AI-powered Healthcare Assistant: A Comprehensive approach to Medical Support Systems

**PROJECT REPORT**

Submitted by

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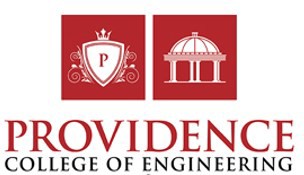
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To

*APJ Abdul Kalam Technological University*

*in partial fulfillment of the requirements for the award of B.Tech Degree in Computer Science and Engineering*

*(Artificial Intelligence)*

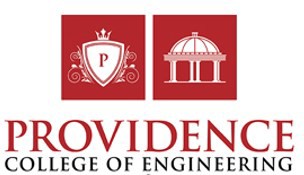


# Department of Artificial Intelligence

# Providence College of Engineering, Chengannur March 2025

DEPARTMENT OF ARTIFICIAL INTELLIGENCE

**PROVIDENCE COLLEGE OF ENGINEERING, CHENGANNUR**



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**CERTIFICATE**

Certified that this report entitled ‘*AI-powered Healthcare Assistant: A Comprehensive Approach to Medical Support Systems’* is the report of project completed by the following students during **2024-2025** in partial fulfillment of the requirements for the award of the Degree of Bachelor of Technology in Computer Science and Engineering(Artificial Intelligence).

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**DECLARATION**

We, hereby declare that, this project report entitled ‘*AI-powered Healthcare Assistant: A Comprehensive Approach to Medical Support Systems’* is the bonafide work of ours carried out under the supervision of **Dr. Anoop P S**, Associate Professor, Department of Artificial Intelligence. We declare that, to the best of our knowledge, the work reported herein does not form part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion to any other candidate. The content of this report is not being presented by any other student to this or any other university for the award of a degree.



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# ABSTRACT

Healthcare accessibility remains a significant challenge, with individuals often struggling to interpret medical data, identify symptoms, and make informed health decisions. The proposed **"AI-powered Healthcare Assistant: A Comprehensive Approach to Medical Support Systems"** addresses these issues by integrating AI-driven functionalities into a single intelligent platform. The system incorporates a **symptoms checker (text and image-based), a virtual dietician, a lab report analysis tool utilizing OCR and LLMs, and general healthcare FAQs** to provide real-time medical insights. The system integrates RAG and advanced AI models to analyze medical data, providing users with real-time insights. Additionally, it offers **an interactive user interface** for seamless access to healthcare-related queries and recommendations. This AI-powered system enhances **health awareness, early detection of potential health risks, and personalized medical assistance**, making healthcare more accessible and user-friendly.

**Keywords**: AI-powered Healthcare, Medical Data Analysis, OCR, LLM, Symptom Checker, Virtual Dietician, Lab Report Interpretation, RAG.

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# LIST OF ABBREVIATIONS

|  |  |
| --- | --- |
| **Abbreviation** | **Expansion** |
| AI | Artificial Intelligence |
| API | Application Programming Interface |
| COCOMO | Constructive Cost Model |
| CSV | Comma-Separated Values |
| DB | DataBase |
| DL | Deep Learning |
| JSON | JavaScript Object Notation |
| LLM | Large Language Model |
| ML | Machine Learning |
| NLP | Natural Language Processing |
| OCR | Optical Character Recognition |
| RAM | Random Access Memory |
| RAG | Retrieval-Augmented Generation |
| REST API | Representational State Transfer API |
| SDK | Software Development Kit |
| SQL | Structured Query Language |
| UI | User Interface |
| UX | User Experience |
| VM | Virtual Machine |
| XML | Extensible Markup Language |

**CHAPTER 1 INTRODUCTION**

## 1.1 Background

The demand for accessible and efficient healthcare solutions is increasing rapidly. With advancements in artificial intelligence, technology-driven healthcare assistants are becoming essential in providing timely medical guidance. Many individuals struggle with understanding lab reports, identifying symptoms, and making informed health decisions, often leading to delayed treatments or unnecessary anxiety.

To address these challenges, **AI-powered Healthcare Assistant: A Comprehensive Approach to Medical Support Systems** is designed as an intelligent medical assistant that integrates multiple healthcare functionalities. It includes a **symptoms checker (text and image-based), a virtual dietician, general healthcare FAQs, and a lab report analysis feature** that utilizes **OCR and LLMs** to extract and interpret medical data. By providing users with **instant, reliable, and AI-assisted medical insights**, this system aims to bridge the gap between patients and healthcare professionals.

