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1 INTRODUCTION

1.1 Project Concepts

Human populations worldwide experience rising dangers from both natural and human-made threats. A hazard is described as any natural occurrence or human-induced event that presents risks to human beings, animals, and the environment. This includes typhoons, floods, and earthquakes that cause extensive destruction of lives alongside properties and natural ecosystems. The occurrence of a hazard often leads to fatal or ill effects, health risks, property damage, social and economic crises, and environmental harm. Several areas across the world face danger because of multiple disaster events (Gohil et al., 2024). According to an article report, in 2024, the global economy suffered great losses from natural catastrophes that reached up to $310 billion, with severe storms, tropical cyclones, and flooding being accountable for 85% of these losses (Allianz Risk Barometer, 2025).

112 The Philippines is one of the highly susceptible countries to natural hazards due to its
92 position on the Pacific Ring of Fire. The country experiences an average of 20 typhoons yearly, with an estimate that eight of them make landfall. Additionally, this country also
54 faces risks like earthquakes, volcanic eruptions, landslides, and flooding. Since 1990, the Philippines has experienced over 565 disasters, resulting in 70,000 total deaths and a cost of $23 billion in terms of damages, which is an enormous toll that reflects just how exposed the country is (World Bank Group, 2021). According to a report by Hogsholt and Razon (2024), the Philippines ranks highest in the world in terms of exposure to extreme natural

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events. This only underscores the importance of strong disaster risk reduction and management (DRRM) systems to save lives.

In the context of this study, Padre Garcia is a second-class municipality in Batangas, traces its legal foundation to 1949 when Padre Vicente Garcia established the town and later obtained its present name. Padre Garcia operates as the "Cattle Trading Capital of the Philippines" since traders from Southern Tagalog and every district of the region visit its expansive livestock trading venue (Municipal Government of Padre Garcia, 2023). The municipality is 41.51 square kilometers, but has a population of over 51,000 people that live within 18 barangays (Philippine Statistics Authority, 2021).

In spite of its economic advantages, Padre Garcia is still threatened because of different natural risks. The inhabitants have documented earthquakes, violent typhoons, and other extreme weather conditions that endanger life and properties. The vulnerability of the municipality was highlighted in the 2020 Taal Volcano eruption, which displaced thousands of Batanguenos and needed to provide emergency medical services to more than 260 Batanguenos in Padre Garcia alone (Sare, 2020). In 2022, emergency response procedures resumed because of the increased volcanic activity again, with the MDRRMO and local officials managing evacuation operations alongside relief efforts (NDRRMC, 2022).

Moreover, Padre Garcia is also vulnerable to other specific incidents. In October 2024, Severe Tropical Storm Kristine affected over 5,000 residents in Batangas, including Padre Garcia, causing widespread flooding and property damage that required relief operations (GMA News, 2024). Also, in 2020, Typhoon Rolly exposed Padre Garcia to a yellow warning of floods, indicating its frequent flood potential. This has led to tragic cases in the region such as the drowning of two locals in the spillways and rivers as the waters rise, and two others are yet to be found (PDRRMO, 2020). Moreover, the problem of road accidents is also present, and an example of such an event is the case of a fatal motorcycle accident in March 2024, which occurred in Barangay Banaba (Opinyon Batangas News Team, 2024). Additionally, a multi-vehicle crash in January 2021 injured three people in Padre Garcia, which shows the necessity of controlling and regulating vehicle accidents (GMA News, 2021). Such cases highlight the need to strengthen the municipality's capacity to respond effectively to disasters.

These incidents highlight persistent problems in disaster preparedness and response. The Municipal Disaster Risk Reduction and Management Office serves as the principal body of risk protection of inhabitants as provided under Republic Act 10121 (2010). However, MDRRMO Padre Garcia currently relies on manual logbooks, scattered Excel files, and a static printed hazard map. Such paper-based and decentralized records complicate: (1) the ability to access incident data promptly, (2) ability to trend data over time, and (3) maintenance of hazard maps in real time. Consequently, evidence-based planning, distributing resources, and response to emergencies is limited.

According to Zulkipli (2021), access to essential information during emergencies at inappropriate times may postpone the response efforts, including those performed by the MDRRMO operations, and the misplaced resources are likely to endanger lives. The author notes that the absence of the efficient disaster management system undermines the

63 capability of an organization to plan and respond better to crisis. In the absence of a centralized and real-time system, MDRRMO will still find it hard to trace and monitor incidences effectively or even itself analyze trends of risks to proactively implement disaster management measures.

To address these, various disaster prone regions across the globe have adopted adoption of digital solutions such as Geographic Information Systems (GIS) to enhance the capacity of their disaster management activities. Organizations attach great significance to the application of GIS technology in the disaster because it prepares real-time and interactive maps that enhance understanding of emergencies in their work (Eminoglu & Tarhan, 2025). Numerous research studies show that web-GIS tools can help authorities to monitor and visualize natural dangers in real time, which helps them protect communities at risk. For this reason, GIS-based systems have become an important tool in modern disaster risk management.

Prior to addressing these challenges, the researchers introduce ResponSys: A Web-Based Incident Management System with Hazard Mapping for Padre Garcia's MDRRMO. This system integrates GIS technology with QGIS software into one platform that incorporates a dashboard with analytics, hazard mapping, incident management, and report generation. The introduction of modernization in the MDRRMO incident management system, whereby manual data management is replaced by a digital one, enables MDRRMOs to enhance their capacity to process risk assessment as well as support data-based decision-making. With the help of the technology implementation, the MDRRMO will be able to reach the operational efficiency, reduce human error and improve access to critical information. As stated by Mr. Loyd Driz, the Local DRRM Assistant, the system, ResponSys, will help in organizing and managing data more effectively and represents an important advancement for the office. By doing so, ResponSys will work towards streamlining the operations of the MDRRMO in managing information and reducing the instances of human error, and increasing access to important information that can aid in making timely and informed decisions in times of emergencies.

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1.2 Purpose and Description

This project is mainly aimed at designing, developing, and evaluating ResponSys, a web-based incident management system with hazard mapping to support the MDRRMO of Padre Garcia, Batangas. The system seeks to substitute the existing manual and decentralized process of recording incidents with a centralized and GIS-supported system capable of offering quicker data access, visualization of hazards and informed decision-making.

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The main beneficiary of the system is the Municipal Disaster Risk Reduction and Management Office (MDRRMO) of Padre Garcia, Batangas. Using the multi-purpose software platform, QGIS, ResponSys will enable the digital mapping of hazards and risk zones, which will give the MDRRMO the ability to easily target the areas that are highly prone to any disaster. These enhancements are designed to aid in better decision-making and planning by enhancing information management and situational awareness, instead of immediate response execution. This will also enable the MDRRMO to get centralized data on hazards in a single system, which is meant to assist in mitigation planning and risk assessment.

This project would also be beneficial to local government units (LGUs). Through the ResponSys, the LGUs would have an opportunity to develop the policies and action plans that would be responsive to the conditions and risks in the area. The availability of credible information will enable LGUs to plan resource distribution effectively and take proactive measures to ensure the community is safe.

Remarkably, the adoption of ResponSys will be of great benefit to the citizens of Padre Garcia. By having a centralized system of managing incidents, the citizens will be in a better position to access information on local hazards and risks. In addition, since the incidents are handled by ResponSys, the MDRRMO will have quicker access to accurate information and enhanced situational awareness, which could aid more effective decisions in emergency situations. Such an increased information access can lead to an increased level of community knowledge and preparedness.

As learners, the proponents will have a chance to know how to build and develop a technology-based hazard mapping system which will be useful in the GIS and Information Technology field. It will enhance their understanding on the aspects of GIS technology, and concepts of disaster risk management, and web-based application development. Moreover, the study will also illustrate the use of geographic information systems in enhancing disaster preparedness cycle.

74 84 Yet, it is hoped that this study will serve as a useful resource for future researchers interested in GIS-based disaster risk assessment. With the results of this research, may serve as their basis for improving existing hazard mapping and incident management systems and also for developing even more sophisticated technologies to enhance disaster preparedness and risk mitigation.

72 1.3 Objectives of the Study

35 14 The main goal of this research project involves developing a web-based incident management system that integrates hazard mapping with data-supported decision-making and streamlined incident reporting to enhance the Municipal Disaster Risk Reduction and Management Office (MDRRMO) coordination capabilities.

36 To achieve this primary objective, the study will address the following objectives:

1. Develop a user-friendly web-based platform for MDRRMO personnel and designated barangay users to efficiently log, manage, and retrieve disaster-related incident reports, and for citizens to report incidents.

    1. Ensure real-time data entry and retrieval for quick incident reporting.
    2. Provide role-based access for MDRRMO staff and authorized barangay users to facilitate secure data management.
    3. Enhance report generation capabilities for post-disaster analysis and planning.

2. Integrate Geographic Information System (GIS) technology for hazard mapping and risk assessment.
    1. Utilize Quantum GIS (QGIS) to visualize disaster-prone areas based on historical data and incident trends.
    2. Enable layered hazard mapping for different risk types (e.g., floods, earthquakes, fires).
    3. Provide interactive mapping tools for dynamic risk assessment and monitoring.
3. Implement a centralized database management system for structured data storage and analysis.
    1. Store and organize incident reports, hazard information, and response records in a secure database.
    2. Facilitate data-driven decision-making through structured analysis and trend tracking.
    3. Ensure data security and backup mechanisms to prevent information loss.

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1.4 Scope and Limitations

The scope of this study are in line with the objectives of ResponSys. It aims at assisting the MDRRMO to document and track the occurrence of a disaster in Padre Garcia, Batangas using a centralized web-based model. It will also offer a centralized platform that enhances the ease of retrieval of past information to support future decision-making. Moreover, the hazard mapping of the area being examined is also entered into the GIS technology, which will serve as the monitoring system for the MDRRMO staff to have an aerial perspective of disaster-susceptible areas. By using GIS, the system will allow MDRRMO personnel to map the incidents on an interactive digital map to facilitate the visualization of vulnerable areas and fundamental pattern identification to use in planning activities.

7 On top of that, ResponSys is web-based, which means that MDRRMO can access and manage the system in a web browser, ensuring that it is efficient, accessible, and is able to facilitate system operations. The system collects data efficiently using digitized and integrated QGIS mapping to improve disaster incident record keeping with the intent of supporting better resource allocation and decision support in disaster risk management. The analytics provided in the system are descriptive in nature. The system will mainly provide descriptive analytics (e.g., frequency counts, simple visual summaries). Predictive analytics and advanced modeling are not within the scope.

Although ResponSys seeks to improve disaster operations in Padre Garcia, it still faces some limitations. First is that the system is designed solely for MDRRMO use in Padre Garcia, with access restricted to authorized personnel for administrative functions, while citizens will have limited access solely for reporting incidents and hazard map viewing. The evaluation of the system will involve selected MDRRMO personnel and designated barangay representatives only, within the duration of the pilot implementation. In addition, while ResponSys provides optimal features on computers and laptops, mobile accessibility is available but may be reduced efficiency in certain functions. Likewise, it will not yet combine external sources of data like automated weather stations, IoT sensors or live hazard detection APIs. Finally, although the system supports integration with QGIS, its main goal is to incorporate the incident reports and hazard mapping into the system, implying that the system will not include other sophisticated GIS features such as spatial analysis, terrain modeling, or disaster simulations.

1.5 Definition of Terms

This section is where the key terms and concepts that are used throughout the project are defined. Defining these terms will assure that readers have a consistent understanding of the terminology, which helps in avoiding confusion and misinterpretation. Each term is explained in the context of the study to provide clearness and enhance the overall comprehension of the project.

Decentralized Records	A decentralized record involves multiple physical documents that are spread across different areas within the office (Iron Mountain, 2022). In this study, it refers to the manual and dispersed storage of MDRRMO's incident reports, making data retrieval and analysis inefficient.
Disaster Preparedness	This just refers to the understanding and capability of professionals to efficiently manage and alleviate the effects of threats (Republic Act 10121, 2010). In this research context, disaster preparedness refers to the strategies, plans, and activities implemented by the MDRRMO, supported by the ResponSys platform, to lessen the consequences of catastrophes on the community of Padre Garcia.
Hazard Mapping	Hazard maps are created to show susceptible areas and are used by various experts to mitigate or negate the harmful effects of different hazards (Pacific Northwest Seismic

	Network, 2020). As used in this study, hazard maps are embedded in the system through the use of QGIS to identify and visualize disaster-prone areas, helping MDRRMO assess risks and plan mitigation strategies.
Incident Management System	An incident management system can be described as the use of tools that can help in managing incidents and preventing them from occurring again (SafetyCulture, 2024). In this study, it serves as a web-based platform for reporting, logging/ recording, and managing disaster-related incidents.
Quantum Geographic Information System (QGIS)	It is a fully and open-source functional GIS that is capable of what an operational GIS should be able to do, including manipulating maps, exporting web maps, and many other more (Ian, 2022). As used in this study, the researchers make use of QGIS software to generate hazard maps and assess disaster-prone areas.
Risk Assessment	Risk assessment refers to the analysis of all the elements of a particular activity in order to identify the possible risks and their detrimental consequences (CCOHS, 2024). Risk assessment, in this study, is the assessment of the documented disaster occurrences to determine disaster-prone areas and assist MDRRMO in decision-making relating to disaster preparedness and resource allocation.
Risk Mitigation	This may be termed as the planning and developing of strategies that shall minimize threats that are experienced by the communities (Lutkevich, 2024). In this research, risk mitigation is the process of developing and deploying the strategies that were identified through ResponSys to minimize the effects of possible disasters in Padre Garcia.
Spatial Data	Spatial data can be defined as a form of data that directs or indirectly addresses a particular geographical region or place (Awati et al., 2024). In the context of this study, spatial data is the location-related data that is processed in QGIS to map hazards, evaluate risks, and aid in disaster preparedness operations of MDRRMO.

2 REVIEW OF RELATED SYSTEMS/STUDIES

The chapter discusses various related systems and research, which allows to better understand such system development practices. The analysis of these related projects shows best practices as well as standard challenges and potential improvements, which are the foundation to enhance ResponSys.

2.1 Technical Background

This section is the summary of the technical basis of ResponSys that consists of vital elements of a successful disaster preparedness and preparedness support system. The discussion encompasses five key areas, including Web-Based Incident Management Systems for Disaster Preparedness, Geographic Information Systems (GIS) for Hazard Mapping and Risk Assessment, Real-Time Data Entry, Retrieval, and Role-Based Access Control, Centralized Database Management for Incident Reporting and Analysis, and Data Security, Backup, and Information Integrity in Disaster Management Systems. All these areas are essential in making sure that ResponSys is a trustworthy platform that can be used to manage information related to disasters and aid in making informed decisions in case of an emergency.

Web-Based Incident Management System for Disaster Preparedness. An incident management system (ICM) is a web-based tool which is a critical disaster risk management tool that can aid real-time incident monitoring, hazard assessment, and even emergency relief. Having a centralized disaster incident management platform enhances the capacity of local response teams to make decisions and, it also, ensures that teams are more responsive whenever necessary. The effectiveness of web-based technologies has been demonstrated by enhancing the efficiency of risk communication and aiding timely emergency planning and coordination during various emergencies (Psaroudakis et al., 2021).

Moreover, ICM also offers the capability that encompasses geospatial technologies to map hazards and assess risks. According to the study conducted by Song et al. (2022), web-based hazard maps that are used to reduce the risk of a disaster enable interactive mapping systems to enhance the way the users understand hazardous areas. This capability is necessary to aid the personnel analysis of the disaster patterns and future risk assessment by the MDRRMO, which enhances the management of resources.

Moreover, this system has been created with an aim of enhancing the safety of people by having early warning tools and real-time reporting of incidents. One study shows that adoption of a web-based platform can enhance community readiness and reduce the response time in case of an emergency (Psaroudakis et al., 2021). Regarding ResponSys, the MDRRMO can use the capabilities of the platform to monitor incidents, update hazards, and improve the situational awareness to inform emergency planning.

64 To do all this, the ResponSys is created with HTML, CSS, and JavaScript as the front-end interface, PHP as the back-end to process data and business logic, and Tailwind CSS to create a future and responsive design. All these technologies together are guaranteed to provide an efficient, maintainable system that fulfills the operational requirements of the MDRRMO.

In this paper, these concepts support the design of ResponSys as a centralized system, which can facilitate real-time reporting on incidents, enhance data availability, and organize information to manage MDRRMO operations.

Geographic Information System (GIS) for Hazard Mapping and Risk Assessment. GIS is a way to analyze and display data with geographic reference (Shapiro & Donato, 2025). It can utilize any kind of data, which includes location. With this technology, users can compare the areas of various things to find out their relationships. For instance, GIS maps have the ability to show which human-made structures are near certain natural landscapes, such as which buildings or places are flood-prone areas (National Geographic Society, 2025). It has been widely adopted in solving problems, monitoring, and risk assessment. By using its capability to process data and integrate with other technologies, GIS surely can assess risks and hazards to help organizations analyze and make effective decisions (Chen et al., 2022).

In this study, QGIS is utilized as it is an open-source software, meaning it has vast support from the community. Compared to other software, QGIS is free. Since it is open-source, it transitions from simply being a source of spatial information to becoming a practical and powerful GIS tool used by various users (Gallardo et al., 2022). To extend its functionality on web applications like ResponSys, Leaflet.js is utilized to embed and display interactive maps on the website. A lightweight and foremost JavaScript library ultimately designed for interactive maps, Leaflet.js is an ideal tool for integrating QGIS-generated maps into ResponSys. This approach also aligns with the recommendation of the

MDRRMO, as this kind of tool is surely an advancement for their office. Furthermore, GIS and QGIS directly support the hazard mapping function of ResponSys by enabling the visualization of risk areas and spatial relationships needed for local disaster planning and monitoring.

Real-Time Data Entry, Retrieval, and Role-Based Access Control. The development in digital technology, as well as the growth of the amount of data, has altered the manner in which organizations tend to operate. Therefore, the timely and informed decision-making that depends on the real-time data processing is critical in strengthening strategies and operations within the MDRRMO. According to Achanta (2024), real-time data helps with operations as it offers immediate insights and information. With the implementation of such capability, the team can react promptly and, therefore, become more proficient in decision-making. However, more stringent security measures ought to be installed to guarantee data reliability since real-time data processing requires strong controls to promote data integrity.

Security is a very important component in web-based disaster reporting system like ResponSys. It secures sensitive data and gives the authorized users ability to access and manage records. ResponSys is developed in a way that supports security and operational efficiency. The following studies below demonstrate how security measures ensure system security and reduce vulnerabilities to improve data integrity in the platform.

25 In a platform that is handling sensitive information like disaster reports, access control is one of the most important security mechanisms in information systems. According to
68 Rao et al. (2021), RBAC (Role-based Access Control) is a security method that relies on

27 the user role definitions to provide access to sensitive information and ensure the integrity of data across the platform. The RBAC also allows users to administer access restrictions flexibly and at scale in an organizational context with large user populations and complicated needs (Mayeke et al., 2024). This would create user privilege structures on the basis of their roles to prevent data breaches and yet still meet operational workflow needs.

Besides the implementation of RBAC, which itself is an implementation of Identity and Access Management (IAM), other IAM features, such as multi-factor authentication and secure login credentials, are also important to provide assurance to the system that its access is not compromised by any unauthorized user. IAM does keep off attackers and at the same time, allows legitimate users to carry out their tasks freely and without necessarily exceeding what they are allowed. Through this, the system helps in simplifying the process of granting users access through automatic assignment of user authority according to roles and responsibilities (Kosinski and Forrest, 2024). These are put in place to make sure that only the authorized users are allowed to read and manipulate the information on disaster issues.

Along with regulating access to the system to prevent tampering or unauthorized access to disaster-related reports, it is necessary to use encryption methods that can secure the stored and transferred data. The researchers, in this case, have applied the Secure Hashing Algorithm 256 (SHA-256) to protect passwords and secure storage of credentials. SHA-256 has been widely adopted in other sectors due to its functions and security. Using SHA-256, passwords that consist of long and complex characters are highly resistant to brute force attacks. The longer and more complex the password, the more difficult the cracking process will be (White, 2025). By using secure hashing, ResponSys can eliminate unauthorized access to the information as sensitive data is stored in a secure, encrypted format.

In this paper, role-based access control and real-time data processing will ensure that ResponSys offers timely updates and limits the system access based on the assigned user roles within the MDRRMO.

Centralized Database Management for Incident Reporting and Analysis. In the modern day, data has become a valuable asset as various organizations utilise large amounts of data to determine various trends and examine them. The growing volume of data poses a challenge to most organizations to adequately handle this due to the lack of effective storage solutions and retrieval and modification solutions. These issues highlight the importance of the Database Management Systems (DBMS). A DBMS is a significant part of data management and organization, which has the ability to store, retrieve, and modify data effectively. As Sinha et al. (2024) state, DBMS is a standardized data storage tool that allows MDRRMO and other organizations to access the required information to make data-driven decisions in an efficient way. Furthermore, it also has in-built security features such as encrypting and encrypting data, authentication procedures, and authorization access control systems that guarantee safe storage of data.

There are many forms of DBMS which include Object-Oriented DBMS, Hierarchical DBMS, Network DBMS and Relational DBMS (RDBMS), which must be familiarized to ensure that the right type of DBMS is applied in the systems which will be developed. The RDBMS that was utilized in this system, as per the study conducted by Patel et al. (2023), is a DBMS in which information is stored in a tabular structure with rows and columns. Each table has a relation to each other using unique keys better known as primary keys. According to them, an RDBMS is the most used and popular type of DBMS because it is easy to understand and learn. Popular RDBMs are MySQL, Oracle, and SQlite. IBM (2021) explained that RDBMS is easy to use because of the large number of communities that use it, and backing it up is easy because it is transactional, meaning it guarantees that the entire database system is always consistent.

With these strengths, an RDBMS explains why it would be a good fit with disaster management systems such as ResponSys because it is an excellent system in terms of easy data organization. According to the researches mentioned above, its system could store and retrieve an enormous amount of data and ensure that vital incident records are accessible, obtained, and organized, and that analysis is simple. Data consistency through the transactional integrity of RDBMS is important and crucial in generating accurate historical records to support disaster preparedness and response decision-making. This will ensure that MDRRMO is able to improve its incident management and reporting efficiency as well as assist in decision-making and situational awareness with centralization of their data using RDBMS in case of an emergency.

The adoption of centralized database in systems such as ResponSys will contribute to the further enhancement of the efficacy of incident reporting and analysis because it will bring together all the essential information they require into one system. This is referred to as the center of information on disasters by DataGuard (2024), who claims that through this, responders have a clear picture of the events. The adoption of this new method will not only allow the MDRRMO to foster prompt access to historical data, patterns of disasters, and provide proactive responses based on the insights, but it will also increase their overall effectiveness of the functions since they will not have redundancy in the data records as opposed to the manual system of record keeping, which again is likely to be lost and subject to human error, which facilitates the smooth communication of the stakeholders during emergencies.

In this study, an RDBMS supports ResponSys by ensuring structured data storage, consistent record management, and reliable retrieval of incident and hazard data for reporting and analysis.

Data Security, Backup, and Information Integrity in Disaster Management Systems. Over the years, organizations have been managing an increasing amount of data, making it essential to ensure its security to preserve its integrity. Data security in the study of Pant et al. (2023) is the full protection of information against unauthorized access, data breaches, and cyberattacks. They also assert that in the digital age, it is important to focus on data security because society relies on digital technologies and also to comply with legal regulations. This just indicates that systems like the one in this study related to disaster management systems need to focus on the security of the entire system so that in the long run, sensitive information about recorded incidents is not compromised and the trust of users is maintained.

In addition to protecting data, ensuring also the data availability and integrity of incident reports requires a good backup system. According to the Carnegie Mellon University (2025), regular backup can be used to avoid the possibility of losing data due to different reasons, such as hardware failure, hacking, viruses, or even human error. They further note that backup data offers the advantage of making sure the data is stored and readily available when required. It says that when data security is significant, data backup is also significant. This will assist organizations such as MDRRMO to keep historical data in order to be able to utilize it to improve and better their operations. Any business or organization, according to Hasan et al. (2023), requires a backup plan to be able to operate properly.

IBM (2024) states that an extensive backup plan involves creating replication copies of data, which can be stored in multiple places such as cloud-based storage servers or local storage centers, to be capable of retrieving the data in case of system failure. Moreover, according to Strydom (2023), encryption techniques can be applied to encrypt the backup files in order to avoid unauthorized access. This would make sure that the information concerning disaster is accurate and available when it is most required.

To sum up, it is possible to indicate that data security, as well as backup systems, is a significant need to establish effective digital systems, especially those that are delivered to disaster management processes. The lack of security measures undermines information protection that poses threats to system integrity and organizational capability of the MDRRMO personnel to plan and coordinate emergency responses. In this study, security and backup systems guarantee that ResponSys maintains data integrity, system reliability, and controlled access required when dealing with sensitive disaster-related information.

2.2 Conceptual Literature

This section explores the review of conceptual literature of five related topics of modern disaster management. These components establish a technological and organizational foundation that supports community resilience against disaster.

Disaster Risk Reduction and Management (DRRM) in Local Government. LGUs have an important role to play in the implementation of proper Disaster Risk Reduction and Management (DRRM) strategies. By entrusting local authorities, they gain the means to lead disaster risk control as well as make their communities more resilient. Jovellanos and Herrera (2024) emphasize that local governments have to be prepared with improved capabilities that can be realized by developing frameworks and monitoring and evaluation in order to align national plans of broad institutional development led by agencies.

Through the Sendai Framework developed by the United Nations Office for Disaster Risk Reduction (UNDRR), the participation of local government and other stakeholders is highly significant in risk reduction measures that focus on disaster threat exposure, vulnerability traits, and hazard characteristics. This acts as a sort of a guidance system to local governance to avoid the development of new risks, reduce existing risks, and increase resilience (UNDRR, 2020a). The framework structures DRRM into four fundamental areas that need integrated national and local approaches for disaster prevention and mitigation as well as preparedness, response, and recovery (Ner et al., 2022).

Also, a UNDRR paper (2020b), in collaboration with the Center of Urban Disaster Risk Reduction and Resilience (CUDRR+R), assesses the local government abilities and capabilities in terms of implementing disaster risk reduction strategies. The initiative is taken as a model to develop cities that would be more resilient to adversities. The Local Disaster Risk Reduction and Management Plans (LDRRMPs) are required by law to ensure stability of disasters at provincial, city, municipal, and barangay government levels. These strategies are re-evaluated periodically with the upper-level authorities to achieve congruency of the national disaster policy (Ner et al., 2022).

The MDRRMOs play significant roles in the disaster risk management policy implementation process, which include identification of hazards in the regions and risk assessment systems, including early warning systems. According to Paz et al. (2024), proactive disaster planning and regular disaster response team training, community involvement, and agency coordination are the key to the success of local disaster mitigation strategies. In addition, according to their study, they indicated that those municipalities with organized Disaster Risk Reduction Management programs receive increased capacity to reduce the impact of disasters by distributing resources optimally and by increasing the emergency planning and coordination.

Incident reporting is one of the crucial aspects of disaster risk reduction as it allows the local governments to come up with timely assessment that informs emergency planning and preparedness. Administrative units can use correct and fast incident reports to determine disaster consequences while distributing resources effectively and plan coordinated emergency actions. Many experts within the field, through their research, established that formalized incident reporting systems improve both emergency team decision outcomes and operational efficiency (Badoc-Gonzales et al., 2021). These experts claim that to attain uniform data, institutions should come up with standardized structures that will aid data reporting processes.

Dale et al. (2020) assert that disaster preparedness programs anchored in local communities in the hazardous regions are efficient in enhancing emergency preparedness in residential places at the coastal and flood-prone regions. The research has shown that the involvement of individuals in disaster-preparatory measures enhances the evacuation plans and simultaneously, heightens awareness and develops more robustness to calamities.

