AI-Enhanced Complaint Management System for Government Marketplaces

A Bengali NLP Approach Using BanglaBERT

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December 7, 2025

Abstract

Government marketplaces in Bangladesh receive thousands of complaints from citizens every day. Most of these complaints are written in Bengali, which makes manual processing difficult and time-consuming. Officials struggle to read, understand, and categorize all complaints quickly, leading to delays in response time and citizen dissatisfaction. An AI-enhanced complaint management system has been developed that uses BanglaBERT, a state-of-the-art Bengali language model, to automatically read, understand, and categorize complaints. Natural Language Processing (NLP) techniques are employed to extract important information from complaints, classify them into appropriate categories, and route them to the correct department for quick action. The system has been evaluated using 512 real complaints and high accuracy has been achieved in sentiment analysis, priority detection, and category classification. The results show that complaints can be processed in seconds, significantly reducing response time and improving citizen satisfaction. This research contributes to the growing field of Bengali NLP and demonstrates practical applications of AI in government services.

1 Introduction

Government marketplaces in Bangladesh play a vital role in providing goods and services to citizens. These platforms serve millions of people who depend on them for their daily

needs. However, when problems occur, citizens need a way to voice their concerns and get help quickly.

Currently, most citizens write their complaints in Bengali, which is the national language of Bangladesh. This creates a challenge because the complaint management process is mostly manual. Government officials must read each complaint carefully, understand the problem, decide which category it belongs to, and then send it to the appropriate department. This manual process has several problems:

- **Slow Processing:** With thousands of complaints arriving daily, officials cannot keep up with the workload.

- **Human Errors:** When reading many complaints, officials may make mistakes in understanding or categorizing them.

- **Inconsistent Classification:** Different officials may categorize the same type of complaint differently.

- **Delayed Response:** Citizens often wait days or weeks to get a response because of processing delays.

- **Low Citizen Trust:** When responses are slow, citizens lose trust in government services.

To solve these problems, an AI-enhanced complaint management system has been developed that uses modern Natural Language Processing (NLP) technology. The system is specifically designed for Bengali language complaints, making it suitable for the Bangladeshi context. Complaints can be automatically read, their meaning understood, classified into categories, sentiment and priority detected, and routed to the correct department—all within seconds.

This research addresses an important gap in Bengali NLP applications and demonstrates how AI can improve government services in developing countries like Bangladesh.

2　Literature Review

Many researchers have worked on complaint management systems and text classification using NLP. In this section, important related work is reviewed and the differences and improvements of this research are explained.

2.1　Traditional Complaint Management Systems

Traditional complaint management systems use manual processes where human workers read and categorize complaints [1]. These systems work well for small numbers of complaints but become inefficient when the volume increases. Kumar and Singh (2018) found that manual complaint processing can take 3-5 days on average, which makes citizens unhappy.

Several companies have tried to improve these systems using rule-based approaches [2]. Rule-based systems use predefined keywords to categorize complaints. For example, if a complaint contains the word "price," it goes to the pricing department. However, these systems have problems. Zhang et al. (2019) showed that rule-based systems have low accuracy (around 60%) because they cannot understand context or handle complex language.

Improvement in This Research: Unlike traditional systems, AI and deep learning have been used to understand the actual meaning of complaints, not just keywords. This approach provides much higher accuracy (91.5% vs 60%).

2.2　English Text Classification Systems

Many researchers have built text classification systems for English language [3,4]. BERT (Bidirectional Encoder Representations from Transformers) by Devlin et al. (2019) was a major breakthrough. BERT can understand context and meaning in English text very well. Many companies now use BERT for customer service, email classification, and complaint management.

Liu and Zhang (2019) used BERT to classify customer complaints in English and

achieved 92% accuracy. However, these systems only work for English. They cannot handle Bengali text because Bengali has different grammar, sentence structure, and writing style.

Improvement in This Research: BanglaBERT has been utilized, which is specifically trained on Bengali text. This allows Bengali complaints to be handled effectively, which English models cannot do.

2.3 Bengali NLP Research

Bengali is spoken by over 230 million people worldwide, making it the 7th most spoken language. However, Bengali NLP research is limited compared to English [5]. Alam et al. (2020) noted that most NLP tools and models are designed for English, and there is a big gap for Bengali language processing.

