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Optimizing Disaster Management with Blockchain Technology: A Decision Support System for Disaster Risk Reduction and Management

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ABSTRACT

As technology advances, the enhancement and development of disaster-related remains limited, and disaster management at the regional level is prompt to actively collect and deliver information at a fast pace while deriving comprehensive disaster insights in real time. However, many organizations still rely on manual reporting as it requires formatting, sorting and proofreading that leads to time consuming, data duplication and delays in decision-making and inefficiencies due to lack of appropriate tools to enhance the organization's productivity. To address these challenges, the researcher developed a Decision Support System with blockchain technology for Disaster Risk Reduction Management for the Office of the Office of Civil Defense Cordillera Administrative Region. This system standardized disaster risk management system and enables for regional agencies to deliver efficiently in near real-time scenario. Additionally, it facilitates streamlined analysis and secure data storage, allowing duty officers to visualize the current situation more effectively. Future researchers can further enhance the system's functionality by adding recommended features such as AI monitoring and notification, import and export of situational reports from different line agencies, plotting of tropical cyclones related incidents, earthquake and fire incident monitoring.

Key words: Blockchain, Blockchain technology, decision support system, disaster, disaster management, disaster risk reduction and management, tropical cyclones

Abbreviations: FFR, False Rejection Ratio; DAA, Decimal Adjust Addition (Arial size 10 normal)

I.INTRODUCTION

The impact of disasters severely affects many people, results in deaths, destruction of infrastructure, and economy loss. This is evident from global statistics of Natural Disasters Data Book (2011) [1], which reflects that 39% of disasters occurred in Asia and 53% caused deaths worldwide. In response to this situation, extensive recovery efforts are required and this study aims to significant benefits to disaster management preparedness by establishing an interpreting disaster-related information before, during and after the disaster.

One of the disasters affecting the Philippines is tropical cyclones, also known as hurricanes or typhoons depending on the region, are among the most devastating natural hazards on the planet. Globally, they are responsible for significant economic damage, human casualties, and have caused long-term environmental impacts. Similarly, natural hazards such as earthquakes, volcanic eruptions, and landslides disrupts normal communities' functions, causing widespread damage and threats to both environment and human life which requires response to mitigate their effects. Subsequently, International Federation of Red Cross (2019) [2], defined disaster as a sudden calamitous event that seriously obstructs the community or society that causes human, material and environmental losses.

Not to mention, a report from the World Meteorological Organization (WMO) shared that tropical cyclones account a large portion of the world's annual economic losses due to natural disasters, often exceeding billions of dollars in damages each year (WMO, 2019) [10]. Moreover, cyclones have caused widespread displacements and contributed to the increasing vulnerability of coastal and low-lying areas (Cutter, 2020) [11].

Identically, the frequency and intensity of tropical cyclones are anticipated to increase due to climate change, leading to more severe impacts globally. This reflects in the study by Knutson et al. (2020) indicating that while the overall number of cyclones may decrease, the intensity of those that do occur is likely to increase, resulting in more Category 4 and 5 storms. These intense storms bring catastrophic winds, torrential rains, and storm surges that cause massive flooding, infrastructure damage, and loss of life.

Consequently, tropical cyclones pose a significant threat to communities worldwide, particularly in provinces like Benguet, where mountainous terrain and fluctuating weather patterns can aggravate their impacts. The optimizing disaster management with blockchain technology: a decision support system to DRRM aims to enhance disaster preparedness and response strategies by providing real-time data and analytics on tropical cyclone activities. Effective management of such natural hazards is crucial to mitigate their effects on infrastructure, agriculture, and the safety of residents.

With the increasing frequency and intensity of tropical cyclones attributed to climate change, there is an urgent need for systems that can facilitate timely decision-making and resource allocation. Previous studies have shown that implementing advanced information systems can significantly improve emergency response efforts. The DSS-DRRM leverages technology to integrate meteorological data, geographical information systems (GIS), and community resources to create a comprehensive platform for stakeholders involved in disaster management.

This study explores the development and implementation of the DSS-DRRM, examining its potential to provide valuable insights and facilitate collaboration among government agencies, local communities, and non-government organizations. By enhancing the capacity to respond to tropical cyclones, the DSS-DRRM contributes to building a more resilient Benguet, ultimately safeguarding lives and livelihoods.

In this regard, assessing the disaster mitigation is crucial as to enhance the disaster response at different levels, be able to identify strengths and weaknesses from economic and environmental perspectives and supporting effective disaster risk management and resource allocation (Cao et al., 2023, Shuai et al., 2023 [18], Zhang et al., 2021a, Zhang et al., 2021b) [13]. With a systematic analysis of disaster mitigation indicators, aids in determining the level of a regional disaster mitigation capacity including social, economic, institutional and infrastructure aspects (Thanvisitthpon et al., 2020 [14], Liu et al., 2022 [15], Cao et al., 2023 [13]). This is also reflected in several studies that provide an analysis of typhoon disaster mitigation in Hainan and Guangxi, China. Likewise, the developed evaluation index system manifests a significant change in disaster prevention, mitigation and rescue (Wang et al., 2022) [16].

Furthermore, according to the authors (Rafliana et al., 2022) [17], implementing effective post-disaster mitigation strategies will prevent further catastrophic consequences in the future. Understanding and evaluating existing mitigation measures provides valuable insights to protect communities against possible upcoming natural hazards.

With this in mind, international efforts to mitigate the impact of tropical cyclones have increasingly focused on disaster risk reduction and resilience-building. The Sendai Framework for Disaster Risk Reduction (2015–2030), adopted by the United Nations, emphasizes the importance of reducing disaster risks through improved governance, risk assessment, and community preparedness (UNDRR, 2019). This framework encourages countries to invest in early warning systems, infrastructure resilience, and disaster education as key strategies to reduce the vulnerability of populations to natural hazards (García et al., 2021). For example, sentinel Asia is one of the initiative satellite remote sensing to showcase the value and impact of Earth observation technologies including Web-GIS technology to assist in disaster management of the Asia-Pacific region (Kaku, 2019).

