

Study on the OEM for Manufacturing Agri-Machinery Spare Parts in Bangladesh

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Abstract

The agricultural machinery sector is a core component of modern farming in Bangladesh, and its efficiency depends significantly on the timely availability of high-quality spare parts. Despite local workshops being the main source for these parts, there is limited empirical research on whether their products meet OEM standards essential for safety, durability, and performance. This study addresses this gap by evaluating 30 workshops across key agricultural districts (Dinajpur, Rangpur, Bogura, Kushtia, Jashore, and Jamalpur) to assess their readiness for OEM-level production. Using a mixed-method approach, the research examines critical dimensions such as machinery availability, workforce expertise, design innovation, quality assurance, and compliance with safety standards. Findings reveal that while workshops demonstrate adaptability in customizing parts (97%) and conducting market research (83%), they lack advanced technologies (e.g., only 6.67% use CNC machines), in-house material testing (0%), and adherence to ISO standards (13%). Furthermore, infrastructural constraints—such as power outages affecting 90% of workshops—and a reliance on unskilled labor lead to inefficiencies. The urgency of policy interventions is underscored in areas such as technology adoption, workforce training, and infrastructure development to align local manufacturing with global standards, ensuring the long-term resilience of Bangladesh's agricultural sector. This study reveals that while local workshops in Bangladesh show strong potential and market awareness, major gaps in technology, quality control, and infrastructure are holding them back from meeting OEM standards for agricultural machinery spare parts.

Keywords

Technological Gaps, Workforce Skills, Quality Control, Safety Protocols, Market Adaptation, Policy Intervention

1. Introduction

Agriculture drives Bangladesh's economy, contributing 13% of GDP and employing 40% of the workforce. To address labor shortages during critical planting and harvesting seasons, farmers increasingly rely on machinery such as rice transplanters, self-propelled reapers, and medium-sized combine harvesters [1]. In 2021, Bangladesh had 754 rice transplanters and 3020 combine harvesters in use, reflecting a sharp rise in combine harvester adoption between 2017 and 2019, when the market value surged from \$4.29 million to \$33.3 million [2]. This demand for agri-machinery has inspired a burgeoning agricultural machinery sector, projected to reach a market size of 2699.3 crore BDT by 2025, with manufacturable spare parts in Bangladesh alone accounting for 1920.6 crore BDT [3]. Domestically produced components like centrifugal pumps, impellers, and fuel filters now dominate the local market, displacing imported Chinese counterparts [1]. However, the sector's growth is constrained by systemic inefficiencies. One notable aspect of manufacturing in Bangladesh is that most of the raw materials come from dismantled cargo ships beached in the Chittagong area, and hence the exact composition of these materials is often uncertain or not well documented [4]. Bangladesh's agricultural machinery ecosystem comprises approximately 70 foundries, 800 manufacturing workshops, and 1500 spare parts units [5]. While these workshops demonstrate adaptability—97% offer custom parts and 83% conduct market research—their capabilities lag behind global OEM (Original Equipment Manufacturer) standards, which mandate adherence to precise design, quality, and safety specifications [6] [7]. Light engineering, a cornerstone of industrial advancement in developing economies, remains hampered by outdated machinery, skill shortages, and fragmented distribution channels [1] [8]. For instance, 87% of workshops lack ISO compliance, 100% lack in-house material testing, and 93% fail to ensure raw material quality [1] [7]. Qualified engineers, even diploma holders, are scarce, leaving gaps in design, heat treatment, and fabrication expertise [1]. Material management inefficiencies further compound these challenges. OEMs frequently grapple with stock-outs and overstocking, undermining cost-effectiveness [7] [9]. While companies with robust material management systems achieve significant production cost savings [10], Bangladeshi workshops face policy barriers such as high customs duties and VAT on imported raw materials, eroding competitiveness against cheaper imports. Seasonal demand fluctuations exacerbate these issues, forcing manufacturers to secure off-season capital to stockpile parts for peak periods—a task complicated by congested workspaces and unsanitary conditions [10]. The decision to manufacture in-house or outsource hinges on labor costs, product security, and standardization needs [11]. However, local workshops rarely engage in outsourcing, relying instead on informal networks for sales and marketing. Promotion of spare parts is driven by personal connections rather than formal advertising, and production volumes are determined using rudimentary sales data from prior years. Though basic quality control measures are adopted, advanced tests—such as metal alloy analysis or heat