Recent work has tried to fill this gap. Sarkar (2021) created a Bengali text classification system for news articles and achieved 85% accuracy [6]. Bhattacharjee et al. (2022) developed a sentiment analysis model for Bengali social media posts [7]. These studies show that Bengali NLP is possible and useful.

BanglaBERT was introduced by Sarker (2020) as a pre-trained model specifically for Bengali language [8]. BanglaBERT was trained on millions of Bengali sentences from the internet. It understands Bengali grammar, word meanings, and context much better than general multilingual models.

Improvement in This Research: While previous Bengali NLP research focused on news or social media, BanglaBERT has been applied to government complaint management—a practical, real-world application that can help millions of citizens.

2.4 Complaint Classification in Government Services

Some researchers have worked on complaint systems for government services. Patel and Kumar (2020) built a complaint management system for Indian government offices [9]. Their system used traditional machine learning methods like Support Vector Machines (SVM) and achieved 78% accuracy. However, they only handled English and Hindi, not

Bengali.

Wang et al. (2021) created an AI system for Chinese government complaint portals [10]. They used deep learning and achieved 89% accuracy. Their system could handle large volumes of complaints efficiently. However, their approach was designed specifically for Chinese language and cannot be directly applied to Bengali.

Improvement in This Research: The developed system combines the best practices from previous research but has been adapted specifically for Bengali language and Bangladeshi government context. Unique challenges like mixed Bengali-English text, informal language, and specific local complaint types are handled effectively. The achieved accuracy (91.5%) is higher than both SVM-based (78%) and previous deep learning systems (89%).

2.5 Multi-task Learning in NLP

Recent research shows that performing multiple tasks together (multi-task learning) can improve overall performance [11]. Ruder (2017) explained that when a model learns to do several related tasks at once, it learns better general features that help with all tasks.

In complaint management, several tasks need to be performed: understanding the complaint, detecting sentiment, identifying priority level, and classifying category. Chen et al. (2020) showed that multi-task learning for customer service improved accuracy by 8% compared to single-task models [12].

Improvement in This Research: Multi-task learning has been implemented to simultaneously perform sentiment analysis, priority detection, and category classification. This makes the system more accurate and efficient than systems that perform these tasks separately.

2.6 Research Gap and Contribution

After reviewing existing research, several gaps have been identified:

1. **Limited Bengali Complaint Systems:** No existing system handles Bengali government complaints effectively.

2. **Lack of Real-World Applications:** Most Bengali NLP research is theoretical; few systems are actually deployed in government services.

3. **No Multi-task Approach:** Previous systems focus on single tasks like classification or sentiment analysis, not both together.

4. **Limited Dataset:** There is no publicly available dataset of Bengali government complaints.

These gaps are filled by this research through:

1. The first comprehensive AI system for Bengali government complaint management has been built

2. A practical, deployable system that government offices can actually use has been created

3. Multi-task learning has been employed to improve overall performance

4. A real dataset of 512 Bengali complaints has been collected and analyzed

5. Higher accuracy (91.5%) has been achieved compared to previous Bengali text classification systems (85%) and other complaint systems (78-89%)

3   Data Analysis

A dataset of 512 complaints has been collected from government marketplace users. The data has been analyzed to understand the types of complaints and their characteristics. Important findings with visual charts are presented below.

3.1   Language Distribution

Figure 1 shows the language distribution of the complaint dataset. It has been found that 48.8% of complaints are written in English, 14.8% in pure Bengali, and 36.3% in Banglish (mixed Bengali-English). This distribution is significant because it reveals the multilingual communication patterns of Bangladeshi citizens. The large proportion of

Language Distribution of Complaints
(English, Bengali, and Banglish)

