DIJEMSS: Dinasti International Journal of Education Management and Social Science
E-ISSN: 2686-6331
P-ISSN: 2686-6358
https://dinastipub.org/DIJEMSS dinasti.info@gmail.com +62 811 7404 455
DOI: https://doi.org/10.38035/dijemss.v7i1

Risk Mapping for Industrial Resilience: A Quantitative Model oF Disaster Mitigation Priorities

Hari Moektiwibowo[1], Cynthia Rahmawati[2], Darmawan Yulianto[3] , Suko Prayitno Adi[4]
[1]Industrial Engineering, Marshal Suryadarma Aerospace University, Jakarta, 13610, Indonesia, harimoekti@unsurya.ac.id
[2]Aviation Engineering, Marshal Suryadarma Aerospace University, Jakarta, 13610, Indonesia, crahmawati@unsurya.ac.id
[3]Industrial Engineering, Marshal Suryadarma Aerospace University, Jakarta, 13610, Indonesia, darmawan_yulianto@yahoo.co.id
[4]State School for Meteorology, Climatology, and Geophysics (STMKG), Jakarta, 10720, Indonesia, suko.prayitno.adi@stmkg.ac.id

Corresponding Author: harimoekti@unsurya.ac.id[1]

Abstract: This study aims to identify potential failure modes caused by earthquake hazards at PT KMI Indonesia's production facilities and to establish disaster mitigation priorities through the integration of Failure Mode and Effects Analysis (FMEA) and Analytical Hierarchy Process (AHP). This approach bridges technical risk assessment and organizational preparedness within the metal industry context. Data were collected through interviews, field observations, and AHP questionnaires from 287 respondents. The FMEA results revealed three critical risks: gas leakage, inaudible alarms, and electrical hazard vulnerability. The AHP analysis prioritized regulatory compliance, early warning and monitoring systems, and human resource competency as the main mitigation criteria. The integration of FMEA and AHP proved effective in producing an objective and data-driven hierarchy of mitigation priorities. Practically, the study recommends improving evacuation facilities, establishing trained emergency response teams, and implementing digital dissemination of safety procedures to enhance industrial resilience against disasters.

Keywords: AHP, Disaster Risk, FMEA, Industrial Resilience, Mitigation Strategy

INTRODUCTION

Indonesia, as an archipelagic country on the Pacific Ring of Fire path, has a high potential for megathrust earthquakes and tsunamis due to tectonic activity in the Sunda and Banda subduction zones (Hasanah et al., 2024; Jumadi et al., 2025; Supendi et al., 2023) Industrial estates in West Java, especially Cikarang, have high susceptibility to earthquakes originating from the Cimandiri, Baribis, Lembang, Garut, and Cipamingkis faults that pass around densely populated areas and manufacturing facilities (Adi et al., 2024; Widiyantoro et al., 2022) This condition underscores the need for a scalable and implementable mitigation system in an industrial environment to minimize the impact of disasters on infrastructure and labor.

Vulnerability mapping that integrates social, structural, and geotechnical aspects has proven to be effective in differentiating risk levels and being the basis for mitigation strategies in earthquake-prone areas (Jena et al., 2020). However, the application of this approach in the industrial sector is still limited to technical aspects without considering human resource preparedness. Synergy between technical risk analysis and the readiness of industrial personnel is needed to reduce potential economic losses and occupational safety due to disasters.

Disaster risk reduction efforts require coordinated governance between the government, the private sector, and the community so that mitigation policies can run effectively (Fatrias & Agustia, 2019). In practice, many companies face obstacles in building risk communication and an ongoing safety culture. Therefore, research that is able to bridge policy, technical, and behavioral aspects is very important to strengthen industrial preparedness.

Although the development of disaster science has increased, actual preparedness in the field is still low compared to physical development efforts (Alcántara-Ayala et al., 2020; Ferreira et al., 2024). This condition is caused by weak risk awareness, a lack of skills, and ineffective implementation of regulations at the company level. This raises a fundamental question: why is industry preparedness still weak even though mitigation technology and knowledge are widely available?

