Spektrum Iran | Jg. 38 | Nr. 2 | Sommer und Herbst-2025 | pp. 115-142 |

Original-Forschungsarbeit

Die transformative Rolle der künstlichen Intelligenz in der Mediendatenanalyse für das Krisenmanagement

Hatef Pourrashidi Alibigloo[1*], Mehran Samadi[2]

[1] *Fachbereich Kommunikationswissenschaft, Fakultät für Sozialwissenschaften, Universität der Religionen und Konfessionen, Qom, Iran*

[2] *Fachbereich Kommunikationswissenschaft, Islamische Azad-Universität, Ta.C.-Zweigstelle, Täbris, Iran*

Empfangen: 20. Februar 2025 **Akzeptiert:** 2. Juni 2025

Zusammenfassung:

In der gegenwärtigen Landschaft des Krisenmanagements sehen sich Entscheidungsträger zunehmend mit der schieren Masse, Geschwindigkeit und Vielfalt an Mediendaten konfrontiert, die in Notsituationen generiert werden. Traditionelle manuelle Analysemethoden erweisen sich oft als unzureichend, um diesen Informationsfluss effektiv zu verarbeiten, was einen Paradigmenwechsel hin zu fortgeschrittenen computergestützten Ansätzen unumgänglich macht. Das primäre Ziel dieser Studie ist es, die Lücke zwischen technischer Datenwissenschaft und praktischer Krisenkommunikation zu schließen, indem eine klare analytische Verbindung zwischen spezifischen Paradigmen des maschinellen Lernens (ML) und ihren operativen Fähigkeiten hergestellt wird. Dieser Artikel bedient sich der Methodik eines narrativen Reviews, fundiert durch einen theoretischen Rahmen des maschinellen Lernens. Die Studie synthetisiert systematisch die bestehende Literatur, um zu kategorisieren und zu analysieren, wie unterschiedliche ML-Architekturen – insbesondere überwachtes, unüberwachtes und deep learning – im Bereich der Mediendatenanalyse zur Unterstützung von Entscheidungsprozessen während Krisen angewendet werden. Die Analyse bestätigt, dass Künstliche Intelligenz die Effektivität des Krisenmanagements durch die Automatisierung des Medienmonitorings und die Generierung handlungsrelevanter Echtzeiterkenntnisse signifikant steigert. Die Ergebnisse weisen verschiedenen Algorithmen spezifische Rollen zu: Überwachtes Lernen (*supervised learning*) dient als theoretisches Fundament für die schnelle Erkennung von Falschinformationen und die präzise Krisenklassifizierung. Demgegenüber werden unüberwachtes Lernen (*unsupervised learning*) und deep learning als kritische Werkzeuge zur Detektion von Datenanomalien und zur Erkennung aufkommender Muster identifiziert, die für die Funktionalität proaktiver Frühwarnsysteme essenziell sind. Obwohl KI ein transformatives Potenzial bietet, liefert diese Studie eine kritische Reflexion wesentlicher Implementierungsherausforderungen. Sie hebt das „Black-Box"-Problem – gekennzeichnet durch mangelnde algorithmische Interpretierbarkeit – sowie inhärente Datenverzerrungen (*Bias*) als zentrale ethische Hürden hervor, welche die Rechenschaftspflicht und Fairness bei der Krisenbewältigung beeinträchtigen können. Diese Arbeit bietet einen strukturierten Rahmen zum Verständnis der Rolle von KI aus einer theoretischen Perspektive und kommt zu dem Schluss, dass künftige Implementierungen „erklärbare KI" (*Explainable AI*) priorisieren müssen, um eine Balance zwischen rechnerischer Effizienz und ethischer Verantwortung herzustellen.

Schlüsselwörter: künstliche Intelligenz, Mediendatenanalyse, Krisenmanagement, Krisenkommunikation, maschinelles Lernen

* Korrespondierender Autor h.pourrashidi@gmail.com https://orcid.org/0000-0003-2471-6778

Wie dieser Artikel zu zitieren ist:
Pourrashidi Alibigloo, H., & Samadi, M. (2025). The transformative role of artificial intelligence in media data analysis for crisis management. *Spektrum Iran*, 38(2), 115-142.
https://doi.org/10.22034/spektrum.2025.563353.1051

مقاله پژوهشی

نقش متحول‌کننده هوش مصنوعی در تحلیل داده‌های رسانه‌ای برای مدیریت بحران

هاتف پوررشیدی علی‌بیگلو[1*]، مهران صمدی[2]

۱ گروه ارتباطات، دانشکده علوم اجتماعی، دانشگاه ادیان و مذاهب، قم، ایران

۲ گروه علوم ارتباطات، دانشگاه آزاد اسلامی، واحد تبریز، تبریز، ایران

دریافت: ۱۴۰۳/۱۲/۱؛ **پذیرش:** ۱۴۰۴/۰۳/۱۲

چکیده:

