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ONLINE EMERGENCY RESPONSE MANAGEMENT SYSTEM FOR CITY DISASTER RISK REDUCTION MANAGEMENT OFFICE OF CALAMBA CITY, LAGUNA

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Abstract **-** This study presents the development of an Online Emergency Response Management System for the City Disaster Risk Reduction and Management Office of Calamba City, Laguna. The system integrates Geographic Information Systems, Machine Learning, and Decision Support Systems to enhance disaster preparedness through real-time hazard monitoring, spatial analysis, and data-driven decision-making. A key feature is the use of Natural Language Processing and TF-IDF to analyze incident reports and generate actionable recommendations for resource allocation and evacuation planning. The research employed a developmental design and stratified sampling, involving CDRRMO personnel, GIS experts, and IT professionals. System evaluation followed the ISO 25010 software quality model and Technology Acceptance Model. The ISO evaluation yielded an overall mean score of 4.61, with Compatibility 4.61, Security 4.56, and Reliability 4.53 receiving the highest marks. The TAM results indicated high user satisfaction: Perceived Usefulness 6.69, Ease of Use 6.68, Attitude Toward Using 6.83, and Behavioral Intention 6.65. These findings confirm the system's effectiveness in improving resource coordination, user engagement, and emergency response. Future improvements include expanding to cover scenarios like wildfires and enhancing user accessibility. Overall, the OERMS proves to be a robust, scalable, and user-validated tool for disaster resilience.

Keywords: Online Emergency Response Management System, Disaster Risk Reduction, Emergency Preparedness, Resource Optimization, Geographic Information Systems (GIS), Machine Learning (ML), Decision Support Systems (DSS), Real-Time Hazard Monitoring, TF-IDF Vectorization, Incident Intelligence, Weather Data Integration

I. INTRODUCTION

The Philippines is one of the most disaster-prone countries worldwide, regularly facing typhoons, earthquakes, floods, and landslides due to its location along the Pacific Ring of Fire and the typhoon belt. Catastrophic events such as Super Typhoon Haiyan in 2013 and the 2020 Luzon earthquake demonstrate the devastating impacts of these hazards on communities, livelihoods, and economic growth. Climate change further intensifies the frequency and severity of disasters, necessitating robust disaster risk management strategies (Asio, 2020). Despite the presence of national agencies like the National Disaster Risk Reduction and Management Council (NDRRMC) and their partnerships with organizations such as PAGASA and PHIVOLCS, challenges persist including limited resources, inadequate training, and poor community engagement, which undermine disaster preparedness and response (Catarata & Villa, 2024).

Locally, Calamba City, Laguna faces heightened risks from its proximity to active fault lines and Laguna de Bay, with rapid urbanization exacerbating flood vulnerabilities due to poor drainage and unplanned development. The city's Disaster Risk Reduction and Management Council (DRRMC) plays a critical role in preparing communities, conducting vulnerability assessments, and coordinating responses. However, inefficiencies stemming from fragmented agency coordination, insufficient community participation, and misallocation of resources lead to delays and ineffective disaster response (Concha et al., 2021).

The literature highlights the importance of integrating technological tools such as Geographic Information Systems (GIS), machine learning, and predictive analytics to improve disaster risk reduction. GIS supports detailed spatial analysis for hazard mapping and vulnerability assessment, enabling targeted resource allocation (Cabrera & Lee, 2020; Gacu et al., 2023). Machine learning enhances predictive capabilities for disaster outcomes, facilitating timely and data-driven decision-making (Mishra & Rahamatkar, 2023; Oluwadare et al., 2024). Additionally, decision support systems combining these technologies promote coordinated and efficient emergency management (Jung et al., 2020; William et al., 2024).

This study aims to leverage these advanced technologies to address the gaps in Calamba City's disaster management framework, optimizing resource distribution, improving community engagement, and strengthening overall resilience. By applying data-driven solutions grounded in the latest research, the system seeks to provide a comprehensive approach that enhances preparedness, response, and recovery efforts against natural disasters.

II. RESEARCH OBJECTIVES

In general, this research focused on the development, enhancement, and evaluation of the system. The aim was to improve disaster preparedness, streamline resource distribution, and provide real-time decision-making support. The system integrated Geographic Information Systems (GIS) for hazard mapping and spatial analysis, as well as Machine Learning (ML) for predictive modeling to anticipate disaster risks and offer actionable recommendations during emergencies. By leveraging these technologies, the system aimed to strengthen protective measures, assist in conservation efforts, and identify high-risk areas, while improving evacuation strategies and optimizing response actions to minimize damage. Furthermore, the system included web-based and mobile platforms to ensure accessibility for emergency responders, administrators, and the public, enabling the swift dissemination of disaster warnings and resource deployment plans.

Specifically, the research aims to:

1. Design and develop a multi-platform emergency response system that provides emergency assistance, weather analysis, evacuation planning, resource tracking, and accomplishment report ensuring full operational functionality across all platforms.
2. Integrate the TF-IDF vectorization technique with a Content-Based Filtering and Natural Language Processing algorithm into a recommendation model to generate actionable insights and support informed decision-making in disaster scenarios.
3. Evaluate the system's effectiveness using ISO 25010 for software quality, Technology Acceptance Model for user adoption, and algorithm accuracy metrics, through structured user testing and performance analysis.

III. LITERATURE OF THE STUDY

This section presents a comprehensive review of relevant studies and literature gathered to support the development and design of the proposed Online Emergency Response Management System (OERMS) for the City Disaster Risk Reduction and Management Office of Calamba City, Laguna.