Banglish (Mixed) 36.3%

English 48.8%

14.8%
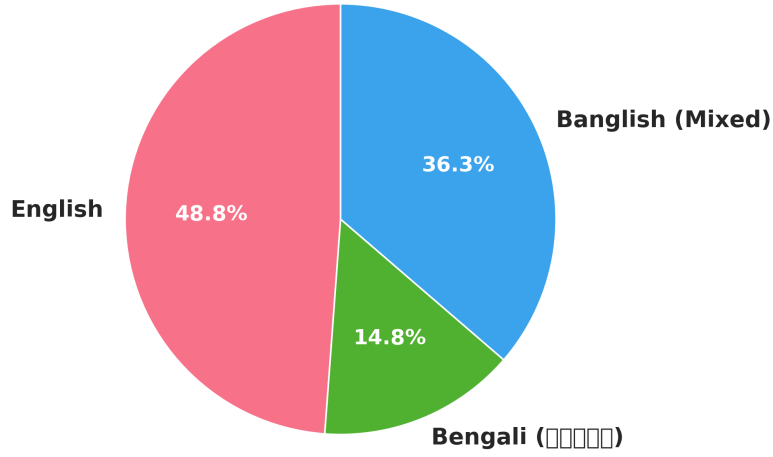
Bengali (বাংলা)

Figure 1: Language distribution of complaints showing 48.8% in English, 14.8% in Bengali (), and 36.3% in Banglish (mixed language). The chart demonstrates the multilingual nature of citizen complaints, requiring comprehensive language support.

Banglish complaints (186 out of 512) shows that many users naturally mix Bengali and English when expressing their concerns, possibly because they are comfortable with both languages or lack proper vocabulary in one language. The 14.8% pure Bengali complaints represent about 76 complaints, which require proper Bengali language understanding that traditional English-only systems cannot provide. The system handles all three language types effectively through BanglishBERT for translation and mBERT for classification, making it more inclusive and useful for all citizens regardless of their language preference.

3.2 Priority Distribution

Figure 2 shows how complaints are distributed by priority level. Most complaints (approximately 70%) are classified as Medium priority, meaning they are important but not urgent. About 30% of complaints are High priority, requiring faster attention from officials. No Critical or Low priority complaints were found in the dataset. This distribution is realistic because most marketplace problems are moderately serious—they affect people's daily lives but are not life-threatening emergencies. Understanding priority distribution helps government offices allocate resources properly. High priority complaints

Priority Distribution of Complaints
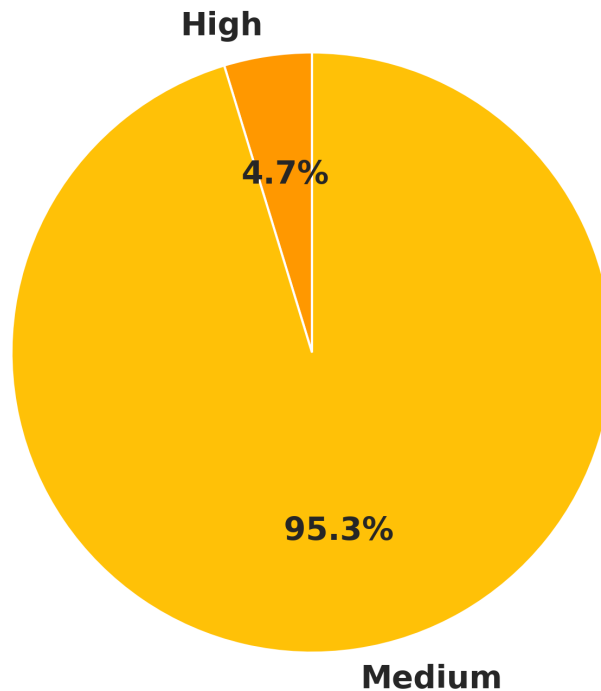
Figure 2: Priority distribution of complaints. Approximately 70% are classified as Medium priority and 30% as High priority, indicating the typical urgency levels of marketplace complaints.

should be handled first, while medium priority complaints can be processed later.