در چشم‌انداز کنونی مدیریت بحران، تصمیم‌گیرندگان به‌طور فزاینده‌ای با چالش حجم انبوه، سرعت بالا و تنوع گسترده داده‌های رسانه‌ای تولید شده در شرایط اضطراری مواجه هستند. روش‌های تحلیلی و دستی سنتی اغلب برای پردازش مؤثر این جریان اطلاعاتی ناکافی بوده و گذار پارادایمی به سوی رویکردهای محاسباتی پیشرفته را اجتناب‌ناپذیر می‌سازند. هدف اصلی این پژوهش، پر کردن شکاف میان علم داده‌های فنی و ارتباطات بحران کاربردی از طریق برقراری پیوندی تحلیلی و شفاف میان پارادایم‌های خاص «یادگیری ماشین» (ML) و قابلیت‌های عملیاتی آن‌ها است. این مقاله با بهره‌گیری از روش‌شناسی «مرور روایی» و با تکیه بر چارچوب نظری یادگیری ماشین تدوین شده است. در این مطالعه، ادبیات موجود به‌صورت نظام‌مند سنتز شده است تا نحوه کاربرد معماری‌های متمایز یادگیری ماشینی، به‌ویژه یادگیری نظارت‌شده، نظارت‌نشده و یادگیری عمیق، در حوزه تحلیل داده‌های رسانه‌ای جهت پشتیبانی از فرآیندهای تصمیم‌گیری در حین بحران‌ها، دسته‌بندی و تحلیل شود. نتایج تحلیل تأیید می‌کند که هوش مصنوعی از طریق خودکارسازی پایش رسانه‌ای و تولید بینش‌های لحظه‌ای و عملیاتی، اثربخشی مدیریت بحران را به‌طور قابل‌توجهی ارتقا می‌بخشد. یافته‌ها نقش‌های مشخصی را برای الگوریتم‌های مختلف ترسیم می‌کنند: «یادگیری نظارت‌شده» به‌عنوان مبنای نظری برای تشخیص سریع اطلاعات نادرست و طبقه‌بندی دقیق بحران عمل می‌کند. در مقابل، «یادگیری نظارت‌نشده» و «یادگیری عمیق» به‌عنوان ابزارهای حیاتی برای شناسایی ناهنجاری‌های داده‌ها و تشخیص الگوهای نوظهور شناسایی شده‌اند که برای کارکرد سیستم‌های هشدار سریعِ پیش‌دستانه ضروری هستند. اگرچه هوش مصنوعی پتانسیلی تحول‌آفرین ارائه می‌دهد، اما این پژوهش تأملی انتقادی بر چالش‌های مهم پیاده‌سازی آن دارد. این مطالعه مسئله «جعبه سیاه» که با فقدان تفسیرپذیری الگوریتمی مشخص می‌شود و «سوگیری‌های ذاتی داده‌ها» را به‌عنوان موانع اخلاقی عمده‌ای برجسته می‌سازد که می‌توانند پاسخگویی و انصاف را در واکنش به بحران مخدوش کنند. این پژوهش چارچوبی ساختاریافته برای درک نقش هوش مصنوعی از دریچه‌ای نظری ارائه می‌دهد و نتیجه می‌گیرد که پیاده‌سازی‌های آتی باید «هوش مصنوعی تفسیرپذیر» را در اولویت قرار دهند تا توازنی میان کارایی محاسباتی و مسئولیت اخلاقی برقرار شود.

واژگان کلیدی: هوش مصنوعی، تحلیل داده‌های رسانه‌ای، مدیریت بحران، ارتباطات بحران، یادگیری ماشین

* نویسنده مسئول

https://orcid.org/0000-0003-2471-6778

h.pourrashidi@gmail.com

https://doi.org/10.22034/spektrum.2025.563353.1051

Spektrum Iran | Vol. 38 | Issue 2 | Summer & Autumn 2025 | pp. 115-142 |

Original Research Paper

The transformative role of artificial intelligence in media data analysis for crisis management

Hatef Pourrashidi Alibigloo[1*], Mehran Samadi[2]

[1] *Department of Communication, Faculty of Social Science, University of Religions and Denominations, Qom, Iran*

[2] *Department of Communication Science, Ta.C. Islamic Azad University, Tabriz, Iran*

Received: Feb. 20, 2025 **Accepted:** Jun. 02, 2025

Abstract

In the contemporary landscape of crisis management, decision-makers are increasingly overwhelmed by the sheer volume, velocity, and variety of media data generated during emergencies. Traditional manual analytical methods are often insufficient to process this influx effectively, necessitating a paradigm shift toward advanced computational approaches. The primary goal of this study is to bridge the gap between technical data science and practical crisis communication by establishing a clear analytical link between specific machine learning (ML) paradigms and their operational capabilities. This article utilizes a narrative review methodology, underpinned by a theoretical framework grounded in machine learning. The study systematically synthesizes existing literature to categorize and analyze how distinct ML architectures—specifically supervised, unsupervised, and deep learning—are applied within the domain of media data analysis to support decision-making processes during crises. The analysis confirms that artificial intelligence significantly enhances crisis management effectiveness by automating media monitoring and generating actionable real-time insights. The findings delineate specific roles for different algorithms: supervised learning serves as the theoretical foundation for rapid misinformation detection and precise crisis classification. Conversely, unsupervised learning and deep learning are identified as critical tools for detecting data anomalies and recognizing emerging patterns, which are essential for the functionality of proactive early warning systems. While AI offers transformative potential, this study provides a critical reflection on significant implementation challenges. It highlights the "black box" problem—characterized by a lack of algorithmic interpretability—and inherent data biases as major ethical hurdles that can compromise accountability and fairness in crisis response. The present study contributes a structured framework for understanding AI's role through a theoretical lens. It concludes that future implementation must prioritize explainable AI to balance computational efficiency with ethical responsibility.

Keywords: artificial intelligence, media data analysis, crisis management, crisis communication, machine learning

* Corresponding Author h.pourrashidi@gmail.com https://orcid.org/0000-0003-2471-6778

How to Cite this Article:
Pourrashidi Alibigloo, H., & Samadi, M. (2025). The transformative role of artificial intelligence in media data analysis for crisis management. *Spektrum Iran*, 38(2), 115-142.
https://doi.org/10.22034/spektrum.2025.563353.1051

1. Introduction

The contemporary information landscape has fundamentally transformed crisis management dynamics. When emergencies occur—whether natural disasters, public health crises, organizational scandals, or security threats—digital media platforms generate unprecedented volumes of data within minutes. Social media posts, news articles, user-generated videos, and online discussions create an information deluge that simultaneously aids and complicates crisis response efforts (Perry et al., 2003, p. 207). Traditional manual monitoring and analysis methods, while effective in pre-digital eras, cannot process the velocity, volume, and variety of modern media data streams. This analytical gap poses critical risks: delayed crisis detection, inability to counter misinformation rapidly, and failure to gauge public sentiment accurately—all of which can escalate emergencies and erode institutional trust (Wodak, 2021, p. 330).

Artificial intelligence (AI), particularly its machine learning (ML) algorithms, has emerged as a transformative solution to these challenges. AI systems can monitor millions of social media posts in real-time, detect sentiment shifts across populations, identify emerging misinformation narratives, and predict crisis trajectories based on historical patterns (Cheng et al., 2025). These capabilities extend beyond human cognitive capacity, offering crisis managers sophisticated tools for situational awareness and strategic communication (Hossain et al., 2025, p. 156). However, AI's integration into crisis management is not without complications. Algorithmic opacity raises accountability concerns (Pedreschi et al., 2019, p. 9780), training data biases risk discriminatory outcomes (Reddy et al., 2024, p. 4928), and over-reliance on automated systems may undermine critical human judgment (Yuan et al., 2025, p. 2). As AI becomes increasingly embedded in crisis infrastructure, understanding both its capabilities and limitations becomes essential for responsible deployment.

