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Research Paper

Systematic Analysis of Crowdsourcing Support for Collaborative Crisis Communication: A Literature Review and User Experience Evaluation

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Abstract. *Background:* This article examines the application of crowdsourcing solutions in collaborative crisis communication, focusing on the challenges faced by crisis and emergency responders, as well as the collaborative potential offered by digital platforms. *Purpose:* The primary objective of this study is to explore and categorize the challenges encountered in collaboration among stakeholders during crises and emergencies. The secondary research goal aims to assess how crowdsourcing solutions, such as crowdfunding, contribute to enhancing communication and coordination in crisis management. *Methods:* To achieve these objectives, a systematic literature review was conducted, categorizing the key challenges faced in crisis scenarios and the system requirements that crowdsourcing solutions must address. Furthermore, an evaluation of User Experience (UX) in crowdfunding campaigns during humanitarian crises was performed, investigating factors that influence donations, donor concerns, and the challenges involved in mobilizing volunteers and resources. *Results:* The analysis identified key entities in crisis communication: the crowd, agents (authorities and professionals), and the environment (platforms, apps, or maps). Requirements emphasized trust, rapid response, efficient coordination, active engagement, and transparency. Challenges included issues with transparency, authenticity, and security. The reputation of institutions was crucial for donations, and participants valued access to updated information and communication channels with institutions. *Conclusion:* Crowd collaboration enhances data sharing, transparency, and resource allocation in crisis scenarios through crowdsourcing solutions. Challenges in developing these solutions include ensuring trust, validating data, and coordinating rapid responses. Similarly, crowdfunding platforms face challenges related to concerns about authenticity and transparency, which significantly influence donation decisions.

Keywords: Crowdsourcing, Collaboration, Crisis Communication

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1 Introduction

The global humanitarian landscape has become increasingly critical. In 2022, conflicts, hunger, and climate-related issues led to a 20% increase in the number of children requiring aid, reaching 149 million [1]. That same year, 387 natural disasters resulted in over 30,000 deaths and affected 185 million people worldwide [2]. Brazil, in particular, has consistently ranked among the top 10 countries most impacted by disasters over the last two decades [3].

In this context, an effective emergency response is vital to save lives and provide essential services such as medical care, food, and shelter. However, achieving the necessary coordination remains a significant challenge. Modern crisis management often struggles with delayed responses, inconsistent information, and suboptimal resource allocation. Despite its importance, there is still a notable scarcity of research focused on optimizing communication in these high-pressure environments.

Scholars emphasize that successful disaster response depends on swift, well-coordinated communication between organizations and the affected population [Benali and Ghomari, 2017; Quarantelli and Dynes, 1977]. To address these gaps, web-based systems—such as Volunteered Geographic Information Systems (VGI) and Spatial Decision Support Systems—have emerged as essential tools for large-scale data gathering [Benali and Ghomari, 2017]. Among these, Crowdsourcing (CS) stands out by leveraging the "power of the crowd" to solve complex problems [Howe *et al.*, 2006].

Originally defined as a way to outsource tasks to a large group of people, CS has been amplified by modern communication technologies, making collaborative projects more accessible and cost-effective. Unlike competitive models, this study focuses on CS as a collaborative mechanism where citizens, organizations, and devices work together toward common goals that would be unattainable through individual efforts [Camarinha-Matos and Afsarmanesh, 2005]. By integrating social media and digital platforms, CS enables the collection of real-time opinions and evaluations, fostering a more inclusive and efficient approach to crisis management.

[1] Global Humanitarian Overview; Available at `https://humanitarianaction.info/` Accessed on 01 August 2026

[2] Global Emergency Event Database (EM-DAT); Available at: `https://www.preventionweb.net/quick/76957`; Accessed on 01 August 2026

[3] United Nations (UN); Available at: `https://brasil.un.org/pt-br/71500-onu-brasil-est%C3%A1-entre-os-10-pa%C3%ADses-com-maior-n%C3%BAmero-de-afetados-por-desastres-nos-%C3%BAltimos-20`; Accessed on 01 August 2026

1.1 Proposal

In emergency situations, the collaborative efforts of individuals can provide essential support to organizations and professionals. This research paper is an extension of [Pestana *et al*., 2024] and investigates the use of CS, as documented in the literature, to enhance collaborative approaches in the realm of crisis communication. The second goal of this paper is to evaluate collaborative platforms for supporting humanitarian campaigns using contributions from the crowd.

