Diversitas Journal
ISSN 2525-5215
Volume 10, Issue 4 (Oct./Dec. 2025) p. 1693 – 1715
https://diversitasjournal.com.br/diversitas_journal

Disaster Risk Assessment System Using Support Vector Machine Algorithm and Risk Indicators

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A B S T R A C T

This study developed a disaster risk assessment system that integrates the Support Vector Machine (SVM) algorithm and risk indicators derived from social media data and official sources. Employing the Rational Unified Process (RUP) for system development and a mixed-methods design for evaluation, the study was conducted in the disaster-prone province of Sorsogon, Philippines. The system utilized a linear kernel SVM classifier to categorize social media posts as disaster-related or not and computed a Disaster Risk Index (DRI) using five key indicators: hazard, exposure, vulnerability, and capacity (hard and soft countermeasures). System features included data extraction modules, GIS-based visualization, and a security layer employing SHA-256 encryption. Usability testing using the USE questionnaire and qualitative interviews showed high levels of perceived usefulness, ease of use, and user satisfaction among disaster management personnel. The results identified Juban, Sta. Magdalena and Bulan as the municipalities with the highest disaster risk levels. The study concludes that the proposed system is an effective tool for enhancing disaster preparedness and recommends its future deployment with real-time data integration and expanded geographic coverage.

RESUMEN

Este estudio desarrolló un sistema de evaluación del riesgo de desastres que integra el algoritmo de Máquina de Vectores de Soporte (SVM, por sus siglas en inglés) y los indicadores de riesgo derivados de datos de redes sociales y fuentes oficiales. Empleando el Proceso Unificado Racional (RUP) para el desarrollo del sistema y un diseño de métodos mixtos para su evaluación, el estudio se llevó a cabo en la provincia propensa a desastres de Sorsogon, Filipinas. El sistema utilizó un clasificador SVM con núcleo lineal para categorizar publicaciones en redes sociales como relacionadas o no con desastres, y calculó un Índice de Riesgo de Desastre (DRI) utilizando cinco indicadores clave: amenaza, exposición, vulnerabilidad y capacidad (medidas de contrarresto duras y blandas). Las funcionalidades del sistema incluyeron módulos de extracción de datos, visualización basada en SIG (Sistemas de Información Geográfica) y una capa de seguridad que emplea cifrado SHA-256. Las pruebas de usabilidad, mediante el cuestionario USE y entrevistas cualitativas, mostraron altos niveles de percepción de utilidad, facilidad de uso y satisfacción por parte del personal de gestión de desastres. Los resultados identificaron a los municipios de Juban, Sta. Magdalena y Bulan como los de mayor nivel de riesgo ante desastres. El estudio concluye que el sistema propuesto es una herramienta eficaz para mejorar la preparación ante desastres y recomienda su implementación futura con integración de datos en tiempo real y cobertura geográfica ampliada.

RESUMO

Este estudo desenvolveu um sistema de avaliação de risco de desastres que integra o algoritmo de Máquina de Vetores de Suporte (SVM) e indicadores de risco derivados de dados de mídias sociais e fontes oficiais. Utilizando o Processo Unificado Racional (RUP) para o desenvolvimento do sistema e uma metodologia mista para a avaliação, o estudo foi conduzido na província de Sorsogon, Filipinas, propensa a desastres. O sistema utilizou um classificador SVM com kernel linear para categorizar postagens em mídias sociais como relacionadas a desastres ou não e calculou um Índice de Risco de Desastres (DRI) utilizando cinco indicadores-chave: perigo, exposição, vulnerabilidade e capacidade (medidas de mitigação e não mitigação). Os recursos do sistema incluíram módulos de extração de dados, visualização baseada em SIG (Sistema de Informação Geográfica) e uma camada de segurança que emprega criptografia SHA-256. Testes de usabilidade utilizando o questionário USE e entrevistas qualitativas demonstraram altos níveis de utilidade percebida, facilidade de uso e satisfação do usuário entre os profissionais de gestão de desastres. Os resultados identificaram Juban, Santa Magdalena e Bulan como os municípios com os maiores níveis de risco de desastres. O estudo conclui que o sistema proposto é uma ferramenta eficaz para melhorar a preparação para desastres e recomenda sua implantação futura com integração de dados em tempo real e cobertura geográfica expandida.

ARTICLE INFORMATION

Article process:
Submitted: 06/01/2025
Approved: 12/10/2025
Published: 12/30/2025

Keywords:
Disaster risk assessment; SVM algorithm; Risk indicators; Mixed methods; Decision Support System; Sorsogon; Philippines

Keywords:
Evaluación del riesgo de desastres; Algoritmo SVM; Indicadores de riesgo; Métodos mixtos; Sistema de apoyo a la toma de decisiones; Sorsogon; Filipinas

DOI: 10.48017/dj.v10i4.3509

Introduction

The Philippines is prone to typhoons due to its geographical location (PAGASA, n.d.). The country also experiences earthquakes daily (PHIVOLCS, n.d.). These and other natural disasters plague the country, raising a challenge for local and national disasters and risk reduction to create a system that may help eliminate or, at the very least, reduce the damages of these natural disasters to life and property. In 2010, the Philippine Congress enacted the National Disaster Risk Reduction and Management Act to create a multi-level disaster risk management system (OCHA, 2021).

The Province of Sorsogon is familiar with the risks of natural disasters (Hassan et al., 2022). It is one of the most disaster-prone provinces in the Philippines (Mirandilla, 2020). The Bicol Region, where it is situated, is one of the places where a typhoon usually lands first. It is also home to several active volcanoes, including the world-famous Mayon Volcano and the Bulusan Volcano. Both of these volcanoes have recently started showing signs of activity. The threat of these volcanoes adds to the challenge local disaster risk reduction and management offices are tackling. Empowering community resilience leads to establishing the local disaster and risk reduction management council under the National Disaster Coordinating Council and the Office of Civil Defense.

The Philippine government also uses disaster risk assessment to evaluate the potential hazards and analyze what could happen if a disaster or a hazard occurs. Besides the current systems used by the Department of Science and Technology and its disaster risk agencies, the Philippine government also employs several web-based applications for disaster risk assessment and reduction. The Philippine government developed a GeoRiskPH-Informed Local Disaster Risk Reduction and Management Plan (LDRRMP) Coaching Sessions in cooperation with the World Bank and the Office of Civil Defense. It developed the PLan Smart Web Application (World Bank Group, 2023). The application aimed to train technical staff from different cities to collect, manage, and integrate their baseline data into the GeoRiskPH platform. This program is used to create a risk-informed Rehabilitation and Recovery Plan, which is different from the proposed algorithm since it focuses on mitigating the impact of disasters.

The Philippine Institute of Volcanology and Seismology (PHIVOLCS) developed a software and decision support tool called Rapid Earthquake Assessment System (REDAS) to assist decision-making and resource allocation in emergencies. The tool is used for real-time hazard monitoring, database development, and multi-hazard impact assessment. The tool helps responders allocate enough resources to avoid duplication of services and resources to those in need after a disaster. This differs from the proposed algorithm since it focuses more on identifying, monitoring, and reducing risks.

The Philippines has been at the forefront of disaster risk management efforts. The use of social media in risk communication and catastrophe response plans has caused a paradigm change in the nation in recent years (Gumasing & Sobrevilla, 2023). Social media platforms like Facebook and Twitter (currently named 'X') have developed into vital resources for organizing relief operations, sharing information in real-time, and fostering connections between impacted communities during disasters or emergencies (Yoo et al., 2020; Shittu et al., 2018; and Seneviratne et al., 2018). The distinct social media culture in the Philippines, marked by a high penetration rate and active user engagement, provides a favorable opportunity for incorporating social media into disaster risk management systems.

At present, several organizations related to disaster management utilize social media to disseminate emergency-relevant information. With the growing usability and significance of social media, these organizations can use this information to gain insight into situations as they unfold (Reuter & Kaufhold, 2018; Palen & Hughes, 2018; Martínez-Rojas et al., 2018; Reuter et al., 2018). Goodchild names this phenomenon as 'Citizens as Sensors,' where Volunteered Geographic Information (VGI) is created, assembled, and disseminated by individuals or groups with knowledge or capabilities using Web 2.0 (Opach et al., 2023; Astaburuaga et al., 2022; and Sadeghi-Niaraki et al., 2020). However, in-depth technological processes must be devised to turn this information into something useful (Ordoñez, 2017).

Several features of information generated during emergencies can be identified and lead to developing a working framework to inform the design and implementation of software systems that employ information extraction strategies. To extract this information from unstructured social media messages, the Natural Language Processing (NLP) technique must be used to convert this information into machine-ready data before it can be classified and validated by a text classifier algorithm. Different methods were proposed for classifying text data; among those methods, the Support Vector Machine (SVM) was the most used algorithm for text classification.