A strong understanding of risk, technical capacity for decision-makers, and adaptive governance are key prerequisites for industrial risk management (Yazdi, 2024). At PT KMI, where more than 300 workers operate using high-risk industrial equipment, the potential for danger increases due to limited investment in occupational safety (Ismail-Zadeh, 2024). This problem shows the need for an analytical approach that can assist organizations in setting mitigation priorities objectively and data-driven.

The Failure Mode and Effects Analysis (FMEA) and Analytical Hierarchy Process (AHP) methods have been widely used to assess risks and determine the priority of actions (Golkhani et al., 2018; Lv et al., 2019; Suci Utami et al., 2022). The FMEA helps identify potential failures through the calculation of severity, likelihood, and detection, while the AHP provides a structured decision-making framework for determining the weight of mitigation. The integration of these two methods offers a quantitative approach capable of linking the identification of critical risks with a measurable mitigation strategy.

Industrial resilience depends not only on emergency response plans, but also on the integration of technical and managerial strategies that are aligned with facility design, redundancy systems, modularity, and sustainable governance (El-Halwagi et al., 2020). This approach increases the adaptive capacity of companies in dealing with disruptions, while strengthening the safety culture that is part of the sustainability strategy (Maceika et al., 2024). Thus, industrial resilience is achieved through a continuous and evidence-based organizational learning process.

Collaboration between technical and managerial approaches creates integrated resilience capacity, namely the ability of organizations to absorb impacts, adapt, and maintain operational continuity in the midst of uncertainty (El-Halwagi et al., 2020; Maceika et al., 2024). This approach not only prevents material losses but also ensures the continuity of manufacturing processes in high-risk sectors. The novelty of this research lies in the application of FMEA-AHP integration in the context of the metal industry in Indonesia, which is still rarely studied in depth.

Previous research has shown that evacuation exercises and individual behaviors during emergencies play an important role in improving preparedness (Bernardini et al., 2019; Gwynne et al., 2020). However, the long-term effectiveness of such training and infrastructure readiness has not been thoroughly evaluated in the industrial environment. At PT KMI, the ability of workers to respond to early warnings, follow evacuation routes, and execute safety protocols has never been systematically measured (Ferreira et al., 2024).

Disaster mitigation activities also highlight the importance of community training and participation in strengthening preparedness (Que et al., 2022). Unfortunately, there is still limited research linking technical failures of industrial equipment to hazard awareness and occupational safety culture. Therefore, an approach that integrates behavioral, technical, and managerial dimensions is needed to make mitigation strategies more comprehensive and sustainable.

This research aims to develop a quantitative model based on the integration of FMEA and AHP to identify and prioritize disaster risks, as well as formulate mitigation strategies that strengthen industrial resilience in the metal manufacturing sector, such as PT KMI. This approach is expected to make a theoretical contribution to the development of an integrated risk assessment methodology as well as a practical contribution in improving industrial preparedness for potential earthquakes in Indonesia.

METHOD

This study uses a mixed methods approach to gain a comprehensive understanding of disaster preparedness and mitigation strategies in the metal manufacturing industry (Oranga, 2025; Clark Plan, 2017). This approach combines semi-structured interviews and quantitative surveys so that the results reflect both the behavioral and technical dimensions that affect organizational resilience.

The research was conducted at PT KMI Indonesia, Jababeka Industrial Estate, Bekasi. A total of 312 AHP questionnaires were distributed, and 287 valid responses were used in the analysis. The quantitative sampling technique is non-probability purposive sampling, with the criteria of respondents who have direct responsibility for occupational safety. In addition, six key informants (production managers, K3 officers, senior operators, and members of the emergency response team) were interviewed to deepen the context of the company's preparedness and internal policies.

The research instruments included interview guides, facility observation sheets, and AHP questionnaires with a paired comparison scale of 1–9 (Saaty & De Paola, 2017). Key interview topics include the effectiveness of safety training, clarity of evacuation routes, and the reliability of early warning systems. Qualitative data was analyzed thematically, while quantitative data was processed through two stages: Failure Mode and Effects Analysis (FMEA) to calculate the Weighted Risk Priority Number (WRPN) based on severity, occurrence, and detection, and Analytical Hierarchy Process (AHP) to determine the weight of mitigation priorities.

