A

Project on

"DISASTER RECOVERY ADVISOR"

A Major project report

Submitted by

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Under the guidance of

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Of
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CERTIFICATE OF ORIGINALITY

We have developed the project entitled "**Disaster Recovery Advisor**" as fulfilment of Master of Computer Applications degree (4th semester). While developing the project no unfair means or illegal copies of software's have been used, and no document has been submitted elsewhere or copied.

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CERTIFICATE OF ACCEPTANCE

The report of the project entitled "**Disaster Recovery Advisor**" is a work done and submitted by **Suchitra Mahato, Kushar Raj Kashyap, Ayush Kumar, Shivam Kumar, Ayush Raj** for their 4th semester project and it is hereby recommended to be accepted for the partial fulfilment of the requirement for MCA degree in **Haldia Institute of Technology.**

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Abstract

The primary goal of this project is to develop an AI/ML-based model that predicts natural disasters such as floods, earthquakes, storms, etc. based on historical data, geographical attributes (latitude, longitude), and time-based factors. The model analyzes past disaster patterns and environmental conditions to provide highly accurate forecasts for disaster preparedness. While predicting the type and duration of disasters, the system also estimates potential casualties, economic losses, and infrastructure damage when applicable. By generating customized recovery plans, it suggests optimal resource allocation, evacuation strategies, medical aid distribution, and post-disaster rebuilding measures.

This project plays a crucial role in supporting governments, NGOs, and emergency responders by enabling data-driven decision-making for disaster mitigation and recovery. The system improves response efficiency, minimizes loss of life and property, and ensures better disaster management through smart recommendation based on AI-powered insights.

Contents

Contents

Chapter 1

Introduction

An introduction typically consists of the following components:

1.1.1 Problem Scenario

- Severe loss of life and infrastructure damage is caused by the natural disasters existing systems struggling with timely and accurate prediction, resource allocation, prior recovery planning and availability of essential relief assistance.
- Existing systems do not have AI-driven insights, which limits the ability to process and analyze vast datasets efficiently and faster decision-making for disaster preparedness and recovery. These systems often fail to provide visibility into the availability and distribution of essential relief materials and this leads to resource shortage and delays during critical moments. The AI/ML part of the system is used to predict and optimally timize resource distribution and provide tailored recovery plans, minimizing disaster impact.

1.1.2 Proposed Solution

- Based on the historical data and geographical attributes, our system makes disaster type, duration, and impact prediction using our AI/ML-based system. With the help of machine learning and AI-based recommendations, it provides forecasts with accuracy and AI-based tailored recovery plan recommendations.
- It is unlike any existing alert-focused systems, as it provides proactive predictions and optimizes resource allocation. The platform aims to be scalable and efficient in dealing with disasters.
- To address the uncertainty of relief materials, the system includes a resource relief assistance module that monitors the availability and distribution of

essential resources. This helps authorities avoid shortages and ensures the timely delivery of aid during critical times.

1.1.3 Purpose

- Developing an AI/ML-based system that will predict natural disasters based on historical data and geographical attributes and then suggest trailored recovery plans accordingly for faster and more efficient recovery processes for affected regions.
- Proactive predictions of disastrous events, better allocation of resources for governments and NGOs to prepare for upcoming misfortunes with relief assistance, and improvement of disaster recovery strategies applied to each specific kind of disaster and its intensity.

1.1.4 Scope

- The project involves predicting natural disasters (floods, earthquakes, storms) with the help of historical data and geographical attributes. It does not offer real-time updates or emergency repair services.
- Disaster prediction, estimation of disaster duration as well as recommendations for AI-driven recovery. This facilitates governments and NGOs in allocating their resources optimally against the impact of predicted disasters.
- Accuracy of the model is conditioned by data quality and completeness. A smart resource assistance is integrated, allowing authorities to monitor relief material inventories and receive prompts for replenishment, ensuring materials are sufficient during emergency responses.

Chapter 2

Literature Survey

2.1 Domain Survey

2.1.1 Introduction to the Domain

- This project belongs to AI-driven disaster management using AI, machine learning, predictive analytics, and optimization of resources deployed to improve preparedness and disaster recovery.
- Natural disasters cause huge damage, and without the predictive models, resources are not allocated efficiently. The aim is to design an AI-based system that can predict disaster types to provide time for proactive planning of a recovery.
- Predictions can be used by Governments and NGOs to allocate resources well. Urban planners can create disaster mitigation strategies as well as integrate them into infrastructure planning, so insurance companies can assess risks better.

2.1.2 Core Terminologies and Definitions

- **Natural Hazard:** Physical phenomena caused by natural events like earthquakes, floods, hurricanes, etc. are known as natural hazards. (Source: IEEE Disaster Risk Management Standards)
- **Risk Assessment:** This is a process consisting of hazard identification, vulnerability analysis, and impact estimation to calculate the risk posed by a disaster. (Source: ACM Disaster Management Frameworks)
- **Machine Learning:** A branch of AI that enables systems to learn patterns from historical data that makes predictions without explicit programming. (Source: IEEE Transactions on AI/ML)

- **Disaster Recovery Planning:** Strategies and measures of disaster recovery plan aimed at restoring normalcy after the expected disaster event. (Source: FEMA, National Institute of Standards and Technology - NIST)

2.1.3 Associated Theoretical Concepts

- **Machine Learning Algorithms:** Random Forest, Support Vector Machine, Navie Bayes, or K-Nearest Neighbor are used to analyze historical data about disasters and predict future occurrences, and that is called predictive analytics models.
- **Historical Evolution:** Conventional disaster management frequently resulted in ineffective preparedness and recovery because it depended on manual risk assessment and generic emergency response plans. Predictive analytics and machine learning have been combined to improve planning and resource allocation by making disaster forecasts more data-driven and accurate.

2.1.4 Challenges and Open Problems

- A lack of historical data has resulted in low accuracy for several catastrophe prediction models. Large-scale ML model deployment in underdeveloped nations is hampered by a lack of computing capacity.
- Location-based disaster forecasts raise privacy concerns. AI-based resource allocation decision-making is subject to legal concerns. As part of social impact, projections are made accessible to communities with inadequate internet infrastructure.

2.2 Literature Survey

2.2.1 Research Review

- P. Purushotham, D. Divya Priya, and Dr. Ajmeera Kiran, "Disaster Analysis Using Machine Learning," presented at the IEEE International Conference on Advancements in Smart, Secure, and Intelligent Computing (ASSIC), 2022. [Online]. Available: ResearchGate.
  - **Abstracted Summary**
    - Reviews ML techniques for disaster and pandemic management, covering prediction, classification, and social media analysis.
    - Explores applications of ML in evacuation planning, damage assessment, and resource allocation.
  - **Problem Statement**
    - Traditional disaster analysis lacks real-time insights and efficient predictive models.
    - Disaster response is often reactive rather than proactive.
    - Processing large, unstructured disaster data poses challenges.
  - **Proposed Solution:**
    - **ML-Based Classification:** Uses supervised learning models (SVM, Decision Trees, KNN) for disaster classification.
    - **Social Media Analysis:** Employs AI to extract disaster-related insights from online sources.
    - **Automated Resource Allocation:** AI-driven decision support for optimizing response efforts.
  - **Methodology**
    - Data preprocessing to clean and structure disaster datasets.
    - Application of classification models for disaster identification.
    - Analysis of model performance using accuracy, recall, and precision.
  - **Results**
    - ML techniques improved classification accuracy of disaster events.
    - SVM and Decision Trees outperformed other models in pattern recognition.
    - Social media integration enhanced real-time disaster tracking.