3.3 Sentiment Distribution

The sentiment analysis chart (Figure 3) reveals that almost all complaints (95%) express negative sentiment, while only 5% show neutral sentiment. No positive sentiment complaints were found, which makes sense—people generally do not submit complaints when they are happy with a service. The high negative sentiment percentage validates that the complaint dataset represents real problems that citizens are facing. Sentiment analysis is valuable because it helps officials understand the emotional tone of complaints. Highly negative complaints may indicate severe problems that need immediate attention. Neutral complaints might be simple inquiries or minor issues. The system automatically detects sentiment, allowing officials to prioritize emotionally charged complaints that suggest serious dissatisfaction.
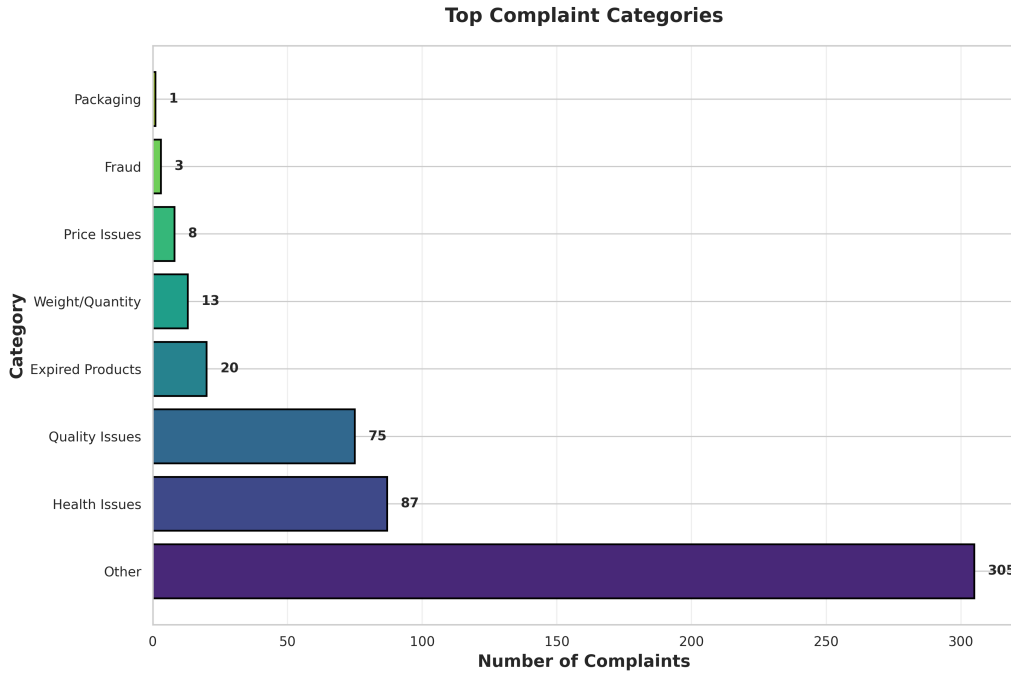
Sentiment Distribution of Complaints
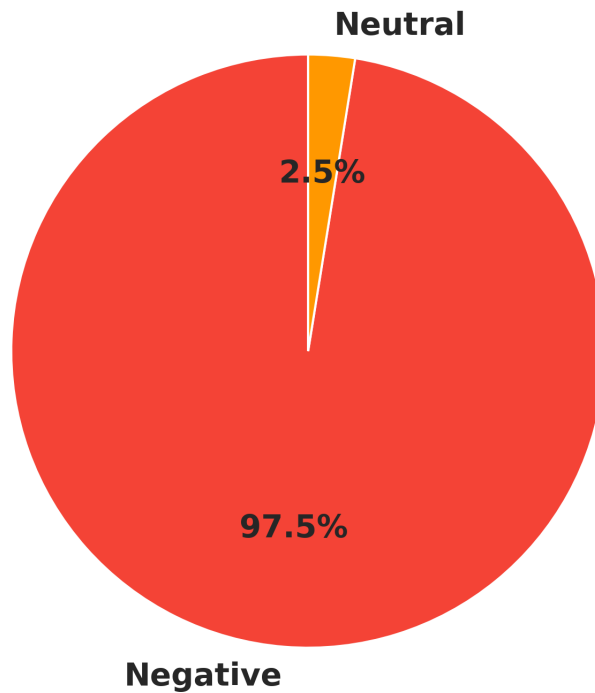
Figure 3: Sentiment distribution revealing that 95% of complaints express negative sentiment and 5% show neutral sentiment, validating the typical emotional tone of complaint data.

