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An Intelligent NLP-Driven Framework for Automated Petition Analysis and Grievance Management

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Abstract

Effective grievance management is crucial to ensure transparency, accountability, and quick processing of citizen petitions. Conventional grievance management systems are built on the principles of manual process of categorization, forwarding and monitoring. Such a process may lead to time-consuming and inconsistent decisions and increase the burden on administration. In this paper, an AI-Powered Petition Analysis and Grievance Management System is proposed. The system will automate the overall processing cycle of the petition from its submission to the final decision making with the intelligent analysis of the text of the petition and automation of workflow. The framework involves petition submission, data validation, central management of the database, text preprocessing, TF-IDF feature extraction, grievance classification, prioritizing, duplicate petitions detection, automated forwarding to the responsible department, and status control in one system. The natural language processing techniques will be used to turn the unstructured petition information into structured administrative action thus facilitating grievances processing and decision making. Also, the proposed system will include duplicate petitions detection mechanism and prioritizing mechanism for better management of the resources and avoidance of unnecessary operations.

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Centralized dashboard will enable monitoring and management of grievances as well as communication between the user and the administration.

Keywords: Grievance Management, Petition Analysis, Natural Language Processing, TF-IDF, Automated Routing, Duplicate Detection, Decision Support Systems, E-Governance.

1. Introduction

In the current digital era, schools, business organizations, and other public service agencies receive enormous number of petitions, complaints, and grievances every day. Proper management of grievances is crucial to ensure transparency and accountability. The conventional grievance management system is based on manual operation; petitions have to be analyzed, categorized, and then routed manually. This approach takes too much time, is prone to errors, and is inefficient when there is a heavy load of grievances. Delay in grievance handling may affect citizen satisfaction.

With the fast developments in Artificial Intelligence (AI) and Natural Language Processing (NLP), there are new chances of automating the process of petitions. NLP tools allow computers to understand human language, process it, and make sense out of it, which makes them capable of handling unstructured petition information. Machine Learning algorithms provide the chance for computers to classify grievances, detect issues, sentiments, and urgency of complaints. The process is less time-consuming and more precise. In modern digital governance projects, citizens' interests are placed at the forefront, together with real-time communication between organizations and people. Intelligent management of grievances allows for efficient allocation of resources, quick decision-making, and better response time. Moreover, analysis through AI technology allows for identification of recurrent problems and monitoring of the service level of different departments.

The project presents an AI-Powered Petition Analysis and Grievance Management System that would automate the entire cycle of grievances processing. This system would use AI and Natural Language Processing algorithms to preprocess petitions' texts, categorize grievances, set their priority levels, find duplicates, and route them to the respective departments. Using Python, FastAPI, SQLAlchemy, and SQLite, the system would offer a scalable and efficient platform for grievances management. Moreover, through real-time tracking and administrative dashboards, it would allow both users and administrators to track

the status of the grievances easily. The key idea of developing the system lies in the desire to speed up and facilitate the process of grievances management and increase its efficiency and transparency. Thus, the main purpose of this system is to minimize the load on administration by means of intelligent automation.

2. Literature Review

The development of digital governance has created the necessity of intelligent systems capable of processing public grievances and petitions. NLP is crucial for information extraction from raw texts, which allows for automatic classification, sentiment analysis, and decision-making [1]. Recently developed chatbot technology with the help of artificial intelligence also showed how useful NLP can be in public services [2]. There has been a lot of development in the area of word embedding which allows representing texts more effectively due to understanding the semantic connections between the words and phrases [3].

Furthermore, the application of attention mechanisms has greatly contributed to the improvement of language understanding and classification of text [5], which became the basis for modern transformers that are currently used in document analysis and classification of grievances. Deep learning has allowed creating intelligent systems capable of finding complex patterns from huge data sets and making accurate classifications and predictions [6].