Comparatively, the 17 Sustainable Development Goals (SDGs) represent a universal call to action, urging nations worldwide, regardless of their economic status, to collaborate cohesively. Hence, The Benguet Tropical Cyclone Management Information System is determined to spur economic growth and monitoring of climate change to preserve our environment. By emphasizing disaster risk reduction for both natural and human-induced hazards, the approach seeks to strike a balance between the economic, social, and environmental aspects of sustainable development. Proactive management is encouraged over reactive management.

In like manner, the Philippines, under the government's efforts, has implemented several programs aimed at reducing the impact of disasters like tropical cyclones. For this reason, the Philippine Disaster Risk Reduction and Management Act of 2010 was established as a comprehensive framework for disaster management, focusing on preparedness, response, and recovery at all government levels (Alcayna et al., 2020) [4]. This act mandates local government units (LGUs) to develop disaster risk reduction plans, establish early warning systems, and allocate funds for disaster preparedness. Also, the application of IT in disaster management has been growing, with various innovations designed to address the country's unique vulnerabilities. Notably, the Flood Monitoring and Early Warning System (EWS) implemented by the Department of Science and Technology (DOST) is an example of how technology can be leveraged to reduce disaster risks (Castañeda & Perez, 2019) [6]. This system uses real-time data from weather stations and river monitoring equipment to predict floods and issue timely warnings to communities.

At the local level, community-based disaster risk reduction programs have been crucial in enhancing resilience in Benguet. These programs involve training residents in disaster preparedness, conducting evacuation drills, and developing localized early warning systems (Delos Reyes et al., 2020) [12]. The active involvement of communities in disaster management has been recognized as a key factor in reducing casualties and ensuring faster recovery after disasters.

Henceforth, the issue with disaster management, as articulated by Sarra Chaiir, Malika Charrad, Narjes Bellamine, and Ben Saoud (2023) [7], lies in the overwhelming influx of information from myriad sources that decision-makers must contend with. This deluge often compels them to depend on personal experience or external counsel. While some may perceive this as a minor inconvenience, within the realm of disaster management, any hesitation or indecision can increase the loss of lives and property, thereby presenting significant threats.

Economically, the impact of these disasters is staggering. The 2017 Atlantic hurricane season alone, which included Hurricanes Harvey, Irma, and Maria, caused an estimated $294 billion in damage, making it the costliest season on record (NOAA, 2019). Developing nations are particularly vulnerable due to their limited resources for disaster preparedness and recovery, often relying heavily on international aid and support (Hallegatte et al., 2020). The Philippines is one of these developing countries.

To concretize, the Philippine Institute for Development Studies (PIDS) estimated the cost of disasters per year in the Philippine economy, based on 1905 to 2017 data, to be around 85 to 422 billion pesos, with 81,302 people killed, 219,874 people injured, 204,336,105 people affected, 6,276,465 homeless, and 210,832,444 total people affected. These staggering statistics point out that disasters need attention in order for the Philippines to cut down on expenses and loss of lives during catastrophic events (Philippine Institute for Development Studies, 2020) [3].

The Cordillera Administrative Region in the Philippines is frequently affected by tropical cyclones, leading to significant impacts on the lives, properties, and livelihood of its residents. These cyclones often result in severe weather conditions such as heavy rainfall, strong winds, and landslides, which can cause extensive damage to infrastructure, agriculture, and homes. Given the region's mountainous terrain and the susceptibility of its communities to such natural hazards, there is a pressing need for an efficient and reliable system to manage information related to tropical cyclone events.

In view of a hazard assessment by the Mines and Geosciences Bureau (MGB), 80% (938 out of 1,172) of barangays in the region are highly susceptible to landslides, and 16% (184 barangays) are very highly susceptible. Additionally, 42% (494 barangays) are highly susceptible to flooding, while 17% (198 barangays) are very highly susceptible to this hazard. Planning and putting precautions in place to reduce risk are essential. Since most disasters involve difficulties with information flows, there is still room for improvement in integrating all the data required to consistently create winning plans, identifying weak points, while taking specific risks and hazards into account.

Significantly, landslides are a recurrent problem in Benguet, exacerbated by deforestation and unsustainable land use practices. The National Disaster Risk Reduction and Management Council (NDRRMC) has identified Benguet as one of the most landslide-prone areas in the country, with numerous incidents recorded each year during the rainy season (NDRRMC, 2021). These landslides not only result in fatalities but also cut off communities from essential services, making disaster response and recovery efforts challenging.

In the Province of Benguet, tropical cyclones pose a significant threat. While Benguet is not usually in the direct path of tropical cyclones, it is highly susceptible to the secondary effects of this hazard, such as landslides and flash floods. The region’s steep terrain and heavy rainfall make it particularly vulnerable, often leading to disasters that claim lives, destroy homes, and disrupt agriculture (Narisma et al., 2021). As a matter of fact, the agricultural sector, which is vital to Benguet's economy, is particularly affected by these natural hazards. Crops such as vegetables and coffee, which are key products of the region, are often destroyed by landslides and floods, leading to significant economic losses for farmers and the local economy (Cruz & David, 2020) [9].

All things considered, information technology has revolutionized disaster management by improving early warning systems, enhancing data collection and analysis, and facilitating communication during emergencies. Satellite-based systems, for example, have become essential in monitoring and predicting the paths of tropical cyclones, providing valuable lead time for communities to prepare and evacuate if necessary (Bettencourt et al., 2021) [5]. Advances in remote sensing and Geographic Information Systems have also enabled more accurate mapping of vulnerable areas, allowing for better planning and risk assessment (Cova et al., 2019) [8]. Specifically, artificial intelligence and machine learning that are increasingly being used to analyze vast amounts of meteorological data, improving the accuracy of cyclone predictions and helping to identify patterns that may indicate impending disasters (Johnson & Lee, 2022). These technologies are crucial in reducing the uncertainty associated with cyclone forecasting and in making more informed decisions about disaster response and resource allocation. Moreover, mobile applications have become vital tools for disaster communication. Applications like the "Safe Philippines" provide users with real-time updates on weather conditions, disaster alerts, and safety tips, allowing individuals to take proactive measures during emergencies (Padua & Mendoza, 2020). These apps also facilitate community reporting of hazards and damage, improving the efficiency of disaster response efforts.

