



I. EXECUTIVE SUMMARY:

1. Project Title: Design and development of a Parallel Gang Cutting Machine
2. Project Proponent
Project Leader: Herminio S. Tinguban
Project Members: Abner Verdoquillo
Mr. Junar T. Amaro
Mr. Renemer S. Duran
3. Project Duration: February 1, 2025 – January 31, 2026 (12 Months)
4. Project Cost: Php 350,000.00

II. RATIONALE:

Negros Oriental is famous for its rich culture and diverse artisanal crafts, with many small and medium enterprises (SMEs) producing furniture, handicrafts, souvenirs, and customized manufacturing products to cater to specific customer preferences and market demands, thereby enhancing the value proposition of their products. These locally made products enhance the tourism experience and promote the province's unique identity. However, traditional manual methods often require a highly skilled workforce and are time-consuming, labor-intensive, and prone to errors. This also limits design complexity and productivity, especially as competitors adopt new technologies for efficiency and intricate designs.

To address these challenges and support the sustainable growth of the province's manufacturing sector, this study aims to design and develop a Parallel Gang Cutting Machine specifically for processing coconut shells, allowing them to be formed into desired polygonal shapes. This innovation will help local artisans and manufacturers create high-quality, personalized products more efficiently, enhancing their competitiveness in regional and global markets. Among the flourishing industries in Negros Oriental is Alama Guitars Corporation, founded in 2017 by William Alama and his associates in Purok 7, Barangay Tugawe, Dauin, Negros Oriental. Owned and operated by six stakeholders, the company specializes in crafting custom-built acoustic guitars from sustainable materials such as gmelina, mahogany, and coconut shells. Each product is tailored to client specifications, from material selection to design aesthetics, including intricate shell inlay designs, making every instrument unique.

In line with this, the researcher envisions a project that introduces Alama Guitars Corporation to new technologies that automate routine tasks, augment human capabilities in quality and craftsmanship, and facilitate the production of intricate and complex designs with ease. Specifically, this study aims to design and develop a versatile machine capable of processing coconut shells into precise polygonal shapes. The research will evaluate the machine's performance, focusing on its reliability and durability, incorporating robust design principles to ensure consistent



performance over extended periods. A prototype mechanism will be developed to improve the precision of cuts made by the machine, and extensive testing will be conducted to assess its capabilities under different cutting conditions. Furthermore, the cost-effectiveness of the machine will be analyzed, considering factors such as initial investment, operating costs, maintenance expenses, and potential productivity gains. Lastly, the machine will be designed to comply with industry standards, safety regulations, and quality requirements to ensure its viability for widespread use.

Specifically, this research study aims to:

1. Design and develop a versatile machine capable of processing coconut shells and forming them into desired polygonal shapes.
2. Assess the machine's performance in terms of reliability and durability, incorporating robust design principles to ensure consistent operation over extended periods.
3. Develop a precision-cutting mechanism to enhance accuracy in shaping coconut shells into polygonal forms.
4. Conduct experimental testing to evaluate the machine's cutting efficiency, quality, and consistency when processing coconut shells under different conditions.
5. Analyze the machine's cost-effectiveness, considering factors such as initial investment, operating costs, maintenance, and productivity improvements (ROI).
6. Ensure compliance with industry standards, safety regulations, and quality requirements for operational efficiency and user safety.

III. MATERIALS AND METHODS:

The genesis of this machine came from a desire to minimize waste. Seeing perfectly usable coconut shells discarded as byproducts of the industry sparked the idea of transforming them into valuable components. The development of the parallel gang cutting machine requires the use of durable and efficient materials to ensure precision and longevity. The primary components include steel tubing for the structural frame, providing stability and support for the cutting mechanism, and aluminum parts, which reduce overall weight while maintaining strength. Stepper motors, particularly NEMA-standard models, serve as the main source of controlled motion, enabling precise positioning. Tool steel is used for the cutting blades due to its hardness and wear resistance, while high-speed steel (HSS) blades ensure accurate cutting of coconut shells into various polygonal shapes. A pneumatic clamping system is used to securely hold work-pieces in place during the cutting process, reducing movement and enhancing precision.

