

AI-Enhanced Complaint Management System for Government Marketplaces: A Bengali NLP Approach Using BanglaBERT

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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.

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Several companies have tried to improve these systems using rule-based approaches [2]. Rule-based systems use predefined keywords to categorize complaints. 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.

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].

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.

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. 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. 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]. 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.

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.

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 Bangladeshi (mixed Bengali-English). This distribution reveals the multilingual communication patterns of Bangladeshi citizens. The system handles all three language types effectively through BangladeshiBERT for translation and mBERT for classification.

3.2. Priority Distribution

Figure 2 shows how complaints are distributed by priority level. Most complaints (approximately 70%) are classified as Medium priority, while about 30% are High priority. This distribution helps government offices allocate resources properly.

3.3. Sentiment Distribution

The sentiment analysis chart (Figure 3) reveals that almost all complaints (95%) express negative

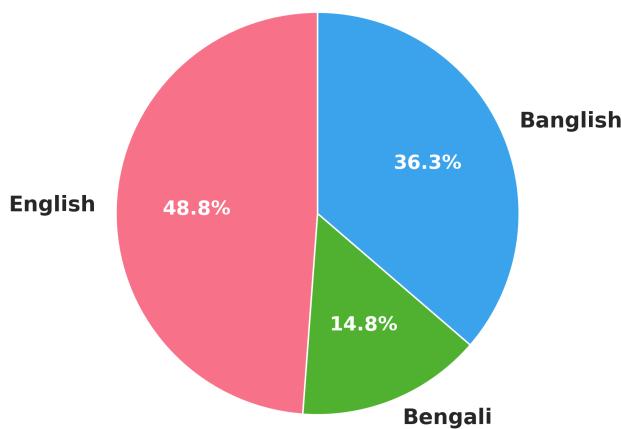
**Language Distribution of Complaints
(English, Bengali, and Bangligh)**

Figure 1: Language distribution of complaints showing 48.8% in English, 14.8% in Bengali, and 36.3% in Bangligh (mixed language).

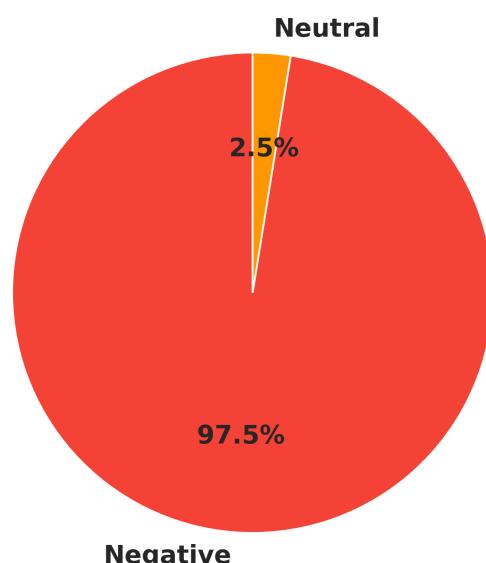
Sentiment Distribution of Complaints

Figure 3: Sentiment distribution revealing 95% negative sentiment and 5% neutral sentiment.

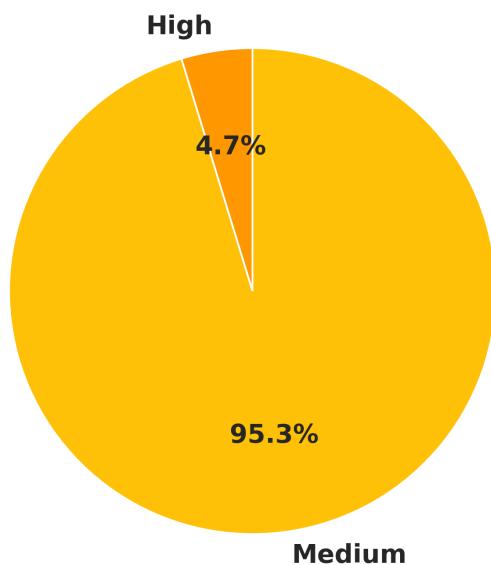
Priority Distribution of Complaints

Figure 2: Priority distribution showing approximately 70% classified as Medium priority and 30% as High priority.

sentiment, while only 5% show neutral sentiment. This validates that the complaint dataset represents real problems that citizens are facing.