treatment verification—remain unaffordable for small-scale units [1]. These gaps stifle innovation, as OEMs' design and marketing capabilities are often restricted by buyer-imposed rules [11]. This study evaluates 30 workshops across Bangladesh's agricultural heartlands to assess their readiness for OEM-level production. By analyzing machinery availability, workforce skills, design innovation, and compliance with safety protocols, it identifies actionable strategies to bridge capability gaps. Addressing these challenges is urgent; aligning local manufacturing with global standards will unlock the sector's projected 2699.3 crore BDT market potential while ensuring the sustainability of Bangladesh's agricultural productivity.

2. Methodology

2.1. Research Design

This study adopts a mixed-methods approach, integrating both quantitative and qualitative analyses to assess the current capabilities of local workshops in manufacturing agricultural spare parts. The research follows an exploratory-descriptive design, aiming to evaluate existing manufacturing practices, identify capability gaps, and propose strategies for strengthening OEM (Original Equipment Manufacturer) capabilities in Bangladesh. The study primarily relies on primary data collected through structured questionnaires from workshop owners and managers across multiple districts. Additionally, secondary data sources, including industry reports, government publications, and case studies, are utilized to complement the findings and benchmark the results against international OEM standards.

2.2. Data Collection Method

The primary data for this study were collected through a structured questionnaire administered to 30 workshops located in Dinajpur, Rangpur, Bogura, Kushtia, Jashore, Chuadanga, Jhenidah, and Jamalpur districts (Figure 1). The questionnaire was designed to cover key aspects of OEM manufacturing, including design control, quality assurance, production infrastructure, heat treatment facilities, workforce skills, supply chain efficiency, compliance with standards, and packaging capabilities. The survey included a combination of closed-ended questions for quantitative assessment and open-ended questions to gather qualitative insights on challenges and opportunities in the sector. Secondary data were gathered through a literature review on best practices in OEM manufacturing, policy documents, and industry reports.

2.3. Sampling Strategy

A purposive sampling technique was employed to select workshops actively involved in agricultural machinery spare-parts manufacturing. A sample size of 30 workshops was chosen to ensure representation from key agricultural regions where manufacturing activities are concentrated. This sampling method was con-

sidered appropriate for the study, as it focuses on specific workshops that play a critical role in the local supply chain of agricultural machinery.

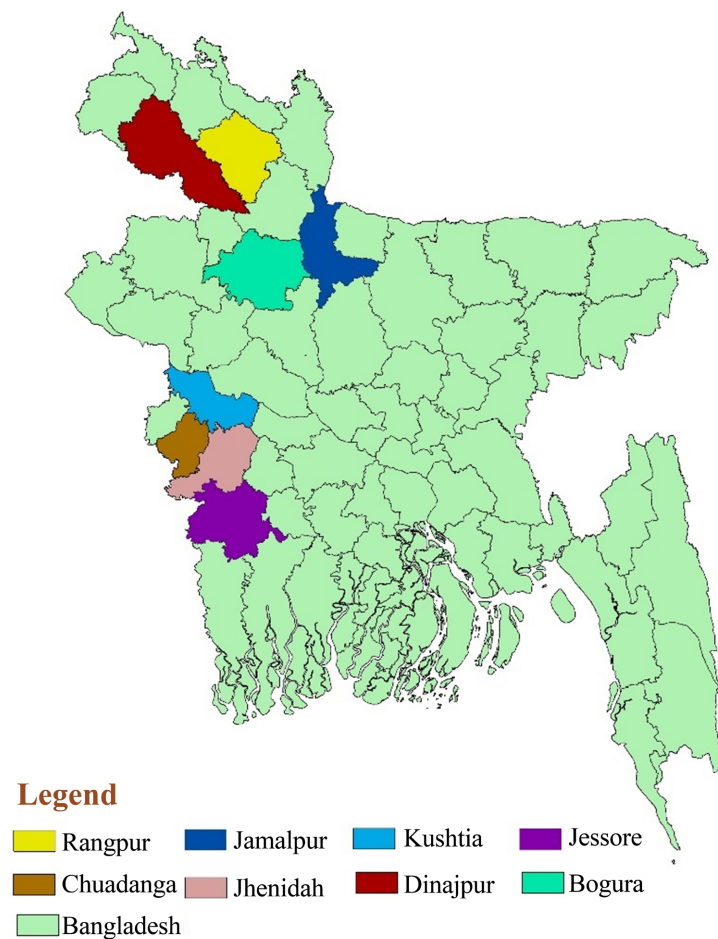


Figure 1. Data collection location.