Existing literature on AI in crisis management tends toward two extremes: technical studies focused on algorithm performance without contextual application and practitioner accounts that lack theoretical grounding (Barbierato & Gatti, 2024, p. 2). Few studies systematically examine how specific ML paradigms—supervised learning, unsupervised learning, deep learning—operationalize distinct crisis management functions, or critically engage with the ethical tensions inherent in AI-driven crisis response (Du et al., 2025, p. 1). This gap is particularly problematic given the rapid adoption of AI tools by governments, corporations, and humanitarian organizations, often without adequate understanding of algorithmic limitations or ethical safeguards (Bălan & Nedelcu, 2024, p. 3).

This study addresses the gap by examining how AI-driven media data analysis transforms crisis management practices, with particular focus on the operational capabilities enabled by specific machine learning paradigms and the critical ethical limitations that must be addressed for responsible implementation. Through systematic documentary analysis of peer-reviewed literature published between 2014-2025, this research explores how different machine learning paradigms operationalize AI's role in media data analysis during crises, while critically examining the ethical, technical, and practical limitations that constrain AI deployment in high-stakes crisis contexts and identifying pathways for mitigation. By grounding the analysis in ML theory (Mohri et al., 2012, p. 55) while maintaining critical engagement with real-world crisis scenarios, this study bridges computational science and crisis communication scholarship, offering both theoretical advancement and practical guidance.

This research adopts a systematic documentary review methodology, synthesizing findings from 20 high-quality peer-reviewed journal articles sourced from Google Scholar and Scopus database. Unlike purely technical reviews, this study integrates perspectives from computer science, communication studies, organizational management, and applied ethics to provide a comprehensive understanding of AI's multifaceted role in crisis management (Sharma et al., 2021, p. 25). The review critically examines not only what AI can do, but what it should do—and under what conditions its use is justified, transparent, and equitable (Gasana, 2024, p. 30).

The paper proceeds as follows: the next section reviews existing literature on AI applications in crisis management, positioning this study within ongoing scholarly debates. The theoretical framework then explains how machine learning paradigms translate to crisis management operations. The methodology section details the systematic documentary approach employed for literature selection and analysis. The findings section discusses AI's capabilities, challenges, and ethical considerations in media data analysis during crises. The conclusion synthesizes theoretical contributions, practical implications, and directions for future research. Throughout, the analysis maintains a focus on the dual imperatives of technological innovation and ethical responsibility, recognizing that effective crisis management requires not only powerful tools but also wise and accountable use of those tools (Parker, 2024, p. 328).

In this regard, research on crisis communication and data management within this process has garnered attention from both domestic and international scholars, with recent advancements in diverse AI tools sparking widespread interest in their application. A notable contribution is the book Media and Crisis Communication (2025), where Cheng et al. in Chapter 8 titled "Crisis Communication in the Age of Artificial Intelligence: Navigating Opportunities, Challenges, and Future Horizons," emphasize that integrating AI into crisis communication signals a paradigm shift in crisis management. This integration offers transformative capabilities for enhancing real-time insights, public engagement, and emergency response optimization, while AI plays a strategic role in information management—particularly countering misinformation and handling public relations—due to its high capacity for large-scale data analysis and rapid identification of false information.

Among domestic studies, Valivand Zamani and Mortazavi Zadeh (2024) examined "The Impact of artificial intelligence Use on Managers' Decision-Making Processes in Organizational Crisis Management." The researchers stress the necessity of adopting new tools and technologies in crisis management, advocating for AI training and development within organizations to enable managers to leverage it for timely, appropriate decisions that prevent crises and foster organizational progress.

Another study by Rahmani Maman and Dehghani Sanich (2024), titled "AI Innovations in Crisis Management: Exploring Applications and Methods," underscores how harnessing cutting-edge knowledge and advanced technologies, especially AI, can play a pivotal role in precise evaluation, comprehensive assessment, and innovative solutions for managing such events. AI excels at rapidly analyzing vast datasets to deliver accurate predictive analysis, thereby supporting more effective decision-making in crisis scenarios.

Bălan and Nedelcu (2024), in "artificial intelligence and Crisis Management," define AI as computers' ability to exhibit human-like reasoning and resolve situations typically requiring human intelligence. They highlight its use in forecasting crises like natural disasters through machine learning and robotics, such as monitoring volcanic ash or predicting water levels via specialized algorithms.

Mintoo et al. (2024), in "Transforming Global Crisis Communication through Digital Synergy: Enhancing Media Response Strategies with machine learning," systematically explore the disruptive role of digital synergy and machine learning (ML) in bolstering crisis communication strategies across domains like pandemics, natural disasters, cybersecurity incidents, and social media interactions. Findings reveal that digital synergy provides real-time, high-fidelity simulations of crisis dynamics, empowering decision-makers to anticipate challenges, allocate resources efficiently, and optimize emergency responses; meanwhile, ML techniques such as deep learning, predictive analytics, and natural language processing (NLP) facilitate misinformation detection, sentiment analysis, and forecasting public emotional responses.

2. Theoretical Framework

The theoretical foundation of this study rests on machine learning (ML) theory, which provides the necessary computational framework to manage and derive actionable insights from the immense volume and velocity of media data during a crisis (Mohri et al., 2012, p. 55). ML is not merely a tool; it encompasses distinct paradigms that directly inform the real-time monitoring and strategic response capabilities of AI systems. The primary analytical utility of ML lies in its ability to transform unstructured media content into actionable intelligence for crisis managers (Hossain et al., 2025, p. 156).

2.1. ML Paradigms for Crisis Media Analysis

The application of ML in crisis media analysis hinges on two key operational functions: immediate classification and discovery of novel patterns. Supervised Learning is paramount for rapid classification tasks, forming the theoretical basis for misinformation detection and crisis type identification. By training on historical labeled data—such as verified crisis reports versus fake news—supervised algorithms enable AI to accurately and instantly categorize incoming media narratives, allowing organizations to triage high-priority information and debunk false claims (Komendantova & Erokhin, 2025, p. 85). This capability is fundamental to maintaining control over the public narrative during high-stakes events.

In contrast, unsupervised learning and deep learning address the complexity of emergent crises and unstructured data. Since crises are often novel events, algorithms are required to discover new patterns without prior labels. Unsupervised methods excel at anomaly detection—identifying unusual spikes in conversation or shifts in sentiment that signal an unrecognized threat (Pattanayak et al., 2024, p. 58). Deep learning models, utilizing architectures like Recurrent Neural Networks, enhance nuanced sentiment and emotion analysis from text and video (Liu & Kirubakaran, 2022, p. 8). These models provide depth to the understanding of public sentiment beyond simple positive/negative labels, linking theory to practical insights regarding public anxiety and potential unrest.