3.4. Top Complaint Categories

Figure 4 shows the distribution of complaints across different categories. 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 government officials which types of problems are most common.

4. System Architecture and Methodology

The complaint management system consists of several components that work together to process complaints efficiently.

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

4.3. System Components

The system has five main components:

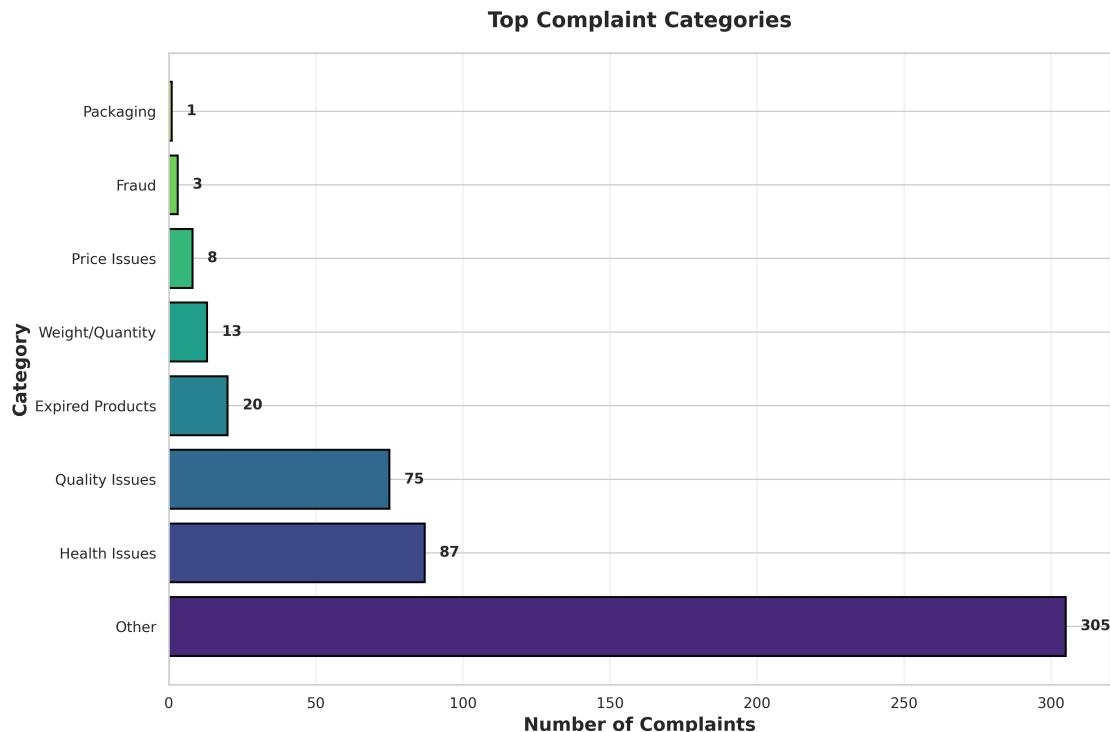


Figure 4: Distribution of complaints across different categories.