Disaster risk reduction and management (DRRM) remain critical challenges in the Philippines, a country frequently affected by natural hazards such as typhoons, earthquakes, and floods due to its geographic location (Asio, 2020). Various studies emphasize that effective disaster management requires robust governance, community involvement, and the integration of technological solutions. For example, Uddin et al. (2020) and Choudhury et al. (2021) highlight the importance of local governance and community participation in improving disaster preparedness and adaptive capacity. Similarly, Ravago et al. (2020) and Gabriel et al. (2021) identify gaps in resource allocation and coordination among local government units, underscoring the need for standardized frameworks and capacity-building initiatives. These findings align with Catarata and Villa (2024), who note that insufficient resources and low community engagement hinder DRRM success in Philippine localities.

Recent advancements in Geographic Information Systems (GIS) have transformed hazard mapping and flood risk assessment. Studies by Cabrera and Lee (2020) and Gacu et al. (2022, 2023) demonstrate how GIS can visualize flood-prone areas and structural vulnerabilities, enabling targeted mitigation efforts. Web-based GIS platforms further enhance disaster monitoring and community engagement, as shown in the work of Gonzales et al. (2021). However, challenges remain related to data accuracy, interoperability, and scalability (Daud et al., 2024; Rezvani et al., 2023).

Machine Learning (ML) and predictive analytics play an increasingly vital role in disaster forecasting and response optimization. Mishra and Rahamatkar (2023) illustrate the use of ML models like Random Forest and Long Short-Term Memory (LSTM) networks for disaster impact prediction, while Oluwadare et al. (2024) report high accuracy in flood forecasting using LSTM. Moreover, ML integration with communication technologies enhances real-time disaster response, as shown by Gupta and Rana (2021) and Rajgure and Mote (2024). These technological advancements enable data-driven decision-making that improves resource allocation and evacuation planning.

Decision Support Systems (DSS) also contribute significantly to disaster management by synthesizing complex data for actionable insights. Jung et al. (2020) and William et al. (2024) developed intelligent DSS frameworks that integrate big data, AI, and open-source intelligence to improve urban disaster resilience. Locally, Bentoso et al. (2021) demonstrated the benefits and limitations of a GIS-based flood warning system in Leyte, Philippines, emphasizing the need for context-specific system adaptations.

Optimization algorithms and network analysis facilitate effective evacuation and resource distribution during disasters. Mao et al. (2023) and Zhu et al. (2022) have advanced evacuation route planning using integer programming and enhanced shortest path algorithms, while Kim et al. (2024) focused on optimizing evacuation in underground spaces. The use of Graph Neural Networks (GNNs) for real-time emergency service routing further illustrates the role of advanced algorithms in disaster logistics (Bose et al., 2024).

Despite these advances, existing systems often face challenges in integration, real-time adaptability, and localized customization. The proposed OERMS addresses these gaps by combining GIS, ML, TF-IDF vectorization for incident report analysis, and network optimization into a unified platform tailored for Calamba City's unique geographic and socio-economic context. This integrative approach aims to enhance situational awareness, optimize resource allocation, and improve community resilience.

IV. METHODOLOGY

A. Research Design

A developmental research approach was chosen in conjunction with descriptive research. The descriptive research approach investigated one or more variables through various research methods. Its aim was to provide an exact and systematic portrayal of a population, situation, or phenomenon. In this approach, different methods were employed to explore the variables. The variables were observed and measured without manipulation or change, distinguishing it from experimental research (McCombes, 2020).

B. Applied Concepts and Techniques This section provides the concepts and techniques used by the researchers to solve the research problem and attain its objectives.

Content-Based Filtering with Natural Language Processing

In this study, the Content-Based Filtering with NLP and the TF-IDF Vectorizer are integrated into the system to enhance disaster response capabilities. When users, such as emergency responders or local officials, interact with the system, they are presented with incident reports that have been processed by the system.

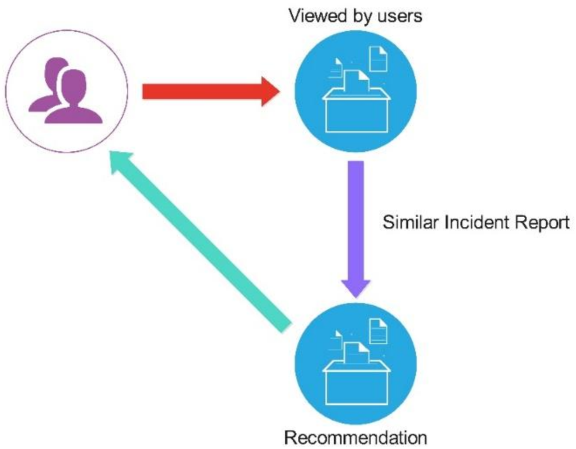

Figure 1. Content-Based Filtering with Natural Language Processing

The figure illustrates how Content-Based Filtering works by comparing incident reports using keyword relevance and historical data. TF-IDF Vectorizer converts text into weighted numerical values to highlight key terms for accurate classification. NLP further enhances understanding by capturing the context and meaning of reports, such as identifying disaster types. Together, these techniques enable the system to generate real-time, actionable recommendations for emergency response, resource allocation, and evacuation planning.

C. Algorithm Analysis

The developed system integrates advanced technologies like Machine Learning, GIS, TF-IDF Vectorizer, Content-Based Filtering, NLP, and Network Analysis to enhance disaster response. It collects and preprocesses real-time data such as weather, incident reports, and resources. TF-IDF highlights key terms in reports, while Content-Based Filtering prioritizes incidents based on relevance to historical data. NLP extracts insights like disaster type and severity, enabling actionable recommendations.

GIS provides spatial visualization for better resource allocation and evacuation planning. Network Analysis optimizes evacuation routes considering road and traffic conditions. Predictive models forecast risks to support proactive decision-making. Together, these components improve disaster preparedness, resource management, and emergency response effectiveness.

D. Data Collection Method

The three (3) techniques for data collection employed included Interviews, Internet Research, and Surveys/Questionnaires.