The evolving nature of disasters further requires the local bodies to adapt their strategies as the disasters transform in both terms of their nature and effects. The adoption of modern technology, such as the development of institutional systems and cooperation with stakeholders, is the foundation of this adaptive process. Through this, the authorities are able to reduce the risks associated with disasters and increase their coordinated emergency plans through their disaster management planning and even their increased ability to report on incidents.

All these studies show that institutional preparedness, quality of information systems, and community coordination are highly critical in the management of disasters at the local levels. However, despite the national frameworks providing a strategic direction, the actual effectiveness of the DRRM implementation rests upon the technological strength of the municipal disaster offices. The lack of integrated information systems tends to limit the process of standardized reporting, coordination, and monitoring in the smaller municipalities such as Padre Garcia.

Incident Management Systems for Disaster Response. The Incident Management Systems (IMS) and similar systems assist disaster response teams to access information and organize their operations more effectively. Being developed by the Federal Emergency Management Agency (FEMA) as a part of the National Incident Management System (NIMS), it streamlines the structure of operations in disaster prevention, disaster protection, disaster mitigation, disaster response operations, and recovery operations (FEMA, 2025).

Farcas et al (2020) showed that Incident Command System (ICS), a part of NIMS, functions at various organizational scales, such as individual departments, whole hospitals, cities, states, and federal jurisdictions. This disaster response coordination system is crucial in carrying out effective actions in an emergency management operation.

The incident management software (IMS) tools are designed to work in a collaborative environment to gather vital incident data that can be used in decision-making. These tools help responders, along with emergency supervisors, to process complex information, which improves both situational cognition and decision-making abilities (Department of Homeland Security, 2021).

Documentation of disasters through automated incident management systems has enhanced efficiency of planning and preparedness operations. The dependence on purely manual systems is based on paper documentation along with telephone communication and physical coordination of teams, which both contribute to slow decision-making and human errors. Contrarily, automated incident management systems utilize digital resources that optimize incident reporting and data acquisition coupled with team-to-team communications. Graglia (2024) indicates that incident automation speeds up emergency response by 40% which enables personnel to reach critical circumstances faster.

Automated incident management systems allow the disaster response teams to execute operational protocols more reliably and make informed decisions. The established work processes within automated systems eliminate errors that happen in manual data systems and ensure each incident is appropriately recorded and forwarded to the upper levels. According to Squadcast (2025), the technology of automation provides structured and real-time notifications to authorities that have to deal with emergency cases and reduces errors in management oversight.

18 The primary advantage of automated systems is their ability to carry out real-time monitoring. Cynet (2024) confirms that automatic incident response systems enhance awareness through scanning disaster detection patterns to reduce emergency responses.

Excessive dependence on automation systems presents several issues to organizations. The nature of the disaster conditions complicates the automation systems to generate false readings which provide false alerts or important risk analysis. The cases of technical failures and cybersecurity issues disrupt automated processes which force operators to take the control of operations to sustain the effectiveness of operations.

The management of incidents has evolved beyond manual systems into automated systems, which then provided significant advantages to assist in planning and coordination of emergency response. Using ResponSys, the emergency preparedness of the local government, in particular, the MDRRMO of Padre Garcia, is reinforced, and it also guarantees the fairer distribution of resources. Installing systems that have technological elements assist them to establish a structured method of handling the information of disasters, which consequently increases disaster preparedness within communities.

All these findings suggest that incident management systems not only improve the coordination of operations but also increase the accuracy of documentation and timely decision-making. Nonetheless, most of the municipal-level offices in the developing regions remain tied to manual or fragmented systems. This gap points to the necessity of streamlined, localized IMS platform, like ResponSys that strives to convert frameworks to practical municipal applications.

Geographic Information Systems (GIS) for Disaster Preparedness. Geographic Information Systems (GIS) serve disaster preparedness since these systems help organize the collection and study, and display geospatial data. The tools enable emergency responders to use risk assessments for planning evacuations and coordinating shelter-in-place activities successfully (Ellipsis Drive, 2024).

GIS helps stakeholders to gain a complete knowledge about disaster effects by means of merging various data sources, thereby supporting emergency response decisions. The study by Twumasi et al. (2020) indicates that GIS technologies can be used as a decision support system to help Southeast Louisiana in the USA develop effective disaster management operations and response-related strategies.

The impact of using emergency management applications on the process of planning and coordination of operations at the pre-incident stage, as well as at the post-incident stage, is significant. Disaster preparedness strategies involve the preparation and decision-making process with the aid of useful maps created through GIS data analysis (Freeman, 2021). Tiwari (2024) examines the GIS functionality in the disaster management of India by assessing its value in various stages of preparedness to recovery and mitigation. The study highlights how GIS systems utilize spatial information to display hazard changes and uncertainty in order to provide correct hazard mapping and live monitoring, and effective resource distribution, which decreases disaster consequences.

The use of the GIS technology empowers the response teams and other stakeholders, as well as the general population, to develop collective awareness of the situation. This tool offers a portable damage assessment feature and assists in the restoration of critical lifeline systems, which is crucial in disaster management teams (Esri, 2024).

The disaster modeling is carried out by the examination of the past data on disasters using GIS to identify the underlying threats before the emergence of potential disasters. By knowing about dangerous locations, resource allocation can take place in advance, allowing the relevant authorities to develop protective elements against disasters that reduce impacts. In this way, precautionary measure enhances resilience of the communities and reduces the number of casualties as well as damage to property (Singh, 2024).

More so, the efficiency of emergency operations improves significantly with the use of GIS as well as development of stakeholder-resilient communities with easily available data information. Users benefit from GIS graphical displays to show challenging datasets because the visualizations facilitate the distribution of hazard data combined with preparedness strategies to different audiences. This approach stimulates public readiness and understanding about potential risks. The combined approach of GIS with additional technologies enhances disaster preparedness by supporting natural disaster evaluation approaches and optimal evacuation planning according to Gyang et al. (2024).

Together, all these studies suggest that GIS is a necessary tool to comprehend hazard exposure, planning, and enhance disaster preparedness. Nevertheless, the use of spatial information in decision-making by MDRRMO-level systems is usually constrained by the level of hazard mapping, which, even in municipalities such as Padre Garcia, is usually outdated and static. This gap promotes the necessity of the availability of an easily accessible web-based GIS platform that can be maintained and updated by local offices in real time.

18 18 Real-Time Data and Decision Support Systems in Disaster Response. Real-time data processing and integration with the decision support systems enhances the efficiency of planning and coordination of disaster preparedness. The availability of up-to-date

information can assist incident responders in developing a rough concept of what to do next, which facilitates the capacity to generate prompt, effective responses. This improves coordination of the responders resulting in improved outcome of the disaster management processes (Eric, 2025).

With real-time disaster intelligence, the intervention teams are able to develop the capability to establish the appropriate resource priorities and to evaluate meaningful areas to allow quick planning and decision-making. Richardson et al. (2021) noted that real-time information based on historical patterns of a disaster allows teams to explore unfolding situations in order to be prepared to allocate the resources appropriately. Having an access to structured data at all times, response teams are more functional than ever before and can contribute to informed data-informing decisions to make sure that the most important threats are addressed first.

According to Jung et al. (2020), having an Intelligent Decision Support System framework allows to improve the efficiency of disaster responses by examining the existing data, along with information on past disasters. Their study articulates the value of systematic data collection practice to encourage real-time operational awareness regarding emergency management decision-making and incident response control systems. The system, which is suggested in their study, can expand operational decision-making capabilities beyond storm, flood, and earthquake response, thus showing real-time DSS functionality in other disaster response situations.

The advantage that the decision support systems may provide to the emergency workers is the ability to visualize the key information about the disaster in real time in order to gather and process it. This enhances situational awareness based on which first responders are able to make rapid decisions that encompass all the information required in the event of crisis (Black, 2024).

According to Soulararidis et al. (2024), the semantic data must be incorporated in time-sensitive decision support systems in real-time. The semantic interoperability combined with the knowledge graphs enables the ability to process and deliver correct data faster and thus, enhances the ability of the emergency teams to make informed decisions during the time of disaster. With the addition of semantic reasoning, decision support systems are proving useful in both crisis preparedness and response plans since they assist in better coordination of the stakeholders.

The real-life use of data offers a vital information source to the assessment procedure following the occurrence of disasters and recovery planning operations. Proper examination of the efficiency of documentation and response by authorities using illustrations can help make discoveries about past disasters, which subsequently can help to be prepared to future disasters. The collected information assists in the creation of more effective disaster preparedness policies that aid in coordinated planning across time (Richardson et al., 2021).

The existing risks of the disaster cases have already turned into complicated issues which require timely decision-making and planning strategies to be effective. Disaster response strategies should involve time-sensitive processing of data along with organized decision support systems. The real-time data reporting units with DSS and aligned resource allocation can enhance the operational efficiency of MDRRMO.

62 Altogether, the current literature on the topic of real-time data and decision support systems demonstrates their relevance in the improvement of situational awareness, distribution of resources, and the effectiveness of responsiveness. However, with smaller MDRRMOs, such as in Padre Garcia, real-time decision support is minimal since the assessment is performed manually and the data is scattered. This highlights the need to have a localized platform in which coordinated and timely information can be made
128 available to improve faster and more accurate decision-making in case of an emergency.

10 Cybersecurity and Data Protection in Disaster Management Systems. To ensure the integrity and security of the data, as well as its availability, disaster management systems need to have cybersecurity and data protection in place. The European Space Agency (ESA, 2022) indicates that disaster response services need to be adequately protected against cyber threats as institutions conduct efforts to secure critical infrastructure against cyberattacks.

The Philippine government understands that cybersecurity is an important aspect in the
48 operations of disaster management. The National Cybersecurity Plan (NCSP) 2023-2028
48 is the strategic plan developed through the Executive Order No. 58, s. 2024 to secure Filipino citizens against cyber threats and protect the institutions and resources (PNA, 2025). In this context, the government has been striving to make proactive defense efforts,

which involve incorporating quality workforce and enhanced policy efforts to enhance its overall cybersecurity preparedness.

A proper integration of effective cybersecurity measures is an essential part of the disaster recovery plans processes. As Faggion (2024) notes, intrusion detection and prevention systems and event monitoring and endpoint threat detection capabilities allow network protection and the continuity of emergency operations.

The Cybersecurity and Infrastructure Security Agency (CISA, 2023) has initiated a range of programs to increase the scale of the emergency management sector and cybersecurity awareness, in addition to the heightened risk management practices. CISA has been able to establish disaster management systems through proven practices and resource sharing that show greater resistance against cyber threats.

The NCSP 2023-2028 also appears to incorporate security improvement measures of the Government Network (GovNet) that entail IDS/IPS systems and secure routing protocols and passive network elements, as specified by GIP Digital Watch (2024). The Cybersecurity Bureau reorganization within the plan focuses on developing the National Computer Emergency Response Team (NCERT) while establishing the National Security Operations Center (NSOC) for continuous cybersecurity posture evaluation of government agencies.

However, it still fails to solve all the challenges in protecting the data related to disasters. As indicated by Joseph (2023), data breaches, unauthorized access, and systems that were not patched are the primary cybersecurity issues. According to the author, many disaster management agencies are experiencing major challenges in acquiring large-scale information networks, particularly when running crisis management activities in real-time. To find solutions to these problems, the author suggests combining several encryption strategies, access control, and scheduled cybersecurity audits are also recommended as the next levels of protection.

The introduction of regulatory standards develops necessary frameworks to ensure the response system of the disaster is in compliance with cybersecurity standards. According to Hanspal (2024), governments need to establish networks in cyber-legal infrastructure because they need to create apparent regulatory frameworks for protecting data in disasters and response mechanisms. This paper supports the development of national cybersecurity laws at international standards to achieve high levels of digital resiliency.

Overall, these findings suggest that cybersecurity is an urgent requirement to guarantee the integrity and the sustainability of the disaster information systems. However, in such municipalities as Padre Garcia, the systems of the MDRRMO are not always adequately secured and confidential data are prone to manipulation. This emphasizes the necessity to incorporate efficient data security and secure system designs into the modern DRRM solution such the ResponSys.

2.3 Related Studies

This section focuses on previous scholarly publications that indicate the application of GIS and web-based systems in the disaster management sectors. Multiple studies demonstrate that digital tools enhance the process of reporting incidents, along with assessment of risks and support of emergency responses. The findings validate the development of ResponSys as an enhancement tool for local preparedness and evidence-based choices.

The development of disaster management technology represents a critical research area in the last few years because it improves incident reporting alongside risk assessment while corroborating informed decision-making during crisis through technological systems. Various research studies prove that Geographic Information Systems (GIS) develop efficient disaster risk reduction capabilities through web-based reporting platforms paired with digital automation systems. The research results validate ResponSys' work toward developing a web-based incident management system which includes hazard mapping for Padre Garcia MDRRMO.

The use of Geographic Information Systems (GIS) provides substantial aid to disaster management because extensive research exists on their uses in hazard mapping and risk assessment. Geographic Information Systems provide responders an opportunity to view real-time location data that helps them determine vulnerable resource distribution areas, according to Peiris (2020). Tomaszewski (2020) studied the linkage between GIS support for emergency planning through predictive geospatial data which enables essential disaster planning for future incidents.

Similarly, recent research by Dabo et al. (2024) stated that disaster hazard assessment functionalities are essential for emergency preparedness as provided by Geographic Information System technology. Local government units create earthquake response plans possible due to GIS visual elements showing dangerous zones accessible to residents. The research method by Leeonis et al. (2024) utilizes combination models of infrastructure data with satellite imagery processed by GIS systems to expedite and improve disaster risk assessment processes. Research findings show that emergency responders along with planners should have simple access to information thus demanding the ResponSys platform in centralizing GIS technology to assist in planning and preparedness.

Additionally, emergency response can be better supported through digital platforms and web-based mechanisms used for detecting incidents. In Alya et al. (2023) study, it is found out that integrating data from different systems supports timely decisions and helps teams communicate better during emergencies. Digital reporting technologies enable local government units to develop data-driven mitigation solutions as it improves operational efficiency, resulting in the detection of a pattern, as stated by Harliana et al. (2024).

44 Moreover, the study conducted by David et al. (2023) evaluated digital solutions for their role in LGU operational processes by enabling automated disaster risk reduction programs. MDRRMO staff receive increased disaster preparedness time through automated manual task processing, which reduces their need to focus on administrative paperwork. Xiao et al. (2022) validated this notion as they described that data collection remains important, yet the main challenge is converting gathered information into meaningful actions. It is based on their study that digital disaster management platforms need analytical tools, as the study demonstrated that these tools transform the collected data into valuable information to support response guidelines.

Also, the automatic decision-making systems that utilize satellite imagery-based risk prediction tools enhance disaster management according to Prevention Web (2021). Organizations use technology-based solutions in disaster planning systems by creating internet connectivity as well as processing capabilities to enhance early warning systems and continuous tracking features.

Consequently, Marcos (2021) confirmed that the operational efficiency improvement of local government units is attained by the introduction of the data retrieval system technology that facilitates the development of the emergency plan. In order to achieve optimum operational success, MDRRMOs must develop effective ways of managing information system integration. This is because, according to the paper, better accuracy in risk assessment is achieved through having a centralized data management system, which reduces repetition.

In essence, the analysis of existing research demonstrates powerful backing for the combination of GIS mapping technology with web-based incident data submission functions that complement ResponSys' main objectives. ResponSys embraces all necessary research elements through its development of a platform featuring easy-to-use real-time incident management features, which help MDRRMO personnel maintain a unified incident logging interface together with analytics tools within defined role-access parameters. The integration of QGIS technology enhances system robustness since users can display hazards while the system increases their capabilities to monitor danger areas and conduct interactive risk evaluations and inform decisions on resource allocation.

Generally, the above research indicates that a web-based disaster management system, ResponSys, is recommended since it integrates GIS technology with digital automation and incident reporting processes to aid in disaster preparedness and planning. The need to address the lack of disaster preparedness now and to provide informed risk assessment and emergency planning makes the modernization of Padre Garcia MDRRMO operations through ResponSys possible.

2.4 Related Systems

This section reviews disaster management systems that apply technology to streamline processes related to emergency planning. Its success and limitations validate the need for ResponSys as a localized solution to strengthen data-driven preparedness.

The surge of technological dependency in disaster risk reduction measures has inspired different disaster management systems, which form the foundation of ResponSys. These systems work toward improving three crucial elements of incident reporting and geographical information system hazard mapping, and supporting coordinated disaster planning efforts. The comparison of the past disaster management systems will facilitate ResponSys to apply best practices and emerging techniques in designing a better data-driven system for Padre Garcia MDRRMO.

The Bandilyo App is one of the most applicable systems, as it is a mandatory risk mitigation platform that incorporates the use of SMS technology with geolocation devices to track. The Bandilyo App was launched in the Philippines as part of the initial phase of disaster management to provide quicker communication between users via its alert system.

A study by De los Santos et al. (2020) confirms the idea that SMS alerts in relation to tracking technology facilitate the rapid response to emergencies, which would enable timely response to dangerous areas with help. Even though it has a powerful alert dissemination capability, the Bandilyo App is more concerned with communication and less with operational disaster management. The system lacks inbuilt hazard mapping and data analysis tools, which aid the municipal-level planning and monitoring. ResponSys, in turn, modifies the real-time alert concept and enhances it with the centralized records of incidents and GIS-based visualization tailored specifically to MDRRMO Padre Garcia.

Similarly, the AlertQC, which represents a tool available on both web and mobile platforms for managing incident reports under Quezon City's Disaster Risk Reduction and Management Office. Resident participation in the system enables them to submit disaster reports, which local officials assess to coordinate response activities as per the FEU Institute of Technology (2021). As stated by Gonzales et al. (2021), situational awareness among emergency responders improved successfully due to the AlertQC system characteristics. The MDRRMO platform, ResponSys, enables systematic disaster incident reporting through its designed data entry function. Although the AlertQC is a good tool to engage the citizens, it is allowed to be used only within Quezon City and will not be directly applicable to municipalities like Padre Garcia without any modifications. Its role is also more geared towards reporting and response management than the long-term storage of the data, trend analysis, and hazard visualization. ResponSys will solve this drawback by having reporting, hazard mapping, and historical incident management within the same system that would suit MDRRMO operations.

Another notable tool is GeoMapperPH, as it represents the crucial disaster management application that GeoRisk Philippines developed. GeoMapperPH functions as an online system that provides smartphone-based capabilities to enable users to process hazard and exposure together with vulnerability data (Quadra-Balibay 2020). Users identify vulnerable locations by using this tool before different organizations devise protective plans. This tool enables sharing and real-time hazard information both ways between national agencies and local government units, and non-government organizations, which strengthens their disaster response potential (OpenGov Asia, 2023). An article by DOST-PHIVOLCS (2020) denotes that GeoMapperPH enables decision-making by providing an organized hazard mapping and analytics to support disaster risk reduction efforts. The system operates effectively because of constant participation and direct data inputs from different government departments, together with non-government organizations that handle data maintenance tasks.

The main feature of GeoMapperPH consists of hazard mapping and data visualization, yet ResponSys completes this functionality through its integration of GIS-based risk assessment with structured incident reporting. Through this integration, MDRRMO personnel can easily log disaster data into the system and manage and retrieve records so they can create an all-encompassing picture of disaster patterns. However, GeoMapperPH is primarily intended for national-level coordination and geospatial analysis rather than daily operational incident recording. This restricts its direct application to municipal disaster offices, which need workflow-based systems. ResponSys bridges this gap by embedding incident documentation into its GIS environment at the local level.

Similarly, HazardHunterPH, another platform of GeoRisk Philippines, provides automated hazard risk assessments for seismic and volcanic, and hydro-meteorological threats. Through this system, users establish real-time hazard reports for specific sites as the system generates useful information for both land developers and local government disaster response organizations and units, according to Villanueva (2024). The advanced hazard models and artificial intelligence analysis in real-time assessments contribute to disaster preparedness, as the article by DJLCaloracan (2024) about HazardHunterPH mentions. The ResponSys platform offers a few of the basic features of HazardHunterPH, but it also offers an organization-wide system of incident reporting and the ability to map hazards, offering GPS-connected capabilities where MDRRMO staff members can keep comprehensive records and view them, and identify patterns in time-related data. This system is implemented to provide a specific platform implementation that connects incident reports to risk assessments via an incident reporting system to meet the needs of local governments. Despite the fact that HazardHunterPH is an excellent tool covering automated hazard analysis, it is not an incident management system and does not assist with internal documentation and incident history tracking. ResponSys enhances this to combine simple hazard interpretation with organised reporting and records management of daily activities at MDRRMO.

Moreover, GeoAnalyticsPH is another important system of GeoRiskPH that serves to enhance risk assessments with the help of data analytics and visualization tools. According to OpenGov Asia (2023), GeoAnalyticsPH embraces advanced digital technologies in assessing and analyzing hazard data to ensure that the stakeholders are able to understand disaster threats on a deeper level. Local governments use predictive models based on seismic sensors and weather stations, and satellite data to forecast hazards, which leads to the strategic development of mitigation plans. GeoAnalyticsPH is yet another site in comparison to GeoMapperPH and HazardHunterPH, because it is more oriented on data interpretation and risk forecasting on the basis of a scenario than hazard mapping and real-time hazard forecasting. Although GeoAnalyticsPH offers sophisticated analytics and prediction, its setup and technical specifications might not be appropriate for the smaller municipal offices with limited resources and training. ResponSys aims at practicality in its operations, providing simplified analytics and dashboards with specific uses in local government.

55 In one of the articles, the United Nations Economic and Social Commission of Asia and the Pacific (UN ESCAP, 2020) presents its assessment to demonstrate the success of geospatial technology in reducing risks of disasters. The implementation of real-time geospatial data not only allows potential discoveries but also simultaneously facilitates the enhancement of hazards discovery and sustainable development in the disaster-risk regions. Ikeda et al. (2024) emphasized that ASEAN must boost disaster risk reduction tech investments because basic tools for proactive regional disaster management include GIS

and predictive analytics, together with AI-powered hazard modeling within this region. The use of technology in managing disasters has also improved the accuracy and speed of the means that combat disaster risks. The disaster management systems such as Bandilyo App, AlertQC, GeoMapperPH, HazardHunterPH, and GeoAnalyticsPH provide a real-time reporting of the incident, and can predictively analyze the risk. The analysis of disaster response improvement is contributed by the studies by UN ESCAP (2020) and Ikeda et al. (2024) discussing the use of geospatial analytic and digital risk tools to facilitate disaster response. One can observe a distinct difference when ResponSys is contrasted with current national and city-level systems as it incorporates the incident reporting features along with GIS tracking so that assessment of all crisis data becomes purposeful to make any decision. The operational capabilities of ResponSys can be implemented to create evidence-based emergency systems that meet MDRRMO functional requirements.

2.5 Synthesis

The digital technology has altered the way in which the disaster management is handled by making the process of risk assessment and coordination, and resource allocation more efficient. The increasing use of digital tools entails a pressing necessity of real-time reporting, systematic databases, and geospatial hazard mapping to be able to manage disasters. Studies have demonstrated that adoption of web-based programs is associated with better situation understanding due to the capacity of emergency responders to exchange information faster and adhere to incident reporting procedures (Psaroudakis et al., 2021; Alya et al., 2023). The incident management system of ResponSys uses web-

14 based development in building particular solutions to the Padre Garcia Municipal Disaster Risk Reduction and Management Office (MDRRMO).

GIS serves as the vital component in disaster preparedness by providing instant hazard detection along with potential risk evaluation. Research indicates that disaster responders successfully use Geographic Information Systems because this technology helps predict disaster patterns and risk distribution and strengthens resource allocation (Peiris 2020; Tomaszewski 2020; Dabo et al. 2024). Strategic emergency preparedness gains strength by using GIS which allows vital disaster-related data to become both accessible and functionally useful. In ResponSys, the MDRRMO employees of Padre Garcia use the QGIS maps to produce hazard maps, which are based on the available historical data and current incidence data.

In addition to this, effective disaster preparedness and planning involves real-time monitoring as well as the appropriate supervision of systematic disaster-related information. Through systematic storage solutions, MDRRMO can cluster key incident reports and historical records and thus support their decision making processes with fact based decisions through retrieval capabilities. Sinha et al. (2024) report that the data storage system provides the MDRRMO personnel with effective information retrieval for data-based decision making. The system uses defensive security solutions that protect vital information from both breaches and unauthorized intrusions. Through its centralized database, ResponSys will help MDRRMO personnel maintain excellent management of disaster-related records.

When dealing with the disasters using digital infrastructure the use of maximum protection measures is necessary to secure the safety of all kinds of sensitive information. Digitally protecting data requires highly secure protection systems to stop unauthorized activity, which keeps genuine and secure information safe. Systems security is a function of encryption measures, along with role-based access control and intrusion detection systems for proper system operations (Faggion, 2024; CISA, 2023). Within ResponSys, security mechanisms are implemented to prevent unauthorized access to sensitive information.

Various disaster management systems currently in use demonstrate their strengths and limitations in operation. Real-time incident reporting stands as the main operational core for Bandilyo App and AlertQC platforms and the GIS-enabled risk evaluation feature dominates GeoMapperPH, HazardHunterPH, and GeoAnalyticsPH systems (De los Santos et al., 2020; Gonzales et al., 2021; OpenGov Asia, 2023). As a distinct feature, ResponSys encompasses total operational assistance by combining various essential features in a single platform that integrates reporting systems with hazard illustrations and houses complete databases.

The disaster management process of ResponSys is what makes it unique compared to other existing platforms. The availability of incident logging and visualization of hazards will provide ResponSys with a distinctive feature relative to the existing platforms, the functional features of which do not depend on each other. ResponSys also enforces role-based access control, meaning that staff can be given the access or ability to modify valuable information in the system, thereby enhancing security.

The other distinctive feature of ResponSys is customized features and functions which will bring more efficiency to the operations of Padre Garcia MDRRMO. ResponSys combines automated tracking of incidents along with historical data analysis and customizable reporting tools that improve access to information by local disaster teams, aiding in their planning and coordination in case of an emergency. Moreover, it will grant the MDRRMO complete jurisdiction to make sure that the accuracy and functionality of the system is controlled by emphasizing the data collection and analysis processes at the local level.

By integrating these findings of various researches and other associated systems, ResponSys can be designed to be an efficient tool in managing disasters and providing better emergency preparedness services. This system will resolve disaster risk reduction challenges by using web-based incident reporting and GIS visualization, and structured data processing capabilities. System reliability will increase as well as data integrity, due to integrated security protocols, which will further enhance MDRRMO operational efficiency. Although national and city level systems like Bandilyo, AlertQC, 33 GeoMapperPH, HazardHunterPH are available, there is still a lack of a web based incident management and hazard mapping system with specific design to the MDRRMO of Padre Garcia, Batangas. Current platforms are usually at a larger geographic level, are not localized in workflow, or do not converge incident data, hazard maps and analytics on a single platform that would support municipal decision making. This gap brings to focus the need of a specialized solution like ResponSys.

2.6 Conceptual Framework

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This conceptual framework emphasizes a systematic design of a web-based incident management system that will be used to help in the preparedness of the disasters and enable informed planning and coordination of the MDRRMO in Padre Garcia. The framework operates on an Input-Process-Output (IPO) model that is used to show how data flows in a system to aid in decision-making and planning processes.