This intelligent assistant not only enhances accessibility but also empowers individuals to take proactive steps in managing their health. With its ability to analyze reports and offer medical suggestions, this AI-powered solution contributes to a more informed and health-conscious society.

## 1.2 Existing System

Current healthcare assistance systems are often **fragmented and limited in functionality**, making it difficult for users to access comprehensive medical support in one place. Many applications provide either **basic symptom checking, general health advice, or limited access to medical records**, but they lack an integrated AI-driven approach for **interpreting lab reports, offering personalized dietary recommendations, and delivering contextual medical insights**.

Some existing AI-based medical assistants and chatbots incorporate **predefined symptom-checking models** or **rule-based decision trees**, but these systems have several limitations:

* **Limited Medical Understanding**: Many rely on static symptom databases rather than leveraging **LLMs and Retrieval-Augmented Generation (RAG)** for dynamic responses.
  + - **Lack of Lab Report Analysis**: Most do not include an **OCR-based system** for interpreting **softcopy or scanned medical reports**, leaving users reliant on manual interpretation.
    - **Generic Recommendations**: Many virtual dieticians provide **generalised meal plans** without considering **individual health conditions and lab results.**
    - **Data Dependence**: Some AI models require extensive **training data and manual updates**, making them less adaptive to new medical findings.
    - **Privacy & Compliance Issues:** Existing systems often struggle with **secure data handling and compliance** with healthcare standards.

## 1.3 Problem Statement

To develop an AI-powered healthcare assistant that enhances medical accessibility by integrating **symptom checking, lab report analysis, virtual dietary guidance, and general healthcare insights**. The system will utilize **OCR, LLMs, and RAG-based AI models** to interpret medical data, provide personalized recommendations, and assist users in understanding their health conditions, ensuring **efficient and informed decision-making in medical support systems**.

## 1.4 Objectives

The following are some of the goals of our proposed paradigm:

* + - **To develop an AI-powered healthcare assistant** that integrates multiple medical support features, including **symptom checking, lab report analysis, and dietary guidance**.
    - **To implement OCR and LLM-based models** for extracting and interpreting medical data from both **hardcopy and digital lab reports**.
    - **To enhance accessibility to medical insights** by providing **real-time, AI-driven health recommendations** to users.
    - **To create a scalable and user-friendly system** suitable for **individual users, healthcare providers, and digital medical platforms**.
    - **To improve healthcare awareness and decision-making** by leveraging **advanced AI techniques** for personalized medical support.

## 1.5 Scope

The system provides an AI-powered solution for medical assistance by integrating symptom checking, lab report analysis, and dietary guidance. It can be used by individuals, healthcare providers, and digital medical platforms to enhance medical accessibility and decision-making. This user-friendly assistant supports early diagnosis, health awareness, and AI-driven insights, making healthcare more accessible and efficient.

# CHAPTER 2 LITERATUREREVIEW

This chapter is about the various existing work in the field of AI-powered Healthcare Assistant Chatbots. The summary of the most relevant 12 papers is provided below.

**S. Manikandan et al.** have proposed a model [1] for developing an AI-Powered Healthcare Chatbot Using Natural Language Processing for Symptom Analysis and Medical Assistance. They can provide basic diagnoses, suggest basic treatments, and recommend precautions based on the symptoms described by users before seeing a doctor. They have used Natural Language Processing (NLP) technology to help the chatbot understand user questions and also employed the Natural Language Toolkit (NLTK) for processing and analyzing user inputs inorder to provide symbolic and statistical natural language processing, allowing the chatbot to understand and respond to queries in a human-like manner. They have implemented this model in the healthcare domain, focusing on initial symptom analysis and helping users to decide whether to seek professional care. Their model shows several advantages like the chatbot’s user-friendly interface ensures accessibility for individuals of all technological skills, making it a versatile tool for a wide variety of users, encourages users to take charge of their health and well-being, promoting a culture of self-care and preventive medicine. The system also aids in health awareness by providing information on diseases, treatments, and preventive measures. But their model fails to handle complex diagnoses and requires healthcare professionals for validation to ensure medical accuracy. Other challenges like ensuring data security, managing algorithmic bias, and maintaining updated medical databases are some limitations in their implementation.

