Hamdard University
Department of Computing
Final Year Project

GlucoPredict: AI-Powered Diabetes Predictor (FYP-017/FL24)

Software Requirements Specifications

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Document Sign off Sheet

Document Information

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Revision History

Date	Version	Description	Author
14/08/2024	1.0	Prepared Draft of SRS	M. Hassan
22/12/2024	1.1	Made changes related to Req.	M. Hassan

Definition of Terms, Acronyms, and Abbreviations

Term	Description
EHR (Electronic Health Records)	Digital versions of patients' paper charts, providing real-time, patient-centered records that make information available instantly and securely.
GDPR (General Data Protection Regulation)	A legal framework that sets guidelines for the collection and processing of personal information
GCP (Google Cloud Platform)	A suite of cloud computing services that runs on the same infrastructure that Google uses for its end-user products.
Logistic Regression	A statistical method for analyzing datasets in which there are one or more independent variables that determine an outcome
Random Forest	An ensemble learning method for classification, regression, and other tasks that operates by constructing multiple decision trees
Flutter/Dart	A UI toolkit for crafting natively compiled applications for mobile, web, and desktop from a single codebase (Flutter), and its programming language (Dart).
Docker	A platform used to develop, ship, and run applications inside containers to ensure they work seamlessly across environments.
Jupyter Notebook	An open-source web application that allows users to create and share documents containing live code, equations, visualizations, and narrative text.
AWS (Amazon Web Services)	A subsidiary of Amazon providing on-demand cloud computing platforms and APIs.
Decision Tree	A decision support tool that uses a tree-like model of decisions and their possible consequences.

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1. Introduction

1.1 Purpose of Document

The purpose of this document is to provide a comprehensive overview of the GlucoPredict project, detailing its objectives, scope, and requirements. This document serves as a guide for all stakeholders, including developers, healthcare professionals, and researchers, ensuring a clear understanding of the system's functionality, constraints, and interfaces. It aims to standardize communication among all parties involved in the project's lifecycle.

1.2 Intended Audience

This project is intended for the following audience:

- **Project Team**: Developers, designers, and testers involved in building and maintaining the GlucoPredict system.
- **Stakeholders**: Sponsors, project champions, and healthcare providers who oversee the project's progress and ensure alignment with its goals.
- **End-Users**: At-risk individuals and healthcare providers who will use the system for predicting diabetes risks and monitoring health outcomes.
- **Researchers**: Individuals exploring advancements in AI-driven healthcare solutions and predictive analytics related to diabetes and chronic disease management.

1.3 Abbreviations

Abbreviation	Description
SRS	Software Requirements Specification
UI	User Interface
JSON	JavaScript Object Notation
ML	Machine Learning
SQL	Structured Query Language
LLM	Large Language Model

2. Overall System Description

2.1 Project Charter

GENERAL PROJECT INFORMATION	
PROJECT NAME	GlucoPredict: AI-Powered Diabetes Predictor
PROJECT SPONSOR	Muhammad Moiez Siddiqui Muhammad Hassan bin Sabih
PROJECT MANAGER	Muhammad Moiez Siddiqui
STAKEHOLDERS	Patients, Health Care Providers, Institutions
EXPECTED START DATE	14/08/2024
EXPECTED COMPLETION DATE	

PROJECT DETAILS	
EXECUTIVE SUMMARY	**GlucoPredict** is a predictive healthcare platform designed to assess an individual's risk of developing diabetes based on their medical and lifestyle data. By integrating advanced machine learning algorithms, health data analytics, and an intuitive user interface, GlucoPredict empowers users and healthcare professionals to make informed decisions for early intervention and prevention. The system simplifies diabetes risk prediction through real-time analysis, personalized recommendations, and report generation, making healthcare management more accessible and data-driven.
AUTHORIZATION	This project has been officially authorized by **Hamdard University**, with the approval of the **Final Year Project Supervisor** and academic evaluation committee. The project aligns with the university's mission to promote technology-driven healthcare solutions and contributes to public health awareness through predictive analytics and AI integration.
OBJECTIVES	• To develop a reliable system for predicting the risk of diabetes using patient medical and lifestyle data. • To provide a user-friendly platform for healthcare professionals and individuals to access risk assessments and recommendations. • To enable secure storage and management of patient records for continuous monitoring and decision-making. • To facilitate early diagnosis and preventive healthcare actions through AI-powered risk analysis

