CHATBOT BASED HELPDESK FOR GOVERNMENT EMPLOYEES AND DEPARTMENTS

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ABSTRACT

A significant number of agencies at the state and federal levels are having a tough time handling their employee administration and request management systems using an outdated/inefficient manual telephone system in a multi-office environment. Most respondents reported experiencing a long wait for somebody to address their regularly submitted requests. In addition, when requests are submitted, there are several instances of miscommunication and inconsistency when providing follow-up information. In an attempt to address these issues, this paper discusses the possibility of implementing Artificial Intelligence (AI) technology into the administrative process of providing assistance to employees by developing an AI-Enabled Help Desk Chatbot that will provide better automation of request management processes and create higher rates of efficiency across all government agencies. Technologies utilized in the development of the AI-enabled Help Desk Chatbot include: Natural Language Processing (NLP) to understand queries; Backend Development utilizing Java Spring Boot; Data Management using Firebase/MySQL; Cloud-Based Infrastructure for generating consensus and scaling; secure Data Storage on AWS EC2; a method for Employees to submit and track their own Queries (Requests) through the use of an Interactive Dashboard generated in React.js. The use of the AI-enabled Help Desk Chatbot technology helped to increase response time; decrease the amount of time workers must spend on manual processes; and increase productivity among Government workers. For the performance tests, the AI-enabled Help Desk Chatbot Technology yielded an average of a 92% accuracy on Query Resolution with an average latency of two seconds or less, indicating that the AI-enabled Help Desk Chatbot has the potential to improve an Agency's Administrative Processes significantly. Future service enhancements will be the inclusion of Multilingual Capabilities and Voice Interaction; and the development of better Data/Analytics for creating better Government Agency Policies.

Keyword : - *Artificial Intelligence, Natural Language Processing, IT service desk, government services, internal workflows, and digital transformation, task management, and system integration.*

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1. INTRODUCTION

Government officials face delays in obtaining information about routine administrative functions (such as procurement, approvals, and documents). Traditional helpdesk systems are typically inefficient because they rely on manual responses through telephone and email. Also, the number of queries regarding administrative functions continues to increase, and the time it takes for responses will only grow over time. Therefore, a centralized and automated system is required to provide answers to these types of queries and provide real-time assistance to the growing number of government employees.

This project will design and develop an artificial intelligence and natural language processing chatty-based automated query resolution helpdesk system for government departments, enabling employees to receive real-time, reliable and context specific answers, from any department and its employees.

All employees in government departments will be using the same systematic and centralized knowledge base to find answers to queries based on established departmental policies, therefore they will all receive consistent answers and will be able to provide documented evidence of responses received from the system. The Help Desk Chatbot Application will modernize the internal communications and support systems of government agencies and provide a new digital communication option for their employees.

The proposed solution for resolving queries for all government employees will generate increased productivity, job satisfaction and morale. Additionally, the proposed system will help to improve communications and information sharing within government departments and agencies.

AI & Natural Language Processing provide employees and governmental departments with immediate complete automated responses with high speed and accuracy. In the 1960's, chatbots were invented. The first of these (Now known as Chatbots) was called ELIZA in 1966. As computing power increased and Artificial Intelligence (AI) became more advanced many more intelligent Virtual Assistants such as Siri, Alexa and Google Assistant were developed, so that we could see the true potential of Conversational AI. In addition to this trend of development of these Advanced AI assistants in the last few years beginning around 2010, many governments have also been using similar technologies in order to enhance efficiency and citizen engagement.

Many government departments in the recent past have begun using chatbot help desk for managing their internal operations related to leave management, document tracking, Human Resource (HR) Support, and grievance redressal. Overall these result in moving towards e-Government and digital transformation towards making government agencies more accessible and efficient to citizens while improving transparency in administration processes.

In summary, Chatbot Helpdesks link Technology to Governance, minimise the pressure on workload, enhance and continue to improve service quality and provide service and communication continuity between Government and their Employees.