**Jomana Anwar et al.** have proposed a model [2] for developing a chatbot-based first aid service in the Arabic language to assist users during emergency situations. They have used Natural Language Processing (NLP) techniques, including intent classification and similarity modules, fine-tuning pre-trained language models such as AraBERTv2 for resolving the challenges of providing timely and accurate first aid information in Arabic, a language with complex morphology and dialectal variations. They have implemented this model in the domain of emergency first aid services, focusing on Modern Standard Arabic (MSA). Their model shows significant merits, including providing real-time, contextually accurate first aid instructions, empathetic interactions for user comfort, and the ability to classify and respond to diverse emergency queries. Additionally, the system demonstrates user satisfaction through evaluations using the Technology Acceptance Model (TAM). However, their model fails to address the need for support in dialectal Arabic and has limited coverage of emergency topics. Future work is required to enhance the similarity model and expand the chatbot’s domain-specific knowledge base.

**Tathagat Yadav & Ankit yadav** have proposed a model [3] for designing and developing a MediBot system to predict diseases based on symptoms provided by users. They have used the Apriori algorithm for symptom-disease mapping and Recurrent Neural Network (RNN) for enabling conversational capabilities, resolving the issues of early disease detection and providing accessible medical assistance. They have implemented this model in the healthcare domain, focusing on disease prediction and general health conversations. Their model shows significant merits, such as providing early disease predictions, enabling users to monitor their health conveniently, and offering a conversational interface for better engagement. Additionally, the use of machine learning ensures adaptability and improved prediction accuracy over time. However, their model fails to address challenges like the lack of comprehensive medical datasets and the high training time required for RNN models. Future work suggests improving dataset availability and integrating offline speech-to-text APIs for enhanced usability

**Chaturvedi U et al.** have proposed a model [4] to examined the role of artificial intelligence in remote healthcare, with a focus on improving patient interaction, connectivity, and overcoming existing barriers. Their study highlights AI-driven remote monitoring systems that use biosensors and wearable devices to detect health irregularities early, allowing for timely medical intervention. They also discuss the impact of AI-powered chatbots and virtual assistants in providing personalized healthcare guidance, improving patient adherence to treatments. Furthermore, the research explores AI’s ability to enhance telemedicine services, making healthcare more accessible to remote and underserved communities. While their findings suggest that AI strengthens remote healthcare by optimizing communication and decision-making, they also acknowledge key challenges such as data security concerns, the need for better digital infrastructure, and biases in AI algorithms. Future advancements should focus on addressing these issues through improved regulatory measures, greater transparency in AI systems, and expanding access to AI-driven healthcare for all.

**Shafaq Fatima Mughal et al.** have proposed a model [5] for designing a domain-specific chatbot, "Mai," to enhance menstrual health education among women in South Asia, specifically Pakistan. They have used DialoGPT’s transformer architecture fine-tuned on English and Roman Urdu datasets for resolving the challenges of providing culturally sensitive and accurate menstrual health information. They have implemented this model in the domain of menstrual health, focusing on stigma reduction and improving access to menstrual hygiene education. “Their model shows significant merits, including providing personalized and contextually accurate information in multiple languages, achieving strong performance metrics such as high BERTScore and ROUGE-L, and receiving positive feedback from users and medical professionals during evaluations.”. However, their model fails to address challenges like biases in datasets, the difficulty of generating responses for complex queries, and reliance on internet-based APIs, which could compromise user privacy in low-resource settings. Future work suggests improving dataset diversity, enhancing privacy measures, and integrating offline capabilities for broader usability.

**Ibrahim Almubark** have proposed a comprehensive review [6] to explore the application of large language models (LLMs) like GPT-4, ChatGPT, GPT-3.5, and LLaMA in disease diagnosis. They have used transformer-based architectures and extensive pre-training on diverse medical data sources, such as patient records, clinical notes, genomic data, and medical images, for resolving the challenges of improving diagnostic accuracy, addressing rare diseases, and assisting clinicians in evidence-based decision-making. They have implemented this review in the domain of healthcare, focusing on disease diagnostics and clinical decision support. Their review highlights significant merits, including the ability of LLMs to process vast and complex medical data, enhance diagnostic precision for a wide range of diseases, and support real-time medical decision-making. Additionally, LLMs demonstrate adaptability across diverse healthcare fields, including oncology, cardiology, and rare diseases. However, their review identifies limitations such as potential biases in training data, lack of transparency in decision-making (black-box nature), data security concerns, and the need for fine-tuning models for specific medical domains. Future research is recommended to address these challenges by improving interpretability, ensuring data diversity, and integrating robust privacy measures.