EXPECTED BENEFITS	• **For Patients:** Early awareness of potential health risks. Access to personalized preventive healthcare guidance. • **For Healthcare Providers:** Improved decision-making support through data-driven risk predictions. Faster and more efficient patient screening and monitoring. • **For Institutions:** Contribution to public health management initiatives. Adoption of AI-based solutions for proactive disease prevention.
SCOPE	• Diabetes risk prediction using machine learning models based on patient data. • User-friendly web-based interface with secure login and patient profile management. • AI-powered result analysis, recommendations, and report generation. • Integration of a database for patient record storage and retrieval. • Scalability for potential integration of additional health risk predictions in the future.
MILESTONES	• Initial requirement Gathering – August 18, 2024 • Prototype Development – Nov 7, 2024 • Backend and Frontend Integration – December 18, 2024 • Final Testing and Deployment – March 16, 2025
SUCCESS METRICS	• 87% accuracy in Predictive Analytics • 94% user satisfaction rate during testing. • Detection of diabetes in no longer than a minute
ESTIMATED COST & RESOURCES	• Budget – Rs 1,40,000 • Human Resources – 2 developers • Tools – Visual Studio Code, Jupiter Notebook, Colabs, SQL Server • Materials – AWS, Laptops, Mobiles for testing and supporting software.
Date	August 14, 2024

2.2 Project Background

Diabetes affects millions globally, and early detection remains a challenge due to limited diagnostic accessibility. The **GlucoPredict** project leverages AI and machine learning to predict diabetes risk using health, demographic, and lifestyle data, empowering proactive measures and data-driven healthcare decisions.

2.3 Problem Statement

Current diabetes detection methods are reactive and resource-intensive, often requiring extensive diagnostic tests and clinical visits. These limitations hinder early intervention, especially in underserved populations. GlucoPredict addresses this gap by offering a predictive, accessible, and user-friendly tool to assess diabetes risk and enable preventative measures.

2.4 Project Scope

The scope of this project includes:

- Developing an AI-powered system to predict diabetes risk.
- Integrating multiple data sources, such as electronic health records (EHR), demographic information, and lifestyle inputs.
- Providing an intuitive user interface for at-risk individuals and healthcare providers.
- Delivering actionable insights for early intervention and better disease management.

2.5 Not In Scope

The following aspects are excluded from the current scope of the project:

- Direct medical treatment or therapeutic interventions.
- Integration with wearable devices or continuous monitoring hardware.
- Real-time glucose level tracking.

2.6 Project Objectives

- Develop a robust predictive model for diabetes risk assessment.
- Ensure data privacy and compliance with relevant regulations, such as GDPR and HIPAA.
- Deliver a scalable and maintainable software solution.
- Facilitate accessibility through a web-based and mobile-friendly interface.

2.7 Project Plan

Phase Name	Description	Start Date	End Date	Duration	Responsible Person
Project Initiation	Proposal drafting, problem identification, supervisor approval	16/08/24	20/8/24	4 Days	Hassan bin Sabih
Requirement Gathering and Analysis	Collect and finalize functional and non – functional requirements	22/8/24	30/8/24	8 Days	Hassan bin Sabih

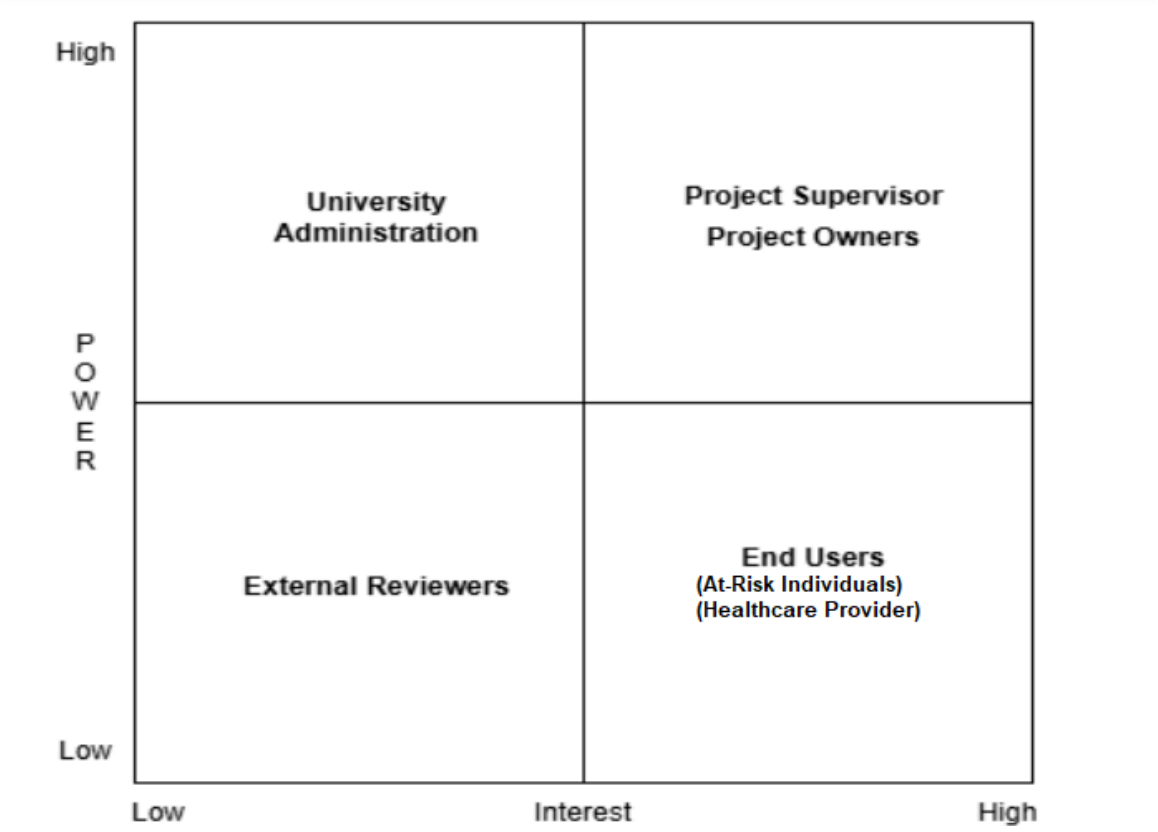
System Architecture & Design	Design system architecture, data flow diagrams, and database schema	2/9/24	9/9/24	7 Days	Hassan bin Sabih
ML Model Development	Data preprocessing, model selection, training and evaluation	10/9/24	4/10/24	27 Days	Moiez Siddiqui
Integration & API Development	Connect app with backend APIs, Firebase, and prediction server	1/1/25	30/1/25	30 Days	Moiez Siddiqui
Testing & Debugging	Perform unit, integration, system, and UAT tests	1/2/25	15/2/25	15 Days	Moiez Siddiqui
Deployment Preparation	Finalize app, hosting, and database setup for production	1/3/25	20/3/25	20 Days	Moiez Siddiqui
Document Finalization	Prepare final FYP report, coding standards, policies, and manuals	1/7/25	2/7/25	1 Day	Hassan bin Sabih
Final Presentation & Submission	Prepare slides, project demonstration, and final submission	2/7/25	3/7/25	1 Day	Hassan bin Sabih