- **Conclusion**
  - ML-based disaster management improves predictive accuracy and response efficiency.
  - Future work includes integrating IoT for better data collection and real-time monitoring.

- Miah Mohammad Asif Syeed, Maisha Farzana, Ishadie Namir, Ipshita Ishrar, Meherin Hossain Nushra, Tanvir Rahman "Flood Prediction Using Machine Learning Models," presented at the IEEE International Congress on Human-Computer Interaction, Optimization, and Robotic Applications (HORA), 2022. [Online]. Available: ResearchGate.
  - **Abstracted Summary**
    - Compares multiple ML models for flood prediction based on rainfall data from Bangladesh (1980-2020).
    - Focuses on improving flood forecasting accuracy using historical meteorological data.
  - **Problem Statement**
    - Traditional flood forecasting models lack precision due to non-linear climate patterns.
    - Accurate and timely flood prediction is critical for disaster preparedness.
  - **Proposed Solution:**
    - **ML-Based Predictions:** Uses Binary Logistic Regression, SVM, KNN, and Decision Trees.
    - **Data Preprocessing:** Cleans and structures rainfall datasets for training models.
    - **Comparative Model Evaluation:** Identifies the best-performing model for flood forecasting.
  - **Methodology**
    - Dataset collected from the Bangladesh Meteorological Department.
    - Feature engineering to extract relevant parameters
    - Model training using an 80:20 train-test split for performance evaluation.
  - **Results**

    * Logistic regression outperformed other models, achieving 86.76 percent accuracy.
    * SVM and KNN performed well but had lower consistency across datasets.
    * Feature scaling improved model efficiency.

  - **Conclusion**
    * ML models enhance flood prediction accuracy, aiding proactive disaster management.
    * Future enhancements include integrating satellite imagery and deep learning techniques.

- Murad Al-Rajab, Yaqoob Arshad Jamil, Mahmoud Ahmed Soliman, Samia Loucif, Mohammed Nezam Al'asad, and Ibrahim Al Qatawneh, "Artificial Intelligence for Real-Time Disaster Management," presented at the IEEE International Conference on Computer, Information, and Telecommunication Systems (CITS), 2024. [Online]. Available: ResearchGate.
  - **Abstracted Summary**
    * Proposes an AI-driven disaster recovery platform for efficient disaster response and volunteer training.
    * Focuses on enhancing disaster management with AI-based resource allocation.
  - **Problem Statement**
    * Existing disaster response systems lack structured recovery plans and efficient resource allocation.
    * Volunteer training for disaster response is inadequate.
  - **Proposed Solution:**
    * **AI-Powered Recovery Planning:** Uses ML to generate disaster-specific recovery strategies.
    * **Volunteer Training System:** Provides AI-driven simulation modules for training responders.
    * **Resource Allocation Optimization:** AI assigns resources based on disaster severity and location.
  - **Methodology**
    * Development of a centralized AI platform for disaster information.

    * Training models on historical disaster data to optimize response strategies.
    * Integration of ML-based decision support systems.

  - **Results**
    * AI-based disaster response reduced recovery time and improved coordination.
    * Trained volunteers responded more effectively to disaster scenarios.
    * Real-time analytics optimized resource distribution.

  - **Conclusion**
    * AI significantly improves disaster recovery planning and volunteer training.
    * Future research will focus on expanding the platform to support multilingual accessibility.

- Rania Rizki Arinta, Andi W.R. Emanuel, ”Natural Disaster Application on Big Data and Machine Learning: A Review,” presented at the IEEE Proceedings, 2021. [Online]. Available: ResearchGate.

  - **Abstracted Summary**
    * Reviews the role of big data and ML in disaster management, covering early warning systems and damage assessment.
    * Explores how AI-driven models can improve disaster forecasting.

  - **Problem Statement**
    * Traditional disaster response systems are limited by incomplete data and inefficient forecasting.
    * Lack of structured data integration hinders early warning accuracy.

  - **Proposed Solution:**
    * **Big Data Processing:** analyzes disaster patterns using satellite imagery and sensor data.
    * **ML-Based Forecasting:** Uses deep learning models to enhance prediction accuracy.
    * **Automated Response Coordination:** AI-driven algorithms optimize disaster recovery strategies.

  - **Methodology**

* Review of ML applications in six disaster management areas (e.g., forecasting, damage assessment).
* Comparison of predictive models for disaster mitigation.
* Evaluation of real-world disaster management frameworks.

– **Results**

* ML models improved early warning system accuracy.
* AI-based damage assessment reduced disaster recovery time.
* Big data integration enhanced disaster response coordination.

– **Conclusion**

* AI and big data significantly improve disaster management efficiency.
* Future research should focus on integrating IoT for real-time disaster tracking.

- Vinay Chamola, Vikas Hassija, Sakshi Gupta, Adit Goyal, Mohsen Guizani, and Biplab Sikdar, ”Disaster and Pandemic Management Using Machine Learning: A Survey,” presented at the IEEE Internet of Things Journal, 2021. [Online]. Available: ResearchGate.

– **Abstracted Summary**

* Provides an extensive review of ML applications in disaster and pandemic management.
* Discusses ML-based solutions for disaster prediction, crowd evacuation, and resource allocation.

– **Problem Statement**

* Traditional disaster response lacks predictive accuracy and real-time coordination.
* Pandemic management requires efficient monitoring and forecasting systems.

– **Proposed Solution:**

* **Supervised Learning for Disaster Prediction:** Uses classification models (SVM, Decision Trees).
* **Unsupervised Learning for Risk Assessment:** Clustering techniques to analyze high-risk areas.
* **Reinforcement Learning for Resource Allocation:** AI optimizes emergency response efforts.

- **Methodology**
  - Literature review of ML models in disaster and pandemic scenarios.
  - Evaluation of model performance based on predictive accuracy.
  - Discussion of integration challenges and future research directions.
- **Results**
  - ML improved disaster prediction and response efficiency.
  - AI-driven decision-making optimized resource allocation.
  - Social media analysis enhanced real-time disaster tracking.
- **Conclusion**
  - ML plays a vital role in disaster and pandemic management.
  - Future research should focus on improving model interpretability and ethical considerations.

2.2.2 Summary of Reviewed Research Papers

- Select **10** research papers.
- Summarize each paper, focusing on:
  - **Authors & Year** of publication.
  - **Problem Statement** and **Research Objectives**.
  - **Methodology/Approach** used.
  - **Key Findings & Contributions**.
  - **Limitations & Future Scope**.

Paper Title	Authors & Year	Problem Statement	Methodology	Key Findings
Disaster Analysis Using Machine	Purushotham et al., 2022	Lack of efficient AI-based disaster prediction models	ML techniques such as SVM, Decision Trees	Improved classification accuracy and resource optimization

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Paper Title	**Authors & Year**	**Problem Statement**	**Methodology**	**Key Findings**
Flood Predic-tion Usin g Machine Learning Models	Syeed et al., 2022	Need for accurate flood prediction using ML	Logistic Regression, KNN, SVM, Decision Tree	Logistic Regression achieved highest accuracy (86.76%)
Artificial Intelligence for Real-Time Disaster Management	Singh & Sinha, 2020	Limited AI integration in disaster recovery	AI-driven recovery planning and volunteer training	Faster response times and improved disaster recovery coordination
Predictive Analytics in Disaster Prevention	IEEE Public Safety Tech Initiative,	Lack of real-time disaster warning systems	ML-based early warning systems	Improved disaster forecasting with real-time data analysis
Natural Disaster Application on Big Data and ML	Arinta & Emanuel, 2021	Need for integrating big data in disaster prediction	CNN, SVM, Bayesian Networks	Enhanced disaster monitoring and prediction using satellite data
Disaster and Pandemic Management Using ML	Sharma et al., 2020	Limited use of ML in pandemic and disaster response	Supervised, Unsupervised, and Reinforcement Learning	Improved outbreak prediction and resource allocation

