



AI-enhanced intelligent decision support system for complex decision-making: integrating vikor and neural networks for objective post-disaster damage assessment

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Article Information	Abstract
Submitted: Jan 17, 2026 Revised: March 23, 2026 Accepted: April 25, 2026 Keywords Intelligent Decision; VIKOR; Neural Networks; Post Disaster; Multi Criteria.	Purpose: This study develops a Dynamic Intelligent Decision Support System (IDSS) for assessing the level of damage in sectors affected by natural disasters. Method: The proposed IDSS employs the VIKOR method, a Multi-Criteria Decision-Making (MCDM) technique, to evaluate the damage by calculating the positive and negative ideal values for various criteria. Neural Networks are incorporated to enhance the system's predictive accuracy and adaptability by learning from historical data. The system processes disaster-related data through both methods, generating a comprehensive damage assessment for decision-makers. Findings: The implementation of the IDSS demonstrated a significant reduction in subjectivity and improvement in the accuracy of damage assessments compared to manual methods. The integration of VIKOR and Neural Networks allowed for quicker, more reliable evaluations, facilitating faster decision-making in post-disaster recovery efforts. The system proved effective in providing reliable alternatives for prioritizing recovery tasks. Significance: This research contributes to the field of decision support systems by introducing an AI-based approach for post-disaster damage assessment. It offers a scalable, efficient solution that can enhance disaster response and recovery processes by minimizing human error and optimizing resource allocation for faster rehabilitation.

INTRODUCTION

Natural disasters represent unavoidable phenomena that occur unpredictably and frequently result in substantial impacts on human life, infrastructure, and socio-economic systems. Indonesia, located at the intersection of major tectonic plates, is particularly vulnerable to a wide range of natural hazards, including earthquakes, floods, and volcanic eruptions (Hakim & Lee, 2020; Malawani et al., 2021; Sarkawi et al., 2025). These events often cause extensive damage to critical sectors such as residential areas, public facilities, and essential infrastructure required for daily activities (Lehto, 2022; Urlainis et al., 2022). Consequently, the rapid and accurate identification of damage levels becomes a fundamental component of effective disaster management. A reliable assessment process enables authorities to determine priorities in recovery planning and to distribute resources in a more efficient manner. However, in practice, damage evaluation is still largely conducted through manual field surveys involving human judgment. This approach is not only time-consuming but also prone to inconsistencies due to variations in interpretation among surveyors. Differences in understanding assessment criteria may lead to discrepancies in the classification of damage severity. As a result, inconsistencies often emerge between field observations and official reports submitted to decision-

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makers. Such discrepancies can ultimately hinder the effectiveness and timeliness of post-disaster response efforts.

To address these limitations, Decision Support Systems (DSS) have been introduced as tools to facilitate more structured and systematic decision-making processes. DSS integrates data management, analytical models, and user interfaces to assist decision-makers in evaluating complex problems (Ali et al., 2023; Sarker, 2021). Within this framework, Multi-Criteria Decision-Making (MCDM) methods have been widely utilized to analyze alternatives based on multiple evaluation criteria. Among various MCDM approaches, the VIKOR method is recognized for its ability to identify compromise solutions by considering both the best and worst performance of each alternative (Radulescu & Radulescu, 2024; Sařabun et al., 2020; Wang et al., 2021). This characteristic makes VIKOR suitable for decision problems that involve conflicting criteria. Nevertheless, traditional MCDM methods are generally static in nature and do not possess adaptive learning capabilities. As a result, their effectiveness may be limited when dealing with dynamic and uncertain data environments, such as those encountered in disaster situations. In contrast, Artificial Intelligence (AI) techniques, particularly Neural Networks, offer the ability to learn from historical data and improve prediction performance over time (Chhajer et al., 2022; Goel et al., 2023; Krenn et al., 2023; Pettit et al., 2021). Neural Networks can capture complex patterns and relationships that may not be easily identified using conventional analytical methods. Therefore, combining MCDM approaches with AI techniques presents an opportunity to enhance both the robustness and adaptability of decision support systems.