2.8 Stakeholders & Affected Groups

Stakeholders Register

Stakeholder	Role	Interest	Influence
At-Risk Individuals	End-User	Accurate diabetes predictions and health insights	High
Healthcare Providers	End-User	Reliable data to support preventive care	High
Project Supervisor	Advisor	Alignment with Project goals and progress	Medium
Development Team	Implementation	Successful delivery of a functional system	High
Researchers	Evaluator	Exploring advancements in predictive healthcare tools	Medium

- **Stakeholder Analysis Matrix**



- **Stakeholder Communication Plan**

Stakeholder	Communication Medium	Frequency	Engagement Strategy
At-Risk Individual	Email, Surveys	Bi-Weekly	Regular feedback and usability testing
Healthcare Provider	Email Presentation	Bi-Weekly	Updates on progress and system features
Project Supervisor	Meetings, Reports	Weekly	Progress updates and milestones reviews
Development Team	Daily Standups	Daily	Collaborative sprints and team discussions
Researchers	Reports, Presentations	Quarterly	Sharing insights and research outcomes

2.9 Operating Environment

The system will operate in a cloud-based environment, utilizing secure and scalable infrastructure. It will support cross-platform functionality, including web browsers and mobile devices. The system ensures compliance with healthcare data privacy regulations.

2.10 System Constraints

- The model's performance depends on the quality and diversity of input data.
- Limited access to comprehensive datasets could affect prediction accuracy.
- Strict adherence to data protection laws may impose constraints on data handling and storage.

2.11 Assumptions & Dependencies

- Users will provide accurate and complete information for the system to generate predictions.
- Internet connectivity is required for the system to function effectively.
- The success of the project depends on the availability of appropriate datasets and cloud infrastructure.

3. External Interface Requirements

3.1 Hardware Interfaces

The hardware interface for GlucoPredict is designed to ensure optimal performance and reliability:

- **Laptop**: Features a multi-core Intel i9 processor, 16GB RAM, and a 500GB SSD, providing powerful computation, smooth multitasking, and ample storage for large datasets.
- **Backup Hard Drives**: Offer secure data redundancy, protecting against data loss and ensuring continuity of development.
- **Internet Dongle**: Ensures reliable high-speed connectivity, crucial for accessing cloud resources, online databases, and collaboration tools.
- **Multifunctional Printer**: Supports printing, scanning, and copying, facilitating documentation, presentations, and efficient record-keeping.

3.2 Software Interfaces

The GlucoPredict application interfaces with several software systems and tools to achieve its functionalities. The table below lists the applications, their external owners, and interface details:

Application	External Owner	Interface Details
Visual Studio Code	Microsoft	Used as the primary environment. Interfaces with GlucoPredict's source code repository and debugging tools via extensions and plugins.
Jupyter Notebook	Open Source Community	Utilized for prototyping and data analysis. Interfaces through Python kernel to test and debug machine learning algorithms.
Google Colab	Google	Cloud-based Jupyter environment. Used for collaborative development and testing, integrating with Python libraries for AI model training and evaluation
SQL Server	Microsoft	Stores user data and application configurations. Interfaces with the GlucoPredict backend through SQL queries using an ODBC/JDBC connection.