The emergence of smart city technologies has shown that there is an increasing need for effective citizen participation and management of public services [7]. There can be AI-based grievance management systems that could assist in establishing communication between the citizens and government agencies, making the process transparent. Machine learning and artificial intelligence can be used effectively in prediction and decision-making purposes, showing how these techniques help analyze complex data and increase efficiency [4], [8], [9]. This technique can also be employed in the process of grievance management.

AI technology has also been successful in addressing real-life problems via automation and analytics [10]. Consequently, incorporating NLP, deep learning, and AI in the development of a Petition Analysis and Grievance Management System will be able to automate complaints handling, increase accuracy, decrease administrative burden, and increase citizens' satisfaction. Generally, from the literature review above, it is evident that NLP, deep learning, transformers,

and AI-based decision support systems form a solid basis for the development of an efficient petition analysis and grievance management system.

3. Methodology

3.1 Proposed Framework

The proposed Intelligent Petitions Processing and Grievance Handling System uses an advanced processing architecture with multiple stages to automate the process of handling grievances. This architecture consists of the following components: petition acquisition, data management, natural language processing, classification of grievances, prioritization, detection of duplicate petitions, and automatic department assignment. The task of the system is to convert unstructured grievances of citizens into structured administrative actions.

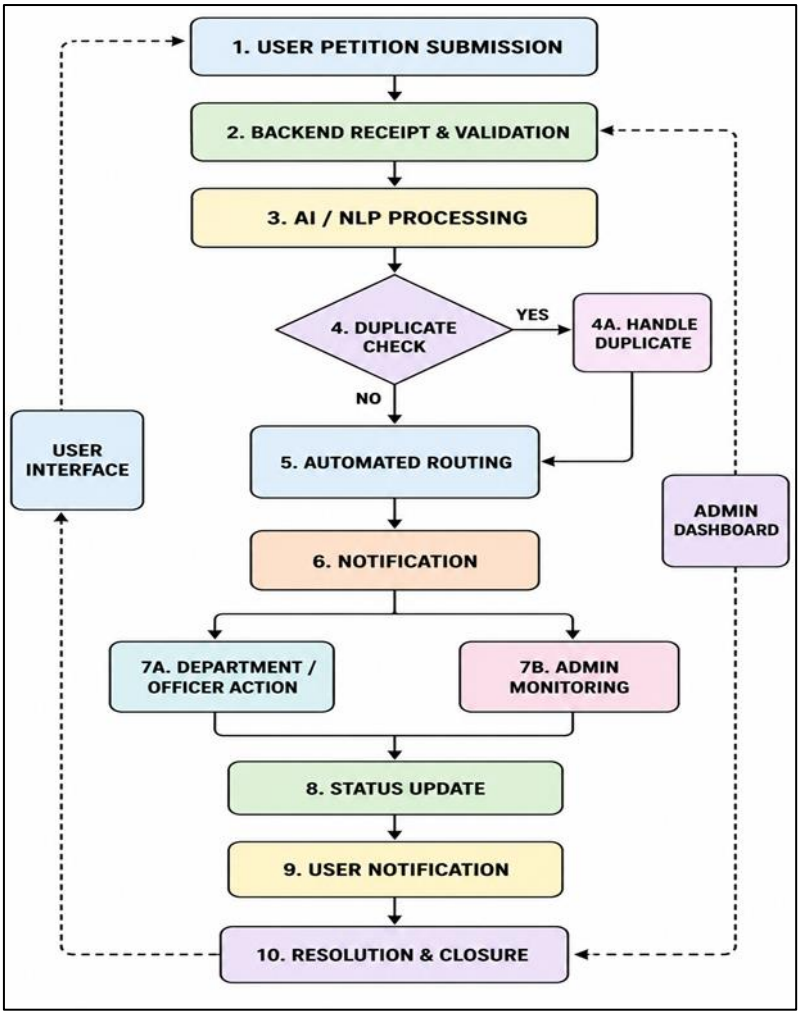

Figure 1. Proposed workflow of the AI-powered grievance management framework.