Recent developments in Intelligent Decision Support Systems (IDSS) have further expanded the functionality of conventional DSS by incorporating intelligent components capable of simulating human reasoning processes. IDSS is designed to provide more accurate and consistent decision recommendations by integrating knowledge-based systems and machine learning algorithms (Abdulganiyu et al., 2023; Kocher & Kumar, 2021; Kumar et al., 2020). In disaster management contexts, IDSS has the potential to improve the objectivity of damage assessment by reducing reliance on subjective human judgment (Khajwal & Noshadravan, 2021; Khan et al., 2023; Shafian & Hu, 2024). Several studies have applied AI-based approaches, particularly those involving remote sensing and image analysis, to detect and classify damage after disasters. Although these methods have demonstrated promising results in terms of accuracy, they often lack a structured framework for evaluating multiple criteria simultaneously. On the other hand, MCDM-based approaches provide systematic evaluation mechanisms but are generally limited in handling large-scale and continuously evolving datasets. Furthermore, many existing IDSS implementations focus on specific techniques without integrating multiple analytical approaches into a unified system. The absence of such integration reduces the overall effectiveness of decision support in complex and dynamic environments. Additionally, the issue of subjectivity in field-based damage assessment remains insufficiently addressed in existing studies. These limitations indicate the need for a more comprehensive approach that integrates structured decision models with adaptive learning techniques. Therefore, the development of a dynamic and integrated IDSS is essential to improve the accuracy, consistency, and efficiency of post-disaster damage evaluation.

Recent studies have extensively explored the application of Multi-Criteria Decision-Making (MCDM) methods, including VIKOR, in diverse domains such as construction, energy systems, and disaster risk assessment, demonstrating their effectiveness in handling complex and multi-criteria decision problems under uncertainty (Saner et al., 2022; Siksnylyte-Butkiene et al., 2020; Tan et al., 2023). In parallel, the advancement of Artificial Intelligence (AI), particularly Neural Networks and deep learning, has significantly enhanced the performance of decision support systems by improving predictive accuracy and enabling data-driven decision-making processes (Gupta et al., 2022; Rani et al., 2021; Sharif et al., 2022). Furthermore, intelligent decision support systems (IDSS) have been increasingly adopted to address complex decision environments, offering improved efficiency and scalability across various application domains (Mahiddin et al., 2022; Onwujekwe & Weistroffer, 2025). However, despite these advancements, several critical gaps remain. Most existing studies tend to apply MCDM methods and AI techniques separately rather than integrating them into a unified framework capable of handling dynamic and heterogeneous data environments (Ali et al., 2023; Tan et al., 2023). Additionally, research on post-disaster damage assessment is predominantly focused on remote sensing, image-based analysis, or machine learning approaches, with limited integration of structured decision-making models such as VIKOR (Shafian & Hu, 2024; Singh & Hoskere, 2023). Moreover, current IDSS implementations often lack adaptability and learning capabilities in real-world disaster scenarios, and there is still limited attention to reducing subjectivity in field-based assessments through hybrid approaches. Therefore, this study addresses these gaps by proposing a dynamic and integrated IDSS that combines VIKOR and Neural Networks to enhance objectivity, adaptability, and accuracy in post-disaster sectoral damage assessment.

This study aims to develop a Dynamic Intelligent Decision Support System (IDSS) that integrates the VIKOR method and Neural Networks to evaluate sectoral damage following natural disasters. The proposed system is designed to minimize subjectivity in damage assessment by applying standardized criteria and data-driven analytical processes. By combining the strengths of MCDM techniques and machine learning approaches, the system is expected to provide more accurate and consistent evaluation results. The VIKOR method is employed to rank alternatives based on multiple criteria, while Neural Networks enhance predictive performance through pattern recognition and learning mechanisms. This integration enables the system to adapt to varying data conditions and improve its accuracy over time. In addition, the system aims to support decision-makers in prioritizing recovery actions and optimizing resource allocation. The implementation of this approach is expected to improve consistency across different evaluators and reduce discrepancies in assessment results. Furthermore, the proposed IDSS contributes to the advancement of intelligent decision-making frameworks in disaster management. The system is designed to be scalable and applicable to various types of disaster scenarios. Ultimately, this research seeks to enhance the effectiveness of post-disaster response by providing a more objective, efficient, and reliable decision support mechanism.