3.3 Communications Interfaces

The GlucoPredict application communicates with various systems and devices through the following interfaces:

1. **Local Area Network (LAN):**
    - The application uses LAN for seamless communication between the development machine and SQL Server during testing and debugging.
    - SQL Server communicates over standard TCP/IP protocols for database queries and management.

2. **Cloud Environment (Google Colab):**
    - The application leverages the internet for connecting with Google Colab to train models on shared or cloud-based datasets.
    - HTTP/HTTPS protocols are used for data transfer and API integration.
3. **Development Tools:**
    - **Visual Studio Code** connects via local file system APIs or Git for version control and collaboration.
    - **Jupyter Notebook** operates locally, communicating directly with Python environments and libraries installed on the system.

4. Risk Analysis

4.1 Risk Identification

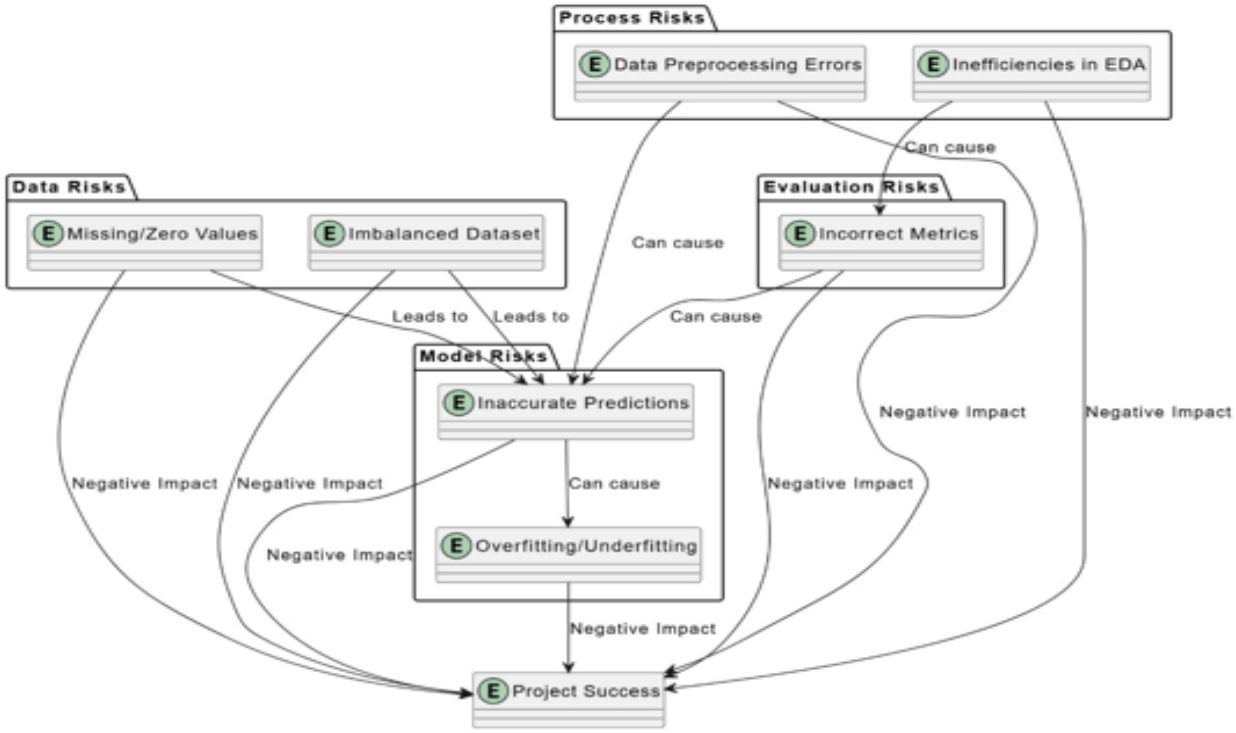
Methods Used for Identifying Risks:

- **Brainstorming Sessions**: Conducted with stakeholders to identify potential risks.
- **SWOT Analysis**: Evaluating the strengths, weaknesses, opportunities, and threats of the project.
- **Expert Consultation**: Input from data security experts, healthcare professionals, and AI specialists.
- **Historical Data Review**: Analyzing similar projects for recurring risks.