This study aims to identify system design requirements and determine the specific key features and creation of Decision Support System for Disaster Risk Reduction and Management with blockchain technology approach of Civil Defense Cordillera.

II.RELATED WORK

Disasters, by their very definition, are "... a sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community's or society's ability to cope using its own resources" (International Federation of Red Cross, 2019). Whether man-made or natural, hazards turned disasters, represent a danger to life and are a real and ever-present threat to individuals, the destruction of property, cultures, and society in general.

An obvious hallmark of a disaster is the trauma it gives to the survivors, leaving them an insurmountable mark. Most studies on the effects of a disaster focused on the survivors which leave out those who perished from the incident out of the picture. For example, in a study by Savage and Torgler (2021), both researchers found out that ex post surveys and interviews have been the mainstay of traditional catastrophe research; yet, this methodology is inherently biased toward survivors. The fact that only survivors may be questioned, naturally leaves out individuals who lost their lives in the incident, which in turn makes the sample non-representative of the general population. This indicates that any conclusions derived are limited to that specific group of survivors who were interviewed and cannot be applied to other groups. Nonetheless, because the survey approach may be used to add to the experimental data set and be collected concurrently, it is extremely compatible with the use of experiments. Standard psychology questions, for instance, are frequently used in surveys to gauge a respondent's emotional or psychological well-being.

In order to effectively monitor the effects of disasters, time-tested and fool-proof plans are pivotal. This effective disaster management is closely linked to the integration of real-time data and predictive modeling.Another country in Asia plagued by disasters is Vietnam. Vietnam is one of the most disaster-impacted nations in the West Pacific region. Natural hazards have been causing significant threats to the livelihoods and lives of millions Vietnamese households. Hence, to reduce the negative effect of catastrophes, it is critical to establish comprehensive disaster preparedness and response strategies for upcoming hazard events. The Disaster Risk Management (DRM) capacity of Vietnam has been improved in recent years. The Natural Disaster Prevention and Control and the National Strategy on Disaster Prevention, Response and Mitigation to 2020 are good examples of the country's efforts to enhance DRM. These efforts are undertaken at the national, provincial and communal levels. Regarding to the authors Huong et.al(2022) states that Vietnam has also made significant progress in developing institution arrangements and proactive DRM policies as well as mainstreaming DRM into national sectoral and local social- economic development priorities.

The Philippines, an archipelago nation in Southeast Asia, is not spared from this dilemma as the country is particularly vulnerable to tropical cyclones. Its location in the typhoon belt, combined with its extensive coastline and mountainous terrain, exposes it to the full force of these storms. Pulhin et. al (2020) highlight this vulnerability in their book, "The Rising Storm: Climate Change and the Philippine Archipelago," and call for a more systematic disaster preparedness approach.

Undoubtedly, enlivening the meaning of the previous paragraph, investing in early warning systems, strengthening infrastructure, and promoting community-based disaster risk reduction initiatives are crucial steps for the Philippines. Additionally, exploring natural defenses, such as mangrove restoration, can provide a buffer against storm surges and flooding.
Other than tropical cyclones, earthquake is also considered as a hurdle in several countries in Asia. Indonesia is not spared from the brunt of nature's disaster owing to almost catastrophic earthquakes from time-to-time. The Indonesian archipelago lies above a complex tectonic zone, where the Eurasian, Indo-Australian, the Philippines and the Pacific Plates meet. In the last 30 years, major earthquake incidents have been recorded and have caused a total economic loss of more than 160 Trillion Indonesian rupias (IDR) and more than 200,000 casualties.

To explicate further, according to the study of Pribadi et. al (2021), other than earthquake resilient structure and disaster resilience in Indonesia, a robust knowledge management system for earthquake resilient infrastructure is being practiced in Indonesia, saving more lives, reducing infrastructure damage, reducing economic loss, and reducing sustainable development disruption. Inferring from their findings, the knowledge management system involves the use of technology with hopes of predicting and mitigating certain issues and lapses of the country's catastrophe management.

The increasing frequency and intensity of tropical cyclones have underscored the urgent need for more systematic detection and mitigation strategies. Current methods often struggle with timely and accurate data integration, leading to delayed responses and increased vulnerabilities. By enhancing monitoring systems and ensuring efficient data accessibility, the government can better predict and manage these natural hazards. Implementing a solid risk reduction measure will not only save lives but also minimize the socioeconomic impacts on affected communities, making resilience a more attainable goal in the face of escalating climate threats.

The preceding paragraph takes it claims from the study conducted by Chairr et. al (2023) who reminded readers that, disaster management includes four main stages: Mitigation, a set of activities to reduce the effects of the disaster; Preparedness, actions taken into account to prepare the community for predicted disasters; Response, activities that should be performed in the wake of a disaster to preserve lives, properties, and the environment; and finally, Recovery encompasses a set of actions taken in long term to reestablish the damaged infrastructure. In all the 4 main stages mentioned, the voluminous amount of data gathered often overwhelms the ability of decision-makers to provide timely and adequate responses. In this regard, recommender systems (RSs) are deemed to be efficient tools that enable people to take prompt decisions and reduce the time required to obtain optimal solutions in the state of various emergencies.

The purpose of recommender systems is to generate suitable recommendations from a large space of possible options, hence reducing the problem of information overload. In order to do this, technological advancements are needed, all involving the development of a software to mitigate the catastrophic effects of disasters.

To funnel the discussion of increasing threats posed by tropical cyclones, the necessity for more systematic detection and mitigation efforts is becoming evident. Traditional methods for detecting and tracking these powerful storms often fall short in accuracy and timeliness, leading to significant challenges in disaster preparedness and response. Recent advancements in technology, such as the use of deep learning and machine learning models, have shown promise in enhancing the accuracy of tropical cyclone detection and tracking. These improvements are crucial for reducing the adverse impacts of these natural disasters on vulnerable communities and infrastructure.

