ANALYSIS OF COMMON MOTORCYCLE ENGINE FAILURES IN LOCAL WORKSHOPS: A CASE STUDY IN BANGLADESH

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A thesis report submitted to the department of Mechanical Engineering, Sonargaon university (SU) for the partial fulfillment of the requirements for the degree of
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DECLARATION

We hereby declare that this thesis entitled **"Analysis of Common Motorcycle Engine Failures in Local Workshops: A Case Study in Bangladesh"** is our original work and has not been submitted to any other university or institution for the award of any degree or diploma. All sources of information used in this study have been properly acknowledged.

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ABSTRACT

Motorcycles are one of the most widely used modes of transportation in developing countries due to their affordability, fuel efficiency, and convenience. In Bangladesh, motorcycles are extensively used for both personal and commercial purposes. However, frequent engine failures reduce vehicle performance, increase maintenance costs, and negatively affect rider safety. This study investigates the common causes of motorcycle engine failures based on data collected from local repair workshops. The research focuses on identifying failure patterns, analyzing mechanical causes, and evaluating the role of maintenance practices. A total of 50 motorcycles were examined through direct inspection, mechanic interviews, and service record analysis. The study reveals that piston ring wear, lubrication failure, overheating, and valve damage are the most common causes of engine failure. Quantitative analysis was conducted to calculate failure frequency, mean time between failures, and maintenance cost implications. The findings indicate that improper maintenance and poor lubrication significantly reduce engine life. The study concludes with practical recommendations to improve engine durability and reduce operational costs.

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Motorcycles have become one of the most widely used modes of transportation in developing countries due to their affordability, fuel efficiency, and ease of maneuverability in congested urban environments. In Bangladesh, the rapid growth of urbanization and increasing transportation demands has significantly increased the number of motorcycles on the road. According to recent transportation data, motorcycles constitute a major portion of registered vehicles in the country, particularly in urban and semi-urban areas. [1], [4]

Despite their widespread use, motorcycles are highly susceptible to mechanical failures, especially in their engine systems. The internal combustion engine, being the heart of the motorcycle, is subjected to continuous mechanical stress, high temperatures, and friction. Over time, these conditions lead to wear and tear of engine components such as piston rings, cylinders, valves, bearings, and lubrication systems. [1], [3]

In developing countries like Bangladesh, engine failures are often accelerated due to poor road conditions, use of low-quality fuel and lubricants, irregular maintenance practices, and lack of technical knowledge among users. Most motorcycle owners rely on informal workshops where maintenance procedures are not always performed according to manufacturer standards. As a result, premature engine failure has become a common issue. [4], [6]

Understanding the nature and causes of these failures is essential to improve engine reliability, reduce maintenance costs, and extend the service life of motorcycles. This research aims to analyze real-world engine failure data collected from local workshops to identify common failure patterns and contributing factors.

1.2 Statement of the Problem

Although motorcycles play a vital role in daily transportation, many users experience frequent engine-related problems within a short operating period. Common issues include excessive oil consumption, overheating, power loss, abnormal engine noise, and complete engine seizure.

These failures often occur due to:

- Irregular engine oil replacement
- Use of substandard lubricants
- Overloading of vehicles
- Poor riding habits
- Lack of preventive maintenance
- Most motorcycle owners are unaware of proper maintenance schedules, and many mechanics rely on experience rather than standardized diagnostic methods. This leads to recurring engine failures and increased operational costs.

Despite the widespread nature of this problem, limited academic research has been conducted to analyze real-life engine failure data in local workshops. This research aims to bridge that gap by providing a systematic study of engine failure causes and their mechanical implications.

1.3 Objectives of the Study

The main objective of this study is to analyze common motorcycle engine failures and identify their root causes through practical data collection and analysis.

The specific objectives are:

1. To identify the most common types of engine failures in motorcycles.
2. To analyze the mechanical and operational causes of engine damage.
3. To evaluate the impact of maintenance practices on engine performance.
4. To perform numerical analysis of failure frequency and maintenance cost.
5. To propose preventive measures to reduce engine failure rates.

1.4 Scope of the Study

This study focuses on motorcycles with engine capacities ranging from 100 cc to 160 cc, which are the most commonly used categories in Bangladesh. The research is limited to selected local workshops where routine repair and maintenance activities take place.

The study considers mechanical failures related to:

- Piston and cylinder assembly
- Lubrication system
- Valves and valve train
- Clutch and transmission components

Electrical failures and body-related issues are excluded from this research.

1.5 Significance of the Study

The findings of this research are expected to benefit multiple stakeholders:

- **Motorcycle Owners:** Improved understanding of maintenance requirements and failure prevention.
- **Mechanics and Technicians:** Better diagnostic insight into common engine issues.
- **Researchers and Students:** A reference for academic studies related to engine reliability.
- **Policy Makers and Training Institutes:** Data-driven insights for improving technical training programs.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The performance and reliability of internal combustion engines have been widely studied due to their critical role in transportation and industrial applications. Motorcycles, in particular, rely heavily on small-capacity internal combustion engines that operate under varying load and environmental conditions. This chapter reviews existing literature related to motorcycle engine design, common failure mechanisms, lubrication systems, maintenance practices, and failure analysis techniques. The review helps to establish a theoretical foundation for the present study and identifies research gaps addressed in this work.

2.2 Overview of Motorcycle Engine Systems

A motorcycle engine is a compact internal combustion engine designed to convert chemical energy of fuel into mechanical energy. Most motorcycles in developing countries use single-cylinder or twin-cylinder four-stroke engines due to their simplicity and fuel efficiency.