Support Vector Machine is a statistical classification method that utilizes computational learning theory's structural risk management principle. It has been proven to be a highly effective method for traditional text categorization compared to other machine learning techniques such as Naive Bayes (Hasan et al., 2022; Cervantes et al., 2020; Kadhim, 2019). Support Vector Machines are handy for disaster risk assessment since they have proven effective at identifying intricate patterns in heterogeneous datasets (Barba et al., 2021; Lagria et al., 2022; Linardos et al., 2022).

The SVM can identify trends within specific areas to help address region-specific disaster risk assessment and mitigation needs. Existing literature emphasizes the need for region-specific risk assessment models that account for distinct geographical areas' unique characteristics and vulnerabilities (Fabbrocino et al., 2019; Sang, 2015). Additionally, the country's increasing frequency and intensity of natural disasters demand innovative approaches. SVM can leverage machine learning techniques for enhanced predictive modeling in disaster risk management and address the need for region-specific risk assessment.

Support Vector Machines can be helpful, but they also must prove their usability in disaster management. SVMs are complex algorithms that may prove a challenge in understanding their recommendations for those on the ground (i.e., emergency responders) during disasters. Several usability factors are critical for SVMs in disaster management, regardless of underlying algorithms. SVMs must be user-friendly and easy to use for experts and novices who use them for disaster management (Asghar et al., 2022). The interface should also be simple and easy to understand and navigate, even under stress (Tochi et al., 2023). It should also be accessible on any device, especially on devices commonly used by emergency responders. In disaster zones, diverse populations who speak different languages may be present. Thus, multilingual support is crucial for clear communication. The information presented must also be actionable and specific for users.

Several methods can be used to test the usability of the SVM. User-testing methods can be used, including moderated usability testing, where an expert observes interacting with the system, asking questions, and guiding them through tasks. This provides rich insights into user behavior and pain points. For a less in-depth analysis, unmoderated usability testing can be used where the user uses pre-recorded instructions to complete tasks. Observation methods can also be used to test the usability of the algorithm. Researchers can observe users interacting with the system in their natural environment. Eye-tracking methods can also reveal areas where users are confused or struggle to navigate. Data collection methods like surveys, interviews, and recordings can be employed to gather feedback and suggestions. The combination of two or more assessment methods can provide a more in-depth analysis of the system, but it all depends on the researcher's budget, timeline, and goals.

In response to this exigency, this study undertakes the development of a system for disaster risk assessment using the SVM algorithm and risk indicators. With the advent of social media, data mining from disaster-related messages can produce valuable information that can be used as data points for models unavailable in conventional simulations. Harnessing information from unstructured data of social media messages could offer a solution to managing disaster preparedness through risk assessment. Undertaking such analysis could allow more informed decisions on priority actions and improve the risk management system in the country.

This study delved into the development of disaster risk assessment using the SVM classification algorithm and risk indicators as a tool to mitigate the result of disasters, with the following specific objectives: (1) To determine the information requirements of the proposed system for disaster risk assessment, (2) To identify and integrate an SVM framework which will be used to assess the disaster risk of the Province of Sorsogon, (3) To identify the features and design a system solution to the problems encountered in managing disaster risk assessment, and (4) To determine the level of usability of the proposed system in terms of (a) usefulness, (b) satisfaction, and (c) ease of use.

Methodology

This study combines iterative design and development with case study design. The mixed methods approach creates and assesses the researcher-developed disaster risk assessment system utilizing the Support Vector Machine (SVM) algorithm and risk indicators. Iterative design and development are a standard method in software engineering and system development that highlights iteration in the system's design, testing, and refinement. This enables a progressive generation of knowledge, concurrency, and changes to improve and optimize the system and its performance based on evaluation and feedback (Wynn & Eckert, 2017).

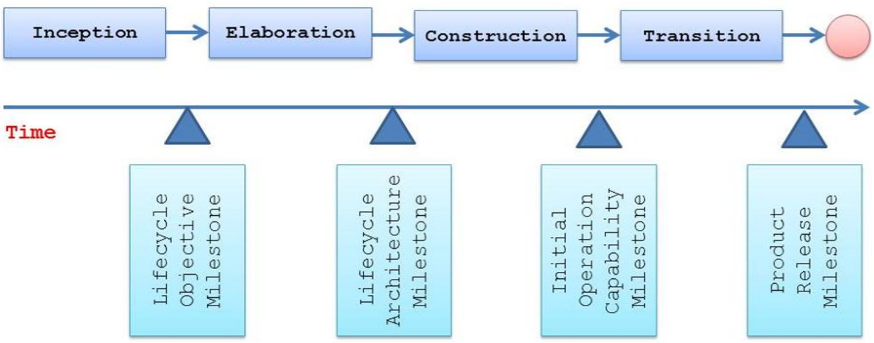
Case study design usually involves an in-depth examination of a specific case (Coombs, 2022). This case study is focused on disaster risk assessment in the province of Sorsogon. This design, which often uses qualitative data, provides a detailed understanding of the local context of the study and an in-depth evaluation of the system's performance in a real-world setting. With the case study design, insights into the applicability and effectiveness of the proposed disaster risk assessment system in the real world.

Furthermore, the study employed the Rational Unified Process (RUP) methodology to design and develop the proposed system. The RUP methodology was chosen because it can support iterative development, systematic requirement management, component architectures, visual modeling, continuous quality verification, and disciplined change management (Bak, 2022; Banks, 2017). An iterative testing approach is also used to ensure system usability. Continuous collaboration with the client facilitates the achievement of comprehensive and user-friendly features, maximizing user satisfaction.

The RUP methodology has four phases—Inception, Elaboration, Construction, and Transition—each with distinct milestones to identify them. These phases adhere to a waterfall paradigm, iterating through tasks including requirement elicitation, analysis, design, implementation, testing, and deployment. Figure 1 illustrates the four phases, emphasizing the control and focus provided by milestones.

Figure 1

The Four Phases of RUP Methodology



During the inception phase, the study determined the project scope, assessed viability, and established the product vision. Data collection, preliminary risk assessment, and interviews with government authorities were among the activities. Using the Unified Modelling Language (UML) for system modeling, the Elaboration Phase addressed significant architectural risks by concentrating on comprehensive use case definitions and system design. In the Construction Phase, the study required coding, using different tools and languages to turn concepts into fundamental components, and attaining important milestones, including developing the data gathering and categorization module and implementing the security module. Through assessment activities that gauged usability, utility, contentment, and simplicity of use, the Transition Phase ensured that stakeholders were satisfied with the system's requirements.

The four phases of RUP constitute a development cycle and generate software. The iterative approach accommodates changes in requirements and implementation strategy. It confronts and mitigates risk as early as possible. It allows the development organization to grow, learn, and improve. It focuses on real, tangible objectives.

This study utilized fifteen (15) participants consisting of five (5) SPDRRMO personnel and ten (10) government employees of the Provincial Government of Sorsogon involved in disaster risk reduction and management. These participants are chosen using purposive sampling to get data directly relevant to the researcher's research questions (Campbell et al., 2020). The participants chosen were active employees of the DRRMO and the provincial government office of Sorsogon who were directly involved in disaster risk management. This sampling technique avoids unnecessary and irrelevant responses since the responses came from experts who work in the field.

Techniques for acquiring data included surveys, document analysis, and interviews. The researcher interviewed government agencies in the province, such as the Sorsogon Provincial Disaster Risk Reduction and Management Office (SPDRRMO), Sorsogon City Disaster Risk Reduction and Management Office (City DRRMO), Philippine Statistics Agency (PSA), the Provincial Government of Sorsogon, and to the Local Government Unit officials to determine the current disaster risk assessment system employed in the province. Data from publications, PAGASA weather bulletins, and government agency documents were also examined to strengthen the significance of the proposed study.

In addition to institutional data sources, this study also relied on social media platforms, which play a crucial role in the data gathering and dissemination of emergency-relevant information. Table 1 summarizes the specific platforms considered, their established significance in disaster communication, and how they were integrated into the study's data collection and analysis.

Table 1.

Social Media Platforms and Tools Used for Disseminating Emergency-Relevant Information and Their Integration in the Study

Platform/ Tool	Common Use in Emergencies	Evidence of Significance	Integration in This Study
Facebook	Widely used for posting situational updates, community calls for help, and government advisories; allows sharing of photos/videos for real-time visualization.	Gumasing & Sobrevilla (2023); Reuter & Kaufhold (2018)	Extracted posts with hashtags/keywords were classified via SVM as disaster-related or not.
Twitter (X) for android	Critical for rapid, short updates, hashtags are used by government agencies (PAGASA, NDRRMC) and news outlets for immediate alerts, enabling quick trend tracking.	Martínez-Rojas et al. (2018); Shittu et al. (2018); Yoo et al. (2020)	Tweets were mined, filtered, and geo-tagged for inclusion in the disaster risk dataset.
TweetDeck (now X Pro)	Real-time monitoring of multiple hashtags, lists, and feeds; widely used by agencies and journalists to track disasters as they unfold.	Yoo et al. (2020) highlight the importance of follower networks; Reuter & Kaufhold (2018) show dashboards enhance crisis informatics.	Served as a reference for how dashboards organize disaster data, but this study's system surpasses it by integrating SVM classification and risk indexing.
TweetCaster for Android	Allowed mobile users to filter, search, and manage disaster-related tweets (e.g., geolocated hashtags, "Zip It" keyword filters).	Palen & Hughes (2018) emphasize the role of social media in disaster communication, showing how tools amplify citizen reporting.	Acknowledged as a legacy example of citizen-driven data reporting, but not directly used in this study due to obsolescence. Its role justifies the need for a custom, sustainable system.