**Matteo Magnini et al.** have proposed a model [7] for integrating small language models (SLMs) into personal medical assistant chatbots to enhance privacy and reliability in telemedicine applications. They utilized a privacy-by-design architectural solution leveraging locally deployed open-source SLMs trained on domain-specific datasets and evaluated them for tasks such as intent recognition, data extraction, and empathetic conversation. They implemented this model in the domain of chronic disease self-management, specifically focusing on hypertension management. Their model demonstrates significant merits, including robust privacy preservation, reduced hardware requirements enabling deployment on personal devices, and strong semantic performance on specific tasks. However, it fails to address challenges such as lower accuracy in intent recognition and data extraction compared to larger language models, limited multilingual support, and occasional generation of unreliable responses. Future work suggests targeted fine-tuning, enhancing multilingual capabilities, and improving task-specific accuracy for broader clinical applications.

**Mulun Huang & Kymora Scotland** have proposed a model [8], UroGPT™, for assisting kidney stone formers by providing tailored health education and management support. They utilized GPT-4's transformer architecture, fine-tuned with kidney stone-related knowledge validated by urologists, and deployed it via a HIPAA-compliant platform to ensure privacy and reliability. They implemented this model in the domain of kidney stone health education and management, focusing on improving patient understanding and access to information.  
Their model shows significant merits, including high user satisfaction (Net Promoter Score of +75.77), ease of use, and its ability to provide empathetic and contextually accurate responses. However, it fails to address challenges such as selection bias toward tech-savvy users, limited validation across diverse demographics, and lack of offline functionality. Future work suggests incorporating a more diverse user base, addressing digital literacy disparities, and exploring features like symptom monitoring for enhanced engagement.

**Claudia Cosma et al.** have proposed a scoping review [9] exploring the contributions of chatbots to enhancing vaccine literacy and uptake. The review analyzed 22 studies focusing on the use of chatbots for disseminating vaccine-related information, countering misinformation, and addressing vaccine hesitancy. They utilized methodologies adhering to PRISMA-ScR guidelines, thematically synthesizing data from studies involving both rule-based and AI-driven chatbots. The review examined chatbot applications across diverse populations, including general users, students, and parents, with a particular focus on COVID-19, HPV, and childhood vaccinations. The findings highlight significant merits, such as chatbots' ability to provide personalized, real-time, and empathetic support, improve vaccine literacy, counter misinformation, and facilitate vaccine appointment scheduling. However, limitations include disparities in technological literacy, challenges in adapting chatbots for culturally diverse populations, and the need for constant updates and rigorous fact-checking to ensure reliability. Future work suggests enhancing multilingual support, integrating voice-based interactions, and addressing algorithmic biases to optimize chatbots' role in public health communication and vaccine advocacy.

**S. Nipu et al.** have explored [10] the effectiveness of AI chatbots in predicting diseases based on patient complaints. Their research assesses the diagnostic accuracy of GPT 4.0, Claude 3 Opus, and Gemini Ultra 1.0 using few-shot learning techniques, comparing their performance with a fine-tuned BERT model. Their findings suggest that GPT 4.0 improves progressively with more training data, Gemini Ultra 1.0 adapts efficiently even with minimal input, and Claude 3 Opus maintains steady performance across different training scenarios. While the study highlights the potential of AI chatbots in automating initial patient assessments, it also identifies several limitations. These include inconsistencies in chatbot adaptability, saturation of learning improvements in Gemini Ultra 1.0, and concerns over the reliability of AI-generated diagnoses. The authors emphasize the need for further refinement in AI-driven healthcare tools, advocating for improved accuracy, robust validation, and integration with human oversight to enhance their safety and clinical reliability.

**Sarma et al.** have proposed a model [11] for developing a Personal Healthcare Chatbot for Medical Suggestions using Artificial Intelligence and Machine Learning. They have implemented natural language processing (NLP) algorithms and decision tree techniques to understand user queries, predict diseases, and provide medical advice based on symptoms. The model supports multiple languages and classifies diseases into major and minor categories, offering tailored recommendations. It also uses a threshold-based confidence system, ensuring disease predictions are made only when symptom confidence exceeds 80%. Their model shows high accuracy in disease prediction, efficient communication through NLP, and features such as user-friendliness, time-saving capabilities, 24/7 availability, quick responses, and appointment scheduling. The chatbot also integrates retrieval-based algorithms to enhance its performance in providing relevant responses, contributing to a seamless user experience. However, the model may lack in addressing complex medical conditions and ensuring precision for more intricate health scenarios, highlighting areas for further improvement.