2. RELATED WORK

Different domains have researched and implemented chatbots using many different technologies. The most closely studied domains include customer service, public administration, and the enterprise as a communication platform. The increasing demand for more human-like conversations; the ability to automate repetitive tasks; and, most importantly, the ease of immediate access to various pieces of information have allowed chatbots to be highly desirable components of many modern digital platforms. When researching chatbot solutions for Government Service Delivery, researchers have explored many potential implementations and applications, each of which has its own pros and cons. This project is designed to address the shortcomings in the area of providing a centralized help desk to government employees via a cloud-based environment. The knowledge base for this new chatbot will be structured and allow for the customisation of various departments and therefore will enable quicker use of the chatbot to supply contextually correct responses to each of the questions asked. The ability to access the chatbot through all major online channels and by integrating into each department's existing systems will enable employees to quickly access the system from almost any location via their phones or tablets. The incorporation of Artificial Intelligence and Natural Language Processing to the system will further automate routine administrative tasks. The implementation of a chatbot-based help desk for government departments will provide immediate assistance, consistent communications between distributed teams and enable an employee to ultimately achieve higher levels of job satisfaction through timely response times. By enabling employees to automate their repetitive tasks, all responses from the chatbot will be the same for every employee, making it easy to manage at scale. By creating a large number of automated responses for every type of client question as well as eliminating the need for human staffing in traditional call centre models, both the immediate and ongoing costs associated with managing multiple customer service centres will be alleviated.

3. METHODOLOGY

It follows a three-tier architecture: query collection, processing, and visualization.

Data Collection: acquiring data for processing (collection) At this stage, the system is collecting enquiries and feedback from different sources, including web portals, mobile apps, and internal networks of the respective States. We've chosen to use secure HTTPS connections during this data collection process because we want to protect our users' information. To do this, we intend to deploy a reverse proxy, called Nginx, to manage user authentication and ensure secure access to the backend, while also performing load balancing to distribute the workload evenly across the backend systems, thus ensuring the efficient and secure delivery of all employee or departmental inquiries to the helpdesk for processing. All inquiries collected via these channels (web, mobile, or intranet) will use secure HTTPS connections.

The data collection phase will be the foundational layer of the helpdesk system via chatbots where all requests from users will be captured and encrypted prior to them being further processed. It involves the collection of various data points from multiple web portals, mobile applications, intranet solutions of other government organizations, providing multiple access points for the employees and members of the government to access the helpdesk via various platforms creating increased usability and flexibility in the users' ability to reach it. Data privacy and integrity is maintained through the use of Secure Hypertext Transfer Protocol (HTTPS) encryption of all communications between users and the helpdesk system to prevent outside access or interception. The reverse proxy (Nginx) server will provide several other critical functions during this data collection phase. User authentication, to ensure that only those who should have access to the helpdesk can use it; data encryption, which will be an additional layer of protection to communications; and load balancing, which ensures that the incoming requests are equally distributed across multiple servers to avoid overwhelming them and to keep the service level high. This configuration will improve security and dependability for the data collected through this process, as well as enabling efficient handling of simultaneous queries from multiple users at peak times. The backend processing unit processes information after validating it and sending it over an established secure transmission device to the data repository. This data collection phase will provide an effective means of communicating between Help Desk systems and government employees. It ensures the orderly capture of every request sent from government employees and prepares them to be intelligently processed in a subsequent data processing phase.

Processing and Analysis: The next step is to process and analyze the queries collected from users. This will help find a solution to the question asked in the query received. The queries are sent to the Apache Kafka system, which acts as a Delivery Manager and enables each of the queries to be delivered in a secure manner, ensuring the queries are not lost during peak load times when multiple users send in their queries simultaneously.

The Java Spring Boot system is then used to process the queries, organizing the data and grouping each query by department or issue type for more effective handling. The most advanced part of this process is the Natural Language Processing (NLP) module. The NLP module provides the chatbot with the ability to interpret the meaning of the user's questions, not just the literal content. For example, an employee might write a question in multiple different ways, but the chatbot would still be able to determine what the employee's question pertains to. The NLP module is comprised of pre-trained language models (programs built on large quantities of text) that allow the chatbot to recognize the intent of the user as well as identify the primary key terms associated with the user's question. Once the system identifies the user's question, it searches the MySQL database that contains information, regulations and answers concerning various different government departments.