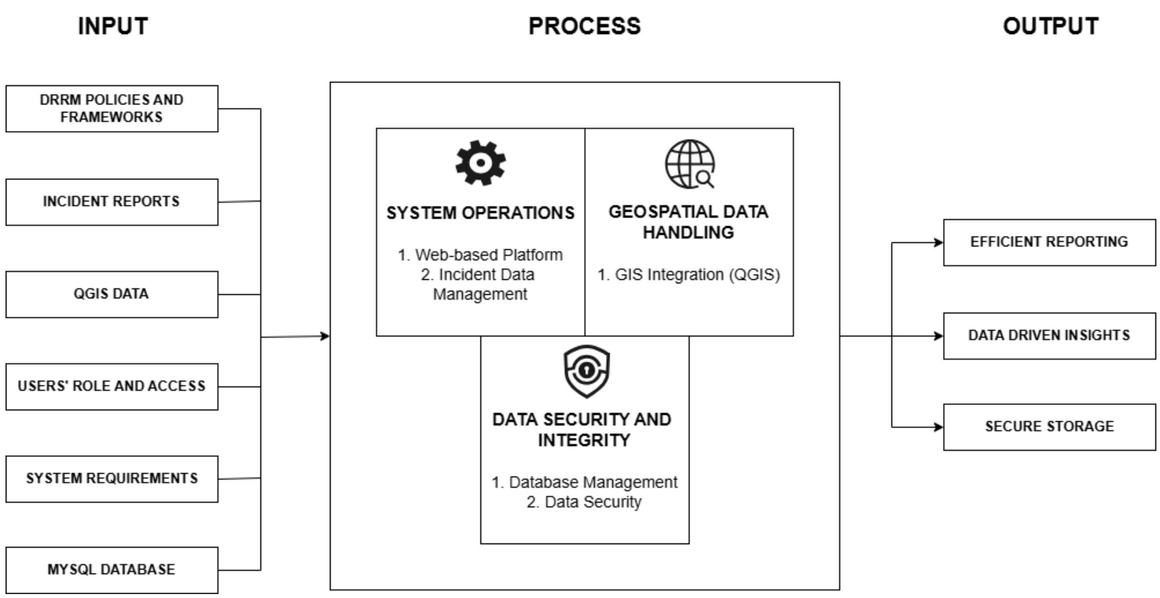

Figure 1. Conceptual Framework

The initial phase of this framework is the Input phase, during which the disaster risk reduction policies and frameworks, local MDRMMO operational needs, and system data including incident report and GIS data are determined. The platform requires the incident reports to contain location and severity information as required data entries. Integrated GIS information on hazard-prone regions and incident reports will enable the MDRRMO to know the potential risks that can occur in the future when planning emergencies. Furthermore, the framework will provide users with the relevant access privileges on secure data management and system protection. In addition, the system requirements consist of software elements and databases, as well as security measures, which are determined to ensure stability and protection of the systems.

The Process stage then transforms this data to a working interactive system. This phase also involves system design and development, GIS configuration, database implementation, and system testing in terms of functionality and usability to ensure that the platform works properly prior to deployment. The web-based platform serves as the central hub where the personnel of MDRRMO can log, retrieve, monitor and manage the incidents of disaster in real-time. The reports will be kept where they can be accessed easily when sensitive information will be required. GIS integration through QGIS enables officials to effectively utilize data to map hazardous area and carry out dynamic danger assessment to identify the vulnerable areas to inform decision-making. The centralized database system will ensure safe data storage and also organize data to be analyzed, therefore, encouraging data-driven decision-making. Moreover, it will also come with a backup system and security measures to protect the information against cyber threats and prevent the loss of information in the event of any emergency. In simple terms, it is the system development itself.

Finally, the Output stage will show the anticipated results of the system that will directly assist in the disaster preparedness and response of MDRRMO in Padre Garcia. The system will support efficient incident reporting, as it will enable rapid data entry and retrieval, better GIS-based hazard mapping that will enable the dynamic visualization of high-risk areas, secure and well-organized information storage in a centralized database, which will assist in data-driven decision-making allowing the allocation of resources effectively, and improved coordination through access to organized information and hazard visualization to support MDRRMO operational activities. These outputs should facilitate MDRRMO decision-making and can help increase preparedness and resilience in the long run. These findings are then used to make a continuous improvement by improving the inputs and processes in the system.

With this conceptual framework, the development of a web-based incident management system, including hazard mapping, offers a procedural and technological approach to solving MDRRMO in Padre Garcia.

3 DESIGN AND METHODOLOGY

This chapter outlines the systems development framework for ResponSys, covering project concepts, development model, requirements analysis, system design, testing and evaluation, deployment, and risk management. It establishes the connection between these methodological choices and the project's goals of enhancing MDRRMO disaster response in Padre Garcia.

3.1 Project Concepts

The ResponSys system modernizes and facilitates the disaster response operation managed by the MDRRMO of Padre Garcia. The study focuses on the implementation process of incident management by substituting the old ways of using the logbooks, spreadsheets, and static hazard maps with a new web-based platform. The MDRRMO can better manage incidents by being able to monitor incidents, evaluate risks, and plan disaster events in a better way through its incident management, hazard mapping, incident reporting, and data analysis capabilities.

79 In order to have a clear definition of the system scope, ResponSys will be made up of various functional modules that collaborate to facilitate the operations of MDRRMO. These are Incident Reporting Module which enables citizens and staff to provide incident information digitally, Hazard Mapping Module which visualizes areas of hazards and location of incidents with the use of GIS, Analytics and Reporting Module where statistical and graphical summaries of planning and evaluation data are generated and User Management Module where role based access control and user permissions are enforced.

These modules describe the boundaries of the system, on which the system is to be designed, developed, and subsequently evaluated.

The primary purpose of ResponSys would allow MDRRMO to view both disaster reports and hazard risk, as well as data analytics that would expose real trends of disasters. The system supports digital recording of occurrences to authorities, which serves as an alternative to manual logbooks and Excel files. It reduces data loss and develops the more efficient access to stored data and methods of retrieval.

Through QGIS, ResponSys offers interactive hazard mapping portal through which it is possible to update it in real time, manage the layers, and visualize the information concerning a disaster spatially. The QGIS system will enable the officers of MDRRMO to control the process of hazard mapping in the municipality by allowing to create and edit map in real time and update hazard maps. The incident mapping tool gives the MDRRMO users enhanced organizational and planning assistance because of its capability to generate real-time visual map of the disaster locations.

The incident reporting module enables the authorized users and the relevant public reporting channels to provide disaster related information directly to MDRRMO. This organized reporting system enhances accuracy of data and minimizes delays that are as a result of manual coding as well as informal reporting.

With its analytics feature, the system provides reporting capabilities through graphical and statistical reports that present tendencies as well as incident frequencies, together with impact analysis. The system enables MDRRMO to determine both geographical risks and information for evaluating emergency preparedness, which guides resource management decisions.

Moreover, the implementation of ResponSys also involves security features as well as accessibility features which are committed to the functions of the developed systems. The system ensures that it protects the information security by using role-based access control to grant the relevant users the authority to use reports and maps as well as control data access permissions. These restrictions provide the security of the sensitive information on disasters to be only accessed by the qualified staff. It further enforces an activity tracking feature alongside archival processes to generate clear record of alterations that are present throughout the MDRRMO operations.

Overall, ResponSys focuses on enhancing MDRRMO efficiency of operations by offering an all-encompassing service to report on incidents, visualize hazards, and manage disaster information.

3.2 Development Model

The system development of ResponSys followed the Agile Methodology, which focuses on flexibility and incremental development. This has been chosen as the development model since it allows the system to adapt to changing requirements by seamlessly incorporating small updates and user suggestions throughout each development phase. The process that is iterative and is built on sprints gives ResponSys the components of incident reporting and hazard mapping that the company needs, as well as role-based access control (RBAC) and data security components (John & Eappen, 2024).

Figure 2. Agile Methodology (Jayathilaka C., 2020)

The first phase of the planning was based on a conversation with the MDRRMO to seek system requirements and establish targets of the project. The team also engaged in consultations to determine the features that the system needed such as real-time incidents logs, mapping of hazards on GIS platform, user authentication, and data security. At this phase, the team outlined the scope and goals of the system along with its project implementation milestones which align with the operational needs of MDRRMO (Belizaire, 2024).

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The design was initiated after the planning phase and the architectural design of the system and other concerns to do with database structure and user interface. The team created the system visualizations based on the prototypes and wireframes, which demonstrate the layout of the platform usage. ResponSys became efficient and convenient to the MDRRMO personnel due to the design process. Furthermore, the database configuration had an aspect of real-time data retrieval and analysis, thus the authorities can access the required information in a short time. Similarly, access controls and data encryption strategies that ensure the security of sensitive information were also introduced as a security measure when the system was deployed.

Next, the development phase was then followed by a series of sprints, each of which had a distinct component like user authentication, hazard mapping, or incident reporting. The Agile methodology enabled the team to develop each feature and ensure that it was testable. It was ensured that the emerging issues and new requirements were introduced without altering the overall timeline by conducting regular sprint reviews with the MDRRMO staff. The team sought informal feedback about the project towards the end of every sprint, and it is up to the MDRRMO staff, who gave these notes on how to improve the project, i.e. by changing the form, fixing map layers and updating the interface. This took care of the fact that the features of the system were constantly developing as influenced by the input of the users.

Moreover, system testing began at the development phase by periodical evaluation detecting initial issues in the development of the system. The testing strategy also involves the three testing methods that are used to confirm the functionality of the system and these are usability testing, system testing, and user acceptance testing (UAT). The user acceptance testing occurred following the real time control of the MDRRMO staff to have a look at system usability and system effectiveness within actual disaster conditions. Team workers worked together in the solution of any detected problem and performance issues that enhance ResponSys performance right before its release. During MDRRMO pilot user testing, feedback was used to directly apply the interface changes, validate the interface, and correct hazard-layers.

Furthermore, the platform will be tested and fully implemented under controlled conditions when the MDRRMO staff members are trained to use the platform properly. The initial implementation of the system afforded some chance to carry out live testing that would monitor the speed of the system and proof of human-machine interactions as well as system functionality. The entire list of problems in usability, in addition to the new features requirements, was documented to be kept as post-deployment additions. The training displayed the ability of the staff of MDRRMO to use the platform to coordinate incident reports and hazard mapping to improve the capabilities of the platform to navigate disasters.

Finally, the system ensures that security in its operations is maintained throughout the entire process, including updating the system in ResponSys. The process stage incorporates security patches, user-generated improvements, and performance improvement activities. Agile methodology facilitated the constant changes during the development process, which allowed enhancing the disaster preparedness capabilities. The continuous improvement and development of ResponSys made it a consistent real-time incident management system to use in the operations of MDRRMO.

3.3 Requirements Analysis

The existing disaster incident reporting system used by the MDRRMO in Padre Garcia is mainly manual based where disaster incidents are recorded in physical logbooks. Additionally, some of it is encoded into Excel spreadsheets for tracking and reference. Also, the current system has challenges such as inefficiencies in data retrieval, updating records, and in overall management operations. Such hurdles decrease MDRRMO's speed in emergency responses alongside their effectiveness in managing disaster reports.

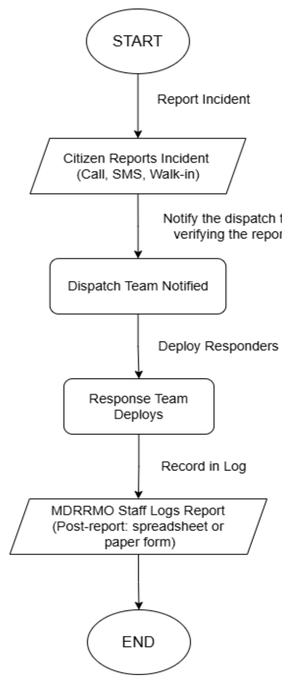

Figure 3. Current System of MDRRMO

The current incident response procedure involves the MDRRMO staff to designate disaster data by hand by writing them into a logbook. The data is difficult to retrieve in case the information is required later because the MDRRMO personnel has to go through multiple pages, and it is time-intensive and inefficient. As these data are being entered in Excel spreadsheets, the process poses other risk such as human error and record-keeping inconsistency. Multiple users cannot trace out the changes and ensure effective management of information since the files are not shared and are only placed in local computers, and thus, staff members are not able to retrieve vital information in other places.

In addition to these issues, the MDRRMO only relies on a static hazard map displayed on the office wall. This map enables the MDRRMO to identify areas vulnerable to floods, landslides, and other risks within the Padre Garcia. However, revising this map is a long process, as new hazard information must be manually gathered, integrated into a new version of the map, printed, and reinstalled. In line with this, relying on the physical maps will cause the information to be obsolete such that even the MDRRMO will not be able to receive or access the current hazard data in the event of any emergencies. This lack of an interactive or digital map display does not facilitate the MDRRMO to identify hazards and track on possible incidents, and integrate new hazardous information into their risk evaluation.

The ResponSys provides solutions to these challenges by providing a web-based platform to support the MDRRMO incidents management activities. Traditional logbook and Excel processes are substituted with digital storage through a database system that ensures the availability of records faster through the retrieval process. In addition, the system that has incorporated the use of QGIS-based hazard mapping enables the MDRRMO to track down on the incidence as well as to update the hazard areas in real time. Under this system MDRRMO has the capability of producing dynamic map of hazards which can showcase fresh hazards and they do not need to be manually reprinted and pinned. It is also a tool that allows MDRRMO teams to monitor hazards in a better way, thus, it is capable of enhancing the emergency planning and making an informed decision on disaster preparedness.

The application of ReponSys will allow the MDRRMO to improve its routine emergency management process by making decisions quickly and improving the performance of its coordination functions. Through this system, fast information management will be facilitated that will help to hasten evaluation, citizen protection planning and effective aid delivery.

Based on these limitations in the existing MDRRMO workflow, the following key functional requirements were obtained to develop ResponSys:

- Secure user login and account management.
- Logging, updating, and tracking disaster incidents.
- Viewing and managing incident-related reports.
- Recording and updating hazard information with dynamic mapping.
- Allowing citizens to submit incident reports.

These functional requirements were subsequently converted to concrete system features and this is described in the Functional Requirements section (Table 1).

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3.4 System Design

The section describes the architectural design of ResponSys system in terms of its architectural elements as well as components and their connection structure. These components come up as a result of the functional system, which is made up of these components.

System Architecture

The system architecture designs its development phase to have a secure operational efficacy and availability towards the capabilities of disaster risk management and reduction. The platform works with three key components having Frontend and Backend systems and Security Layer that facilitate its key functionalities.

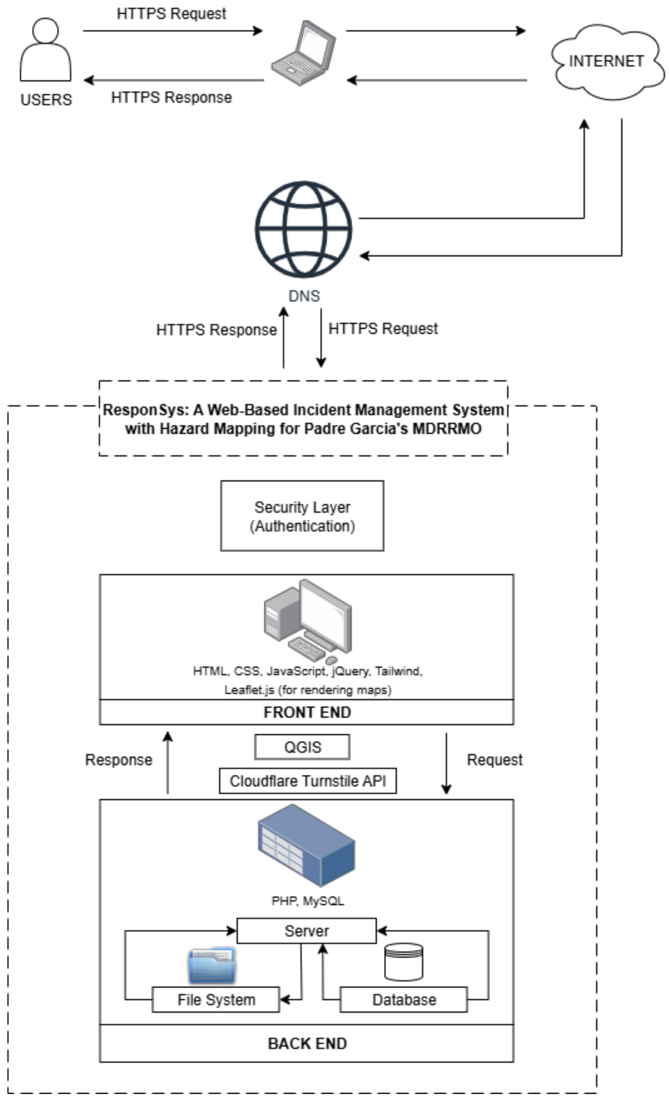

Figure 4. System Architecture

In this system architecture, the front-end component of this system architecture implements Tailwind Framework for CSS elements, as well as Leaflet.js mapping and HTML templates incorporated within its structure. A combination of these technologies allows the front-end developers to develop multi-device applications with browser condition safety embedded in the designed interfaces. PHP Hypertext Preprocessor is a server-side computer program that handles server-side processing and communicates securely with the MySQL database through parameterized queries and validation measures. The system achieves operational protection due to the RBAC features and RBAC and encryption technologies coupled with the implementation of the Google reCAPTCHA API.

QGIS is used to prepare hazard layers, which are exported and integrated into the web interface through Leaflet.js. This enables MDRRMO staff to visualize hazard zones interactively. The pre-exported QGIS maps forward its contents to the system via the Leaflet.js front-end rendering which runs out of a stable deployment platform. The system allows a user to access maps via secure HTTPS requests beginning with the front-end and proceeding to the back-end before back to the front-end. The designed system structure establishes separate areas for front-end interface display and back-end functionality, and uses QGIS-generated maps to store data in the database.

Context Flow Diagram

Figure 5 shows the context flow diagram of the ResponSys. It shows the interactions and specific processes with external entities. Three (3) entities are considered as the system's users, mainly the admin, staff/barangay, and citizens. These entities are allowed to input and save specific information within the system, and they can access different outputs such as records in the system.

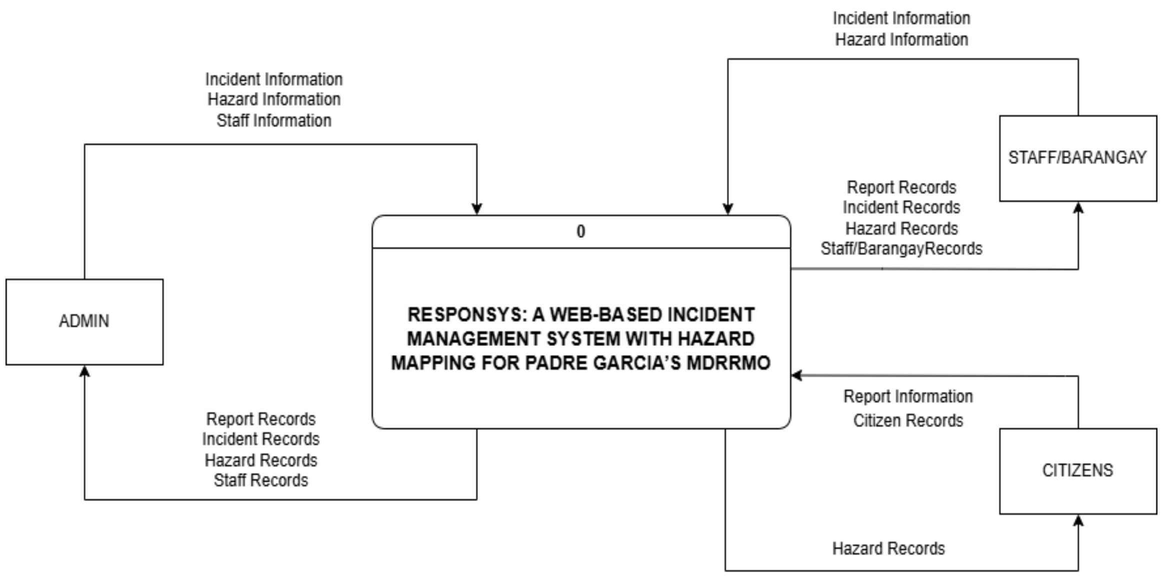

Figure 5. Context Flow Diagram of the System

Data Flow Diagram

Figure 6.1 shows the admin's level 1 data flow diagram. To access the system's functionalities, the admin must validate first his/her credentials to successfully login, he/she can also reset his/her password if forgotten. The admin then, will be able to access the specific functionalities of the system, including, but not limited to, managing users, managing reports, managing incidents, and managing the hazards. The creation of user accounts is exclusively the responsibility of the administrator only.

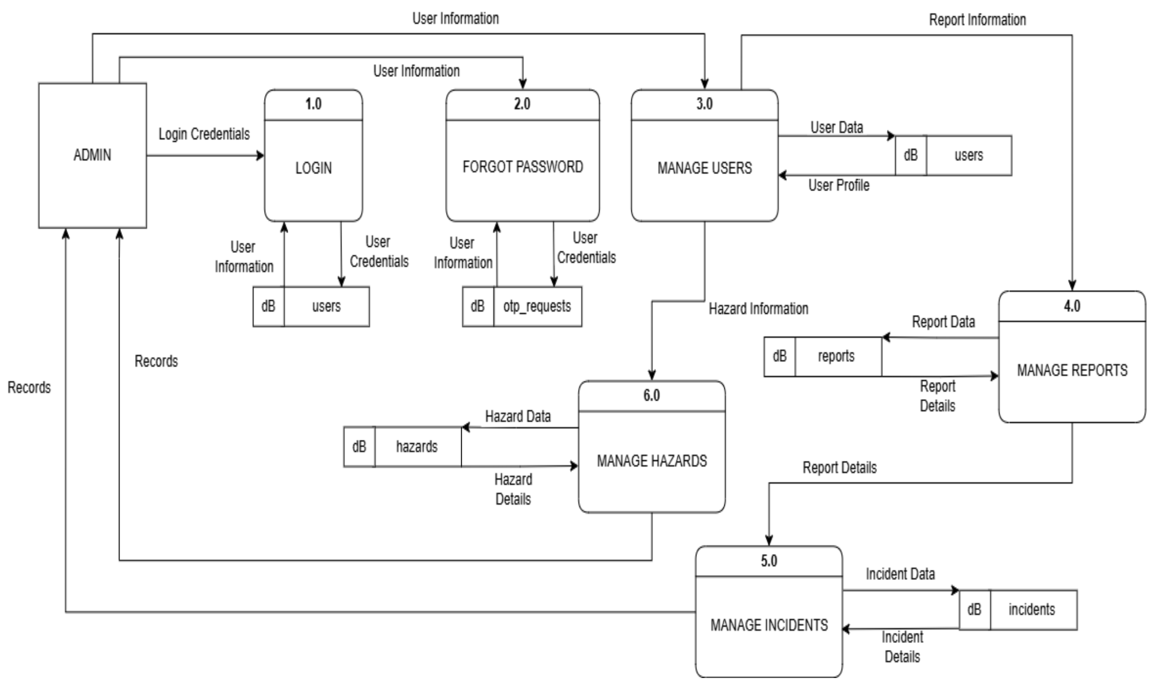

Figure 6.1 Level 1 Data Flow Diagram of the Admin

Figure 6.2 shows the sub-processes of the 3.0 module on the first level of the admin's data flow diagram. The process includes new account setup, user information updates, including status changes, and user account archival.

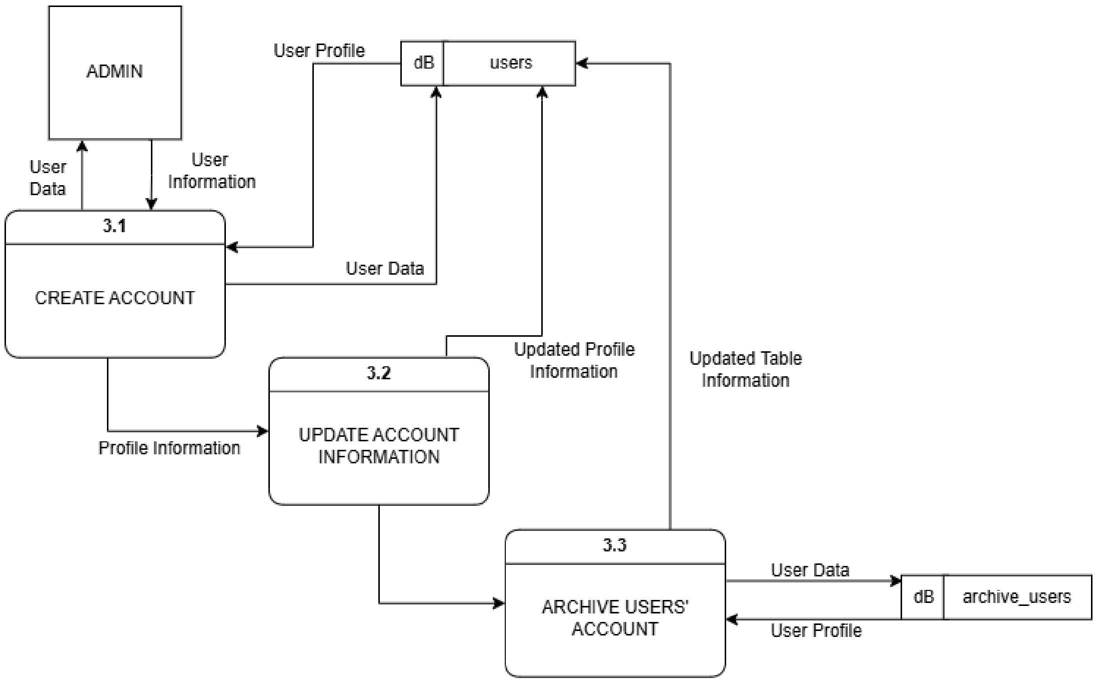

Figure 6.2 Level 2 Data Flow Diagram of the Admin's 3.0 Process

Figure 6.3 shows the sub-process of the 4.0 module on the first level of the admin's data flow diagram. The process includes updating the report status of the citizens and report archival.

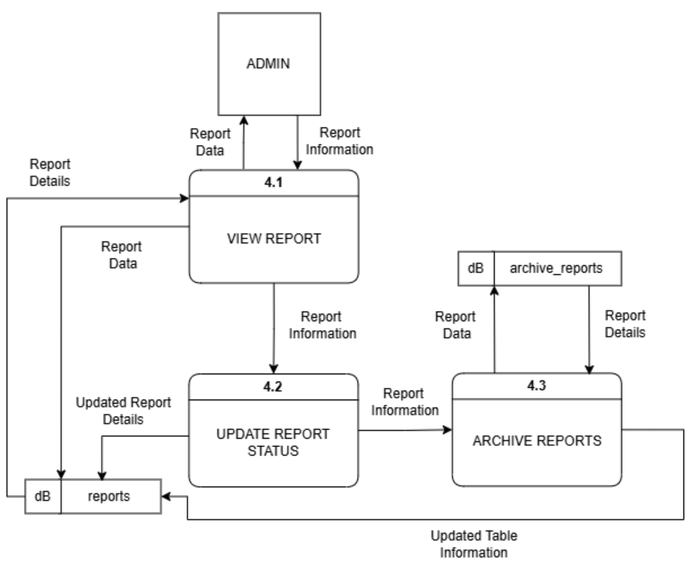

Figure 6.3 Level 2 Data Flow Diagram of the Admin's 4.0 Process

Figure 6.4 shows the sub-processes of the 5.0 module on the first level of the admin's data flow diagram. The process includes logging incident records on the system, incident status updates, and incident records archival.