**Ni et al.** have proposed a model [12] for analyzing the implementation of chatbot technology in healthcare. They have used bibliometric analysis to summarize the current status and future trends of health-related chatbots. They have implemented this model in the domain of health chatbot research, focusing on publication patterns, co-authorship networks, software tools, functionalities, and applications. Their model shows the potential of AI chatbots to transform healthcare by streamlining administrative processes, assisting in diagnosis, providing health information, and improving health care quality. It highlights tools like VOSViewer and CiteSpace used in bibliometric analysis, offering insights for researchers, engineers, and policymakers to develop innovative chatbot solutions. However, their model fails to address the sophistication of AI algorithms needed for precise human-chatbot interactions, the lack of interdisciplinary collaboration due to unfamiliarity with underlying technologies, and the absence of standardized guidelines for developing health-related chatbots.

From our analysis, we found that no AI-powered healthcare assistant integrates symptom checking, lab report analysis, and dietary guidance using OCR and LLMs for accurate medical interpretation. Existing systems are fragmented and lack a unified approach.

# CHAPTER 3

# SYSTEM ANALYSIS

This chapter addresses the system analysis for the **AI-powered Healthcare Assistant: A Comprehensive Approach to Medical Support Systems**. It specifies the **functional requirements, non-functional requirements, feasibility analysis, hardware requirements, and software requirements**.

## 3.1 Functional Requirements

The proposed **AI-powered Healthcare Assistant** is expected to meet the following functional requirements:

**FR1:** Symptom Analysis

*Description*: The system must analyze user-reported symptoms and provide possible medical insights.

*Input*: User-entered symptoms or image-based inputs.

*Output*: Suggested possible conditions and general health recommendations.

**FR2**: Lab Report Analysis

*Description*: The system must process medical lab reports and extract relevant data using OCR.

*Input*: Scanned or uploaded medical reports (PDF/images).

*Output*: Structured health data and insights based on report findings.

**FR3**: Dietary Guidance

*Description*: The system must offer personalized diet recommendations based on user health conditions.

*Input*: User's medical conditions and dietary preferences.

*Output*: AI-driven nutritional suggestions.

**FR4**: Medical FAQs & General Assistance

*Description*: The system must provide answers to common healthcare queries.

*Input*: User queries related to general health topics.

*Output*: AI-generated responses with medical insights.

**FR5**: User Profile Management

*Description*: Users should be able to manage personal health profiles.

*Input*: User-entered health details.

*Output*: Personalized health insights and recommendations.

**FR6**: Real-time Health Alerts

*Description*: The system must notify users of concerning symptoms or abnormal lab report findings.

*Input*: Analysis results from symptoms or lab reports.

*Output*: Alerts with potential health risks and suggested actions.

**FR7**: Secure Data Storage & Retrieval

*Description*: The system must securely store and retrieve user medical history.

*Input*: User health data and past interactions.

*Output*: Accessible historical records for reference.

**FR8:** Multi-platform Accessibility

*Description*: The system must be accessible via web and mobile platforms.

*Input*: User authentication and access requests.

*Output*: Responsive interface with health-related features.

## 3.2 Non-Functional Requirements

The proposed **AI-powered Healthcare Assistant** must also meet the following non-functional requirements:

**NFR1: Availability:** Operate continuously 24×7 with minimal downtime.

**NFR2: Reliability:** Ensure accurate medical insights and consistent system performance.

**NFR3: Maintainability:** Support easy updates and modifications without disrupting core functionality.

**NFR4: Performance:** Optimize response time for symptom analysis and lab report processing.

**NFR 5: Security:** Protect user health data through encryption and secure authentication mechanisms.

## 3.3 Feasibility Analysis

The feasibility study for the above-mentioned requirements is done and it is concluded that it is practically possible to build such a system. The technical, economical and feasibility analysis is discussed below.

## 3.3.1 Technical feasibility

The system integrates **OCR, LLMs, and RAG-based AI models** for lab report analysis, symptom checking, and dietary recommendations. Cloud-based storage and real-time processing ensure efficient medical assistance. The use of readily available AI frameworks and APIs makes the implementation feasible.