All calculations were performed using Microsoft Excel and Expert Choice 11, which were used to obtain the consistency value (CR) and the final weight of the mitigation criteria. The integration of these two methods results in the most critical risk sequence as well as the most relevant mitigation strategies for improving disaster preparedness in the metals industry environment.

RESULTS AND DISCUSSION

This study combines qualitative and quantitative analyses to address the gaps identified in the introduction, namely the absence of an integrated model that links technical risks to organizational preparedness in the metals industry sector. This approach helps explain how technical and behavioral factors interact to shape risk, as well as why preparedness in industrial estates is still low despite the availability of safety technologies and procedures (Alcántara-Ayala et al., 2020; Ferreira et al., 2024).

The results of interviews and field observations show that workers' awareness of earthquake hazards has been formed, but the implementation of safety practices has not been optimal (Bernardini et al., 2019; Gwynne et al., 2020). Some workers admitted that they did not understand the evacuation route or had not participated in an emergency simulation in the past six months (Bernardini et al., 2019) Other problems that are often mentioned are the less audible alarm system and personal protective equipment (PPE) that is not always available in the work area (Gwynne et al., 2020) These findings are in line with the research of Bernardini et al. (2019) and Gwynne et al. (2020), who said that safety behaviors are often hampered by weak risk communication and a lack of evaluation of evacuation infrastructure.

Quantitative results through the Failure Mode and Effects Analysis (FMEA) method strengthen the field findings. As presented in Table 1, the three most critical risks at PT KMI are gas leakage (WRPN 6.513), unclear alarms (WRPN 5.650), and electrical hazard vulnerability (WRPN 5.575). All three reflect a combination of technical threats and weaknesses in early warning systems. Leaking gases can trigger large explosions, while weak alarms can delay evacuations and magnify casualties. These results also show that early warning systems have not functioned optimally as part of industrial risk management (Golkhani et al., 2018; Yazdi, 2024).

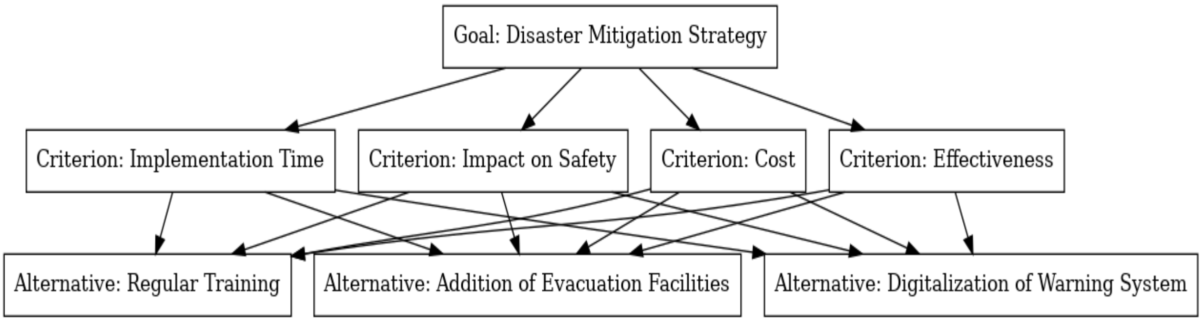
Table 1. Hazard Weighted Risk Priority Number (WRPN) Identified at PT KMI using FMEA

No	Failure Mode	Effects of Failure	*Severity (S)*	*Occurrence (O)*	*Detection (D)*	WRPN (SxOxD)
1	Gas leakage (pipe/cylinder)	Gas explosions and burns	8.5	5.5	4.75	6.513
2	Alarm not heard clearly	Workers are late in responding to hazard warnings	7.750	5.5	2.5	5.650
3	Electrical hazard vulnerability	Electrical interference and electric shock hazards	7	4	5.5	5.575

Source: Research data

The analysis shows that the highest risks at PT KMI are gas leaks (WRPN 6,513), inaudible alarms (WRPN 5,650), and electrical hazard vulnerability (WRPN 5,575), as summarized in Table 1. Gas leaks are the most critical hazard due to their severe safety implications and potential disruption to the production process. The limited audibility of alarms highlights weaknesses in early warning systems that can delay evacuation and increase the risk of casualties, while electrical hazards have the potential to trigger accidents and damage vital equipment. These findings underscore the need for technical improvements to gas, alarm, and electrical systems that must be accompanied by organizational readiness to prevent multi-stage failures.