2.4. Sample Size Determination

In this study, a total of 30 respondents were selected through purposive sampling. The sample size was determined based on a 90% confidence level and a 15% margin of error, calculated using the standard sample size formula:

$$\frac{Z^2 \cdot p \cdot (1-p)}{E^2}$$

where,

$Z = 1.645$ (for a 90% confidence level, since $\alpha = 0.10$).

$p = 0.5$ (the most conservative estimate for an unknown population proportion).

$E = 0.15$ (assuming a 15% margin of error is acceptable due to resource constraints).

$$n = \frac{(1.645)^2 \times 0.5 \times (1-0.5)}{(0.15)^2} \approx 30.07$$

The calculated sample size was approximately 30. Therefore, the chosen sample size is statistically justifiable for exploratory analysis, considering practical constraints and industry accessibility.

2.5. Pre-Test

Before conducting the final survey, a pre-test of the questionnaire was carried out to ensure its reliability, clarity, and effectiveness in capturing the intended data. The pre-test was conducted with a small sample of OEM representatives. By incorporating insights from the pre-test, the final questionnaire was formed, ensuring that the data collected during the main survey would be both reliable and meaningful for evaluating local OEMs.

2.6. Data Analysis Techniques

The collected data were analyzed using a combination of quantitative and qualitative techniques. Descriptive statistical methods were used to analyze the structured questionnaire responses. A gap analysis was conducted to compare the workshops' current capabilities against standard OEM requirements. Furthermore, qualitative data from the open-ended responses were subjected to thematic analysis to identify key challenges, opportunities, and emerging trends in the local manufacturing sector.

In this study, "OEM standards" refer to internationally recognized benchmarks that original equipment manufacturers adhere to in the design, production, and quality assurance of agricultural machinery spare parts. For the purpose of the gap analysis, the following key parameters were used to assess local manufacturers against OEM standards:

Material traceability	Ability to verify the origin and composition of raw materials used in production
Dimensional tolerance specifications	Adherence to precise manufacturing dimensions as per engineering drawings, typically within ± 0.01 mm.
Surface finish requirements	Meeting specified surface roughness levels that are relevant to functional performance.
ISO 9001 quality management compliance	Implementation of standardized quality control systems and documentation practices.
Heat Treatment and Hardness Standards	Compliance with heat treatment processes and mechanical property benchmarks, such as Rockwell hardness ratings.

2.7. Data Analysis

The Statistical Package for Social Science (SPSS) software was used to conduct the analysis. Frequency count, number, and percentage were examples of the descrip-

tive analysis employed.

2.7.1. Frequency

The frequency (f) of a value is simply the number of times that value appears in the dataset. Frequency distributions are mainly constructed to present data in a condensed form and for easy understanding.

f = number of occurrences of a particular value.

By analyzing frequencies, the study captures the distribution of key operational practices, such as in-house design development, the presence of CNC machines, the use of safety measures, and access to training programs. This approach provides valuable insights into which capabilities are prevalent and which are lacking in the current manufacturing landscape.

2.7.2. Percentage (%)

The percentage expresses the frequency as a proportion of the total number of observations, multiplied by 100.

$$\frac{f}{N} \times 100$$

where,

f = Frequency of a specific category.

N = Total number of all observations.

This method allows for a clear, comparative analysis of the capabilities of local workshops across multiple assessment areas. By quantifying each factor in percentage terms, the study identifies specific strengths and weaknesses within the current manufacturing ecosystem.