2.2. Critical Limitations: Accountability and Ethics

To provide the necessary critical reflection, the application of ML theory must acknowledge its inherent limitations regarding accountability and ethics (Yuan et al., 2025, p. 14). Data bias remains a significant theoretical and practical challenge. If training data reflects societal prejudices, the resulting ML model will propagate those biases, potentially leading to unfair resource allocation or disproportionate monitoring during a crisis (Reddy et al., 2024, p. 4930). The lack of model interpretability—the "black box" problem—compromises trust and justification (Pedreschi et al., 2019, p. 9780). Crisis managers must be able to explain why an AI system recommended a specific action. The opaqueness of many deep learning models undermines the theoretical requirement for transparency in high-impact decision-making. These limitations necessitate integrating ethical governance with the computational theory of ML to ensure that AI-driven crisis responses are not only effective but also equitable and accountable (Barbierato & Gatti, 2024, p. 2).

2.3. Crisis Communication

Crisis communication, a specialized public relations field, addresses the critical need to manage and mitigate reputational damage during crises—

events that threaten stakeholder safety, security, or welfare and impact operations and public image. It guides crisis managers to limit harm to stakeholders and organizations, emerging as a serious U.S. research concern in the 1980s with rapid growth in definitions and theorization thereafter (Coombs, 2014, p. 2). Effective crisis communication minimizes negative effects through timely, accurate, and consistent information, establishing best practices for pre-, during-, and post-crisis engagement (Spradley, 2017).

A comprehensive crisis communication plan serves as a roadmap, outlining identification, assessment, and response protocols, including crisis teams, communication channels, key messages, and stakeholder targeting to enable swift, coordinated responses. Organizations must adapt strategies against misinformation, prioritizing transparency, accuracy, and accountability, with leadership fostering trust and ethical practices (Gasana, 2024, p. 28). Transparency and honesty are paramount; concealing information erodes trust, while admitting errors rebuilds it, as media amplify crises, shaping public perception: "In crisis conditions, public reliance on media peaks, enabling crisis exacerbation or resolution, agenda-setting, hope instillation or despair, and opinion influence" (Nasrollahi Kasmani, 2018, p. 282).

Effective crisis communication tailors messages to diverse stakeholders—employees, customers, investors, media—via active listening and dialogue, defined as "a strategic approach to managing undesired events' impact on reputation, operations, and stakeholders" (Nuortimo, 2024). Social media complicates this, demanding vigilant monitoring and engagement to counter rapid misinformation spread, as crises induce fear amid uncertainty (Wodak, 2021, p. 332).

2.4. Crisis Management

Crisis management demands a proactive, adaptive approach to unforeseen disruptions, analyzing key components like preparation, response, and recovery to highlight the need for robust strategies. Crises are inherently unstable threats to strategic goals, reputation, or survival, distinct from incidents and requiring unique approaches amid social and personal disruptions reducing control and predictability (Hamidovic, 2012, p. 1; Jafari et al., 2021, p. 9).

Emergency preparedness has evolved into an all-hazards framework encompassing mitigation, preparation, response, and recovery (Herstein et al., 2021, p. 2), with preparation identifying vulnerabilities, risk assessments, and comprehensive plans specifying roles, protocols, training, and simulations. Essential steps include competent staffing, leadership modeling, rapid issue resolution, accountability, defined processes, continuous learning, open feedback cultures, and effective safety communication (Kapur et al., 2024, p. 11).

The response phase requires swift, decisive action with transparent internal and external communication to reduce panic, build trust, and control narratives, guided by pre-set protocols amid adaptations. As the most time-intensive stage, coordinated responses significantly limit impacts (Saghaei, 2023, p. 128). Recovery focuses on operational restoration, damage assessment, corrective actions, and lessons learned to rebuild stakeholder trust through ongoing commitment.

Effective crisis management is a continuous cycle of preparation, response, and improvement, rooted in strong planning, clear communication, and experiential learning, positioning resilient organizations to navigate disruptions with minimal damage (Parker, 2022, p. 328).

3. Materials and Methods

The present study adopts a systematic documentary review approach to critically synthesize existing literature on the transformative role of artificial intelligence in media data analysis for crisis management. Documentary reviews are particularly suited for emerging interdisciplinary topics, enabling comprehensive integration of theoretical insights, empirical findings, and practical implications across multiple scholarly domains (Greenhalgh, 2016, p. 97). This methodology allows researchers to explore complex phenomena like AI applications in dynamic crisis contexts, identifying patterns, gaps, and future research directions through interpretive thematic analysis.

3.1. Research Design

The review employed a systematic documentary methodology, drawing exclusively from peer-reviewed journal articles to ensure scholarly rigor and credibility. Unlike purely technical surveys, this study integrates perspectives from computer science, communication studies, organizational management, and applied ethics to provide a multifaceted understanding of AI's role in crisis management (Sharma et al., 2021, p. 25). The systematic approach ensures transparency and replicability while maintaining the conceptual flexibility necessary for interdisciplinary synthesis.

3.2. Search Strategy and Data Sources

Literature searches were conducted using Google Scholar and Scopus database, selected for their comprehensive coverage of English-language scholarship in artificial intelligence, media studies, and crisis communication. The search employed Boolean operators combining keywords: ("artificial intelligence" or "machine learning" or "deep learning") and ("media data analysis" or "media monitoring") and ("crisis management" or "crisis communication" or "emergency response"). The temporal scope spanned 2014–2025, capturing AI's rapid evolution following deep learning breakthroughs while ensuring contemporary relevance. Initial searches yielded over 200 results across both databases.

3.3. Inclusion and Exclusion Criteria

Rigorous inclusion criteria were applied to ensure analytical quality. Articles were included if they: (1) were peer-reviewed journal publications in English; (2) explicitly addressed AI or ML applications in crisis or emergency contexts; (3) focused on media data analysis, monitoring, or communication strategies; and (4) provided empirical findings, theoretical frameworks, or systematic reviews. Exclusion criteria eliminated: conference proceedings without full peer review, non-English publications, purely technical papers lacking crisis context, and editorials or opinion pieces without empirical grounding. After applying these criteria and removing duplicates, 20 high-quality articles were selected for comprehensive analysis, as detailed in Table 1.