IFTTT	Automated workflows such as logging tweets with disaster hashtags into spreadsheets or sending alerts when agencies post.	Palen & Hughes (2018) emphasize automation in disaster communication; Reuter et al. (2018) discuss "citizens as sensors" through participatory tools.	Considered as an automation baseline; the study's system improves on this by not only collecting but classifying and analyzing disaster-related posts through SVM.
Twitter Web Client (X Web Client)	Primary official interface for viewing and posting disaster updates, monitoring hashtags (#OdettePH, #EarthquakePH), and accessing government advisories.	Martínez-Rojas et al. (2018) show Twitter's role in emergencies; Shittu et al. (2018) emphasize its role in real-time coordination.	One of the key sources of text-based data for extraction; posts were mined and preprocessed for classification using the SVM algorithm.
Twitter for iPhone (X for iPhone)	Widely used in the Philippines for rapid disaster reporting, often with geotags, images, and hashtags directly from affected citizens.	Gumasing & Sobrevilla (2023) note Filipinos' high mobile engagement; Murzintcev & Cheng (2017) stress hashtags' utility in crisis mapping.	Integrated as a key input channel; tweets posted from iPhones enriched the dataset with time, location, and multimedia cues useful for classification and risk indexing.

As shown in Table 1, Facebook and Twitter (currently known as X) were the primary social media platforms integrated into this study, given their widespread penetration in the Philippines and their established role in emergency communication. These platforms were used to extract posts, hashtags, and keywords, which were then classified by the SVM algorithm as disaster-related or not. While other tools, such as IFTTT, were considered as an automation baseline. This ensured that the social media data gathered was both significant for disaster communication and methodologically aligned with the study's objectives.

Quantitative and qualitative data were gathered from the participants through survey questionnaires and semi-structured interviews to measure the usability of the proposed system. The USE Questionnaire was adapted from the study of Lasala et al. (2025a). It was disseminated and utilized as an instrument of this study to test the usability of the proposed system based on the users' perspective.

This study utilized quantitative and qualitative data analysis procedures to analyze data gathered throughout the study. Data from interviews with the agencies and document analyses were analyzed thematically for the analysis requirements for the proposed SVM system for disaster risk assessment. Qualitative data gathered throughout the iterative system development process through feedback sessions during interviews and observation were also thematically analyzed to identify recurring issues and suggestions for system improvement relating to system functionalities or features, accuracy of risk assessment, and usability. Frequency distribution and analysis of the computed risk index by the system were also done to analyze the functionality and accuracy of the proposed system with regard to risk assessment.

For the usability testing, descriptive statistics, specifically frequency and weighted mean, were used to analyze the usability of a proposed system based on the participants' responses on the USE Questionnaire, which was distributed among them. Thematic analysis was also employed to analyze qualitative data regarding the proposed system's usability gathered through semi-structured interviews with the participants. The findings from these different data analysis techniques were integrated to provide a comprehensive understanding of the proposed system's effectiveness in assessing disaster risks within Sorsogon province.

Results and Discussion

This section presents empirical evidence and dives deeper into the implications of our findings for disaster risk assessment using the SVM algorithm and social media indicators. The discussion of results relating to this study's problems seeks to provide valuable insights into the ongoing discourse on innovative approaches to disaster risk assessment, emphasizing the role of technology in enhancing the resilience of vulnerable communities.

Information Requirements Needed in the Proposed System

Thematic and document analysis of data gathered revealed two critical information requirements for the proposed system on assessing disaster risks using SVM algorithms and risk indicators in social media posts: posted messages in social media and risk indicators from DRRM agencies. This information guided the development of the proposed system for disaster risk assessment. Their necessity in the proposed system is discussed below.

Social Media Posted Messages. Accurate and pertinent data is essential for making informed decisions, especially when assessing the risk of disasters. Cuizon (2019) asserted that an individual's social media content or posts reflect personal information or events in a person's life. Critical information needs for social media messages include the message source, language, text, and user ID. These details are essential for determining how frequently articles about disasters will be made. The SVM algorithm will be used to clean and classify the data, and related datasets will include a bag of words with phrases relevant to disasters for SVM training. Table 2 lists the data obtained from posted social media messages as text classification datasets.

Table 2.

Datasets for Social Media Posted Messages

Item #	Posted Message Datasets		
1	From-User	7	Text
2	From-User-Id	8	Geo-Location-Latitude
3	To-User	9	Geo-Location-Longitude
4	To-User-Id	10	Retweet-Count/ Shared-Count
5	Language	11	Id
6	Source		

The above table shows the fundamental attributes of tweets and posted Facebook messages. These are the basic atomic building blocks of all things in social media messages. In the study, these shall be collected by the posted social media messages extractor and used for text classification using the SVM Algorithm.

Risk Indicators. The Sorsogon Provincial Disaster Risk Reduction Management Office information requirements and its counterpart agencies are the information obtained from previous experiences and records filed in the office (historical information). It consists of five risk indicators used to measure the risk index of the province. These indicators include the hazard, exposure, essential vulnerability, capacity, and hard and soft countermeasures, as shown in Table 3.

Table 3.

Datasets for DRI Indicators

Index	Indicators	Data Used	Unit
Hazard	Annual Ave. Monthly Rainfall	Annual average monthly rainfall per municipality	mm/year
	Typhoon Proneness Indicator	Frequency of typhoon affecting the province	Times
	Topographical Information	Elevation of the barangays	Elev. (m)

Exposure	Basic Population Density	Population density in the area per sq. km.	Pop/km²
	Lowland Areas Population Density	Population in the area where elevation < 10m	Pop
	Population Growth	Increase in Population	% pop
Basic Vulnerability	Good Governance Index (GGI)	Good Governance Index	GGI Index
	Income Index	Income Index	Income Index
	Expenditure Index	Expenditure Index	Exp. Index
Capacity	Infrastructure Index	Infrastructure Index	Infra. Index
Hard Countermeasures	Resiliency Index	Resiliency Index	Res. Index
	Government Efficiency	Government Efficiency	Gov. Efficiency
Capacity	Simple Literacy Rate	Simple Literacy Rate (PSA)	%pop
Soft Countermeasures	Functional Literacy Rate	Functional Literacy Rate (PSA)	%pop
	Access to Information Indicator	Household connection to electricity	%household

Table 3 was patterned from the datasets used by Fano (2010) in the paper entitled "Establishment of Philippine Flood Risk Index by Province Based on Natural and Social Factors."The indicators per index are selected based on the availability of the data, which are mostly limited to the provincial or municipal level only.

Support Vector Machine (SVM) Framework

Through document and thematic analyses, this study used the Linear Kernel Support Vector Classifier as the suggested framework for classifying disaster-related messages in social media. Existing studies on the use of SVM in disaster risk management specifically support the use of linear SVM classifiers to solve binary classification problems because of their efficiency in handling linearly separable text classification tasks (Achirul Nanda et al., 2018; Su et al., 2021). Since this study is concerned with classifying social media messages or posts as disaster-related messages or not, the linear SVM framework is deemed an appropriate choice.

A linear SVM framework is critical when many features are involved. This is frequently used when text classification is applied to big datasets containing many instances (documents) and features (words). The rationale behind using the Linear Kernel Support Vector Machine (SVM) is its ability to produce hyperplanes through its coefficient values—straight lines, planes, or non-linear curves—that effectively classify data into discrete groups. In extracting the coefficient values of the Linear SVM equation, the β refers to the coefficient values of the SVM model (Linear SVM classifier) with an equation linearly dependent on the predictors X1 and X2, which was represented by the mathematical equation below:

$$y_i = f(x, \beta) = \beta_0 + \beta_1 . X_1 + \beta_2 X_2$$

A line was generated to plot the result, which refers to the soft margin and includes the support vector within. The marks (dot) above the line, which are on the positive side, refer to non-disaster-related posts, while those marks (dot) in the negative and below the line are disaster-related posts or messages. The alignment of this choice with established best-text classification gives credibility to the study's choice of framework for disaster risk assessment and mitigation. This is also illustrated in the figure below.