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Paper Title	**Authors & Year**	**Problem Statement**	**Methodology**	**Key Findings**
Disaster Recovery Techniques in Cloud Computing	Tamimi et al., 2019	Cloud-based disaster recov - ery limitations	Virtualization, Replication, and Fault Tolerance	Enhanced recovery speed and data security in cloud-based disasters
ML-Based Earthquake Damage Prediction	Kumar et al., 2021	Need for improved earthquake damage assessment	Neural Networks, Decision Trees	Higher prediction accuracy in damage assessment
AI in Disaster Relief Resource Allocation	Wang et al., 2021	Inefficient resource allocation post-disaster	AI-based optimization algorithms	Faster and more accurate distribution of resources
Social Media Analytics for Disaster Response	Li et al., 2020	Lack of real-time disaster updates from social media	NLP, Sentiment Analysis	More effective disaster response through social media insights

2.2.3 Identified Research Gaps

- Highlight **unexplored areas** in the literature.
- Discuss **shortcomings in current approaches**.
- Identify areas where improvement is needed.

- **Limited Real-Time Adaptation** – Most platforms rely on pre-trained AI models rather than real-time adaptability.
- **Lack of Holistic Assessment** – NLP-based grading struggles with open-ended subjective responses.
- **Engagement Challenges** – Gamification is used inconsistently across platforms.

- **High Cost of AI Implementation** – Premium AI-based education solutions are not accessible to all learners.

2.2.4 Comparative Study of Existing Applications (If Applicable)

- Select **3 to 4 existing applications** related to the project domain.
- Compare them in terms of:
  - **Features**
  - **Performance**
  - **User Experience**
  - **Technology Stack**
  - **Limitations**

Platform	Features	Technology Used	Strengths	Limitations
FEMA's National Incident Management System (NIMS)	Disaster alerts, emergency preparedness tips	Web-based system with GIS mapping	User-friendly interface, tailored disaster response	Limited to U.S. regions, lacks global applicability
Google Crisis Response	Real-time disaster alerts and mapping	Google Maps API, AI-based analytics	Global coverage, seamless integration with Google Maps	No recovery recommendations, dependent on third-party data
GDACS (Global Disaster Alert and Coordination System)	International disaster alerts and response coordination	AI-driven risk analysis and real-time tracking	Provides comprehensive global disaster alerts	Designed for government agencies, lacks usability for general

2.3 NOTE

- Ensure that all research papers are **recent (last 5 years)**.
- Use **formal academic writing** with proper citations.
- The **comparative study** should focus on features, strengths, and weaknesses **without bias**.
- The **research gaps should logically justify the need for your project**.

Chapter 3

Hardware and Software Requirements

3.1 Introduction

This chapter provides a detailed description of the **hardware and software** tools used in the development and deployment of this project. The selection of these technologies is based on **performance, scalability, and compatibility** with the project requirements.

3.2 Hardware Requirements

The project requires a system with sufficient computational power to support development, testing, and execution efficiently.

3.2.1 Minimum Hardware Specifications

The following table lists the **minimum hardware configuration** required:

Component	Specification
Processor	Intel Core i5 (or equivalent)
RAM	8GB
Storage	256GB SSD
GPU (if required)	Integrated GPU
Network Interface	Wi-Fi 802.11ac / Ethernet
Peripherals	Keyboard, Mouse, Display

Table 3.1: Minimum Hardware Requirements

3.2.2 Recommended Hardware Specifications

For optimal performance, the **recommended configuration** is:

Component	Specification
Processor	Intel Core i7/i9 or AMD Ryzen 7/9
RAM	16GB or higher
Storage	512GB SSD or higher
GPU	NVIDIA RTX 3060 (for AI tasks)
Network Interface	Gigabit Ethernet / Wi-Fi 6

Table 3.2: Recommended Hardware Specifications

3.3 Software Requirements

The software stack used in this project includes **development tools, programming languages, and frameworks** that ensure smooth implementation and execution.

3.3.1 Operating System

The project was developed and tested on multiple platforms to ensure cross-platform compatibility.

Operating System	Version
Windows	Windows 10/11 (64-bit)
Linux (Preferred)	Ubuntu 20.04+ / Fedora 36+
macOS (Optional)	macOS 11+

Table 3.3: Operating System Requirements

3.3.2 Development Tools

To facilitate efficient coding and debugging, the following development tools were used:

Software	Purpose
Jupyter Notebook	Model development and testing
GitHub/GitLab	Version control and collaboration
VS Code / PyCharm	Code editing and debugging
Docker (Optional)	Containerization and deployment

Table 3.4: Development Tools

3.3.3 Programming Languages & Frameworks

The project was implemented using a combination of programming languages and frameworks:

Technology	Usage
Python 3.x	Backend development, AI models
Flask / FastAPI	Backend API development
JavaScript (Node.js)	Server-side scripting
HTML/CSS/JS	Frontend development

Table 3.5: Programming Languages and Frameworks

3.3.4 Additional Libraries & APIs

Various libraries and APIs were integrated to enhance project functionality.

Library/API	Purpose
sckit-learn	Machine Learning models
Pandas / NumPy	Data preprocessing and analysis
Matplotlib / Seaborn	Data visualization

Table 3.6: Additional Libraries and APIs

Chapter 4

Software Requirements Specification

4.1 Users

- **General Public**

  The general public can access one module that provides awareness about predicted future disasters based on their geographical location. They can also view customized recovery plans to help prepare their accommodations in advance.

  - View predicted disaster types relevant to their location.
  - Access tailored recovery measures to minimize the impact of potential disasters.

- **Government/NGO**

  This user group has access to two modules. One is similar to the general public module, where they can view disaster types and corresponding recovery plans. The second module allows them to monitor relief inventory and evaluate whether the available resources—such as medical staff, food, and shelters are sufficient to handle a predicted disaster.

  - View disaster predictions and impact analysis.

- Receive AI-driven recovery recommendations.
- Utilize an interactive interface for disaster status visualization.
- Access the relief planner to analyze current stock levels and determine sufficiency for disaster response.

4.2 Functional Requirements

FR1. **Data Pre-processing**

The system processes historical disaster data by removing irrelevant or redundant information, normalizing values, and structuring the dataset for better analysis.

This cleaned and structured data serves as input for machine learning models to ensure accurate disaster predictions and recommendations.

FR2. **Login and Signup Module**

The login and signup modules enable user authentication, ensuring personalized access to the platform. Upon successful login, users are directed to a tailored version of the website based on their profile.

FR3. **ML Model Development for Prediction**

A machine learning-based predictive model analyzes historical disaster patterns and and geographical features to determine the type and duration of potential disasters.

The model is trained using past disaster data and continuously optimized to improve accuracy and reliability.

FR4. **Recommendation System for Recovery**

Based on the predicted disaster type and severity, the system generates personalized recovery plans, including evacuation strategies, resource allocation, and response measures.

These recommendations help authorities and individuals make informed decisions to minimize disaster impact.

FR5. **Disaster Relief Assistance System**

Allows government bodies and NGOs to add and monitor their relief materials. The system checks whether sufficient resources are available, if not, it prompts for additional provisioning to ensure effective disaster response and preparedness.

FR6. **User-Friendly Interface for Visualization and Insights**

The platform provides an intuitive dashboard where users can view disaster predictions, risk assessments, and recommended actions.