The study gathered information through interviews with the City Disaster Risk Reduction Management Office (CDRRMO) and IT experts to develop a comprehensive emergency management system using GIS and predictive analytics. This collaborative effort involved multiple stakeholders and aimed to enhance disaster response and resource allocation for natural hazards such as floods, earthquakes, and typhoons.

Internet research was conducted extensively through platforms like Google Scholar, Academia.edu, and e-journals to collect relevant data on disaster risk reduction, emergency management, and predictive modeling. These resources informed the system's design, particularly its GIS mapping, resource distribution, and evacuation planning functionalities using tools like LeafletJS.

Surveys and questionnaires were utilized to evaluate user acceptance and satisfaction with the system. Careful instrument design ensured the collection of meaningful feedback to identify improvement areas, supporting the system's continuous enhancement.

E. Data Model Generation

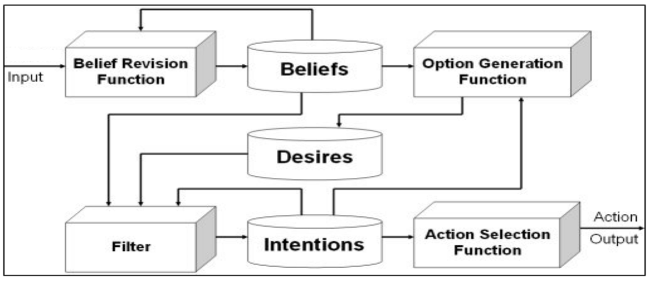

Figure 2. Belief Desire Intention Data Model Generation

The Figure illustrates the Belief-Desire-Intention (BDI) model, a widely used framework for designing intelligent software agents that has recently been applied to disaster risk management to enhance emergency response through complex decision-making. For example, Melendez et al. (2021) developed a BDI-based model simulating community resilience during disasters, where agents assess beliefs, desires, and intentions to optimize resource allocation and response strategies. In emergency management, the BDI system acts as a decision support tool by processing real-time data such as weather forecasts, incident reports, resource availability, infrastructure status, and population demographics. It continuously revises its beliefs as new information arrives, prioritizes critical data through filtering, and maintains an understanding of the disaster's impact and available resources. The system's desires focus on minimizing casualties, reducing damage, and optimizing resource use, while its intentions involve planning actions like coordinating evacuations and deploying emergency services. Through an option function, it generates possible actions, which are then evaluated by an action selection function to choose the most effective measures based on current beliefs, desires, and intentions. Finally, the system outputs actionable recommendations to emergency responders, including evacuation orders and resource distribution plans, while providing ongoing monitoring and adjustment to improve disaster response effectiveness.

Data Acquisition

Data acquisition is essential as it directly affects the performance of the model. High-quality data ensures that machine learning algorithms can learn efficiently and make accurate predictions. Prior to the audio recording sessions, the researchers obtained consent from the participants and anonymized the recordings by removing any personal information in accordance with ethical guidelines. Additionally, the researchers gathered typical interview questions from faculty members who acted as interviewers.

Data Pre-Processing

The researchers encountered significant challenges during the preprocessing phase, particularly with disaster-related incident reports. This difficulty stemmed from the unstructured and diverse nature of the textual data, which required careful handling to ensure accuracy and usability. The incident reports contained various formats, inconsistent terminologies, and incomplete information, complicating the task of extracting meaningful insights. To address these challenges, the researchers employed advanced techniques such as Natural Language Processing (NLP) and TF-IDF vectorization to convert the raw text into structured, numerical data suitable for analysis. This preprocessing step was crucial for enabling effective classification and prioritization of incidents, ultimately enhancing the system's ability to generate actionable recommendations for disaster response. The rigorous preprocessing ensured that the subsequent machine learning algorithms and content-based filtering could operate efficiently, supporting timely and data-driven decision-making in emergency situations.

Table 1. Data Preparation

Row No.	Location	Incident Type	Number of Victim	Age	Date
001	Brgy. Mayapa	Ambulance Assistance	1	5	1/1/2024
002	Brgy. Pansol	Road Crash	1	50	1/1/2024
003	Barangay 1	Road Crash	1	63	1/2/2024
004	Brgy. La Mesa	Ambulance Assistance	1	95	1/2/2024
005	Brgy. San Cristobal	Road Crash	1	47	1/3/2024
006	Brgy. Makiling	Medical Emergency	1	30	1/3/2024
007	Brgy. Parian	Road Crash	1	44	1/3/2024
008	Brgy. Parian	Road Crash	1	28	1/3/2024
009	Brgy. Bucal	Road Crash	1	30	1/3/2024
010	Brgy. Real	Road Crash	1	41	1/3/2024
011	Brgy. Pansol	Road Crash	1	41	1/4/2024
012	Brgy. 6	Medical Emergency	1	77	1/5/2024
013	Brgy Lecheria	Medical Emergency	1	60	1/6/2024
014	Brgy. Bucal	Ambulance Assistance	1	9	1/6/2024
015	Brgy. Real	Brgy. Stand-by Ambulance	1	32	1/7/2024
016	Brgy Prinza	Medical Emergency	1	34	1/7/2024
017	Brgy. Maunong	Medical Emergency	1	25	1/8/2024
018	Brgy. 3	Road Crash	1	33	1/9/2024
019	Brgy. Looc	Road Crash	1	20	1/10/2024
020	Brgy. Parian	Medical Emergency	1	38	1/10/2024

The table presents a detailed dataset of recorded incidents across multiple barangays, including location, incident type, victim count and ages, and incident dates. This comprehensive data on various emergencies serves as a vital foundation for the system to generate real-time recommendations, optimize resource allocation, and enhance disaster response strategies.