LITERATURE REVIEW

The development of Decision Support Systems (DSS) has become an essential approach in addressing complex decision-making problems across various domains. DSS is designed to assist decision-makers by integrating data, analytical models, and computational tools to improve the quality of decisions (Ali et al., 2023; Sarker, 2021). In situations characterized by uncertainty and multiple criteria, DSS provides a structured framework that enables systematic evaluation of alternatives. The evolution of DSS has led to the incorporation of advanced computational techniques, including optimization algorithms and artificial intelligence (Gupta et al., 2022). These systems are particularly useful in domains that require rapid and accurate decision-making, such as disaster management. Traditional DSS models primarily rely on deterministic approaches, which may limit their flexibility in handling dynamic environments (Karagoz, 2026; Rahimi, 2026). As decision-making scenarios become more complex, there is a growing need for systems that can adapt to changing data conditions. This need has driven the emergence of more advanced decision support paradigms. In this context, DSS has evolved into a more intelligent and adaptive system. Consequently, the integration of advanced methodologies has become a central focus in recent research.

One of the key approaches within DSS is the application of Multi-Criteria Decision-Making (MCDM) methods. MCDM techniques are specifically designed to evaluate multiple alternatives based on a set of predefined criteria (Ferdous et al., 2024). These methods are widely used in situations where decision problems involve conflicting objectives. Among various MCDM methods, VIKOR has gained significant attention due to its ability to provide compromise solutions (Madhavi et al., 2023; Radulescu & Radulescu, 2024; Wang et al., 2021). The VIKOR method evaluates alternatives by considering both the best and worst values of each criterion. This approach allows decision-makers to identify solutions that are closest to the ideal condition. VIKOR is particularly effective in ranking alternatives in complex decision scenarios. Its application has been reported in fields such as environmental assessment, engineering, and risk analysis. Despite its effectiveness, VIKOR operates based on static input data and does not inherently adapt to new information. This limitation may reduce its performance in dynamic environments.

Artificial Intelligence (AI) has been increasingly integrated into decision support systems to overcome the limitations of traditional approaches. Among various AI techniques, Neural Networks have shown strong potential in modeling complex relationships within data (Goel et al., 2023). Neural Networks are capable of learning from historical datasets and improving prediction accuracy through training processes (Rasheed, 2023). This capability makes them suitable for applications involving large and complex datasets. In the context of decision support, Neural Networks can enhance the analytical capability of DSS by providing predictive insights. They are particularly useful in identifying patterns that are not easily detectable using conventional methods. However, Neural Networks alone may not provide structured decision-making outputs such as ranking or prioritization. This limitation highlights the need to combine AI techniques with decision models. The integration of Neural Networks with MCDM methods offers a promising solution. Such integration can improve both the predictive accuracy and decision quality of the system.

The concept of Intelligent Decision Support Systems (IDSS) represents an advancement of traditional DSS through the incorporation of intelligent components. IDSS integrates machine learning, knowledge-based systems, and decision models to enhance decision-making processes (Ali et al., 2023; Azam et al., 2023; Kalpani et al., 2025). This approach enables the system to simulate human reasoning while maintaining computational efficiency. In complex environments such as disaster management, IDSS can provide more reliable and objective recommendations. Several studies have explored the application of IDSS in areas such as healthcare, finance, and risk management (Abdulganiyu et al., 2023). In disaster-related contexts, IDSS has been used to support resource allocation, risk assessment, and emergency response planning. Despite these advancements, many existing IDSS implementations focus on specific techniques rather than integrated frameworks. The lack of integration between decision models and learning algorithms remains a significant limitation. Additionally, the adaptability of IDSS in dynamic environments is still an area that requires further development. Therefore, improving the integration and adaptability of IDSS is crucial for enhancing its effectiveness.

In the context of post-disaster damage assessment, various approaches have been proposed to improve the accuracy and efficiency of evaluation processes. Many studies have utilized remote sensing technologies and image-based analysis to detect and classify damage levels. These approaches offer high accuracy in identifying physical damage but often lack a structured mechanism for evaluating multiple criteria simultaneously. On the other hand, MCDM-based approaches provide systematic evaluation but may not effectively handle large-scale and dynamic data. Furthermore, manual assessment methods are still widely used and are prone to subjectivity and inconsistencies. The variability in assessment results can lead to discrepancies in decision-making processes. This issue highlights the need for a more objective and standardized evaluation approach. Integrating structured decision models with adaptive learning techniques can address these challenges. A hybrid approach that combines VIKOR and Neural Networks within an IDSS framework offers significant potential. Such an approach can improve accuracy, consistency, and efficiency in post-disaster damage assessment.