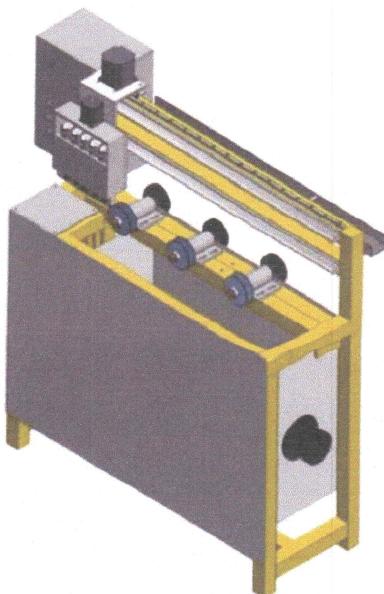
The development process begins with conceptual design and analysis using Computer-Aided Design (CAD) software to develop a novel machine that efficiently cuts coconut shell materials while optimizing stability, load distribution, and material efficiency. The steel tubing frame is then fabricated by cutting, welding, and



assembling to house all essential components with minimal vibration. The cutting mechanism consists of three double HSS blades driven by a high-speed electric motor, mounted on a fixed cutting depth. Stepper motors, paired with a programmable control unit, automate the cutting, material positioning, and pneumatic clamping operations, ensuring efficiency and repeatability. A key feature of the machine is its pneumatic clamping integration, which secures coconut shells firmly in place to prevent displacement during cutting. This system enhances precision and allows for automation in mass production. After assembly, the machine undergoes multiple testing phases, including calibration of cutting speed and precision, stepper motor operation, and pneumatic clamping force adjustments. These tests ensure the machine's ability to produce intricate shapes such as hexagons, squares, and circles while maintaining an efficient cutting speed of approximately 1 minute per batch of five pieces.

The parallel gang cutting machine is designed for efficient material utilization, precise shaping of coconut shells, and mechanical stability. Its applications extend beyond traditional uses, allowing the production of high-value acoustic guitar components like bridges, frets, and inlays. By leveraging the durability and aesthetic appeal of coconut shells, this machine promotes sustainability and enhances both industrial and creative production.

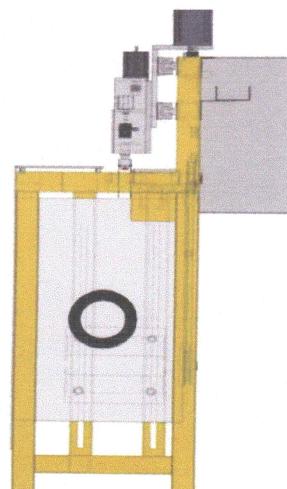
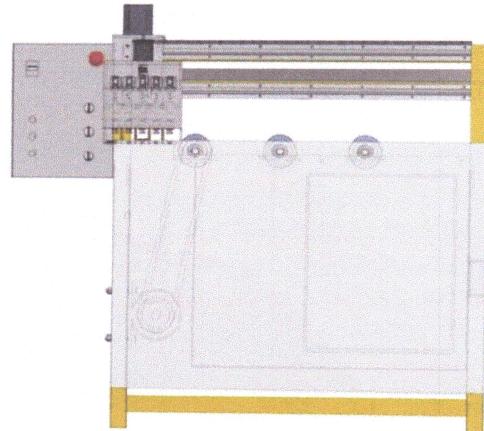
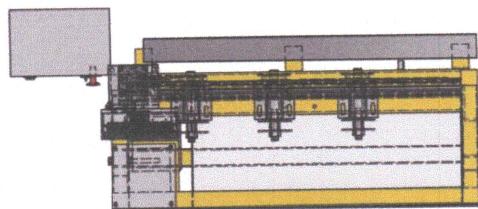
PERSPICTIVE VIEW