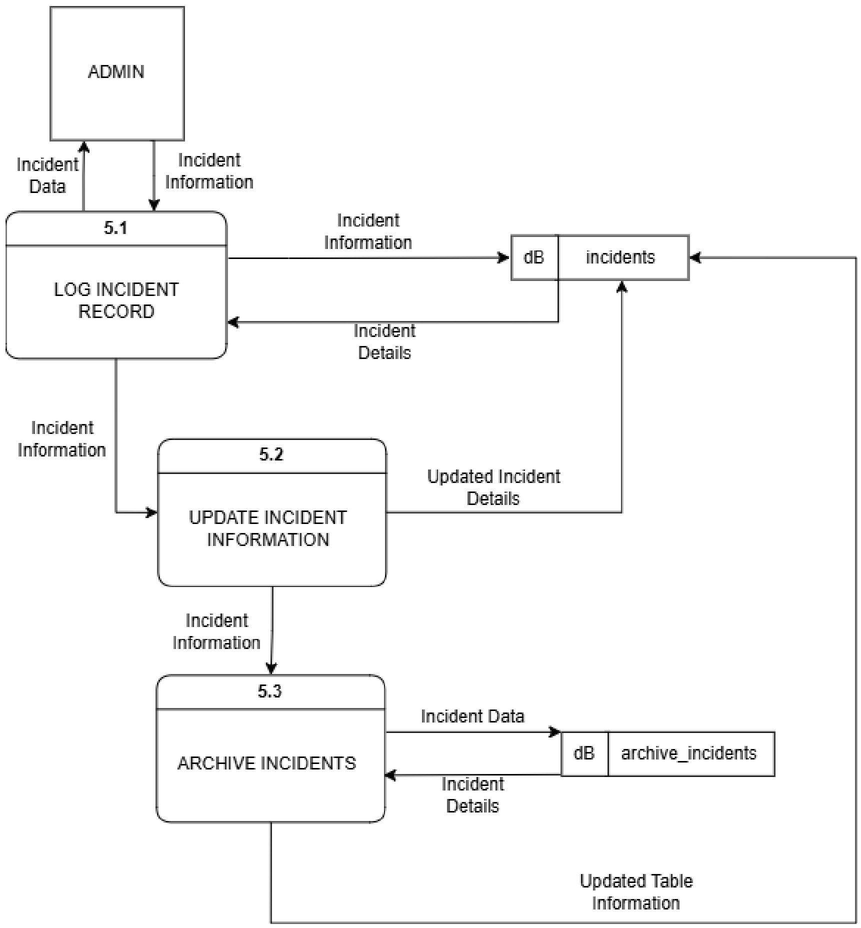

Figure 6.4 Level 2 Data Flow Diagram of the Admin's 5.0 Process

Figure 6.5 shows the sub-processes of the 6.0 module on the first level of the admin's data flow diagram. The process includes drawing a shaped hazard, hazard information updates, including status changes, and its archival.

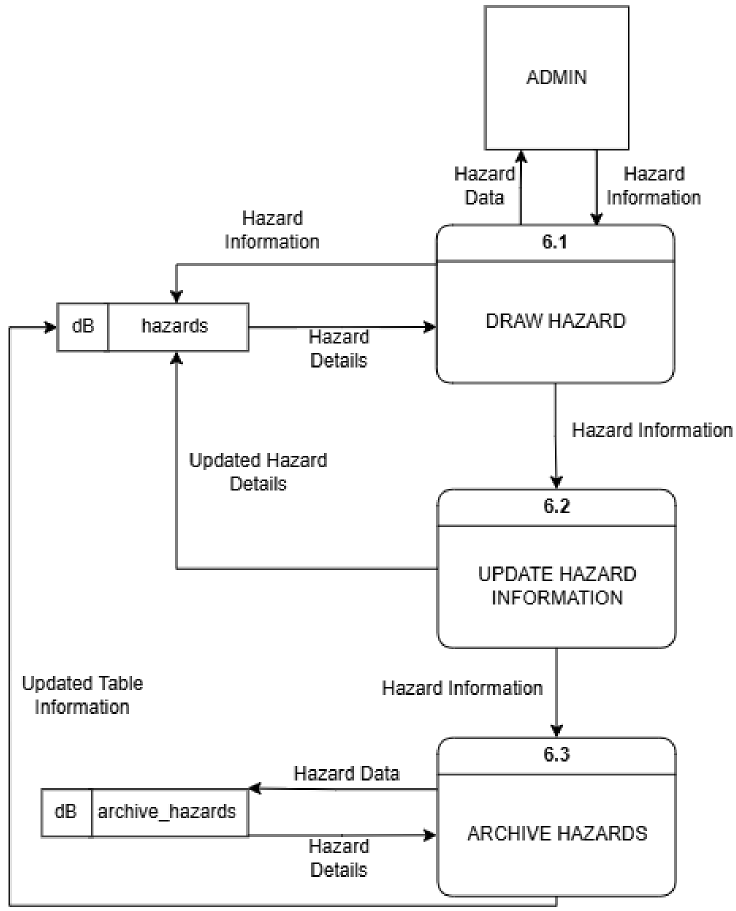

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Figure 6.5 Level 2 Data Flow Diagram of the Admin's 6.0 Process

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Figure 7.1 shows the staff's level 1 data flow diagram. To access the system's functionalities, the staff must validate first his/her credentials to successfully login. The staff will be able to access the specific functionalities of the system, including, but not limited to, managing his/her account, managing reports, managing incidents, and managing the hazards. Unlike the administrator, the staff's access is limited to their access and does not include control over user account creation.

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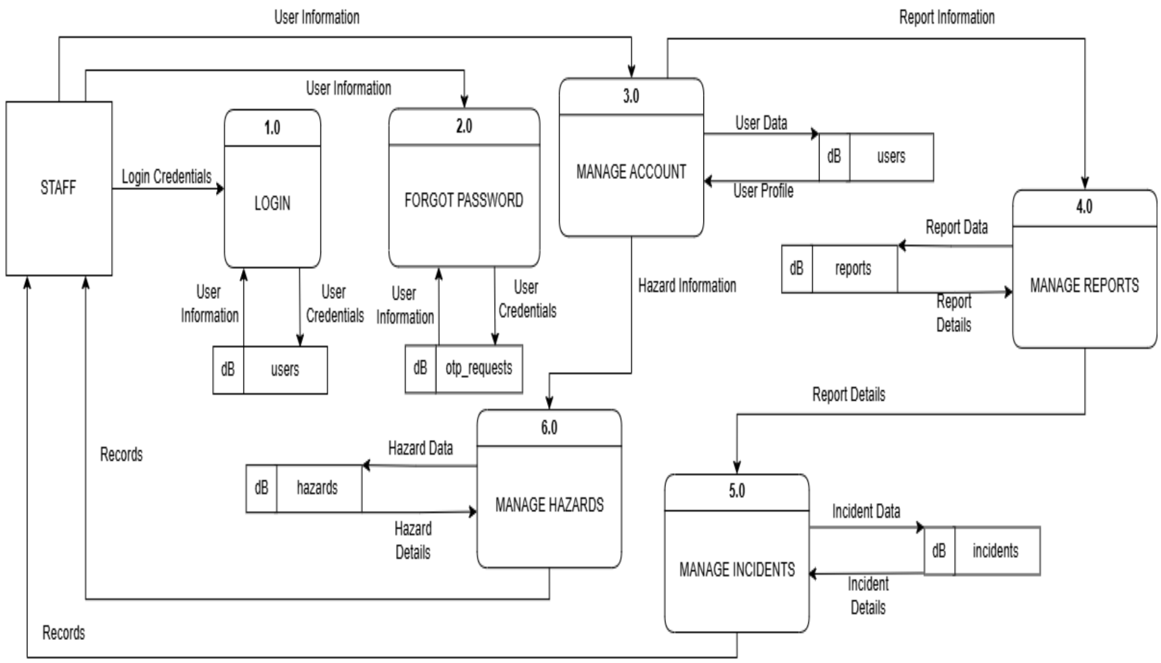

Figure 7.1. Level 1 Data Flow Diagram of the Staff

Figure 7.2 shows the sub-processes of the 3.0 module on the first level of the staff's data flow diagram. The process includes updating his/her account information.

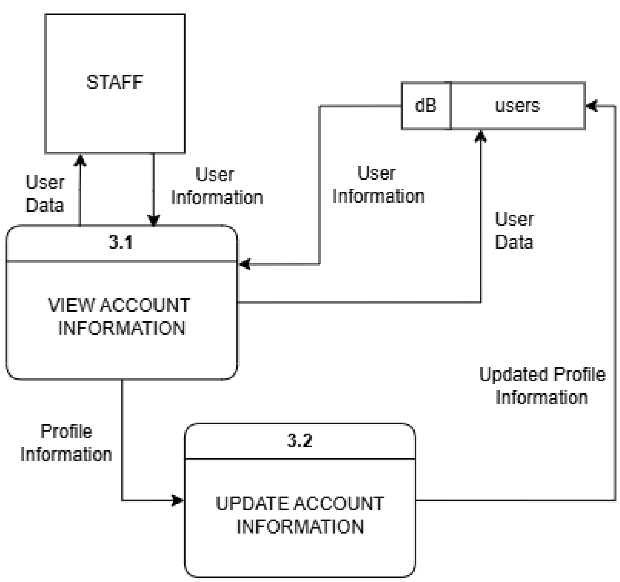

Figure 7.2 Level 2 Data Flow Diagram of the Staff's 3.0 Process

Figure 7.3 shows the sub-process of the 4.0 module on the first level of the staff's data flow diagram. The process includes updating the report status of the citizens and report archival.

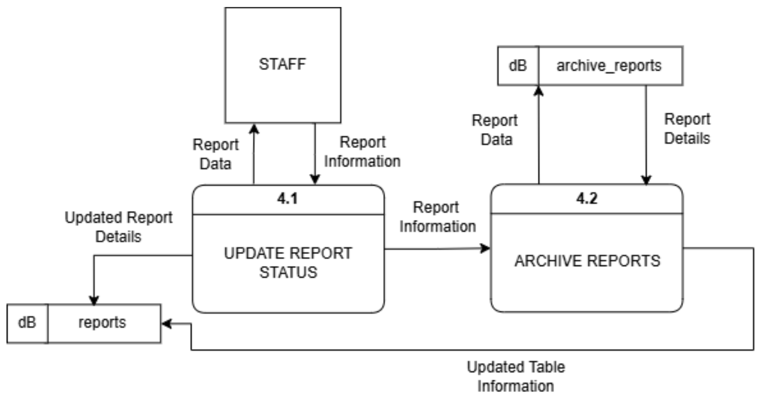

Figure 7.3 Level 2 Data Flow Diagram of the Staff's 4.0 Process

Figure 7.4 shows the sub-processes of the 5.0 module on the first level of the staff's data flow diagram. The process includes logging records on the system, incident status updates, and incident records archival.

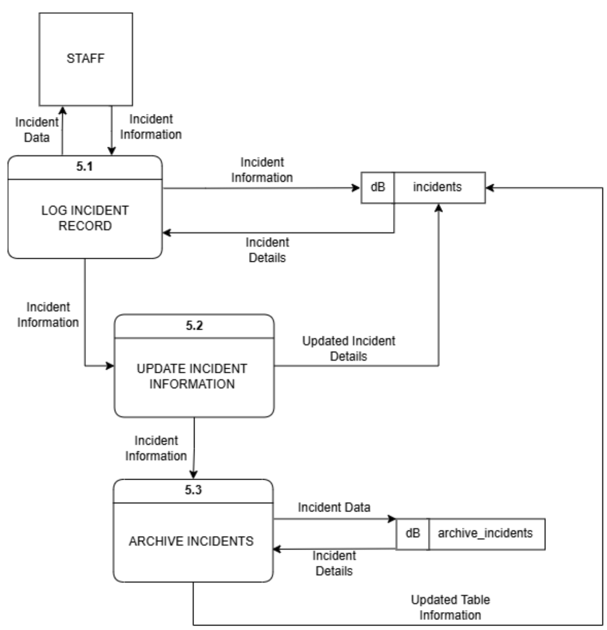

Figure 7.4 Level 2 Data Flow Diagram of the Staff's 5.0 Process

Figure 7.5 shows the sub-processes of the 6.0 module on the first level of the staff's data flow diagram. The process includes drawing a shaped hazard, hazard information updates, including status changes, and its archival.

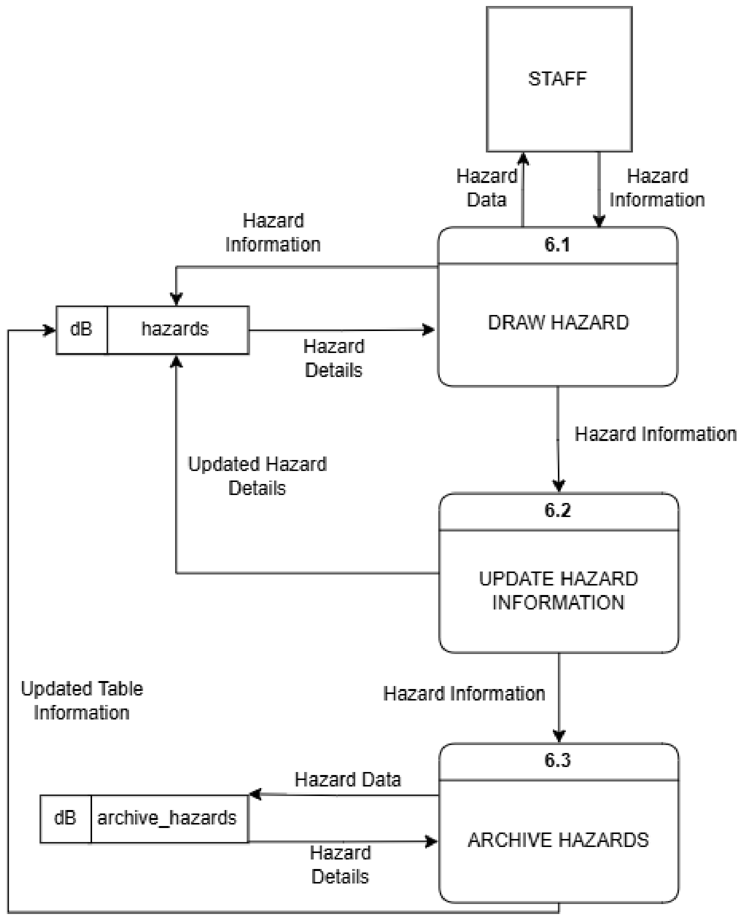

Figure 7.5 Level 2 Data Flow Diagram of the Staff's 6.0 Process

Figure 8.1 shows the barangay user's level 1 data flow diagram. To access the system's functionalities, the barangay user must validate first his/her credentials to successfully login. The barangay user will be able to access the specific functionalities of the system, including, but not limited to, managing his/her account, managing reports, managing incidents, and managing the hazards. Unlike the administrator/staff, the barangay user's access is limited to their access and does not include control over user account creation and archive records.

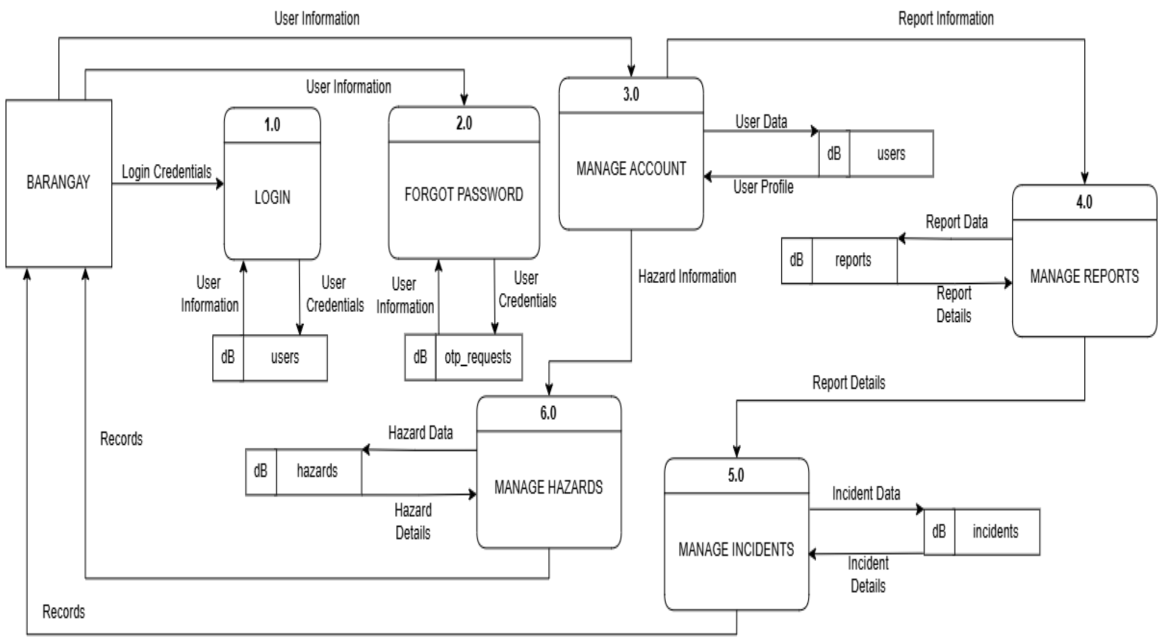

Figure 8.1. Level 1 Data Flow Diagram of the Barangay User

Figure 8.2 shows the sub-processes of the 3.0 module on the first level of the barangay user's data flow diagram. The process includes updating his/her account information.

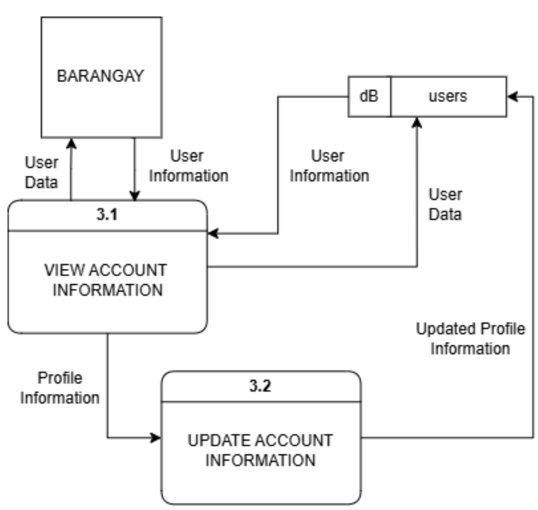

Figure 8.2 Level 2 Data Flow Diagram of the Barangay User's 3.0 Process

Figure 8.3 shows the sub-process of the 4.0 module on the first level of the barangay user's data flow diagram. The process includes updating the report status of the citizens.

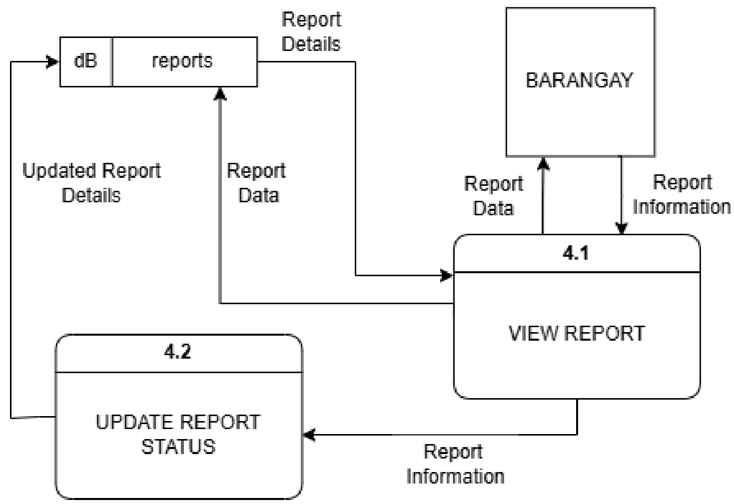

Figure 8.3 Level 2 Data Flow Diagram of the Barangay User's 4.0 Process

Figure 8.4 shows the sub-processes of the 5.0 module on the first level of the barangay user's data flow diagram. The process includes logging records on the system and incident status updates.

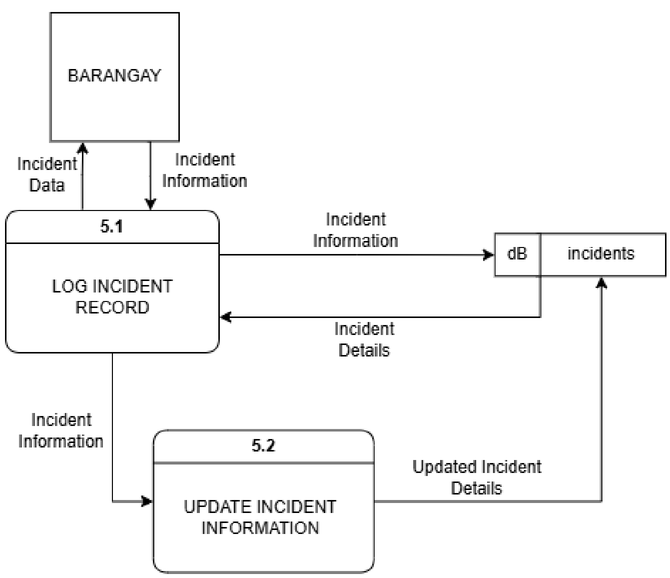

Figure 8.4 Level 2 Data Flow Diagram of the Barangay User's 5.0 Process

Figure 8.5 shows the sub-processes of the 6.0 module on the first level of the barangay user's data flow diagram. The process includes drawing a shaped hazard and hazard information updates.

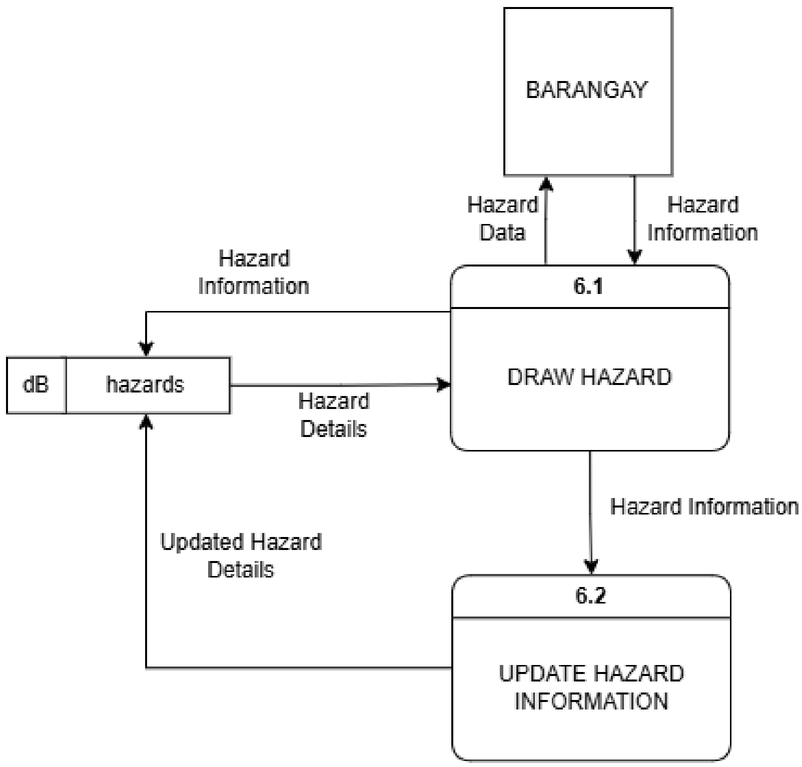

Figure 8.5 Level 2 Data Flow Diagram of the Barangay User's 6.0 Process

Figure 9 shows a citizen's level 1 data flow diagram. To access the system's functionalities, the citizens can simply access the website. The citizens will be able to access the specific functionalities of the system, including, but not limited to, incident reporting and hazard map viewing. Citizens have the option to create an account for tracking accountability, or not, ensuring that incident reporting and hazard map viewing is quick and hassle-free. This limited access sets them apart from administrator/s and staff who have broader functionalities.

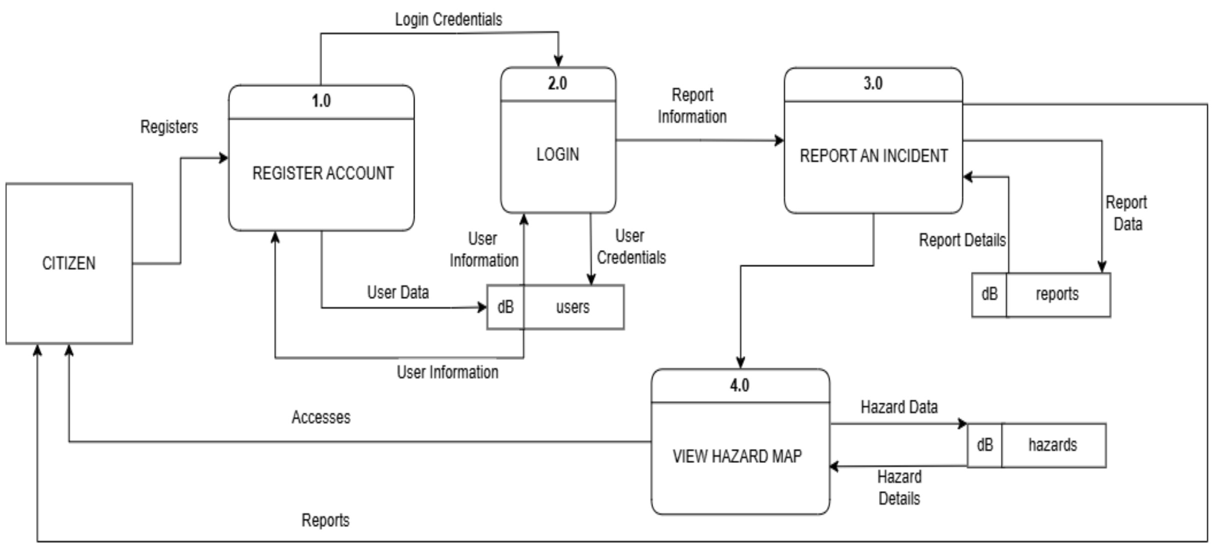

Figure 9. Level 1 Data Flow Diagram of a Citizen

3.4.1 Software Requirements Specifications

The section provides an analysis of essential software requirements specifications that contain functional and non-functional requirements for system creation.

3.4.1.1Functional Requirements

The functional requirements describe what ResponSys is designed to do, specifying its behavior and operations. Such requirements will ensure the system is able to handle information on disasters and enable communication whenever there is an emergency.

Table 1 presents these requirements and identifies the different functionalities that will be part of the specific modules. It is used as a framework in comprehending the level of operation of the system that the various parts of the system have.

Table 1

Functional Requirements

ID	Module	Description
FR-01	Login	The system will require the users (MDRRMO personnel) to enter their valid credentials to enter the system.
FR-02	Manage System User Accounts	The system only allows the admin to create and manage system user accounts.
FR-03	Manage Accounts	The system will allow all users to manage their accounts.
FR-04	Manage Reports	The system will allow all authorized users to view and take action with incident-related reports on the system.
FR-05	Manage Incidents	The system will allow all authorized users to manage and log incidents on the system.
FR-06	Manage Hazards	The system will allow all authorized users to manage and log hazards on the system.
FR-07	Incident Reporting	The system will publish the map for public use, enabling citizens to report incidents for authorities to respond and take action.

3.4.1.2Non-Functional Requirements

The non-functional requirements specify the operational requirements and the system attributes that ResponSys has to follow considering the objectives of the client. All these requirements were developed according to the ISO/IEC 25010 software quality characteristics, that is, functionality, reliability, efficiency, usability, and security. They will make the system to be very efficient, perform on par and improve on the user satisfaction.

Table 2 illustrates a summary of the non-functional requirements. Important modules discussed in it include functionality, reliability, efficiency, usability and security. These factors are necessary in the system to support its effectiveness and guarantee its success in the long term.

Table 2

Non-Functional Requirements

Module	Description
Functionality	The system accomplishes its intended actions and functions, fulfilling all necessary operations without error.
Performance	The system optimizes processing time and resource utilization to maintain responsiveness and minimize loading delays.
Reliability	The system remains stable and dependable, consistently working and performing well.
Efficiency	The system executes tasks quickly and responds to user actions without delay.
Usability	The system is intuitive and easy to navigate, ensuring that the users can learn and manipulate the program with ease.
Security	The system uses secure login mechanisms and role-based access control to ensure only authorized individuals have access to sensitive information.
Compatibility	The system operates smoothly across different browsers, devices, and environments, ensuring consistent performance.
Maintainability	The system is structured to support efficient updates, debugging, and future enhancements, allowing for sustainable long-term use.
Portability	The system can be deployed and run across various platforms with minimal configuration changes, enabling flexible use in different environments.

3.4.2 Hardware and Software Requirements

The system operating requirements are provided in separate sections detailing the hardware specifications as well as software requirements. There are tables that constitute key hardware requirements to use the system and the software requirements to have the system work in the document.

Table 3 provides information on the hardware requirements to enable users to use ResponSys. The adherence to these specifications will ensure that there is optimum performance during the use of the system.