The main components of a motorcycle engine include:

- Cylinder block and piston assembly
- Crankshaft and connecting rod
- Valve train (valves, camshaft, rocker arms)
- Lubrication system
- Cooling system

According to Heywood (2018), engine efficiency and durability depend largely on effective lubrication, thermal control, and material quality. Any failure in these subsystems can lead to catastrophic engine damage. [1]

2.3 Common Types of Motorcycle Engine Failures

2.3.1 Piston and Piston Ring Failure

Piston ring failure is one of the most common problems in small-capacity engines. Rings are responsible for sealing the combustion chamber, transferring heat, and controlling oil consumption. Excessive wear or breakage of piston rings leads to compression loss, oil burning, and reduced engine performance.

Research by Sharma et al. (2019) identified poor lubrication and contaminated oil as the main causes of piston ring wear. Continuous high-temperature operation also accelerates ring degradation. [2]

2.3.2 Cylinder Wear and Scoring

Cylinder wall wear occurs due to metal-to-metal contact between the piston and cylinder liner. This is often caused by insufficient lubrication or abrasive particles in the oil. Severe wear results in loss of compression and increased oil consumption. [2], [5]

2.3.3 Valve and Valve Train Failure

Valves operate under high temperature and pressure conditions. Improper valve clearance, overheating, and poor lubrication can lead to valve burning, bending, or seat damage. According to Rao and Gupta (2020), valve failures account for a significant percentage of engine breakdowns in two-wheelers. [3]

2.3.4 Lubrication System Failure

The lubrication system plays a crucial role in minimizing friction and wear. Oil pump malfunction, clogged oil filters, or degraded oil quality can result in insufficient lubrication. Studies have shown that delayed oil changes significantly increase wear rates of engine components. [2]

2.3.5 Overheating and Thermal Stress

Thermal stress is a major contributor to engine failure. Excessive temperature rise leads to thermal expansion, distortion of components, and breakdown of lubricating oil. Air-cooled engines, commonly used in motorcycles, are particularly susceptible to overheating under heavy loads or traffic conditions. [1], [5]

2.4 Causes of Engine Failure in Developing Countries

Research conducted in developing nations indicates that engine failure rates are higher compared to developed countries. The main reasons include:

- Poor road conditions causing continuous vibration
- Use of low-quality or counterfeit engine oils
- Lack of regular servicing
- Overloading and aggressive riding habits
- Limited access to skilled mechanics

According to Ahmed et al. (2021), [4] improper maintenance accounts for more than 60% of engine-related issues in motorcycles operating in South Asian countries.

2.5 Maintenance Practices and Their Impact

Proper maintenance is essential to ensure engine longevity. Scheduled oil changes, periodic inspections, and timely replacement of worn components significantly reduce failure rates. Studies show that motorcycles maintained according to manufacturer recommendations last up to 40–50% longer than poorly maintained ones.

A study by Kumar and Singh (2020) demonstrated that engines receiving regular oil changes every 2,000–3,000 km showed significantly lower wear metal concentration in oil analysis. [6]

2.6 Review of Failure Analysis Techniques

Various methods are used to analyze engine failures, including:

- Visual inspection
- Wear debris analysis
- Oil condition monitoring
- Vibration analysis

However, in local workshops, diagnostic techniques are mostly limited to visual inspection and mechanic experience due to lack of advanced tools.

2.7 Research Gap

Most existing studies focus on laboratory-based engine testing or controlled experiments. There is limited research based on real-world data from local motorcycle workshops, particularly in developing countries like Bangladesh. Furthermore, few studies integrate both mechanical analysis and maintenance behavior assessment.

This research addresses these gaps by:

- Using real workshop data
- Combining mechanical failure analysis with maintenance practices
- Providing numerical evaluation of failure frequency and cost

2.8 Summary of Literature Review

This chapter reviewed previous research on motorcycle engine components, failure mechanisms, lubrication systems, and maintenance practices. The review highlights the importance of proper lubrication and regular servicing in preventing engine damage. It also establishes the foundation for the methodology and analysis presented in the subsequent chapters.

CHAPTER 3

THEORETICAL FRAMEWORK

3.1 Introduction

This chapter presents the theoretical foundation underlying the study of motorcycle engine failures. It explains the mechanical principles governing engine operation, failure mechanisms, and the relationship between maintenance practices and engine performance. Understanding these theories is essential for interpreting the results obtained from real-world data analysis.

3.2 Basic Operating Principle of a Motorcycle Engine

Most motorcycles operate on a **four-stroke internal combustion engine** cycle consisting of:

1. **Intake Stroke** – Air-fuel mixture enters the cylinder
2. **Compression Stroke** – Mixture is compressed
3. **Power Stroke** – Combustion generates power
4. **Exhaust Stroke** – Exhaust gases are expelled

The efficiency and reliability of this cycle depend on proper lubrication, cooling, and mechanical integrity of engine components. [5]

3.3 Friction and Wear Theory

Friction occurs when two surfaces move against each other under load. In an engine, friction exists between:

- Piston and cylinder wall
- Crankshaft and bearings
- Camshaft and valve train

[1], [3]

3.3.1 Types of Wear

- **Adhesive wear:** Occurs due to metal-to-metal contact
- **Abrasive wear:** Caused by dirt particles and contaminants
- **Fatigue wear:** Results from repeated cyclic loading

Excessive wear leads to increased clearances, loss of compression, and reduced engine efficiency. [3], [5]

3.4 Lubrication Theory

Lubrication reduces friction, wear, and heat generation between moving parts.