V. RESULTS AND DISCUSSION

This chapter provides the results, analysis, and interpretation of the data collected for the study. The gathered data is displayed in both textual and tabular formats, with statistical methods applied for analysis and interpretation. The presentation of the data is organized in alignment with the specific objectives outlined in Chapter 1, following a logical sequence.

RESEARCH OBJECTIVE 1: Design and develop a multi-platform emergency response system that provides emergency assistance, weather analysis, evacuation planning, resource tracking, and accomplishment report ensuring full operational functionality across all platforms.

RESEARCH OBJECTIVE 2: Integrate the TF-IDF vectorization technique with a Content-Based Filtering and Natural Language Processing algorithm into a recommendation model to generate actionable insights and support informed decision-making in disaster scenarios.

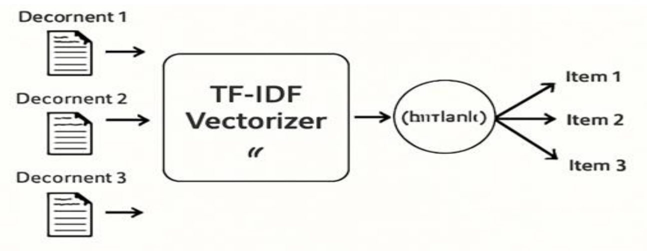

Figure 3. TF-IDF Vectorizer and Content-Based with NLP Data Process

The figure illustrates the data processing workflow of the TF-IDF Vectorizer and Content-Based Filtering with NLP. Three separate documents are individually processed, where key features are extracted. The TF-IDF Vectorizer converts the text into numerical vectors by weighing term frequency and inverse document frequency, making the data machine-readable. Content-Based Filtering then calculates similarities between these vectors to identify related documents, enabling the system to generate personalized and relevant recommendations.

RESEARCH OBJECTIVE 3: Evaluate the system's effectiveness using ISO 25010 for software quality, Technology Acceptance Model for user adoption, and algorithm accuracy metrics, through structured user testing and performance analysis.

Table 2. Summary of the Result of the Evaluation Procedure

CHARACTERISTICS	WEIGHTED MEAN	PERCENT
Functionality Suitability	4.45	SA
Reliability	4.53	SA
Performance Efficiency	4.49	SA
Operability	4.53	SA
Security	4.56	SA
Compatibility	4.61	SA
Maintainability	4.51	SA
Group Mean	4.61	SA

Legend: *4.21 -5.00 Acceptable – Strongly Agree (SA) 3.41 – 4.20 Slightly Acceptable – Agree (A) 2.61 – 3.40 Undecided – Nor Agree (NA) 1.81 – 2.60 Slightly Unacceptable - Disagree (D) 1.00 – 1.80 Unacceptable – Strongly Disagree (SD)*

Table 2 presents the evaluation results across seven key characteristics, with the system achieving a strong overall mean score of 4.61, categorized as Strongly Agree. Compatibility scored highest, followed by Security, Performance Efficiency, and Reliability. Operability, Functionality Suitability, and Maintainability also received high marks, reflecting the system's user-friendliness, effectiveness, and sustainability. Overall, the system demonstrated strong performance, with minor areas identified for potential improvement.

Table 3. Summary of the Quality Factors

INDICATORS	MEAN	PERCENT
1. **Correctness:** The developed system provides correct and accurate real-time information regarding disaster-related incidents, weather analysis, and incident recommendation.	6.55	PA
2. **Reliability:** The developed system offers all necessary functions and features to assist City Disaster Risk Reduction and Management Office (CDRRMO) personnel in managing disaster incidents, resources, and response plan.	6.48	PA
3. **Efficiency:** The developed system includes relevant and complete features tailored to different user roles, allowing users to perform specific tasks efficiently, such as reporting incidents, managing resources, and coordinating disaster responses.	6.60	PA
4. **Integrity:** The developed system ensures comprehensive user role management, providing secure password protection for CDRRMO personnel and community users, while enabling real-time communication and updates.	6.55	PA
General Assessment	6.54	PA

Legend *6.15-7.00 Perfectly Acceptable (PA) 5.29-6.14 Acceptable (A) 4.43-5.28 Slightly acceptable (SA) 3.57-4.42 Neutral (N) 2.71- 3.56 Slightly unacceptable (SU) 1.86- 2.70 Unacceptable (U) 1.00 – 1.85 Totally unacceptable (TU)*

The table 3 shows the quality factors evaluating indicators such as Correctness, Reliability, Efficiency, and Integrity. All indicators received high ratings, with mean scores ranging from 6.48 to 6.60, categorized as Perfectly Acceptable. The General Assessment score of 6.54 further supports the system's overall effectiveness in providing accurate information, assisting disaster management tasks, ensuring secure communication, and optimizing efficiency.

Table 4. Summary of the Results of the Perceive Ease of Use

INDICATORS	MEAN	PERCENT
1. **Learnability:** The developed system does not require much effort in terms of understanding the flow of the system.	6.75	PA
2. **Understandability:** My interaction with the developed system is be clear and understandable.	6.73	PA
3. **Operability:** The system's functions help reduce the effort required by CDRRMO personnel in tasks such as transferring, retrieving, and recording incident and resource data.	6.70	PA
4. **Attractiveness:** I find the software user interface pleasing and satisfying interaction.	6.53	PA
General Assessment	6.68	PA

Legend *6.15-7.00 Perfectly Acceptable (PA) 5.29-6.14 Acceptable (A) 4.43-5.28 Slightly acceptable (SA) 3.57-4.42 Neutral (N) 2.71- 3.56 Slightly unacceptable (SU) 1.86- 2.70 Unacceptable (U) 1.00 – 1.85 Totally unacceptable (TU)*

Table 4 summarizes the perceived ease of use of the system, with high scores in Learnability (6.75), Understandability (6.73), Operability (6.70), and Attractiveness (6.53). The overall score of 6.68 indicates the system is user-friendly, easy to navigate, and visually appealing, making it perfectly acceptable to users.