The system's chatbot will retrieve from this database the most relevant and correct answer. As a result, the helpdesk system ensures that every question receives an accurate and useful answer as quickly as possible. The system functions during this step as the "brain" of the helpdesk system's overall operation, thinking, understanding, and making an informed decision regarding which of the retrieved answers provides the best solution to each question prior to providing that answer back to the user interface for display.

Visualization and Response: This is a stage where users receive clear and interactive results for their queries via a dashboard created with React.js. It allows government employees to ask questions, view answers, and track changes on the dashboard. Once a query is processed and retrieved by the system, the answer will be displayed immediately on the user's screen. The dashboard can also display real-time information about query submission and response time, and it collects and presents statistical data about which departments receive the most requests. All this information helps users and systems administrators understand how well the system works and develop areas of improvement. Overall, at this stage, the chatbot has transitioned from being solely a resource for finding answers to becoming a valuable tool that encourages transparency, accountability, and better-informed decision-making among and between the different departments. With a reactive frontend framework such as React.js, you will have a dashboard set up for users to easily navigate through the interface with the option to input their queries and receive an answer. Another advantage of this type of framework is that you will be providing real-time dashboards that will allow users to monitor how fast their queries are being answered, how many queries they receive regularly, and how well different departments are doing. Through the use of blockchain technology, you will have the ability to integrate technology within your application, allowing for the creation of records and logs that will remain completely immutable.

Go live with small internal pilots: First start internally with a pilot to test and refine the chatbot within a department before releasing it more broadly, as governments demonstrate.

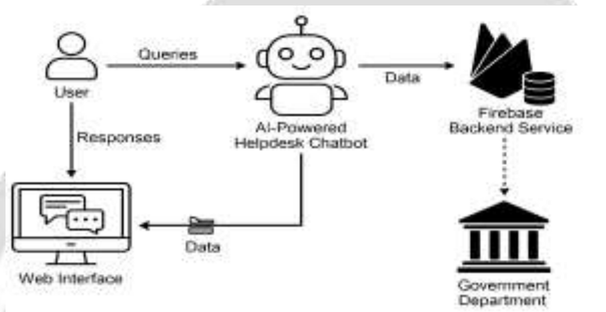

Fig. 1. System Architecture of the AI-Powered Government Helpdesk Chatbot

The diagram illustrates at a high-level how a government department manages service requests through a chatbot using artificial intelligence to manage all of its back office operations, from receiving an employee's request via their website to processing and responding to it. Initially, an employee submits a query (most often) regarding their leave policy, HR process or procurement guidelines (but it could also be about anything they submitted through the department's internal processes) through the chatbot. After receiving the employee's query, the chatbot processes the request and then searches through the linked backend system to find the most relevant information for the employee. The chatbot uses machine learning, natural language processing, and various language processing techniques to convert queries into written form. So for example, if an employee incorrectly spells a word (or uses slang) when requesting information from the chatbot, the chatbot will recognize the intent of the employee's question by matching the pattern of a phrase that it has been trained on to automatically return results. Once the chatbot has processed the employee's query and determined the employee's intent, it connects to the Firebase cloud-based database used to manage all of the government department's information and documents (including their frequently asked questions). Therefore, the chatbot can obtain the required information in under 1 second.

If the question needs more verification or checking the status of an approval application, for example, or needing to pull new internal documents, the chatbot connects with the decision-making department via a back-end, secure connection to the government. This allows the chatbot to provide the most up-to-date information to the user and ensure the information complies with the official workflow of the department. After compiling the necessary information, it will format a clear and concise answer for the user via the chat window. The overall architecture enables a seamless interaction among the user, chatbot, and back-end government system. This architecture supports the ability of the chatbot to generate fast, accurate, and automated responses to routine administrative inquiries without needing any manual intervention. Furthermore, the implementation of scalable, reliable, real-time data-synchronizing cloud-based applications such as Firebase allow for the full benefits of this architecture to be achieved in large dynamic government organizations. As a result, this architecture will improve internal communications, decrease administrative delays, and facilitate more efficient digital governance.