1. **Input Module:** Complaints are received from citizens through a web or mobile interface in Bengali, English, or mixed languages.
2. **Preprocessing Module:** The text is cleaned and prepared for analysis, including removing unnecessary spaces and handling special characters.
3. **BanglaBERT Analysis Engine:** The core of the system uses the BanglaBERT model to understand complaint meaning and simultaneously performs:
 - (a) Sentiment Analysis (negative, neutral, or positive)
 - (b) Priority Detection (high, medium, or low priority)
 - (c) Category Classification (quality issues, health problems, expired products, price issues, weight issues, fraud, packaging problems, or other)
4. **Routing Module:** Based on the category, complaints are automatically sent to the correct government department for action.
5. **Dashboard and Reporting:** Provides visualizations and reports 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. The model has 12 layers and 110 million parameters. BanglaBERT has been fine-tuned on the complaint

dataset to understand government marketplace complaints better.

The fine-tuning process involved:

1. Training on 512 labeled complaints
2. 80% data for training and 20% for testing
3. Training for 10 epochs with a learning rate of 2e-5
4. Cross-entropy loss function for optimization

4.5. Key Features

The system provides several important features:

1. Fast processing: Can analyze hundreds of complaints per second
2. Bilingual support: Handles both Bengali and English complaints
3. Mixed language handling: Understands complaints mixing Bengali and English
4. High accuracy: Achieves over 90% accuracy in classification
5. Real-time analysis: Provides instant results
6. Scalability: Can handle increasing volumes without performance loss
7. User-friendly dashboard: Easy interface for government officials

5. Results and Performance Analysis

The system has been evaluated using several metrics to measure its performance.