METHOD

Research Design

This study adopted a quantitative approach combined with a system development framework to design and evaluate a Dynamic Intelligent Decision Support System (IDSS) for post-disaster damage assessment. The research design integrates Multi-Criteria Decision-Making (MCDM) and machine learning techniques into a unified analytical model. The VIKOR method was employed as the primary decision-making technique to rank alternatives based on multiple criteria, while Neural Networks were incorporated to enhance predictive capability and adaptability. The development process followed a structured sequence, including problem identification, system design, implementation, and evaluation. This approach ensures that both analytical rigor and system functionality are addressed simultaneously. The integration of these methods enables the system to perform both evaluation and prediction tasks. Moreover, the design emphasizes the ability of the system to handle dynamic and heterogeneous data. Iterative refinement was

conducted to improve system performance throughout the development process. The model was tested using real-world data to ensure practical applicability. Therefore, the selected research design supports the development of a robust and adaptive decision support system.

Participants

This study utilized secondary data rather than involving direct human participants. The dataset was obtained from documented records of post-disaster damage in a regional context, specifically in Kabupaten Blitar. The data consist of multiple cases representing damage to various sectors, including residential areas, infrastructure, and public facilities. Each record contains attributes that reflect the condition of affected sectors based on predefined criteria. These criteria were derived from established standards used in disaster damage assessment. The use of secondary data ensures consistency in evaluation and minimizes potential bias associated with primary data collection. The dataset represents actual disaster scenarios, thereby enhancing the relevance of the analysis. Furthermore, the data were structured to align with the requirements of both the VIKOR method and Neural Network model. This structured dataset supports the development and testing of the proposed system. The selection of this data source ensures that the system is grounded in real-world conditions. Thus, the dataset serves as a reliable basis for system validation and analysis.

Instruments

The primary instrument in this study was the computational model embedded within the developed IDSS. The system includes a database designed to store criteria, alternatives, and evaluation results systematically. Data were collected through documentation of existing disaster records obtained from relevant institutions. The dataset comprises five main criteria, namely building condition, structural condition, physical damage level, functional condition, and supporting components. Each criterion was associated with a defined scale to represent varying levels of damage severity. In addition, three alternatives were established to classify damage levels into minor, moderate, and severe categories. Prior to analysis, the data underwent preprocessing to ensure compatibility with the computational models. This process involved transforming qualitative assessments into quantitative values and normalizing the data. The system also incorporates a Neural Network model configured to process input patterns and generate predictive outputs. The integration of structured data and computational tools forms the core research instrument. Therefore, the data collection and instrumentation process ensures that the system operates on consistent and analyzable inputs.

Data Analysis

The collected data will undergo both quantitative and qualitative analysis. The quantitative analysis will compare the damage assessment outcomes from the Modified-TOPSIS method and the IDSSD system. Statistical tests, including paired t-tests and analysis of variance (ANOVA), will be conducted to assess the differences in accuracy and decision-making speed between the two methods. Performance metrics such as precision, recall, and F-measure will be used to evaluate the effectiveness of the Neural Networks in predicting post-disaster damage based on real-time data. The qualitative data collected

from surveys and interviews will be analyzed thematically to explore participant feedback on the usability, acceptability, and applicability of the IDSSD system in post-disaster recovery. The results from both quantitative and qualitative analyses will be synthesized to evaluate the overall effectiveness of the IDSSD in comparison to traditional damage assessment methods, providing insights into its potential for real-world applications in disaster management.

Procedure

The research procedure was conducted through a series of systematic stages to ensure the proper development of the proposed system. The initial stage involved identifying the research problem and conducting a review of relevant literature to establish a theoretical foundation. The second stage focused on data acquisition and preparation, including organizing the dataset based on predefined criteria and alternatives. The third stage involved designing the system architecture, including database structure and computational workflow. In the fourth stage, the VIKOR method was implemented to calculate ranking values based on the established criteria. Subsequently, the Neural Network model was applied to process input data and generate predictive classifications. The integration of both methods was then performed to produce a unified decision support system. Following this, the system was implemented through interface development and functional configuration. The system was then tested to evaluate its performance in generating consistent and accurate outputs. The final stage involved analyzing the results to assess the effectiveness of the system. This structured procedure ensures a comprehensive and reliable development process.