The international community has a vital role to play in improving tropical cyclone detection and mitigation. Organizations like the World Meteorological Organization (WMO) coordinate international efforts in monitoring and predicting these storms. Sharing data and expertise on weather forecasting, disaster preparedness, and risk reduction strategies are critical for global resilience.

To sum up, data analysis from organizations like the International Disaster Database (2024) plays a crucial role in understanding historical trends and identifying areas most prone to tropical cyclones. This data can be used to develop targeted mitigation strategies and prioritize investments in vulnerable regions.

Impact of Disasters Globally and Locally

Natural hazards, particularly tropical cyclones, have had devastating effects both globally and locally. Globally, these events have become more frequent and intense, largely due to climate change. As Cutter et. al (2020) point out, the increasing severity of tropical cyclones has led to significant economic losses, particularly in vulnerable, low-income countries. This growing global threat necessitates robust disaster management strategies. Focusing on the Philippines, the impact of tropical cyclones is equally severe, with the country ranking among the most disaster-prone in the world. Narisma et. al (2021) emphasized that the Philippines, including the Benguet province, faces significant challenges from these natural hazards. The steep terrain and heavy rainfall in Benguet worsen the risks, making landslides and flash floods a recurrent problem. Thus, there is a pressing need for localized disaster management systems tailored to these specific vulnerabilities.

Disaster Management Programs and Solutions in Other Countries

Building on the global and local impacts of disasters, it is essential to examine the disaster management programs that have been implemented in other countries. Japan, for instance, has developed a comprehensive disaster management system that integrates early warning systems, community preparedness, and public education campaigns. Shiroshita (2020) highlights that these measures have significantly reduced casualties during natural disasters in Japan, demonstrating the effectiveness of a well-coordinated approach. Similarly, in the United States, Federal Emergency Management Agency's (FEMA) disaster management strategies emphasize preparedness, response, recovery, and mitigation. The use of advanced technologies, such as AI for disaster prediction and social media for real-time communication, has enhanced FEMA's ability to manage disasters effectively (Kapucu&Ustun, 2021). These examples from Japan and the U.S. offer valuable insights that could be adapted to improve disaster management in the Philippines.

IT Technologies and Innovations in Disaster Management

Advancements in information technology have further revolutionized disaster management globally, providing new tools and methods to predict, respond to, and recover from disasters. The integration of AI and machine learning into disaster management has significantly improved predictive capabilities, particularly for tropical cyclones. Bettencourt, Cintra, and De la Rosa (2021) discuss how AI-driven models have enhanced the accuracy of cyclone path predictions, thereby saving lives and reducing economic damage. Moreover, the potential of blockchain technology in disaster management is being explored, particularly in enhancing transparency and efficiency in the distribution of aid and resources during emergencies. As Tapscott and Tapscott (2019) note, blockchain could play a crucial role in ensuring that disaster relief reaches those who need it most, without the delays and corruption that often plague traditional systems. These innovations highlight the transformative role of IT in enhancing global disaster resilience.

Local Disaster Management Systems in the Philippines

Turning to the Philippines, local systems such as PAGASA and the NDRRMC play critical roles in disaster management. PAGASA, the country's primary weather agency, has made significant strides in improving the accuracy of its tropical cyclone forecasts. Cruz, David, and Tiglao (2020) emphasize that these improvements have provided valuable lead time for disaster preparedness, reducing the impact of these events on vulnerable communities. The NDRRMC, on the other hand, coordinates disaster management efforts across the country, integrating community-based early warning systems and utilizing drones for rapid damage assessment (Alcayna et al., 2020). These local systems are crucial in a country as hazard-prone as the Philippines, where timely and effective disaster management can mean the difference between life and death.

Disaster Management in the Cordillera Administrative Region

The Cordillera region, particularly Benguet province, presents unique challenges and opportunities for disaster management. The Baguio PAGASA station, as Gonzales, Carandang, and Sevilla (2019) explain, is crucial in monitoring weather patterns in the region, providing data vital for predicting landslides and other hazards. This localized monitoring is essential in a region where the terrain and weather conditions make hazards particularly dangerous. In addition, the Office of Civil Defense – Cordillera Administrative Region (OCD-CAR) has implemented community-based risk assessment programs and GIS-based hazard mapping from Mines and Geosciences Bureau (MGB-CAR), which are vital for disaster preparedness and response (Delos Reyes, Serrano, & Villar, 2020). These initiatives underscore the importance of tailored disaster management strategies that address the specific risks faced by communities in the Cordillera region.

Statistical Figures in Connection to Livelihood

Disasters not only pose a threat to life and property but also have a profound impact on livelihoods, particularly in agricultural regions like Benguet. Cruz and David (2020) discuss how tropical cyclones cause significant losses in agriculture, disrupting the livelihoods of farmers and the local economy. The destruction of crops and the resulting economic instability highlight the importance of developing disaster management systems that also focus on protecting and restoring livelihoods. Economic losses from natural hazards in the Cordillera region have been substantial, as reported by the National Economic and Development Authority – Cordillera Administrative Region (NEDA-CAR, 2021). These losses further justify the need for enhanced disaster management systems that not only respond to immediate threats but also support long-term economic recovery.

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III.METHODOLOGY

3.1 Research Design

This study utilized a quantitative type of method with design thinking principles. Quantitative data are collected through a survey questionnaire that reflects the usability of the development of DSS-DRRM. Meanwhile, gathered qualitative data are through interviews with the Operations Section with open-ended questions it provides in-depth information on current operations section practices of gathering data, challenges encountered in disaster data management and desired functionality.

Most data from this study were collected through a survey questionnaire and interviews with Civil Defense Cordillera Operations Section team and Baguio PAGASA Synoptic and Upper-Air Station through a survey questionnaire was used to gather quantitative data.

The collected data were analyzed using descriptive statistics. This was utilized to analyze the quantitative data gathered from the interviews. The results from the analysis were used to provide recommendations for the creation and enhancement of Decision Support System for Cordillera Disaster Risk Reduction and Management with blockchain technology.