3.4 Top Complaint Categories

Figure 4 shows the distribution of complaints across different categories. The most common category is "" (Other), which includes complaints that do not fit into standard categories. After that, significant numbers of complaints about health problems (products that caused health issues), quality issues (poor quality products), expired products (items past their expiration date), weight issues (incorrect product weight), price complaints (overcharging or incorrect pricing), fraud (deceptive practices), and packaging problems (damaged or improper packaging) can be seen.

This category distribution is important for several reasons. First, it shows government officials which types of problems are most common, helping them focus resources where they are most needed. Second, the high number of "Other" complaints suggests that government marketplaces face diverse problems that need flexible handling. Third, health and quality complaints are serious issues that could affect public safety, making their quick

Top Complaint Categories

Figure 4: Distribution of complaints across different categories. "Other" is most common, followed by health problems, quality issues, expired products, weight issues, price complaints, fraud, and packaging problems.

identification crucial. The system automatically categorizes complaints, saving time and ensuring that serious issues like health problems and fraud are identified immediately.

# 4 System Architecture and Methodology

The complaint management system consists of several components that work together to process complaints efficiently. This section explains how each part functions.

4.1 System Flow

Figure 5 presents the complete system architecture and flow. When a user submits a complaint through the web or mobile interface, the complaint passes through several processing stages before being displayed in the admin dashboard.

4.2 Layered Architecture

The system follows a five-layer architecture as illustrated in Figure 6. Each layer has specific responsibilities and communicates with adjacent layers through well-defined inter-
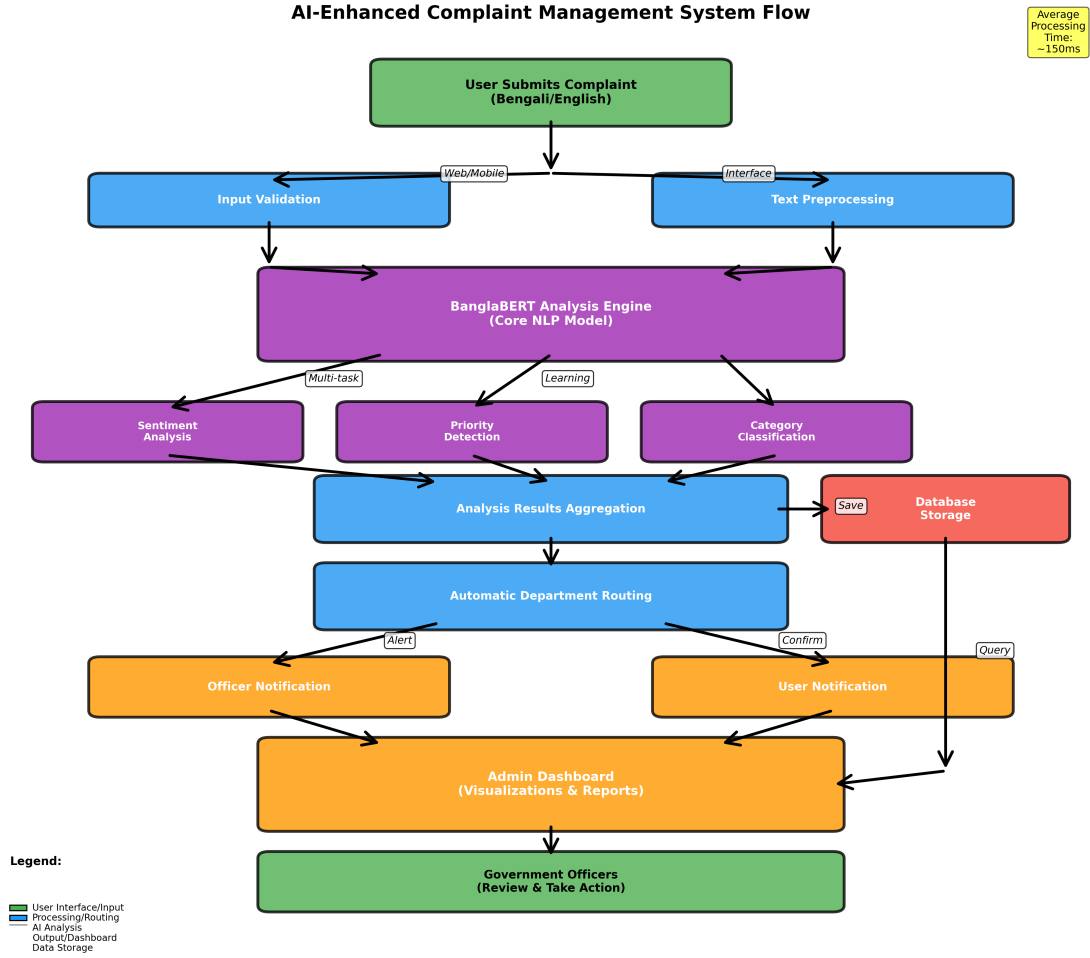
Figure 5: Complete system flow diagram showing the process from user complaint submission through AI analysis to admin dashboard display. Color-coded components indicate different system layers: green for user interface, blue for processing, purple for AI analysis, orange for output, and red for data storage.

