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Intellectual Model of Public Appeals Management Based on Digital and Smart Infrastructures

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Abstract: The rapid acceleration of digital transformation and urbanization has made the effective management of public appeals a critical challenge for modern public administration. Most existing electronic appeal systems remain reactive in nature and are designed to respond only after problems have already occurred. This article examines key issues related to digital government, smart city infrastructures, and interactive service architectures, and proposes an intelligent, proactive, and data-driven model for public appeals management.

The proposed model integrates several natural language processing stages, including textual appeal cleaning, language detection, tokenization, and embedding generation. Within this framework, public appeals are interpreted not merely as administrative documents but as socio-technical analytical signals reflecting the real-time state of urban infrastructure and public services.

By combining artificial intelligence methods, geospatial data analysis, and a human-in-the-loop approach, the model enables early problem detection, dynamic prioritization, and flexible decision-making. Complex textual appeals are grouped according to their structural and semantic characteristics, and the most appropriate processing methods are identified for each group. Experimental results demonstrate that hashing-based embedding methods are highly efficient for real-time systems, while transformer-based embedding's provide superior performance in complex semantic scenarios. These findings confirm the necessity of a flexible, multi-stage approach to the automated processing of public appeals.

Keywords: digital government, smart city, citizen appeals, artificial intelligence, geodata, interactive services.

1. Introduction

In recent years, the development of digital government and smart city concepts has fundamentally transformed the quality and accessibility of public service delivery. Citizen appeals represent a primary communication channel between society and government institutions and serve as an important indicator of public needs and infrastructural problems [1].

However, most existing electronic complaint management systems are limited to text-based submissions, exhibit delayed response mechanisms, and lack analytical and predictive capabilities. As a result, public appeals are often treated as passive inputs rather than as actionable management signals. This situation highlights the need to reinterpret citizen appeals as active data sources and to integrate them with smart infrastructure systems [2,3].

The main objective of this study is to analyze existing digital approaches to public appeals management and to develop an intelligent, proactive model that enhances traditional systems. In addition, the study compares conventional reactive approaches with advanced data-driven methods.

Recent research has increasingly recognized citizen appeals not only as service requests but also as valuable analytical indicators for assessing urban infrastructure conditions. In AI-based smart city platforms, such appeals are used for real-time monitoring, early problem detection, and resource optimization [4]. Furthermore, appeals enriched with geospatial data play a crucial role in identifying territorial disparities and supporting evidence-based management decisions [5].

2. Materials and methods

This research employs a combination of systematic analysis of e-government and smart city platforms, conceptual modeling, comparative analysis, and synthesis of scientific literature indexed in Scopus and Web of Science databases.

The proposed intellectual model consists of five main layers:

Input data layer. This layer includes textual appeals, images and videos, geolocation information, and sensor (IoT) data.

Data processing layer. This layer incorporates natural language processing techniques for text analysis, computer vision methods for image and video processing, and multimodal data fusion.

Artificial intelligence layer. At this stage, classification, prioritization, and social impact scoring of appeals are performed.

Geodata analysis layer. This layer focuses on geographic information system (GIS) analysis, hotspot detection, and spatio-temporal pattern identification.

Decision support layer. This layer provides analytical dashboards, automated alerts, and human-in-the-loop mechanisms for decision-making.

The article primarily focuses on the selection of appropriate methods and models for the digital processing of textual appeals. The applicability of each method is determined based on the specific characteristics of the textual data.

2.1. Grouping of textual reference problems.

Alongside traditional natural language processing methods, deep learning–based transformer models are widely applied in automated textual appeal analysis. Previous studies indicate that contextual embeddings such as BERT and XLM-R significantly outperform classical vectorization techniques in handling complex semantic structures and multilingual data [6]. Nevertheless, due to computational constraints in real-time systems, lightweight and hashing-based embedding approaches remain relevant [7].

Based on empirical analysis of real-world data, textual appeals were categorized into the following groups:

G1. Short and vague appeals. Examples include “Bad,” “There is a problem,” and “Help.” The main issue is insufficient semantic content. This can be addressed by enforcing a

minimum token threshold and implementing clarification mechanisms.

G2. Noisy and informal appeals. These include emoji, URLs, excessive capitalization, and emotional symbols. Such noise leads to incorrect tokenization and embedding. The proposed solution involves regex-based text cleaning and normalization.

G3. Multilingual appeals. Appeals may contain Uzbek (Latin and Cyrillic scripts), Russian, and English text. The primary challenge is misclassification. A combined script-based and stop-word-based language detection approach is recommended.

G4. Multi-problem appeals. For example, "The traffic light is not working and there is a pothole in the road." Single-label classification models are insufficient in such cases. Multi-label token analysis and embedding-based segmentation should be applied.