Figure 1 shows the entire process involved in the proposed framework. The system processes the petitions that are submitted to it, analyzes them using NLP techniques, determines the class/priority, and then directs the complaints to the right departments for processing and tracking.

3.2 Petition Submission and Data Collection

The grievances management process starts from the petitions being lodged using the website interface. The information about the complaint is provided along with additional context needed for the analysis of the data. Prior to saving the information into the database, input verification takes place to maintain data integrity.

Table 1. Petition information collected by the system.

Field	**Description**
Petition ID	Unique identifier for tracking
User Details	Name, contact information, and user credentials
Complaint Description	Detailed grievance text
Location Information	Area or region associated with the complaint
Supporting Documents	Images or files uploaded by users
Submission Timestamp	Date and time of petition submission
Status	Current grievance processing stage

Table 1 summarizes the information required for grievance processing, tracking, routing, and resolution management throughout the petition lifecycle.

3.3 Sample Petition Records and Database Structure

The success of the intelligent grievance management system depends largely on how well the recorded grievances are organized and accessible the grievances are recorded. The suggested intelligent grievance management system uses relational databases in which grievances are recorded in an organized way from start to finish. Every single grievance is recorded as an individual record with all the details of the complaint, including classification results and resolution.

Table 2. Sample petition records maintained by the proposed framework.

Timestamp	User ID	Petition Text	Category	Department	Urgency	Status
2025-04-20 09:15:32	user123	Street light not working on Main St.	Street Light Issue	Electricity	High	Assigned
2024-04-20 10:27:11	user456	Frequent water supply disruptions in our area.	Water Problem	Water	High	Assigned
2025-04-20 11:43:25	user789	Garbage not collected in our street for 3 days.	Garbage Issue	Sanitation	Normal	Assigned
2025-04-20 12:56:46	user101	Open manhole near ABC Apartments, posing danger.	Road Hazard	General	Critical	Pending
2025-04-20 13:34:51	user456	Power outage in XYZ Colony since last evening.	Power Outage	Electricity	High	Assigned
2025-04-20 15:19:09	user789	Overflowing sewage at 7th Avenue. Needs urgent attention.	Sewage Problem	Sanitation	High	Critical
2025-04-20 15:19:09	user789	Overflowing sewage at 7th Avenue. Needs urgent attention.	Sewage Problem	Sanitation	Critical	Pending

Representative copies of grievances that exist in the centralized database are shown in Table 2. The schema design facilitates smooth interoperability among petition collection, analysis using AI technology, routing, duplicate elimination, and status monitoring processes.

3.4 Text Preprocessing and Feature Extraction

Submission of petitions can be modeled by unstructured textual data, which has inconsistent format, spelling errors, punctuation marks, and uninformative words. Thus, the

use of a preprocessing pipeline helps to enhance the consistency of textual data before classification.

Preprocessing involves processes such as text normalization, removal of stop-words, tokenization, and lexical normalization. Preprocessing enhances the consistency of the textual data prior to feature extraction. After the process of preprocessing, the textual data is converted into numerical vectors through the use of the term frequency-inverse document frequency (TF-IDF).

The TF-IDF score is calculated as:

$$TF\text{-}IDF(t,d) = TF(t,d) \times \log\left(\frac{N}{DF(t)}\right) \quad (1)$$

where

- $TF(t,d)$ = Frequency of term t in petition d
- $DF(t)$ = Number of petitions containing term t
- N = Total number of petitions in the database
- $TF\text{-}IDF(t,d)$ = Importance score of term t in petition d

3.5 Grievance Classification and Analysis

The classification module acts as the main analyzing element of the suggested system. The extracted feature vectors undergo analysis to determine the right grievance category according to the lexical information found within the petition text.

By employing the classification process, there is automatic categorization of the grievances under predefined administrative categories such as water, electricity, health services, sanitation, education, and infrastructural services. Classification automates the screening process and makes sure that grievances are consistently distributed among departments.