3. Results and Discussion

3.1. Workshop Machine Availability

Among the workshops under study, conventional equipment such as lathe machines (90%) and welding machines (80%) is widely used, underscoring a reliance on manual fabrication and basic metalworking processes (**Table 1**). Grinding (63.3%) and drilling machines (43.3%) further highlight intermediate finishing capabilities but fall short of precision manufacturing. Advanced machinery essential for OEM-grade production, such as CNC machines (6.67%), laser cutters (3.33%), and induction furnaces (3.33%), is nearly absent. According to surveyed respondents, such absence of advanced machinery is primarily due to limited investment capacity and a lack of expert personnel to operate machinery requiring computer command, such as CNC machines. This reflects a technological gap, limiting workshops' ability to produce standardized, high-tolerance components required for modern agricultural machinery. The minimal usage of hydraulic presses (10%), plasma cutters (10%), and MIG welding (6.67%) indicates a lack of automated processes, perpetuating dependence on labor-inten-

sive methods that hinder scalability and consistency.

Table 1. Machine availability and operations in the surveyed workshops.

Sl. no.	Machine type	No. of workshops using (%)
1	Lathe Machine	27 (90%)
2	Welding Machine	24 (80%)
3	Grinding Machine	19 (63.3%)
4	Drill Machine	13 (43.3%)
5	Shaper Machine	8 (26.7%)
6	Bending Machine	11 (36.7%)
7	Milling Machine	6 (20%)
8	Gas Welding/Cutting	10 (33.3%)
9	Rolling Machine	4 (13.3%)
10	Power Press Machine	3 (10%)
11	CNC Machine	2 (6.67%)
12	Hydraulic Press	3 (10%)
13	Plasma Cutter	3 (10%)
14	Induction Furnace	1 (3.33%)
15	Compressor	2 (6.67%)
16	Laser Cutter	1 (3.33%)
17	Mig Welding	2 (6.67%)

3.2. Maintenance Schedule

In the sample group, only 23.3% of workshops follow structured maintenance schedules, exposing them to frequent machine breakdowns, unplanned downtime, and compromised product quality (**Figure 2**). The respondents identified a lack of formal systems as the reason for not maintaining schedules. This neglect exacerbates inefficiencies and raises production costs, undermining competitiveness.

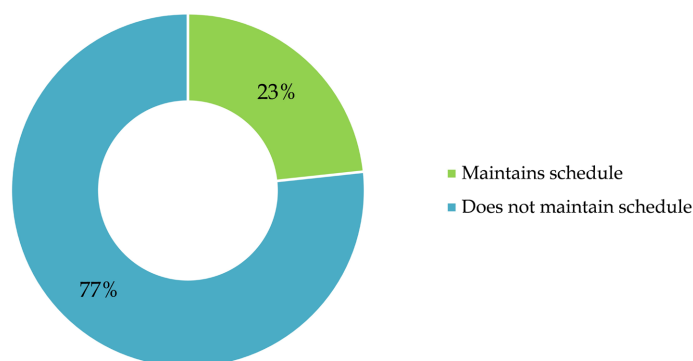


Figure 2. Workshop maintenance schedule in surveyed workshops.

3.3. Organogram of Workshop Personnel

The workforce structure in Bangladeshi workshops is heavily skewed toward administrative and low-skilled roles, with helpers (26 workshops) and managers (23 workshops) dominating the labor pool within the 30 workshops under study (Table 2). Proprietors (16 workshops) frequently oversee operations, reflecting small-scale, owner-driven enterprises. Critical technical roles such as designers (1 workshop), electricians (1), and marketing officers (1) are scarce, highlighting a severe shortage of specialized expertise. While skilled laborers (19 workshops) and mechanics (9) form a moderate base for basic operations, the near absence of supervisors (1) and foremen (6) signals weak hierarchical oversight, potentially compromising workflow efficiency. The presence of night guards (7 workshops) underscores security concerns but contrasts sharply with the lack of investment in technical or design personnel, hindering innovation and OEM compliance. The small-scale nature of workshops has been identified by the surveyed workshop owners as the core reason behind not employing personnel with specialized roles (design engineers, skilled technicians).

Table 2. Workforce distribution by position in surveyed workshops.