4.3 Non-Functional Requirements

NFR1. **Availability**

The system should be accessible at all times to ensure uninterrupted disaster prediction and recovery recommendations.

The website should be live 24/7 so that it can be accessed anywhere, from everywhere, and in this way it should be available so it can be helpful for the people and help in accessing and availability of the website remain constant.

NFR2. **Performance**

The disaster prediction system should process and analyze large datasets efficiently while ensuring minimal response time for users.

Machine learning models should generate disaster predictions within a few seconds, and the visualization dashboard should load predictions and insights smoothly for an optimal user experience.

NFR3. **Reliability**

The system should provide accurate and consistent disaster predictions and recovery recommendations with minimal downtime.

AI models must be periodically updated and retrained with new disaster data to enhance prediction accuracy. Additionally, error-handling mechanisms should be implemented to ensure system stability.

NFR4. **Scalability**

The platform should be scalable to handle an increasing number of users and datasets over time.

The architecture should support the integration of additional disaster types, new machine learning models, and extended functionalities as needed.

Chapter 5

System Design

5.1 Architecture Diagram

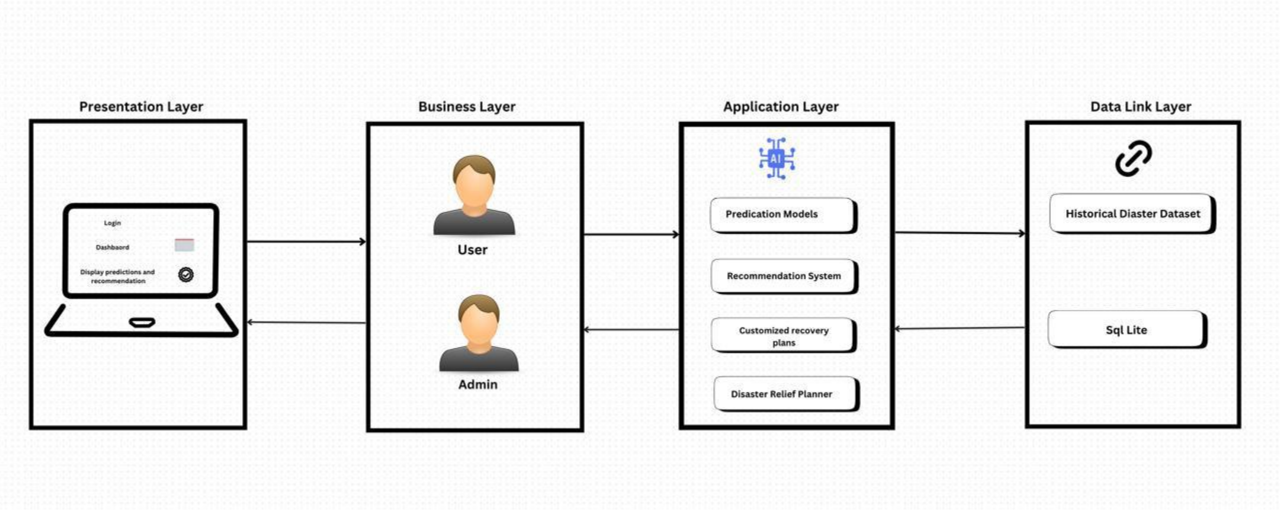

Figure 5.1: Architecture Diagram

The system is structured into four layers:

- **Presentation Layer:** This layer includes the user interface where interaction with the system occurs. It provides:
  - Login authentication
  - Dashboard displaying predictions and recommendations
- **Business Layer:** Serves as the bridge between users (Admin and General User) and the application logic. It:
  - Accepts user actions (from both Admin and User)
  - Relays commands to and from the Application Layer

- **Application Layer:** This core functional layer handles processing and intelligent decision-making, including:
  - *Prediction Models* – Forecasts disaster type, severity, and duration.
  - *Recommendation System* – Suggests recovery strategies using AI.
  - *Customized Recovery Plans* – Generates user-specific recovery blueprints.
  - *Disaster Relief Planner* – Assesses relief inventory and restocking needs.
- **Data Link Layer:** Manages access to and from the data sources. It includes:
  - *Historical Disaster Dataset* – Repository of past disaster data.
  - *SQLite Database* – Stores user input and AI predictions.

5.2 Data Flow Diagram

5.2.1 Process Flow Diagram

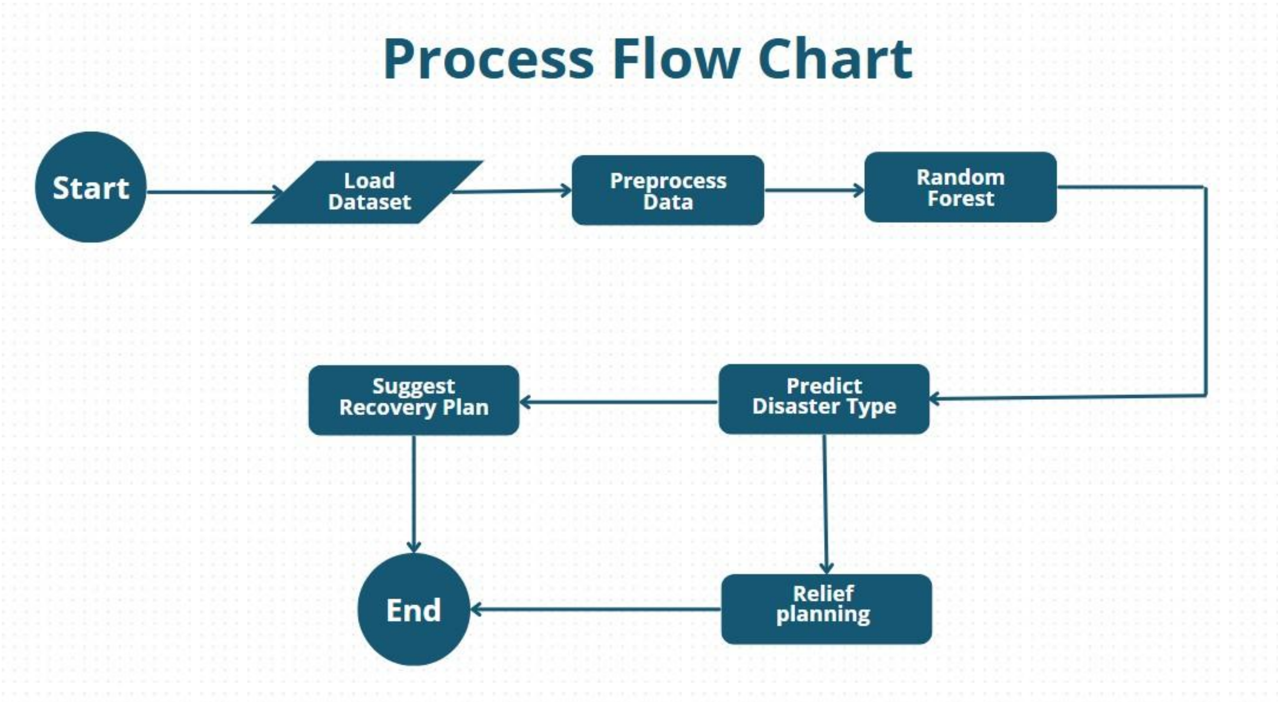

Figure 5.2: Process Flow Diagram

The process flow diagram illustrates the step-by-step functioning of the disaster prediction and recovery system:

- **Start:** The system initializes the disaster prediction workflow.

- **Load Dataset:** Historical disaster data is loaded, containing past incidents, environmental factors, and geographical data.