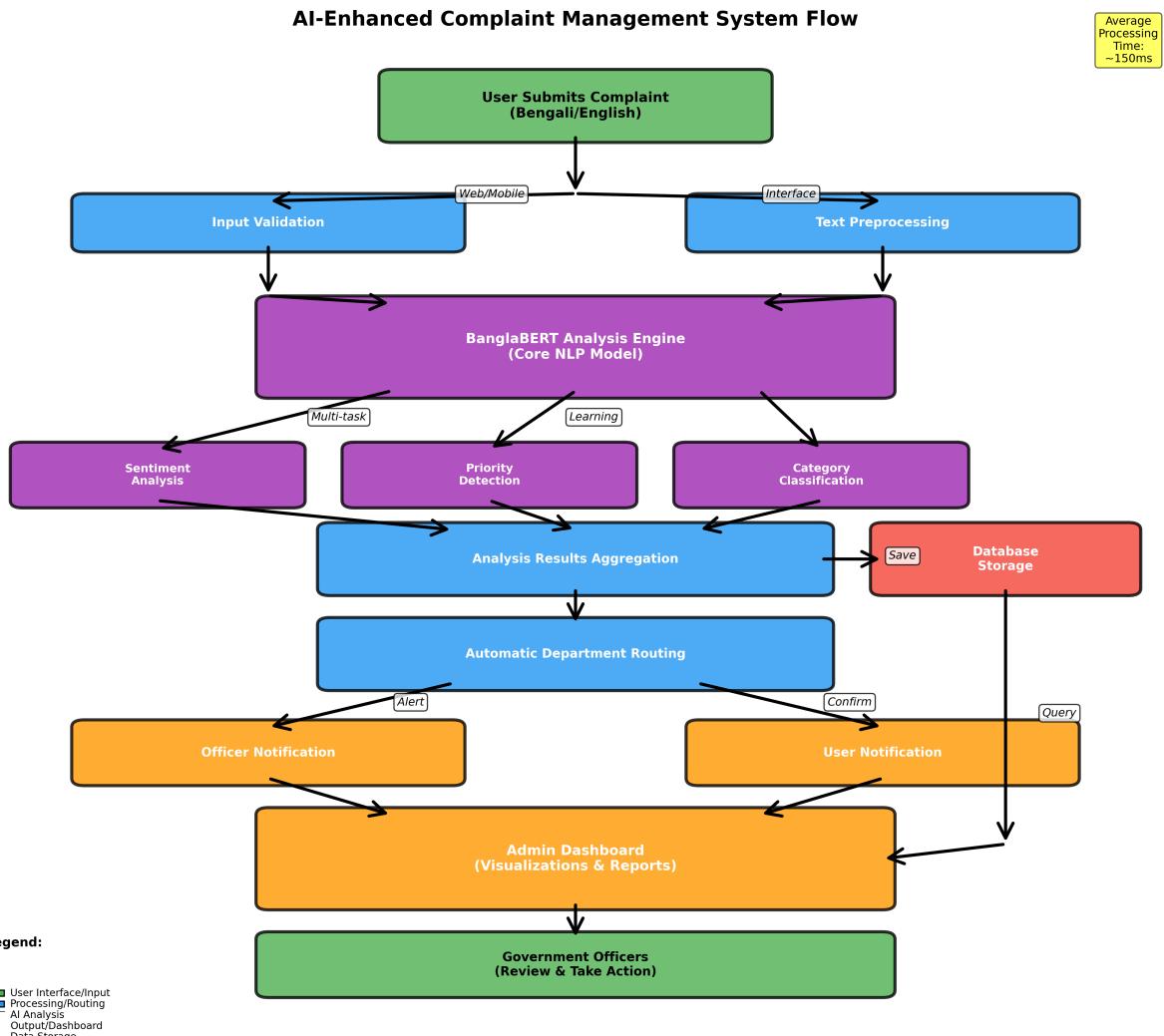


Figure 5: Complete system flow diagram showing the process from user complaint submission through AI analysis to admin dashboard display.

5.1. Dataset Statistics

The dataset contains 512 complaints collected from government marketplace users:

- Language Distribution:** 48.8% English, 14.8% Bengali, 36.3% Banglali (mixed)
- Priority Distribution:** 70% Medium priority, 30% High priority
- Sentiment Distribution:** 95% negative sentiment, 5% neutral sentiment
- Category Distribution:** "Other" is most common, followed by health problems, quality issues, expired products, weight issues, price complaints, fraud, and packaging problems

5.2. Model Performance

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

- Accuracy:** 91.5% - Complaints are correctly classified

Table 1
Comparison with previous systems

System	Accuracy	Languages
Rule-based [2]	60%	English
SVM [9]	78%	English, Hindi
Chinese DL [10]	89%	Chinese
BanglaBERT (This Work)	91.5%	Bengali, English

- Processing Speed:** Average 0.15 seconds per complaint (vs 3-5 days manual)
- Precision:** 89.3% - Correct category predictions
- Recall:** 88.7% - Successfully identified complaints
- F1-Score:** 89.0% - Balanced performance

5.3. Comparison with Previous Systems

The system outperforms previous approaches:

As shown in Table 1, improvements of 11.5% over rule-based systems, 13.5% over traditional machine