Sl	Workforce position	Workshop count
1	Proprietor	16
2	Manager	23
3	Skilled laborer	19
4	Mechanic	9
5	Foreman	6
6	Helper	26
7	Painter	9
8	Accountant	4
9	Marketing officer	1
10	Electrician	1
11	Designer	1
12	Supervisor	1
13	Night guard	7
14	Unskilled laborer	3
15	Office assistant	1

3.4. Infrastructure and Operational Management

Workshops in Bangladesh face significant infrastructural limitations, with only 46.67% of the surveyed sample reporting sufficient workspace and 73.33% lacking segregated areas for specialized tasks, leading to disorganized production flows (Table 3). While 93.33% have adequate ventilation and lighting, critical for worker safety, 90% suffer frequent power outages, severely disrupting operations.

Compounding this issue, 60% lack backup power solutions, exacerbating downtime risks. Despite 40% acknowledging infrastructural limitations (e.g., outdated equipment, poor storage), only 26.67% maintain separate workspaces, a necessity for quality control and OEM-grade standardization. Planning the infrastructure without any standardization criteria or expertise is identified by the respondents as the core reason behind not designing separate areas for work. These constraints hinder scalability, efficiency, and compliance with safety protocols, aligning with broader challenges in materials management and technological gaps identified in prior findings.

Table 3. Infrastructure availability in surveyed workshops.

Parameter	Available (nos.)	Available (%)	Not available (nos.)	Not available (%)
Sufficient size	14	46.67%	16	53.33%
Separate areas for work	8	26.67%	22	73.33%
Adequate ventilation/lighting	28	93.33%	2	6.67%
Limitations in infrastructure	12	40.00%	18	60.00%
Load-shedding impact	27	90.00%	3	10.00%
Backup power availability	12	40.00%	18	60.00%

3.5. Quality Control

The absence of in-house material testing (0%) and near-total non-compliance with raw material quality standards (93%) in the workshops under study reveal severe shortcomings in quality assurance practices (Table 4). No workshops conduct internal material testing, relying instead on untested raw materials, which jeopardizes product durability and safety. Only 7% of workshops ensure their materials meet industry specifications, exposing systemic negligence in quality control. The workshop owners stated that the high cost of testing equipment, lack of technical expertise, and easy market access without quality assurance allow the gaps in quality compliance. These gaps directly contradict OEM requirements for standardized production and align with prior findings on technological inadequacies (e.g., 0% ISO compliance, 6.67% CNC usage) and workforce skill shortages (Alam, 2017; Murshid *et al.*, 2022). The lack of material compliance further exacerbates risks of machinery failure, undermining farmer trust in domestically produced spare parts.

Table 4. Material quality control practices in surveyed workshops.

Parameter	Available (nos.)	Available (%)	Not available (nos.)	Not available (%)
In-house material testing	0	0%	30	100%
Ensure raw material meets standards	2	7%	28	93%

3.6. Technological Status and Design Approaches

Workshops exhibit limited design autonomy and technological adoption, with only 30% across the selected workshops designing parts in-house and a mere 17% utilizing CAD/CAM software, reflecting reliance on outdated manual methods (Table 5). The near-total absence of collaboration with R&D or Original Design Manufacturers (ODMs) (97% no engagement) underscores a systemic lack of innovation, stifling product development and customization. These gaps align with earlier findings on workforce skill shortages (e.g., only 1 designer across 30 workshops) and technological defects (e.g., 6.67% CNC usage). Unavailability of CNC machines and shortage of trained design engineers are identified by the respondents behind this. The inability to innovate or adopt digital design tools hinders compliance with OEM standards for precision and adaptability, perpetuating dependency on reverse engineering or imported designs.

Table 5. Design capacity in surveyed workshops.

Parameter	Practiced	Practiced (%)	Not practiced	Not practiced (%)
Design parts in-house	9	30%	21	70%
Use CAD/CAM software	5	17%	25	83%
Work with R&D or ODM for innovation	1	3%	29	97%

3.7. Heat-Treatment Facilities

Heat treatment facilities—critical for enhancing component durability and wear resistance—are severely underdeveloped, with only 13% of evaluated workshops performing it in-house and 93% lacking external partnerships for outsourcing (Table 6). Respondents identified high initial setup costs as the reason behind the absence of heat treatment facilities. This gap compromises the longevity and reliability of spare parts, particularly for high-stress agricultural machinery like combine harvesters. The near-total absence of heat treatment aligns with prior findings on material testing inefficiencies (0% in-house testing, Table 4) and workforce skill shortages, reflecting systemic neglect of post-production processes essential for OEM standards. Without heat treatment, components are prone to premature failure, undermining farmer trust in domestically manufactured parts and perpetuating reliance on imported alternatives.