## 3.3.2 Operational feasibility

The assistant simplifies medical support by **analyzing reports, answering health-related queries, and offering dietary guidance**. A user-friendly chatbot interface ensures accessibility for both medical professionals and general users with minimal learning requirements.

## 3.3.3 Economic feasibility

By leveraging **open-source AI models and cloud-based solutions**, the system minimizes costs while maximizing efficiency. The automation of medical data analysis reduces the need for manual intervention, making it a cost-effective healthcare solution.

## 3.4 Hardware Requirements

* **Cloud Server** – For hosting AI models and managing data.
* **User Devices** – Smart phones or PCs.
* **Scanner or Camera** – Captures lab reports for OCR-based data extraction

(for hardcopy reports).

* **Internet Connectivity** – Ensures real-time access to cloud services, medical
* databases, and APIs.

## 3.5 Software Requirements

* Python 3.x
* PyCharm
* Flask (for backend server)
* Ngrok (to expose the local server for Dialogflow)
* Dialogflow (for chatbot development)
* DeepSeek API (for AI-powered responses)
* Requests (Python library for API calls)
* Json (for handling API responses)
* Postman (for testing API endpoints)

## 3.6 Life Cycle Used

For this project, we adopted an **Agile approach**, specifically using **Kanban** as our development life cycle model. Agile allows us to iterate quickly, making adjustments as needed while integrating **Dialogflow and DeepSeek API**.

Kanban helps us **track progress**, ensuring smooth workflow management. Each stage—**setting up Dialogflow, developing the Flask backend, integrating DeepSeek API, and testing responses**—is managed through Kanban to maintain clarity and accountability.

This approach enables us to **incorporate feedback continuously**, refine chatbot responses, and address potential integration issues early on. The flexibility of Agile ensures that new features can be added seamlessly during development.

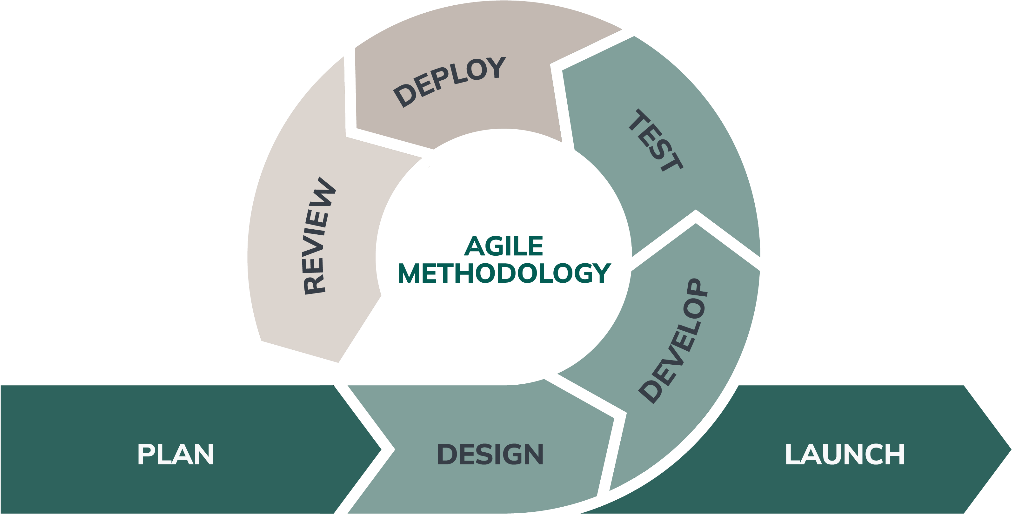


Figure 1.1: Agile Model

## 3.7 Cost Estimation

## 

## 3.7.1 Software Cost Estimation

For cost estimation, the COCOMO (Constructive Cost Estimation Model) is used.