The systematic review method was employed to address the following query: How and why does CS offer valuable contributions to collaborative crisis communication? This inquiry is addressed through an analysis of the existing literature, focusing on CS solutions that employ collaborative practices to support crisis communication. Additionally, to complement the practical implications of this research, we also conducted a survey based on UX. This survey was previously published in [Pestana and Vieira, 2024].

The structure of this paper is as follows: Section 2 introduces the fundamental concepts required to understand crisis communication challenges and the role of CS. Section 3 describes the systematic literature review method, including the research questions, search strategy, selection criteria, and data extraction process. Section 4 synthesizes and categorizes the selected studies into thematic groups, summarizing the evidence and collaboration problems reported in the literature. Section 5 analyzes the review findings by answering the research questions and discussing the main entities and requirements for CS-supported collaborative crisis communication. Section 6 presents an empirical validation through a UX-oriented survey grounded in crowdfunding experiences for crisis relief. Section 7 provides an in-depth analysis of crowdfunding as a collaborative solution for crisis relief, detailing the UX design, method, results, derived system requirements, and validity limitations. Section 8 discusses how the systematic review findings align with the UX survey results. Finally, Section 9 concludes the paper.

1.2 Ethical Issues

1.2.1 *Systematic Literature Review*

All data used in the systematic literature review were obtained exclusively from published scientific studies, in accordance with copyright and licensing regulations. As this phase of the research did not involve human participants or the collection of personal data, no ethical approval was required.

1.2.2 *User Experience Evaluation*

The User Experience (UX) evaluation involved an anonymous, voluntary questionnaire applied to participants. Before accessing the questionnaire, all participants were presented with a Free and Informed Consent Form (TCLE) and could only proceed after explicitly agreeing to participate. No identifying personal data were collected, and all responses were analyzed in aggregate. Although this study was not submitted to an ethics committee at the time of data collection, recognized ethical guidelines for academic research were followed.

2 Fundamental Concepts

This section begins by outlining the challenges of crisis communication, providing context for the communication issues encountered in crisis management. It then introduces the fundamental concepts of CS, which are essential for understanding the scope and procedures of this research.

2.1 Crisis Communication Challenges

According to Quarantelli and Dynes [1977], emergencies are critical situations that can be natural or human-induced. The consequences of an emergency lead to a crisis scenario. Consolidating a communication strategy between the parties involved is one of the primary goals of crisis management. These parties can include witnesses, operational forces, rescuers, command centers, affected communities, authorities, the press, volunteers, and people in surrounding areas. However, current media often does not provide adequate coordination for supporting crisis management.

Quarantelli and Dynes [1977] also highlights the importance of considering communication between different system organizations. These systems of specialized organizations are designed to perform particular disaster-related tasks. For example, medical systems provide emergency medical services, and military systems provide security. Communication among participating organizations is not one-way; there are multiple two-way and chain communications between different kinds of multi-layered groups, as defined by Quarantelli and Dynes [1977]. Examples include aid stations in a medical system, ambulances or transporting units, public and private hospitals, and various authorities operating within jurisdictions. Therefore, communication becomes more difficult and problematic during a community disaster. Rapid and accurate communications are essential elements for providing effective and efficient organizational responses to disasters, as described by Quarantelli and Dynes [1977].

Considering the challenges faced when implementing crisis communication support, CS techniques can be used to improve the reach of the message. Furthermore, collaboration techniques should be considered to provide adequate coordination among the involved actors and crisis relief. Gadiraju *et al*. [2014] defines that the quality of CS outcomes is uncertain since it depends on how the crowd performs a task. To overcome the limitations of CS, crisis organizations can define mechanisms to support eventual difficulties faced by users.

2.2 CS: a Communication Solution

The concept of harnessing the collective power of the crowd is not a novel notion. According to The Economist[4], as far back as 1714, the British government established the Longitude Prize, promising a monetary reward for an efficient solution to pinpoint ships' locations at sea. Instead of exclusively funding an individual scientist, they embraced a visionary strategy now recognized as "crowdsourcing." This historical example underscores that while the concept is old, its potency has been significantly amplified by the advent of the internet, making its application cost-effective and accessible across a myriad of unforeseen domains.