- **Preprocess Data:** The dataset is cleaned and transformed to handle missing values, normalize input features, and prepare it for model training.

- **Random Forest:** A Random Forest classifier is applied to analyze patterns and build a model capable of predicting disaster types.

- **Predict Disaster Type:** The trained model identifies the most likely disaster type based on input attributes and model inference.

- **Relief Planning:** Based on the predicted disaster, the system checks the availability of critical relief resources (such as food, doctors, shelter, etc.) and evaluates if current stock levels are sufficient.

- **Suggest Recovery Plan:** Tailored AI-generated recovery strategies are recommended depending on disaster type, severity, and available resources.

- **End:** The process concludes by delivering both the predicted disaster type and a recommended recovery plan for early preparedness.

5.2.2 Context Diagram

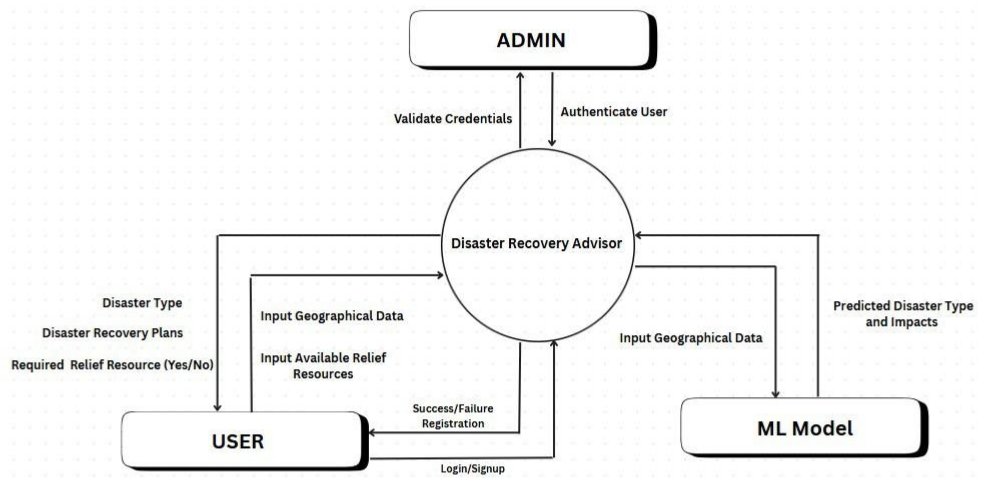

Figure 5.3: Context Diagram level 2

The context diagram illustrates the interaction between the main system entities:

- **Disaster Recovery Advisor:** Serves as the central system. It handles login/signup from users, validates credentials via the admin, processes geographical and resource data submitted by users, and sends this information to the ML model. It returns predictions and coordinates the generation of recovery plans and relief decisions.
- **User:** Interacts with the Disaster Recovery Advisor to input geographical data, disaster details, and available relief resources. Users can register/login, and receive customized recovery recommendations and resource requirements.
- **Admin:** Validates and authenticates user credentials during registration and login via the Disaster Recovery Advisor interface.
- **ML Model:** Accepts geographical input data from the Disaster Recovery Advisor and responds with predicted disaster types and their potential impacts, aiding in recovery planning.

Chapter 6

Detailed Design

6.1 Use Case Diagram

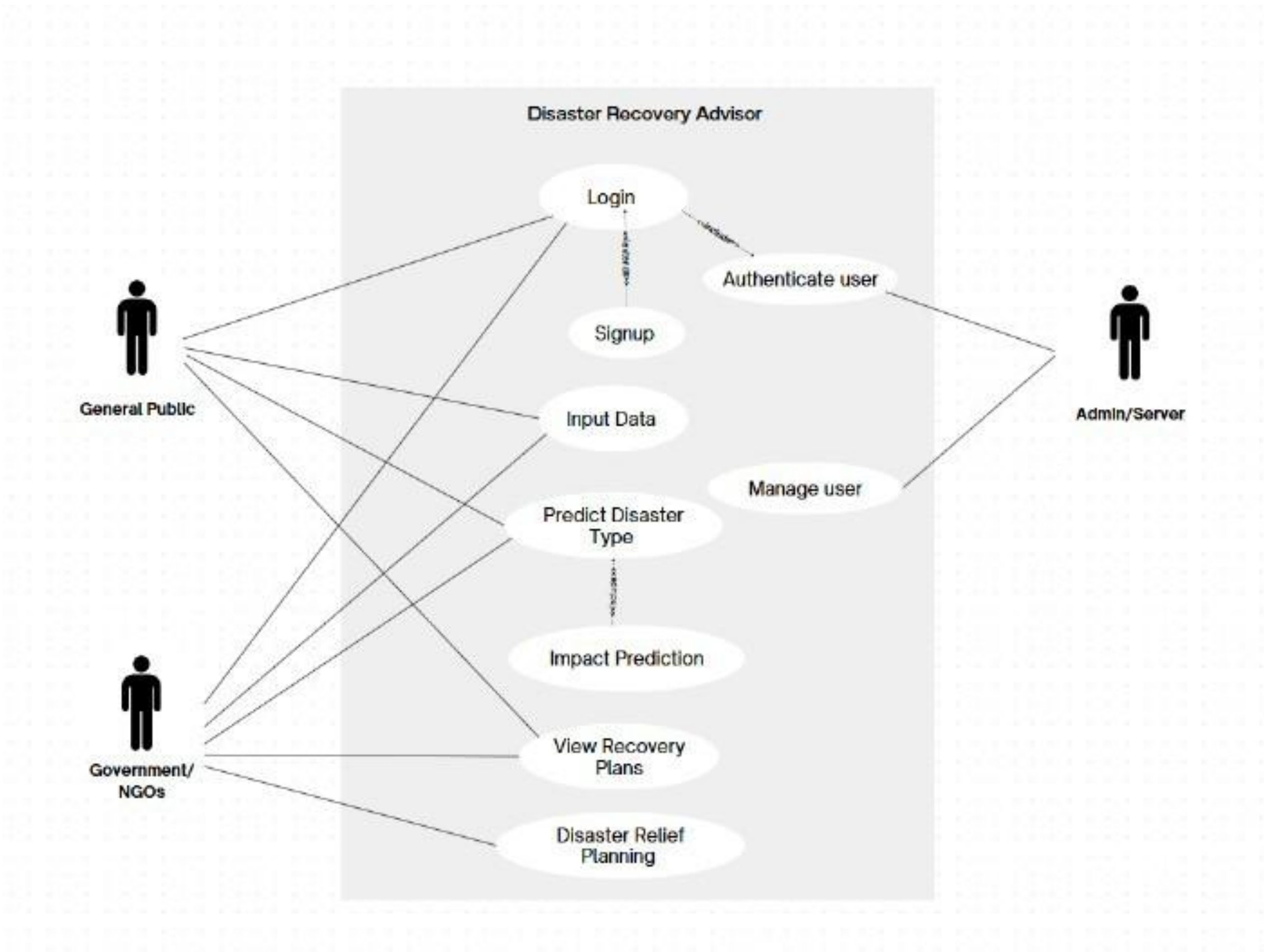

Figure 6.1: Use Case Diagram

The use case diagram illustrates interactions among three key actors—General Public, Government/NGOs, and Admin/Server—with the Disaster Recovery Advisor system.

- The General Public and Government/NGOs can sign up and log in to the system.
- Once authenticated (by the Admin/Server), these users input geographical and disaster-related data.
- The system processes this data to predict the type of disaster likely to occur and then performs impact analysis to estimate the severity and affected areas.
- Based on the predictions, users can view tailored recovery plans.
- Government/NGOs can further engage in detailed disaster relief planning using the system's recommendations.
- Admin/Server actors manage user access and system integrity by authenticating users and managing their accounts.