Table 3.1: COCOMO model coefficients

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Software Category** | **A** | **B** | **c** | d |
| **Organic** | 2.4 | 1.05 | 2.5 | 0.38 |
| **Semi-detached** | 3.0 | 1.12 | 2.5 | 0.35 |
| **Embedded** | 3.6 | 1.20 | 2.5 | 0.32 |

**Software Project Category:** Semi-Detached

* **Estimated Lines of Code(LOC):**800LOC(**Flask Backend & Webhook Handling: 500 LOC** + **DeepSeek API Integration & Handling Requests: 300 LOC**) = 0.8 KLOC

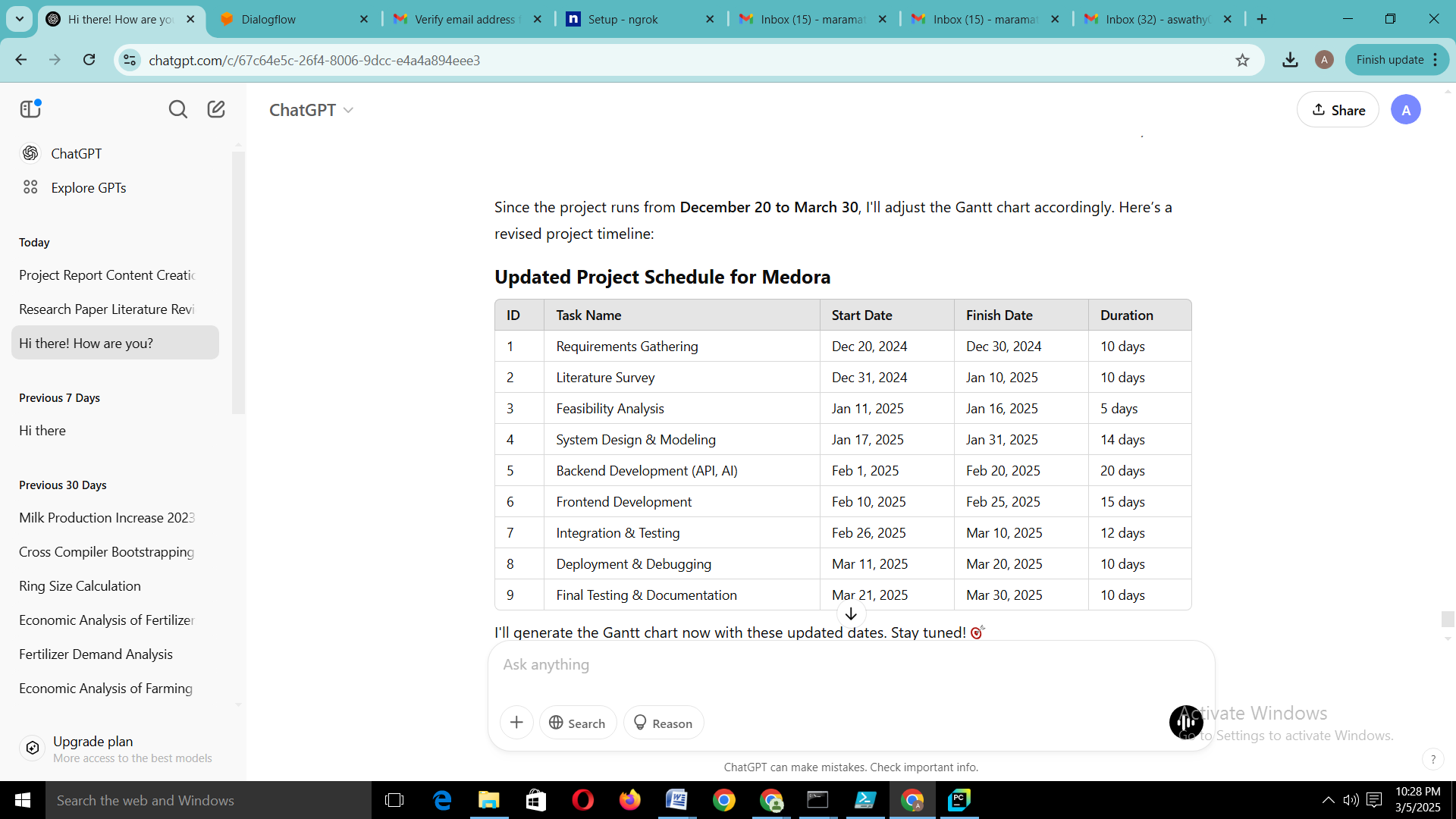
**Effort applied** = a\*(KLOC)b [Person-Months]=2.4(0.8)1.05 = 1.99PM(Person-Months) **Development Time** =c\*(Effort)d = 2.5(1.99)0.38 = 2.68 months ≈ 124 days

**No: of Persons** = Effort / Development Time = 1.99 / 2.68 = 0.74 ≈ 1 person.

If ‘X’ is the salary of one person, then total development cost is 1×X×2.68 for this project.