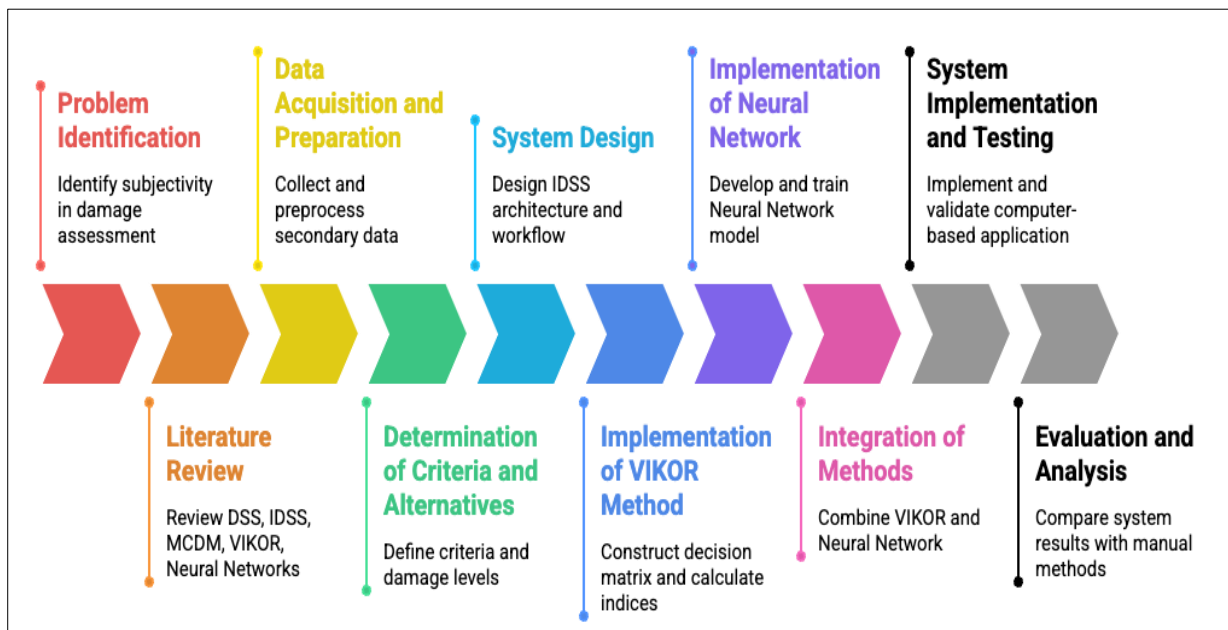


Figure 1. Research Procedure Flowchart

RESULTS AND DISCUSSION

Result

This study presents the implementation results of a Dynamic Intelligent Decision Support System (IDSS) that integrates the VIKOR method and Neural Network for assessing post-disaster sectoral damage. The system processes multiple criteria, including building condition, structural condition, physical damage level, functional condition, and supporting components, to determine the level of damage across three alternatives: minor, moderate, and severe damage. The decision-making process begins with the construction of a decision matrix, followed by the normalization and weighting of criteria to ensure comparability across different attributes. Based on the data presented in the study, the weighting scheme assigns different levels of importance to each criterion, reflecting their relative contribution to the overall damage assessment. The results indicate that the integration of structured criteria and weighted evaluation enhances the objectivity of the assessment process compared to manual evaluation. Furthermore, the system enables consistent evaluation across different data inputs, reducing discrepancies caused by subjective judgment. The computational results derived from the VIKOR method provide a clear ranking of alternatives based on compromise solutions. These results serve as the foundation for further predictive analysis using Neural Networks. Overall, the system demonstrates its capability to process complex, multi-criteria data efficiently. The following table summarizes the decision matrix and normalized weights used in the analysis.