The priority score is calculated as:

$$PriorityScore = \alpha K + \beta S \quad (2)$$

where

- K = Critical keyword score
- S = Sentiment score of the petition

- α = Weight assigned to keyword importance
- β = Weight assigned to sentiment importance
- $PriorityScore$ = Overall urgency score of the grievance

Subject to,

$$\alpha + \beta = 1 \tag{3}$$

3.6 Priority Assessment and Duplicate Detection

In addition to category classification, the model contains a priority assignment system that allows differentiating urgent complaints from normal requests for service. The complaints that have to do with public safety threats, infrastructure issues, and other problems that affect essential services are granted higher priorities to ensure their faster resolution by administration. At the same time, duplication detection is carried out via the comparison of incoming complaints against previous complaints by means of similarity detection.

Table 3. Priority levels and response strategy

Priority Level	Response Strategy
High	Immediate administrative action
Medium	Scheduled investigation and response
Low	Routine processing

Table 3 summarizes the prioritization framework adopted to improve administrative responsiveness and optimize resource allocation during grievance resolution.

3.7 Automated Routing and Resolution Management

After the classification and determination of the priority of complaints, they are automatically forwarded to the concerned department according to the identified category and level of urgency. Routing is automated and helps maintain consistency in assigning grievances to the concerned administrative department.

The implementation architecture is based on the use of FastAPI, SQLAlchemy, SQLite, and NLP analysis tools. Constant synchronization between the processing and database components allows for monitoring the current state of grievances at all stages of their life cycle.

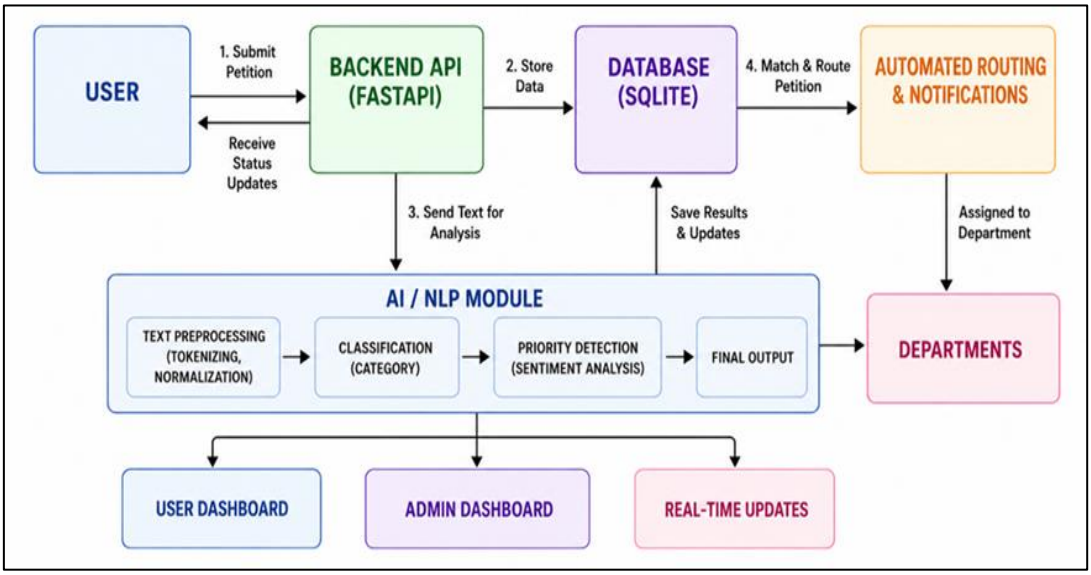

Figure 2. Real-time petition processing and resolution architecture

Figure 2 illustrates the interaction between analytical components, routing mechanisms, database services, and monitoring modules responsible for real-time grievance handling and resolution tracking.

4. Results and Discussion

4.1 System Implementation Results

The implemented AI-Powered Petitions Analysis and Grievances Management System has been successfully tested and validated by completing a full cycle of grievance processing. The proposed system covers petitioning, automatic petitions analysis, grievances departmental routing, status monitoring, and management processes.