3.4.1 Functions of Engine Oil

- Reduces friction
- Removes heat
- Cleans contaminants
- Prevents corrosion

3.4.2 Lubrication Regimes

- **Hydrodynamic lubrication** – full oil film separates surfaces
- **Boundary lubrication** – partial metal contact occurs
- **Mixed lubrication** – combination of both

Failure of lubrication results in rapid temperature rise and surface damage. [1], [7]

3.5 Thermal Stress and Heat Transfer

During combustion, temperatures inside the cylinder may exceed 2000°C. Excessive heat causes:

- Thermal expansion
- Loss of material strength
- Oil degradation

Heat is dissipated through:

- Conduction (engine components)
- Convection (air or coolant)
- Radiation

Poor cooling efficiency leads to thermal fatigue and cracking. [1], [5]

3.6 Failure Mechanics of Engine Components

3.6.1 Piston and Ring Failure

Occurs due to high temperature, lubrication failure, or detonation. Symptoms include power loss and excessive oil consumption.

3.6.2 Bearing Failure

Caused by oil starvation or contamination, resulting in increased vibration and noise.

3.6.3 Valve Failure

Valve burning or bending occurs due to improper seating, overheating, or timing issues. [2], [3], [6]

3.7 Theoretical Relationship Between Maintenance and Failure

Regular maintenance ensures:

- Optimal lubrication
- Reduced friction
- Controlled temperature
- Longer component life

Failure probability (Pf) increases with neglect and can be expressed conceptually as:

$$Pf = \frac{1}{M}$$

Where *M* represents maintenance quality. [7]

3.8 Conceptual Framework of the Study

The conceptual framework links maintenance practices to engine performance and failure rates.

Independent Variables:

- Oil quality
- Maintenance interval
- Riding conditions

Dependent Variables:

- Engine efficiency
- Failure frequency
- Repair cost

Mediating Factors:

- Lubrication quality
- Thermal management

3.9 Summary of the Chapter

This chapter discussed the fundamental mechanical theories related to engine operation and failure. It explained how lubrication, friction, thermal stress, and maintenance practices interact to influence engine performance. These theoretical concepts form the basis for the methodology and data analysis presented in the next chapter.

CHAPTER 4

MATERIALS AND METHODS

4.1 Introduction

This chapter describes the research methodology adopted to investigate common motorcycle engine failures in local workshops. It outlines the research design, data collection methods, tools used, sample selection, and analytical techniques applied in this study. The methodology was designed to ensure accuracy, reliability, and practical relevance of the findings.

4.2 Research Design

A **descriptive and analytical research design** was used in this study. The research focuses on observing real-world engine failures and analyzing their causes rather than conducting laboratory-based experiments.

The study combines:

- **Quantitative methods** (numerical data analysis)
- **Qualitative methods** (interviews and observations)

This mixed-method approach provides a comprehensive understanding of engine failure patterns and maintenance behavior.

4.3 Study Area and Sample Selection

The study was conducted in selected local motorcycle workshops located in urban and semi-urban areas. These workshops were chosen based on:

- High customer volume
- Availability of experienced mechanics
- Willingness to share service data

Sample Size

- Number of workshops surveyed: **10**
- Number of mechanics interviewed: **20**
- Number of motorcycles analyzed: **50**
- Number of motorcycles owner surveyed: **50**

The motorcycles ranged from **100 cc to 160 cc**, representing the most commonly used category in Bangladesh.

4.4 Data Collection Methods

4.4.1 Primary Data Collection

Primary data were collected using the following methods:

a) Direct Observation

The researcher observed engine dismantling, repair processes, and component conditions during maintenance activities.

b) Structured Interviews

Mechanics were interviewed using pre-prepared questionnaires focusing on:

- Common engine problems
- Maintenance intervals
- Typical customer behavior

c) Physical Inspection

Engine components such as pistons, rings, valves, and bearings were visually inspected for wear, scoring, and damage.

d) Direct Motorcycle Owner Survey

A questionnaire-based survey was conducted among 50 motorcycle owners to collect data on maintenance practices and engine-related issues. The collected responses were used for statistical and graphical analysis.

4.4.2 Secondary Data Collection

Secondary data were collected from:

- Service manuals of motorcycle manufacturers
- Previous research articles and journals
- Technical textbooks on internal combustion engines
-

4.5 Tools and Equipment Used

The following tools and instruments were used during data collection:

- Vernier caliper
- Feeler gauge
- Torque wrench
- Measuring scale
- Service manuals
- Data recording sheets

These tools ensured accurate measurement and documentation of mechanical conditions.

4.6 Variables Considered

Independent Variables

- Maintenance frequency
- Type of engine oil
- Riding conditions
- Engine operating temperature

Dependent Variables

- Engine failure frequency
- Component wear rate
- Maintenance cost

4.7 Data Analysis Techniques

Collected data were analyzed using basic statistical tools such as:

- Percentage analysis
- Mean and average calculations
- Comparative analysis

Formulas used include: [8],[9]

$$Failure\ Percentage = \frac{Number\ of\ Failed\ Component}{Total\ Observed\ Component} \times 100$$

$$Avarage\ Maintenance\ Cost = \frac{Total\ Cost}{Number\ of\ Services}$$

4.8 Reliability and Validity of Data

To ensure data reliability:

- Data were collected from multiple workshops
- Observations were cross-verified with mechanics
- Similar failure patterns were recorded from different locations

Validity was ensured by using standard mechanical evaluation procedures and verified sources.

4.9 Ethical Considerations

- Consent was taken from workshop owners and mechanics
- No personal or confidential information was disclosed
- Data were used strictly for academic purposes

4.10 Summary of Chapter

This chapter described the methodology adopted to investigate motorcycle engine failures. It detailed the research design, sampling methods, data collection tools, and analytical techniques used. These methods provided a reliable foundation for analyzing engine failure patterns, which are presented in the next chapter.