Isometric View of Design Setup



Top View



Side
View

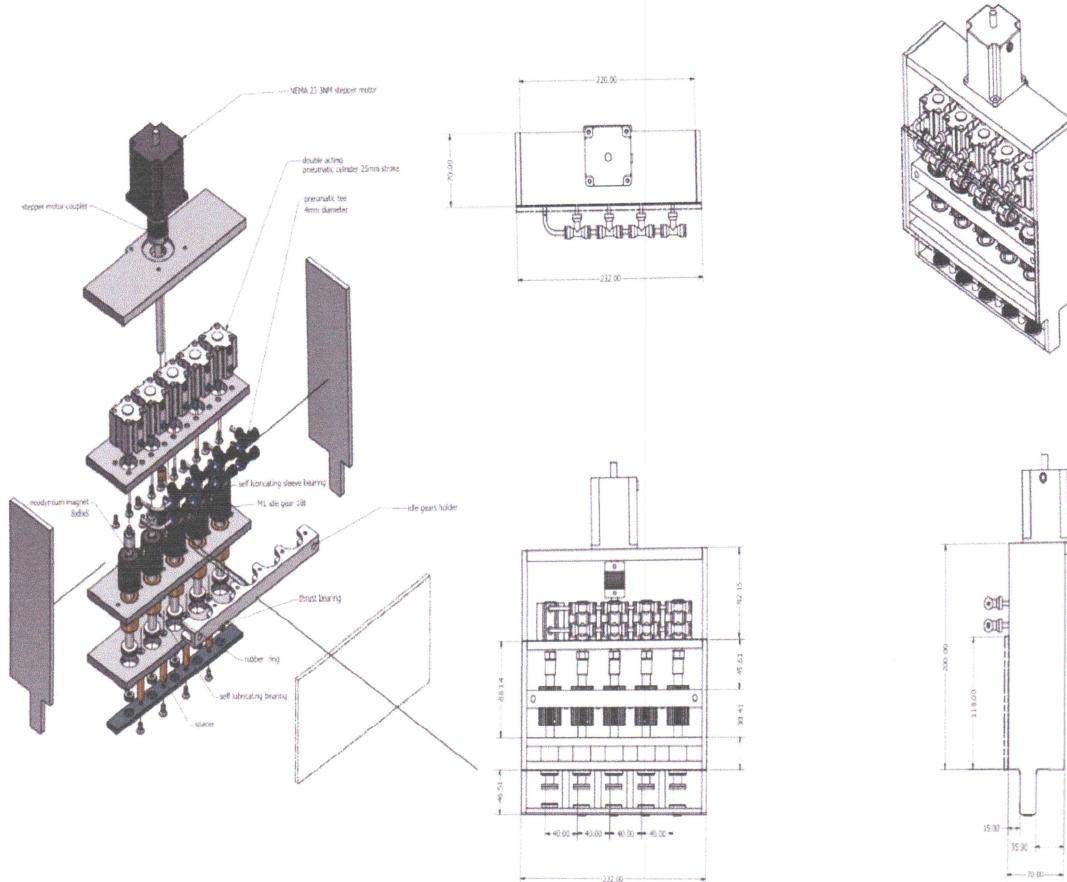
Orthographic Views of Design Setup



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MATERIAL CARRIER ASSY



IV. WORKPLAN (Gantt Chart):

| Project Flow of Activities | Month | | | | | | | | | | | |
|---|-------|---|---|---|---|---|---|---|---|----|----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| a) Design and fabrication of alpha prototype | | | | | | | | | | | | |
| b) Selection of materials, collection of data, and purchase of equipment / supplies | | | | | | | | | | | | |
| c) Fabrication of the beta prototype | | | | | | | | | | | | |
| d) Configuration of the final design of the device | | | | | | | | | | | | |
| e) Testing and Evaluation/ Performance Analysis of the Final Product | | | | | | | | | | | | |
| f) Patent application and presentations | | | | | | | | | | | | |

V. EXPECTED OUTPUTS:

The project aims to achieve the following outputs:

1. Prototype equipment (*Include target parameters, special features, etc.*)
2. Patent (*Invention, utility model and industrial design*)
3. Publication

VI. TARGET BENEFICIARIES (Clients, size of market, expected outcome/effects of the use of the project output)

The Guitar Market size is projected to grow at a compound annual growth rate (CAGR) of 9.5% from 2024 to 2031, transitioning from USD 36 Billion in 2023 to USD 67.96 Billion by 2031.

<https://www.google.com/search?q=global+guitar+market+size&oq=global+guitar+market+size&gs>



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BCjEZOTQ5ajBqMTWoAgiwAgE&sourceid=chrome&ie=UTF-8*
ALAMA GUITARS CORPORATION

(expected outcome/effects of the use of the project output)

The company is aiming to further increase the production capacity, by adding new facilities to produce new quality and sustainable products that can be mass produced and commercially available. From an average of 60 custom made guitars to 120 custom made guitars per year.