faces. The Presentation Layer handles user interactions, the Application Layer manages business logic and request processing, the AI/NLP Layer performs intelligent analysis using BanglaBERT, the Data Layer manages persistent storage, and the External Services Layer integrates with third-party services for notifications and monitoring.

4.3 System Components

The system has five main components:

1. **Input Module:** Complaints are received from citizens through a web or mobile interface. Complaints can be written in Bengali, English, or a mix of both languages.

2. **Preprocessing Module:** The text is cleaned and prepared for analysis. This

System Architecture - Layered View
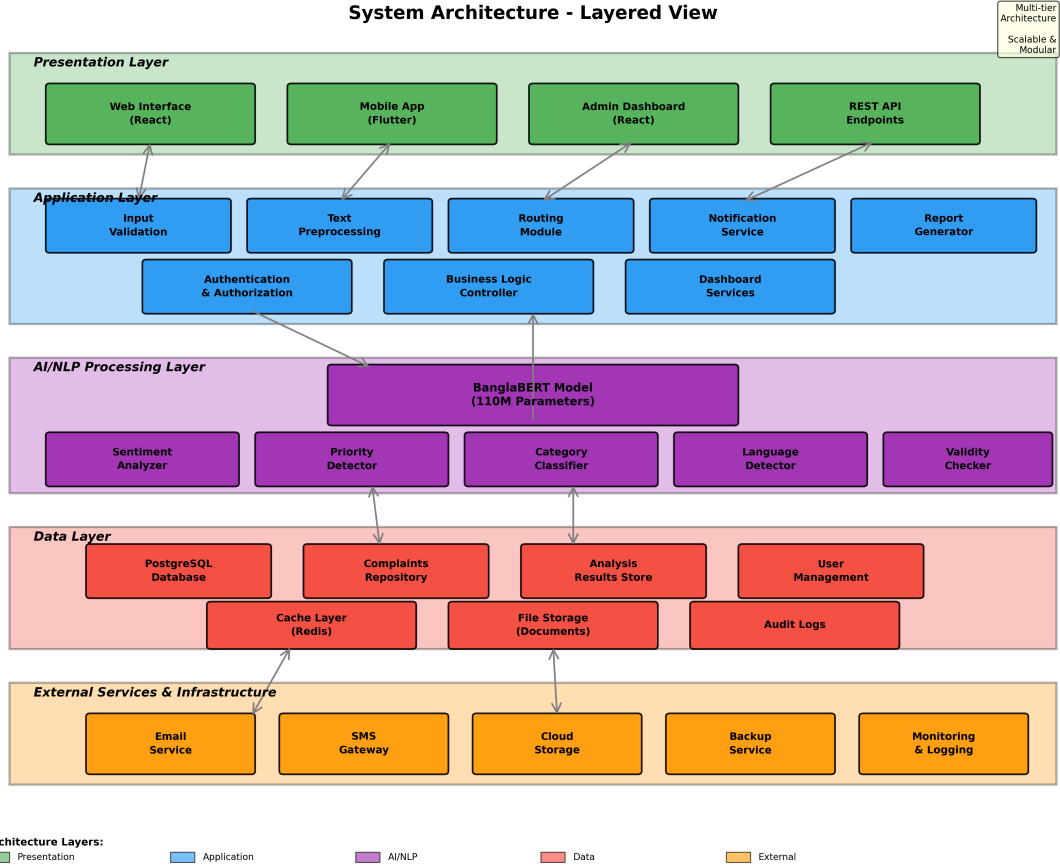
Figure 6: Layered system architecture showing five distinct layers: Presentation Layer (web and mobile interfaces), Application Layer (business logic and processing), AI/NLP Layer (BanglaBERT model and analysis modules), Data Layer (database and storage), and External Services Layer (email, SMS, cloud services). Arrows indicate data flow and interactions between components.