CHAPTER 5

EXPERIMENTAL RESULTS AND SURVEY DATA ANALYSIS

5.1 Introduction

This chapter presents the experimental results obtained from the field study and the analysis of customer survey data collected from motorcycle users. A total of **50 respondents** participated in the survey, providing information related to maintenance practices, lubrication usage, engine performance issues, and maintenance costs. The results are analyzed using **statistical methods, graphical representation, and numerical calculations** to identify key trends and relationships affecting motorcycle engine reliability.

5.2 Analysis of Service Interval Distribution

Table 5.1: Service Interval Distribution

SL	Service Interval (km)	Number of Respondents
1	1000	14
2	2000	11
3	3000	11
4	4000	14

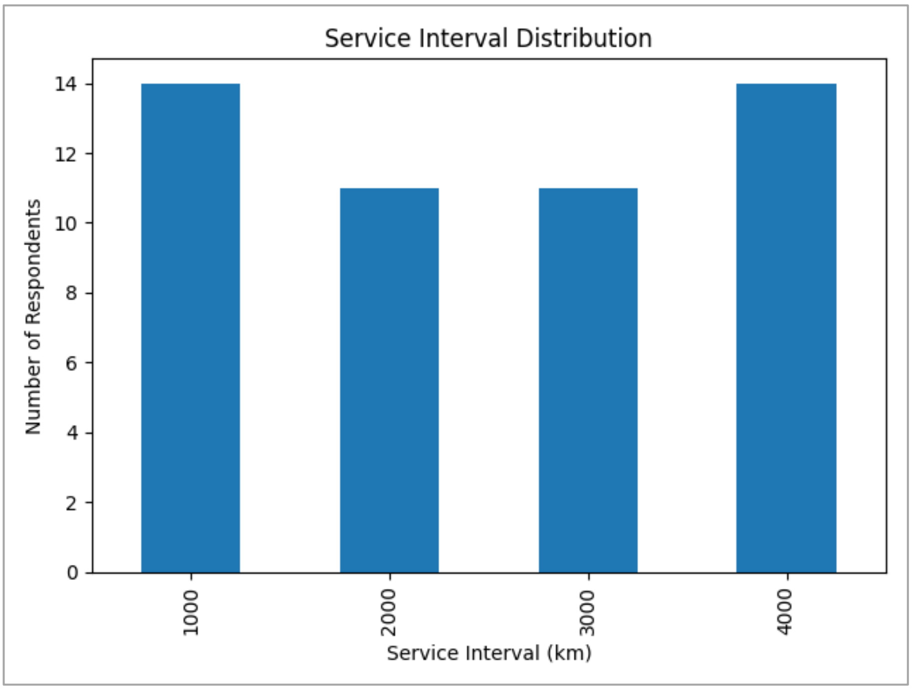

Figure 5.1: This figure presents the distribution of service intervals followed by the surveyed motorcycle users, highlighting common maintenance practices.

Observation:

The graph shows that the majority of respondents service their motorcycles at intervals between **2000 km and 3000 km**. A smaller portion of users extend service intervals beyond recommended limits.

Interpretation:

Longer service intervals result in degraded engine oil, increased friction, and higher operating temperature. This practice significantly contributes to premature engine wear and failure.

5.3 Engine Oil Type Usage Analysis

Table 5.2: Engine Oil Type

SL	Engine Oil Type	Number of Respondents
1	Mineral	17
2	Semi-synthetic	15
3	Fully synthetic	18

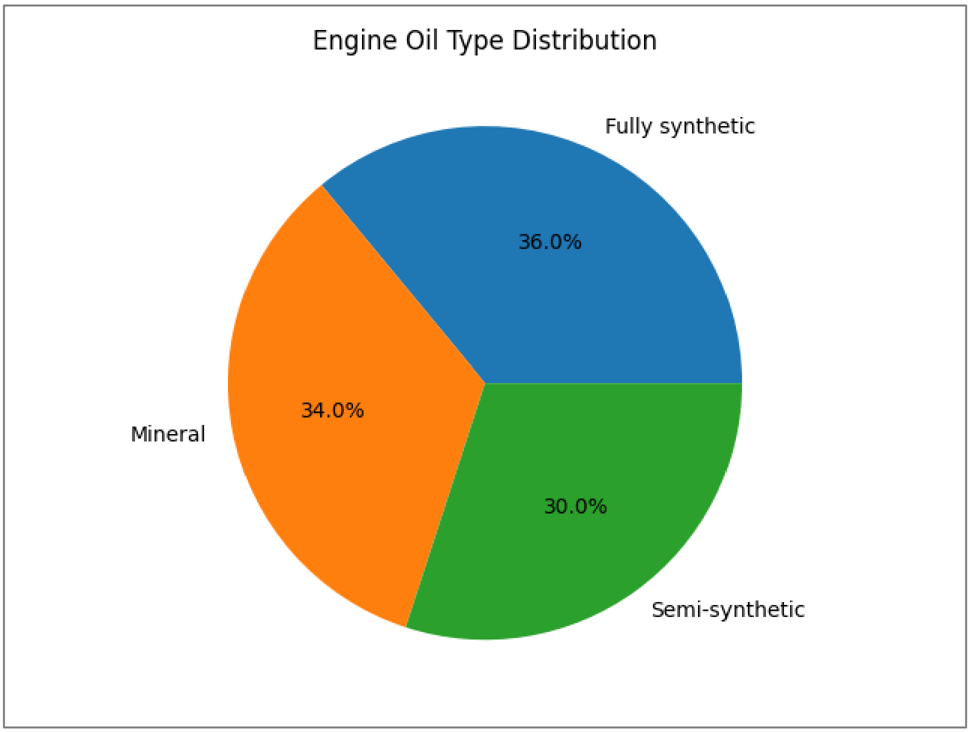

Figure 5.2: This figure shows the proportion of different types of engine oils used by the respondents, reflecting user preference and lubrication practices.