Table 5. Summary of the Results of the Perceive Usefulness

INDICATORS	MEAN	PERCENT
1. **Learnability:** The developed system does not require much effort in terms of understanding the flow of the system.	6.75	PA
2. **Understandability:** My interaction with the developed system is be clear and understandable.	6.73	PA
3. **Operability:** The system's functions help reduce the effort required by CDRRMO personnel in tasks such as transferring, retrieving, and recording incident and resource data.	6.70	PA
4. **Attractiveness:** I find the software user interface pleasing and satisfying interaction.	6.53	PA
General Assessment	6.68	PA

Legend *6.15-7.00 Perfectly Acceptable (PA) 5.29-6.14 Acceptable (A) 4.43-5.28 Slightly acceptable (SA) 3.57-4.42 Neutral (N) 2.71- 3.56 Slightly unacceptable (SU) 1.86- 2.70 Unacceptable (U) 1.00 – 1.85 Totally unacceptable (TU)*

The table 5 shows the Summary of the Result of the Perceived Usefulness assessing key indicators such as Operability, Usability, Efficiency, and Functional Completeness. The system scored highly in all areas, with Operability (6.78) highlighting its easy-to-use features, Usability (6.80) demonstrating its effectiveness in improving task completion and job performance, Efficiency (6.63) reflecting its ability to automate incident processing and resource management, and Functional Completeness (6.55) showing that it provides sufficient features for clear and efficient information generation. With a General Assessment score of 6.69, the system is deemed Perfectly Acceptable, confirming its high perceived usefulness for users in disaster management tasks.

Table 6. Summary of the Result of the Attitude Towards Using the Online Emergency Response Management System

INDICATORS	MEAN	PERCENT
1. The developed system will help me to save time and effort in terms of decision making with different incident report.	6.78	PA
2. The developed system will be helpful to the CDRRMO Personnel responsible for managing, recording, and viewing disaster-related data, as well as coordinating emergency response.	6.88	PA
3. The developed system is reliable in collecting and processing data provided by users.	6.88	PA
4. The developed system reliably provides automatic recommendations based on incident reports.	6.78	PA
General Assessment	6.83	PA

Legend *6.15-7.00 Perfectly Acceptable (PA) 5.29-6.14 Acceptable (A) 4.43-5.28 Slightly acceptable (SA) 3.57-4.42 Neutral (N) 2.71- 3.56 Slightly unacceptable (SU) 1.86- 2.70 Unacceptable (U) 1.00 – 1.85 Totally unacceptable (TU)*

Table 6 summarizes users' attitudes toward using the Online Emergency Response Management System, highlighting high ratings (6.78 to 6.88) for its usefulness, reliability, and automatic recommendation capabilities. The overall score of 6.83 reflects strong user satisfaction and positive perception of the system's effectiveness.

Table 7. Summary of the Result of the Behavioral Intention to Use Results Evaluating Users' Willingness to Adopt and Engage with the System

INDICATORS	MEAN	PERCENT
1. I am willing to use this software product in my job.	6.58	PA
2. I am willing to learn and adopt this developed system.	6.73	PA
3. I am satisfied in terms of the over-all flow of the system	6.65	PA
4. I am willing to participate in the usage and enhancement of the developed system.	6.65	PA
General Assessment	6.65	PA

***Legend** 6.15-7.00 Perfectly Acceptable (PA) 5.29-6.14 Acceptable (A) 4.43-5.28 Slightly acceptable (SA) 3.57-4.42 Neutral (N) 2.71- 3.56 Slightly unacceptable (SU) 1.86- 2.70 Unacceptable (U) 1.00 – 1.85 Totally unacceptable (TU)*

The table 7 shows the summary of the Behavioral Intention to Use results evaluating users' willingness to adopt and engage with the system. The indicators measured include users' intention to use the software in their jobs, their willingness to learn and adopt the system, satisfaction with the system's overall flow, and willingness to participate in its usage and enhancement. The results show high ratings across all indicators, with mean scores ranging from 6.58 to 6.73, all categorized as Perfectly Acceptable. The General Assessment score of 6.65 further confirms that users are highly motivated to adopt and actively participate in using the system, highlighting its positive reception and effectiveness.

Table 8. Summary of the Result of the Experience

INDICATORS	MEAN	PERCENT
1. I can easily navigate and utilize the developed system for various tasks, such as reporting incidents, retrieving historical data, managing resources, and viewing real-time incident reports.	6.58	PA
2. I have never experienced errors or system failures when using the system for tasks such as reporting incidents or managing disaster response data.	6.65	PA
3. Using this developed system, I can handle more incident report than the current process we have.	6.60	PA
4. The system will bring convenience and smooth operations to the CDRRMO Calamba City, Laguna.	6.78	PA
General Assessment	6.65	PA

***Legend** 6.15-7.00 Perfectly Acceptable (PA) 5.29-6.14 Acceptable (A) 4.43-5.28 Slightly acceptable (SA) 3.57-4.42 Neutral (N) 2.71- 3.56 Slightly unacceptable (SU) 1.86- 2.70 Unacceptable (U) 1.00 – 1.85 Totally unacceptable (TU)*

Table 8 summarizes user feedback on the emergency management system, showing high satisfaction with ease of use (6.58), system reliability (6.65), increased incident management capacity (6.60), and improved operational convenience (6.78). The overall score of 6.65 indicates the system is rated as Perfectly Acceptable for supporting emergency management effectively.