3.2 Development Process

The researcher application of Feature-Driven Development (FDD) focus on delivering client-valued features that can be escalated to a larger project. It is an agile methodology that's objective with tangible software results efficiently. The iterative nature of FDD guarantees that the development process remains responsive to changes and constantly adapts to client desires. Harvard Business School Dean Srikant Datar [19] uses a four-stage innovation framework. The stages move from concrete to abstract thinking and back as the process iterates, reverses, and repeats. These stages include (4) phases in the software development workflow as shown in figure 1.

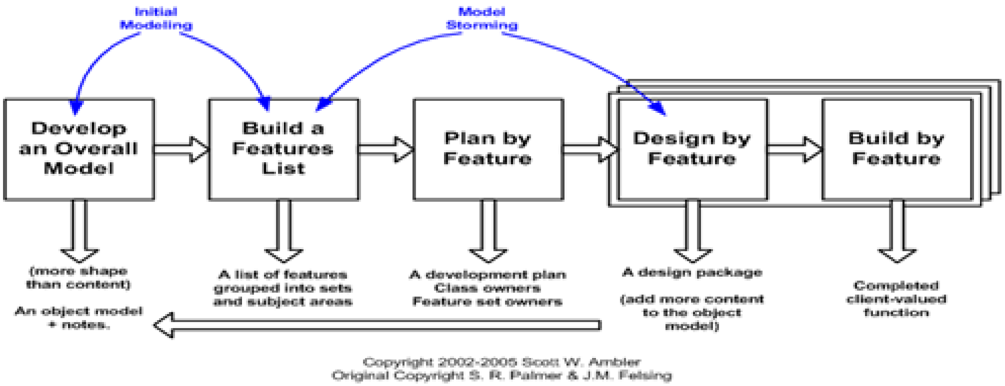

Figure 1. Feature-Driven Development (FDD)

Phase 1: Develop an overall model. This phase emphasizes understanding the context of the project particularly its scope while establishing clear objectives, identify current requirements and accumulating the needed data. Based from SRM Tech (2024), this phase serves as the fundamental base of the system that will be built. Initial gathering of crucial data needed to create the overall model and needs to emphasize the key elements of the proposed system development by data gathering and develop outline of the system.

Phase 2: Build a feature list. According to Laura Fitzgibbons, describes this phase as creating a list of features with a focus on completing a provided timeline that align with client priorities. Additionally, complex queries or request are broken down into a series of smaller feature sets to complete the required data. This phase aims to create a preliminary design focusing on the user interface, database and interaction flows. Based on the gathered information, this phase generates ideas and concepts, including prototyping and brainstorming.

Phase 3: Plan by feature. Analysis each feature and tasks, evaluating their functionality and assessing their complexity. Launch Darkly (2021) supports this approach, emphasizing the importance of determining the order in which features are developed and implemented to identify potential risks, limitations and dependencies. Feature-base planning builds on the final results of phase 2 which involves assessing from the perspective of each development stage by ranking the identified key features into high, medium and low which will aid prioritize and specify the most important features to include and implement.

Phase 4: Design by feature. Author Rachelle Lynn states that this is the process of implementing all the components and determine the functionality. Afterwards, there is a need to review and test the prototype for client inspection. The innovation of proposed system is commenced according to the established design specifications, key components integration and initial user inspection. Also, this phase the user interface can be reviewed and evaluated by the client to verify functionality, address any concerns, and ensure that it meets the final design expectations.

Phase 5: Built by feature. As stated by Lucid Chart, all feature designs have been implemented and completed. Similarly, the detailed components and prototypes of the features have been built, tested, and approved by the client. The final phase involves usability testing and end-user testing as well as providing of complete technical design, key functional features and completed system based on client satisfaction and achieved the objective.

IV.RESULTS AND DISCUSSIONS

This manifests and discusses the study's results which consists of system requirements for designing and developing the Optimizing Disaster Management with Blockchain Technology: A Decision Support System for Disaster Risk Reduction and Management and the extent of usability of the proposed system. The utilization of 5-point Likert Scale reveal the efficiency of the system which exhibits components and integrate accomplishment that is lighter and uncomplicated. To determine the minimum and the maximum length of the 5-point Likert type scale, the range is calculated by (5 − 1 = 4) then divided by five as it is the greatest value of the scale (4 ÷ 5 = 0.80). The scale ranged from 5 being the highest with descriptive equivalent of excellent and 1 being the lowest with descriptive equivalent for system acceptability and efficiency.

Table 1. Interpretation of results

Length	Point Scale	Descriptive Equivalent	Interpretation
1.00 - 1.80	**1**	**Poor**	**Not Acceptable**
1.81 - 2.60	**2**	**Fair**	**Poorly Acceptable**
2.61 - 3.40	**3**	**Good**	**Acceptable**
3.41 - 4.20	**4**	**Very Good**	**Fairly Acceptable**

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4.21 - 5.00	5	Excellent	Very Acceptable

4.1 Requirements Needed in the Developed Decision Support System for Disaster Risk Reduction and Management with Blockchain Technology

User Activity and User Level Access Logging. Implement a basic user authentication system (username and password) with the following roles: super admin, EOC manager, Planning Coordinator, Logistic Coordinator, DPWH, DSWD user, DOH CHD user and Director.

Blockchain technology integration. For recording and verifying OCD-CAR budget and resource allocation transactions. A simple smart contract for recording fund allocations and retrieve transaction history.

4.2 Features of the Cordillera Decision Support System for Disaster Risk Reduction and Management with Blockchain technology

The features of the developed system were based on the situational reports received from the regional line agencies such as DSWD FOCAR, DOH CHD CAR and DPWH CAR.

Regional Situational Data Dashboard. Display essential disaster incident data that includes active tropical cyclone monitoring, dam information, national roads monitoring in the Cordillera Administrative Region, DSWD stockpiles, casualties monitoring and Office of Civil Defense – CAR stockpiles. Allow users to enter disaster incident data and show key metrics of the system.