To strengthen the analysis, the Analytical Hierarchy Process (AHP) method is applied to determine the priority order of mitigation strategies more objectively. The assessment is carried out by considering the factors of cost, effectiveness, implementation time, and impact on work safety. The first step of this process is to establish a decision-making hierarchy that includes key objectives, evaluation criteria, as well as alternative mitigation strategies, as shown in Figure 1.



Source: Model Developed in this Study

Figure 1. Decision-Making Hierarchy for Disaster Mitigation Strategies using AHP

The hierarchical structure in Figure 1 is the basis for the application of the Analytical Hierarchy Process (AHP) method in determining the priority of mitigation strategies. Each respondent compared the relative importance levels of the ten mitigation criteria using a scale of 1–9 according to the Saaty model, and the results of the 10×10 matrix aggregation showed a good consistency ratio (CR < 0.1), indicating that respondents' assessments were reliable (Saaty & De Paola, 2017).

This approach answers the research gap mentioned in the introduction, that so far, there has been no structured model that is able to transform the subjective perception of workers into a measurable policy priority. Through AHP, this study explains how individual assessments can be converted into objective decision weights, as well as why strengthening human factors and governance is at the core of industry preparedness (El-Halwagi et al., 2020; Maceika et al., 2024).

The results of the AHP weight calculation show five criteria with the highest priority: Regulatory Compliance (0.1573), Early Warning & Monitoring (0.1495), Human Resources Competence (0.1430), Emergency Team Readiness (0.1392), and Disaster Training and Simulation (0.0870). These findings reinforce that industrial resilience can only be achieved through synergies between regulatory, technical, and human resource capacity (Ferreira et al., 2024; Que et al., 2022). The complete ranking of all criteria and priority weights is presented in Table 2.

Table 2. Priority Weighting of Evaluation Criteria for Mitigation Strategies Based on the AHP Method

Ranking	Criteria	Priority Weight
1	Regulatory Compliance	0.1573
2	Early Warning & Monitoring	0.1495
3	Human Resources Competency	0.1430
4	Emergency Team Readiness	0.1392
5	Disaster Training and Simulation	0.0870
6	Risk Management Readiness	0.0845
7	Building Safety Facilities	0.0700
8	Availability of Emergency Response Procedures	0.0588
9	Building Structure & Layout	0.0558
10	Availability of Evacuation Equipment and Facilities	0.0550

Note: λ_{max} = 10.1281; CI = 0.0142; CR = 0.0096 (RI = 1.49; n = 10). The consistency ratio (CR < 0.1) indicates that the expert judgments are consistent and reliable.

Source: Research data

Table 2 shows that Regulatory Compliance (0.1573) is the highest priority criterion, which confirms the importance of aligning mitigation strategies with legal and institutional frameworks. This shows that industry preparedness does not only depend on technical readiness, but also on compliance with safety standards set nationally and internally by the company. The next criteria, Early Warning and Monitoring (0.1495) and Human Resource Competency (0.1430), highlight the important role of early detection systems and worker skills in ensuring a quick and effective response. Emergency Team Readiness (0.1392) emphasizes the need for well-trained emergency response units, while Disaster Training and Simulation (0.0870) remains a key factor in building a culture of preparedness through continuous learning.

These findings answer the knowledge gap outlined in the introduction that integration between technical, regulatory, and human behavior dimensions often does not run synergistically in the industrial environment. These results show how quantitative approaches such as AHP can transform risk perceptions into concrete policy priorities, as well as (why) human capacity building and governance are determinants of mitigation success (El-Halwagi et al., 2020; Maceika et al., 2024; Que et al., 2022). Thus, the results of this study confirm the need for a balanced combination of regulatory, technical, and human resources steps in determining mitigation strategies at PT KMI.