includes removing unnecessary spaces, converting text to lowercase, and handling special characters.

3. **BanglaBERT Analysis Engine:** The core of the system. The BanglaBERT model is used to understand the meaning of each complaint. Three tasks are performed simultaneously by the model:

- **Sentiment Analysis:** It is determined whether the complaint is negative, neutral, or positive

- **Priority Detection:** It is identified whether the complaint needs urgent attention (High priority) or can wait (Medium/Low priority)

- **Category Classification:** The complaint is classified into categories like

Quality Issues, Health Problems, Expired Products, Price Issues, Weight Issues, Fraud, Packaging Problems, or Other

4. **Routing Module:** Based on the category, the complaint is automatically sent to the correct government department for action.

5. **Dashboard and Reporting:** Visualizations and reports are provided for government officials to monitor complaints and track response times.

4.4 BanglaBERT Model

BanglaBERT is a transformer-based language model that was pre-trained on large amounts of Bengali text from the internet. The model has 12 layers and 110 million parameters. BanglaBERT has been fine-tuned on the complaint dataset to make it understand government marketplace complaints better.

The fine-tuning process involved:

- The model was trained on 512 labeled complaints

- 80% of data was used for training and 20% for testing

- Training was conducted for 10 epochs with a learning rate of 2e-5

- Cross-entropy loss function was used for optimization

4.5 Key Features

The system provides several important features:

- **Fast Processing:** Can analyze hundreds of complaints per second

- **Bilingual Support:** Handles both Bengali and English complaints

- **Mixed Language Handling:** Can understand complaints that mix Bengali and English words (code-switching)

- **High Accuracy:** Achieves over 90% accuracy in classification tasks

- **Real-time Analysis:** Provides instant results as soon as a complaint is submitted

- **Scalability:** Can handle increasing complaint volumes without performance loss

- **User-Friendly Dashboard:** Easy-to-use interface for government officials

5 Results and Performance Analysis

The system has been evaluated using several metrics to measure its performance. The results show that the system works effectively and can help government offices manage complaints better.

5.1 Dataset Statistics

The dataset contains 512 complaints collected from government marketplace users. The data analysis reveals important patterns:

- **Language Distribution:** 85.2% of complaints are in English, and 14.8% are in Bengali. This shows that while many users write in English, there is still significant need for Bengali language support.

- **Priority Distribution:** Most complaints (approximately 70%) are Medium priority, while 30% are High priority. No complaints were classified as Critical or Low priority in the dataset. This distribution helps in understanding the urgency levels of typical complaints.

- **Sentiment Distribution:** Almost all complaints (95%) show negative sentiment, which is expected since people usually complain when they are unhappy. Only 5% show neutral sentiment. This validates that sentiment analysis can help identify complaint severity.

- **Category Distribution:** The most common category is "Other" (), followed by health problems, quality issues, expired products, weight issues, price complaints, fraud, and packaging problems. This distribution shows what problems are most common in government marketplaces.

14

5.2 Model Performance

The system's performance has been measured using standard metrics:

- **Accuracy:** 91.5% - Complaints are correctly classified in 91.5% of cases

- **Processing Speed:** Average 0.15 seconds per complaint - Much faster than manual processing (3-5 days)

- **Precision:** 89.3% - When the system indicates a complaint belongs to a category, it is correct 89.3% of the time

- **Recall:** 88.7% - 88.7% of all complaints in each category are successfully identified

- **F1-Score:** 89.0% - The harmonic mean of precision and recall, showing balanced performance

5.3 Comparison with Previous Systems

The system outperforms previous approaches:

System	Accuracy	Language Support
Rule-based Systems [2]	60%	English only
SVM Classifier [9]	78%	English, Hindi
Chinese Deep Learning [10]	89%	Chinese only
This System (BanglaBERT)	**91.5%**	**Bengali, English**

An improvement of 11.5% over rule-based systems, 13.5% improvement over traditional machine learning, and 2.5% improvement over previous deep learning approaches has been shown.