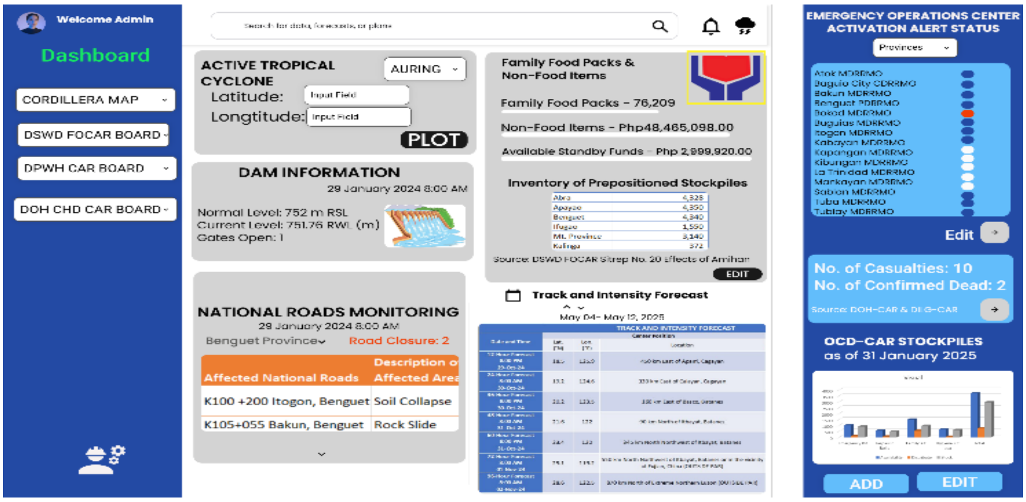

Figure 2. Dashboard of the Cordillera Decision Support System for Disaster Risk Reduction and Management

Department of Social Welfare and Development (DSWD) board. The content of this board manifest quantity of family food packs (ffp) available and prepositioned ffp's in different provinces in the Cordillera Administrative Region.

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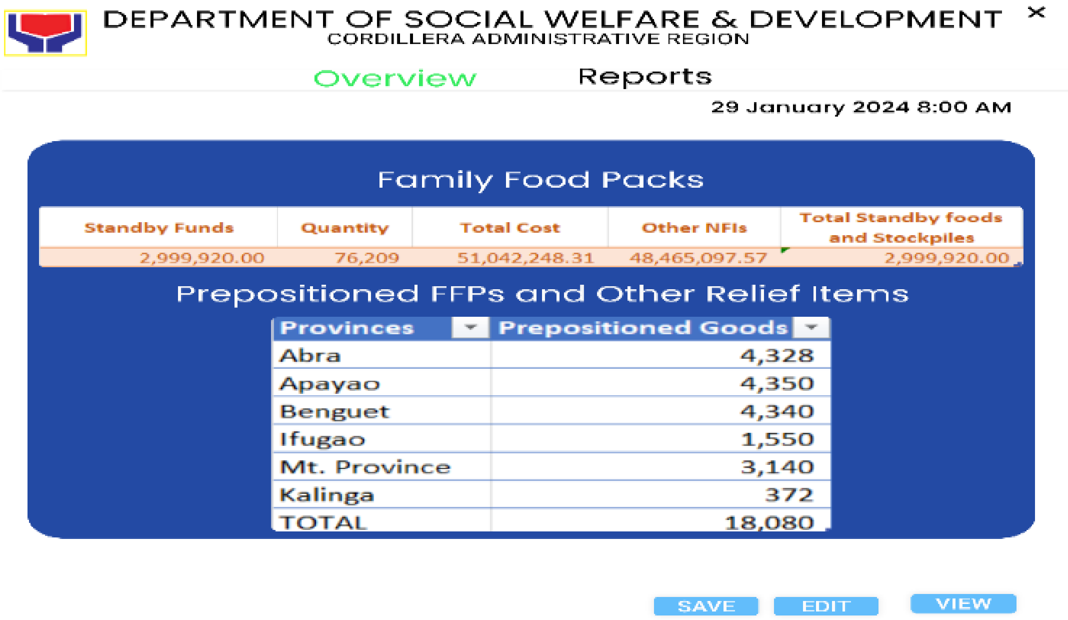

Figure 3. DSWD FOCAR board

Department of Public Work and Highways (DPWH) board. The DPWH board covers the name of affected national roads, description of affected area and remarks. It also reflects the count of affected national road due to tropical cyclone.