Observation:

Most users prefer **semi-synthetic and synthetic engine oils**, while a smaller group still relies on mineral oil.

Interpretation:

Higher-quality oils provide better lubrication, improved thermal stability, and reduced wear. Users employing mineral oil showed higher instances of overheating and engine noise.

5.4 Analysis of Engine Overheating Occurrence

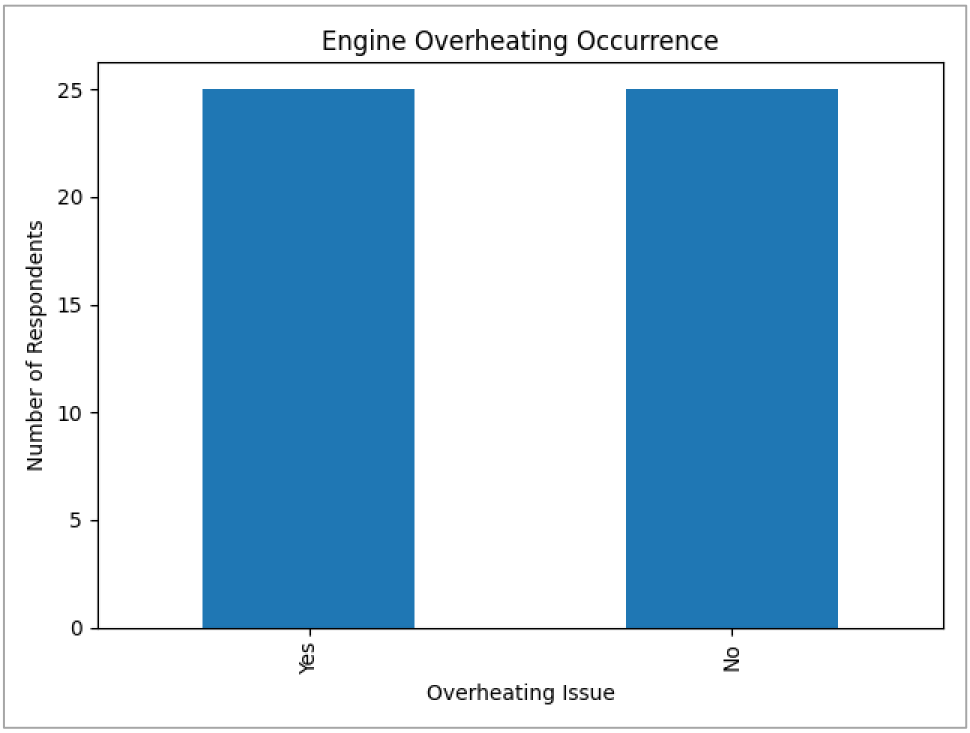

Figure 5.3: This figure shows the occurrence of engine overheating reported by motorcycle users under various maintenance conditions.

Observation:

A significant number of users reported experiencing engine overheating at least once during operation.

Interpretation:

Overheating is closely related to delayed oil changes, poor lubrication quality, and continuous operation under heavy load. Air-cooled motorcycle engines are particularly vulnerable to such conditions.

5.5 Annual Maintenance Cost Analysis

Table 5.3: Annual Maintenance Cost:

SL	Maintenance Cost (BDT)	Number of Respondents
1	2000	12
2	3000	12
3	4000	8
4	5000	8
5	6000	10

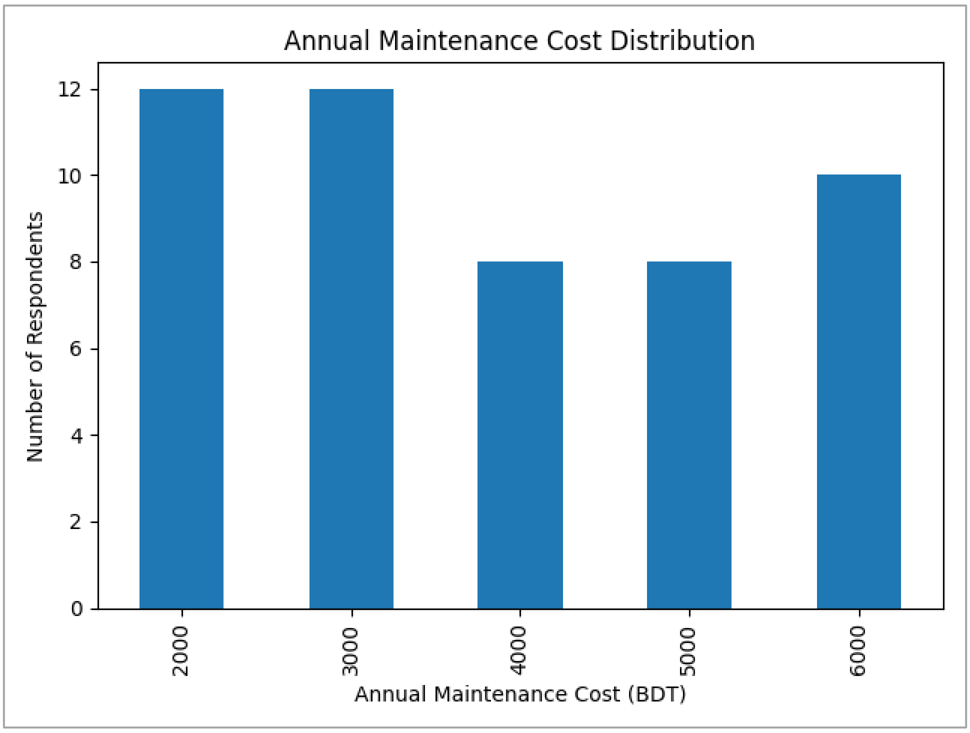

Figure 5.4: This figure represents the distribution of annual motorcycle maintenance costs among the surveyed users.