Based on these weighted criteria, several alternative mitigation strategies were identified through questionnaire responses and AHP analysis. These strategies reflect a complementary approach that combines improving technical aspects with strengthening organizational readiness, thus forming a more adaptive and sustainable mitigation system (Bernardini et al., 2019; Ferreira et al., 2024). Table 3 summarizes the alternative mitigation strategies considered in this study.

Table 3. Alternative Mitigation Strategies Identified through AHP Questionnaire Responses and Analysis

Code	Alternative Mitigation Strategy
A1	Improved evacuation facilities and safe routes
A2	Formation and training of emergency response teams
A3	Digital dissemination of SOPs and risk awareness materials

Table 3 presents three alternative mitigation strategies derived from the results of the AHP analysis. Strategy A1 (Improvement of evacuation facilities and safe routes) focuses on strengthening physical infrastructure to ensure a fast and safe evacuation process. A2 (Formation and training of emergency response teams) emphasizes organizational capacity building through skill development, coordination, and cross-unit responsibility. Meanwhile, A3 (Digital dissemination of SOPs and risk awareness materials) is oriented towards risk communication and increasing collective awareness among workers. These three strategies together underscore the importance of a balance between technical readiness and organizational capacity, which is the foundation of industrial resilience to disasters.

The integration of FMEA and AHP results shows that disaster risk in industrial estates includes two main dimensions: (i) technical failures in high-risk systems such as electricity, alarms, and pressurized gases; and (ii) organizational deficiencies in terms of preparedness, training, and workforce awareness. This result broadens the understanding of what is unknown which is described in the introduction that mitigation failures in industry are not only due to technological weaknesses, but also weak human readiness and institutional coordination. This integrated approach explains how risk can be managed through the mutual relationship between technical systems and organizational behavior, as well as why the formation of a safety culture is key to strengthening industry resilience (Bernardini et al., 2019; El-Halwagi et al., 2020; Gwynne et al., 2020; Maceika et al., 2024).

The findings from PT KMI confirm that evacuation planning, workforce training, and facility readiness have complementary roles in creating a disaster resilient system. The concept of integrated resilience is relevant as it requires balancing fail-safe engineering solutions with human-centered risk management. This is in line with the views of Ferreira et al. (2024) Que et al. (2022) which emphasizes the importance of worker participation, continuous simulation, and organizational learning as the core of effective risk management in the industrial sector.

Overall, the combination of qualitative and quantitative analysis in this study provides a comprehensive understanding of risk dynamics in high-risk industrial estates such as PT KMI. FMEA is responsible for identifying the source of hazards and assessing the severity of their operations, while AHP helps prioritize the most effective mitigation measures based on human and organizational considerations. The integration of the two shows that technical interventions without strengthening organizational capacity will not result in sustainable preparedness. Therefore, this integrated approach offers an industrial risk management model that is applicable to earthquake-prone areas in Indonesia, strengthening the scientific basis for the Conclusions and Recommendations section below.

CONCLUSION

This study successfully identified potential failure modes due to earthquake hazards at PT KMI Indonesia's production facilities and established priority mitigation strategies through the integration of Failure Mode and Effects Analysis (FMEA) and Analytical Hierarchy Process (AHP) methods. The results of the FMEA analysis showed that gas leaks (WRPN = 420), inaudible alarms (WRPN = 375), and electrical hazard vulnerabilities (WRPN = 360) were the most critical risks that required immediate mitigation. These findings confirm that technical hazards such as pressurized gas and electrical systems are inseparable from human and organizational preparedness in responding to emergencies.

The combined FMEA-AHP approach has proven effective in linking technical risk assessments with systematic weighting of decision criteria. The integration of these two methods results in an objective and evidence-based sequence of mitigation priorities, with five main criteria including regulatory compliance (0.1573), early warning and monitoring (0.1495), human resource competence (0.1430), emergency team readiness (0.1392), and disaster training and simulation (0.0870). Thus, this approach provides an evaluation model that can be applied directly to improve industry preparedness and resilience to disasters.