Table 1: Key Peer-Reviewed Articles Reviewed (N = 20, Google Scholar & Scopus)

	Authors (Year)	**Journal**	**Key Focus**	**AI/Crisis Media Relevance**
1	Cheng et al. (2025)	Media and Crisis Communication	AI in crisis comm.	Real-time misinformation countering
2	Eismann et al. (2021)	Journal of Strategic Information Systems	Social media in crises	Organizational learning via AI monitoring
3	Farrokhi et al. (2020)	Industrial Marketing Management	AI event detection	B2B crisis decision-making
4	Valivand Zamani & Mortazavi Zadeh (2024)	Motaleat-e Modiriyat-e Bohran	AI in org. crises	Managerial decision processes
5	Mintoo et al. (2024)	Journal of Next-Gen Engineering Systems	ML in crisis comm.	Digital synergy for media responses
6	Du et al. (2025)	Mathematics	ML theory	Generalization in high-stakes data
7	Barbierato & Gatti (2024)	Electronics	ML challenges	Crisis-applicable model limitations
8	BĂLAN & NEDELCU (2024)	Social Economic Debates	AI crisis mgmt.	Forecasting via ML algorithms
9	Rahmani Maman & Dehghani Sanich (2024)	Conference Proceedings	AI crisis innovations	Predictive analytics
10	Gerlich et al. (2023)	Frontiers in Communication	AI influencer analysis	Public opinion in marketing crises
11	Mishra (2024)	Int. J. Scientific Research	AI/ML review	Media data ethics
12	Dabas (2023)	Integrated Journal for Research	AI media landscapes	Automated monitoring
13	Aleessawi & Alzubi (2024)	Studies in Media and Communication	AI media quality	Content analysis biases
14	Gao et al. (2023)	SAGE Open	AI advertising	Personalization in crises
15	Nuortimo et al. (2024)	Journal of Marketing Analytics	Reputation mgmt.	Crisis narrative control
16	Pedreschi et al. (2019)	AAAI Conference	Explainable AI	Black box issues in crises
17	Reynolds et al. (2025)	Trends in Ecology & Evolution	AI conservation	Anomaly detection analogy
18	Sharma et al. (2021)	Global Transitions Proceedings	ML applications	Deep learning in media
19	Gasana (2024)	Journal of Public Relations	Fake news mgmt.	AI transparency needs
20	Maleki Varnosfaderani & Forouzanfar (2024)	Bioengineering	AI healthcare	Real-time crisis parallels

4. Results & Discussion

4.1. The Operational Necessity of AI in Crisis Media Environments

The contemporary crisis landscape confronts organizations with unprecedented media data challenges that fundamentally exceed traditional analytical capabilities. During major crises, organizations face exponential information flows: millions of social media posts, news articles, citizen reports, and multimedia content generated within hours (Perry et al., 2003, p. 210). This volume, combined with velocity demands for real-time response, creates what Lundsgaard-Larsen and Gadegaard (2016, p. 15) term “the crisis data paradox”—the simultaneous necessity and impossibility of comprehensive media monitoring using conventional human-centered methods. The problem is not merely quantitative but qualitative: crisis media data exhibits high dimensionality, linguistic variability, contextual ambiguity, and intentional manipulation through coordinated disinformation campaigns (Komendantova & Erokhin, 2025, p. 83). These characteristics demand computational approaches capable of pattern recognition, semantic understanding, and adaptive learning—capabilities that define artificial intelligence systems grounded in machine learning paradigms.

The analytical framework established in the theoretical section—distinguishing supervised learning, unsupervised learning, and deep learning—directly translates to specific operational capabilities essential for crisis management. Each ML paradigm addresses distinct crisis communication challenges, and understanding these correspondences is critical for both theoretical advancement and practical implementation (Sharma et al., 2021, p. 26). The findings below systematically examine how these paradigms operationalize AI’s role in media data analysis during crises, while critically engaging with the ethical, technical, and practical limitations that constrain responsible deployment.

4.2. Supervised Learning: Real-Time Content Classification and Misinformation Detection

Supervised learning models, trained on labeled datasets to recognize predetermined patterns, provide crisis managers with immediate classification capabilities for incoming media content. This paradigm’s primary operational value lies in its ability to rapidly categorize vast streams of social media posts, news articles, and citizen reports into actionable intelligence categories: urgent threats requiring immediate response, misinformation requiring correction, public sentiment indicators, and resource allocation signals (Farrokhi et al., 2020, p. 1356). During the COVID-19 pandemic, supervised learning algorithms demonstrated the capacity to process millions of social media posts daily, identifying critical patterns such as emerging outbreak clusters, public compliance with health measures, and coordinated disinformation campaigns—analyses that would require thousands of human analysts working continuously (Jafari et al., 2021, p. 12).

The most critical application of supervised learning in crisis contexts is misinformation and disinformation detection. False information during crises—whether accidental rumors or deliberate propaganda—can directly endanger lives by misdirecting evacuations, undermining public health measures, or inciting panic (Gasana, 2024, p. 32). AI systems trained on historical examples of verified versus false crisis claims can flag suspicious content with accuracy rates exceeding 85% in controlled studies, dramatically reducing verification time from hours to seconds (Komendantova & Erokhin, 2025, p. 88). For instance, during natural disasters, supervised models can distinguish legitimate eyewitness reports from recycled imagery, satire misinterpreted as fact, or intentional fabrications designed to manipulate relief efforts. This capability allows crisis communication teams to prioritize verification resources and issue timely corrections before false narratives achieve viral spread.

However, the effectiveness of supervised learning is fundamentally constrained by training data quality and representativeness. Models can only recognize patterns they have encountered during training, creating vulnerability to novel crisis types, emerging linguistic patterns, or culturally specific misinformation tactics (Barbierato & Gatti, 2024, p. 8). More critically, if training datasets contain systematic biases—for example, overrepresenting urban perspectives, certain demographic groups, or specific geographic regions—the resulting models will perpetuate these biases in operational deployment (Reddy et al., 2024, p. 4929). In crisis contexts where equitable resource allocation and fair representation of all affected populations are ethical imperatives, biased AI systems risk amplifying existing social inequities rather than ameliorating them. This tension between operational efficiency and ethical responsibility represents a central challenge that supervised learning applications must address through rigorous debiasing protocols and continuous fairness auditing.

4.3. Unsupervised Learning: Anomaly Detection and Early Warning Systems

While supervised learning excels at recognizing known patterns, crises frequently manifest through unprecedented combinations of events that defy pre-labeled categories. Unsupervised learning addresses this limitation by identifying hidden structures, anomalies, and emerging patterns within unlabeled media data without requiring prior examples (Pattanayak et al., 2024, p. 58). This paradigm's operational value for crisis management lies in its capacity to serve as an early warning system, detecting signals of emerging crises before they escalate to full-scale emergencies requiring reactive response (Reynolds et al., 2025, p. 198).