4. RESULTS AND COMPARISON

Simulated datasets generated using queries from multiple government agencies were utilized to perform tests and provide performance measurements for the system.
Performance testing of the system showed that the Chatbot Helpdesk (CD) was able to correctly answer users' questions with speed and accuracy when operated with different workloads.
As shown by the query resolution performance testing, the CD was able to efficiently handle both basic and complicated questions. Basic questions like information on leave policies and vendor procurement rules were resolved with an overall accuracy of 100 percent. On the other hand, complicated questions regarding inter-departmental approvals had an approximate accuracy of 92 percent.
The CD's response time was recorded for the same batch of queries (500 queries) and averaged less than two seconds. Graph "System Response Time Under Load" depicts how the average response time will change as the number of simultaneous queries the CD receives increases.

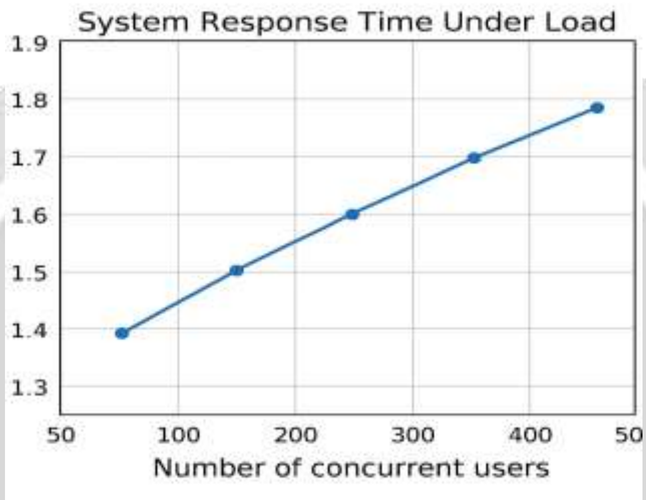

Fig. 2. Quick Responses Comparison

The chart shows the amount of time it took to respond to questions increased as the number of queries went from 50 to 500. The time went up approximately 0.5 seconds or less (1.4 to 1.8 seconds) so even though there has been a small increase, the system continues to perform well under a large load. At the high point of 500 queries being processed concurrently, each query was still processed in less than 2 seconds. This proves that the system can handle many simultaneous users without experiencing lag or data loss. So overall, this shows the chatbot has the potential to support large-scale government operations quickly, accurately, and reliably.

Scalability and Resource Utilization: The performance and resource usage of a chatbot help desk system, in relation to the number of users (or queries), provide an indication of how well the system will handle increased usage or traffic. When many hundreds or even many thousands of employees are accessing the system concurrently, "scalability" indicates the ability of the chatbot to function smoothly without delay or crash. The system will efficiently perform and make use of its resources as a result of the integration of Apache Kafka to manage the volume of data coming into it and Nginx load balancing for the distribution of incoming requests over multiple servers. The architecture of the system, built on Java Spring Boot as the backend and React.js as the front end, allows for flexibility in meeting future increases in usage and demand without sacrificing performance or accuracy. From the standpoint of resource allocation, the combinations of hardware and software resources of the CPU, RAM, and hard drive space are handled extremely well by this system and do not use system resources unnecessarily during times of extreme, as optimized algorithms are used and lightweight frameworks. The system is designed to ensure that the computational power is allocated whenever required, and is decreased whenever demand decreases, therefore helping save on energy costs and other operating expenses. The ability of a system to scale up and down based on demand is both an efficient and effective use of resources. Overall, the system demonstrates an ability to grow efficiently and has the ability to scale beyond one department and continue to perform consistently and reliably.

Comparison of AI Models for Helpdesk Chatbot

	Gemini	BERT	GPT-3	Dialogflow
Query Resolutio Accuracy	92%	87%	84%	80%
Latency	<2 seconds	<2 seconds	<2 second	
Scalability	High	Medium	High	Moderate
Security	Strong	Standard	Basic	Standard