The contribution of this research is theoretical and practical. Theoretically, this study extends the application of industrial quantitative methods (FMEA–AHP) into the context of local geological risk mitigation, offering a more measurable analytical approach to industrial preparedness. In practical terms, the results provide actionable recommendations, such as improving evacuation facilities, training emergency response teams, and digital dissemination of safety SOPs to strengthen the culture of preparedness in the manufacturing sector.

The limitations of this study lie in the limited scope of one company and the relatively short observation period. Follow-up research with a wider scope, involving different types of industries and regions with different risk characteristics, is recommended to improve external validity and strengthen the generalization of findings. In addition, the development of dynamic simulation-based models or integration with artificial intelligence systems can be the next research direction to enrich industrial disaster risk management in Indonesia.

REFERENCES

Adi, S. P., Simanjuntak, A. V. H., Supendi, P., Wei, S., Muksin, U., Daryono, D., Wibowo, B. A., Karnawati, D., & Sinambela, M. (2024). Different Faulting of the 2023 (Mw 5.7 and 5.9) South-Central Java Earthquakes in the Backthrust Fault System. *Geotechnical and Geological Engineering*, *42*(5), 3123–3135. https://doi.org/10.1007/s10706-023-02720-1

Alcántara-Ayala, I., Rodríguez-Velázquez, D., Garnica-Peña, R. J., & Maldonado-Martínez, A. (2020). Multi-Sectoral Reflections and Efforts in Strengthening Partnerships to Reduce Disaster Risk in Mexico: The First MuSe-IDRiM Conference. *International Journal of Disaster Risk Science*, *11*(5), 686–691. https://doi.org/10.1007/s13753-020-00302-w

Bernardini, G., Lovreglio, R., & Quagliarini, E. (2019). Proposing behavior-oriented strategies for earthquake emergency evacuation: A behavioral data analysis from New Zealand, Italy and Japan. *Safety Science*, *116*(February 2018), 295–309. https://doi.org/10.1016/j.ssci.2019.03.023

El-Halwagi, M. M., Sengupta, D., Pistikopoulos, E. N., Sammons, J., Eljack, F., & Kazi, M. K. (2020). Disaster-Resilient Design of Manufacturing Facilities Through Process Integration: Principal Strategies, Perspectives, and Research Challenges. *Frontiers in Sustainability*, *1*(November), 1–17. https://doi.org/10.3389/frsus.2020.595961

Fatrias, D., & Agustia, R. S. R. (2019). Model Hubungan Antar Pemangku Kepentingan dalam Koordinasi Penanganan Bencana di Kota Padang. *Jurnal Optimasi Sistem Industri*, *18*(1), 48–54. https://doi.org/10.25077/josi.v18.n1.p48-54.2019

Ferreira, M. A., Oliveira, C. S., & Francisco, R. (2024). Tsunami risk mitigation: the role of evacuation routes, preparedness and urban planning. *Natural Hazards*. https://doi.org/10.1007/s11069-024-07061-7

Golkhani, A. F., Ravandi, G. M., Balochkhane, A. F., & Ravandi R, G. M. (2018). The Use of Failure Mode Effects Analysis (FMEA) and Analytic Hierarchy Process (AHP) Methods to Determine the Most Important Safety Hazards The Use of Failure Mode Effects Analysis (FMEA) and Analytic Hi-erarchy Process (AHP) Methods to Determine the Most Important Safety Hazards The Use of Failure Mode Effects Analysis (FMEA) and Analytic Hierarchy Process (AHP) Methods to. In *Health Education and Health Promotion* (Vol. 6, Issue 1).