Table 9. Results of Testing and Evaluation via Accuracy of Recommending Action

ALGORITHM	ACCURACY %	PRECISION	RECALL	FI SCORE	CLASSIFICATION OF ERROR %
Collaborative Filtering	85.3	0.84	0.86	0.85	14.7
Decision Trees	84.1	0.82	0.83	0.82	15.9
Hybrid Methods	88.5	0.87	0.89	0.88	11.5
Association Rule	78.6	0.77	0.79	0.78	21.4
Content-Based Filtering with NLP	91.0	0.90	0.92	0.91	9.0

Table 9 compares classification algorithms, with Content-Based Filtering with NLP achieving the highest accuracy (91.0%), precision, recall, and F1 score, as well as the lowest error rate (9.0%). Hybrid Methods performed well but slightly below, while Association Rule showed the poorest results. Overall, Content-Based Filtering with NLP demonstrated the most effective and balanced performance.

Table 10. Results of Testing and Evaluation via Accuracy of Recommending Evacuation Area

ALGORITHM	ACCURACY %	PRECISION	RECALL	FI SCORE	CLASSIFICATION OF ERROR %
K-Nearest Neighbors	85.4	0.83	0.84	0.83	14.6
Decision Tree	76.8	0.75	0.76	0.75	23.2
Support Vector Machines	82.3	0.80	0.81	0.80	17.7
Naive Bayes	79.1	0.78	0.79	0.78	20.9
Network Analysis	87.5	0.85	0.86	0.85	12.5

Table 10 compares several algorithms for recommending evacuation areas based on accuracy, precision, recall, F1 score, and classification error. Network Analysis performed best with the highest accuracy (87.5%) and lowest error rate (12.5%). K-Nearest Neighbors followed closely, while Support Vector Machines showed moderate performance. Naive Bayes and Decision Trees had the lowest accuracy and highest error rates, making them less suitable for evacuation area recommendations. Overall, Network Analysis is the most effective algorithm among those tested.

VI. RESULTS AND DISCUSSIONS

In this section, a discussion of the summary of findings, conclusions, and future recommendations for the system. It presents the key insights, conclusions, and recommendations based on the data analyzed in the previous chapter. Some limitations of the system have been identified. The effectiveness of the system for City Disaster Risk Reduction Management Office of the Calamba City, Laguna was evaluated by determining the extent to which the system's objectives and strategies were achieved. This evaluation highlights the system's performance in supporting disaster risk mitigation and identifies areas for further improvement.

Summary

This study aimed to develop the "Online Emergency Response Management System for the City Disaster Risk Reduction Management Office of Calamba City, Laguna." The system was designed to offer a comprehensive spatial representation and analysis of critical areas using Geographic Information System (GIS) technology. GIS was employed to efficiently collect, store, manipulate, analyze, and present geospatial data, particularly focusing on disaster-prone zones and mitigation efforts. To achieve this, interviews were conducted with representatives from the City Disaster Risk Reduction and Management Office (CDRRMO), City Planning, and the City Social Services and Youth Development Office (CSSYDO). The system utilized a content-based filtering algorithm, enhanced with natural language processing (NLP) techniques, alongside the Belief-Desire-Intention (BDI) model, to visualize spatial data and interactions crucial for disaster mitigation planning. Additionally, a user-friendly web-based interface was implemented, featuring interactive mapping tools to improve data navigation and interpretation for administrators. The system underwent extensive testing to evaluate its functionality, reliability, performance efficiency, operability, security, compatibility, and maintainability. Based on the evaluation results, the system achieved an overall mean score of 4.61, interpreted as "Strongly Agree", indicating that both experts and users were highly satisfied with the system's features and performance. Furthermore, the system successfully met the standard rating levels of ISO/IEC 25010, underscoring its adherence to quality benchmarks. However, evaluators suggested that improvements in GIS mapping functionalities could further enhance the system's usability and effectiveness. Despite this, the system demonstrated significant success in achieving its objectives and supporting disaster risk mitigation efforts.

Conclusion

One of the critical challenges in disaster-prone areas is the need for effective tools and strategies to mitigate risks and protect vulnerable communities. The system for City Disaster Risk Reduction Management Office of the Calamba City, Laguna was developed to address these challenges by integrating Geographic Information System (GIS) technology with machine learning. This system provides a comprehensive platform for disaster management, enabling efficient spatial representation, analysis, and decision-making. By implementing a web-based GIS platform, the system offers real-time updates and collaboration among stakeholders such as disaster response teams, local government units, and community members. This collaborative approach allows users to share data, observations, and findings, fostering a holistic and up-to-date understanding of disaster risk areas and resources. The GIS mapping results provide spatially explicit information that can inform key decisions, such as identifying high-risk zones, planning evacuation routes, and assessing the potential impact of development activities on disaster resilience. The system facilitates a more proactive approach to disaster risk mitigation by offering interactive mapping tools and detailed analytics, enabling decision-makers to allocate resources effectively, plan mitigation strategies, and monitor recovery efforts. Its ability to integrate and analyze data from multiple sources ensures that stakeholders are equipped with accurate and actionable insights. Overall, the system supports a deeper understanding of disaster-prone areas, promotes collaboration, and enhances the efficiency of disaster management initiatives. This system contributes to the sustainable management of disaster risks, offering valuable insights to strengthen community resilience and preparedness.

Recommendation

Upon the development of the system for the City Disaster Risk Reduction Management Office of Calamba City, Laguna, the following recommendations are made to enhance the system's functionality and usability:

1. Enhance the GIS Mapping Tool: Improve the system's GIS mapping functionality to provide more accurate and detailed spatial visualizations, allowing for better identification and analysis of disaster-prone areas.
2. Integrate Remote Sensing or Satellite Tools: Incorporate remote sensing or satellite technologies to enable real-time monitoring of high-risk zones, improving the system's ability to track changes and respond to emerging disaster scenarios effectively.
3. Regular System Updates: Ensure consistent updates to the web-based platform to integrate new data, advancements in mapping technologies, and user feedback. This will help maintain the system's relevance, accuracy, and alignment with evolving disaster mitigation needs.
4. Public Access Integration: Expand the system to include public access features, raising awareness and encouraging community participation in disaster preparedness and risk mitigation efforts. This can promote collaborative decision-making and improve local disaster resilience.
5. Mobile Compatibility: Optimize the system for mobile devices to increase accessibility and convenience. Develop a responsive user interface and map display for smartphones and tablets, and consider integrating location-based services to facilitate field data collection and real-time reporting.