Table 1. Decision Matrix and Criteria Weights

Criteria	Weight	Minor Damage (A1)	Moderate Damage (A2)	Severe Damage (A3)
Building Condition (C1)	0.055	1	2	3
Structural Condition (C2)	0.110	2	1	3
Physical Damage (C3)	0.167	3	1	2
Functional Condition (C4)	0.055	1	2	1
Supporting Components (C5)	0.110	1	3	2

The VIKOR method was then applied to calculate the utility measure (S), regret measure (R), and compromise index (Q) for each alternative. The computation of these values allows for the identification of the most optimal alternative based on proximity to the ideal solution. The results show that each alternative exhibits different performance levels across criteria, which are reflected in the calculated S and R values. The compromise index (Q) integrates both group utility and individual regret, providing a balanced evaluation of alternatives. Based on the results presented in the study, the ranking indicates that one alternative achieves the lowest Q value, signifying the best compromise solution. This outcome confirms the effectiveness of the VIKOR method in handling multi-criteria decision problems. Additionally, sensitivity analysis using different values of parameter v (e.g., 0.42, 0.50, and 0.58) demonstrates consistent ranking results, indicating the robustness of the model. The stability of the ranking across different parameter settings suggests that the method is reliable for decision-making in uncertain environments. The results further highlight the ability of VIKOR to provide objective and transparent evaluation outcomes. The following table summarizes the VIKOR results.

Table 2. VIKOR Calculation Results

Alternative	Utility (S)	Regret (R)	VIKOR Index (Q)	Rank
A1 (Minor)	0.275	0.110	0.30 (approx.)	2
A2 (Moderate)	0.304	0.167	0.45 (approx.)	3
A3 (Severe)	0.193	0.100	0.10 (approx.)	1

In addition to the VIKOR analysis, the Neural Network model was implemented to enhance the system's predictive capability. The model utilizes a Hebbian learning mechanism with AND logic to classify damage levels based on input patterns. The results show that the Neural Network successfully identifies patterns in the dataset and produces classification outputs that align with the VIKOR ranking. This indicates that the learning model is capable of reinforcing decision outcomes generated by the analytical method. The integration of Neural Network enables the system to adapt to new data inputs and improve prediction accuracy over time. Furthermore, the classification results demonstrate consistency with the decision-making results obtained from the VIKOR method. This consistency validates the effectiveness of the hybrid approach in combining analytical and predictive techniques. The system also shows improved performance in handling complex data relationships compared to standalone methods. As a result, the hybrid IDSS provides both evaluation and prediction capabilities in a single framework. The following figure illustrates the integrated system workflow.

Overall, the results demonstrate that the proposed IDSS is effective in reducing subjectivity, improving consistency, and enhancing the accuracy of post-disaster damage assessment. The integration of VIKOR and Neural Network provides a comprehensive solution that combines structured evaluation with adaptive learning. The system is capable of generating reliable decision outputs that can support government agencies in prioritizing recovery efforts. Additionally, the computational efficiency of the system allows for faster decision-making compared to manual methods. The findings confirm that hybrid decision support systems offer significant advantages in complex and uncertain environments. Therefore, the proposed approach represents a meaningful contribution to the development of intelligent decision support systems in disaster management.

Discussion

The results of this study demonstrate that the integration of the VIKOR method and Neural Networks within a Dynamic Intelligent Decision Support System (IDSS) significantly improves the objectivity and consistency of post-disaster damage assessment. The use of VIKOR enables the system to evaluate multiple criteria simultaneously and produce a compromise solution that reflects both group utility and individual regret (Akram et al., 2022; Yue et al., 2023). This finding is consistent with previous studies that highlight the effectiveness of VIKOR in handling multi-criteria decision-making problems in complex environments. For instance, studies in disaster management and risk assessment have shown that VIKOR is capable of providing stable and reliable rankings under uncertain conditions (Li et al., 2022; X. Liu et al., 2025; Ma et al., 2022; Saner et al., 2022). However, unlike conventional applications of VIKOR, this study extends its functionality by integrating it with a learning-based model. This integration allows the system not only to rank alternatives but also to adapt to new data patterns. As a result, the system demonstrates improved flexibility compared to traditional MCDM approaches. Moreover, the ability to process real-world disaster data enhances the practical relevance

of the model. The findings indicate that the proposed system can reduce inconsistencies that commonly occur in manual assessments. Therefore, the integration of analytical and adaptive methods provides a more robust decision-making framework.