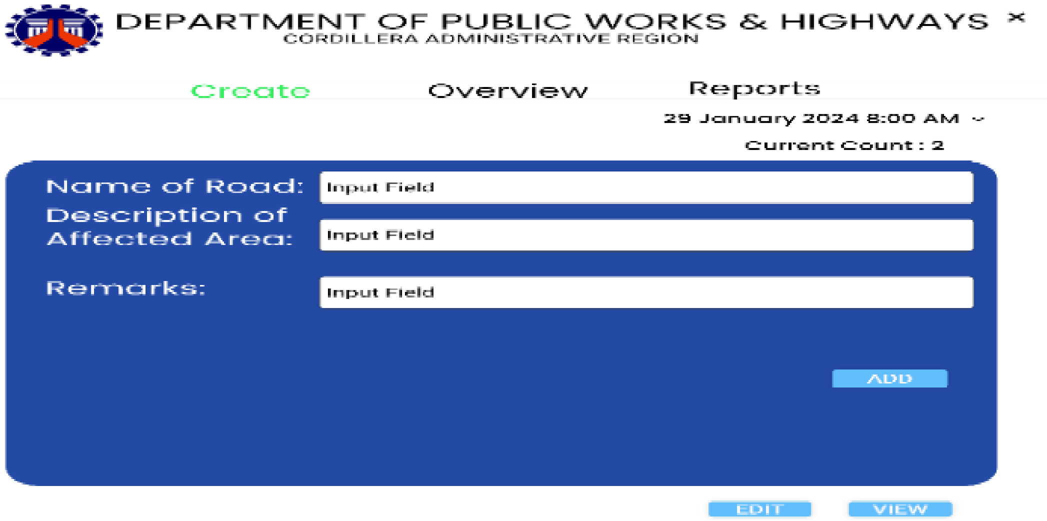

Figure 4. DPWH CAR board – Creation of report

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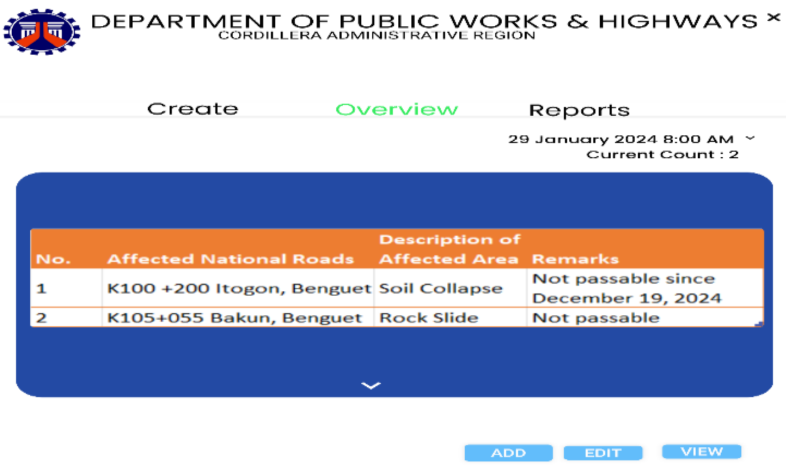

Figure 5. DPWH CAR board – Overview of report created

Department of Health Center for Health Development (DOH CHD) board. The DOH CHD board reflects the name, gender, address, hospital, date seen and date discharged of casualties. Included also the management of the dead and missing persons that covers time period covered, province category, municipality category, name, address, age and remarks.

Figure 6. DOH CHD CAR board – Creation of the report

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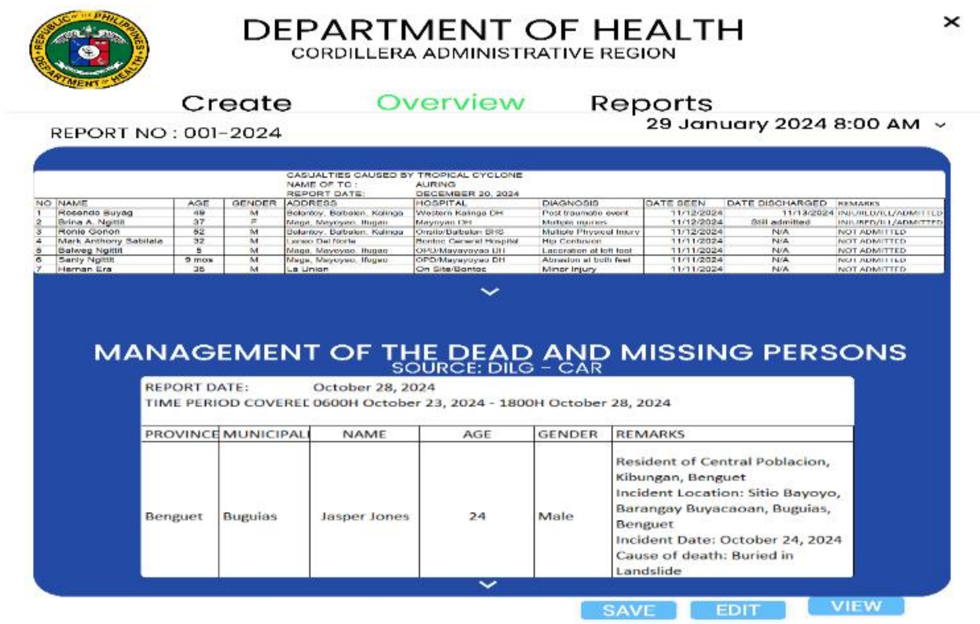

Figure 7. DOH CHD CAR board – Overview of the report created

4.3 Level of Usability of Cordillera DSS for DRRM with Blockchain technology

The respondents were from the personnel of Operations Section Team of Civil Defense Cordillera. System usability reflects the ease of use of a system and can be measured by considering the context of use of the system that is described n ISO 9241 (Shojaei, D. et.al, 2013) [20]

It exhibits from Table 2 that the mean score of the Cordillera DSS for DRRM with Blockchain technology in terms of Functionality is 4.38 with a descriptive equivalent of Excellent, described as "Very Acceptable". It also evident that acceptability, suitability and learnability of the system has the highest means of 4.83, interoperability comes second with then mean of 4.67 while user interface design gained the lowest mean with 3.33, labeled as "Acceptable." Therefore, the developed Cordillera DSS for DRRM with Blockchain technology is convenient, as the results show that the system's functionality is acceptable, suitable and effective for monitoring of duty personnel in the Cordillera RDRRMC Emergency Operations Center. This leads to easier data access and retrieval, as well as more efficient task management and workload distribution.

Table 2. Functional Standpoint for the Usability Level of theCordillera DSS for DRRM with Blockchain Technology

Indicator	Statistical Range	Descriptive Equivalent	Descriptive Interpretation
Acceptability	4.83	Excellent	Very Acceptable
Simplicity	4.5	Excellent	Very Acceptable
Suitability	4.83	Excellent	Very Acceptable
Interoperability	4.67	Excellent	Very Acceptable
User Interface	3.33	Good	Acceptable

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Overall impression	3.67	Very Good	Fairly Acceptable
Learnability	4.83	Excellent	Very Acceptable
Mean	**4.38**	**Excellent**	**Very Acceptable**

Table 3 indicates that the overall usability of the system is rated at 4.42, which corresponds to the descriptive rating of Excellent and equivalent interpretation as “Very Acceptable”. The data shows that most indicator including operability, interaction and accessibility are highly tag as Excellent. In contrast, the attractiveness had received the lowest rating of 3.33 highlighting the need to enhance in the user interface design. Overall, the developed Cordillera DSS for DRRM with Blockchain technology is highly accepted, effectively handled with errors and security.