Figure 3 depicts the core user interaction process flow, which includes authentication, submission of petitions, and monitoring of grievances' statuses. These interactions allow users to register their complaints, submit necessary information, and monitor the status of the complaint through the whole process of its resolution.

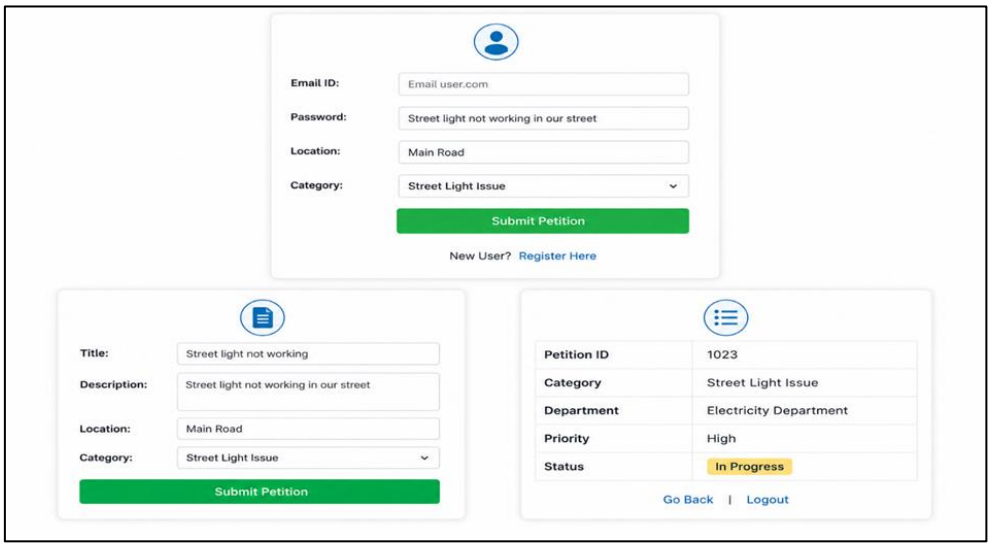

Figure 3. User interaction and petition processing interfaces.

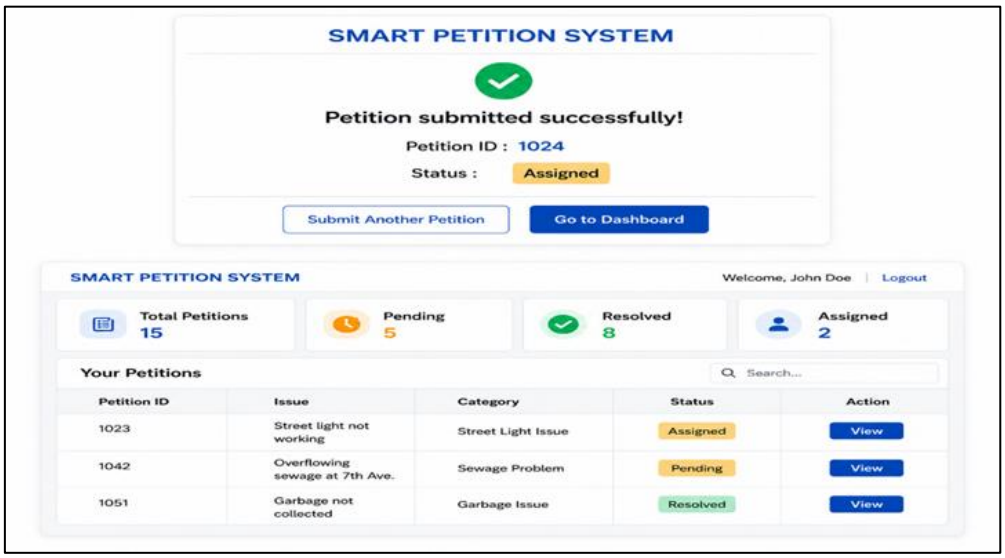

Figure 4. Petition confirmation and dashboard interfaces.