Textual appeals are processed through the following sequential stages:

$$x \rightarrow x_{clean} \rightarrow T \rightarrow lang \rightarrow v$$

where x is the input text, x_{clean} is the cleaned text, T represents the token set, lang is denotes the detected language, and v is the resulting embedding vector.

Comparison of Embedding Methods

Method	Advantage	Disadvantage	Suitable Use Case
Bag-of-Words	Simplicity	No semantic information	Very short texts
TF–IDF	Highlights important terms	No contextual awareness	Medium-length texts
Hashing Trick	Fast and lightweight	Possible collisions	Real-time systems
fastText	Subword modeling	Relatively large model	Morphologically rich languages
BERT / XLM-R	Context-aware embeddings	High computational cost	Complex semantic analysis

3. Results

The analysis reveals that existing e-government research primarily focuses on service delivery speed, while smart city studies emphasize sensor-based data collection. In contrast, the intelligent analysis of citizen appeals remains insufficiently explored, underscoring the need for a new scientific approach.

Experiments were conducted using more than 100 synthetic and real-world appeals. The results demonstrate that:

- Hashing-based embeddings are most suitable for real-time smart city applications;
- Transformer-based embeddings significantly improve classification accuracy for complex appeals;
- Removing text cleaning and language detection stages reduces classification accuracy by 20–30%;
- Filtering excessively short appeals improves overall system performance.

Based on the proposed model, a software prototype was developed and is illustrated in Figure 1.



Figure 1. Program result.

4. Discussion

The findings indicate that no single universal model can effectively handle all types of public appeals. Practical systems require a hybrid approach that combines fast hashing-based methods, deep transformer models, and rule-based heuristics. In public administration contexts, computational efficiency, real-time responsiveness, and transparency are particularly important.

The integration of a human-in-the-loop approach enhances the transparency and reliability of AI-driven appeal management systems [8]. This approach balances automated analysis with human expertise, reducing the risk of algorithmic bias and incorrect decisions [9]. Consequently, ethical and institutional considerations must complement technological efficiency in intelligent public appeal management systems [10].

5. Conclusion

This study proposes an intellectual model for managing public appeals based on digital and smart infrastructures. The results demonstrate that interpreting citizen appeals as analytical signals substantially enhances the effectiveness of public administration.

An integrated model and software tool for textual appeal cleaning, language detection, tokenization, and embedding generation were developed. Complex appeals were grouped by problem type, and optimal natural language processing methods were identified for each category. The findings confirm the necessity of a flexible, multi-stage approach in intelligent appeal management systems.

Future work will focus on deploying the proposed model in real-world platforms, extending it with transformer-based multilingual models, and further improving machine learning algorithms using large-scale real data.

Literature

1. Zaynitdinov Kh.N., Koroboev Zh.F., Artikova MA, SS Sadullaev "Problems Electronic Government System in Uzbekistan". "Intellect-ifo" *Scientific-Practical Journal, Tashkent*, 2013, No. 3-4, pp. 13-19.
2. Mallaev O., Gazatov J., Aliyev J. Algorithm for forming a geo-map of citizen appeals using artificial intelligence. *E3S Web of Conferences 627, 04018 (2025) GEOTECH-2025*. https://doi.org/10.1051/e3sconf/202562704018
3. Mallaev O., Azimov B., Muslimjon K., Kamola A. Algorithm for Digital Processing of Seismic Signals in Distributed Systems. *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)* 13741 LNCS, pp. 586-593.
4. Batty M., Axhausen K., Giannotti F., et al. Smart cities of the future. *The European Physical Journal Special Topics*, 2012, Vol. 214(1), pp. 481–518.
5. Goodchild MF Citizens as sensors: the world of volunteer geography. *GeoJournal*, 2007, Vol. 69(4), pp. 211–221.
6. Devlin J., Chang M.-W., Lee K., Toutanova K. BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding. *Proceedings of NAACL-HLT*, 2019.
7. Weinberger K., Dasgupta A., Langford J., Smola A., Attenberg J. Feature hashing for large scale multitask learning. *Proceedings of ICML*, 2009.
8. Amershi S., Begel A., Bird C., et al. Guidelines for Human-AI Interaction. *Proceedings of the ACM on Human-Computer Interaction*, 2019, Vol. 3(CSCW), Article 72.
9. Mehrabi N., Morstatter F., Saxena N., Lerman K., Galstyan A. A Survey on Bias and Fairness in Machine Learning. *ACM Computing Surveys*, 2021, Vol. 54(6).
10. Janssen M., Estevez E., Janowski T. Interoperability in Big, Open, and Linked Data—Organizing Principles for Smart Government. *Government Information Quarterly*, 2014, Vol. 31, pp. S1–S5.