Table 3

Hardware Requirements for Using the System

Hardware	Type/Specification
Processor	Intel i7 or higher
RAM	At least 4 GB
Bandwidth	At least 15 Mbps
Storage	At least 8 GB

Table 4 outlines the software requirements that are required of the users to run ResponSys successfully. With these requirements met, the system will be in a position to ensure that each user is able to access and use it smoothly.

Table 4

Software Requirements for Using the System

Software	Type/Specification
Operating System	Windows 11 or higher
Browser	Google Chrome Version 135.0.7049.84 (Official Build) (64-bit), Microsoft Edge 135.0.3179.54 (Official build) (64-bit), or Safari Version 18.3

3.4.3 Database Design

The section shows the way the data will be structured and managed in the database to ensure that the database is of maximum use.

Entity Relationship Diagram (ERD)

Entity Relationship Diagram (ERD) allows users to create the visualization and structure database designs simplifying the procedure of visualizing sophisticated data relations and preventing issues beforehand and creating structured effective databases (Agarwal et al., 2024). Figure 10 represents the plan of organization of the database of the system. It provides smooth integration of data, high performance, and scalability to maximize its future improvement.

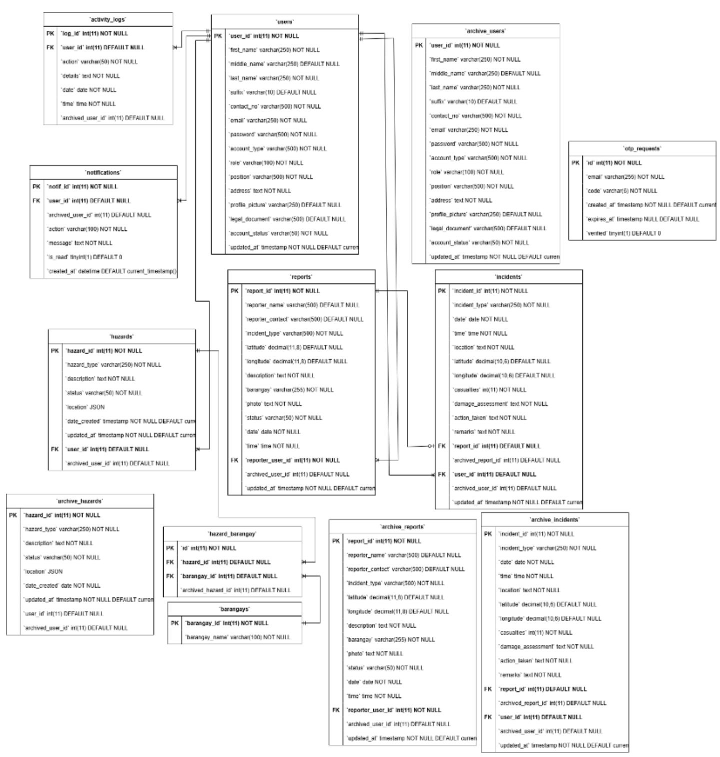

Figure 10. Entity Relationship Diagram (ERD)

ResponSys database structure defines the clear connections between the entities to promote effective incident management and reporting. Every incident is connected to a single report, and a report can be connected to the registered user, but a report may also be made by a citizen who is not registered. A junction table connects hazards with multiple barangays, and therefore, one hazard could impact many locations. The users get linked to the incidents and hazards they record, along with the activity logs and notifications, allowing tracking system activities in their entirety. This relationship model allows the well-integration of data, historical record-keeping by archive tables, and offers the basis of analytics, reporting, and dynamic mapping.

3.5 Development

The development section of ResponSys needs particular software and hardware instruments that support continuous functional operation and future expansion needs. The system implements selected tools that fulfill its functional requirements and address evolving needs.

3.5.1 Software Development Tools

Table 5 shows the software requirements. It lists the tools needed to develop and run the system smoothly. These specifications are aligned with ResponSys' goals to ensure the system works dependably and can grow in the future.

Table 5

Software Requirements for Developing the System

Software	Type/Specification
Operating System	Windows 11 or higher
Development Environment	Visual Studio Code version 1.99.0
Front-end	HTML5, CSS3, Tailwind v3.4.17, Leaflet.js v1.7.1
Back-end	PHP v8.2
Mapping	QGIS 3.42.1 'Münster'
Web Development Framework	Ajax, jQuery v3.6.0
Database	MySQL (MariaDB) v10.5.16
Version Control	Git with GitHub
Deployment Tools	Hostinger

Each software was chosen to make sure that ResponSys can be efficient, reliable, and scalable. Leaflet.js was selected due to its lightweight and interactive qualities in web-based mapping, which would be suitable to show the real-time hazard and incident information. QGIS is a powerful, free, and open-source GIS platform already known to most LGUs, which can be used in hazard mapping and spatial analysis. PHP and MySQL (MariaDB) are chosen due to their compatibility and stability in web development, while Ajax and jQuery allow dynamic and responsive interaction on the front-end. Visual Studio Code provides a versatile development tool, whereas Git and GitHub can be used in version control and collaborative development. Lastly, Hostinger was selected as a deployment platform to guarantee the reliability of hosting and accessibility to the users.

3.5.2 Hardware Development Tools

Table 6 shows the minimum hardware requirements needed to help developers effectively create the system.

Table 6

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Hardware Requirements for Developing the System

Hardware	Type/Specification
Processor	Intel i7 or higher
RAM	At least 8 GB
Bandwidth	At least 10 Mbps
Storage	At least 32 GB

3.6 Testing and Evaluation

This paper used a developmental research design to design, develop, and refine the ResponSys system and descriptive-evaluative research design to evaluate the quality of its software and acceptability by users. The developmental component was concerned with the systematic development, testing, and refinement of the system according to the requirements identified, whereas the descriptive-evaluative one was focused on the measurement of the perceptions of the users towards the performance of the system, based on the established software quality criteria.

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The section outlines the testing and evaluation processes that are implemented to ensure reliability of the system, performance, and user acceptability of the system by having clearly defined testing strategies, evaluation criteria, data gathering procedures, and data analysis procedures.

3.6.1 Testing Strategy

The testing strategy of Responsys uses a systematic approach to testing to make sure the system achieves functionality, reliability, efficiency, usability and security as per the ISO/IEC 25010 quality attributes. This unified method is a way of ensuring that systems components are synchronized and that it also addresses the requirements of both administrators and end-users.

Individual modules of the system will be tested individually in isolation using unit testing. This step will begin in the initial stages when the project will build the necessary backend features which will comprise the incident report features, real-time alerts, and the hazard visualization features. In this testing, every module is tested to detect the defects and remedy them beforehand. Through this, it minimizes the initial problems and does not allow them to propagate through different layers of the system.

Another testing method that is going to be used is the integration testing which will test how the various modules of the system will interact. Integration testing will also be used to give assurance that the data is correctly transmitted between the front-end, backend, and Cloudflare Turnstile. It will also pay attention to the fact that the data exchange is correct, the report monitoring is real-time, and features such as incident submission and administrative dashboard outputs are functionally consistent. In this testing, it will ensure that system components will cooperate as a system.

System testing, on the contrary, will test the system as a whole to ensure that the system satisfies all the stipulated functional and non-functional requirements. The team will also conduct performance testing coupled with security testing to ascertain whether or not the system could accommodate the multi-user load conditions without compromising its security measures. The usability testing will be carried out to identify that the interface is quite handy in facilitating convenient interactions between various gadgets and browsers. Taken together, these steps lead the system a step closer to the deployment as they expose the issues and ensure that they are thoroughly handled.

Finally, the black-box testing will also be utilized to test the behavior of the system in the stringent context of the user perception without any details of the internal code structure and the nature of the implementation specifically. The test is significant because it allows the detection of user experience, logic and business process problems that are not visible when looked at at the code and inside level. This will be carried out under the system and acceptance testing which will examine how the system will respond to different inputs and test cases.

Through conducting these tests, the team aims at coming up with ResponSys so that it has the security, flexibility and credible operating capabilities. Every testing will enhance the overall performance of ResponSys, which will guarantee that the platform will be able to fulfill the operational needs of the users.

3.6.2 Evaluation Criteria

The system performance and user feedback were measured on a 5-point Likert scale to make sure that there was a standardized interpretation of the test results. The evaluation criteria were based on the ISO/IEC 25010 software quality model that addressed the quality characteristics, which were evaluated in this study, which are: Functionality, Performance, Compatibility, Usability, Reliability, Security, Maintainability, and Portability. The assessment tool was created in adherence to these groups, and the items were categorized on the basis of their respective quality characteristic and content validation was done to ensure the appropriateness, relevance, and clarity in the measurement of user acceptance. The descriptive-evaluative design enabled the study to quantify the perceptions of system quality and system acceptance among users without manipulation of the variables.

Table 7 displays the associated ranges and verbally interpreted values.

Table 7

Evaluation Criteria Rating

Scale	Mean Weight Range	Verbal Interpretation
5	4.50 – 5.00	Strongly Agree
4	3.50 – 4.49	Agree
3	2.50 – 3.49	Neutral
2	1.50 – 2.49	Disagree
1	1.00 – 1.49	Strongly Disagree

This evaluation framework was used as a basis in interpreting the responses as part of the User Acceptance Testing (UAT) step, which ensures that there is consistency and clarity in determining the effectiveness of ResponSys and how satisfied the users are with it.

3.6.3 Data Gathering Procedure

The data gathering process of evaluating ResponSys was done in a systematic manner to gather credible user feedbacks. Before data collection, formal consent was obtained with the Municipal Disaster Risk Reduction and Management Office (MDRRMO). The respondents were then oriented regarding the purpose of the research and the capabilities of the system.

A pilot use and system demonstration of ResponSys was carried out in order to enable respondents to use the platform. Following system utilization, the User Acceptance Testing (UAT) survey tool was conducted. Finished questionnaires were gathered and prepared to interpret the data.

3.6.4 Data Analysis

Descriptive statistics were used to analyze the data of the User Acceptance Testing (UAT). The mean was calculated to know how much the users agreed with each evaluation criterion and overall rating of the system. The calculated mean scores were interpreted with the help of the five-point Likert scale and their respective verbal answers that are introduced in Table 7, making it possible to objectively evaluate the quality of the system, its effectiveness, and its acceptance by users.

3.7 Deployment

In this section, the deployment process and the extended maintenance framework lead to long-run reliability of the systems.

3.7.1 Sustainability and Maintenance Plan

The deployment plan for ResponSys was initiated with a pilot testing on InfinityFree, which is a free and ad free web hosting service. This enabled the developers to test the system under a controlled environment, evaluate its functions as well as any bugs. The input of the clients at this stage was essential in getting positive feedbacks concerning the design and functional attributes of the system. Following the feedback, it was possible to make the required adjustments to the platform to narrow down to the ultimate deployment of the system.

Once the pilot stage was completed, the system was implemented on Hostinger, a more scalable and reliable hosting service that is more stable. To maintain stability, security and continuity, it is suggested that a long-term production should be hosted on the server that is controlled by LGU, in Padre Garcia to maintain stability, security, and continuity. After that, efficient training agenda was offered to users in the post-deployment phase, which taught how they should use the system to perform tasks such as incident report monitoring and hazard mapping to identify vulnerable locations. This training involved simple troubleshooting habits that assist the users to solve smaller issues without accessing any outside assistance.

The system was officially handed over to the MDRRMO of Padre Garcia after the training, and there were some follow-up sessions on system maintenance and resolution of typical technical challenges. In this manner, the MDRRMO can be tasked with the responsibility of owning the system wholesomely hence not having to rely on the team, but also guaranteeing that ResponSys will be maintained in house.

113 To facilitate this move, a contract between the client and the development team must exist, which would define the responsibilities and roles of system maintenance exercises. Additionally, the maintenance plan was time-bound wherein the full responsibility was transferred gradually to the MDRRMO.

In this agreement, the users were properly trained such that by the end of the agreement, the users will be fully able to support and manage the system on their own. It not only certifies a handoff of the system but also the transfer of capability to enable the local office to handle the platform on its own.

3.7.2 Risk Management Plan

Risk is part of the design and implementation of information systems, and particularly those that are intended to support key vital processes such as reduction and management of disaster risk. A proper risk management framework is a formalized method that defines, assesses, and mitigates any possible risks that may compromise the integrity of the system, data integrity, or overall system functionality. With a risk-anticipatory approach, the organizations are in a better place to efficiently allocate resources and protect the survival of vital operations.

One of the most frequently used tools in this initiative is the risk assessment matrix that measures potential risks in two dimensions: their likelihood of occurring and the severity of their effects. This matrix still provides the decision-makers with a structurally organized channel of prioritizing the risks, thus separating the low-level risks that require the least possible intervention and the high-level risks that require urgent focus (De Felice, 2024).

In this paper, the risk matrix provides an analytical model upon which the potential vulnerabilities of a web-based incident management system, including hazard mapping, real-time reporting, and data-driven decision-making, are evaluated. By doing so, risks can be categorized, rated, and allocated to the mitigation strategies that correspond to those risks, in order to make the system more resilient and to make sure that the system achieves its mandate in supporting the Municipal Disaster Risk Reduction and Management Office (MDRRMO).

Severity Likelihood	**Neglible**	**Minor**	**Moderate**	**Significant**	**Severe**
Very Likely	Low Med	Medium	Med Hi	High	High
Likely	Low	Low Med	Medium	Med Hi	High
Possible	Low	Low Med	Medium	Med Hi	Med Hi
Unlikely	Low	Low Med	Low Med	Medium	Med Hi
Very Unlikely	Low	Low	Low Med	Medium	Medium

Figure 11. Risk Matrix (De Felice, 2024)

Table 8

Risk Analysis

Risk	Category	Likelihood	Severity	Risk Rating	Mitigation Strategy
Fake or fraudulent reports	Operational / Human	Likely	Significant	Med-High	Enable geolocation validation to ensure reports are within the covered area; require live image capture with automatic geotagging.
System downtime	Technical / Operational	Possible	Severe	Med-High	Maintain reliable hosting infrastructure, implement backup, and conduct regular system health checks.
Unauthorized access	Security	Possible	Severe	Med-High	Strengthen role-based access control (RBAC) and limit privileges strictly by user role.
Data loss	Technical	Unlikely	Severe	Med-High	Automate database backups and periodically test recovery.
Delayed real-time retrieval of data	Technical / Operational	Possible	Moderate	Medium	Optimize database queries and improve server performance.
User training gaps	Operational / Human	Very Unlikely	Minor	Low	Provide in-system onboarding tour with step-by-step guidance.

Among the risks identified, system downtime, unauthorized access, and loss of data are the most critical to ResponSys as they can cause considerable disruption to the operations or sensitive information through the course of disaster management activities. To prevent these risks, the system adopted some of these security measures, including reliable hosting and back-ups, role-based access control (RBAC) to control user privileges, periodic database back-ups with recovery tests, and secure communication protocols (HTTPS /SSL). Such actions can guarantee that ResponSys is resilient, secure, and available when it is needed most, so that the MDRRMO can continue to have functional incident reporting, hazard mapping, and data-driven decision-making. These measures collectively ensure that ResponSys remains reliable and secure, even during high-demand disaster situations when system availability is most critical.

4 RESULTS AND DISCUSSION

70 This chapter discusses the design and development of a web-based incident management system, Responsys. It introduces the general outline, interface and essential features of the system and the way each component has been developed to suit the specified needs. Figures and descriptions are used to demonstrate how the system looks and how it works. The section also explains the interpretation of the alignment between the implementation results with the system objectives and the operational requirements of the MDRRMO of Padre Garcia.

4.1 Development of a User-Friendly Web-Based Platform for Incident Reporting

This section focuses on the findings in terms of the first objective which is the development of a web based platform to enhance the incident reporting, documentation, and response coordination of the MDRRMO of Padre Garcia.

In implementing ResponSys, the researchers were dealing with the fact that the MDRRMO has long been dependent on manual reporting systems, such as handwritten logbooks and spreadsheets. Switching to digital platform generated instant changes in operations, especially the speed of reporting, records accuracy, and availability of incident data. There was also observable positive changes that featured a decrease in the number of reporting delays, the presentation of information was clearer, and the records could be obtained faster in an emergency situation. The findings show a significant level of reduction in delays that was generally attributed to manual reporting channels.

4.1.1 Real-Time Data Entry and Retrieval for Quick Incident Reporting

This section presents the results that relate to the first objective of the research which was to develop a user-friendly web-based system that will improve the reporting and documentation of incidents at the MDRRMO of Padre Garcia. As stated above the MDRRMO had been working with handwritten logbooks and spreadsheets thus causing a slow reporting process, misplaced data and non-accessibility to the information about incidences at time of necessity during an emergency.

The shortcomings were overcome by the introduction of ResponSys that substituted the manual and decentralized reporting systems with a centralized web-based one. The results indicated that operational improvements were visible, namely, the speed of incident reporting, outcome and consistency of records, and availability of incident data. The reductions that would have been noticed were the reduction in the reporting delays, the presentability of information, and speed in retrieving records in case of emergency operations.

Overall, the results indicate that the system met the required specifications of the first objective. The system provided in the system in the centralized interface of incident data management made it easier to improve the coordination and information flow in

MDRRMO. These improvements are attributed to the certain characteristics that have been addressed in the following subsections.

Figure 12 is then the incident reporting map interface. The zoom feature enables the user to focus the map to have a better view (1), while the measurement tool enables the user to estimate the distance or area on the map (2). There is also a location button that can put the map at the physical location of a user (3). The system opens an incident reporting form whenever one clicks on the map, and the information can be filled (4). It has a search option that helps a user to find a particular place or address within a short time (5). Lastly, it has a guide that assist the users on using and reading the map interface (6). These controls enhance usability since they enable the users to easily find the incidents, minimizing the level of mistakes in reports concerning location.

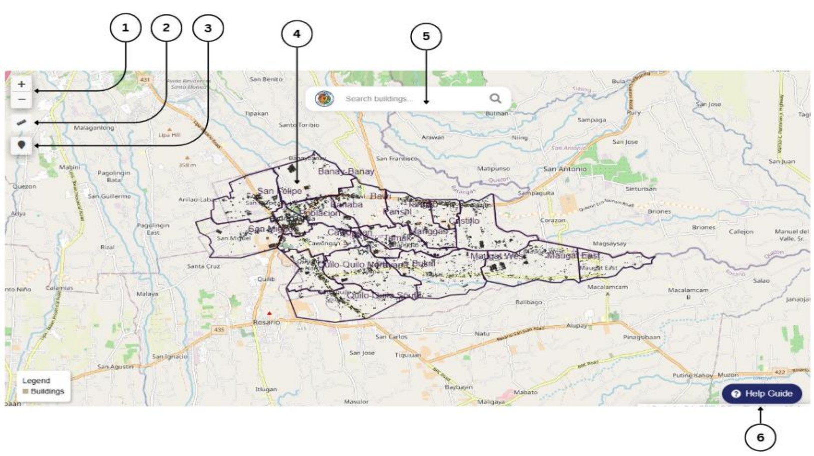

Figure 12. Incident Report Map

1 – Zoom Control

3 – Location

2 – Measurement

4 – Click on the map

5 – Search 6 – Guide

Figure 13 represents the report incident form of the system. Close button is offered to leave the form (7) and it may also be left to users to tap outside the form in order to leave the form. This section now includes fields for entering the user's name (8) and contact number (9). A feature is also provided for users to take a real-time photo of the incident (10), as uploading pre-captured images is not allowed to help mitigate false reports. Another section is provided for selecting the incident type (11) and for writing the description of the reported incident (12). A Cloudflare Turnstile verification field is provided to confirm that the individual accessing the website is human (13), while this button allows the user to submit their report directly to the MDRRMO of Padre Garcia (14). Finally, links to the Terms and Conditions (15) and the Privacy Policy (16) are available for users to view. The systematic nature of the form makes reports complete so as to maximize the missing important information in emergencies.

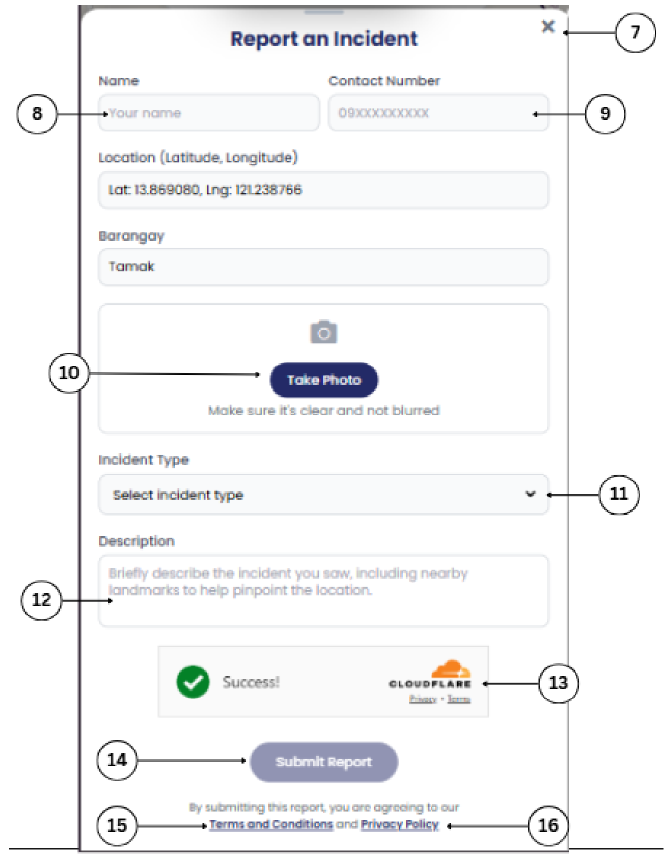

Figure 13. Report Incident Form

7 – Close Button

8 – Name

9 – Contact Number

10 – Take Photo

11 – Incident Type

12 – Description

13 – Cloudflare Turnstile

14 – Submit Report

15 – Terms and Conditions

16 – Privacy Policy

In Figure 14, the incident map of the system is presented with all the reported incidents being plotted. From here, the user can open a dropdown to switch between different map views (1) or use a link within the dropdown to go to the incident map page (2). The map itself can be zoomed in and out using this button (3), while another button detects and centers on the user's current location (4). A measurement tool is also available (5), allowing distances across the map to be calculated. When a report marker is clicked, a pop-up will appear (6), and an additional button shows the captured image of the incident (7). The user may also view the exact location of the incident through Google Street View (8) and search for buildings across the map using this search bar (9). The interactive map assists MDRRMO personnel in visualizing incident clusters and prioritizing responses.

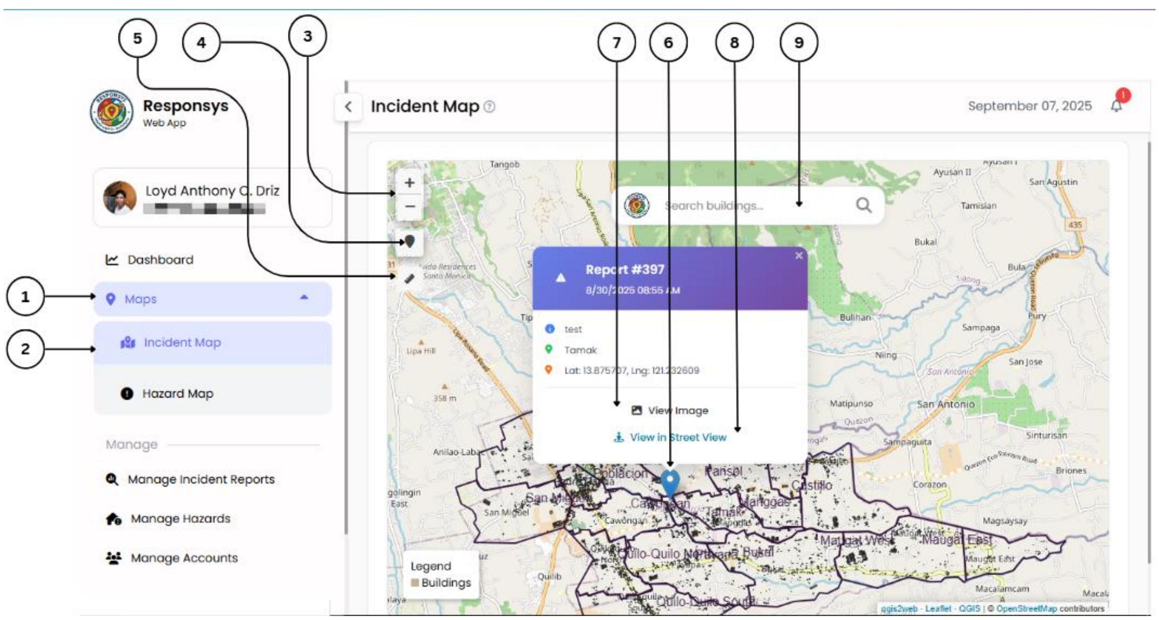

Figure 14. Incident Map

1 – Map Dropdown

2 – Incident Map Button

3 – Zoom Control

4 – Location

5 – Measurement

6 – Report Marker

7 – View Image

8 – View in Street View

9 – Search

4.1.2 Role-Based Access for Secure Data Management

This paragraph shows the findings that pertained to another aspect of the first objective, which was to have secure data management by controlled system access. As mentioned in Chapter 1, there was no digital system in place at the MDRRMO to control the access to data since incident information was handled with paper records, phone calls, and manually distributed files. This setup pose risks to integrity of data and accountability as well as confidential information regarding disasters.

When ResponSys was deployed, role based access control system was employed to deal with these issues. The system classifies the users into different classes and the access and functions on the system can be delegated according to the responsibility. The findings revealed that such structure restricted the viewing and editing of data to authorized persons, and then access by unauthorized people was minimal, and accountability was upheld in the system.

The role-based access implementation was beneficial in the safe management of the growing amount of incident data created by real-time reporting. The separation of the user responsibilities and permissions ensured that the sensitive records were not compromised and citizens were also able to contribute to the incident reporting through their interaction with the system. It was confirmed that user roles experienced access controls always, which
105 enhanced the security of data and ensured the integrity of official MDRRMO records. The interfaces that facilitate this mechanism of access control are shown in the figures below.

To facilitate this role based system, Figure 15 shows the 'Login Form' which does not only authenticate user credentials but also confirms the type of account assigned to the user so that each user is redirected to the necessary features and functions that are spelt out by his/her job. This is to enter an email address in order to identify the user (1). This serves as a field to input the password that grants access to the user's account (2), and this icon is for showing the password in text form (3). Users may reset their password through this link (4). A security check is provided to confirm that the login attempt is performed by a human (5). This button, when clicked, verifies the entered credentials and, if successful, grants the user access to the system (6). In addition, users can view the 'Terms and Conditions' (7) and 'Privacy Policy' (8) related to system use.

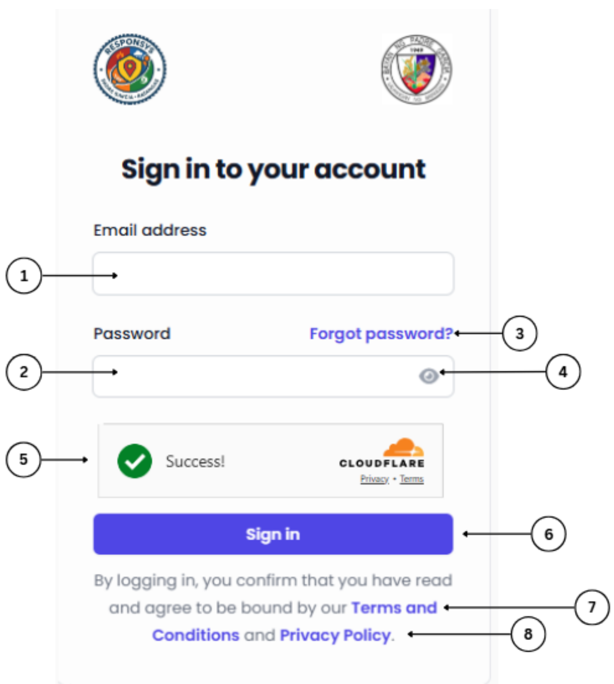

Figure 15. Login Page

1 – Email

2 – Password

3 – Forgot Password

4 – Show Password

5 – Cloudflare Turnstile

6 – Sign in

7 – Terms and Conditions

8 – Privacy Policy

To further illustrate how account verification determines the available system functions, Figure 16 shows the interfaces accessible to MDRRMO administrators and staff. While both roles share features such as the Dashboard (1), Map Dropdown (2), Manage Incident Reports (3), Manage Hazards (4), Settings (6), and Logout (7), the Manage Accounts option (5) only appears for administrators, highlighting the restricted control of user access.