Figure 4 shows the outputs produced by the system following the processing of the petition. The confirmation module presents the user with an identifier that will be used in identifying the petition in future, while the dashboard provides the users with an easy access point to all their grievances records and submissions.

4.2 Petition Analysis and Routing Outcomes

Efficiency of the framework has been tested based on the analysis of the petitions that have been processed by the system in different categories of grievances. Using the automated

classification and routing system helped in ensuring that grievances were assigned to respective departments in an efficient manner.

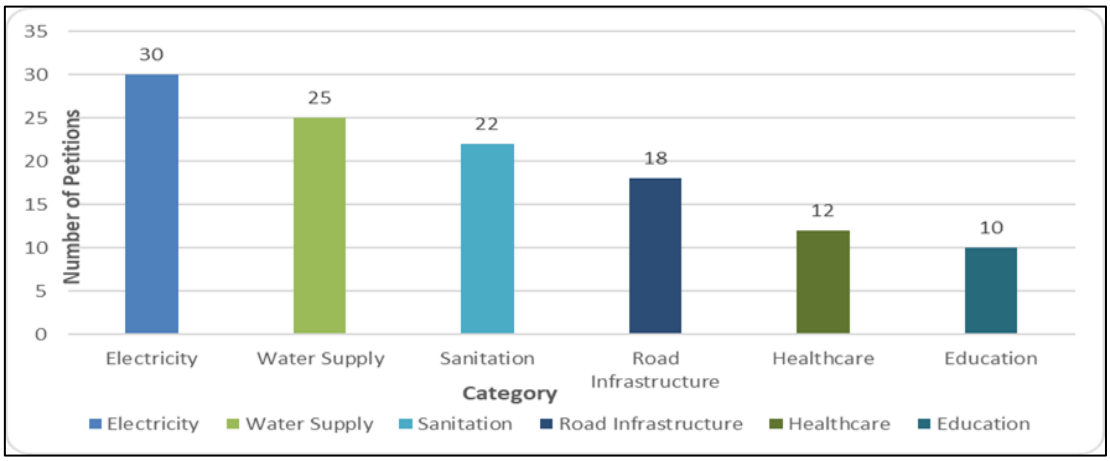

Figure 5. Petition distribution across grievance categories.

Category-wise distribution of the petitions, as depicted in Figure 5, highlights the capability of the framework in classifying the diverse petitions in organized administrative categories. This will help distribute the workload more efficiently among the departments, and also facilitate better decision making. Moreover, the analysis performed can also enable the administrators to find out about those common problems which arise often.

4.3 Technical Contributions of the Proposed Framework

The framework presented above combines complaint registration, classification, prioritization, duplicate identification, complaint routing, and tracking in one platform for managing grievances. The framework allows decreasing manual work and increasing the consistency of grievances processing by performing all these operations within one process.

One of the important achievements of the proposed framework is the possibility to transform informal citizen complaints into formal administrative actions with the help of NLP technology. The use of automated processes of classification, prioritization, and routing allows processing the complaints more effectively. Also, the feature of duplicate identification allows avoiding the duplication of records and unnecessary work of the administrative staff.

Table 4. Technical contributions of the proposed framework.

Framework Component	**Functionality**	**Contribution to Grievance Management**
Complaint Registration Module	Captures citizen grievances through a centralized interface	Simplifies complaint submission and record creation
NLP-Based Categorization	Analyzes petition text and identifies grievance categories	Reduces manual classification effort and improves consistency
Priority Assessment Module	Determines urgency level of complaints	Supports timely handling of critical grievances
Duplicate Detection Module	Identifies similar or repeated complaints	Minimizes redundant processing and administrative workload
Automated Routing Module	Assigns grievances to relevant departments	Improves response efficiency and reduces assignment errors
Centralized Database Management	Stores and manages grievance records	Enhances data accessibility, traceability, and transparency
Status Tracking System	Monitors grievance progress throughout the lifecycle	Provides real-time visibility for citizens and administrators