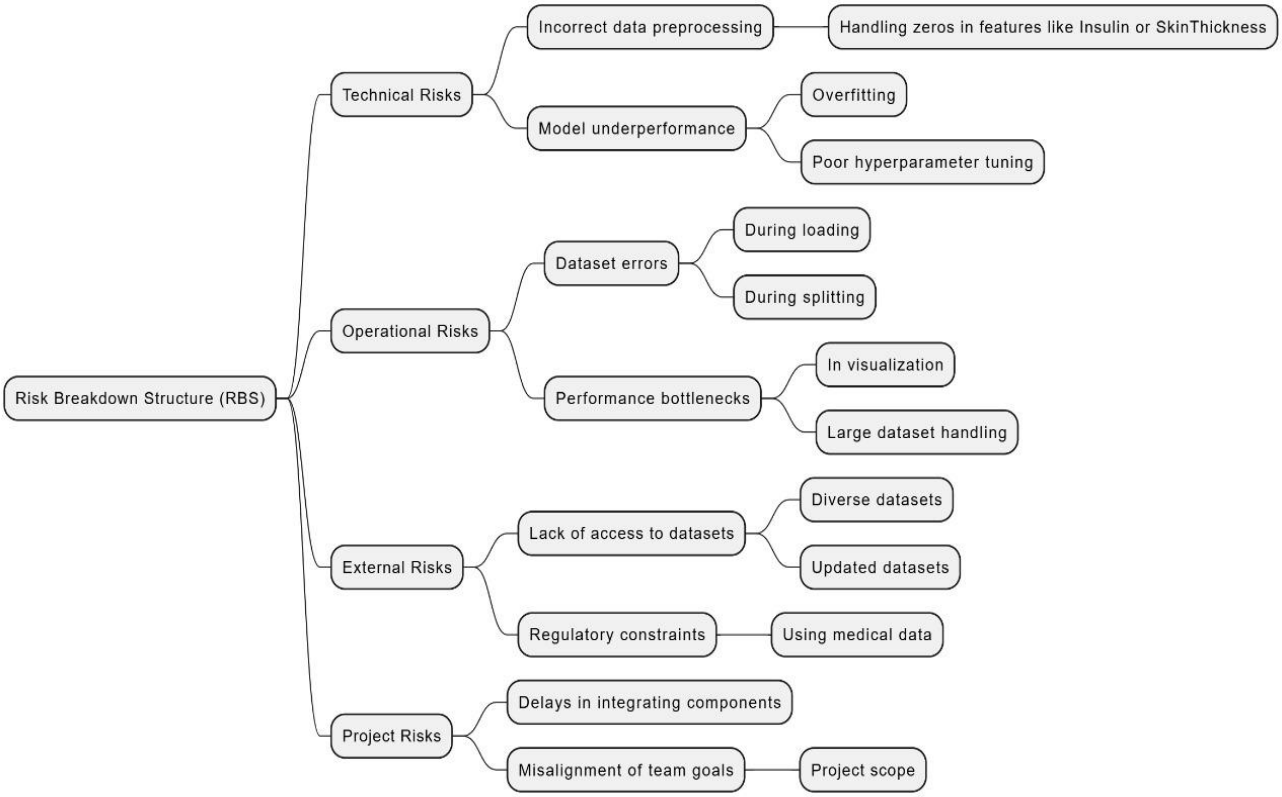
List of Identified Risks:

1. **Data Privacy Risks**: Potential breaches of sensitive user data.
2. **Model Accuracy**: Inaccurate predictions due to biased or insufficient training data.
3. **Regulatory Compliance**: Non-adherence to GDPR, HIPAA, or other healthcare data laws.
4. **System Downtime**: Service disruptions caused by server overload or failure.
5. **User Adoption Challenges**: Users may hesitate to trust or adopt the technology.
6. **Development Delays**: Delays due to resource shortages or technical complexities.
7. **Integration Issues**: Challenges in integrating the system with external tools or APIs.

Risk Breakdown Strategy:
Operational Risk



Technical Risk



4.2 Risk Mitigation Strategy

1. **Data Privacy Risks**:
   - Employ end-to-end encryption and secure authentication mechanisms.
   - Regularly audit data security practices.
2. **Model Accuracy**:
   - Use diverse datasets and perform regular validation and retraining.
   - Implement explain ability features for transparency in predictions.
3. **Regulatory Compliance**:
   - Consult legal experts to ensure adherence to laws.
   - Maintain detailed records of compliance measures.
4. **System Downtime**:
   - Utilize scalable cloud infrastructure and backup systems.
   - Set up automated monitoring and failover mechanisms.
5. **User Adoption Challenges**:
   - Provide educational materials and a simple user interface.
   - Gather and implement user feedback to enhance trust.
6. **Development Delays**:
   - Use agile project management to adapt to challenges quickly.
   - Allocate resources effectively to high-priority tasks.
7. **Integration Issues**:

- Test system compatibility with external APIs during development.
- Maintain clear documentation for integrations.