Figure 2

Intelligent Model for Disaster Risk Management

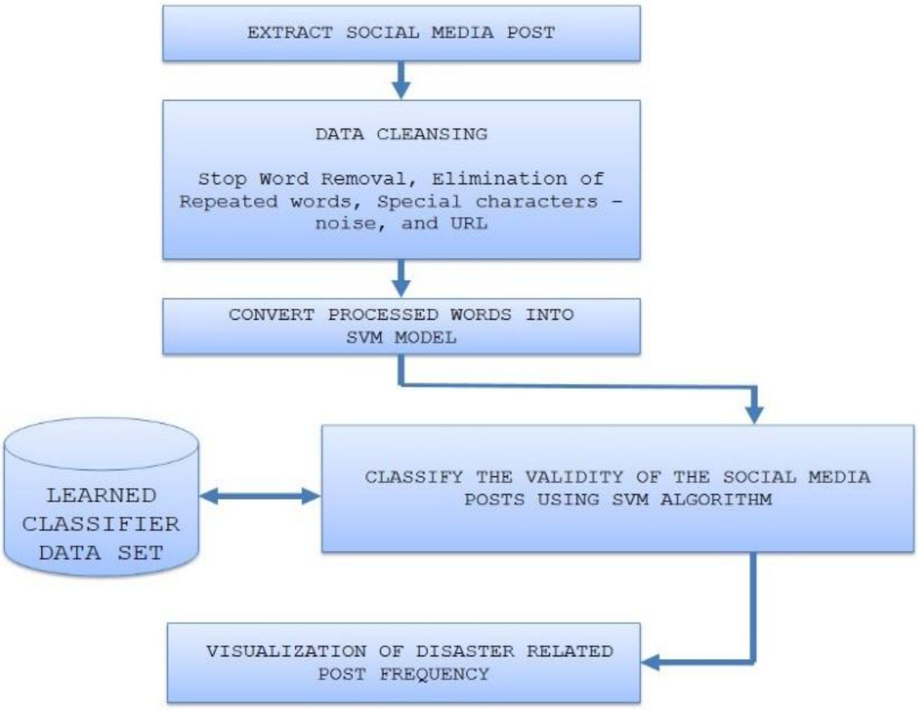
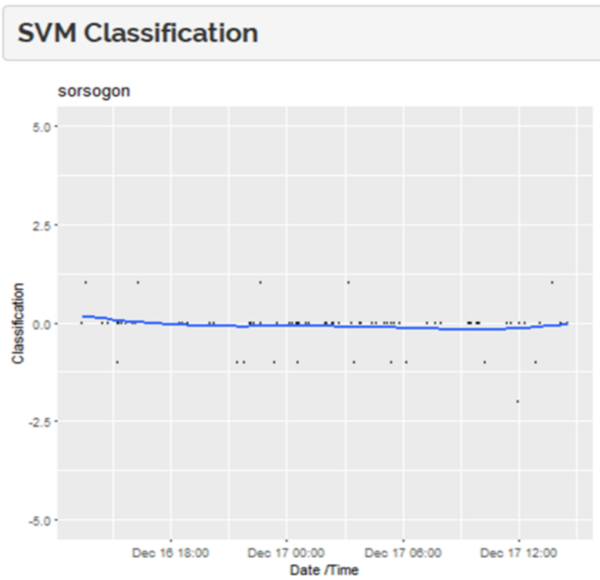


Figure 3

SVM Disaster Related Post Classifier



This figure shows the Hyperplanes for the keyword "sorsogon," which classify collected messages as disaster-related or not. The dot markings indicate the frequency of disaster-related posts, demonstrating that hashtags effectively capture individual experiences through their dense distribution.

Features of the Proposed System

The main functionality of the system is divided into three (3) modules: the data collection and extraction module, the disaster risk assessment module, and the security module. These modules contain different features representing different functionalities. Thematic analysis of data from interviews with different government agencies and document analysis on the current trends and systems for disaster risk assessment in the Philippines highlighted the common features of these three modules to ensure the efficiency and effectiveness of the proposed system.

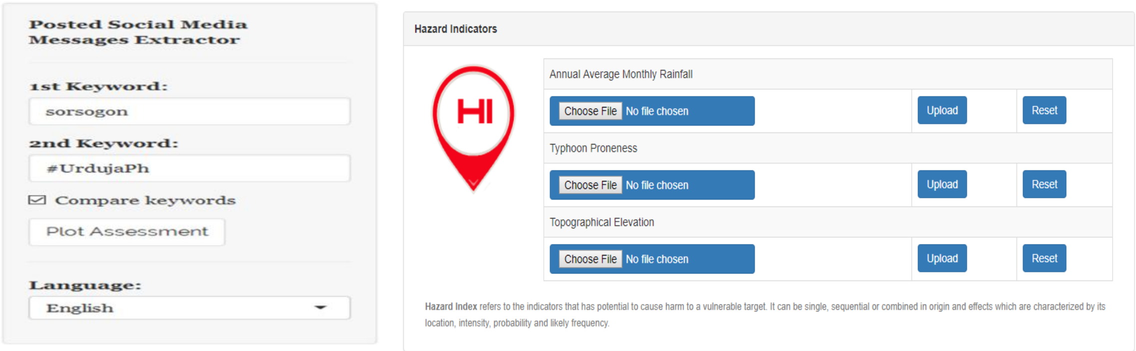
Data Collection and Extraction Module. Users can collect and extract crucial data for computing the Disaster Risk Index (DRI) and figuring out how frequently communications connected to disasters are sent out with the help of the Data Collection and Extraction Module. The system measures five primary indices and defined indicators to compute the DRI. The gathered data is saved in Comma Separated Values (CSV) files for additional analysis.

Utilizing the Shiny Application framework and the R programming language, the social media message extraction and collection process provides a polished and user-friendly graphical user interface. A flexible R package called Shiny Application makes it easier to create interactive dashboards and web apps that improve accessibility and aesthetic appeal. Its importance goes beyond web hosting for applications that have been released.

The R programming language is widely used, emphasizing its usefulness for creating statistical software and carrying out data analysis, especially among statisticians and data miners. Figure 3 illustrates the use of an extractor, where users input specific keywords or hashtags for mapping the frequency and categorization of social media messages. At the same time, the other modules provide a portal for uploading DRI and historical data gathered from various government agencies.

Figure 4

Data Collection and Extraction Module



The social media extractor's user interface, created with the Shiny Application for the Graphical User Interface (GUI) and the R programming language, is shown in Figure 3. Securing user OAUTH for access to Twitter and Facebook APIs, the application is hosted on the Shiny App server. It includes the consumer key, consumer secrets, access token, and access token secret. The machine learning framework allows the program to extract keywords and relate them to users' queries or messages (Petralba, 2020). This module has two search boxes where users can enter hashtags and keywords for data mining. The study also proposes using targeted hashtags to improve software utility by making location identification in posted communications easier, especially in cases where users choose not to disclose their locations, as shown in the following table.

Table 4.

Recommended Hashtags for Municipalities in Sorsogon Province

Municipality	Hashtag		
Barcelona	*#BarciSor*	Juban	*#JubanSor*
Bulan	*#BulanSor*	Magallanes	*#MagSor*
Bulusan	*#BulusanSor*	Matnog	*#MatSor*
Casiguran	*#CasigSor*	Pilar	*#PilarSor*
Castilla	*#CastillaSor*	Prieto Diaz	*#PDSor*
Donsol	*#DonsolSor*	Santa Magdalena	*#SMSor*
Gubat	*#GubatSor*	Sorsogon City	*#SorCity*
Irosin	*#IrosinSor*		

The hashtags suggested for social media users in each municipality when posting about disasters are included in Table 4. Using insights from document analysis and studies on natural language processing, hashtags are essential for presenting and elucidating personal experiences during a crisis. Previous studies have demonstrated that the use of hashtags improves post visibility and helps group communications. It has been observed that roughly 50% of messages linked to disasters may be identified with this method. The suggested hashtags are utilized in this research to classify posts about disasters and determine their locations effectively, especially when geographic data is inaccessible (Murzintcev & Cheng, 2017; PCDSPO, 2014).

Disaster risk assessment module. Another feature of the proposed system is the disaster risk assessment module. This feature refers to the primary process of the system. Upon completing the information needed for the system for DRI computation, the system automatically assesses the status of each municipality in the province. The Pressure and Release Model (PAR Model) was used in the study because of its simplicity, which was patterned from the equation 'Risk = Hazard x Vulnerability.' This concept defines "disaster as the intersection of two opposing forces which are hazard and vulnerability" (Wisner et al., 2004). The concept calculates the Province of Sorsogon's Disaster Risk Index (DRI). The DRI refers to the level of disaster proneness of an area that was highly usable by those people in the field of disaster management for the generation of timely and applicable decisions.

To calculate the Disaster Risk Index, the following datasets for indicators and indices are expressed as follows:

$$DRI = \frac{H \times E \times V}{C_S + C_H}$$

Where:

H: Hazard Index
E: Exposure Index
V: Basic Vulnerability Index
C_S: Capacity Soft Index
C_H: Capacity Hard Index

Indicator: [(LN(x)-LN(Min(x))]/[LN(Max(x))-LN(Min(x))]
Index: Indicator1 + Indicator2 + Indicator3

To measure the Disaster Risk Index (DRI) of each municipality in the Province of Sorsogon, the hazard should be multiplied by the exposure and vulnerability indexes. The numerator's result shall be divided by the sum of the capacity hard and soft countermeasure indices.