Table 6. Heat treatment capability of the surveyed workshops.

Parameter	Available (nos.)	Available (%)	Not available (nos.)	Not available (%)
Perform heat treatment in-house	4	13%	26	87%
Have external heat treatment arrangements	2	7%	28	93%

3.8. Quality Assurance Processes

Quality assurance practices in Bangladeshi workshops are critically underdeveloped, with only 13% of the surveyed group adhering to ISO standards and none possessing in-house testing laboratories (Table 7). All of the respondents were identified as not being knowledgeable about ISO standards, which may be the main cause of limited awareness of quality standards. This systemic neglect of quality control mechanisms, such as material testing (0% in-house labs, Table 4) and compliance certifications, directly undermines product reliability and safety. The absence of standardized protocols aligns with prior findings on workforce skill gaps (e.g., 3% R and D collaboration, Table 5) and infrastructural limitations (e.g., 90% power outages, Table 3), perpetuating reliance on informal, untested production methods. These flaws expose end-users to risks of machinery failure, eroding trust in domestically manufactured spare parts and hindering OEM-level scalability.

Table 7. Quality control in surveyed workshops.

Parameter	Practiced	Practiced (%)	Not practiced	Not practiced (%)
Follow ISO standards	4	13%	26	87%
Have an in-house testing lab	0	0%	30	100%

3.9. Workplace Safety

Table 8. Health and safety measures in surveyed workshop environments.

Parameter	Implemented	Implemented (%)	Not implemented	Not implemented (%)
Safety measures for workers	4	13%	26	87%
Safety/emergency training provided	14	47%	16	53%
Regular health/safety checks	2	7%	28	93%
Use hazardous materials safely	24	80%	6	20%
Follow safety guidelines	15	50%	15	50%
Provide specific safety training	8	27%	22	73%

Workshops in Bangladesh exhibit alarming gaps in workplace safety, as seen across the selected workshops, with only 13% implementing basic safety measures and 93% neglecting regular health/safety inspections (Table 8). While 80% handle hazardous materials safely, a critical requirement for OEM compliance, half of the

workshops disregard safety guidelines, and 73% fail to provide specific safety training. These are compounded by infrastructural challenges (e.g., 73.33% lack segregated workspaces, **Table 3**) and workforce skill shortages (e.g., only 1 supervisor across 30 workshops, **Table 2**). The respondents identified the lack of workplace safety as resulting from a lack of awareness and an insufficient acknowledgment of the severity of accidents that might occur. The absence of structured safety protocols exposes workers to preventable risks and undermines operational sustainability, contradicting OEM standards for safe and ethical manufacturing.

3.10. After-Sales Service

The workshops under study demonstrate strong customer-centric adaptability, with 97% offering custom parts, reflecting responsiveness to farmer needs (**Table 9**). According to the respondents, this high adaptability exists as local workshops rely primarily on direct farmer feedback. However, 23% lack a structured complaint resolution process due to the informal nature of workshop structure, as mentioned by the surveyed workers, risking long-term client trust and retention. This gap aligns with findings on limited marketing strategies (e.g., only 53% branding plans, **Table 10**) and weak quality assurance (e.g., 0% in-house testing labs, **Table 4**), suggesting that customer satisfaction may be superficial without systemic quality and service improvements. While customization showcases flexibility, the absence of formal feedback mechanisms and quality guarantees undermines OEM standards for reliability and accountability.

Table 9. Customer satisfaction provided by the surveyed workshops.

Parameter	Offered	Offered (%)	Not offered	Not offered (%)
Custom parts for clients	29	97%	1	3%
Complaint handling process	23	77%	7	23%

3.11. Market Linkage

According to the surveyed units, workshops excel in after-sales service (97%) and market research (83%), due to dependency on close relationships with local farmers (**Table 10**). This reflects strong customer engagement and demand responsiveness. However, strategic weaknesses persist: only 17% assess their market position against competitors, and 63% avoid trade shows, limiting industry exposure. While 53% have branding plans, customer retention strategies (43% offers for repeat purchases) and competitor monitoring (40%) lag, indicating reactive rather than proactive market approaches. These gaps align with workforce shortages in marketing roles (only 1 marketing officer across 30 workshops, **Table 2**) and infrastructural constraints (e.g., 90% power outages, **Table 3**), which hinder sustained growth. The disconnect between strong service delivery and weak strategic positioning risks hindering competitiveness despite high customization capabilities (97% custom parts, **Table 9**).