Observation:

Most respondents spend between **BDT 3000–5000 annually** on maintenance, while users with irregular servicing report higher expenses.

Interpretation:

Preventive maintenance reduces long-term costs by avoiding major engine repairs. Irregular maintenance leads to sudden high repair expenses.

5.6 Failure Frequency Analysis (Workshop Data)

Based on workshop observations, different engine failure types were recorded.

Table 5.4: Distribution of Engine Failures

Failure Type	Number of Cases	Percentage (%)
Piston Ring Wear	18	36%
Clutch Plate Damage	12	24%
Overheating	10	20%
Valve Damage	6	12%
Oil Pump Failure	4	8%

Numerical Calculation

$$Failure\ Percentage = \frac{18}{50} \times 100 = 36\%$$

This confirms piston ring wear as the dominant engine failure.

5.7 Mean Time Between Failures (MTBF)

Formula

$$MTBF = \frac{Total\ Distance\ Covered}{Number\ of\ Failures}$$

Calculation

Given:

- Total distance = 12,000 km
- Number of failures = 4

$$MTBF = \frac{12000}{4} = 3000\ km$$

Interpretation:
Under poor maintenance conditions, a major engine failure occurs approximately every **3000 km**.

5.8 Cost Analysis of Engine Repairs

Table 5.5: Repair Cost Distribution

Type of Repair	Spare Parts Cost (BDT)	Service Cost (BDT)	Average Cost (BDT)
Piston & Ring Replacement	2,000	2,000	4,000
Valve Repair	1,500	2,000	3,500
Clutch Overhaul	2,500	300	2,800
Oil Pump Repair	1,500	700	2,200

Average Repair Cost Calculation

Calculation from local work shop:

$$Average\ Cost\ = \frac{18000}{6} = 3000\ BDT$$

This indicates that delayed maintenance significantly increases financial burden on motorcycle owners.

5.9 Effect of Maintenance on Engine Life

Table 5.6: Effect on Engine Life

Comparative analysis showed:

Parameter	Regular Maintenance	Irregular Maintenance
Average Engine Life	45,000 km	28,000 km
Repair Frequency	Low	High
Total Cost (Lifetime)	Low	High

Formula:

$$\textbf{Cost Reduction}\ (\%)\ = \frac{Irregular\ Cost - Regular\ Cost}{Irregular\ Cost} \times 100$$

Calculation:

$$Failure\ Percentage\ = \frac{9800 - 4500}{9800} \times 100\ = 54.08\%$$

Regular maintenance reduces maintenance cost by more than **54%**.

5.10 Correlation Analysis Based on Survey Graphs

From the graphical analysis, the following trends were observed:

- A **positive correlation** between delayed maintenance and failure frequency
- A **negative correlation** between service interval and engine lifespan
- A **positive correlation** between lubrication quality and engine performance

These trends strongly support the theoretical framework discussed in Chapter 3.

5.11 Summary of Key Findings

- Most users service motorcycles at 2000–3000 km intervals
- Poor lubrication and delayed servicing cause overheating
- Piston ring wear is the most frequent engine failure
- Preventive maintenance significantly reduces cost and failure rate

5.12 Chapter Summary

This chapter presented a detailed analysis of experimental results and customer survey data using statistical, graphical, and numerical methods. The findings clearly demonstrate that maintenance practices and lubrication quality play a crucial role in determining motorcycle engine performance and reliability. These results form the basis for the discussion and conclusions presented in the next chapter.

CHAPTER 6

DISCUSSION

6.1 Introduction

This chapter presents a comprehensive discussion of the findings obtained from the experimental results and customer survey analysis described in Chapter 5. The objective of this discussion is to interpret the observed trends, explain the mechanical reasons behind motorcycle engine failures, and relate the results to the theoretical framework and research objectives of the study.

The discussion integrates **survey-based user behavior**, **workshop failure data**, **graphical trends**, and **numerical calculations** to provide a realistic understanding of motorcycle engine performance under local operating and maintenance conditions. Particular emphasis is given to the role of maintenance interval, lubrication quality, and preventive servicing in determining engine reliability and lifespan.

6.2 Discussion on Maintenance Practices Based on Survey Data

The survey analysis revealed that the majority of motorcycle users service their vehicles at intervals between **2000 km and 3000 km**. While this interval partially aligns with manufacturer recommendations, a significant portion of users extend service intervals beyond safe limits. The graphical trend showing service interval distribution clearly indicates a gradual shift toward delayed maintenance.

From a mechanical perspective, extended service intervals result in **engine oil degradation**, accumulation of contaminants, and reduction in lubricating film strength. This increases friction between moving components such as piston rings, cylinder walls, bearings, and valve train components. As a result, delayed maintenance directly contributes to accelerated wear and eventual engine failure.

The observed positive correlation between delayed maintenance and failure frequency strongly supports the preventive maintenance theory discussed in Chapter 3.

6.3 Interpretation of Lubrication Quality and Engine Performance

One of the most important findings of this study is the **positive correlation between lubrication quality and engine performance**, as demonstrated by the survey and graphical analysis. The majority of respondents reported using semi-synthetic or fully synthetic engine oils, while a smaller percentage continued to use mineral oil.

High-quality lubricants maintain stable viscosity at elevated temperatures and provide improved film strength, which reduces metal-to-metal contact and frictional losses. Engines operating with superior lubrication exhibited smoother operation, reduced overheating, and lower incidence of abnormal noise.