The datasets for this framework are collected from various historical information from different government agencies (SPDRRMO, CDRRMO, Province of Sorsogon, LGUs, PSA, PAGASA, and MGB). The required data for each Indicator should be up to the barangay level; however, some indicators are processed up to the municipal level only; therefore, modification to the above Indicator's formula may vary.

To cluster the level of disaster proneness of the municipalities, the researcher used Sturge's Rule in frequency distribution, which is expressed below:

$$K = 1 + 3.3 \log N$$

Where:

K: Number of class intervals
N: Total number of observations (15, 14 municipalities and one city)
Log N: logarithm of N to the base 10

After computation, the ideal number of class intervals for the study was 5 (rounded 4.88 to the following whole number). In contrast, the interval size (class size or width) was determined using the following formula:

$$C = \frac{R}{K}$$

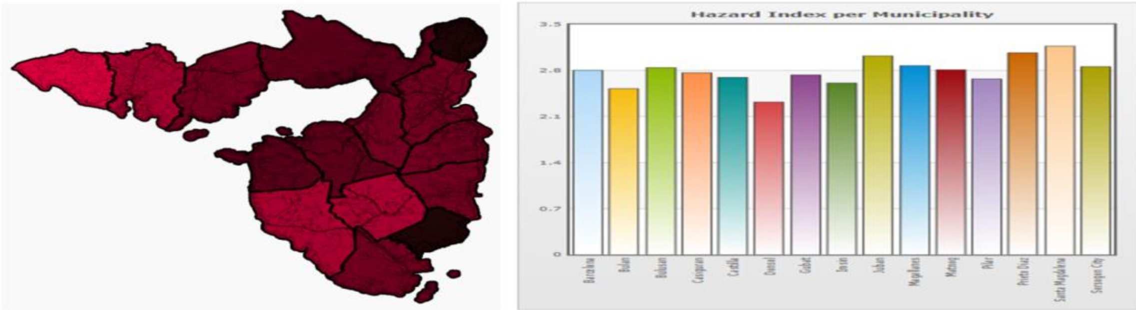
Where:

C: interval size (class size or class u
R: range
K: Number of class interval
R = Highest Value (HV) – Lowest Value (LV)

This formula was used to determine the class size of each interval, which will be the basis for ranking each municipality's disaster proneness level. Each Disaster Risk indicator (Hazard Index, Exposure Index, Vulnerability Index, Capacity Hard, and Soft Countermeasures Index) has class intervals with adjectival descriptions. Using the Sturge's Rule in the study, the five class intervals were categorized into very low, low, moderate, high, and very high.

Figure 5

Hazard Index

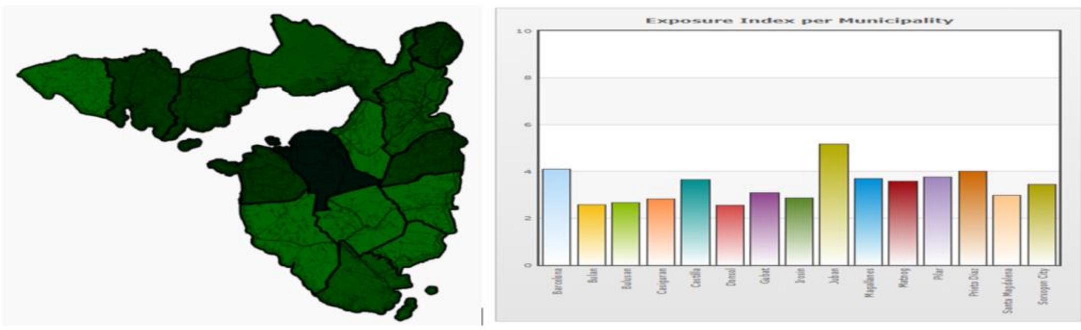


Color Code	Range	Remarks	Interpretation
	2.32 - 2.49	Very Low Hazard Index	Refers to an upland areas with high topographical elevation which are very low susceptible for flooding however in some part with steep slopes and underlain by weak materials are susceptible for landslides. These areas are likely to experience flood heights of less than 0.5 meter and/or flood duration during less than 1 day.
	2.50 - 2.67	Low Hazard Index	Refers to an upland areas with low hills and gentle slopes which are likely to experience flood heights of less than 0.5 meter and/or flood duration during less than 1 day with sparse to moderate drainage density. In some areas with steep to very steep slopes and underlain by weak materials may experience landslides.
	2.68 - 2.85	Moderate Hazard Index	Refers to an areas with fluvial terraces, alluvial fans, and infilled valleys which are moderately subjected to flooding. These areas are likely to experience flood heights to 0.5 to 1 meter and/or flood duration of 1 to 3 days. Areas with moderately steep slopes, soil creep and other indications for possible landslide occurence are present.
	2.86 - 3.03	High Hazard Index	Refers to an areas which includes landforms of topographic lows such as active river channels, abandoned river channels and areas along river banks which are prone to flashfloods. These areas are likey to experience flood heights of greater than 1 meter and/or flood duration of more than 3 days. Some parts of these areas are immediately flooded during heavy rains of several hours. In some areas with mooderately steep slopes indications for landslide are possible.
	3.04 - 3.21	Very High Hazard Index	Refers to an areas with low topographical elevation which are higly susceptible for flooding. Lowlying areas are easily flooded. Most places are gently sloping area which landslide has low susceptibility.

The map illustrates the Hazard Index (HI) levels in Sorsogon Province, with dark red indicating high hazard-prone areas and light red representing lower hazard-prone areas. The top five most hazardous municipalities are Santa Magdalena (3.17 HI), Prieto Diaz (3.07 HI), Juban (3.02 HI), Magallanes (2.87 HI), and Sorsogon City (2.86 HI). Donsol has the lowest HI at 2.32.

Figure 6

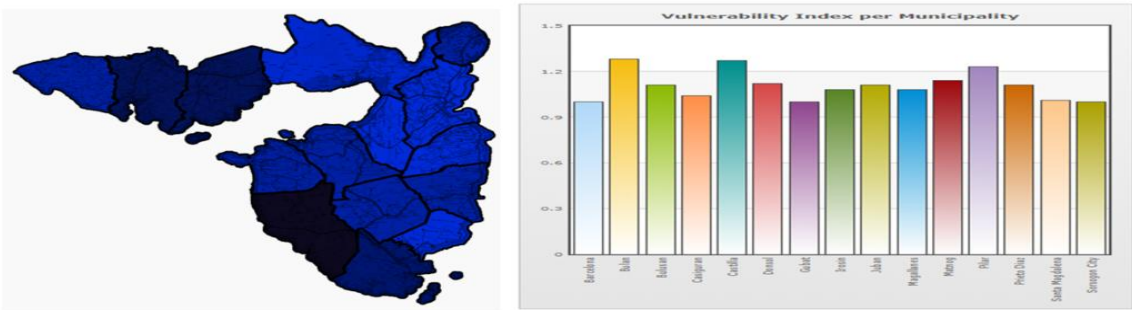
Exposure Index



Color Code	Range	Remarks	Interpretation
	2.55 - 3.07	Very Low Exposure Index	Refers to the areas which are very low exposed to disasters. These areas has the least affected population living in less than 10m topographical elevation with lowest population density per km^2 and its population growth.
	3.08 - 3.60	Low Exposure Index	Refers to the areas which are low exposed to the disasters. These areas has low affected population living in less than 10m topographical elevation with low population density per km^2 and its population growth.
	3.61 - 4.13	Moderate Exposure Index	Refers to the areas which are moderately exposed to the disasters. These areas has moderate affected population living in less than 10m topographical elevation with moderate population density per km^2 and its population growth.
	4.14 - 4.66	High Exposure Index	Refers to the areas which are highly exposed to the disasters. These areas had higher numbers of affected population living in less than 10m topographical elevation with high population density per km^2 and its population growth.
	4.67 - 5.19	Very High Exposure Index	Refers to the areas which are very highly exposed to the disasters. These areas has the highest numbers of affected population living in less than 10m topographical elevation with the highest population density per km^2 and its population growth.

Figure 6 presents the Exposure Index (EI) levels in Sorsogon Province, with dark green indicating high disaster exposure and light green representing lower exposure. The top five most exposed municipalities are Juban (5.17 EI), Barcelona (4.10 EI), Prieto Diaz (4.00 EI), Pilar (3.76 EI), and Magallanes (3.70 EI), while Donsol has the lowest EI at 2.55.