Risk Register

Risk ID	Risk Description	Likelihood	Impact	Mitigation Strategy	Owner	Status
R1	Data privacy and security breaches	High	Critical	Implement robust encryption, comply with GDPR and HIPAA, and conduct regular audits	Project Manager (PM)	Open
R2	Inaccurate AI predictions leading to user mistrust	Medium	High	Continuously improve and validate the AI model using diverse datasets	AI Development Lead	Open
R3	Limited availability of comprehensive datasets	High	High	Partner with healthcare institutions and leverage public health data sources.	Data Acquisition	Open
R4	User resistance to adopting the system	Medium	Moderate	Conduct user education campaigns and design an intuitive user	UX/UI Designer	Open
R5	Integration challenges with healthcare workflows	Medium	High	Collaborate with healthcare providers during the development phase	System Integration Lead	Open
R6	Technical issues during deployment	Low	High	Conduct extensive testing and maintain a contingency plan for rollbacks	DevOps Engineer	Open
R7	High initial development and operational costs	Medium	High	Seek external funding and allocate resources efficiently.	Financial Manager	Open
R8	Regulatory compliance challenges	Medium	High	Engage legal experts and stay updated on healthcare regulations	Legal Advisor	Open
R9	Dependency on third-party services for data storage and processing	Low	Moderate	Diversify cloud providers and ensure service-level agreement	Infrastructure Lead	Open
R10	Lack of skilled personnel	Low	Moderate	Provide training programs and hire experience professionals	HR Manager	Open

5. System Functions / Functional Requirements

5.1 System Functions

The GlucoPredict system functions are listed below, arranged according to their logical functionalities, along with descriptions of their characteristics and limitations.

#	Functions	Category	Attributes	Constraints
R1.1	Collect user health data (e.g., age, weight, glucose levels).	Evident	System Response Time	User data collection form should load within 2 seconds
R1.2	Train predictive models using historical and real-time health data.	Hidden	Concurrent Processing Load	The system should handle up to 5 training processes simultaneously
R1.3	Provide diabetes risk-predictions to users in an interpretable format	Evident	Response Time	Predictions must be generated and displayed within 3 seconds
R1.4	Allow integration with SQL Server for secure data storage and retrieval	Hidden	Database Access Latency	Queries should execute with a response time of less than 1 second
R1.5	Enable collaboration via Google Colab for shared analysis and testing.	Frill	Compatibility	Supports collaborative editing in real time for up to 3 users

System Attributes/ Nonfunctional Requirements

Attribute	Details & Boundary Constraints	Category
Response Time	Predictions delivered within 3 seconds	Mandatory
Concurrent User Load	Minimum of 10 users connected and querying simultaneously	Mandatory
Interface Metaphor	Graphical, web-based, intuitive dashboard	Optional
Usability	Designed for both technical and non-technical users	Mandatory

5.2 Use Cases

5.2.1 List of Actors

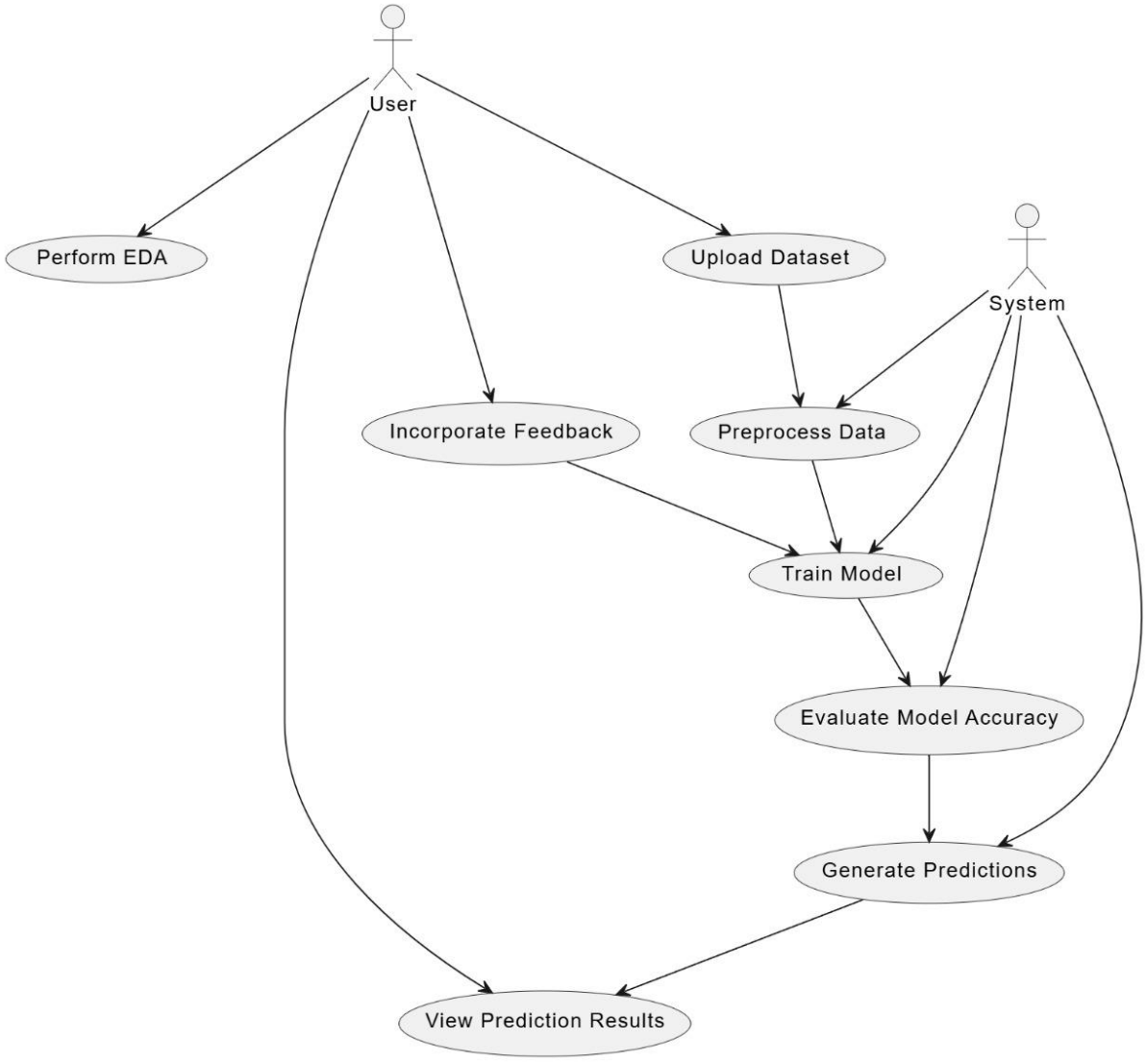
- **End-User:** An individual who inputs health data to receive diabetes risk predictions
- **Healthcare Provider:** A professional reviewing predictive results to make informed clinical decisions.
- **Data Scientist:** A researcher analyzing model outputs and refining predictive algorithms.