VII. BILL OF MATERIALS

| ITEMS OF EXPENDITURES | QTY | COST (Php) | TOTAL PRICE (Php) |
|---|-----|------------|-------------------|
| A. Maintenance and Other Operating Expenses (MOOE) <u>Supplies and Materials</u> | | | |
| 1. NEMA 34 Stepper motor-closed-loop 6NM or higher with drive | 1 | 20,000/set | 20,000 |
| 2. NEMA 23 Stepper motor-closed-loop, 3NM or higher with drive | 1 | 15,000/set | 15,000 |
| 3. Rack Gear and Pinion 1meter long, module 3 | 1 | 8000/meter | 8,000 |
| 4. Linear Guide Rail 16 mm dia. x 1meter long | 2 | 5000/pc | 10,000 |
| 5. SBR16 Linear bearing 16mm dia. | 4 | 1,5000/pc | 6,000 |
| 6. Stepper Motor couple, 8mm x 8mm x 40mm | 1 | 1000/pc | 1,000 |
| 7. Tool steel shafting 4140, 12mm dia. | 2 | 300/ft | 600 |
| 8. Tool steel shafting 4140, 20mm dia. | 2 | 600/ft | 1,200 |
| 9. Tool steel shafting 4140, 25mm dia. | 1 | 900/ft | 900 |
| 10. V- Pulley 2.5" dia. single | 1 | 650/pc | 650 |
| 11. V- Pulley 2.5" dia. double | 2 | 1,200/pc | 2,400 |
| 12. V- Pulley 5" dia. single | 1 | 2,500/pc | 2,500 |
| 13. V-Belt A23 | 2 | 650/pc | 1,300 |
| 14. V-Belt A34 | 1 | 650/pc | 650 |



| ITEMS OF EXPENDITURES | QTY | COST (Php) | TOTAL PRICE (Php) |
|---|-----|------------|-------------------|
| 15. Pneumatic cylinder double acting 25mm length of stroke | 5 | 3,000/pc | 15,000 |
| 16. Tool steel shafting 4140, 1 1/2" dia. | 4 | 1750/ft | 7,000 |
| 17. Tiger Bronze 1" dia. x 12" long | 1 | 3,590/kg | 3,590 |
| 18. Trust Bearing (F8-14M) inner dia. 8mm x outside dia. 14mm x 4mm width | 5 | 350/pc | 1,750 |
| 19. Snap Ring Bearing Circlip 8mm dia. stainless | 5 | 125/pc | 625 |
| 20. Pneumatic Filly Quick Connects 4mm dia. | 20 | 150/pc | 750 |
| 21. Pneumatic Filly tee 4mm dia. | 20 | 150/pc | 3,000 |
| 22. Air Solenoid Valve 5-way Port 2 position 24volts | 3 | 1,500/pc | 4,500 |
| 23. Pneumatic Hose 4mm dia. | 25 | 75/meter | 1,875 |
| 24. Air Compressor 1HP | 1 | 15,000/pc | 15,000 |
| 25. Dust Collector High Grade Double barrel w/ suction hose | 1 | 5,000/pc | 5,000 |
| 26. Pillow block bearing 20mm dia. | 6 | 850/pc | 5,100 |
| 27. Circular Saw Blade 0.8 mm thick x 100mm dia. x 72 teeth | 6 | 1,850/pc | 11,100 |
| 28. Stainless Nut M16x1.5 | 3 | 126/pc | 378 |
| 29. Cable Drag Chain Frame w/ end Connector (25mm inner size x 57mm) 2 meters | 2 | 2,000/m | 4,000 |
| 30. Panel Box (20cmx50cmx50cm) Metal Enclosure | 1 | 2,000/pc | 2,000 |
| 31. Circuit breaker Track (50cm long) | 2 | 150/pc | 300 |
| 32. Circuit breaker 20A with casing | 1 | 500/pc | 500 |
| 33. Circuit breaker 10A with casing | 3 | 400/pc | 1,200 |
| 34. Magnetic Contactor (CJX2-0910) | 3 | 1,500/pc | 4,500 |
| 35. Switch mode type power supply (220-AC-24 x DC-10A) | 1 | 1,500/pc | 1,500 |
| 36. Switch mode type power supply (220-AC-5 x DC-6A) | 1 | 1,500/pc | 1,500 |
| 37. Pneumatic pressure regulator and lubricator filter | 1 | 5,000/pc | 5,000 |