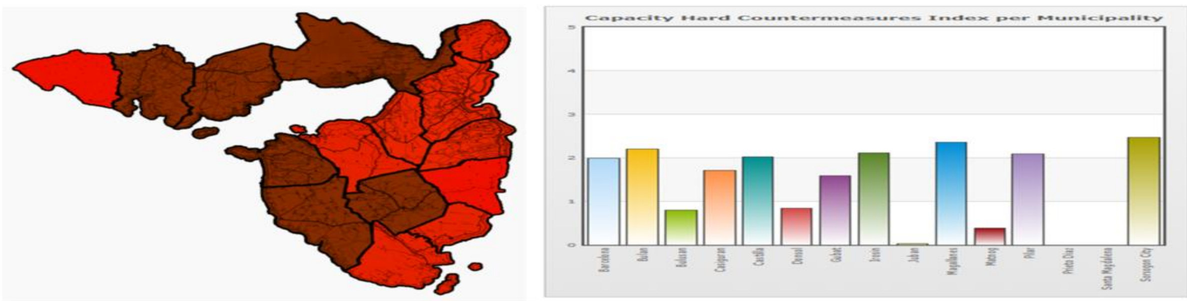
Figure 7
Vulnerability Index



Color Code	Range	Remarks	Interpretation
	1.00 - 1.06	Very Low Vulnerability Index	Refers to the areas which are very low vulnerable to disasters because of very high Good Governance Index, Income Index, and Expenditure Index. These indicators refers to the LGU's support in education, manpower development, health, nutrition and population control, and economic services.
	1.07 - 1.13	Low Vulnerability Index	Refers to the areas which are low vulnerable to disasters because of high Good Governance Index, Income Index, and Expenditure Index. These indicators refers to the LGU's support in education, manpower development, health, nutrition and population control, and economic services.
	1.14 - 1.20	Moderate Vulnerability Index	Refers to the areas which are moderate vulnerable to disasters because of moderate Good Governance Index, Income Index, and Expenditure Index. These indicators refers to the LGU's support in education, manpower development, health, nutrition and population control, and economic services.
	1.21 - 1.27	High Vulnerability Index	Refers to the areas which are high vulnerable to disasters because of low Good Governance Index, Income Index, and Expenditure Index. These indicators refers to the LGU's support in education, manpower development, health, nutrition and population control, and economic services.
	1.28 - 1.34	Very High Vulnerability Index	Refers to the areas which are the highest vulnerable to disasters because of very low Good Governance Index, Income Index, and Expenditure Index. These indicators refers to the LGU's support in education, manpower development, health, nutrition and population control, and economic services.

Figure 7 illustrates the Vulnerability Index (VI) levels across Sorsogon Province, with dark blue indicating high vulnerability to disasters and light blue representing lower vulnerability. The five most vulnerable municipalities are Bulan (1.28 VI), Castilla (1.27 VI), Pilar (1.23 VI), Matnog (1.14 VI), and Donsol (1.12 VI), while Barcelona, Gubat, and Sorsogon City are the least vulnerable, each with a VI of 1.00.

Figure 8
Capacity Hard Countermeasure Index

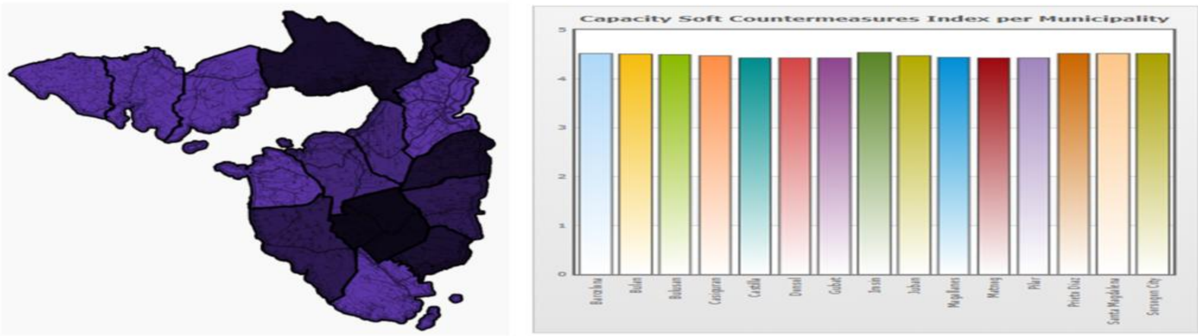


Color Code	Range	Remarks	Interpretation
	0.00 - 0.49	Very Low Capacity Hard Countermeasures Index	Refers to areas which has very low capacity hard countermeasures for disasters. These areas has least government efficiency in terms of directives, investment, generating local resource, health services, school services, licensing systems, peace and order and social protection. In terms of infrastructure these areas has low road network, port distance, utilities, transport vehicles, education, health, accomodation and information technology capacity. Likewise, these areas has low resiliency in terms of landuse, DRR plan, disaster drill, warning systems, budget for DRRMP, employment and sanitation.
	0.50 - 0.99	Low Capacity Hard Countermeasures Index	Refers to areas which has low capacity hard countermeasures for disasters. These areas has least government efficiency in terms of directives, investment, generating local resource, health services, school services, licensing systems, peace and order and social protection. In terms of infrastructure these areas has low road network, port distance, utilities, transport vehicles, education, health, accomodation and information technology capacity. Likewise, these areas has low resiliency in terms of landuse, DRR plan, disaster drill, warning systems, budget for DRRMP, employment and sanitation.
	1.00 - 1.49	Moderate Capacity Hard Countermeasures Index	Refers to areas which has moderate capacity hard countermeasures for disasters. These areas has least government efficiency in terms of directives, investment, generating local resource, health services, school services, licensing systems, peace and order and social protection. In terms of infrastructure these areas has low road network, port distance, utilities, transport vehicles, education, health, accomodation and information technology capacity. Likewise, these areas has low resiliency in terms of landuse, DRR plan, disaster drill, warning systems, budget for DRRMP, employment and sanitation.
	1.50 - 1.99	High Capacity Hard Countermeasures Index	Refers to areas which has high capacity hard countermeasures for disasters. These areas has least government efficiency in terms of directives, investment, generating local resource, health services, school services, licensing systems, peace and order and social protection. In terms of infrastructure these areas has low road network, port distance, utilities, transport vehicles, education, health, accomodation and information technology capacity. Likewise, these areas has low resiliency in terms of landuse, DRR plan, disaster drill, warning systems, budget for DRRMP, employment and sanitation.
	2.00 - 2.49	Very High Capacity Hard Countermeasures Index	Refers to areas which has very high capacity hard countermeasures for disasters. These areas has least government efficiency in terms of directives, investment, generating local resource, health services, school services, licensing systems, peace and order and social protection. In terms of infrastructure these areas has low road network, port distance, utilities, transport vehicles, education, health, accomodation and information technology capacity. Likewise, these areas has low resiliency in terms of landuse, DRR plan, disaster drill, warning systems, budget for DRRMP, employment and sanitation.

Figure 8 presents the Capacity Hard Countermeasures Index (CHI) of Sorsogon Province's municipalities, reflecting government efficiency through Infrastructure, Resiliency, and Government indices. The top five municipalities are Sorsogon City (2.47 CHI), Magallanes (2.35 CHI), Bulan (2.20 CHI), Irosin (2.11 CHI), and Pilar (2.09 CHI). Santa Magdalena and Prieto Diaz have the lowest CHI at 0.0, as they did not meet the document requirements of the National Competitiveness Council of the Philippines (NCCP).

Figure 9

Capacity Soft Countermeasure Index

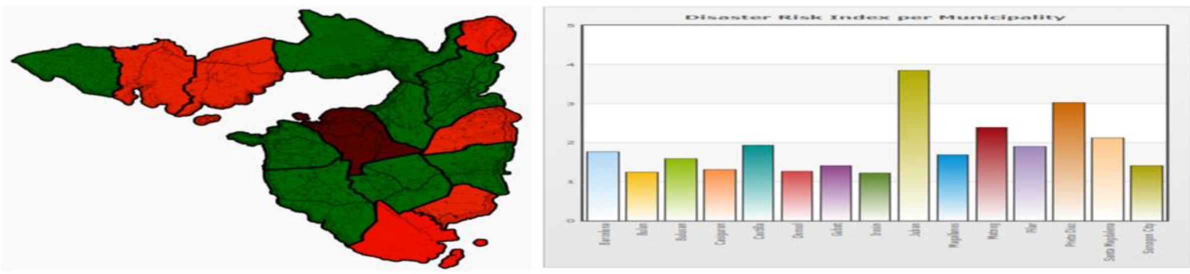


Color Code	Range	Remarks	Interpretation
	4.42 - 4.44	Very Low Capacity Soft Countermeasures Index	Refers to the areas which are very low in terms of capacity soft countermeasures for disasters. These areas are recorded with least literacy rating (both in simple and functional level). Likewise, access to information in these areas are limited due to low electrification index.
	4.45 - 4.47	Low Capacity Soft Countermeasures Index	Refers to the areas which are low in terms of capacity soft countermeasures for disasters. These areas are recorded with least literacy rating (both in simple and functional level). Likewise, access to information in these areas are limited due to low electrification index.
	4.48 - 4.50	Moderate Capacity Soft Countermeasures Index	Refers to the areas which are moderate in terms of capacity soft countermeasures for disasters. These areas are recorded with least literacy rating (both in simple and functional level). Likewise, access to information in these areas are limited due to low electrification index.
	4.51 - 4.53	High Capacity Soft Countermeasures Index	Refers to the areas which are high in terms of capacity soft countermeasures for disasters. These areas are recorded with least literacy rating (both in simple and functional level). Likewise, access to information in these areas are limited due to low electrification index.
	4.54 - 4.56	Very High Capacity Soft Countermeasures Index	Refers to the areas which are very high in terms of capacity soft countermeasures for disasters. These areas are recorded with least literacy rating (both in simple and functional level). Likewise, access to information in these areas are limited due to low electrification index.