Unsupervised anomaly detection algorithms continuously monitor baseline patterns of media activity—typical volumes of posts about specific topics, normal sentiment distributions, expected geographic distributions of content—and flag statistically significant deviations that may indicate emerging threats (Eismann et al., 2021, p. 4). For example, a sudden spike in social media posts containing health-related keywords from a specific geographic region, coupled with abnormal sentiment patterns expressing fear or confusion, might indicate an emerging disease outbreak, chemical exposure, or infrastructure failure before official reports reach authorities. Similarly, unexpected clustering of posts containing specific hashtags or coordinated messaging patterns can reveal organized disinformation campaigns in their initial stages, enabling preemptive countermeasures before false narratives achieve widespread acceptance (Komendantova & Erokhin, 2025, p. 91).

The strategic advantage of unsupervised learning lies in its "unknown unknown" detection capability—identifying threats that crisis planners did not anticipate and therefore could not prepare supervised models to recognize. This capability aligns directly with the contemporary shift toward all-hazards emergency preparedness frameworks that acknowledge the impossibility of predicting all potential crisis scenarios (Herstein et al., 2021, p. 3). However, unsupervised learning's strength is simultaneously its operational weakness: anomaly detection generates high false-positive rates, flagging numerous statistical deviations that represent benign variations rather than genuine threats. Crisis managers must therefore balance sensitivity (detecting real emerging threats) against specificity (avoiding alert fatigue from false alarms), a trade-off that requires careful threshold calibration and integration with human expertise for context interpretation (Pattanayak et al., 2024, p. 61). Without this integration, unsupervised systems risk overwhelming response teams with noise rather than signal.

4.4. Deep Learning: Semantic Understanding and Emotion Analysis

Deep learning, particularly through neural network architectures, extends AI capabilities beyond pattern recognition to semantic understanding of media content's meaning, context, and emotional valence. This paradigm addresses a fundamental limitation of traditional ML approaches: the inability to comprehend linguistic nuance, contextual irony, cultural references, and emotional undertones that profoundly influence crisis communication effectiveness (Liu & Kirubakaran, 2022, p. 4). Deep learning models, especially those utilizing natural language processing (NLP) architectures like transformers, can analyze not merely what is being said but how it is being said and what emotions it conveys—capabilities essential for assessing public psychological states and tailoring communication strategies accordingly (Mintoo et al., 2024, p. 41).

Sentiment and emotion analysis powered by deep learning provides crisis managers with real-time assessments of public emotional responses to both the crisis itself and organizational communications. During major crises, tracking the emotional trajectory of public discourse—from initial shock and fear through anger, bargaining, and eventual acceptance or sustained trauma—enables organizations to adapt messaging strategies to meet populations where they are psychologically rather than where planners assume they should be (Liu & Kirubakaran, 2022, p. 12). For instance, if deep learning analysis reveals that public sentiment toward official health guidance is shifting from compliance to skepticism or anger, crisis communicators can adjust tone, provide additional transparency about decision-making processes, or engage trusted community voices to rebuild confidence before complete trust erosion occurs.

Deep learning also enables sophisticated content generation and personalization capabilities that can enhance crisis communication effectiveness. By analyzing individual users' historical interactions, concerns expressed, and information-seeking patterns, AI systems can tailor crisis messages to address specific population segments' priorities (Gao et al., 2023, p. 8). Elderly populations may require different messaging emphasis (focusing on accessibility of services, transportation assistance) compared to parents of young children (focusing on school closures, childcare resources) or individuals with disabilities (focusing on accessible evacuation routes, specialized medical support). This personalization, when implemented ethically with appropriate consent and privacy protections, can significantly improve message relevance and reduce the one-size-fits-all communication failures that have characterized many historical crisis responses (Maleki Varnosfaderani & Forouzanfar, 2024, p. 8).

However, deep learning's semantic sophistication comes at substantial cost. The neural network architectures required for NLP and emotion analysis are computationally intensive, requiring significant hardware resources and energy consumption that may be impractical during crises when infrastructure is compromised (Barbierato & Gatti, 2024, p.12). More fundamentally, deep learning models exhibit the most severe manifestation of the "black box" problem: their decision-making processes involve millions or billions of parameters interacting in ways that resist human interpretation even by the models' creators (Pedreschi et al., 2019, p. 9781). When a deep learning system classifies content as threatening or recommends prioritizing aid to specific populations, explaining why that decision was reached—a requirement for accountability in high-stakes crisis contexts—becomes extraordinarily difficult or extremely difficult with current architectures.

4.5. Integrated Crisis Communication: Strategic Narrative Control and Stakeholder Engagement

Beyond individual analytical capabilities, AI's transformative impact on crisis management emerges from integrated deployment across the complete crisis communication cycle. Modern crises unfold simultaneously across multiple media platforms—traditional news outlets, social media ecosystems, messaging applications, video platforms—each with distinct audience demographics, communication norms, and information diffusion dynamics (Perry et al., 2003, p. 218). Managing coherent organizational narratives across this fragmented landscape manually is increasingly infeasible; AI provides the necessary coordination infrastructure.

Strategic narrative control during crises requires organizations to move beyond reactive "firefighting" toward proactive shaping of information environments. AI enables this shift through several mechanisms. First, by analyzing which information sources and influencers are shaping public understanding of the crisis, AI systems can guide communication teams to engage these key nodes directly with accurate information before misinformation takes root (Gerlich et al., 2023, p. 8). During the COVID-19 pandemic, public health agencies that successfully identified and collaborated with trusted community influencers—religious leaders, local celebrities, community organizers—achieved significantly higher vaccination rates than those relying exclusively on official government channels. AI's network analysis capabilities make systematic identification of these influential voices feasible at scale. Recent computational discourse research further illustrates how large-scale social media analysis—integrating topic modeling, sentiment and emotion classification, and entity recognition—can illuminate the thematic structures, affective currents, and power configurations shaping digital public debate, demonstrating how algorithmic analysis reveals not only patterns of influence but also the broader sociopolitical dynamics embedded within contemporary information environments (Salehi et al., 2025).

Second, AI enables dynamic communication channel optimization. Different population segments consume information through different platforms and respond to different communication styles. Young adults may be reached most effectively through Instagram and TikTok with visual, concise messaging, while older populations may rely on Facebook and traditional news with more detailed, text-based information (Dabas, 2023, p. 252). AI systems can analyze which channels are reaching which demographics with what messages, allowing real-time strategy adjustments to maximize coverage across diverse stakeholder groups. This capability proves particularly valuable in international crises requiring coordination across linguistic and cultural boundaries.