5.2.2 List of Use Cases

Use Case	Brief Description
Input User Data	Collect user health details for diabetes risk analysis
Generate Risk Prediction	Provides diabetes risk result based on user input.

Visualize Prediction Results	Displays predictions and insights in an interpretable format (e.g., charts).
Model Training	Allows researchers to train and validate predictive models using new datasets.
Data Storage and Management	Stores and retrieves user health data securely in SQL Server.
Collaborative Model Analysis	Supports collaborative evaluation and tuning of AI models via Google Colab.

5.2.3 Use Case Diagram



5.2.4 Description of Use Cases

Section: Main	
Name:	*Input User Data*
Actors:	*End User*
Purpose:	*Collect user health information for diabetes risk analysis*
Description:	*The end user provides their personal health-related data, such as age, weight, glucose levels, and other relevant metrics. The system validates the input and stores it securely in the database for further processing.*
Cross References:	*Functions: R1.1, R1.5* *Use Cases: Data must be stored in the system before generating risk predictions.*
Pre-Conditions	*User is authenticated and logged in.*
Successful Post-Conditions	*Data is securely stored and validated.*
Failure Post-Conditions	*Invalid data is flagged, and the user is prompted to errors.*

Typical Course of Events

Actor Action		**System Response**	
1	*The user opens the data input form*	*2.*	*Displays a user-friendly form for entering personal and health data.*
3.	*The user inputs the required data fields*	*4*	*Validates the input and highlights any missing or invalid information.*
5	*User submits the form*	*6*	*Stores the data in the SQL Server database.*

Alternative Course	
Step 3:	*User enters incomplete or invalid data. System displays an error message and highlights invalid fields.*
Step 5:	*Database connection fails. System prompts the user to retry or contact support.*

Section: Generate Risk Prediction	
Name	*Generate Risk Prediction*
Actors:	*End use, Healthcare Provider*
Purpose:	*Provide a diabetes risk assessment based on user input*
Description	*The system analyzes the collected data using pre-trained AI models and returns a risk prediction score with relevant insights*
Cross References	*Functions: R1.2, R1.3* *Use Cases: User must have completed the Input User Data use case.*
Pre- Conditions	*User data is present in the system*
Successful Post-Conditions	*Risk prediction and insights are displayed.*