Figure 9 presents the Capacity Soft Countermeasure Index (CSI) for each municipality in the Province of Sorsogon. This index measures the effectiveness of non-structural strategies in disaster preparedness, such as community awareness, education, emergency planning, and local governance initiatives. Areas shaded in dark violet indicate municipalities with the highest capacity for soft countermeasures, reflecting stronger preparedness and community resilience. In contrast, light violet areas represent municipalities with lower CSI values, suggesting a need for enhanced disaster readiness programs. The top five municipalities with the highest CSI are Irosin (4.54), Barcelona (4.52), Prieto Diaz (4.51), Santa Magdalena (4.51), and Sorsogon City (4.51). Meanwhile, Gubat registers the lowest CSI at 4.42, indicating the potential for improvement in its disaster preparedness measures.

Figure 10

Disaster Risk Index of the Municipalities in the Province of Sorsogon



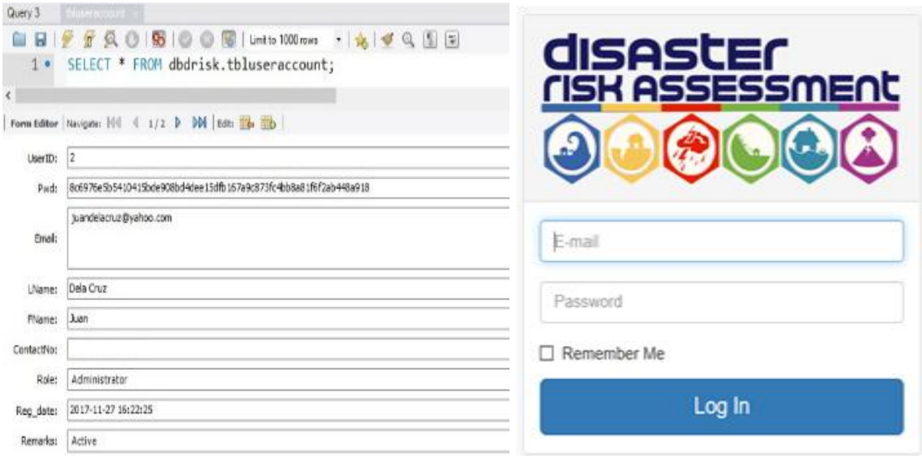
Color Code	Range	Remarks	Interpretation
	1.22 - 1.75	Very Low Disaster Risk Index	Refers to the least disaster prone areas. These areas has least hazard, exposure, and vulnerability index. Likewise, these areas has the highest countermeasures both in capacity hard and soft indicators.
	1.76 - 2.29	Low Disaster Risk Index	Refers to the low disaster prone areas. These areas has low hazard, exposure, and vulnerability index. Likewise, these areas has higher countermeasures both in capacity hard and soft indicators.
	2.30 - 2.83	Moderate Disaster Risk Index	Refers to the moderate disaster prone areas. These areas has moderate hazard, exposure, and vulnerability index. Likewise, these areas has moderate countermeasures both in capacity hard and soft indicators.
	2.84 - 3.37	High Disaster Risk Index	Refers to the high disaster prone areas. These areas has high hazard, exposure, and vulnerability index. Likewise, these areas has low countermeasures both in capacity hard and soft indicators.
	3.38 - 3.91	Very High Disaster Risk Index	Refers to the highest disaster prone areas. These areas has highest hazard, exposure, and vulnerability index. Likewise, these areas has the lowest countermeasures both in capacity hard and soft indicators.

Figure 10 illustrates the Disaster Risk Index (DRI) for each municipality in the Province of Sorsogon, providing a measure of disaster proneness based on factors such as exposure, vulnerability, and capacity to manage risks. This index helps identify areas most at risk during natural calamities, enabling targeted disaster preparedness and risk reduction strategies. Municipalities shaded in darker colors represent higher disaster risk, while lighter shades indicate relatively lower risk levels. According to the data, the top five most disaster-prone municipalities are Juban with the highest DRI of 3.85, followed by Prieto Diaz (3.02), Matnog (2.39), Santa Magdalena (2.12), and Castilla (1.93). These areas are more susceptible to the impacts of disasters due to their geographic location, infrastructure resilience, and community preparedness. On the other hand, Irosin has the lowest DRI in the province at 1.22, indicating better resilience and reduced disaster vulnerability compared to the others. This information is crucial for local government units to prioritize disaster management efforts and resource allocation.

Security Module. This feature ensures the system user's authenticity. This module helps improve the reliability of the system's stored and generated information through an embedded security mechanism called the SHA256 function. This Secure Hash Algorithm (SHA)-256 algorithm generates an almost unique size 256-bit (32-byte) hash, which makes it suitable for password validation, challenge hash authentication, anti-tamper, and digital signatures.

Figure 11

SHA-256 Algorithm and Login Verification



The SHA-256 algorithm is a cryptographic hashing algorithm used to determine the integrity of a particular piece of data commonly used by SSL certificate authorities to sign certificates. The 64 alphanumeric character combinations strengthen the system's security compared to using primitive data types such as varchar. Login authentication gets the e-mail and password of the system user. The system has two levels of authority: the administrator and the guest. The administrator has full control of the system's functionality, while the guest is limited to viewing only stored information and reports generated by the system. Upon entering the correct authentication information, the user can directly control the system's main feature, which includes updating personal account information. An error message will be displayed in case of mismatched or invalid entries, and there are no limits in logging into the system. Using hashing and log-in authentication increases the system's security, securing the data gathered and extracted from social media posts and maintaining the integrity of the data (Algredo-Badillo et al., 2022; Mohanty et al., 2022).

Usability Level of the Proposed System

For this study, the level of usability was measured in three (3) terms, including Satisfaction and Ease of Use. The researcher used the USE Questionnaire and ISO/IEC 9126 to measure the quality of the developed system. The succeeding tables present the stakeholders' usability ratings and the evaluation interpretation. The responses were computed using the Weighted Mean formula, which the Adjective Description interpreted.

Usefulness of the Proposed System. This evaluation refers to a set of indicators that measure the proposed system's overall usefulness.

Table 5.
Level of Usefulness of the Proposed System

Item	Indicator	WM	Adj. Desc.
1	The system can provide significant information in relation to disaster risk for the province of Sorsogon.	4.07	HU
2	Data mining from social media is of great help in determining the extent of such disasters.	4.00	VU
3	The system offers consolidation of various information needed for disaster risk assessment.	4.00	VU
4	The system-generated results are usable for decision-making activity.	4.00	VU
5	The system can operate on any available platform.	4.13	VU
	Over-all	**4.04**	**HU**

Legend: HU – highly useful; VU – very useful

Table 5 shows the developed system's usefulness level, with an overall rating of 4.04, which means that it was highly useful. The above evaluation result for the proposed system's usefulness shows that the system's features are useful as a decision support system for the PDRRM decision-making activities. The proposed system's usefulness implies that it is visible and relevant to its users. When users become familiar with and able to receive warnings and information through the system, the system becomes more valuable and beneficial to improving disaster risk assessment and management (Sakurai & Murayama, 2019; Takemoto et al., 2019). Thus, it shall improve the disaster preparedness of the council through timely and actionable information. This evaluation shows how useful the developed system is regarding the council's various operational transactions. Insights from the interviews with the participants also revealed that the proposed system is especially useful in collating posted messages relating to disaster risk assessment on different social media platforms.

Satisfaction with the Proposed System. This index refers to a set of indicators that measure the reliability and fulfillment of the respondents' expectations or needs regarding the developed system.

Table 6.
Level of Satisfaction with the Proposed System

Item	Indicator	WM	Adj. Desc.
1	The information being held by the system is safe and secure.	3.87	VS
2	When performing its function under stated conditions, the system is capable of providing appropriate response, processing, and throughput rates.	4.20	HS
3	The information that the system maintains is not susceptible to data corruption.	3.80	VS
4	The features of the system are well integrated according to its purpose.	4.00	VS
5	The information being held by the system reflects the actual situation of the disaster risk of the province.	4.13	HS
	Over-all	**4.00**	**VS**

Legend: HS – highly satisfied; VS – very satisfied

The positive and high ratings participants gave to all indicators of the level of satisfaction with the proposed system, as shown in Table 6, suggest that the proposed system effectively meets the needs and expectations of its users. The results presented in the table also highlight key aspects of the system's performance: high security and integrity of information, quick response and positive time, accurate and relevant information, and well-integrated and intuitive usability features. With the consistently high ratings on the components of user satisfaction relating to the usability of the proposed system, it can be inferred that the proposed system is well-designed with the user in mind during the development process.