Table 10. Market research, analysis, and marketing in surveyed workshops.

Parameter	Practiced	Practiced (%)	Not practiced	Not practiced (%)
Regular market research	25	83%	5	17%
Attend trade shows	11	37%	19	63%
After-sales service	29	97%	1	3%
Strategies to attract customers	12	40%	18	60%
Offers for repeat purchases	13	43%	17	57%
Monitor competitors	12	40%	18	60%
Market position vs. competitors	5	17%	25	83%
Branding/marketing plans	16	53%	14	47%

3.12. Storage and Packaging Facilities

Storage and packaging practices in Bangladeshi workshops are inconsistent, with only 53% of the sample group properly storing raw/finished parts and 40% providing specialized storage for sensitive components critical for preventing corrosion and damage (Table 11). While 53% adopt basic packaging methods, 87% face transport packaging challenges, exposing products to the risk of damage during transit. The lack of robust packaging and storage systems exacerbates post-production losses, particularly for high-demand machinery parts like combine harvester components, and contradicts global standards for supply chain reliability.

Table 11. Storage and packaging compliance of surveyed workshops.

Parameter	Available (nos.)	Available (%)	Not available (nos.)	Not available (%)
Store raw/finished parts	16	53%	14	47%
Special storage for sensitive parts	12	40%	18	60%
Packaging methods	16	53%	14	47%
Transport packaging issues	4	13%	26	87%

4. Conclusions

This study highlights a critical paradox in Bangladesh's agricultural machinery sector: local workshops demonstrate adaptability in customizing parts (97%) and understanding market needs (83% conduct research), yet face systemic barriers to achieving OEM standards. Technological gaps, evidenced by minimal CNC usage (6.67%), hinder precision manufacturing. Workforce shortages, infrastructural limitations (e.g., 90% power outages), and noncompliance with safety (87% lack safety measures) and quality protocols (87% disregard ISO standards) further undermine OEM readiness.

A root cause behind the absence of quality control practices, with zero in-house material testing and 93% non-compliance with material standards, may be the sourcing practice of the materials, as it was found that raw materials come from dismantled ships and are often not well documented [4]. There is a huge absence of skilled professionals; e.g., only one designer was found among 30 workshops, which limits the technical capability required for machinery innovations and reverse engineering. The scarcity of specialized roles is visible in the low rates of in-house designs and near-total absence of R&D collaborations. Despite high demand for domestically produced spare parts, reliance on outdated practices and unskilled labor undermines product reliability and sector growth. This may result in eroding farmer trust in domestic parts, increasing reliance on higher-quality imports, and stunting the development of a resilient local supply chain.

Strategic investments in technology, training, and infrastructure, coupled with policy reforms, are essential to align local manufacturing with global standards and to ensure the sustainability of Bangladesh's agricultural productivity.

5. Recommendations

To uplift local OEM capabilities, it is essential to start by reforming policies that directly impact production costs. Reducing tariffs on raw materials and offering subsidies to small and medium enterprises can address the technological gaps identified (e.g., 6.67% CNC usage); and significantly ease the financial burden on local manufacturers. Alongside this, since nearly all face frequent power outages (90%) and 73.33% lack an individual area for specialized tasks, improving infrastructure is equally critical—ensuring a stable power supply, expanding production space, and developing dedicated storage facilities will create a more efficient and reliable manufacturing environment.

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Author's Contribution

Md. Rizwanur Rahman designed the survey questionnaire, collected and analyzed data, assisted in data collection, performed statistical analysis, contributed to the writing of the manuscript. Fariha Akhter conducted the literature review and contributed to the discussion and interpretation of findings and contributed to writing and formatting the manuscript, and AKM Saiful Islam conceptualized the study, provided technical insights on OEM manufacturing, supervised the research process, and reviewed and refined the final manuscript.

Conflicts of Interest

In conducting this research, there was no conflict of interest on the researcher's part.

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