Gwynne, S., Amos, M., Kinateder, M., Bénichou, N., Boyce, K., Natalie van der Wal, C., & Ronchi, E. (2020). The future of evacuation drills: Assessing and enhancing evacuee performance. *Safety Science*, *129*(March), 104767. https://doi.org/10.1016/j.ssci.2020.104767

Hasanah, M. U., Supendi, P., Nugraha, A. D., Widiyantoro, S., & Syaifuddin, F. (2024). The new insight of tectonic setting in Sunda-Banda transition zone using tomography seismic. Case study: 7.1 M deep earthquake 29 August 2023. *Open Geosciences*, *16*(1). https://doi.org/10.1515/geo-2022-0710

Ismail-Zadeh, A. (2024). Earthquakes yes, disasters no. *Npj Natural Hazards*, *1*(1). https://doi.org/10.1038/s44304-024-00049-0

Jena, R., Pradhan, B., & Beydoun, G. (2020). Earthquake vulnerability assessment in Northern Sumatra province by using a multi-criteria decision-making model. *International Journal of Disaster Risk Reduction*, *46*(January), 101518. https://doi.org/10.1016/j.ijdrr.2020.101518

Jumadi, J., Priyono, K. D., Amin, C., Saputra, A., Gomez, C., Lam, K. C., Rohman, A., Patel, N., Sattar, F., Nawaz, M., & Wardani, K. S. (2025). Tsunami Risk Mapping and Sustainable Mitigation Strategies for Megathrust Earthquake Scenario in Pacitan Coastal Areas, Indonesia. *Sustainability (Switzerland)*, *17*(6). https://doi.org/10.3390/su17062564

Lv, L., Li, H., Wang, L., Xia, Q., & Ji, L. (2019). Failure mode and Effect Analysis (FMEA) with extended MULTIMOORA method based on interval-valued intuitionistic fuzzy set: Application in operational risk evaluation for infrastructure. *Information (Switzerland)*, *10*(10). https://doi.org/10.3390/info10100313

Maceika, A., Bugajev, A., & Šostak, O. R. (2024). Enhancing Organizational Resilience: Sustainable Development Scenarios Incorporating Disaster Impacts and AI Tools.

Sustainability (Switzerland), *16*(24), 1–39. https://doi.org/10.3390/su162411147

Que, T., Wu, Y., Hu, S., Cai, J., Jiang, N., & Xing, H. (2022). Factors Influencing Public Participation in Community Disaster Mitigation Activities: A Comparison of Model and Nonmodel Disaster Mitigation Communities. *International Journal of Environmental Research and Public Health*, *19*(19). https://doi.org/10.3390/ijerph191912278

Saaty, T. L., & De Paola, P. (2017). Rethinking design and urban planning for the cities of the future. *Buildings*, *7*(3), 1–22. https://doi.org/10.3390/buildings7030076

Suci Utami, K., Djumiati Sitania, F., & Profita, A. (2022). Penerapan FMEA Dan AHP Dalam Perumusan Strategi Mitigasi Risiko Proses Penyaluran Jaringan Gas Application Of FMEA And AHP In The Formulation Of Risk Mitigation Strategies In Gas Network Distribution Process. *JIME (Journal of Industrial and Manufacture Engineering)*, *6*(1), 2549–6336. https://doi.org/10.31289/jime.v6i1.6187

Supendi, P., Widiyantoro, S., Rawlinson, N., Yatimantoro, T., Muhari, A., Hanifa, N. R., Gunawan, E., Shiddiqi, H. A., Imran, I., Anugrah, S. D., Daryono, D., Prayitno, B. S., Adi, S. P., Karnawati, D., Faizal, L., & Damanik, R. (2023). On the potential for megathrust earthquakes and tsunamis off the southern coast of West Java and southeast Sumatra, Indonesia. *Natural Hazards*, *116*(1), 1315–1328. https://doi.org/10.1007/s11069-022-05696-y

Widiyantoro, S., Supendi, P., Ardianto, A., Baskara, A. W., Bacon, C. A., Damanik, R., Rawlinson, N., Gunawan, E., Sahara, D. P., Zulfakriza, Z., Husni, Y. M., & Lesmana, A. (2022). Implications for fault locking south of Jakarta from an investigation of seismic activity along the Baribis fault, northwestern Java, Indonesia. *Scientific Reports*, *12*(1), 6–15. https://doi.org/10.1038/s41598-022-13896-6

Yazdi, M. (2024). Enhancing System Safety and Reliability through Integrated FMEA and Game Theory: A Multi-Factor Approach. *Safety*, *10*(1). https://doi.org/10.3390/safety10010004