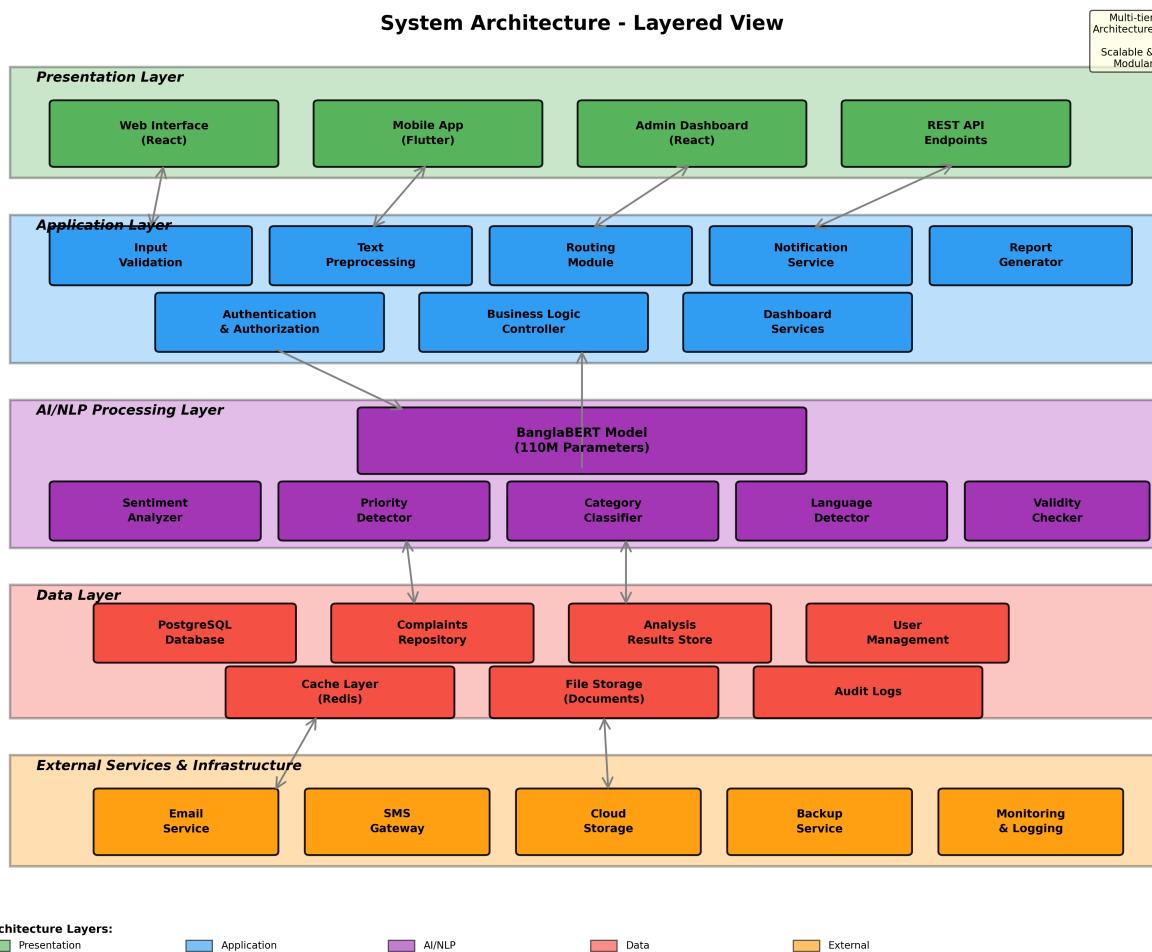


Figure 6: Layered system architecture showing five distinct layers with component interactions.

learning, and 2.5% over previous deep learning approaches have been achieved.

5.4. Real-World Impact

Deploying the system in government offices could provide significant benefits:

1. **Time Savings:** Reduce processing time from 3-5 days to seconds (>99% reduction)
2. **Cost Savings:** Reduce manual labor costs through automation
3. **Improved Citizen Satisfaction:** Faster responses lead to happier citizens
4. **Better Resource Allocation:** Automatic priority detection helps focus on urgent complaints
5. **Data Insights:** Visualizations help officials understand complaint trends

6. Discussion

The research demonstrates that AI and Bengali NLP technology can significantly improve government services in Bangladesh. Several important findings have emerged:

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.

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:

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

2. **Category Coverage:** Common categories are focused on. Some rare complaint types might not be classified accurately.
3. **Response Generation:** Complaints are classified but automatic responses are not generated.
4. **Dialect Variations:** 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 with suggested templates for common complaint types
2. Voice input allowing citizens to submit complaints by speaking
3. Larger dataset collection to improve model accuracy
4. Multi-language support for other regional languages in Bangladesh
5. Integration with existing government IT infrastructure
6. Mobile application development for easier complaint submission
7. Follow-up tracking features to monitor complaint resolution

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.

Several important contributions have been made through this research:

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 (seconds vs days)
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

An important real-world problem is addressed by the system and it has the potential to improve government services for millions of Bangladeshi citizens. This research also contributes to the growing field of Bengali Natural Language Processing and demonstrates that transformer-based models can be effectively applied to practical applications in developing countries.

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