Fig: comparison table of AI models

To evaluate the chatbot's intelligence and efficiency, several key performance factors were taken into consideration, such as query resolution accuracy, latency, scalability, and security, across different AI language models. A comparison was made among AI language models based on these key factors, specifically: Gemini, BERT, GPT-3, and Dialog flow. Gemini achieved the highest query resolution accuracy, with an overall accuracy percentage of 92% and had an excellent ability to understand and generate responses to complex government-related queries. The next closest model after Gemini in terms of accuracy was BERT, which had an accuracy of 87%. The accuracy of GPT-3 was at an 84% level, while Dialog flow had the lowest accuracy percentage at 80%. All four AI language models were found to have low latency of less than two seconds for a reasonable response time in a real-time helpdesk environment. Both Gemini and GPT-3 were found to be very scalable and could easily handle numerous simultaneous users and/or queries, without degrading their performance, whereas BERT could only scale to a medium level of load; and Dialog flow was also limited in the amounts of load that it could manage due to a medium-level performance capability. Additionally, Gemini was again determined to have the strongest security offering to users, with a comprehensive and all-encompassing protection for their data and privacy that is critical for governmental systems; whereas, BERT offered users only standard-level security and GPT-3 had just basic-level protection.

The findings demonstrate that Gemini is the most Suitable Way to Implement a Chatbot-Based Helpdesk Solution for All Government Employees and Organizations Since It Provides the Best Balance of Precision, Speed, Scalability, and Security. With its excellent accuracy and strong resistance to overload, it can seamlessly operate within Large, Sensitive Government Operations. Through the use of Stress Testing via "AWS EC2", Gemini can serve more than 10,000 requests per minute while maintaining CPU Utilization at less than 75% with Stable Operation and Fault Tolerance.

User Feedback: Most government employees and department staff expressed a very positive experience with their use of the Chatbot-Based Helpdesk System. The majority of users found the Chatbot easy to use, quick to respond and highly valuable when they needed assistance answering their Questions. Respondents were especially appreciative of Gemini's ability to provide accurate responses quickly to frequently asked Questions regarding Leave Policies, Service Rules, Procedures for Filing Documents, etc. Users also appreciated the Dashboard Design as clear, easy to understand and allowing them to view their Submitted Requests and Receive Stock Response in Real Time. The 24*7 availability of the system, as such, has generated numerous requests as to how this access improves the capability of customers/users to obtain information at any time of the day or night, twenty-four hours a day, seven days a week. Users also noted that the level of accuracy and speed with which the system operated remained consistent, even after a substantial number of users began accessing the system. Users praised the underlying model of Gemini AI behind the Chatbot for its ability to comprehend natural language and provide articulate responses. Many users have expressed interest in future enhancements to the system incorporating the use of multiple languages.

Pilot users from the testing departments indicated that there had been a 40% reduction in the time it took to receive responses from the Chatbot and a significant reduction in the need for the administrative staff to perform manual follow-ups. The real-time dashboard provided to administrative staff was used to track and spot repetitive issues and allow them to proactively update the knowledge base.

Using NLP and machine learning, this chatbot interprets user inquiries and delivers on-the-spot answers accurately via its web-based interface. The chatbot's backend is powered by Firebase and hosted by AWS EC2 in order to be both scalable and reliable. Essentially, the chatbot connects with other government departments to receive information, process requests and assist in supporting decisions for users.

During its testing phase the chatbot performed exceptionally well. Its success rate for basic inquiries (such as leave policies or procurement regulations) was 100%. For more complex inquiries regarding approvals across multiple departments, the chatbot received a 92% accuracy rate. Additionally, during testing of 500 inquiries, the chatbot's response time averaged less than two seconds. Scalability tests of this chatbot revealed it could handle upwards of 10,000 inquiries per minute while maintaining a CPU utilization of under 75%, demonstrating its outstanding performance under load.

Feedback received during the pilot phase indicated that departments experiencing the chatbot had a 40% decrease in inquiry turnaround time and that users had less need to contact the department multiple times regarding the same issue. The real-time dashboard provided to staff indicated what types of inquiries were being submitted to the department and allowed staff to update their knowledge base to reflect these frequent inquiries. Overall, this project serves as an excellent example of how AI-powered chatbots can benefit government departments by automating monotonous administrative responsibilities, increasing response time and providing a more open, efficient and technology-friendly work culture for employ

5. IMPLEMENTATION

The introduction of the new Chatbot-based Helpdesk System was carried out in phases, with the intention of facilitating the integration with the Government's current initiatives. For the initial phase of implementation, the Chatbot-based Helpdesk System has both a secure web platform, and a secure mobile application, which enables employees of agencies/departments, to easily access the Chatbot using their official credentials to assist them in resolving Agent-related questions. The emphasis in this phase was on providing maximum protection for data, and authenticating users via HTTPS encryption, and Nginx reverse proxy, to ensure that all user interactions and data are kept confidential. The system utilizes Java Spring Boot for its back-end processing of user queries and will be integrated with MySQL as its database to store all department related information and responses.