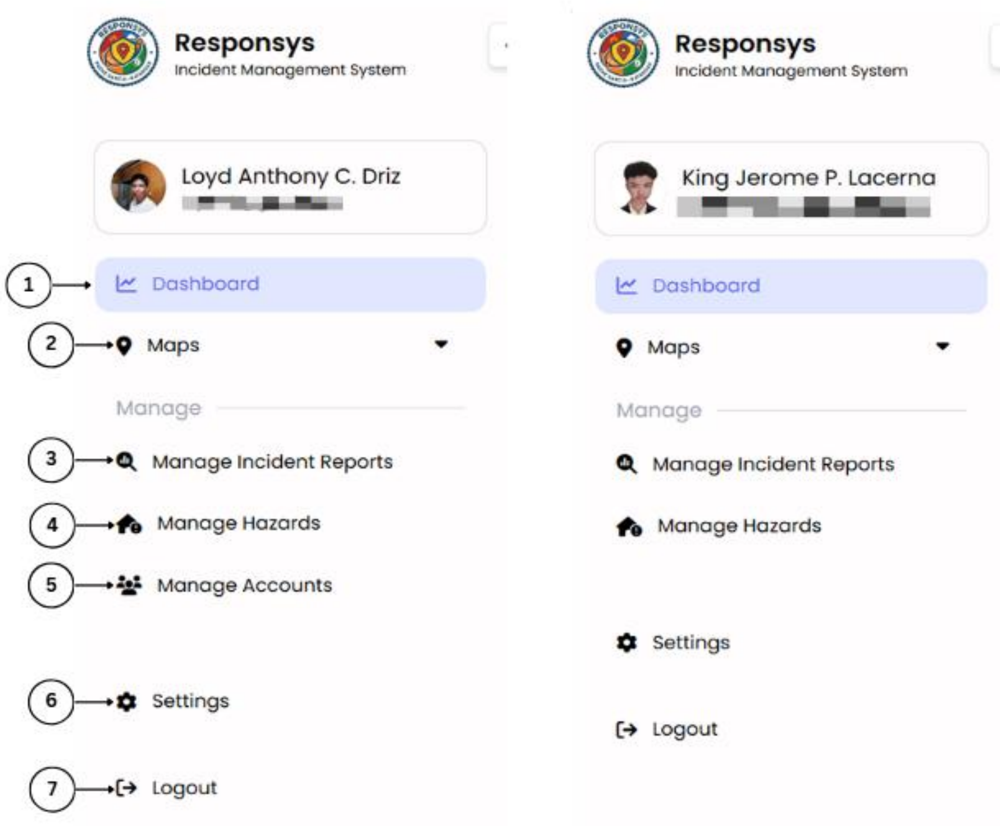

Figure 16. Sample Admin vs Staff Interface

1 – Dashboard

2 – Map Dropdown

3 – Manage Incident Reports

4 – Manage Hazards

5 – Manage Accounts (Admin Only)

6 – Settings

7 – Logout

4.1.3 Enhanced Report Generation for Post-Disaster Analysis and Planning

This subsection identifies the findings associated with the other component of the first objective, which was to enhance the analysis and planning of post-disaster by enhancing report generation. Previously, incident records were recorded manually, typically in Excel sheets, which caused the lack of consistency in formatting, inability to consolidate data, and an incapacity to create reliable post-disaster summaries.

With the implementation of ResponSys, the report generation component automated the process of generation of structured and standardized reports that were generated directly using the centralized database. The system enabled MDRRMO staff to create summaries containing the number of incidents, casualties, cases resolved, and the distribution of hazards in barangays, with the option of sorting the data by date or location. These results indicated that this feature increased the consistency, accuracy, and accessibility of post-disaster data.

Also, the possibility to produce reports in various formats, including Excel, CSV, or PDF, offered a flexibility in documentation and analysis, as well as in keeping official records. The testing confirmed that the generated reports were the accurate reflection of the recorded data, which warrants reliable evaluation and informed decision-making. These additions were used to solve the earlier issues of the fragmented and manual reports.

The results indicate that this enhancement allowed the MDRRMO to analyze the trends of the disasters more appropriately, track the incidents and be prepared to mitigate them in the future. The interactive interfaces and outputs assisting this report generation capability are as shown in the following figures.

As Figure 17 shows, the user can administer incident report records using a number of interactive controls. By clicking this button (1) one has access to the main module to handle reports. This (2) is an option that would change the number of reports to be displayed on the list, whereas filters allow to put the results into a narrower range based on date (3), barangay (6), or status (7). This button deletes all the filters applied in one click in case it is necessary (9). Post-incident records (4) and an export option (5) are also available in the interface to save the data to an external location. Next, there is a search bar (8) where one can do quick searches. In every report, the user has an option of viewing the position of the report on the map (10), reviewing the image taken (11), or changing the status of the report directly (12). Another button allows the user to make a post-incident record (13).

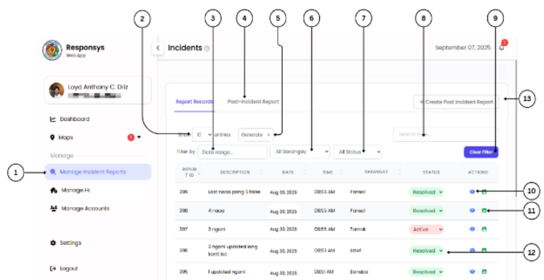

Figure 17. Manage Incident Reports

1 – Manage Incident Reports Button

2 – Show Entries

3 – Filter by Date

4 – Post-Incident Records

5 – Export

6 – Filter by Barangay

7 – Filter by Status

8 – Search

9 – Clear Filter

10 – Show on the Map

11 – Show Image

12 – Update Status

13 – Create Post-Incident Record

Figure 18 displays a form used to create a post-incident record. This button (14) can be used to close the form or one can use the outside of the window to do so. It starts with defining the type of incident (15). If the incident being responded to already exists in the system, it can be linked through this optional field (16); however, if the report did not originate from the system, this field may be left blank. Other information is a tooltip with guidance (17), date (18), and time (19) of the incident. It is also possible to provide location information by entering the latitude (20) and longitude (21) manually or by pointing at the location on the map (22). The barangay where the incident occurred is then added (23), the number of casualties (24), damage evaluation (25), response action (26), and any remarks are added (27). After completing all the necessary information, the user may cancel the process (28) or complete it by generating the post-incident report (29).

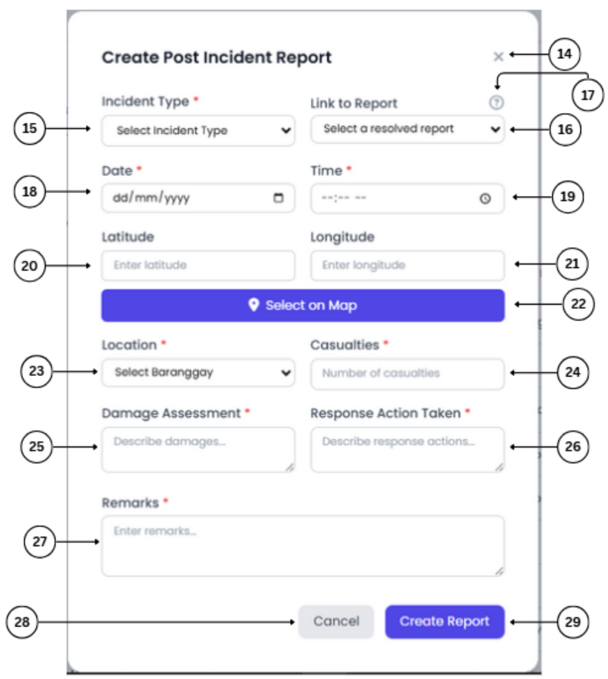

Figure 18. Post-Incident Form

14 – Close

15 – Incident Type

16 – Link to Report

17 – Tooltip

18 – Date

19 – Time

20 – Latitude

21 – Longitude

22 – Select on Map

23 – Location

24– Casualties

25 – Damage Assessment

26 – Response Action Taken

27 – Remarks

28 – Cancel

29 – Create Report

The figure below (Figure 19) shows the management of post-incident records. Similar to Figure 17, it includes filters, a search bar, and control buttons commonly found in a table. One button allows the user to update a post-incident record (30); when clicked, it opens a form similar to Figure 41, but instead of creating a new record, it updates the existing one. Another button enables archiving of an existing record (31), while the last button displays the location of that incident record on the map (32). Finally, there is a button (33), which helps the user to create a full incident report of the chosen record of the post-incident, summarizing key information such as the details of the incident, the measures taken, and the results. This report could be either exported or printed to be used in documentation and review.

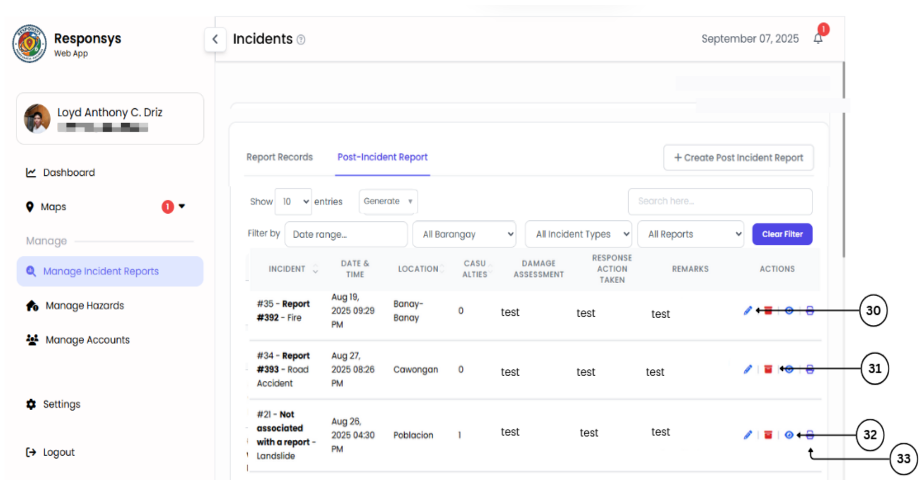

Figure 19. Manage Post-Incident Records

30 – Update

31 – Archive Record

32 – Show on the Map

33 – Generate an Incident Report

A sample of a report generation is illustrated in the figure below. This output summarizes all the information recorded in the course of operation, including but not limited to incident information, location, assessment, response actions, and comments, into an organized document. There are also two control buttons, one (1) to print/ save the report, and the other (2) to cancel and leave the view. The produced report is able to give a concise overview, which may be utilized to document, analyze, and keep official records of MDRRMO, as well as be exported or printed to serve administrative purposes.

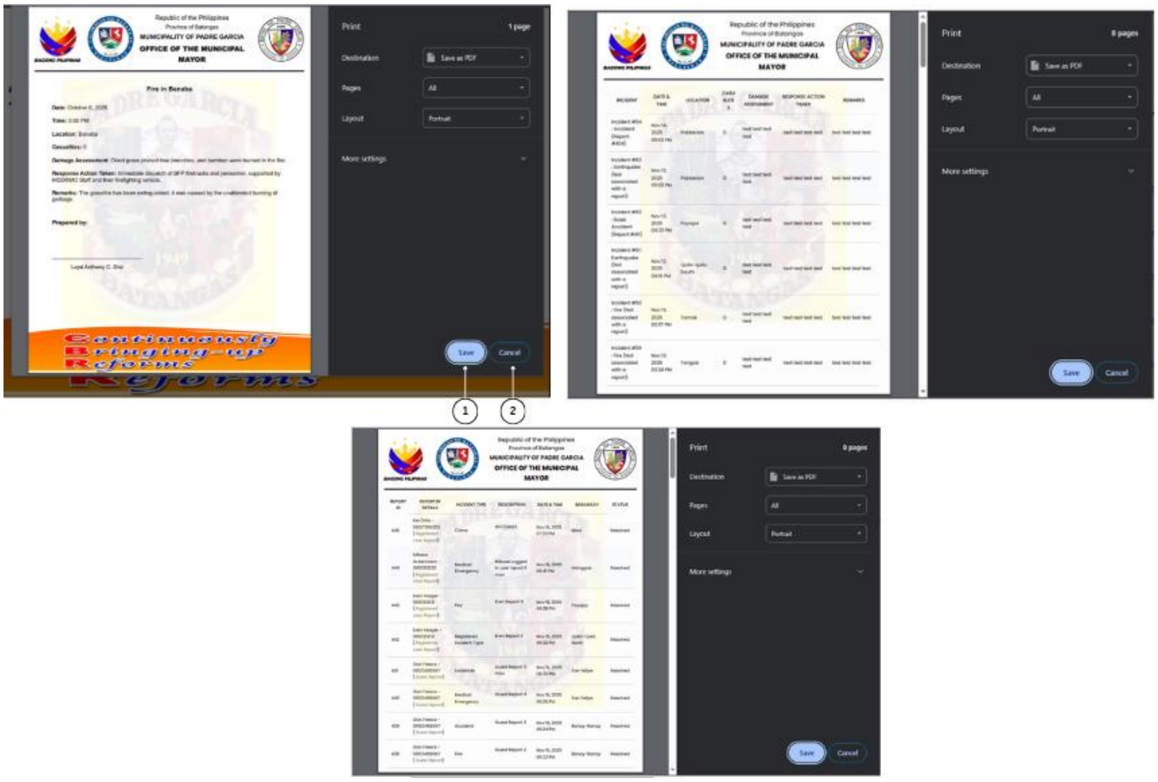

Figure 20. Sample Report Generation for Post-Incident Record

1 – Print/Save

2 – Cancel

In general, the findings of this section confirm that the created platform addressed previous problems with slow reporting and documentation fragmentation and manual consolidation. ResponSys brought a better system of information flow between the community and the MDRRMO to enhance operational responsiveness and decision-making in times of disaster.

4.2 Incorporation of Geospatial Tools for Hazard Mapping

Once the reporting and data management functionality was operational, the researchers moved to integration of geospatial tools to further facilitate hazard identification and risk analysis, which is the second objective of the study. In the past setup, hazard information had to be documented in hardcopy documents, and this proved cumbersome when the MDRRMO needed to establish the high-risk areas or overlapping hazards. With the introduction of GIS functionality, the hazard data could be now displayed in a spatial manner, which enabled the MDRRMO to examine hazards relative to particular barangays, infrastructure, and population density. This application verifies the results of Shapiro and Donato (2025) and Chen et al. (2022), who pointed out that GIS helps to understand hazards in space, which encourages interpretation of exposure and vulnerability.

Through this space representation, the staff was now able to identify the barangays at risk of multiple threats at once, like flooding and landslides. This can be used to help in more specific planning of resource allocation and disaster preparedness efforts. The interactive visualization is also advantageous to residents, since more hazard locations can be understood, thus aiding in the proper delivery of hazard information to residents. These findings are compliant with literature by Twumasi et al. (2020), Freeman (2021), and Singh (2024), whose findings supported the notion that mapping with the help of GIS promotes risk assessment, emergency planning, and informed decision-making at the local level.

29

4.2.1 Integration of GIS Technology for Hazard Mapping and Risk Assessment

The following subsection will provide findings regarding the second objective, i.e.
29 integration of GIS technology in hazard mapping and risk assessment. The researcher

incorporated GIS technology in ResponSys using the reporting and data management modules to create interactive maps of disaster prone areas in Padre Garcia. The MDRRMO spatial data of barangays and hazard records were read and then fined in QGIS, an open-source GIS platform that is most popular due to its flexibility and support of the community (Gallardo et al., 2022). The polished geographic layers have subsequently been integrated to the ResponSys with the Leaflet.js and have allowed people to access hazard information in a dynamic and interactive format using any web browser.

The system enabled the users to switch between hazard layers and assist in the perception of the distribution and overlapping of various disaster types. The usability and accessibility of the map was improved by features like zooming, location tracking, distance measurement, filtering and search. It was tested that there was a match between the spatial data and official records and the color contrast as well as the clarity of the legend was done to make the hazard information easily readable. This method is consistent with the literature provided by Gyang et al. (2024) and Esri (2024) about the significance of GIS in the development of situational awareness, data-driven risk assessment, and the role of GIS in increasing disaster preparedness at the municipal level.

The system will enable the MDRRMO staff to identify the vulnerable areas and better comprehend the geographic connections of hazards, as well as give information on local risks to the residents, by converting the static records into interactive visualizations. The above improvements demonstrate the application of geospatial tools to local disaster management and planning, in line with accepted best practices in the use of GIS-based risk assessment.

To explain these findings, in Figure 21 it is possible to illustrate all hazard occurrences in Padre Garcia hence making citizens aware of the areas that are most at risk because of hazards. The zoom control allows the user to zoom in and out to have a better view of the map (1), as well as the location button is given, which centers the map to the current position of the user (2). Then, a meter will enable the users to measure distances or areas on the map (3). Moreover, one can narrow down the view even more by use of the search functionality (4) and the filter (5). In conjunction with this, the following figure (Figure 22) also indicates the QGIS workspace (1) upon which the web map was generated, illustrating the layers as well as tools and the spatial data environment which were used to create the visualization of the hazard.

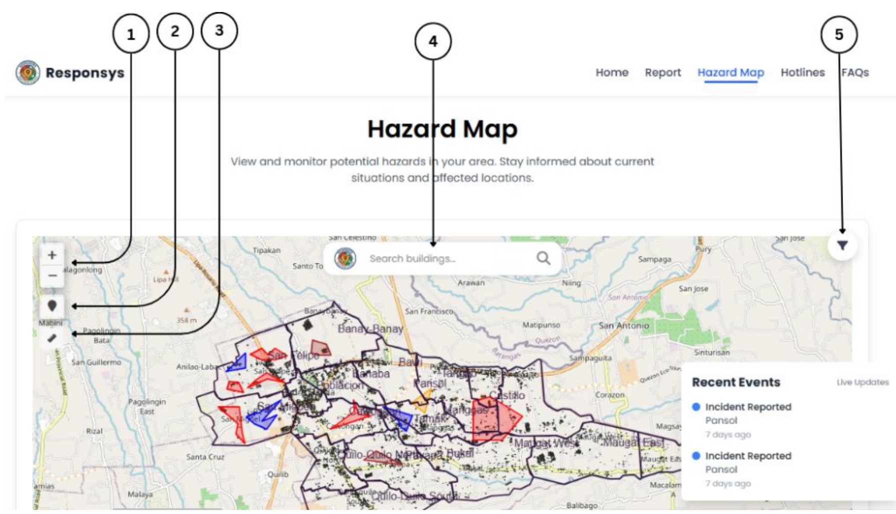

Figure 21. Hazard Map

1 – Zoom Controls

2 – Location

3 – Measurement

4 – Search

5 – Filter

The interactive map increases situational awareness by showing real-time hazard concentration.

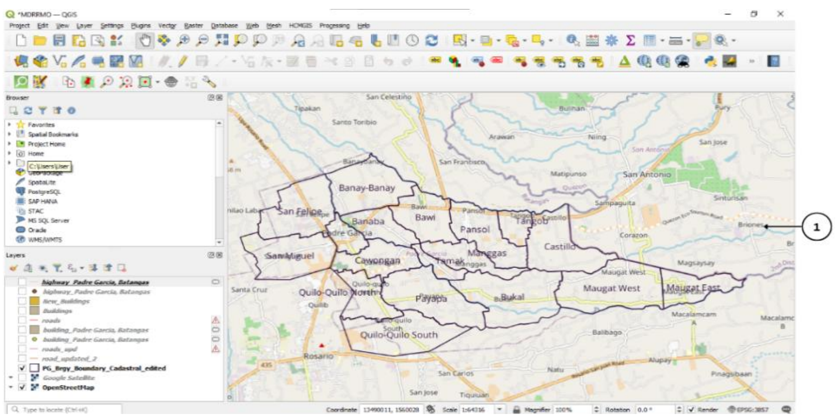

Figure 22. QGIS Workspace Used in Creating the Web Map

1 – QGIS Workspace

These tools ensured precision in hazard encoding and mapping accuracy.

4.2.2 Layered Hazard Mapping for Different Risk Types

In this section, the layered hazard mapping implementation and discussion are presented. After the base map had been developed, the researchers developed the system with a layer of hazard mapping to offer a more detailed and comparative perspective of the disaster risks. The ability to split the hazards into elements, e.g., flood, fire, and landslides, allowed the user to view each of the aspects separately or identify the overlaps to facilitate the understanding of compounded risks. Color coding was employed such as visual differences, such as color coded floods in blue, fire in red and landslide in brown, to help facilitate recognition and interpretation by the staff and residents of MDRRMO.

The interactive filters were added to the layers to enable the users to switch on or off certain types of hazards so as to make the layers functional. This helps to make MDRRMO plan and even evaluate areas at risk of several risks. Besides these, the labeling of maps, legends, and the responsiveness of the interface were streamlined, so that they could be interpreted and used by any device. The system was also put to test on the live hosting environment to ensure that it would run smoothly with several layers running at the same time.

MDRRMO staff members reported that layered mapping was useful in situational awareness and in planning based on facts. The capability to visualize risk areas also benefited residents in terms of the ability to comprehend about local risks. The layered hazard feature by converting a fixed reference map into an analytical resource placed ResponSys in a position to act as a platform of proactive risk evaluation and rational decision making, as is common in the existing practice of GIS based disaster management.

On this basis, Figure 23 is the sample layered hazard map interface, in which there are several layers of hazards (1) that can overlap with each other. This interface will give its users the authority to explore particular hazard layers, compare risk zones, and understand how hazards are distributed in Padre Garcia in a better way. It is possible to compare risk through multiple layers.

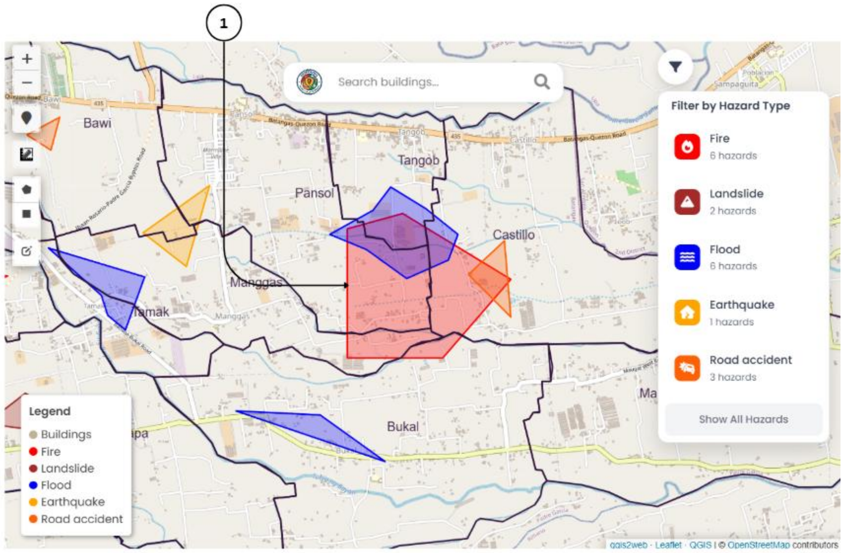

Figure 23. Layered Hazard Map Interface

1 – Multiple Hazard Layers

4.2.3 Interactive Mapping Tools for Dynamic Risk Assessment and Monitoring

The interactive mapping tools are addressed in this sub-section. After doing the layered hazard mapping, it was now time to enhance the system with the introduction of interactive mapping tools, which can be utilized to do dynamic assessment of risks and real time tracking. These features transformed the hazard map into a dynamic application and as a tool of work that allows the MDRRMO staff and the citizens to interact with the spatial data to facilitate decision-making. This also complies with Chapter 2 studies that emphasise the significance of GIS in disaster preparedness whereby the significance of spatial visualization is significant in the aspects of risk assessment and situational awareness. The map became a good means of hazard distribution and source allocation planning and vulnerabilities assessment across the municipality with the interactivity.

To achieve this, the system included zoom tools, location finder, and the possibility to make measurements. These features were used to increase location awareness and thus users were able to see the areas that were prone to hazards in a lot of detail. The possibility to filter and search made it possible to isolate certain types of hazards, which simplified the analysis process and made it more effective. One of them is a legend and guide, and it is clear that the map can be easily read to decipher the meaning behind symbols and colors used, and a responsive design ensured that the map will be applicable on devices including mobile phones that are important during emergencies. The given advances may be attributed to the concepts described by Twumasi et al. (2020) and Tiwari (2024), who stated that the GIS-based interactive tools allow making the process of decision-making and resource allocation in disaster management more effective.

In the course of the test, the MDRRMO staff members stated that the interactive tools facilitated their perception of hazards and enhanced collaboration in the process of planning activities. They pointed out that features like filtering, distance measurement, and location of hazards increased situational awareness, which can be analyzed and planned. These results confirm the applicability of GIS as mentioned in the literature because interactive spatial information can be used in the planning, monitoring, and responding of disasters by local governments.

This step indicates that ResponSys can now be used as a real time tool and not simply a reporting system and can offer a platform that can support real time analysis and assist in disaster preparedness across the entire municipality.

In order to illustrate the application of these interactive features, Figure 24 shows the hazard map of the system, which has a number of interactive controls. A dropdown menu (1) allows to control various options of map, whereas the button of a hazard map (2) will give immediate access to hazard-related data. Drawing tools also exist, such as square tool (3), and polygon tool (4) that allow the user to draw some sections of the map. Other operations are the edit (5), which enables the editing of the already drawn shapes, and the search (6) which enables finding specific places as well. Besides this, the user can also reduce the view with the filter option (7), and a legend (8) is included to clarify the symbols, and colors adopted on the map. Planning and hazard boundary analysis is made possible through drawing tools.

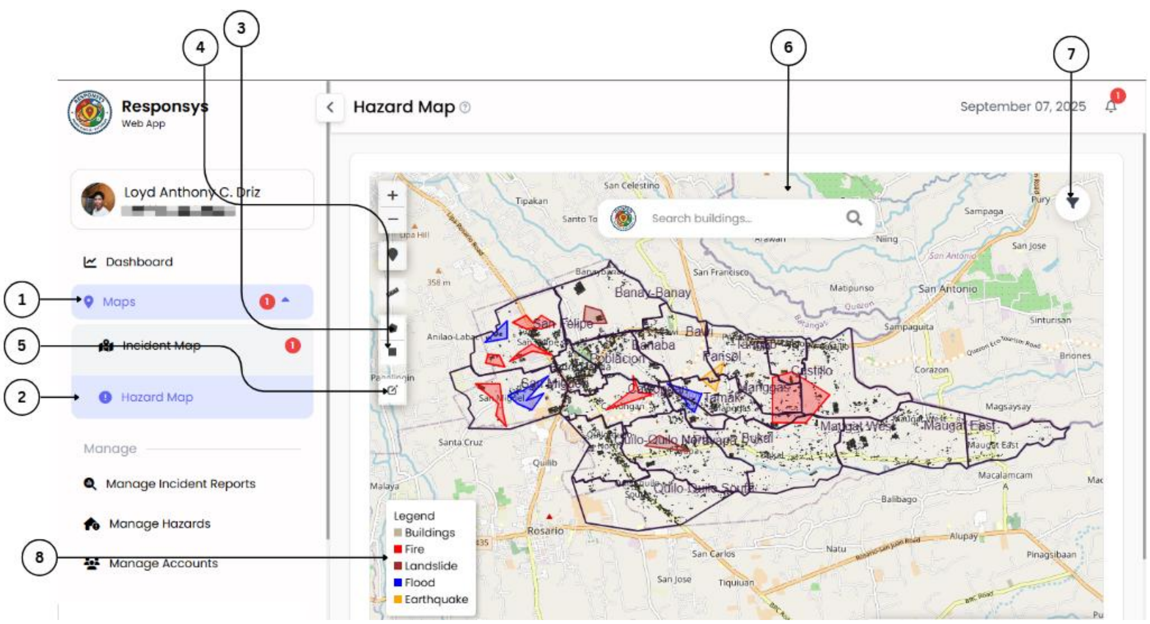

Figure 24. Hazard Map

1 – Map Dropdown

2 – Hazard Map Button

3 – Draw a Square

4 – Draw Polygon

5 – Edit

6 – Search

7 – Filter

8 – Legend

Figure 25 shows the interface for managing hazards. Similar to the other tables, it provides the same control options. The page can be accessed using this button (1). To refine the records, users can filter by date (2), hazard type (3), status (5), or barangay (6). In terms of records management, one can update the status of a hazard with a button (4) but can also edit the data of the hazard (7), view its location on the map (8), or even archive the record (9). Administrative tools improve hazard life-cycle management.