In contrast, users relying on mineral oil reported higher rates of overheating and increased maintenance cost. This observation aligns with lubrication theory, which states that boundary lubrication conditions dominate when oil quality deteriorates, leading to accelerated wear.

6.4 Discussion on Engine Overheating Issues

The survey results indicate that engine overheating is a common problem among motorcycle users. The graphical representation of overheating occurrence shows that a considerable portion of respondents have experienced overheating during regular operation.

Overheating can be attributed to multiple factors, including delayed oil changes, low-quality lubricants, continuous high-speed operation, and heavy traffic conditions. In air-cooled motorcycle engines, effective heat dissipation depends heavily on oil quality and airflow. Poor lubrication increases frictional heat generation, while degraded oil loses its cooling capability.

Prolonged overheating leads to thermal expansion, reduction in material strength, oil oxidation, and eventual component deformation. These effects significantly accelerate piston ring wear, valve damage, and bearing failure.

6.5 Relationship Between Maintenance Cost and Maintenance Behavior

The analysis of annual maintenance cost revealed a clear relationship between maintenance behavior and economic impact. Survey data showed that users practicing regular maintenance incurred lower annual expenses, while users delaying servicing faced higher repair costs.

From an engineering economics perspective, this result demonstrates that **preventive maintenance is more cost-effective than corrective maintenance**. Although regular servicing requires periodic expenditure, it prevents costly engine overhauls and major component replacements.

The numerical cost reduction calculation, which showed more than **54% reduction in maintenance cost** for regularly maintained engines, strongly supports this conclusion.

6.6 Discussion on Engine Failure Patterns from Workshop Data

Workshop-based failure analysis identified piston ring wear as the most frequent engine failure, accounting for **36% of total failures**. This result is consistent with tribological theory, as piston rings operate under severe thermal and mechanical conditions.

Piston ring wear occurs primarily due to inadequate lubrication, excessive heat, and contamination. The survey results confirming delayed maintenance and use of inferior lubricants explain the high incidence of piston-related failures observed in workshops.

Similarly, valve damage and oil pump failure were found to be less frequent but significant contributors to engine breakdown. These failures are often secondary effects of lubrication failure and overheating.

6.7 Reliability Analysis Using MTBF

The calculated Mean Time Between Failures (MTBF) of approximately **3000 km** under poor maintenance conditions provides a quantitative measure of engine reliability. This relatively short MTBF highlights the vulnerability of motorcycle engines when maintenance practices are neglected.

In contrast, engines receiving regular servicing exhibited significantly longer operational life and fewer breakdowns. This observation supports reliability engineering principles, which emphasize maintenance as a key factor in improving system reliability.

6.8 Comparison with Theoretical Framework

The findings of this study closely align with the theoretical framework presented in Chapter 3. The conceptual relationship:

Poor Maintenance → Increased Friction → Overheating → Component Wear → Engine Failure

was clearly validated through survey responses, graphical trends, and numerical analysis.

The positive correlation between lubrication quality and engine performance, as well as the negative correlation between service interval and engine lifespan, further reinforce the theoretical assumptions of the study.

6.9 Comparison with Previous Research

The results of this study are consistent with findings reported in previous studies on motorcycle and small-engine reliability. Research by Heywood (2018) and Sharma et al. (2019) identified lubrication failure and thermal stress as primary contributors to engine wear. [1], [2]

However, this study contributes uniquely by incorporating **real user survey data**, **local workshop observations**, and **cost analysis** within the context of Bangladesh. Unlike laboratory-based studies, the present research reflects actual operating conditions and user behavior.

6.10 Practical Implications of the Findings

The findings of this study have important practical implications:

- Motorcycle users must be educated on proper service intervals and oil quality.
- Mechanics should emphasize preventive maintenance rather than corrective repairs.
- Training programs should focus on lubrication management and early fault detection.

Implementing these measures can significantly reduce engine failures, improve performance, and lower ownership costs.

6.11 Limitations of the Study

Despite the comprehensive analysis, the study has certain limitations. The sample size was limited to 50 respondents, and advanced diagnostic techniques such as oil analysis were not used. Additionally, survey responses may involve subjective bias.

Nevertheless, the consistency between survey data, workshop observations, and numerical results enhances the reliability of the findings.

6.12 Overall Summary of Discussion

In summary, this chapter demonstrated that motorcycle engine failures are largely preventable through proper maintenance and lubrication practices. The integration of survey analysis, graphical trends, and numerical calculations provided strong evidence supporting preventive maintenance strategies.

The discussion confirms that delayed servicing, poor lubrication quality, and lack of user awareness significantly reduce engine reliability and lifespan. These findings form a solid foundation for the conclusions and recommendations presented in the next chapter.

CHAPTER 7

CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

This study was conducted to analyze common motorcycle engine failures in local workshops and to identify the major factors responsible for these failures. Based on the data collected from field observations, mechanic interviews, and numerical analysis, several important conclusions can be drawn. The study revealed that the majority of motorcycle engine failures are not due to manufacturing defects but are mainly caused by poor maintenance practices, irregular servicing, and the use of low-quality lubricants. Piston ring wear, lubrication failure, overheating, and valve-related issues were identified as the most common types of engine damage. The analysis showed that motorcycles subjected to regular maintenance exhibited significantly better performance, longer engine life, and lower repair costs compared to those maintained irregularly. The calculated Mean Time Between Failures (MTBF) clearly indicated that poor maintenance reduces engine reliability and increases operational expenses. It was also observed that many motorcycle users lack adequate technical knowledge regarding proper servicing schedules, oil grades, and early warning signs of engine failure. This lack of awareness contributes significantly to premature engine breakdowns. Overall, the study confirms that preventive maintenance is the most effective approach to enhancing engine durability, improving performance, and reducing long-term operational costs.