In contemporary terms, Crowdsourcing (CS) has revolutionized the way tasks are accomplished, challenges are ad-

[4]The Economist; Available at `https://www.economist.com/technology-quarterly/2008/09/06/following-the-crowd`; accessed on 01 August 2026

dressed, and ideas are generated. The term gained prominence following the work of Howe *et al*. [2006], who highlighted the difference between outsourcing and crowdsourcing, noting that the latter replaces traditional employees with the diverse talents of the crowd. From creative projects to complex problem-solving, CS has emerged as a powerful tool that transcends traditional boundaries and fosters collaborative engagement on an unprecedented scale.

In this study, we introduce CS-based solutions that are operationalized through digital platforms, where the crowd interacts via mobile devices to contribute to crisis relief efforts. To ensure clarity, we distinguish between CS solutions—the functional approaches and strategies designed to address specific challenges—and platforms—the digital tools, such as mobile apps or websites, through which these solutions are implemented. Summarizing this technical structure, CS platforms are composed of requesters, workers, and tasks. A CS solution encompasses tasks generated by the Requester and completed by the Workers; these tasks are stored on a server and subsequently executed on mobile devices employed by the crowd.

According to Brabham [2013], CS initiatives are managed by organizations or individuals who submit tasks. In public administration, for example, governments can find solutions to manage cities by consulting citizens. Recently, these platforms have become more accessible and established, such as the microtasking platforms Amazon's Mechanical Turk (MTurk)[5] and CrowdFlower[6]. While MTurk creates human intelligence tasks in exchange for monetary value, other applications like Pinterest provide a bank for registering ideas, and the DesignCrowd platform connects organizations with professional designers.

The evolution of communication technologies has further propelled these advancements, making the process more economical for large-scale business or organizational projects. Esteemed corporations like IBM, Dell, Starbucks, and Unilever have turned to CS to unearth enhanced ideas, products, or projects [Mota and Lima, 2018]. These examples illustrate how different platforms provide the necessary infrastructure to execute diverse CS solutions, enabling society to develop collaborative projects and become more efficient in addressing global challenges.

3 Systematic Review Method

This study presents a systematic literature review (SLR) focused on CS and crisis communication. The investigation aims to identify existing CS solutions that incorporate collaborative practices to effectively support communication processes during crises. The review follows the established guidelines defined by Kitchenham and Charters Kitchenham [2004].

The research process evolved through distinct stages of refinement. The systematic review regarding crisis communication supported by the crowd was initiated in 2021. However, the research protocol was formally revised in 2023, leading to an update of the search string with necessary corrections and refinements to better align with the study's scope. Following this revision, a new round of searches was conducted in October 2024 to ensure the inclusion of recent literature. The final verification of the retrieved records and eligibility decisions was completed in January 2025.

The complete methodological workflow is summarized in Figure 1. First, we formulated seven Research Questions (RQ1–RQ7) to guide the review. Next, we defined a search string based on the central problem addressed in this study, aiming to retrieve papers that propose solutions in the context of CS for crisis communication. The search scope was restricted to publications after 2006, as the term "crowdsourcing" was formally coined that year. We then executed the search across the selected scientific libraries and refined the results by applying predefined inclusion and exclusion criteria.