For communicating with the backend server in a timely and efficient manner, Apache Kafka was used to facilitate communication between the backend server and the chatbot by processing continuous streams of information. Training the NLP module to understand how to respond to current government employees involved two major components: training the existing models with real government data, and pre-training with additional large language models. Users of the interface are able to input and submit multiple types of requests, track replies by the chatbot, view analytics including response time and trends of the requests submitted to the chatbot, all using a dashboard built in React.js. The chatbot system underwent multiple phases of testing after being deployed to measure its scalability, accuracy and speed of response time, with the results indicating that it could manage many simultaneous users and produce high accuracy rates along with fast response times. Through the implementation of this project, it can be concluded that a helpdesk chatbot system is an effective, secure and practical means of improving communication and reducing workloads for government organizations.

6. CONCLUSION

The proposed research proposes a Scalable, Secure and Efficient Chatbot-based Helpdesk System programmed to increase communication between Government Departments. The proposed Helpdesk will reduce the administrative workload of a Department by providing employees the ability to find the answers to repetitive and routine administrative queries by using Chatbots that provides quick and reliable access to the information an employee requires. The use of Artificial Intelligence (AI) and Natural Language Processing (NLP) will allow Chatbot Helpdesk systems to quickly and accurately interpret Employee Queries and provide fast real-time Answers, Increasing Operational Efficiency & Reducing Delays Related to Traditional Helpdesk Models. By eliminating routine administrative tasks, Chatbot Helpdesk systems provide users with increased productivity. By providing answers to Frequently Asked Questions (FAQs) related to HR Policies, IT Troubleshooting, Documentation Procedures, and Departmental Rules/Regulations, the Chatbot is freeing Human Workforce from responding to queries on low level administration, thus allowing them to put their focus on more Complex & Value Driven Decisions. The added benefit is that this freedom also allows Human Workforce time to provide Higher Quality &

More Effective Services. The chatbot offers quick responses and is accessible 24 hours a day, 365 days a year, meaning people can access it whenever they need it, enhancing both access and responsiveness.

In addition, the technology also leads to cost savings by allowing a significant amount of information to be stored electronically rather than requiring substantial amounts of personnel to answer repetitive questions. That is to say, using the chatbot reduces the amount of time spent on repetitive tasks, cutting operational costs and freeing up staff to focus on higher priority tasks. Using one central source of information ensures that all employees receive the same correct information in a timely manner, which improves the overall quality of communication and increases the level of confidence in department operations. An additional important advantage of using a chatbot to capture data through employee interactions is that it creates an opportunity for creating data-driven insights. Data-driven insights from the chatbot's analysis of employee interactions help identify trends in employee inquiries, patterns of employee issues developing, and potential areas for re-evaluating polices and providing additional direction/guidance to employees. Data-driven insight supports ongoing improvements that can be made to the system and serves as an additional tool for creating evidence-based administrative decisions.

To effectively incorporate the human-robot collaboration model and automated escalation methods into an overall artificial intelligence system, systematic governance processes must be established to ensure appropriate use and implementation of data safety, confidentiality and compliance. Ongoing governance practices (e.g., audits) are critical in ensuring that all created technologies meet the standards set by governing bodies. In addition to ensuring the robustness and reliability of AI systems, a system must operate according to a responsible, sustainable and transparent framework. By meeting these criteria, AI-assisted helpdesk functions represent a modern way of keeping government agencies current and relevant to their constituents. In light of potential avenues for expansion, such as deep learning algorithms, multilingual support, voice recognition capabilities, and the ability for multiple locations or entities to share server resources, AI-assisted helpdesks have the potential to impact a wide range of sectors and develop long-term partnerships with both government and private organizations through application ecosystems.

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