4.4 Discussion

The implementation results show that the proposed framework for grievance management is superior to the traditional systems for handling complaints by combining the functions of grievance collection, analysis, routing, and monitoring in one framework. The distribution of petitions in Figure 5 shows the capability of the framework in classifying the grievances and allocating the same to the respective department for quick processing. This will help in the avoidance of delay in the manual sorting and increase the efficiency of use of resources. The process automation in the system includes duplicate checking, prioritization of grievances, and routing the grievances. These help in the efficient functioning of workflows and urgent complaints get handled on time. The contributions, as shown in Table 4, demonstrate how intelligent analysis and workflow automation have been integrated in the framework.

5. Conclusion and Future Work

This research demonstrated an AI-Powered Petition Analysis and Grievance Management System aimed at increasing the effectiveness and transparency of the grievances process. The suggested solution consists of petition submission, petition analysis using NLP techniques, prioritization, duplication identification, automated routing, and status monitoring within the same platform. Transforming unstructured petition data into structured administrative decisions saves administrative efforts and ensures consistency and faster processing of petitions. Automatic categorization and decision support systems contribute to administrative coordination, whereas tracking methods ensure transparency and citizen engagement. It is possible to demonstrate the practicality of using AI, NLP, and automation to deliver effective digital governance. This framework can be used as the basis to upgrade the grievance management and public services provision. Future improvements will involve using multi-language solutions, transformer models, and advanced language and semantic analysis for better decision making and classification of petitions in large-scale e-governance.

References

[1] Singh, Jyotika. "Natural Language Processing in the Real World: Text Processing, Analytics, and Classification." Chapman and Hall/CRC, 2023.

[2] AlGhozali, Sultan, and Siti Mukminatun. "Natural Language Processing of Gemini Artificial Intelligence Powered Chatbot." Balangkas: An International Multidisciplinary Research Journal 2024, vol. 1, no. 1: 41-48.

[3] Fodor, James, Simon De Deyne, and Shinsuke Suzuki. "Compositionality and Sentence Meaning: Comparing Semantic Parsing and Transformers on a Challenging Sentence Similarity Dataset." Computational Linguistics 2025, vol. 51, no. 1: 139-190.

[4] Garg, Umang, Deepak Kumar Chohan, and Dinesh C. Dobhal. "The Prediction of Power in Solar Panel using Machine Learning." International Conference on Computational Performance Evaluation (ComPE), IEEE, 2021. 354-358.

[5] Ahn, Kwangjun, Xiang Cheng, Minhak Song, Chulhee Yun, Ali Jadbabaie, and Suvrit Sra. "Linear Attention is (maybe) All You Need (to understand transformer

optimization)." In International Conference on Learning Representations 2024, vol. 2024, 16193-16205.

[6] Kollmannsberger, Stefan, Davide D'Angella, Moritz Jokeit, and Leon Herrmann. Deep Learning in Computational Mechanics. Springer International Publishing, 2021.

[7] Garg, Hemant, Sushil Gupta, and Basant Garg. "Smart Cities and the Internet of Things." Big Data Analytics for Internet of Things 2021: 187-195.

[8] Mantri, Vishesh, NamoNarayan Sharma, and Ramkumar Jayaraman. "Solar Power Generation Prediction for Better Energy Efficiency using Machine Learning." 7th International Conference on Communication and Electronics Systems (ICCES), IEEE, 2022: 1185-1191.

[9] Rupesh, M., J. Swathi Chandana, A. Aishwarya, C. Anusha, and B. Meghana. "Prediction of Solar Power using Machine Learning Algorithm." In Intelligent Data Communication Technologies and Internet of Things: Proceedings of ICICI 2021, Springer Nature Singapore, 2022: 529-539.

[10] Zatsarinnaya, Yuliya, Evgeny Rep'ev, and Marina Shustrova. "Artificial Intelligence Applications to Solve Solar Power Problems." International Conference on Electrotechnical Complexes and Systems (ICOECS), IEEE 2021, 180-184.