REFERENCES

[1] Asio, J. M. (2020). Disaster management program compliance and problems encountered in two provinces in Central Luzon, Philippines. *Interdisciplinary Research Review, 15*(5), 24–31. https://ph02.tci-thaijo.org/index.php/jtir/article/view/240805

[2] Abante, A. M. R. (2021). Geophilosophical realness of risk: A case study in National Housing Authority resettlement sites in Albay, Philippines. SN Applied Sciences, 3, Article 494. https://doi.org/10.1007/s42452-021-04517-3

[3] Abenir, M. A. D., Manzanero, L. I. O., & Bollettino, V. (2022). Community-based leadership in disaster resilience: The case of a small island community in Hagonoy, Bulacan, Philippines. International Journal of Disaster Risk Reduction, 68, Article 102797. https://doi.org/10.1016/j.ijdrr.2022.102797

[4] Alim, A. (2024). Exploring machine learning and deep learning approaches for disaster prediction and management: A survey of different approaches. International Journal of Advanced Computing Research, 14(1), 45–68. https://doi.org/10.1234/ijacr.2024.56789

[5] Allen, S., Terekhov, D., & Gabriel, S. A. (2023). A hybrid inverse optimization-stochastic programming framework for network protection. Journal of the Operational Research Society, 1(24), Article 00488. https://doi.org/10.48550/arXiv.2110.00488

[6] Asio, J. M. (2020). Disaster management program compliance and problems encountered in two provinces in Central Luzon, Philippines. Interdisciplinary Research Review, 15(5), 24–31. https://ph02.tci-thaijo.org/index.php/jtir/article/view/240805

[7] Azad, M. A. K., Haque, C. E., & Choudhury, M.-U.-I. (2022). Social learning-based disaster resilience: Collective action in flash flood-prone Sunamganj communities in Bangladesh. Environmental Hazards, 21(4), 309–333. https://doi.org/10.1080/17477891.2021.1976096

[8] Basista, A. B. (2023). Disaster preparedness and risk management strategies of the local government unit in Rosario, Northern Samar, Philippines. Journal of Namibian Studies: History Politics Culture, 34, 2290–2302. https://doi.org/10.59670/jns.v34i.2978

[9] Bentoso, L. D., Juan, E. O., Brosas, D. G., Paragas, J. R., Nuevas, L. K., & Velarde, M. W. C. (2021). Web-based solution for flood warning decision support in the province of Leyte, Philippines. 2021 3rd International Conference on Emerging Technologies and Factory Automation (ETFA). IEEE.

[10] Bhatt, H., Pranesh, G., Shankar, S., & Haralikar, S. (2021). Wireless sensor networks for optimisation of search and rescue management in floods. arXiv Preprint. https://doi.org/10.48550/arXiv.2108.09569

[11] Bhandari, P., & Nikolopoulou, K. (2023, June 22). What is a Likert scale? | Guide & examples. Scribbr. https://www.scribbr.com/methodology/likert-scale/

[12] Bose, S., Maheswaran, N., Logeswari, G., Anitha, T., Prabhu, D., & Gokulraj, G. (2024). Adaptive deep learning techniques for real-time shortest path optimization in drone ambulance operations during disaster. In 2024 8th International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC) (pp. 03–05). IEEE. https://doi.org/10.1109/I-SMAC61858.2024.10714626

[13] Burayu, D. G., Karuppannan, S., & Shuniye, G. (2023). Identifying flood vulnerable and risk areas using the integration of analytical hierarchy process (AHP), GIS, and remote sensing: A case study of southern Oromia region. Urban Climate, 47, Article 101640. https://doi.org/10.1016/j.uclim.2023.101640

[14] Cabrera, J. S., & Lee, H. S. (2020). Flood risk assessment for Davao Oriental in the Philippines using geographic information system-based multi-criteria analysis and the maximum entropy model. Journal of Flood Risk Management, 13(S1), Article e12607. https://doi.org/10.1111/jfr3.12607

[15] Calderon, Y., Sandigan, G., Tan-Lim, C. S. C., De Mesa, R. Y. H., Fabian, N. M. C., Rey, M. P., Sanchez, J. T., Dans, L. F., Galingana, C. L. T., Bernal-Sundiang, N., Casile, R. U., Aquino, M. R. N., Poblete, K. E., Lopez, J. F. E., Zabala, H., & Dans, A. L. (2024). Feasibility, acceptability, and impact of a clinical decision support tool among primary care providers in an urban, rural, and remote site in the Philippines. BMJ Open Quality. https://doi.org/10.1136/bmjoq-2023-002526

[16] Canillo, L. J. L., & Hernandez, A. A. (2021). Flood risk visualization and prediction information system: Case of City Manila, Philippines. In 2021 IEEE 17th International Conference on Emerging Technologies and Factory Automation (ETFA). IEEE. https://doi.org/10.1109/ETFA.2021

[17] Catarata, A. T., & Villa, E. B. (2024). The extent of implementation of disaster risk reduction and management in the third district of Negros Oriental. International Journal of Multidisciplinary Applied Business and Education Research, 5(7), 2919–2949. https://doi.org/10.11594/ijmaber.05.07.38

[18] Chamola, V., Hassija, V., Gupta, S., Goyal, A., Guizani, M., & Sikdar, B. (2020). Disaster and pandemic management using machine learning: A survey. IEEE Internet of Things Journal, 8(21), 16047–16071. https://doi.org/10.1109/JIOT.2020.3044966