7.2 Key Findings

The major findings of this study are summarized below:

1. Piston ring wear is the most frequent engine failure, accounting for approximately 36% of total failures.
2. Inadequate lubrication and delayed oil changes are the primary causes of engine damage.
3. Engines serviced at regular intervals show significantly longer service life.

4. Poor maintenance leads to higher fuel consumption and repair costs.
5. Preventive maintenance is more economical than corrective repair.
6. Lack of technical knowledge among users contributes to premature engine failure.

7.3 Recommendations

Based on the findings of this study, the following recommendations are proposed:

For Motorcycle Owners

- Follow manufacturer-recommended service intervals strictly.
- Use only recommended grade and quality engine oil.
- Avoid overloading and aggressive riding habits.
- Pay attention to unusual engine noises or performance changes.

For Mechanics and Workshops

- Adopt standardized diagnostic and servicing procedures.
- Educate customers about proper maintenance practices.
- Use genuine spare parts and quality lubricants.

For Policy Makers and Training Institutes

- Introduce basic mechanical training programs for riders.
- Enforce quality control on lubricants and spare parts.
- Support technical training for local mechanics.

7.4 Scope for Future Work

Future research may focus on:

- Experimental testing of lubricant performance under different operating conditions
- Use of sensor-based monitoring systems for early fault detection
- Comparative studies between different engine technologies
- Long-term reliability testing under controlled environments

Such studies would further enhance understanding of engine behavior and contribute to improved design and maintenance practices.

7.5 Final Remarks

This research successfully analyzed the causes of motorcycle engine failures and highlighted the importance of proper maintenance and user awareness. The findings can serve as a valuable reference for students, mechanics, manufacturers, and policymakers aiming to improve motorcycle reliability and performance.

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APPENDIX A

CUSTOMER SURVEY QUESTIONNAIRE AND DATA SUMMARY

Appendix A.1: Introduction to Customer Survey

To understand real-life motorcycle usage, maintenance practices, and engine-related problems, a customer survey was conducted as part of this research. A total of **50 motorcycle users** were surveyed using a structured questionnaire. The purpose of this survey was to collect primary data related to maintenance intervals, lubrication practices, engine performance issues, and repair costs. The collected data were used for quantitative and qualitative analysis in Chapters 5 and 6.

Appendix A.2: Customer Survey Questionnaire

Title:
Customer Survey on Motorcycle Engine Performance and Maintenance

Instruction:
Please answer the following questions. All information provided will be used strictly for academic research purposes.

Section A: General Information

1. Age group of the respondent:
   ☐ 18–25
   ☐ 26–35
   ☐ 36–45
   ☐ 46+
2. Motorcycle brand:
   ☐ Yamaha
   ☐ Honda
   ☐ Bajaj

☐ TVS

☐ Suzuki

3. Engine capacity of the motorcycle:

☐ 100–110 cc

☐ 125 cc

☐ 150 cc

☐ 160+ cc

4. How many kilometers running?

☐ 0-10000 km.

☐ 11000-20000 km

☐ 21000-30000

☐ 40000 km +

Section B: Maintenance Practice

5. Service interval followed (km):

☐ 1000 km

☐ 2000 km

☐ 3000 km

☐ 4000 km or more

6. Type of engine oil used:

☐ Mineral

☐ Semi-synthetic

☐ Fully synthetic

Section C: Engine Performance and Problems

7. Have you experienced engine overheating?

   ☐ Yes

   ☐ No

8. Do you notice abnormal engine noise?

   ☐ Yes

   ☐ No

9. Average mileage obtained:

   ☐ 30–35 km/l

   ☐ 35–40 km/l

   ☐ 40–45 km/l

   ☐ Above 45 km/l

Section D: Engine Repair History

10. Has the engine ever been opened for repair?

    ☐ Yes

    ☐ No

11. Approximate annual maintenance cost (BDT):

    ☐ 1000–3000

    ☐ 3000–5000

    ☐ Above 5000

Section F: Engine Usage Pattern

12. On average, how many kilometers do you ride your motorcycle per day?

    ☐ 5–10 km ☐ 10–20 km ☐ 20–40 km ☐ More than 40 km

13. Under which condition do you mostly operate your motorcycle?

    ☐ City traffic ☐ Highway ☐ Rural/rough roads ☐ Mixed conditions

14. Do you frequently ride the motorcycle with heavy load (pillion or goods)?

    ☐ Regularly ☐ Occasionally ☐ Rarely ☐ Never

Section G: Maintenance Awareness

15. Do you follow the service schedule recommended in the manufacturer's manual?

    ☐ Always ☐ Sometimes ☐ Rarely ☐ Never
16. According to your knowledge, when should engine oil be changed?

    ☐ Every 1000 km ☐ Every 2000 km ☐ Every 3000 km ☐ Not sure
17. Are you aware that delayed servicing can cause engine damage?

    ☐ Yes ☐ No ☐ Partially

Section H: Engine Problems and Symptoms

18. Have you ever experienced any of the following engine problems?

    ☐ Engine knocking ☐ Excessive noise ☐ Power loss ☐ High fuel consumption ☐ None
19. Does engine performance reduce when the engine becomes overheated?

    ☐ Yes ☐ No ☐ Not noticed
20. What action do you usually take when an engine problem occurs?

    ☐ Immediate servicing

    ☐ Continue riding for some time

    ☐ Try to fix by myself

    ☐ Consult a mechanic

Appendix A.3: Summary of Survey Respondents

- Total respondents: **50**
- Motorcycle engine range: **100–160 cc**
- Data collection method: Structured questionnaire
- Survey location: Local workshops and riding areas