| ITEMS OF EXPENDITURES | QTY | COST (Php) | TOTAL PRICE (Php) |
|--|-----|------------|-------------------|
| 38. 8-core wire shielded cable-pure copper AWG #20 | 5 | 650/meter | 3,250 |
| 39. Proximity switch metal sensor | 2 | 2,500/pc | 5,000 |
| 40. Programable micro controller MEGA 2560-pro | 2 | 1,500/set | 3,000 |
| 41. Relay Module- 5V DC 6 channels | 2 | 200/pc | 400 |
| 42. Emergency Stop push button switch | 1 | 300/pc | 300 |
| 43. Push button switch | 6 | 250/pc | 1,500 |
| 44. Royal Chord 3-Phase #12 | 10 | 120/meter | 1,200 |
| 45. Stainless steel sheet 4ft x 8ft x 1.5mm thick | 1 | 13,000/pc | 13,000 |
| 46. T-6 Aluminum 26mm x 35mm x 220mm long | 1 | 600/pc | 600 |
| 47. T-6 Aluminum 13mm x 160mm x 1000mm long | 1 | 4,500/pc | 4,500 |
| 48. T-6 Aluminum 13mm x 235mm x 245mm long | 1 | 2,000/pc | 2,000 |
| 49. T-6 Aluminum 13mm x 200mm x 220mm long | 1 | 1,500/pc | 1,500 |
| 50. Self-lubricating bushing bronze 4mm x 8mm x 8mm | 4 | 900/pc | 3,600 |
| 51. Self-lubricating bushing bronze 8mm x 10mm x 14mm | 2 | 1000/pc | 2,000 |
| 52. Set screw Allen head – M5x2.5 | 100 | 59/pc | 5,900 |
| 53. Set screw Allen head – M6x2.5 | 100 | 79/pc | 7,900 |
| 54. Set screw Allen head – M5x2.0 | 100 | 59/pc | 5,900 |
| 55. Galvanized square tubing 2mmx50mmx50mmx6m. | 2 | 800 | 1,600 |
| 56. Welding Electrode 3/32" dia. E6012 | 3 | 200 | 600 |
| 57. Epoxy primer paint white | 2 | 400/liter | 800 |
| 58. Lacquer thinner | 1 | 900/gal | 900 |
| Sub-total | | | 226,318 |
| B. Semi-expendable Item (e.g., pH meter, torque meter, other testing and debugging equipment should not exceed Php 50,000.00) | | | |



| ITEMS OF EXPENDITURES | QTY | COST (Php) | TOTAL PRICE (Php) |
|--|-----|------------|-------------------|
| 1. 18 teeth spur gear module 1, 4mm dia. hole | 5 | 1250/pc | 6,250 |
| 2. Module gear cutter -Module #1 cutter #1,2,3,4,5 | 5 | 1650/pc | 8,250 |
| 3. Drill Bit Set HSS 1.0 to 13mm range by 0.5mm | 1 | 8,000/set | 8,000 |
| 4. Hand Tap Set M5x0.8 | 1 | 250/set | 250.00 |
| 5. Hand Tap Set M6x1.0 | 1 | 300/set | 300.00 |
| 6. Hand Tap Set M8x1.25 | 1 | 400/set | 400.00 |
| 7. Hand Tap Set M10x1.25 | 1 | 500/set | 500.00 |
| 8. Hand Tap Set M12x1.25 | 1 | 600/set | 600.00 |
| 9. Hand Tap Handle | 1 | 1,500/set | 1,500 |
| 10. Set of Tap & Threading Die (6.00 mm to 20.00 mm) | 1 | 41,000/set | 41,000 |
| Sub-total | | | 67,050 |
| Total Cost of BOM | | | 293,368 |

| | SUBMITTED BY (Focal person/Researcher) | ENDORSED BY (University President) |
|--------------|---|---|
| Signature |  |  |
| Printed Name | HERMINIO S. TINGUBAN, Ph.D. CIT Dean | NOEL MARJON E. YASI, Psy.D. University President |
| Date | March 11, 2025 | March 11, 2025 |