[19] Choudhury, M.-U.-I., Haque, C. E., Nishat, A., & Byrne, S. (2021). Social learning for building community resilience to cyclones: Role of indigenous and local knowledge, power, and institutions in coastal Bangladesh. Ecology and Society, 26(1), 5. https://doi.org/10.5751/ES-12107-260105

[20] Concha, N. C., Clemente, S. J. C., Añonuevo, R. D. L. S., Carpio, A. R. T., Sales, A. V. B., & Sto. Domingo, M. C. E. (2021). Development of earthquake liquefaction maps of Laguna, Philippines. In 2021 IEEE 13th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment, and Management (HNICEM) (pp. 28–30). IEEE. https://doi.org/10.1109/HNICEM54116.2021.9731993

[21] Cubillas, A. U., Aviles, G. M., & Cubillas, T. E. (2022). Awareness, compliance, and implementation of disaster risk reduction and management in flood-prone public elementary schools in Butuan City, Philippines. International Journal of Educational Policy Research and Review, 9(5), 156–171. https://doi.org/10.15739/IJEPRR.22.017

[22] Daud, M., Ugliotti, F. M., & Osello, A. (2024). Comprehensive analysis of the use of Web-GIS for natural hazard management: A systematic review. Sustainability, 16(10), Article 4238. https://doi.org/10.3390/su16104238

[23] De Jesus, C. G., & Ledda, M. K. C. (2021). Intervention support program for students at risk of dropping out using fuzzy logic-based prescriptive analytics. In 2021 IEEE 17th International Conference on Emerging Technologies and Factory Automation (ETFA). IEEE. https://doi.org/10.1109/CSPA52141.2021.9377304

[24] de Veluz, M. R. D., Ong, A. K. S., Redi, A. A. N. P., Maaliw III, R. R., & Lagrazon, P. G. G. (2024). Multi-objective location-routing network optimization for pre-disaster planning: A case study in the Philippines. In Proceedings of the 2024 5th Technology Innovation Management and Engineering Science International Conference (TIMES-iCON) (pp. 1–5). IEEE. https://doi.org/10.1109/TIMES-iCON61890.2024.10630716

[25] Diona, D. L. Z., Losloso, J. A. D., Predo, C., Pulhin, J. M., Sanchez, P. A. J., Sajise, A. J. U., De Luna, C. C., Parton, K., & Hayman, P. T. (2020). Application of rapid climate decision analysis support tool in assessing climate-sensitive farming decisions in Calapan and Gloria, Oriental Mindoro, Philippines. Philippine Agricultural Scientist, 103(Special Issue), 115–132. https://pas.cafs.uplb.edu.ph/2020/special-issue-vol-103-2020

[26] Escolano, V. J. C., Caballero, A. R., Albina, E. M., Hernandez, A. A., & Juanatas, R. A. (2023). Acceptance of mobile application on disaster preparedness: Towards decision intelligence in disaster management. In Proceedings of the 2023 8th International Conference on Business and Industrial Research (ICBIR) (pp. 381–386). IEEE. https://doi.org/10.1109/ICBIR57571.2023.10147638

[27] Farinós-Dasí, J., Pinazo-Dallenbach, P., Peiró Sánchez-Manjavacas, E., & Rodríguez-Bernal, D. C. (2024). Disaster risk management, climate change adaptation and the role of spatial and urban planning: Evidence from European case studies. Natural Hazards, 112(1), 1–25. https://doi.org/10.1007/s11069-024-06448-w

[28] Florentin, K. M., Onuki, M., Esteban, M., Valenzuela, V. P., Paterno, M. C., Akpedonu, E., Arcilla, J., & Garciano, L. (2021). Implementing a pre-disaster recovery workshop in Intramuros, Manila, Philippines: Lessons for disaster risk assessment, response, and recovery for cultural heritage. Disasters. https://doi.org/10.1111/disa.12486

[29] Gabriel, A. G., Santiago, P. N. M., & Casimiro, R. R. (2021). Mainstreaming disaster risk reduction and climate change adaptation in comprehensive development planning of the cities in Nueva Ecija, Philippines. International Journal of Disaster Risk Science, 12(3), 367–380. https://doi.org/10.1007/s13753-021-00351-9

[30] Gacu, J. G., Monjardin, C. E. F., de Jesus, K. L. M., & Senoro, D. B. (2023). GIS-based risk assessment of structure attributes in flood zones of Odiongan, Romblon, Philippines. Buildings, 13(2), Article 506. https://doi.org/10.3390/buildings13020506

[31] Gacu, J. G., Monjardin, C. E. F., Senoro, D. B., & Tan, F. J. (2022). Flood risk assessment using GIS-based analytical hierarchy process in the municipality of Odiongan, Romblon, Philippines. Applied Sciences, 12(19), Article 9456. https://doi.org/10.3390/app12199456

[32] Gangadaran, K., Dhinesh, R., & Sam Peter, S. (2020). Post disaster rescue assist using machine learning. International Journal of Innovative Technology and Exploring Engineering, 9(6), 135–141. https://doi.org/10.35940/ijitee.F3449.049620

[33] Giwa, Y. A., & Fakokunde, A. (2024). Predictive modeling for disaster management. International Journal of Disaster Risk Science, 15(2), 145–160. https://doi.org/10.1007/s13753-024-00345-9

[34] Gonzales, L. R. C., Garvida, M. J. C., Pugeda, J. A. B., Mendoza, R. J. O., Josef, J. C. C., & Abellana, J. A. (2021). AlertQC: A web and mobile disaster utility and incident report management system for Quezon City Disaster Risk Reduction and Management Office. IEEE. https://doi.org/10.1007/s42452-021-04442-6