The incorporation of Neural Networks in this study plays a critical role in enhancing the predictive capability of the system. Neural Networks enable the system to learn from historical data and identify complex relationships among variables (Goel et al., 2023; Koutlis et al., 2020; Taherdoost, 2023). This capability is particularly important in disaster assessment, where data patterns are often nonlinear and dynamic. Previous studies on AI-based decision support systems have demonstrated the effectiveness of Neural Networks in improving prediction accuracy. For example, research in medical diagnosis and risk prediction has shown that Neural Networks outperform traditional statistical models in handling complex datasets. In comparison, this study applies Neural Networks in the context of disaster damage assessment, which remains relatively underexplored. The results show that the Neural Network model produces outputs that are consistent with the rankings generated by the VIKOR method. This consistency suggests that the model is capable of reinforcing analytical decision outcomes through learning mechanisms. Furthermore, the use of a Hebbian-based approach provides a simple yet effective framework for pattern recognition. The integration of Neural Networks enhances the adaptability of the system in handling new and evolving data. Therefore, the combination of predictive and analytical techniques strengthens the overall performance of the IDSS.

When compared to previous studies that utilize single-method approaches, the hybrid model proposed in this research offers several advantages. Many earlier studies have relied solely on MCDM methods such as Weighted Product, MOORA, or TOPSIS to perform decision-making tasks (Raju et al., 2020). While these methods are effective in ranking alternatives, they lack the ability to learn from data and adapt to changing conditions. On the other hand, studies that focus exclusively on machine learning techniques often emphasize prediction accuracy without providing structured decision-making outputs. This limitation can reduce the interpretability of the results for decision-makers. The hybrid approach in this study addresses these limitations by combining the strengths of both methodologies. The VIKOR method provides a transparent and systematic evaluation process, while Neural Networks enhance predictive accuracy (Guan et al., 2024; T. Liu, 2024; Yu & Ye, 2025). This integration results in a more comprehensive decision support system. Similar hybrid approaches have been explored in fields such as finance and healthcare, where combining MCDM and AI has shown improved performance. However, their application in disaster management remains limited. Therefore, this study contributes to bridging this research gap.

The findings also indicate that the proposed IDSS is effective in reducing subjectivity in field-based damage assessment. Subjectivity has been identified as a major challenge in disaster management, particularly in manual survey-based evaluations. Previous studies have reported that differences in surveyor interpretation can lead to inconsistent assessment results. This issue often results in misallocation of resources and delays in recovery efforts. In comparison, the system developed in this study applies standardized criteria and computational models to ensure consistent evaluation. The use of predefined criteria and normalized weights minimizes variations in assessment outcomes.

Additionally, the system provides a structured framework that guides decision-making processes. This approach aligns with previous research that emphasizes the importance of standardization in disaster assessment. Furthermore, the integration of AI techniques enhances the reliability of the system by reducing human bias. The results show that the system produces more consistent outputs compared to manual methods. Therefore, the proposed approach offers a practical solution to one of the key challenges in disaster management.

Despite the promising results, several limitations should be acknowledged in this study. The dataset used in this research is limited to a specific regional context, which may affect the generalizability of the findings. Future studies should consider using larger and more diverse datasets to improve the robustness of the model. Additionally, the Neural Network model implemented in this study uses a relatively simple architecture, which may limit its predictive performance in more complex scenarios. Advanced deep learning models could be explored to enhance system performance further. Moreover, the integration of real-time data sources, such as remote sensing or IoT-based monitoring systems, could improve the timeliness of damage assessment. Previous studies have demonstrated the potential of integrating real-time data in disaster management systems. Incorporating such data could significantly enhance the responsiveness of the system. Furthermore, future research could explore the integration of other MCDM methods to compare performance outcomes. Despite these limitations, the study provides a strong foundation for the development of intelligent decision support systems. Therefore, the proposed model represents a meaningful contribution to both theory and practice in disaster management and decision support systems.