Third, AI facilitates continuous feedback loops between organizational communication and public response. Rather than issuing statements and hoping for compliance, modern crisis management involves monitoring how messages are received, identifying misunderstandings or resistance points, and iteratively refining communication strategies based on observed patterns (Nuortimo et al., 2024, p. 12). AI's real-time processing enables this adaptive approach at the speed crises demand. For example, if AI analysis reveals that a particular population segment is misinterpreting a technical term in emergency instructions, communicators can immediately issue clarifications using accessible language before dangerous misunderstandings lead to injuries.

However, this integration also concentrates substantial power in organizational hands, raising ethical questions about manipulation and transparency. The same capabilities that enable effective crisis communication could be weaponized for propaganda, narrative suppression, or selective information disclosure. When organizations use AI to identify and engage influencers, are they facilitating information dissemination or orchestrating astroturfing? When they personalize messages based on psychological profiling, are they increasing relevance or engaging in manipulative microtargeting? These questions lack clear answers but demand explicit ethical frameworks governing AI use in crisis contexts (Yuan et al., 2025, p. 9).

4.6. Critical Limitations: Interpretability, Bias, and Implementation Challenges

While AI offers substantial operational capabilities for crisis media analysis, acknowledging and critically examining its fundamental limitations is essential for responsible implementation. These limitations are not merely technical challenges awaiting engineering solutions but represent inherent tensions between AI's operational logic and the ethical, social, and political requirements of just crisis management.

The interpretability challenge—commonly termed the "black box problem"—poses fundamental obstacles to accountability in high-stakes crisis decision-making. As ML models, particularly deep neural networks, increase in complexity and accuracy, their internal decision-making processes become increasingly opaque (Pedreschi et al., 2019, p. 9780). When an AI system recommends prioritizing aid distribution to specific geographic areas, classifying social media content as threatening, or identifying certain populations as high-risk, human operators cannot readily understand which features, patterns, or correlations drove those recommendations. In non-crisis contexts, this opacity may be acceptable if overall performance is satisfactory. In crisis contexts, where every decision can affect human lives, the inability to explain why a system made a specific recommendation undermines accountability, prevents meaningful human oversight, and erodes public trust (Reynolds et al., 2025, p. 201). Parallel concerns have been documented in other high-stakes AI domains, where critical reviews emphasize that systems deployed in socially sensitive contexts require robust explainability, transparency, and human oversight to prevent the normalization of opaque decision-making and to safeguard ethical accountability (Salehi et al., 2026).

This problem extends beyond technical explanation to epistemic concerns about AI's reasoning. Even when researchers employ explainability techniques like SHAP values or attention mechanisms to identify which input features most influenced a model's output, these technical explanations often fail to align with human causal reasoning or ethical principles. An AI system might accurately predict crisis escalation based on correlations that are statistically valid but ethically inappropriate to act upon—for example, demographic characteristics protected by anti-discrimination law. The system cannot distinguish between predictive accuracy and ethical permissibility, placing full responsibility for this distinction on human operators who may lack complete understanding of what patterns the AI is exploiting (Valivand Zamani & Mortazavi Zadeh, 2024, p. 22).

Data bias represents an equally serious concern with direct implications for social justice in crisis response. AI models learn from historical data, inheriting and often amplifying whatever biases that data contains. In crisis media analysis, multiple bias sources converge: media coverage itself exhibits systematic biases toward urban areas, wealthier populations, and dominant cultural groups; social media participation is demographically skewed with significant digital divides excluding marginalized populations; and training dataset construction involves subjective human judgments about what constitutes relevant, threatening, or important content (Reddy et al., 2024, p. 4930). When AI systems trained on such data are deployed in crisis contexts, they risk perpetuating historical patterns of unequal attention, resource allocation, and voice amplification.

For example, if training data overrepresents media coverage of crises affecting wealthy urban areas while underrepresenting rural or economically disadvantaged regions, AI systems may be less sensitive to early warning signals emerging from these underrepresented areas. Similarly, if sentiment analysis models are trained predominantly on standard language varieties, they may misinterpret or fail to process dialectal variations, code-switching, or multilingual content common in diverse communities—effectively silencing these populations' voices in crisis monitoring systems (Aleessawi & Alzubi, 2024, p. 57). The operational consequence is not merely technical inaccuracy but systematic injustice: the populations most vulnerable during crises become invisible to the AI systems designed to protect them.

Addressing bias requires more than technical debiasing algorithms; it demands critical examination of what crisis management priorities are being embedded in AI systems and whose interests these systems serve. Current research on algorithmic fairness offers various mathematical definitions of fairness—demographic parity, equalized odds, individual fairness—but these definitions can conflict, and selecting among them involves normative judgments about social values that technical experts alone cannot make (Reddy et al., 2024, p. 4931). Crisis management organizations deploying AI must therefore engage in participatory processes involving affected communities, ethicists, social scientists, and domain experts to establish fairness criteria appropriate to specific contexts, and must commit to ongoing auditing and adjustment as new biases emerge.

Implementation challenges extend beyond algorithmic limitations to organizational, infrastructural, and sociotechnical factors. AI systems require substantial computational resources, high-quality data streams, technical expertise for deployment and maintenance, and organizational cultures that can effectively integrate algorithmic insights with human judgment (Barbierato & Gatti, 2024, p. 15). Many organizations responsible for crisis management—particularly in resource-constrained settings, developing nations, or rural areas—lack these prerequisites. Even when technical capabilities exist, organizational resistance to AI-driven recommendations, misplaced trust in algorithmic authority, or lack of training in appropriate AI use can undermine effectiveness or create new vulnerabilities (Valivand Zamani & Mortazavi Zadeh, 2024, p. 20).

The COVID-19 pandemic illustrated these implementation challenges clearly. While sophisticated AI systems for epidemiological modeling, misinformation detection, and resource optimization were developed rapidly, their practical impact varied enormously across contexts. Organizations with strong technical capacity, interdisciplinary collaboration, and established crisis management protocols could integrate AI effectively; those lacking these foundations found AI tools unhelpful or actively counterproductive when deployed without adequate support infrastructure (Wodak, 2021, p. 338). This disparity risks creating a two-tiered crisis management landscape where technologically advanced organizations can leverage AI's capabilities while others fall further behind, exacerbating global inequalities in crisis preparedness and response capacity.

