Splitting Machine Consistency

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Figure 6 shows the splitting consistency of the old machine during rattan processing. Based on the output presented, the old machine produced evenly split rattan with a more consistent size and appearance. The processed rattan showed fewer defects and smoother results, indicating stable machine performance during operation. The consistency of the output demonstrates that the old machine performed the splitting process effectively, with minimal interruptions and adjustments.

Table 5: Survey results mean scores and interpretations by category.

Category	Items (Q#)	Mean Score	Interpretation
Machine Performance Evaluation	Q1-Q4	4.28	Strongly Agree
Perceived Usefulness	Q1-Q2	4.25	Strongly Agree
Perceived Ease of Use	Q3-Q4	4.60	Strongly Agree
Attitude Towards Use	Q5-Q6	4.85	Strongly Agree
Behavioral Intention to Use	Q7-Q8	4.35	Strongly Agree

This section presents the survey results, categorized into Machine Performance Evaluation, Perceived Usefulness, Perceived Ease of Use, Attitude Towards Use, and Behavioral Intention to Use. Each category is interpreted using the Likert scale: Very High/Very Positive (4.21–5.00), High/Positive (3.41–4.20), Moderate (2.61–3.40), Low (1.81–2.60), and Very Low (1.00–1.80). The findings show that all categories achieved high mean scores, indicating that respondents are highly satisfied with the machine and strongly accept its use in rattan processing operations.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization, Methodology; Author 2: Data curation, Writing-Original draft preparation, Writing-Reviewing; Author 3: Investigation, Validation, Visualization, Writing- Reviewing; Author 4: Data curation, Writing-Original draft preparation

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GENERATIVE AI STATEMENT

The authors used ChatGPT solely as a language-support tool to improve the clarity, coherence, and grammatical accuracy of the manuscript. All AI-assisted outputs were critically reviewed, revised, and validated by the authors to ensure the accuracy, integrity, and originality of the content. The authors accept full responsibility for the final version of the manuscript and its published content.

ETHICAL CONSIDERATIONS

Prior to the data gathering, ethical approval was obtained from the University of Cebu Academic Research Ethics Committee (UCAREC). The approved protocol ensured adherence to the principles of respect for persons, beneficence, justice, voluntary participation, informed consent, confidentiality, and anonymity, and compliance with the Data Privacy Act throughout the research process.

DECLARATION OF INTEREST

The authors declare that they have no competing financial, professional, or personal interests that could have influenced the conduct, findings, or publication of this study.

DATA AVAILABILITY

Data will be made available by the corresponding author on request.

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