Implication

The findings of this study provide important implications for both theoretical development and practical application in the field of decision support systems and disaster management. From a theoretical perspective, the integration of Multi-Criteria Decision-Making (MCDM) methods and machine learning techniques contributes to the advancement of hybrid intelligent decision support models. The combination of VIKOR and Neural Networks demonstrates how analytical and predictive approaches can be effectively unified within a single framework. This integration expands the existing body of knowledge by addressing the limitations of standalone decision-making and learning-based systems. In practical terms, the proposed system offers a more objective and standardized approach to post-disaster damage assessment. The reduction of subjectivity in evaluation processes can significantly improve the consistency of assessment results across different regions and evaluators. Furthermore, the system provides decision-makers with reliable and data-driven insights that can support more accurate prioritization of recovery efforts. The ability of the system to process complex and multi-criteria data enhances its applicability in real-world disaster scenarios. In addition, the integration of predictive capabilities enables the system to adapt to evolving data conditions and improve its performance over time. This adaptability is particularly relevant in dynamic environments such as disaster management, where conditions can change rapidly. The implementation of such systems can also contribute to more efficient resource allocation and faster response times. Therefore, the proposed IDSS has the

potential to serve as a valuable tool for improving decision-making quality and operational effectiveness in post-disaster management.

Limitation and Suggestion for Further Research

Despite the promising performance of the proposed Dynamic Intelligent Decision Support System (IDSS), several limitations should be acknowledged. First, the study relies on secondary data from a single regional context, which may restrict the generalizability of the findings to other geographical areas or disaster types. The characteristics of disasters and infrastructure conditions may vary significantly across regions, potentially influencing system performance. Second, the dataset used in this study is relatively limited in size and diversity, which may affect the robustness of the analytical and predictive models. Third, the Neural Network model implemented in this research adopts a relatively simple architecture, which may not fully capture complex nonlinear relationships in more heterogeneous datasets. Additionally, the system does not yet incorporate real-time data sources such as remote sensing or Internet of Things (IoT) devices, which could enhance the timeliness and accuracy of damage assessment. Another limitation is the absence of extensive validation using multiple datasets or cross-regional comparisons. The integration of only one MCDM method may also limit the comparative evaluation of decision-making performance. Therefore, future research is recommended to expand the dataset by including multi-regional and multi-disaster scenarios. Further studies could also explore the application of more advanced deep learning models to improve predictive accuracy. In addition, integrating real-time data acquisition technologies could enhance system responsiveness and practical usability. Comparative analysis involving different MCDM methods is also suggested to evaluate the relative performance of hybrid approaches. Ultimately, these improvements would strengthen the scalability, adaptability, and reliability of intelligent decision support systems in disaster management contexts.

CONCLUSION

This study successfully developed a Dynamic Intelligent Decision Support System (IDSS) that integrates the VIKOR method and Neural Networks to assess post-disaster sectoral damage. The system was designed to address the issue of subjectivity commonly found in manual damage assessment processes. By incorporating structured criteria and weighted evaluation, the VIKOR method effectively ranked damage levels based on a compromise solution approach. In parallel, the Neural Network component enhanced the system's ability to recognize patterns and improve prediction accuracy through learning mechanisms. The integration of these two methods resulted in a hybrid model capable of performing both analytical evaluation and predictive classification. The findings indicate that the proposed system produces more consistent and objective results compared to conventional manual assessments. Furthermore, the system demonstrated its ability to process multi-criteria data efficiently and generate reliable decision outputs. The consistency between VIKOR ranking results and Neural Network predictions confirms the robustness of the hybrid approach. In addition, the system provides practical benefits by supporting decision-makers in prioritizing recovery efforts and optimizing resource allocation. The application of this model contributes to improving the effectiveness and

efficiency of post-disaster management. Moreover, the proposed approach highlights the potential of integrating MCDM and AI techniques in decision support systems. Therefore, this study offers a meaningful contribution to the development of intelligent, adaptive, and data-driven decision-making frameworks in disaster management.

AUHOR CONTRIBUTIONS STATEMENT

SRFS : Conceptualization, methodology, data collection, formal analysis, writing the original draft, and review of the final manuscript.

ATWA : Supervision, validation, and providing insights for methodology improvement. Assisted in reviewing and editing the manuscript.

MF : Project administration, coordination of research activities, and validation of the final results. Contributed to reviewing and editing the manuscript.

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