4.7. Toward Responsible AI Integration: Requirements for Ethical Crisis Management

The findings above demonstrate that AI's role in crisis media analysis is neither purely beneficial nor inherently problematic but fundamentally ambivalent—offering transformative capabilities while introducing serious risks. Responsible integration requires deliberate design choices, robust governance frameworks, and ongoing critical engagement with AI's limitations rather than uncritical enthusiasm for its possibilities. Recent scholarship in disaster risk management similarly characterizes AI as a dual-use technology, simultaneously embedded within exploitative data economies and capable of enhancing early warning systems and post-disaster resilience, underscoring the necessity of governance models grounded in transparency, data sovereignty, and explainability (Sharifi Poor Bgheshmi et al., 2026).

First, explainable AI (XAI) development must become a priority for crisis management applications. Current XAI research focuses primarily on technical interpretability metrics that may not align with crisis managers' decision-making needs or ethical accountability requirements (Pedreschi et al., 2019, p. 9783). What crisis contexts demand is human-centered explainability: explanations that help human operators understand not just which features influenced a model's output but whether the model's reasoning aligns with domain knowledge, ethical principles, and organizational values. This requires interdisciplinary collaboration between ML researchers, crisis management practitioners, ethicists, and affected communities to define what constitutes adequate explanation in specific crisis contexts.

Second, bias mitigation must extend beyond technical debiasing algorithms to systemic approaches addressing root causes of data inequality. This includes deliberately oversampling underrepresented populations in training data, developing culturally sensitive annotation protocols that respect linguistic and contextual diversity, establishing participatory processes for affected communities to influence system design and evaluation criteria, and implementing continuous fairness auditing with consequences for systems that perpetuate discriminatory patterns (Reddy et al., 2024, p. 4930). Organizations must also acknowledge that perfect fairness may be unattainable and prepare contingency plans for addressing algorithmic failures when they occur.

Third, human-AI collaboration frameworks must recognize that effective crisis management requires combining AI's computational strengths with human capacities for contextual judgment, ethical reasoning, and adaptive improvisation. AI should augment rather than replace human decision-makers, with clear protocols specifying when algorithmic recommendations should be followed, questioned, or overridden (Hossain et al., 2025, p. 159). This requires organizational cultures that value critical questioning of technology, provide training in AI literacy and limitations, and protect individuals who raise concerns about algorithmic recommendations from institutional pressure to defer to automated systems.

Fourth, governance frameworks must establish accountability structures for AI-driven crisis decisions. When AI systems contribute to decisions that affect human lives—resource allocation, evacuation orders, communication prioritization—clear chains of responsibility must exist. This includes transparency about what AI systems are being used, documentation of their training data and known limitations, processes for appealing or contesting algorithmic recommendations, and mechanisms for redress when AI systems cause harm (Yuan et al., 2025, p. 12). Such accountability cannot exist without transparency, requiring organizations to resist proprietary secrecy about AI systems used in crisis contexts.

Finally, capacity building must ensure that AI's benefits extend beyond technologically advanced organizations to the full range of actors involved in crisis management globally. This requires open-source tool development, training programs accessible to resource-constrained organizations, technical assistance for AI implementation in diverse contexts, and critical examination of how AI deployment may exacerbate existing global inequalities (Komendantova & Erokhin, 2025, p. 98). The goal is not universal adoption of AI but rather equitable access to AI's capabilities for those contexts where it can genuinely improve crisis outcomes.

5. Conclusion

This study utilized a narrative review methodology, underpinned by machine learning (ML) theory, to explore the transformative role of AI in media data analysis during crisis management. The necessity of this framework stems from the unprecedented volume and velocity of media data that render traditional analytical methods obsolete. The findings strongly suggest that AI's operational effectiveness is not merely technical but is rooted in distinct ML paradigms: supervised learning facilitates the immediate classification and detection of misinformation and disinformation, drastically reducing verification time, while unsupervised learning and deep learning enable the identification of emerging patterns, hidden trends, and anomalies essential for building proactive early warning systems. Our theoretical contribution lies in establishing a clear analytical link between these specific ML mechanisms and their resultant operational capabilities in the crisis domain, thereby moving beyond a generic description of AI's functional assistance.

However, the research also highlights critical challenges that prevent the uncritical adoption of these technologies. The lack of interpretability in complex ML models fundamentally challenges the need for accountability and public trust in high-stakes crisis decision-making, where every intervention requires robust justification. Furthermore, data bias remains a significant ethical and operational concern, risking the propagation of existing inequities in media coverage and potentially leading to the misallocation of aid resources or misrepresentation of vulnerable populations. Methodologically, as a narrative review, this study's findings are theoretical and conceptual, and must be validated through rigorous empirical testing before practical implementation can be fully assured.

To advance the field, future research should focus on developing Explainable AI (XAI) frameworks specifically tailored for crisis media analysis to effectively address the interpretability challenge and enhance human-AI collaboration during emergencies. Further empirical studies are needed to quantitatively test the impact of debiasing techniques on ML models operating under the dynamic and volatile conditions of real-world crises. This work is essential to ensure that future AI applications in crisis management are not only effective in terms of speed and accuracy but also transparent, ethical, and equitable in their overall societal impact.

Conflict of Interest

The authors declare no potential conflicts of interest regarding the publication of this work. In addition, ethical issues including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been fully addressed by the authors.

Author contributions

The authors confirm the study conception and design: Hatef Pourrashidi Alibigloo; data collection: Hatef Pourrashidi Alibigloo; analysis and interpretation of results: Hatef Pourrashidi Alibigloo and Mehran Samadi; draft manuscript preparation: Hatef Pourrashidi Alibigloo. The results were evaluated by all authors, and the final version of the manuscript was approved.

AI Disclosure Statement

Artificial intelligence tools were employed in the initial stages of this manuscript's preparation. Specifically, AI-assisted technologies were used for:

- Initial Conceptual Framing: AI tools assisted in organizing preliminary ideas and structuring the initial outline of the manuscript, helping to establish the conceptual framework for exploring AI's role in crisis management.

- Translation and Language Enhancement: AI-powered translation tools were utilized to translate the initial draft from Persian to English, followed by language refinement to ensure academic tone, clarity, and grammatical accuracy appropriate for scholarly publication.

- Literature Organization: AI tools helped in preliminary organization and categorization of research sources during the early literature review phase.

However, all substantive intellectual content—including the research design, methodology, theoretical framework, critical analysis, interpretation of findings, and conclusions—represents the original scholarly work of the authors. All cited sources were independently verified by the authors, and the final manuscript underwent comprehensive human review and revision to ensure accuracy, academic integrity, and alignment with the study's research objectives. The authors retain full responsibility for all content, arguments, and any errors in this manuscript.

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