Table 3. Usability Standpoint for the Usability Level of theCordillera DSS for DRRM with Blockchain Technology

Indicator	Statistical Range	Descriptive Equivalent	Descriptive Interpretation
Operability	5	Excellent	Very Acceptable
Interaction	4.5	Excellent	Very Acceptable
Accessibility	4.83	Excellent	Very Acceptable
Attractiveness	3.33	Good	Acceptable
Mean	**4.42**	**Excellent**	**Very Acceptable**

Finally, productivity refers to how the system elevate the efficiency of producing more outputs in a manner of time. Based on the results, table 4 has an average score of 4.67 in terms of productivity, that results to “Excellent” descriptive equivalent and “Very Acceptable” as interpretation result. Despite the stability is the lowest with an average of 3.17, rated as “Acceptable.”

Table 4. Productivity Standpoint for the Usability Level of theCordillera DSS for DRRM with Blockchain Technology

Indicator	Statistical Range	Descriptive Equivalent	Descriptive Interpretation
Stability	3.17	Good	Acceptable
Time-saving	5	Excellent	Very Acceptable
Resource utilization	4.83	Excellent	Very Acceptable
Changeability	4.67	Excellent	Very Acceptable
Mean	**4.67**	**Excellent**	**Very Acceptable**

V.CONCLUSIONS

This section presents the conclusion of the developed Cordillera DSS for DRRM with Blockchain Technology as follows:

1. The results indicate that the system design and development required information gathered from various situational reports of regional agencies. This includes forecast of tropical cyclone, DSWD FOCAR family food packs, non-food items, and inventory of prepositioned stockpiles, DPWH-

CAR roads monitoring, OCD-CAR stockpiles and DOH CHD CAR reports on casualties and confirmed fatalities

2. The features integrated into the developed system can still be enhanced while the current version includes the following a regional situational data dashboard that displaying essential disaster incident data. Additionally, blockchain technology has been integrated for recording and verifying OCD-CAR budget and resource allocation transactions.
3. Overall, the developed system is highly acceptable in terms of functionality, usability, and productivity, demonstrating efficiency and reliable performance. Therefore, implementing this system supports Cordillera RDRRMC EOC duty personnel in visualizing near real-time data and effective management of resource allocation.

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REFERENCES :

[1] Natural Disasters Data Book-2011 (2012). analyzed by Asian Disaster Reduction Center by CRED EM-DAT database, Retrieved November 12, 2023

[2] International Red Cross (2020), What is a disaster? Retrieved June 26, 2024

[3] Philippine Institute for Development Studies. (2020). Estimating the economic costs of natural disasters in the Philippines. Retrieved from PIDS website July 14, 2024.

[4] Alcayna, T., Bollettino, V., Dy, P., & Vinck, P. (2020). Resilience and disaster risk reduction: A Philippines case study. Journal of Disaster Risk Management, 5(1), 34-45.

[5] Bettencourt, L. M., Cintra, R. J., & De la Rosa, D. (2021). The role of satellite technology in disaster management: A focus on tropical cyclones. Journal of Remote Sensing and GIS, 12(4), 567-580.

[6] Castañeda, R. D., & Perez, M. G. (2019). Flood Monitoring and Early Warning Systems in the Philippines: Implementation and impact. Journal of Environmental Monitoring and Assessment, 54(2), 123-135.

[7] Chaiir, S., Charrad, M., &Bellamine Ben Saoud, N. (2023). Automatic identification of assistance needs in disaster situations using hybrid word embedding techniques. In Proceedings of the 37th Pacific Asia Conference on Language, Information and Computation (pp. 510-515). Association for Computational Linguistics.

[8] Cova, T. J., Dennison, P. E., & Drews, F. A. (2019). GIS and remote sensing technologies in disaster risk management. Journal of Disaster Research, 14(1), 88-102.

ISSN: 2582 - 6379
Orange Publications
International Journal for Interdisciplinary Sciences and Engineering Applications
IJISEA - An International Peer- Reviewed Journal
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www.ijisea.org

[9] Cruz, R. V., & David, M. P. (2020). The impact of tropical cyclones on agricultural productivity in the Cordillera region, Philippines. Philippine Journal of Agricultural Economics, 77(3), 201-214.

[10] World Meteorological Organization (2019). Tropical Cyclone. Retrieved June 26, 2024

[11] Cutter, S. L. (2020). Global vulnerabilities to natural disasters: A growing concern in the face of climate change. Global Environmental Change, 63, 102-117.https://doi.org/10.1016/j.gloenvcha.2020.102017

[12] Delos Reyes, R. A., Serrano, M. J., & Villar, C. F. (2020). Community-based disaster risk reduction: Lessons from Benguet province. Philippine Journal of Public Administration, 64(1), 34-50.

[13] Cao, F.F., Xu, X.F., Zhang, C.L., Kong, W.B., 2023. Evaluation of urban flood resilience and its Space-Time Evolution: a case study of Zhejiang Province. China. Ecol. Indic.154, 110643

[14] Thanvisitthpon, N., Shrestha, S., Pal, I., Ninsawat, S., Chaowiwat, W., 2020. Assessment of flood adaptive capacity of urban areas in Thailand. Environ. Impact Assess. Rev.81, 106363

[15] Liu, F., Xu, E., Zhang, H., 2022. An improved typhoon risk model coupled with mitigation capacity and its relationship to disaster losses. J. Clean. Prod. 357,131913

[16] Wang, T., Wu, S., Gao, J., Wei, B., 2022. Coping Capacity Assessment of Regional Typhoon-flood-geological Disaster Chain. J. Catastrophol. 37 (193–200), 210.

[17] Rafliana, I., et al., 2022. Tsunami risk communication and management: contemporary gaps and challenges. Int. J. Disaster Risk Reduction 70, 102771.

[18] Shuai, X., Lei, Z., Jun, X., Yi, D., Yang, Z., Yao, T., 2023. Assessment of the urban waterlogging resilience and identification of its driving factors: a case study of Wuhan City. China. Sci. Total Environ. 866, 161321

[19] Harvard Business School Online (2022), What Is Design Thinking & Why Is It Important?, Retrieved August 1, 2024

[20] Shojaei, D., Kalantari, M., Bishop, I. D., Rajabifard, A., &Aien, A. (2013). Visualization requirements for 3D cadastral systems. Computers, Environment and Urban Systems, 41, 39–54. doi:10.1016/j.compenvurbsys.2013.