## 3.8 Project Scheduling using Gantt chart

Table 3.2: Project timeline

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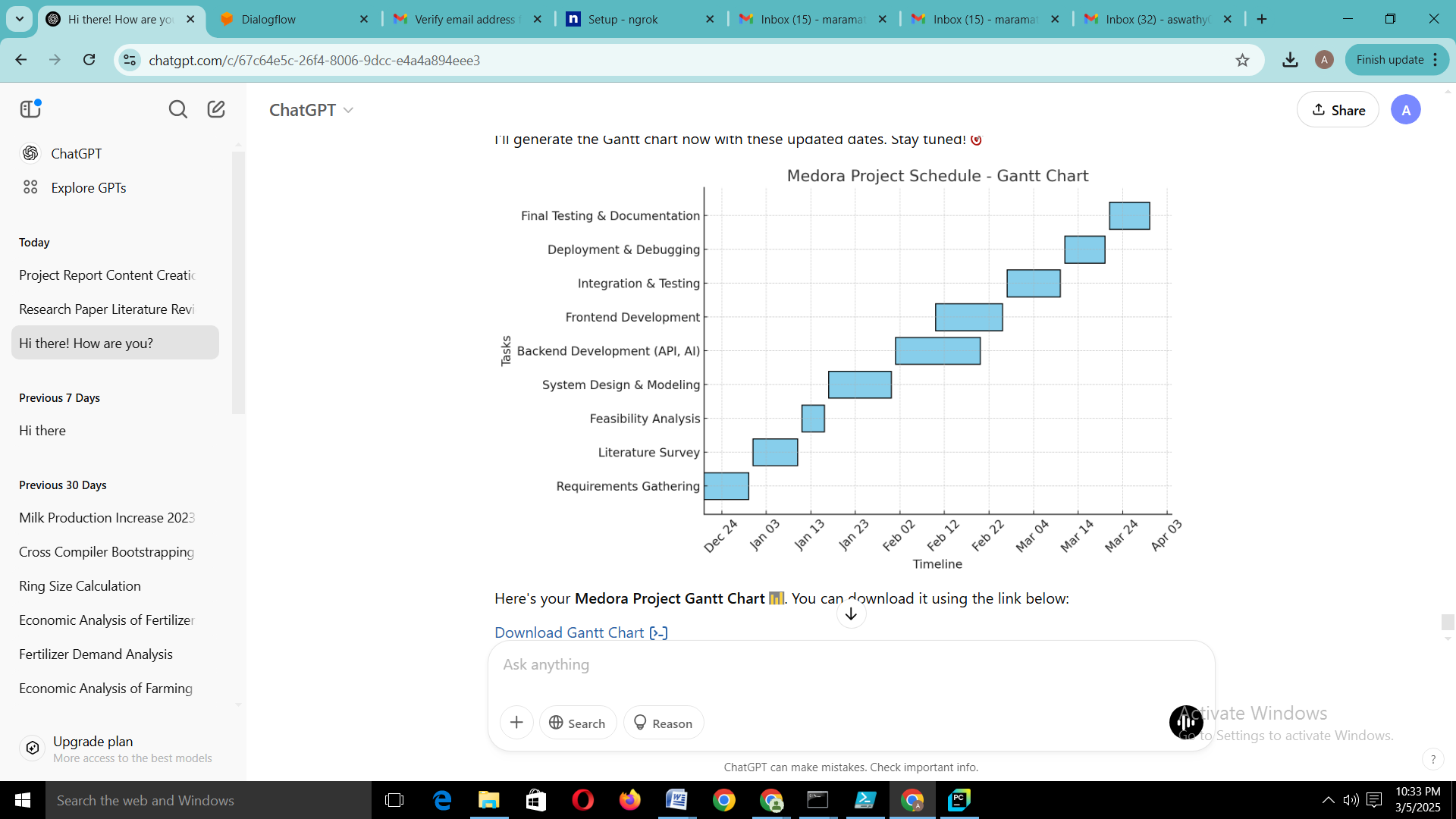
****

Figure3.2: Project Schedule using Gantt chart

The Gantt chart shows the project scheduling. Gantt chart shows the start and finish date of the project. The project phases will be completed as per the prescribed time schedule in the above Gantt chart shown in Figure 3.2. The starting date was 24/12/2024 and the project is expected to complete on 31/03/2025.

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