NASENI COMMERCIALIZATION RESEARCH GRANT PROPOSAL

Project Title: Commercialization of Locally-Developed Medium Carbon Steel Mold Technology for Bajaj Motorcycle Brake Shoe Production

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1. Executive Summary

This proposal seeks commercialization funding from the National Agency for Science and Engineering Infrastructure (NASENI) to upscale and adapt the findings of the Master's research titled *"Application of Medium Carbon Steel for Injection Molding"* into a viable industrial mold-making technology for Bajaj motorcycle brake shoe production.

The project aims to replace imported mold steels with locally heat-treated medium carbon steel (MCS), proven to offer competitive mechanical and thermal characteristics suitable for mold applications. This innovation will drastically reduce mold importation costs, support local foundry and machining SMEs, and strengthen Nigeria's automotive parts manufacturing capacity in alignment with NASENI's commercialization and local content policy.

2. Background and Rationale

The Nigerian motorcycle market is dominated by the Bajaj brand, with millions of units in active use. The brake shoe—a safety-critical component—is typically cast using imported aluminum molds, which are expensive, prone to fatigue, and difficult to maintain locally.

Previous research demonstrated that medium carbon steel, when subjected to appropriate heat treatment, can achieve superior hardness (up to 510 HV), tensile strength (over 1,000 MPa), and thermal resistance suitable for repeated injection or die casting operations.

Therefore, this project seeks to commercialize a locally-sourced MCS mold technology for use in Bajaj brake shoe casting, reducing dependency on imported tool steels like P20 and promoting indigenous manufacturing solutions.

3. Problem Statement

Nigeria's brake shoe mold industry faces:

- Over 90% dependence on imported molds and P20 tool steels.
- Frequent mold failures due to poor thermal fatigue resistance.
- High replacement costs and foreign exchange loss.
- Low confidence in local mold engineers due to lack of tested indigenous alternatives.

This project will address these issues through localized production of heat-treated MCS molds, with optimized strength, wear resistance, and service life comparable to imported alternatives.

4. Project Objectives

1. To design and fabricate a prototype brake shoe mold using heat-treated medium carbon steel.
2. To analyze the structural and thermal behavior of the mold under aluminum casting conditions.
3. To conduct pilot brake shoe casting trials with local foundries.

4. To compare performance and lifespan with imported P20 molds.
5. To develop a commercialization and SME deployment framework for large-scale mold production.

6. Project Justification

Challenge	Proposed NASENI-Backed Solution
Dependence on imported mold steels	Develop indigenous MCS mold technology
High mold cost and downtime	Locally fabricated, affordable mold with faster replacement
Skill gaps in mold maintenance	Capacity building via NASENI–NEDDI Foundry collaboration
Unsustainable import reliance	Promote self-reliant, locally-sourced manufacturing ecosystem

This project contributes to NASENI's mandate by:

- Strengthening local content utilization.
- Promoting import substitution and SME empowerment.
- Generating new revenue streams from mold fabrication and brake shoe component sales.

6. Technical Description

a. Material Optimization

- Base material: Medium Carbon Steel (C = 0.32%, Mn = 0.85%)
- Heat treatment: Normalizing, Hardening, and Quenching at 850–950°C
- Achieved properties:
    - Tensile Strength: 890–1050 MPa
    - Hardness: 440–510 HV
    - Thermal Conductivity: 50 W/m°C
    - Service Temperature: 400°C

b. Mold Design and Fabrication

- 3D modeling: SolidWorks CAD
- Mold analysis: ANSYS Workbench (thermal & structural)
- Mold material: Treated MCS with surface polishing and nitriding
- Casting metal: Foundry-grade aluminum alloy

c. Validation and Testing

- Mold subjected to 50 casting cycles under foundry conditions.
- Thermal flux and deformation tests to evaluate fatigue resistance.
- Comparison with P20 and aluminum molds on dimensional accuracy and durability.

d. Commercialization Strategy

- Collaborate with NEDDI, NASENI Technology Incubation Centres, and local brake shoe manufacturers.
- Establish a pilot mold fabrication workshop in Nnewi industrial cluster.
- Develop training modules for mold designers and foundry engineers.

7. Expected Deliverables

Deliverable	Description
Prototype MCS mold	Completed mold for Bajaj brake shoe casting
Comparative test report	Mechanical and thermal analysis vs P20 steel
Pilot brake shoe production	Local foundry trial of at least 100 pairs
Commercialization blueprint	Licensing and scaling plan for local SMEs
Capacity building	Trained technicians and mold fabricators

8. Market Potential and Economic Impact

- Motorcycle brake shoe market: over 10 million pairs/year in Nigeria.
- Estimated mold import cost: ₦6–8 million per unit.
- Local MCS mold cost: ₦3.5–4 million (≈50% savings).
- Expected import substitution value: ₦5 billion annually.
- Employment potential:
    - 30 direct technical jobs
    - 150+ indirect jobs across foundry, machining, and recycling sectors

9. Work Plan (12 Months)

Phase	**Activity**	**Duration**
Phase 1	Material optimization and heat treatment	2 months
Phase 2	Mold design and simulation (CAD/ANSYS)	2 months
Phase 3	Prototype mold fabrication	3 months
Phase 4	Foundry casting trials and testing	3 months
Phase 5	Commercialization, training & dissemination	2 months

10. Estimated Budget (₦)

S/N	Item Description	Cost (#)
1	Raw materials (MCS, quenching media, consumables)	3,200,000
2	Heat treatment and equipment use	35,000,000
3	CAD design and simulation	2,000,000
4	Mold fabrication and machining	3,500,000
5	Testing and field validation	2,200,000
6	Training/workshop and dissemination	3,000,000
7	Documentation and commercialization setup	2,800,000
8	Contingency at 10%	4,850,320
9	**Total**	**₦53,353,520**

11. Sustainability and Commercialization Plan

- Establish mold fabrication incubation centre under NEDDI/NASENI.
- Integrate into Nigerian automotive component clusters (Nnewi, Ibadan, Kaduna).
- Train SMEs on mold maintenance and reuse.
- Continuous improvement through recycling and tool life testing.

12. Expected Benefits to NASENI

- Demonstration of NASENI's success in commercializing local research outputs.
- Reinforcement of NASENI–NEDDI collaboration on technology diffusion.
- Visibility as a national champion of local industrial tooling development.
- Model project for replication in other tooling and mold manufacturing sectors.

Figure 1: Sample of the shoe brakes produced

13. References

1. Irabodemeh, J. M. (2023). *Application of Medium Carbon Steel for Injection Molding*. M.Eng. Thesis, COOU.
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5. NEDDI (2024). *Technical Report on Indigenous Foundry Development in Nigeria*.