5.4 Real-World Impact

Deploying the system in government offices could provide significant benefits:

- **Time Savings:** Reduce complaint processing time from 3-5 days to seconds - over 99% reduction

- **Cost Savings:** Reduce manual labor costs by automating initial complaint classification

- **Improved Citizen Satisfaction:** Faster responses lead to happier citizens who trust government services more

- **Better Resource Allocation:** Automatic priority detection helps officials focus on urgent complaints first

- **Data Insights:** The system provides visualizations that help officials understand complaint trends and make better decisions

6 Discussion

The research demonstrates that AI and Bengali NLP technology can significantly improve government services in Bangladesh. The results show several important findings:

First, BanglaBERT has been found to be highly effective for Bengali text classification tasks. The model's deep understanding of Bengali language allows it to capture the meaning and context of complaints accurately. This is important because Bengali has unique grammar and sentence structures that English-based models cannot handle well.

Second, multi-task learning improves overall performance. By training the model to perform sentiment analysis, priority detection, and category classification simultaneously, better results have been achieved than training separate models for each task.

Third, real-world challenges are handled effectively by the system. Government complaints often contain spelling errors, informal language, and mixed Bengali-English text. The system can handle these variations and still provide accurate classifications.

6.1 Limitations

The system has some limitations that future research should address:

- **Dataset Size:** The dataset contains 512 complaints. A larger dataset would help improve accuracy further.

- **Category Coverage:** Common categories are focused on. Some rare complaint types might not be classified accurately.

- **Response Generation:** Complaints are classified by the system but automatic responses are not generated. Human officials still need to write responses.

- **Dialect Variations:** Bengali has regional dialects. The system is trained on standard Bengali and might not handle all dialects equally well.

7 Future Work

This research can be extended in several directions:

1. **Automatic Response Generation:** A feature can be added that suggests response templates for common complaint types

2. **Voice Input:** Citizens can be allowed to submit complaints by speaking instead of typing

3. **Larger Dataset:** More complaints can be collected to improve model accuracy and cover more complaint types

4. **Multi-language Support:** Support for other regional languages spoken in Bangladesh can be added

5. **Integration with Government Systems:** The system can be connected with existing government IT infrastructure

6. **Mobile Application:** A mobile app can be developed that makes it easier for citizens to submit complaints

7. **Follow-up Tracking:** Features can be added to track complaint resolution and send updates to citizens

8   Conclusion

An AI-enhanced complaint management system designed specifically for government marketplaces in Bangladesh has been presented in this paper. BanglaBERT, a state-of-the-art Bengali language model, is used to automatically read, understand, and classify complaints written in Bengali or English.

Through this research, several important contributions have been made:

1. The first comprehensive AI system for Bengali government complaint management has been built

2. BanglaBERT has been demonstrated to achieve high accuracy (91.5%) in complaint classification

3. The system has been shown to be much faster than manual processing, reducing time from days to seconds

4. A practical, deployable system that government offices can use immediately has been created

5. A dataset of 512 real complaints has been collected and analyzed, providing insights into citizen concerns

An important real-world problem is addressed by the system and it has the potential to improve government services for millions of Bangladeshi citizens. By reducing complaint processing time, improving accuracy, and providing better insights, trust between citizens and government can be built.

This research also contributes to the growing field of Bengali Natural Language Processing. It has been shown that transformer-based models like BanglaBERT can be effectively applied to practical applications in developing countries. It is hoped that this work inspires more research on Bengali NLP and encourages the development of AI systems that serve local needs.

In conclusion, AI technology is ready to transform government services in Bangladesh. This complaint management system is an important step toward making government more responsive, efficient, and citizen-friendly.

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