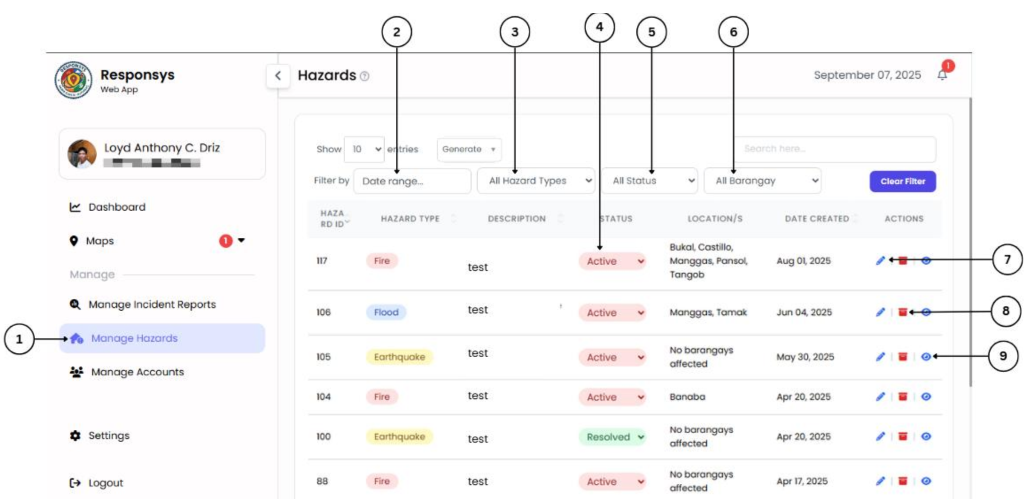

Figure 25. Manage Hazards

1 – Manage Hazards Button

2 – Filter by Date

3 – Filter by Hazard Type

4 – Update Status

5 – Filter by Status

6 – Filter by Barangay

7 – Edit

8 – Show on the Map

9 – Archive Record

GIS integration enhanced the functionality of ResponSys to a higher level as it increased the visualization of hazards and helped the MDRRMO staff to plan and monitor the risks of disasters.

4.3 Interactive Mapping Tools for Dynamic Risk Assessment and Monitoring

To support the reporting, mapping, and analytical functions of the system, the researchers focused on the development of the centralized database where all the information linked to the disasters can be stored safely and organized. The centralization minimized duplication and enhanced access of records. This database would enable effective data retrieval as well as real-time updating and organized management, which is the backbone of ResponSys. The structured organization also guarantees the stored data could easily be retrieved and summed up, which will be the foundation of the analysis dashboards and trend tracking. The results focus on the reliability, speed of access, and consistency of data.

4.3.1 Implementation of a Centralized Database Management System

This subsection discusses the implementation of the centralized database, representing the first key component of the third objective. Once all the work on the user interface and mapping components was done, the researchers began to create the centralized database management system, which was to hold and structure all the information that a disaster could bring in a safe and organized form. This component determined overall system reliability as the effectiveness of the platform relied on the ability of the data to be stored, retrieved, and analyzed when needed by the MDRRMO.

The database was designed on MySQL as it is reliable and compatible with PHP as the backend of the system. This allowed effective querying and scaling. The team created an ERD in the first stage to show the relationship between different tables. Each of the tables had been designed in a manner that minimized redundancy and quick retrieval of data had been addressed. After the database structure was finalized, it was linked with the reporting and mapping modules so that all the incidents or hazard records that were submitted could automatically be added to the database.

The researchers also added real-time synchronization on MDRRMO dashboard. It allowed the incident reports provided by the citizens to be immediately shown in the administrative panel, where the staff could review and classify them, and provided them easier access to submitted reports. The system also included a search and filter feature which provided the user with a chance of sorting reports based on barangay, date, type of hazard, or status. By this, it would be easy to identify recurring patterns, such as the frequently affected regions or the most common instances of the incidents, for the MDRRMO.

102 To ensure security and integrity of the data, the researchers embraced role-based authentication where sensitive records could only be viewed by authorized individuals. Only authorized MDRRMO employees had the right to edit, update, or create reports.

The database was also responsive during the testing period despite multiple simultaneous activities like incident submissions, hazard updates, and generation of reports. This change of localhost to web hosting also tested that the database was maintained with a stable connection and responsiveness. As it was mentioned by the staff of MDRRMO, the centralized storage made it easy to monitor real-time updates and generate analytical reports of disaster management activities.

The results of this phase found that the centralized database could provide an effective backbone to ResponSys. Not only did it produce a safe and systematic storage of disaster information, but also helped in the efficient search of information as well as the utilization of the data to make decisions. In general, the adoption of a centralized database facilitated the working capabilities of the MDRRMO since it offered a well-organized and trusted system of working with essential disaster-related records.

As indicated in the following figure, the sample database interface (1) is where all the system records are stored and arranged to enable authorized users to manage and access necessary disaster-management information effectively.

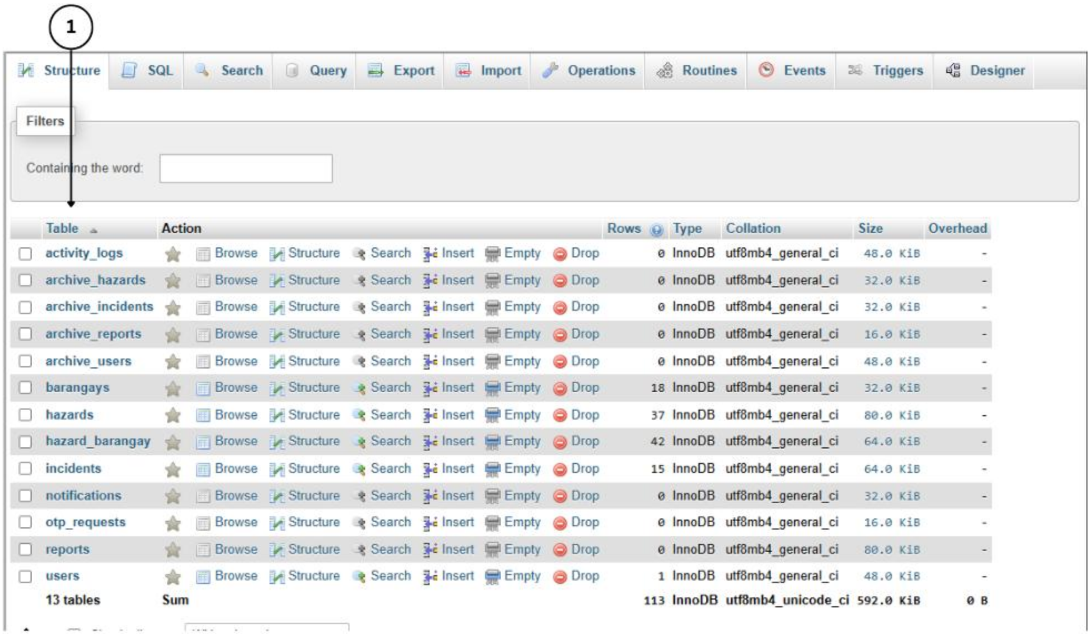

Table	Action						Rows	Type	Collation	Size	Overhead
activity_logs	Browse	Structure	Search	Insert	Empty	Drop	0	InnoDB	utf8mb4_general_ci	48.0 KiB	-
archive_hazards	Browse	Structure	Search	Insert	Empty	Drop	0	InnoDB	utf8mb4_general_ci	32.0 KiB	-
archive_incidents	Browse	Structure	Search	Insert	Empty	Drop	0	InnoDB	utf8mb4_general_ci	32.0 KiB	-
archive_reports	Browse	Structure	Search	Insert	Empty	Drop	0	InnoDB	utf8mb4_general_ci	16.0 KiB	-
archive_users	Browse	Structure	Search	Insert	Empty	Drop	0	InnoDB	utf8mb4_general_ci	48.0 KiB	-
barangays	Browse	Structure	Search	Insert	Empty	Drop	18	InnoDB	utf8mb4_general_ci	32.0 KiB	-
hazards	Browse	Structure	Search	Insert	Empty	Drop	37	InnoDB	utf8mb4_general_ci	80.0 KiB	-
hazard_barangay	Browse	Structure	Search	Insert	Empty	Drop	42	InnoDB	utf8mb4_general_ci	64.0 KiB	-
incidents	Browse	Structure	Search	Insert	Empty	Drop	15	InnoDB	utf8mb4_general_ci	64.0 KiB	-
notifications	Browse	Structure	Search	Insert	Empty	Drop	0	InnoDB	utf8mb4_general_ci	32.0 KiB	-
otp_requests	Browse	Structure	Search	Insert	Empty	Drop	0	InnoDB	utf8mb4_general_ci	16.0 KiB	-
reports	Browse	Structure	Search	Insert	Empty	Drop	0	InnoDB	utf8mb4_general_ci	80.0 KiB	-
users	Browse	Structure	Search	Insert	Empty	Drop	1	InnoDB	utf8mb4_general_ci	48.0 KiB	-
13 tables	Sum						113	InnoDB	utf8mb4_unicode_ci	592.0 KiB	0 B

Figure 26. Sample Database Management System

1 – Database Tables

4.3.2 Data-Driven Decision-Making through Structured Analysis and Trend Tracking

Another element of the system is the development of structured analysis and trend tracking tools, which is presented in this subsection. Once the centralized database was successfully built, the researchers began to focus on the creation of the tools that would assist MDRRMO in interpreting data and offering the foundation on which a decision-making can be made. The purpose of this stage was to convert the stored data information to meaningful information that can aid disaster preparedness and disaster planning in Padre Garcia.

The first step is to determine the particular types of data that would be beneficial to the MDRRMO. The analysis of the incident reports, the nature of hazards and geographical features was done in order to show what variables could be included in the statistical and graphic analysis. After that, the researchers developed analytical functions that would enable the system to automatically compute and summarize the statistics such as the total incidents, active cases, casualties, and recurring hazards. All these summaries were then displayed in a visual representation, such as charts, graph, and a heat map, to simplify the interpretation of data by the personnel at a glance.

There were also filters and sorting features that allowed users to filter down to a particular group of data. As an example, the MDRRMO staff could be able to access records based on barangay, hazard type, or incident type. This allowed identifying the high-risk areas and frequent occurrences, which in turn could be used to aid in disaster reduction. These dashboards offer descriptive analytics, summarization of trends, distributions, and counts, as opposed to predictive modeling, which may enable the evidence-based operational planning. In addition, this characteristic enabled users to monitor trends and have a clearer image of how the frequency and the severity of the incidents evolved during different months or even years.

In the course of testing, these analytical tools were proved helpful and assisted the MDRRMO in deriving actionable insights out of raw data. Specifically, the capacity to visualize the events using charts and heat maps, enabled users to rapidly view patterns without having to go through the reports individually. As MDRRMO staff affirmed, this feature simplified their monitoring work significantly, and this feature assisted in putting the disaster planning process into a better order.

The results of the this stage demonstrated that ResponSys was able to introduce the system of data analysis and trend monitoring into its core operations. This consequently transformed the stored information into visual and statistical information in order to provide the MDRRMO with a more solid foundations on which to base decisions based on the information. This helped facilitate a more effective data review and may be useful to long-term disaster preparedness efforts.

In order to demonstrate these analytical abilities, the figure below shows the user dashboard, where descriptive analytics is displayed on all charts, summarized count, distribution, and trends. Here, the dashboard page will be available directly (1), where it is possible to filter the records by year (2) or reset the filter used (3). There is also an onboarding guide that can guide new users (4). The dashboard presents four summary cards, with the first one reflecting the total number of incidents relative to the prior month (5), the second one representing the number of cases in progress this month (6), the third one representing the total casualties per month in comparison to last month (7), and the fourth one reflecting the same comparison of hazards (8). The users may also access the notifications panel (9), access the graphical trends of monthly incidents (10) and hazards (11), expand the heat map to see them better (12), or log out of the system (13).

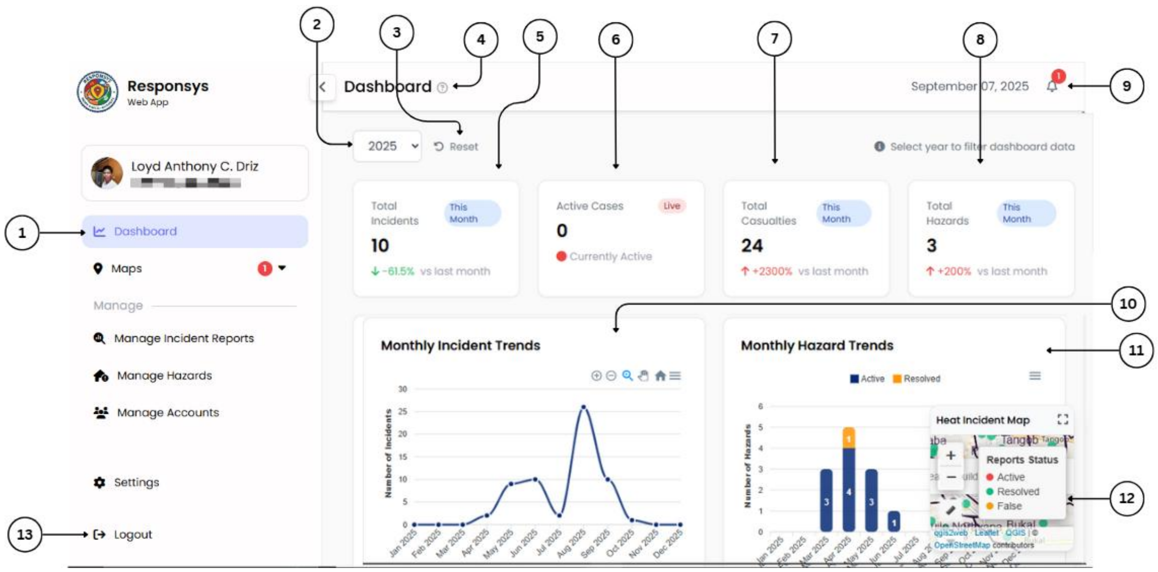

Figure 27. Dashboard

1 – Dashboard Button

2 – Filter by Year

3 – Reset

4 – Onboarding Guide

5 – Total Incidents

6 – Active Cases

7 – Total Casualties

8 – Total Hazards

9 – Show Notifications

10 – Monthly Incident Trends

11 – Monthly Hazards Trends

12 – Enlarge the Heat Map

13 – Logout

Figure 28 displays the dashboard distribution charts, which include incident types (14) and hazard types (15). These charts will allow the MDRRMO to identify the most common types of incidents and hazards faster and allocate resources, enhance preparedness, and take specific action in the more vulnerable areas.

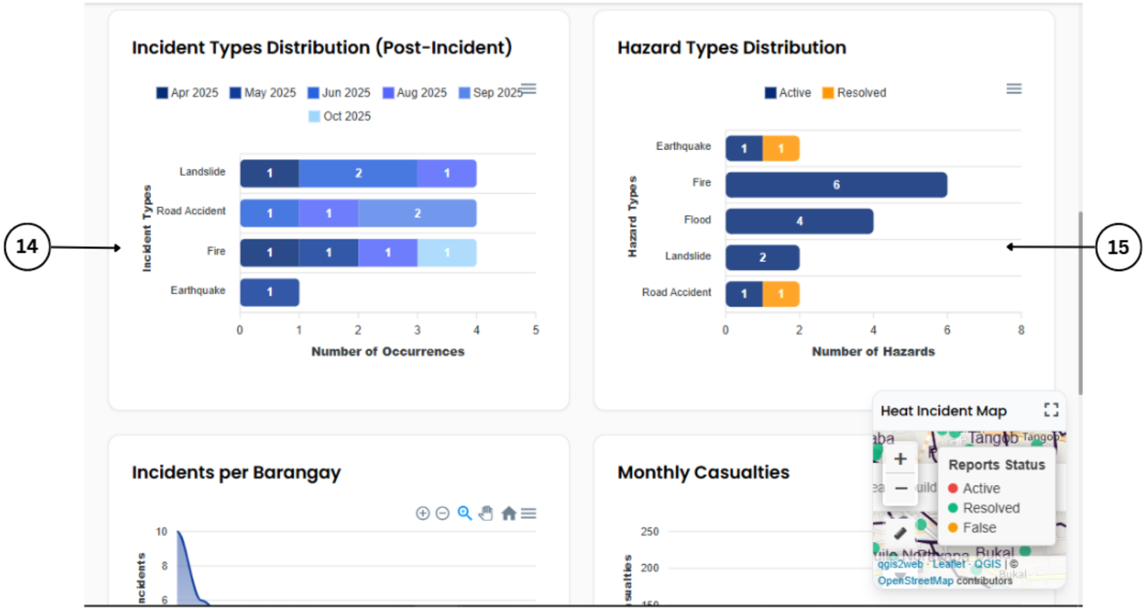

Figure 28. Dashboard Distribution Charts

14 – Incident Types Distribution

15 – Hazard Types Distribution

As shown in Figure 29, there is the dashboard location chart that shows the number of incidents occurrences per barangay (16) and a summary of the monthly casualties (17) to assist the MDRRMO to identify the most affected regions and plan resources and response efforts accordingly.

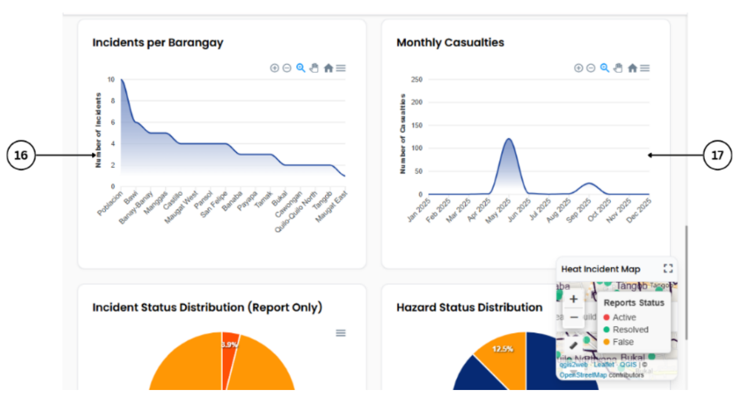

Figure 29. Dashboard Location and Casualties Charts

16 – Incidents per Barangay

17 – Monthly Casualties

Figure 30 presents the status of reports (18), which reports are active, false, or resolved, and the status of hazards, which are false or resolved (19). This helps the MDRRMO to track the current cases, the issues that have been resolved, and the necessary follow-ups.

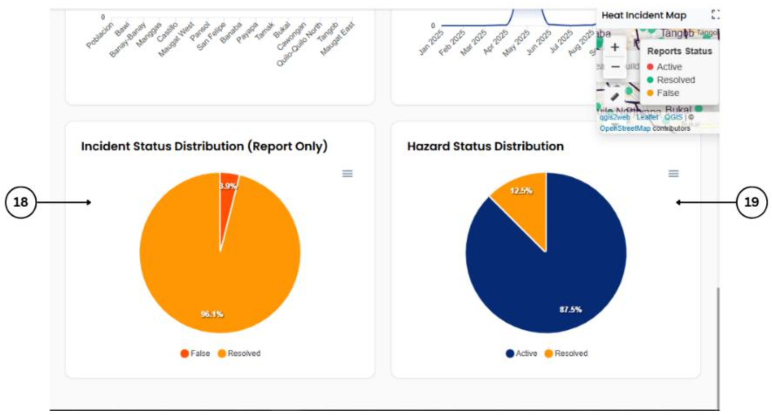

Figure 30. Dashboard Status Distribution Charts

18 – Incident Status Distribution

19 – Hazard Status Distribution

4.3.3 Ensuring Data Security and Backup Mechanisms

The subsection covers the security and backup solutions of ResponSys, where efforts have been made to secure and safeguard the data of the area of disaster. The last section of the system development dealt with the security and the safety of all disaster-related data in ResponSys. Since the system handles sensitive data, such as incident reports, hazard records, and user accounts, the researchers prioritize highly secure measures and backup systems on the list of priorities. These measures were necessary to maintain the integrity of the information as well as to have the system available at all times in case of technical failure or unauthorized access.

In order to mitigate the possible threats of unauthorized access, accidental loss, or system failure, the researchers adopted role-based access control (RBAC) system that allows every user only to perform actions authorized by the assigned role. Therefore, citizens had the right to submit and update their reports, but only MDRRMO personnel had the right to check and update, and keep records. This organization assisted in preserving confidentiality and access to important data to authorized personnel.

Moreover, the encryption protocols were employed during submission and retrieval of reports so that data transmission could not be intercepted. The researchers have also introduced authentication and input validation measures to avert majority of the security
81 attacks, such as cross-site scripting and injection attacks. All these steps assisted in securing the system against both external and internal threats, as well as supporting the safety of disaster-related data, and the reduction of risks such as unauthorized access, accidental loss of data, and disruptions in services.

In addition, as an integrity measure, the system was configured to have an automated back-up system that regularly produces copies of the database and files. All these backups
10 were stored in safe locations to ensure that the data could be restored in the case of accidental failure or corruption. During testing, the backup and restoration processes were

implemented successfully, which proves the system is capable of supporting credible backup and restoration of disaster-related data. This stage proved that ResponSys helps to sustain operations, allowing MDRRMO staff to have a platform to store, administer, and retrieve data related to disasters.

Following this security setup, Figures 31-32 identify the defensive and backup measures of the system. Figure 31 presents the unauthorized-access page, which contains one control button (1) that enables the user to go back to the Login. The automated daily backup procedure is shown in Figure 32, with its available actions like, Files Backup (1), Database Backup (2), Restore Files (3), and Download Files (4) so that administrators may handle and restore system data when required.

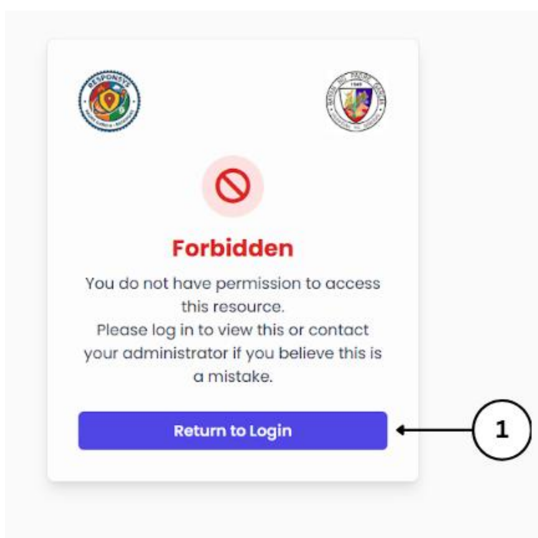

Figure 31. Sample Access-Denied Page for Unauthorized Requests

1 – Return to Login

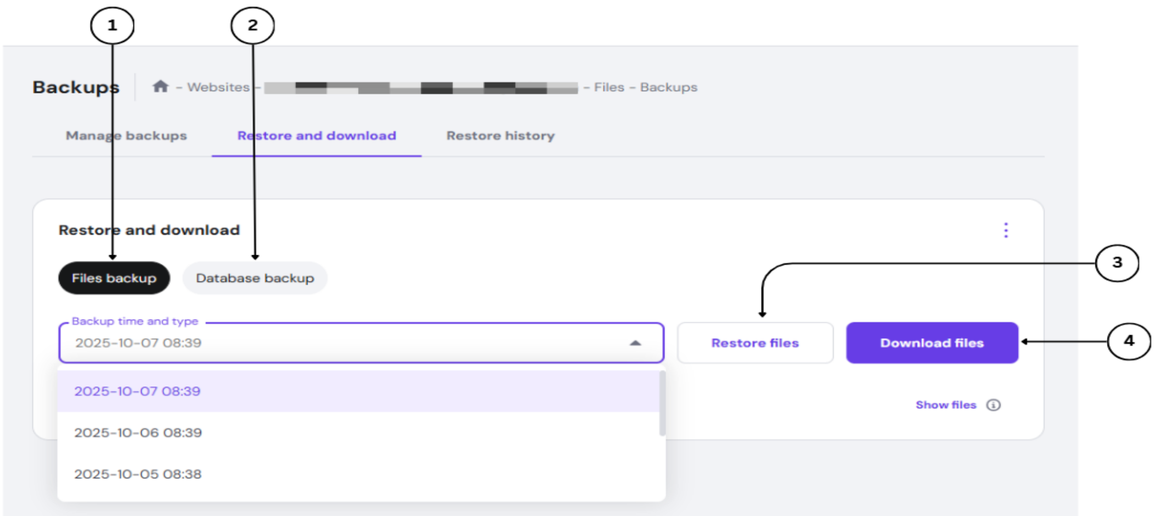

Figure 32. Sample Daily Backup Process in the Hosting Environment

1 – Files Backup

2 – Database Backup

3 – Restore Files

4 – Download Files

These backup system and security mechanisms complement the centralized database and analytics features, which ensures that the information used to report, map and make decisions is accurate, reliable, and secure at all times.

System Evaluation

The system assessment of ResponSys was performed to determine the general performance of system, usability, and deployment readiness. This assessment was carried out using User Acceptance Testing (UAT) and developer-based functions to establish whether the system is in compliance with ISO/IEC 25010 standards and whether it is appropriate to meet the operation needs of the MDRRMO and community residents. The

UAT was conducted on fifteen (15) respondents who provided their feedback on some of the most important quality features (functionality, usability, reliability and security).

The findings indicated that the rating of all criteria was very high with a weighted mean of 4.78, which is interpreted as Strongly Agree. Users indicated that the system is effective, user-friendly, and responsive when in actual use. The characteristics of incident reporting, real-time visualization of hazards, and precise data retrieval were reported to be of high value when it comes to supporting the disaster response operations. These improvements directly respond to the challenges identified in Chapter 1, particularly the issues of decentralized incident data and static hazard mapping, by providing a centralized and dynamic platform for disaster-related information. Both residents and MDRRMO staff noted that ResponSys has greatly improved their current manual procedures as well as local preparedness.

In parallel with UAT, the developers implemented technical testing, which consisted of unit testing, integration testing, and system testing, so that all the modules were stable and working correctly. The system proved to be reliable, well-integrated in terms of modules, and effective in performing its fundamental features. In general, the assessment findings have proved ResponSys to be working, reliable, and capable of being implemented in the Municipality of Padre Garcia.

User Acceptance Testing (UAT)

A User Acceptance Testing (UAT) survey was administered to fifteen (15) respondents, comprising four (4) MDRRMO staff and eleven (11) community citizens. These participants included administrative users who would handle the incident management and the general users who would use the system to report and access hazard information. The survey was checked to make sure that it was clear and relevant, and the results were interpreted with the help of the 5-point Likert scale, which is outlined in Chapter 3. The UAT served as a crucial mechanism for getting feedback that allowed the developers to recognize the strengths and areas for improvement. The assessment tool was designed according to ISO/IEC 25010 software quality characteristics and was aligned to the non-functional requirements stated in Chapter 3.

Using a 5-point Likert scale, responses were interpreted using a weighted mean range with the range of 4.50-5.00 indicating Strongly Agree. The overall results showed that the residents and staff members of the MDRRMO were quite sure that ResponSys met the expectations in the aspects of usability, operational performance, and the accuracy of information. The system was perceived to be effective, secure, and easy to use because it offered the necessary functionalities to help in disaster preparedness and planning.