The table also shows the respondents' satisfaction level with the developed system, which was weighted at 4.00, indicating a very usable state. In this index, the proposed system got three very high usability ratings for the first, third, and fifth Indicators. In contrast, a highly usable remark was accumulated for the second and fifth Indicators. In this context, the proposed system met the needs and expectations of the respondents. Studies show that users' satisfaction with disaster management systems reflects the effectiveness of the technical architecture, features, design interface, and system performance (Cvetković & Filipović, 2017; Tolentino et al., 2022). The high usability rating in this aspect means that the users are very satisfied with the proposed system and perceive it to be useful, interactive, and user-friendly. This underscores the system's high potential as a user-friendly tool for disaster risk management. The interactive and user-friendly nature of the proposed system adds to its potential for real-world applications in disaster risk assessment and management.

Ease of use of the Proposed System. This index refers to a set of indicators that measure the efficiency of the developed system.

Table 7.

Ease of Use of the Proposed System

Item	Indicator	WM	Adj. Desc.
1	The website orientation is easily understood, so anybody can use the system with ease even without proper training by simply observing the system's environment, layout, and page formatting. The design of icons also reflects the action they represent.	4.40	HU
2	The system's usage can be learned easily with the help of its built-in help mechanism. The web design and layout are also helpful in guiding the user in the proper use of the system.	4.20	HU
3	The feature of the system is very accessible and does not require specialized devices to use.	3.87	VU
4	The system provides an easy-to-use feature for collecting and extracting messages posted on social media.	4.33	HU
5	The stored information can be easily accessed and retrieved.	4.13	HU
	Over-all	**4.19**	**HU**

Legend: HU – highly usable; VU – very usable

The results in Table 7 show that the participants found the proposed system highly or very usable in ease of use. Most indicators received a highly usable rating, except for the third Indicator, which received a very usable (VU) rating. The findings demonstrate that the proposed system is perceived by the participants or users as a user-friendly and efficient tool, meeting high standards for ease of use across the indicators identified.

This is also reflected in the overall rating for the level of ease of use of the developed system, which is 4.19, which means that it was highly usable for managing process transactions and could be understood quickly. Likewise, it was also capable of generating results with accuracy and completeness. Most of the indicators for this index got a highly usable remark for ease of use except for the third Indicator, where a very usable remark was computed. The increased access to disaster-related information and having a system that encompasses all types of disaster within the province makes the proposed system more effective and user-friendly and, consequently, improve disaster risk assessment as agencies and people involved could get the needed warning and resources to prepare for the disaster right away (Tan et al., 2022). The system's intuitive design and effective help mechanism contribute to its high usability. The proposed system allows users to navigate and use its functions with minimal training and high precision. The above results generally show that the proposed system was user-friendly. These results indicate that the proposed system is efficient, adaptable, and accessible, making it a valuable tool for disaster risk assessment and management.

The table below shows the summary rating of the proposed system's usability. Upon evaluation from the stakeholders, the system received a mean score of 4.08, indicating that it was highly usable.

Table 8.

Summary Table on the Level of Usability of the Proposed System

Index	**Weighted Mean**	
Usefulness	4.04	
Satisfaction	4.00	
Ease of Use	4.19	
LEVEL OF USABILITY	4.08	Highly Usable
	Overall Mean	**Verbal Interpretation**

The high usability rating on the overall level of usability of the proposed system implies that it is beneficial, satisfying, and easy to use and navigate for users (Loberes et al., 2025). With a positive rating for the proposed system, its utilization can improve disaster risk assessment and reduction. The proposed system can still be enhanced to address development gaps and has the potential for a bigger scale of implementation of disaster risk assessment.

Thematic Analysis of Proposed System Usability

The quantitative findings were also supported by the deductive thematic analysis of data gathered from semi-structured interviews that the researcher conducted with the participants (Lasala et al., 2025b). Three key themes emerged from the analysis to support the proposed system's high usability: intuitive design, practical functionality, and high user satisfaction. The table below shows the thematic coding results of the qualitative data for the system's usability testing.

Table 9.
Coding for Thematic Analysis of the Proposed System's Usability

Themes/ Codes	**Number of Participants Contributing (N=15)**	**Number of Transcript excerpts assigned**	**Sample Quotes**
Intuitive design	13	19	"The system's layout and design are very easy to understand. I could use its features with ease." (P11)
Effective Functionality	9	15	"Collecting and analyzing data from social media posts, with the proposed system, is simple and effective."
User Satisfaction	8	8	"The proposed system met our needs and exceeded our expectations. Although it is still a prototype, I am very satisfied with it."

The participants repeatedly acknowledge the intuitiveness of the proposed system. They emphasized that they could have done more extensive training to understand the system's mechanism in assessing and navigating disaster risks. The proposed system's layout and design allow users to efficiently and effectively navigate and conduct a disaster risk assessment with the help of the SVM algorithm and risk indicators utilized by the proposed system. The participants particularly praised the system's layout and iconography as contributing factors to its intuitiveness. The numerous remarks on the intuitive design of the proposed system reflect its high usability scores, especially in terms of ease of use index.

Another recurring theme in the proposed system's high usability is its effective functionality. The participants appreciated the system's numerous and intuitive functioning features. The features integrated into the proposed system provide essential functionalities for accurate and time-responsive disaster risk assessment. Participants also highlighted the effectiveness and efficiency of data mining and consolidation from social media platforms when using the proposed system. This supports participants' high scores on the proposed system's usability, specifically regarding the usefulness index.

Additionally, a high level of user satisfaction was also reported repeatedly during the interviews with the participants. As the users of the proposed system, the participants expressed their confidence in using it and its reliability, security, and accuracy. Most of the participants collectively agreed that the proposed system met their needs and expectations, which aligns with the high usability scores they gave in terms of the level of satisfaction index. These qualitative findings from thematic analysis align with the quantitative findings. These also highlight the strengths of the proposed system as a potential disaster risk assessment tool.

Conclusion

This study navigated the complexities of disaster risk assessment, leveraging innovative and technological approaches to improve understanding of the role of social media and the benefits of using the SVM algorithm in disaster risk assessment and management. This study developed and proposed a system using the SVM algorithm and information requirements from social media and risk indicators to shed light on the broader implications for disaster management and decision-making. The information requirements from social media and historical records are usable to assess the disaster risk of the municipalities in the Province of Sorsogon. Identifying the level of disaster proneness and measuring the frequency of posted social media messages could increase the awareness of the personnel in charge of disaster management (SPDRRMO) for better decision-making activity, which could mitigate the impact of such a disaster.

Additionally, it is concluded that linear kernel support vector classifiers can be used as a framework for disaster risk assessment, especially when the text problem refers to binary classification. The integration of the linear kernel SVM framework proves to be a judicious choice, substantiated by its capacity to categorize disaster-related social media messages effectively.

The proposed system's features offer convenience in managing disaster risk assessment. Features like the data collection and extraction module, the disaster risk assessment module, and the security module make it easier to access timely and relevant information necessary to improve disaster risk assessment. With the features integrated in the proposed system, users can assess disaster risks more effectively.

For the result, the indices highlight the disaster risk levels across Sorsogon Province, with Juban ranking highest in overall Disaster Risk Index (DRI) and in Exposure, Sta. Magdalena in Hazard, and Bulan in Vulnerability. Sorsogon City leads in Capacity Hard Countermeasures, while Donsol and Irosin have the lowest risk levels.

Upon evaluation, based on quantitative and qualitative analyses, the proposed system was highly usable for disaster risk assessment in terms of usefulness, user satisfaction, and ease of use. This means that the users perceived the proposed system as functioning, efficient, user-friendly, and highly performing. The different features of the proposed system contributed to its high usability rating based on the user's perceptions.

Based on the conclusions, integrating social media data and the SVM algorithm, particularly the Linear Kernel framework, can be integral to comprehensive disaster risk assessment strategies. To gain broader community engagement, continued refinement of its features and interfaces is also recommended. The iterative nature of system development allows for changes and refinement of the proposed system for better disaster risk assessment and management.

Furthermore, disseminating and promoting recommended hashtags per municipality is crucial for maximizing the potential of social media platforms in disaster risk assessment. Incorporating these hashtags when posting or reporting disaster-related situations will significantly enhance data extraction and disaster risk assessment. Community awareness of these recommended hashtags can improve disaster risk assessment performance and results.

Collaboration with relevant government agencies, disaster response teams, and community leaders is recommended to ensure the integration of the proposed system into the existing disaster management system. As disaster risk assessment and management is a collaborative effort, the proposed system can be enhanced to foster more collective efforts from the community. By embracing these recommendations, the outcomes can be improved, and the proposed system can be optimized.

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