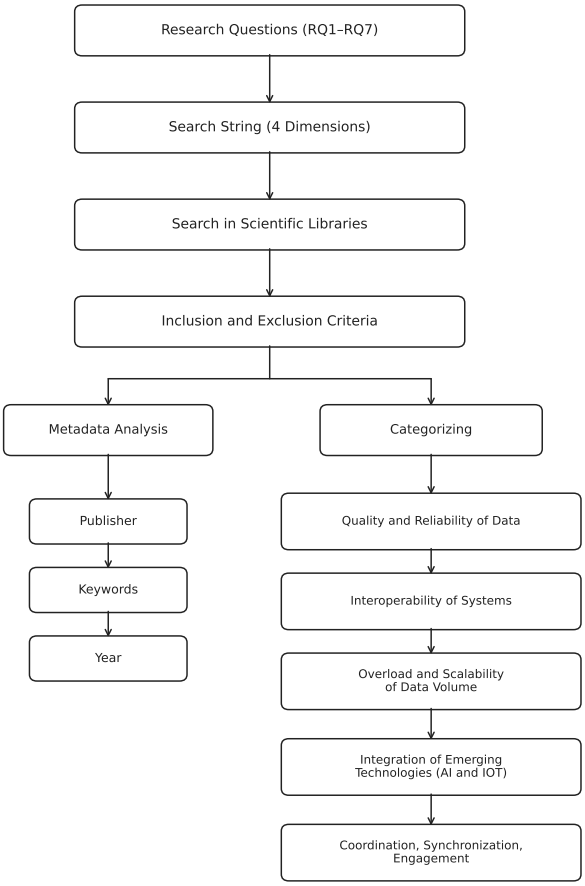

Figure 1. Systematic literature review workflow: from the formulation of research questions to study selection, metadata analysis, and thematic categorization

After the final set of studies was established, we performed two complementary analyses: (i) a *metadata analysis* to summarize publication characteristics (publisher, keywords, and year), and (ii) a *categorization* step to organize the evidence into five thematic groups. This categorization was performed manually by identifying similarities in the articles' titles or abstracts and comparing the themes with those found in other studies. These groups include: quality and reliability of data; interoperability of systems; overload and scalability of data volume; integration of emerging technologies (AI and IoT); and coordination, synchronization, and engagement.

[5]www.mturk.com
[6]www.crowdflower.com

Ethical procedures relevant to this research, particularly regarding the subsequent user evaluation, are addressed in the Ethical Issues subsection.

3.1 Research Questions

We defined seven research questions (RQ) to collect data on how CS solutions contribute to overcoming crisis communication challenges. This study aimed to answer the following questions during data extraction:

RQ1: What are the key challenges encountered in collaboration during crisis communication, particularly when coordinating diverse stakeholders?

RQ2: How does CS contribute to enhancing collaboration in crisis communication processes?

RQ3: What methods are used to evaluate CS solutions for crisis communication?

RQ4: Who are the intended users or beneficiaries of the CS solutions studied in the context of crisis communication?

RQ5: What types or categories of crises are addressed by CS solutions in the analyzed studies?

RQ6: What are the roles and functions of the key actors involved in the crisis communication process?

RQ7: What communication strategies or methods are applied in CS solutions for crisis scenarios?

3.2 Search String

The search string was composed of four dimensions as described in Table 1: (i) crowdsourcing and similar; (ii) collaboration; (iii) communication; (iv) crisis and similar. Each dimension is connected with the "AND" operator. At least one term of each dimension should be present in the paper's title, abstract, or author keywords.

Table 1. The search string for the literature review.

Dimensions	String
1	"Crowdsourcing" OR "Collective Intelligence" OR "Crowd Comput*"
2	"Collab*"
3	"Communicat*"
4	"Crisis" OR "Disaster" OR "Emergency" OR "Emergencies"

The first dimension is one of the main topics of the study: crowdsourcing and similar terms such as collective intelligence and crowd computing, or crowd plus derived words from "comp". The second dimension concerns the specific aspect of crowdsourcing we want to examine, such as collaboration (or words derived from "collab"). These terms bring themes related to collaboration to the returned papers. The third dimension is communication (or words derived from the root "communicat"). The area of communication is associated with delivering a message, notifying, or alerting a certain public. The last dimension is the keyword "crisis" and similar words such as "disaster", "emergency", or "emergencies". These keywords relate to the context in which the selected papers should be situated.

3.3 Digital Libraries

The scientific libraries used in the search process are described in Table 2. The choice of libraries took into account the relevance of the papers indexed in these engines for the academic community.

Table 2. Scientific Basis for the Literature Systematic Review.

Scientific Library	Portal
Scopus (Elsevier)	`https://www.scopus.com/search/form.uri`
Science Direct (Elsevier)	`https://www.sciencedirect.com/`
IEEE Xplore	`https://ieeexplore.ieee.org/Xplore/home.jsp`

The search string was adapted for use in each scientific database. From one main string, we created three adapted strings described in Table 3.

Table 3. Adapted strings for the Scientific Basis.