Failure Post-Conditions	*Displays an error message and prompts for retry.*
Typical Course of Events	
Actor Action	**System Response**
1. User requests a risk prediction	*2. Fetches the user data from the database*
3. System processes the data through the AI model.	*4. Displays the risk prediction score and supporting insights.*
Alternative Course	
Step 1:	*User data is incomplete or corrupted. System displays an error and requests updated data.*
Step 3:	*Model processing fails due to a system error. Systems logs the error and notifies the user of a temporary issue.*
Section: Collaborative Model Analysis	
Name	*Collaborative Model Analysis*
Actors	*Data Scientist*
Purpose	*Enable multiple data scientists to collaboratively train and refine models*
Description	*The system provides an interface for collaborative model development using cloud-based platforms like Google Colab.*
Cross References	*Functions: R1.4, R1.5* *Use Cases: Data storage and user authentication must be functional*
Pre-Conditions	*User is authenticated*
Successful Post-Conditions	*Models changes are saved and synced*
Failure Post-Conditions	*Collaborative session fails, and users are notified*
Typical Course of Events	
Actor Action	***System Response***
1. User initiates a collaborative	*2. Connects to Google Colab and sets up the environment*
3. Users make changes to the model	*4. Syncs updates in real-time and logs changes*
Alternative Course	
Step 1:	*Connection to Colab fails. System retires the connection or offers an offline option.*
Step 3:	*Conflicting updates occur. System flags conflictsand prompts users to resolve them.*

6. Non - Functional Requirements

6.1 Performance Requirements

• **Prediction Response Time:** The system must deliver diabetes risk predictions within 3 seconds of receiving user input.
• **Concurrent Users:** The system should support a minimum of 10 simultaneous users performing queries.
• **Data Processing:** Training models should complete within a maximum of 30 minutes for datasets up to 1GB.

6.2 Safety Requirements

- **Data Accuracy:** The system must validate input data to prevent errors in predictions that could mislead users about their health status.
- **Model Interpretability:** Predictions must include confidence levels and clear explanations to ensure users understand the results and do not act on misleading or unclear information.
- **Health Disclaimer:** The system must display a disclaimer indicating that results are not a substitute for professional medical advice.

6.3 Security Requirements

- **Data Encryption:** All user data must be encrypted during transmission (TLS 1.2 or higher) and at rest (AES-256).
- **Authentication:** Multi-factor authentication (MFA) is required for access to administrative features and sensitive data.
- **Access Control:** Role-based access control must be implemented to restrict data scientist, healthcare provider, and end-user access levels.
- **Data Breach Response:** The system must have a breach notification system in compliance with relevant regulations (e.g., GDPR, HIPAA).

6.4 Reliability Requirements

- **Uptime:** The system should maintain an uptime of 99.9% annually.
- **Backup:** Automatic daily backups of the database are required, with a retention policy of 30 days.
- **Error Handling:** The system must provide meaningful error messages and fallback mechanisms for failures (e.g., database connection loss).

6.5 Usability Requirements

- **Intuitive Interface:** The user interface must be easy to navigate, with minimal training required for end users and healthcare providers.
- **Accessibility:** The system should meet accessibility standards (e.g., WCAG 2.1 Level AA).
- **Multilingual Support:** The system must support at least three languages, including English, to cater to diverse users.

6.6 Supportability Requirements

- **Scalability:** The system should be designed to scale horizontally to support increased user loads and data volumes.
- **Platform Compatibility:** Ensure compatibility with multiple environments, including Windows, macOS, and Linux for local use.
- **Documentation:** Comprehensive technical documentation must be provided for developers and system administrators.

6.7 User Documentation

- **User Manual:** A detailed guide for end users, explaining data input, prediction interpretation, and system navigation.
- **FAQ:** A repository of frequently asked questions and troubleshooting steps.
- **Training Resources:** Video tutorials and training materials for healthcare providers and researchers.
- **Support Portal:** An online portal for reporting issues, accessing updates, and requesting feature enhancements.

7. References

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- [1] Diabetes Risk Prediction using Machine Learning Techniques. Journal of Medical Informatics, 2021.
- [2] World Health Organization. (2022). Diabetes Fact Sheet. [Online]. Available: https://www.who.int
- [3] American Diabetes Association. (2023). Standards of Medical Care in Diabetes. [Online]. Available: https://diabetes.org

• Tools and Technologies

- Visual Studio Code: https://code.visualstudio.com
- Jupyter Notebook: https://jupyter.org
- Google Colab: https://colab.research.google.com
- SQL Server Documentation: https://docs.microsoft.com/sql

• Standards and Guidelines

- GDPR Compliance Documentation: https://gdpr-info.eu
- HIPAA Compliance Guidelines: https://www.hhs.gov/hipaa
- Web Content Accessibility Guidelines (WCAG 2.1): https://www.w3.org/WAI/standards-guidelines/wcag

• Frameworks and Libraries

- Scikit-learn: https://scikit-learn.org
- TensorFlow: https://www.tensorflow.org

• Development and Testing Tools

- Github: https://github.com/Moiez-Siddiqui/Gluco_Diabetes
- Pytest: https://docs.pytest.org

• Other References

- GlucoPredict Project Proposal Document (Internal).
- Requirements Gathering Interview Notes (Internal).
- Data Sources: https://www.kaggle.com for healthcare datasets.