Respondents commended the system in terms of easy-to-use interface, quick reporting of an incident, solid processing of the data, and real-time display of the hazards. These qualities were regarded as highly useful especially to local emergency operations. Particularly, the hazard map, a combination of QGIS with Leaflet.js, was positively reviewed as a tool to increase the awareness of the users about risk-prone zones and the better situational comprehension. This is in line with the associated studies analyzed in

Chapter 2, which highlight the importance of intuitive and visually informative interfaces in disaster risk reduction and management systems.

The calculated overall mean of 4.78 verifies that ResponSys is in compliance with ISO/IEC 25010 standards of software quality. This implies that the system satisfies the desired software quality features, functional suitability, performance efficiency, reliability, usability, security, maintainability, compatibility, and portability, which informed the design of the non-functional requirements in Chapter 3. The findings of each quality feature are given in the tables as follows.

Table 9

Summary of User Acceptance Testing (UAT) Results for ResponSys

Software Quality Characteristic (ISO/IEC 25010)	Mean Score	Verbal Interpretation
Functional Suitability	4.80	Strongly Agree
Performance Efficiency	4.71	Strongly Agree
Compatibility	4.82	Strongly Agree
Usability	4.89	Strongly Agree
Reliability	4.62	Strongly Agree
Security	4.88	Strongly Agree
Maintainability	4.60	Strongly Agree
Portability	4.91	Strongly Agree
Computed Mean	4.78	Strongly Agree

The User Acceptance Testing (UAT) results indicate that ResponSys has conformed to the ISO/IEC 25010 model of quality requirements of software. The overall weighted average of 4.78 indicates that both the MDRRMO and the community users highly agree that the system is functional and user-friendly. Of the considered criteria, portability scored the highest mean (4.91), indicating a high level of users satisfaction with the system functionality to work with various platforms and devices. The findings confirm the system is effective, enhances safe data management, and it can be applied to all barangays of Padre Garcia. Despite the fact that reliability (4.62) and maintainability (4.60) criteria received slightly lower mean scores than the other criteria, both of them were still seen as Strongly Agree, which means that the specified areas are also decent but leave room to further improve the system.

After establishing the overall system performance within the context of the ISO/IEC 25010 quality characteristics, the analysis proceeded with a further breakdown of all the criteria. The purpose of this dissection was to determine the degree of effectiveness of the system to respond to the attributes of the chosen specific features with respect to the functional suitability, performance, compatibility, usability, reliability, security, maintainability, and portability. The table presenting the findings of each criteria commences with Table 10, which gives the details of responses of the first group of indicators.

Table 10 summarizes the output of the system evaluation upon the basis of the functionality criteria. The general performance of the developed system obtained a rating of 4.80, equivalent to strongly agree rating. The weighted averages of each criterion are as follows, 4.87 in the first criterion, 4.80 in the second criterion, 4.73 in the third criterion, 4.80 in the fourth criterion, 4.80 in the fifth criterion, and in the sixth criterion, 4.87. These findings show that the developed system was able to achieve its intended goals. The collected outcomes of the questionnaire to the users were valuable in assisting the developers to ascertain the success and efficiency of the system in accessing the modules.

Table 10.

Summary of User Acceptance Testing (UAT) Results for ResponSys in Terms of Functionality

Functionality	Weighted Mean	Verbal Interpretation
1. ResponSys provides the necessary features for incident reporting and hazard mapping.	4.87	Strongly Agree
2. User features (reporting, hazard viewing, FAQs, hotlines) operate correctly.	4.80	Strongly Agree
3. Admin features (login, dashboard, report validation, account management) operate correctly.	4.73	Strongly Agree
4. Input processing and outputs (reports, exports) are accurate.	4.80	Strongly Agree
5. Role-based access and permissions work as intended.	4.80	Strongly Agree
6. Report generation and export produce correct summaries.	4.87	Strongly Agree
Computed Mean	4.80	Strongly Agree

The findings indicate that the users highly agree that ResponSys provides all functional elements needed in incident management and hazard mapping system. Incident reporting, role-based access, input/output accuracy, and report generation are rated high, which means that the citizen and admin modules are functioning properly. This is a direct response to the reliance on manual logbooks, dispersed Excel files, and static hazard maps, identified in Chapter 1, by ensuring that core functional modules are now a complete digital system.

The scores have consistently been high, and this is a testament to the trust of the users in the reliability of the system to perform actual disaster-related tasks. Overall, the functionality outcomes suggest that the system is actually performing to achieve the intended operational objective.

Table 11 is a summary of the system evaluation of the system in terms of performance criteria. The total performance of the developed system scored 4.71, which is strongly agree rating. The weighted average of the criteria are as follows: 4.73 in the first criterion, 4.67 in the second criterion, 4.73 in the third criterion, 4.80 in the fourth criterion, and 4.60 in the fifth criterion. These findings show that the developed system was able to achieve its intended goals. The collected outcomes of the questionnaire to the users were valuable in assisting the developers to ascertain the success and efficiency of the system in accessing the modules.

Table 11.

Summary of User Acceptance Testing (UAT) Results for ResponSys in Terms of Performance

Performance	Weighted Mean	Verbal Interpretation
1. Pages and maps load quickly during navigation.	4.73	Strongly Agree
2. Incident report submission responds promptly.	4.67	Strongly Agree
3. Map interactions (layer loading, zoom, search) are responsive.	4.73	Strongly Agree
4. The system remains responsive during repeated use.	4.80	Strongly Agree
5. The system performs reliably with multiple users	4.60	Strongly Agree

Computed Mean	4.71	Strongly Agree

The system scored a high rating of strongly agree on all the performance indicators implying that users were satisfied with how ResponSys was fast and responsive despite frequent usage. The loading of the page, the interaction in the map, and the submission of the incident were always reviewed as efficient and smooth. Despite the lowest score (4.60) in multi-user performance, this scores is high in terms of satisfaction. This justifies the need to have access to incident information in time as was mentioned in Chapter 1 where delays in manual reporting were observed to impede disaster response. These results imply that the system is capable of performing at an acceptable level of speed and reliability on its usual user demands.

Table 12 is a summary of the results of the system evaluation according to the compatibility criteria. The overall compatibility of the developed system scored 4.82, which is a strongly agree rating. The weighted average scores of the three criteria are as follows: 4.93 in the first criterion, 4.87 in the second criterion, and 4.67 in the third criterion. These findings show that the developed system was able to achieve its intended goals. The collected outcomes of the questionnaire to the users were valuable in assisting the developers to ascertain the success and efficiency of the system in accessing the modules.

Table 12.

4

Summary of User Acceptance Testing (UAT) Results for ResponSys in Terms of Compatibility

Compatibility	Weighted Mean	Verbal Interpretation
1. ResponSys runs consistently across desktop, laptop, and mobile.	4.93	Strongly Agree
2. The system works well on modern browsers (Chrome, Firefox, Edge).	4.87	Strongly Agree
3. Integration between reporting, mapping, and database modules is seamless.	4.67	Strongly Agree
Computed Mean	4.82	Strongly Agree

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These compatibility results show that there is a high degree of compatibility particularly cross-device compatibility and multi-browser compatibility. The respondents mentioned that ResponSys could be used on desktop, laptop, and mobile platforms without any major differences in functionality. Good ratings also assure the interconnection between modules such as reporting, mapping, and database operations. This corresponds to Chapters 2 and 3 which concern web-based GIS applications in interactive mapping of hazards and system integration across modules and devices. These findings imply that the system is consistent across platforms and environments.

The outcomes of the system evaluation according to the usability criteria are summarized in table 13. The general usability of the developed system scored 4.89 which can be rated as strongly agree. The weighted averages of the each of the criteria are as follows: the first criterion has a weighted average of 5.00, second criterion has a weighted

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verage of 4.93, third criterion has a weighted average of 4.87, fourth criterion has weighted average of 4.80 and fifth criterion has weighted average of 4.87. These findings show that the system that was developed achieved its planned purposes. The collected outcomes of the questionnaire to the users assisted the developers in assessing the effectiveness and efficiency of the system in accessing the modules.

Table 13.

Summary of User Acceptance Testing (UAT) Results for ResponSys in Terms of Usability

Usability	Weighted Mean	Verbal Interpretation
1. The interface is intuitive and easy to navigate.	5.00	Strongly Agree
2. First-time users can perform tasks without technical assistance.	4.93	Strongly Agree
3. System messages and feedback are clear and helpful.	4.87	Strongly Agree
4. The design is consistent and visually clear.	4.80	Strongly Agree
5. Accessibility is considered for various user types.	4.87	Strongly Agree
Computed Mean	4.89	Strongly Agree

The usability rating was the highest on all categories and it indicates that the interface is user friendly and easy to navigate. The ease of use scored the highest (5.00) indicating that even the individuals who were using the system on the first time could not find much trouble with it. The system feedback, clarity, and design scores are always above average, which means that the platform is an easy and cozy experience. The findings confirm that the system design aims at accessibility and user satisfaction as stipulated in non functional requirements of usability.

Table 14 summarizes the results of the system evaluation based on the reliability criteria. The overall reliability of the developed system achieved a score of 4.62, which corresponds to a strongly agree rating. The weighted means for each criterion are as follows: 4.67 for the first criterion, 4.67 for the second criterion, 4.60 for the third criterion, and 4.53 for the fourth criterion. These results indicate that the developed system successfully met its intended objectives. The gathered results of the questionnaire for users helped the developers determine the effectiveness and success of the system in accessing the modules.

Table 14.

Summary of User Acceptance Testing (UAT) Results for ResponSys in Terms of Reliability

Reliability	Weighted Mean	Verbal Interpretation
1. The system runs without crashes or freezes.	4.67	Strongly Agree
2. Data submitted is reliably stored and retrievable.	4.67	Strongly Agree
3. The system can recover from minor issues.	4.60	Strongly Agree
4. Backup and recovery mechanisms function as intended.	4.53	Strongly Agree
Computed Mean	4.62	Strongly Agree

Users expressed that ResponSys is highly reliable to use, and no major crashes or system failures have occurred. With high data storage and retrieval scores, it is affirmative that the integrity of the information in the system is preserved. Despite the fact that recovery of minor issues was rated lowest (4.60), it was still a sign of functional reliability. Overall, the results suggest that the system can operate in a consistent way with no impact on performance or data, which represents the Chapter 3 architecture of data retrieval in real-time and centralized database management.

97 Table 15 provides a summary of the system analysis in terms of the security criteria. The general security of the developed system scored 4.88, and that is strongly agree. The weighted average of the mean of each criterion is as follows: 4.93 in the first criterion, 4.80 in the second criterion, 4.87 in the third criterion, and 4.93 in the fourth criterion. These findings show that the system that was developed achieved its planned purposes. The collected outcomes of the questionnaire to the users assisted the developers in assessing the effectiveness and efficiency of the system in accessing the modules.

Table 15.

Summary of User Acceptance Testing (UAT) Results for ResponSys in Terms of Security

Security	Weighted Mean	Verbal Interpretation
1. Only authorized users can access specific features.	4.93	Strongly Agree
2. Sensitive data is handled and stored securely.	4.80	Strongly Agree
3. The system prevents unauthorized actions.	4.87	Strongly Agree

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4. Login and session management work properly.	4.93	Strongly Agree
Computed Mean	4.88	Strongly Agree

Security results indicate high confidence in the system protection measures and this especially on authorization and session management where they score 4.93. The system was reportedly efficient by users in averting unauthorized activities and making sure that sensitive information is not lost. The score of 4.80 on the data handling is rather low but still very good meaning that there are several aspects that can be fine-tuned, and yet it is in the strong satisfaction domain. The findings verify high security with regard to the management of sensitive information, which is in line with the Chapter 3 design of role-based access control, secure authentication, and data encryption.

Table 16 shows the outcome of the system assessment in relation to the maintainability criteria. The general maintainability attained by the developed system was 4.60 marking strongly agree rating. The weighted averages of each criterion are as follows: 4.73 of the first criterion, 4.53 of the second criterion, 4.60 of the third criterion and 4.53 of the fourth criterion. These findings show that the system developed was able to achieve its intended purposes. The compiled findings of the questionnaire to users assisted the

38 developers ascertain the efficiency and effectiveness of the system to access the modules.

Table 16.

Summary of User Acceptance Testing (UAT) Results for ResponSys in Terms of Maintainability

Maintainability	Weighted Mean	Verbal Interpretation
1. The system is modular and easy to modify.	4.73	Strongly Agree
2. Codebase and documentation support long-term maintenance.	4.53	Strongly Agree
3. System updates do not disrupt existing features.	4.60	Strongly Agree
4. Database maintenance and scaling are feasible.	4.53	Strongly Agree
Computed Mean	4.60	Strongly Agree

The ratings of maintainability were very high, indicating that the system was perceived by the users and developers as viable to update and modify it. Modularity of the system and the availability of documentation facilitate the ease in long-term maintenance. Though the scaling of databases and documentation is slightly reduced (4.53), it is at the strong agreement area. These findings are in line with the Agile system and modular design in Chapter 3, which allows efficient updates and modifications without interfering with current functions. Generally, the results confirm that ResponSys is designed in such a way that it can be maintained and improved in the future.

Table 17 is the summary of the system evaluation in terms of the portability criteria. The overall portability of the developed system achieved a score of 4.91, which corresponds to a strongly agree rating. The weighted means for each criterion are as follows: 4.93 for the first criterion, 4.93 for the second criterion, and 4.87 for the third criterion. These results indicate that the developed system successfully met its intended objectives. The gathered results of the questionnaire for users helped the developers determine the effectiveness and success of the system in accessing the modules.

Table 17.

Summary of User Acceptance Testing (UAT) Results for ResponSys in Terms of Portability

Compatibility	Weighted Mean	Verbal Interpretation
1. The system runs smoothly across different networks (Wi-Fi, mobile data).	4.93	Strongly Agree
2. The system adapts well to different browsers and devices.	4.93	Strongly Agree
3. The system could be deployed in other LGUs or municipalities with minimal changes.	4.87	Strongly Agree
Computed Mean	4.91	Strongly Agree

The portability results are also the highest in all categories, which means that ResponSys works well under any type of network, as well as any type of device. Users highly concurred that the system is compatible across various browsers and device environments. A rating of 4.87 on the ease of deployment in other LGUs is a good indication that it can be more broadly adopted by municipalities. This indicates the cross-platform, web-based nature of the design mentioned in Chapter 3 that allows ResponSys to be implemented in various platforms and environments with only slight modifications. Overall, the findings confirm the fact that the system is dynamic and can be implemented into different environments.

Developer Evaluation

Along with the collection of user feedback during UAT, the developers conducted a thorough technical assessment of ResponSys to assure the stability and accuracy of the system prior to implementation. The testing was based on three key areas such as the User Module Testing, Admin Module Testing, and System Testing. The end-user test revealed that the fundamental features of the site, including landing page, navigation of the hazard map, and reporting incident, worked well, and all the required interactions worked as anticipated.

The testing on the administrator side confirmed that MDRRMO staff were able to consistently control incident reports, hazard layers, account records and system settings. The core backend tasks like filtering, updating statuses, creating reports, and restoring archives worked on the correct and consistent bases, which shows that the administrative tools are functional and can be used in the real-life environment.

System Testing examined overall behavior including access control, data integrity, hosting stability, and performance across devices and browsers. While free hosting resulted in database connectivity issues, migrating to a stable hosting environment resolved these problems, and all remaining system-level tests passed. Overall, developer evaluation confirms that ResponSys is technically sound, functionally complete, and capable of supporting actual emergency response operations. The following tables summarize the major results of the developer-performed test cases.

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Table 18 shows the outcome of the user-side test cases carried out to test the core citizen functionalities of ResponSys. It puts emphasis on whether the key interactions like page landing, incident reports, and navigation on the hazard map work as intended.

Table 18.

Summary of the Test Case for the Users

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Test Case ID	Test Scenario	Expected Result	Actual Result	Status
US-001	Access Landing Page	Landing page loads with Report Incident, Hazard Map, Hotlines, FAQ	Landing page displayed correctly	5/5 = 100% Passed
US-002	Location Button	Map centers to user location	Map centered correctly	5/5 = 100% Passed
US-003	Open Incident Report Form	Incident form appears upon clicking map	Form displayed correctly	5/5 = 100% Passed
US-004	Submit Incident Report	Report is submitted and appears in dashboard	Report submitted successfully	5/5 = 100% Passed
US-005	Search Hazard Map	Map displays searched location	Search displayed correctly	5/5 = 100% Passed
US-006	View Hotlines	Hotlines list displayed	Hotlines displayed successfully	5/5 = 100% Passed
US-007	View FAQs	FAQs and answers displayed	FAQs displayed successfully	5/5 = 100% Passed

The outcome of the user testing indicates that all the functions that were tested by the citizens worked perfectly with a 100 percent success rate. There was no issue with

29 navigation, submitting a form, or interacting with the maps. This proves the fact that the system offers a smooth and user-friendly experience to citizens.

Table 19 summarizes administrative functionalities evaluation in ResponSys. It demonstrates the ability of MDRRMO staff to handle essential tasks including incident report management, hazard data management and user accounts appropriately.

Table 19.

Summary of the Test Case for the Admin

10

Test Case ID	Test Scenario	Expected Result	Actual Result	Status
AD-001	Admin Login (Valid/Invalid)	Correct authentication with proper error handling	All login conditions verified	5/5 = 100% Passed
AD-002	Filter Incident Reports	Incident records update based on applied filters	Filters worked correctly	5/5 = 100% Passed
AD-003	Update Incident Report Status	Status updates and reflects in dashboard	Status updated successfully	5/5 = 100% Passed
AD-004	Create Post-Incident Record	Post-incident record is created and stored	Record created successfully	5/5 = 100% Passed
AD-005	Filter Hazard Records	Hazard list updates according to type/status	Filters applied successfully	5/5 = 100% Passed
AD-006	Update Hazard Status	Hazard status changes and saves correctly	Status updated successfully	5/5 = 100% Passed
AD-007	Create New Account	New unique account is created; duplicates blocked	Account creation validated	5/5 = 100% Passed

AD-008	Update User Role/Status	Role or status changes reflect correctly	Role/Status updated successfully	5/5 = 100% Passed
AD-009	Restore Archived Record	Archived data restored to active list	Restoration successful	5/5 = 100% Passed

The results demonstrate that all administrative functions are operative, and that all test cases were passed. It helps administrators to effectively control reports, accounts, and hazard information, thus efficiency in operations of MDRRMO. The backend system also exhibits strong robustness and consistency across all the scenarios tested.

Table 20 shows the results of overall system testing that assures end-to-end functionality, data integrity, access control, and stability of hosting. The table points out the ability of ResponSys to operate with various users, as well as, operate on a variety of browsers and environments.

Table 20.

Summary of the Test Case for the System Testing

Test Case ID	Test Scenario	Expected Result	Actual Result	Status
SYS-001	Citizen Access Restriction	Citizens cannot access admin modules	Access blocked successfully	5/5 = 100% Passed
SYS-002	Admin Access Verification	Admin can access all modules	Full access verified	5/5 = 100% Passed
SYS-003	Data Storage & Retrieval	Submitted reports should appear in dashboard	Data stored and retrieved correctly	5/5 = 100% Passed

SYS-004	Data Integrity Check	Database values match submitted inputs	Data integrity maintained	5/5 = 100% Passed
SYS-005	Hostinger Deployment	Stable performance with no disconnections	Hosting stable	5/5 = 100% Passed
SYS-006	Cross-Browser Compatibility	System works on Chrome, Firefox, Edge	All browsers worked correctly	5/5 = 100% Passed
SYS-007	Concurrent Users	System handles multiple simultaneous actions	System stable under load	5/5 = 100% Passed

The system testing ensures that ResponSys can be trusted to be able to work under real-world conditions to guarantee that it has been able to maintain the integrity of the data, access controls, and performance across the browsers. Moving to Hostinger improved the connectivity problems that had occurred previously and made it stable. In general, the system is operational, responsive, and deployable.

3

5 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter will give the summary of the study, conclusions that are brought about by the findings and recommendations to improve in the future. The summary contains the goals, procedures, and findings of the research, and the conclusions show information on how the system resolved the problems revealed. Lastly, recommendations are provided
42 with practical recommendations on how the system can be improved and future research
46 concerning disaster risk reduction and management.

5.1 Summary of Findings

110 9

The study developed ResponSys, a web-based system of incident management with hazard mapping, to the Municipal Disaster Risk Reduction and Management Office (MDRRMO) of Padre Garcia. Its key objective was to enhance efficiency in reporting of incidents, visualization of hazards and data management of disaster-related information. This system was developed with the necessity to have a more solid and available platform that will enhance disaster preparedness and facilitate emergency planning and management throughout the municipality. The key results after the development and testing of the project were as follows:

1. The system that was developed gave an effective and easy to use interface that allowed the user to effectively execute tasks associated with incident reporting, data monitoring, and visualization of hazards.

   1.1 MDRRMO staff could handle incident reports, check data and live track on the current emergencies.

   1.2 Community users could be able to post incident reports correctly, which facilitated response faster and enhanced coordination.

   1.3 Report generation feature was able to auto-generate formatted and detailed incident summaries and reduced the use of manual documentation and human error.

2. The incorporation of Geographic Information System (GIS) technology using QGIS offered a proper and precise illustration of areas with the likelihood of hazards in the municipality.

2.1 Flood-prone and landslide-prone areas and other risk areas were mapped, which contributed to the improvement of the disaster preparedness and situational awareness.

2.2 The supported visualization enhanced future planning and data-driven decision-making on disaster response.

2.3 The maps were capable of interaction with users who would plot new incidences to enable them to organize and investigate the hazard information effectively.

3. It was effective to save and organize the incident, user, and hazard data in the centralized database of the system to provide the accuracy, consistency, and data security.

3.1 The reliability of data retrieval and updating was tested using the functional testing and the integration testing.

3.2 An organized study of past and real-time data enabled MDRRMO staff to determine trends, make sound decisions on disaster response and allocate resources in the best way.

3.3 Backup and storage features ensured that there was integrity in data throughout the operation of the system.

Based on the User Acceptance Testing (overall mean rating of 4.78 out of 5), MDRRMO employees, along with selected citizens, rated the system as very functional, usable, and reliable. They claimed that ResponSys contributed to the increase of communication and information flow between citizens and responders greatly, which consequently provided a possibility of reporting within a shorter time frame and efficiently verifying the incident. Another aspect noted by the respondents is that the system made daily operations smoother and the documentation process became simpler which eventually enhanced the general management of disasters in the town. Besides, the system proved not only to be stable and responsive on a variety of devices and browsers, but also the hosting environment under the Hostinger Business Plan also allowed transactions of real-time data flow, which, in turn, contributed to the effective management of incidents.

Overall, the results showed that the developed system achieved its objectives, because it provided a safe, scalable and efficient platform that enhanced coordination, disaster response, and community resilience within the municipality of Padre Garcia.

5.2 Conclusions

The conclusions are related to the aforementioned issues of decentralized incident reporting, fixed hazard maps, and challenges in retrieving information in MDRRMO Padre Garcia by offering a centralized, GIS-powered platform that will improve situational awareness, coordination, and data-driven disaster planning.

3 The research findings show that the implementation of a web-based incident management system can be useful in improving the operational efficiency and the capability of Padre Garcia MDRRMO in addressing disaster incidents. The substitution of these manual logbooks and fixed hazard maps with a centralized and real time digital platform is a viable way of streamlining operations, enhancing coordination and bolstering situational awareness in times of emergencies. GIS tools also lead to the proactive planning

of DRRM as the personnel are also able to find the areas at risk and place the resources more strategically. Altogether, the findings prove that digital solutions like ResponSys can improve the efficiency and resilience of DRRM activities carried out by municipalities and help communities be prepared.

Therefore, the following were goals attained:

1. The researchers made the conclusion that user-friendly web-based system is a viable and efficient method to municipal DRRM offices. As ResponSys has shown, the work of MDRRMO can be transformed as it will be possible to transition to a multifaceted digital platform without experiencing the loss of any functionality, which will allow to log many incidents faster and respond much more efficiently.

1.1 The system was able to facilitate real time incident reporting and data retrieval enabling the MDRRMO personnel as well as the citizens to write and retrieve reports instantly, enhancing coordination and effectiveness of response in written form.

1.2 ResponSys had secure and role-based access to the personnel of MDRRMO, giving administrative functions protection and allowing citizens to report incidents and see hazard maps, which does not interfere with operational security but makes the system usable.

1.3 Each platform included incident data report and summary generation tools, post-disaster analysis, tracking trends and evidence-informed decision-making, thereby offering a more substantial basis to plan and allocate resources, but long-term performance needs to be reevaluated.

2. The authors came to the conclusion that risk assessment could be enhanced significantly by using GIS in hazard mapping and disaster preparedness. The ResponSys has been used to enable the MDRRMO staff to dynamically visualize hazard-prone areas and prioritize resources in response to constraints of the traditional hazard maps.

2.1 Hazard mapping with the QGIS gave visual images of the areas at risk of disasters to enable the personnel understand the areas at risk better and how to intervene.

2.2 Stratified visualization of hazards, including floods, earthquakes, and fires, enabled various risk evaluation and sound decision-making in various disaster events.

2.3 The interactive GIS tools enabled the users to navigate hazard maps, add new incidents, and evaluate risks, and in the framework of the tested capabilities of the system, it assisted in enhancing situational awareness and preparedness.

3. The researchers came to the conclusion that a centralized database can offer a systematic and safe method of data storage and analysis in case of disasters. This allowed the MDRRMO staff to be more confident in accessing and reviewing records to support informed decision-making and overcome the challenges of the past whereby logbooks were scattered and records were not kept consistently.

3.1 Incident reports, hazard information and response records were stored in a secure and structured format in the centralized database, which facilitated the ability to manage data in a consistent manner.

3.2 Significant analysis of past and present-day data enabled the personnel to detect trends, make informed decisions in the event of disaster management and better resource allocation.

3.3 Data security and backup mechanisms Over records were safeguarded against any loss and sensitive information was safeguarded securely giving the continuity of operation reliable basis.

In general, this study validates that the combination of the web-based incident management and the GIS-enabled hazard mapping and centralized and secure database is a feasible solution to MDRRMO Padre Garcia. One such model that can be replicated by other local government units in attempts to modernize on disaster information systems and enhance their operational efficiency is ResponSys.

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5.3 Recommendations

Based on the findings and the conclusions of the research, a number of recommendations are offered that can help to further develop ResponSys and to educate future scholars in order to improve disaster management systems.

1. For MDRRMO and the Local Government Unit:

    1.1 Given that ResponSys is already restricted to a few MDRRMO staff, it is advisable to officially accept the system to be regularly used and train or give capacity-building to the staff and barangay focal persons.

1.2 It is advisable to move ResponSys to a more formidable institutional or cloud-based server system since the present hosting environment is weak, which will improve system stability, expand user access, and operational continuity.

2. For Future Developers:

2.1 Considering that ResponSys is only compatible with desktop/web browsers, it will be advisable to develop a special mobile application that will enable them to report and see the hazard map on their mobile phones, though it is clear that some of the functions might not be as efficient when used on smaller screens.

2.2 To address the limitation that the external data sources are not presently connected to the system, the system should be connected to automated weather stations, IoT sensors, or live hazard detection APIs to enrich the information about the environment within the system.

2.3 Since ResponSys currently limits access to MDRRMO personnel, it is recommended to establish controlled role-based access for additional users such as emergency responders, ensuring data security while enabling functionality.

3. For Future Researchers:

3.1 In realizing that the current GIS integration presents easy visualization of hazards, it is recommended to consider more advanced GIS applications such as spatial analysis, terrain modeling and predictive simulation which can be applied to support planning process and visualization.

45 3.2 Because the system can only give descriptive analytics, it is advised that future studies should explore the integration of predictive analytics or early warning indicators.

To summarize, ResponSys offered a powerful web-based tool to handle disaster-related cases and assist with the work of MDRRMO. Its current restrictions can be also addressed in order to increase its usefulness and contribution to local disaster management efforts.