6.2 Sequence Diagram

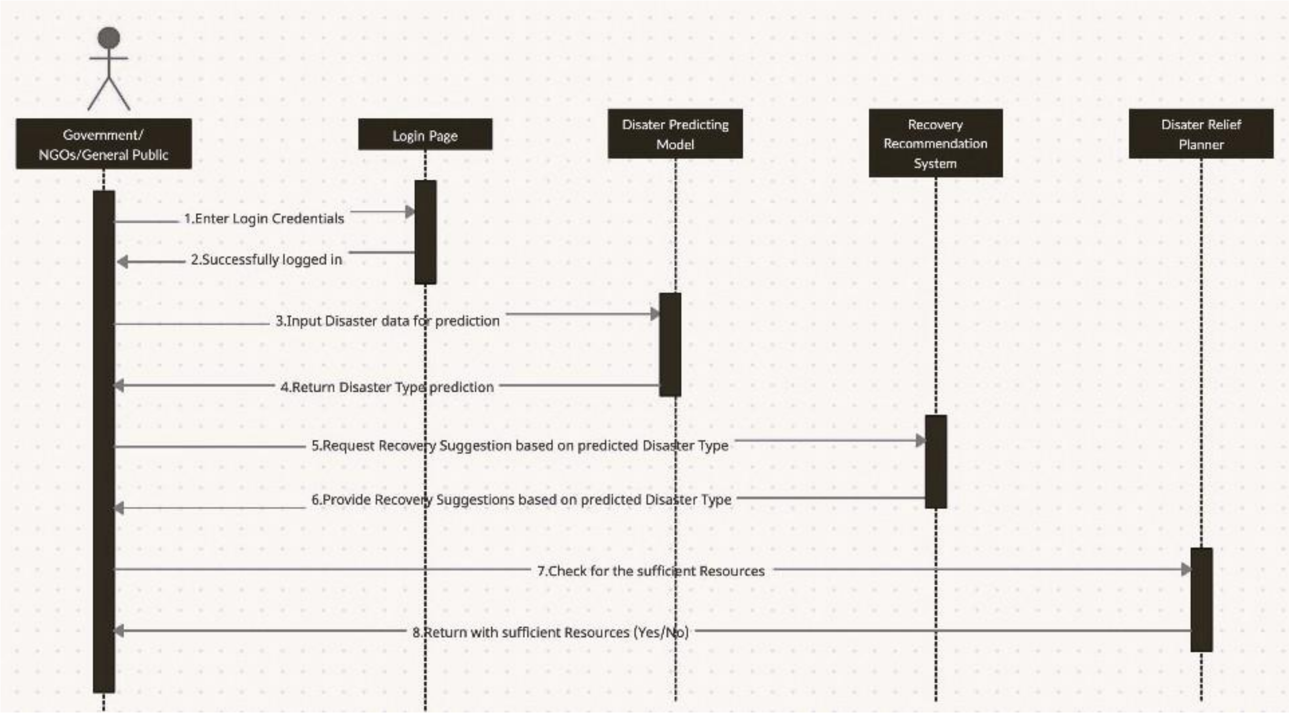

Figure 6.2: Sequence Diagram

The sequence diagram illustrates the interaction between the user (Government/NGOs/General Public) and the Disaster Recovery Advisor system. The user starts by entering login credentials on the login page and is authenticated successfully. Then, the user inputs disaster-related data, which is sent to the Disaster Predicting Model to identify the disaster type. This prediction is returned to the user. Based on the prediction, the user requests recovery suggestions, which the Recovery Recommendation System processes and provides. The system then checks for the availability of sufficient resources through the Disaster Relief Planner and returns the availability status (Yes/No) to the user. This flow ensures informed decision-making and resource planning in response to predicted disasters.

Chapter 7

Implementation

7.1 Implementation Screenshots

7.1.1 Disaster Type Prediction

Below is a screenshot of the implemented program:

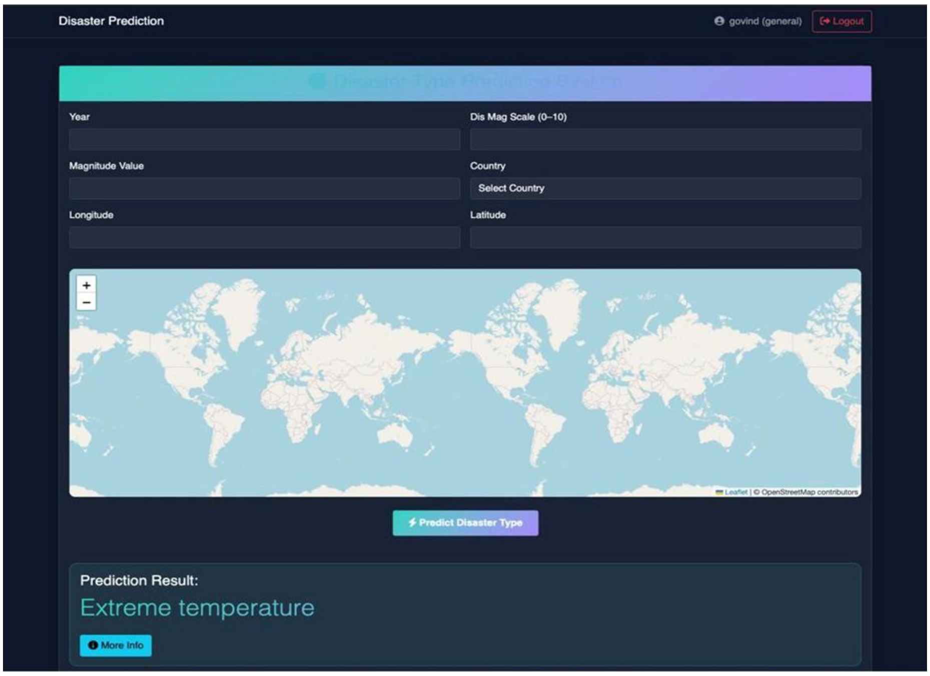

Figure 7.1: Disaster Type Prediction

In this screenshot, it shows how the ML Model predict the Disaster type based on historical data and geographical attributes.

7.2 Disaster Impact Prediction

Below is a screenshot of the implemented program:

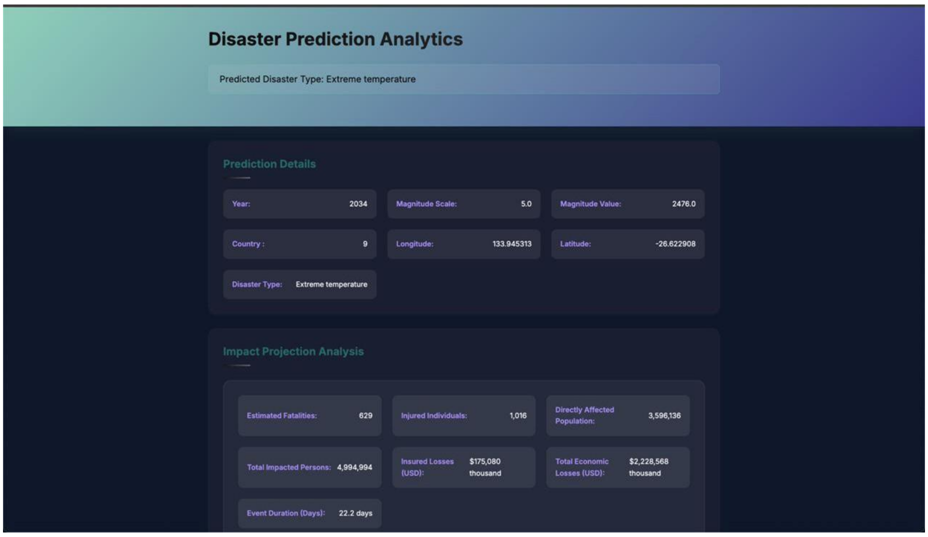

Figure 7.2: Disaster Type Prediction

In this screenshot, it shows how the ML model predicts disaster type prediction and impact prediction using machine learning:

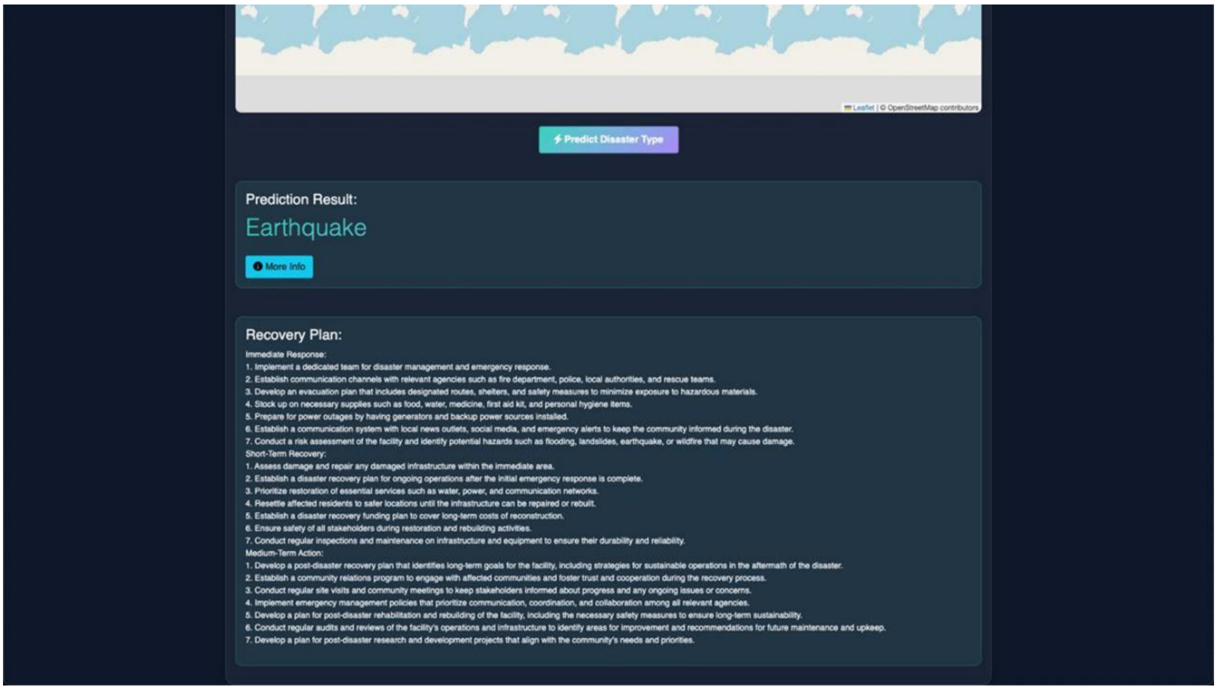

Figure 7.3: Disaster Type Prediction

26

Listing 7.2: Function to Generate Recovery Plan using Ollama

7.4 Disaster Relief Assistance

Below is a screenshot of the implemented program:

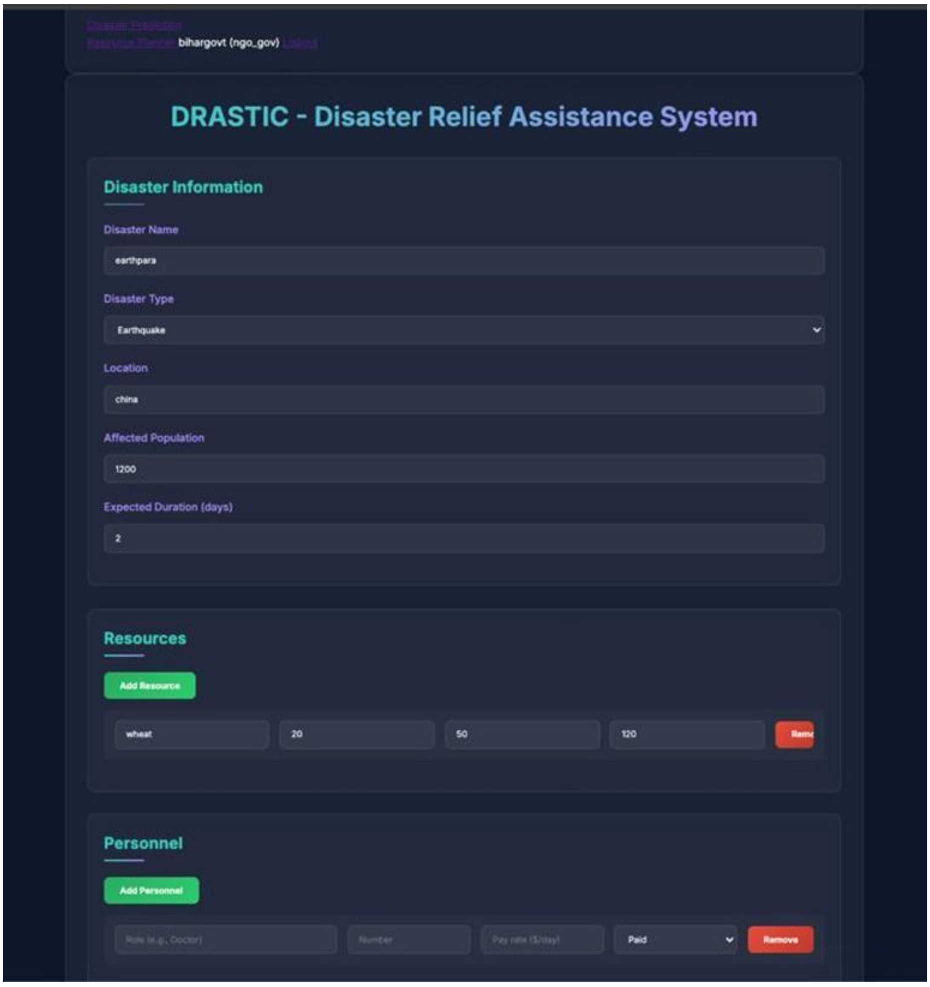

Figure 7.4: Disaster Relief Assistance

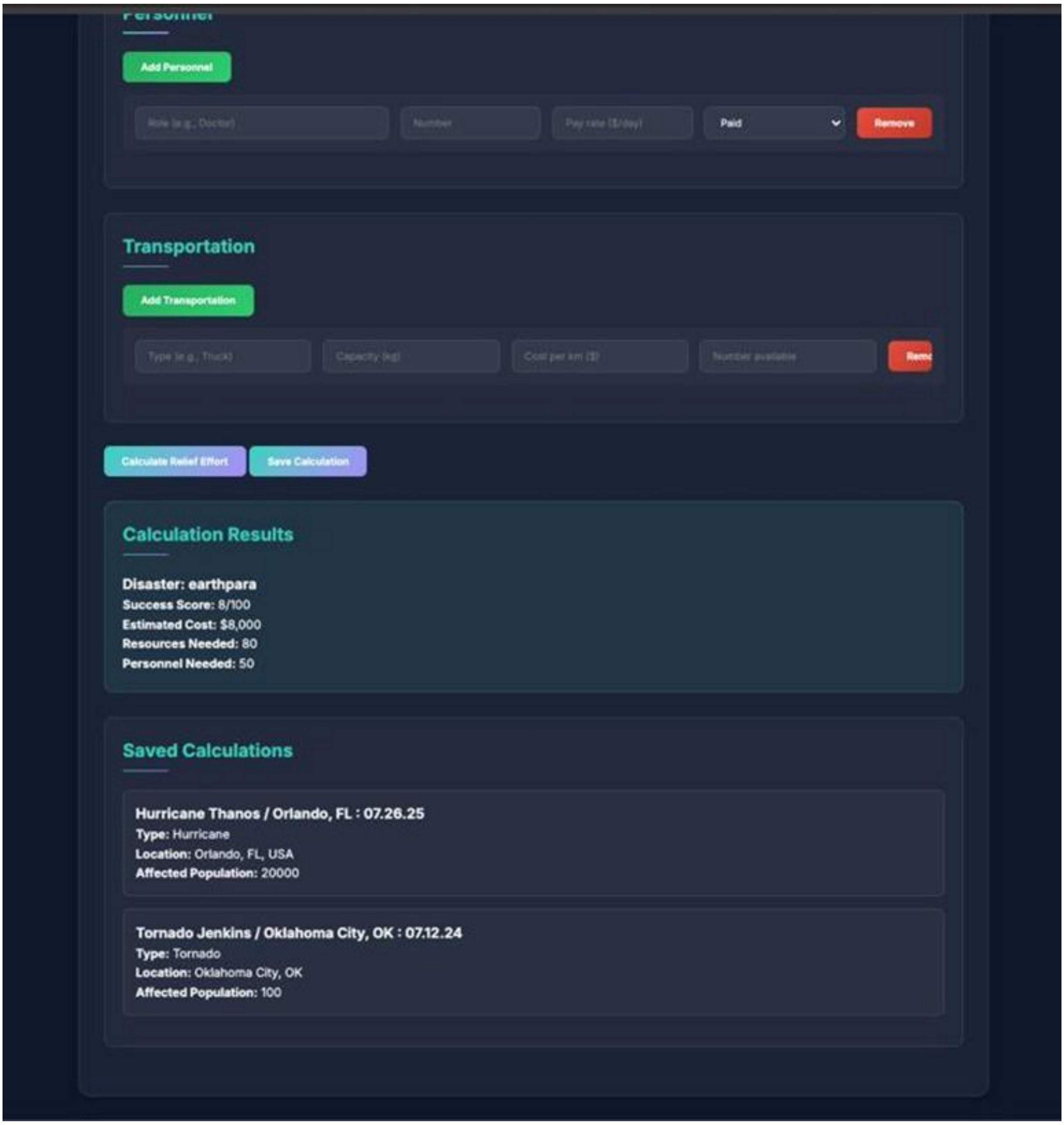

Figure 7.5: Disaster Relief Assistance

Chapter 8

Software Testing

8.1 Manual Testing

Table 8.1: User Authentication

Test Case ID	Step Details	Expected Results	Actual Results	Pass/Fail
TC01	Register with valid email (test@domain.com) and password.	Account successfully created.	Account successfully created.	Pass
TC02	Login with incorrect password (e.g., ”password123”).	Shows ”Invalid username or password” error.	Error message displayed.	Pass

Table 8.2: Disaster Prediction

Test Case ID	**Step Details**	**Expected Results**	**Actual Results**	**Pass/Fail**
TC01	Load dataset "historical_disasters.csv" and preprocess (fill missing values, encode categories).	Dataset cleaned and structured for model training.	Dataset loaded; missing values filled, categories encoded.	Pass
TC02	Train Random Forest model (80% training data) to predict disaster type.	Model trains successfully with F1 score ¿ 0.85.	Model trained with F1 score = 0.88.	Pass
TC03	Predict earthquake duration (rainfall=300mm, magnitude=7.0). Returns duration (e.g., "4–7 days") with 85% accuracy. Predicted duration: "5–8 days" (accuracy 83%).	Fail		

Table 8.3: Recovery Plans

Test Case ID	**Step Details**	**Expected Results**	**Actual Results**	**Pass/Fail**
TC01	Select "Earthquake" as disaster type.	Recommends steps: "Evacuation routes, sandbag distribution, medical camps."	Recommendations displayed as expected.	Pass
TC02	Input "unknown" disaster type (e.g., "Volcanic eruption").	Displays "Recommendations unavailable for this disaster type."	Message shown: "No recommendations available."	Pass

Table 8.4: Relief Inventory Management

Test Case ID	**Step Details**	**Expected Results**	**Actual Results**	**Pass/Fail**
TC01	Add 1,000 blankets to "Shelter" category.	Inventory updates to "Blankets: 1,000" with success message.	Inventory updated to "Blankets: 1,000."	Pass
TC02	Attempt to allocate 800 tents (current stock = 500).	Shows "Insufficient inventory. Only 500 tents available."	Warning message displayed.	Pass
TC03	Add 50 paid medical personnel at $100/day for 5 days.	Personnel count updates to 50; cost reflects $25,000.	Personnel updated to 50; cost shows $25,000.	Pass
TC04	Add 1 truck (100kg capacity) to move 1,000kg supplies.	Shows "Insufficient transportation capacity. Only 100kg available."	Warning message displayed.	Pass

Chapter 9

Application in the Real World

The advancements in **Disaster Recovery Advisor** have led to significant real-world applications based on historical disaster data. This section highlights key areas where the proposed system can be effectively utilized to improve disaster preparedness and recovery planning.

9.1 Personal Uses

- **Community Preparedness**:
  - Educates individuals and communities about disaster risks specific to their location
  - Provides personalized recovery plans (e.g., evacuation routes, emergency kits) via user-friendly interfaces
- **Household Safety**:
  - Recommends safety measures (e.g., securing furniture for earthquakes, flood barriers)
  - Alerts users about impending disasters based on AI predictions

9.2 Business Applications

- **Insurance Companies**:

  - Uses risk assessment models to tailor policies and premiums
  - Validates claims using disaster impact predictions

- **Urban Planning & Infrastructure**:
  - Guides construction of resilient infrastructure (e.g., flood-resistant buildings)
  - Identifies high-risk zones for development restrictions

- **Supply Chain Management**:
  - Predicts disruptions and reroutes logistics using disaster forecasts

9.3 Privacy Advocacy

- **Data Protection**:
  - Ensures user data (e.g., location, disaster reports) is anonymized and encrypted
  - Complies with GDPR/regional privacy laws for sensitive information

- **Ethical AI**:
  - Avoids biases in disaster predictions (e.g., equitable resource allocation)

9.4 Security and Surveillance

- **Relief Coordination**:
  - Tracks relief material distribution via blockchain to prevent fraud
  - Uses geofencing to monitor NGO/government access to sensitive data

- **Real-Time Monitoring**:
  - Integrates IoT sensors (e.g., flood gauges) with AI for early warnings

9.5 Future Enhancements

1. **Mobile App for Field Agents**:
   - Lightweight app for real-time updates from disaster zones
2. **Multilingual Support**:
   - Adds regional languages for broader accessibility
3. **Blockchain Integration**:
   - Transparent tracking of relief funds/resources
4. **Collaboration Dashboard**:
   - Shared platform for NGOs/govt. to coordinate efforts

9.6 Conclusion

This section demonstrates how the **Disaster Recovery Advisor** provides valuable insights based on historical disaster data. By analyzing past patterns and recovery strategies, the system helps in better disaster preparedness, infrastructure planning, and recovery efforts, making it a crucial tool for decision-makers in various sectors.

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