Scopus
TITLE-ABS-KEY ((Crowdsourcing OR "Collective Intelligence" OR "Crowd Comput*") AND (Collab*) AND (Communicat*) AND (Crisis OR Disaster OR Emergency OR emergencies)) AND PUBYEAR AFT 2006 AND (DOCTYPE(cp) OR DOCTYPE(ar))
Science Direct
(Crowdsourcing OR Collective Intelligence OR Crowd Computing) AND (Collaboration) AND (Communication) AND (Crisis OR Disaster OR Emergency)
IEEE Xplore
("All Metadata":"Crowdsourcing" OR "All Metadata":"Collective Intelligence" OR "All Metadata":"Crowd Comput*") AND ("All Metadata":"Collab*") AND ("All Metadata":"Communicat*") AND ("All Metadata":"Crisis" OR "All Metadata":"Disaster" OR "All Metadata":"Emergency" OR "All Metadata":"Emergencies")

3.4 Inclusion and Exclusion Criteria

The inclusion criteria included papers that are: (i) scientific papers; (ii) primary research; (iii) published in a conference, book, or journal; (iv) articles presenting crowdsourcing (CS) solutions for crisis communication, including artifacts such as architectures, frameworks, diagrams, or models; (v) papers written in English.

The exclusion criteria removed papers that are: (i) non-scientific articles; (ii) secondary articles; (iii) theses and dissertations; (iv) duplicates; (v) articles presenting only conceptual or theoretical proposals without practical details of the artifacts; (vi) articles that only mention crisis communication superficially without a detailed analysis or a focused study of the crisis communication domain; (vii) articles where communication does not explicitly involve human agents or is limited to communication solely between non-human entities (e.g., robots or autonomous systems); (viii) papers not written in English.

3.5 Data Extraction

Initially, the total number of papers returned in the searches was 72. After applying exclusion/inclusion criteria by title and abstract reading or, in some cases, full-text scanning, 44 articles were excluded. A total of 28 papers were selected. Table 4 shows the remaining papers in each database after selection. The IEEE Xplore database included 16 papers out of 35, and Scopus included 12 out of 34 papers. Science Direct had all 3 of its papers removed.

From the 28 selected papers, we extracted data by summarizing the full content into a concise text. This summary

Table 4. Papers remaining in each scientific database after selection.

Library	Papers Returned	Total After Selection
Scopus	34	12
Science Direct	3	0
IEEE Xplore	35	16
All Libraries	72	28

highlighted key aspects, including the identified problems and challenges, the proposed solution artifacts, and the discussion of the investigation's results.

4 Categorizing CS for Crisis Communication

We conducted a detailed analysis of the solutions presented in the selected papers, extracting valuable insights regarding collaboration problems. These problems were categorized according to the main topic addressed.

Regarding **Quality and Reliability of Data**, the literature emphasizes that citizen- and volunteer-generated information must be accurate and verifiable, even under offline or chaotic conditions. Studies discuss validation, quality control, and trust mechanisms, such as blockchain, to mitigate the impact of incorrect or fraudulent inputs. For instance, Samir *et al*. [2019] identify that trust between aid providers and requesters, along with network connectivity, constitute primary challenges in ensuring data integrity.

The **Interoperability of Systems** category addresses how crisis response depends on sharing information across fragmented agencies, jurisdictions, and different platforms. The focus is on connecting systems and integrating heterogeneous sources, such as social media, into operational workflows. This is evidenced by Kuehn *et al*. [2011], who observe that the fragmentation of public safety systems and jurisdictional conflicts represent significant barriers to effective collaboration.

In terms of **Overload and Scalability of Data Volume**, the literature highlights that crises generate large, rapid data streams—including reports, images, and maps—that can overwhelm both human teams and technical tools. Researchers propose methods for filtering and real-time streaming analysis to maintain situational awareness. As noted by Zhang *et al*. [2022], algorithms are frequently assessed for their effectiveness in disaster damage estimation to handle the massive influx of crowdsourced images.

The **Integration of Emerging Technologies (AI and IoT)** involves relying on advanced sensing and intelligent processing to improve crisis support through resource discovery and automated analysis. These technologies are increasingly integrated into crisis communication environments to enhance response strategies. For example, MacRi *et al*. [2023] discuss how IoT-based sensing and AI-driven analysis serve as a technical backbone for modern crisis management solutions.

Finally, **Coordination, Synchronization, Engagement, and Mobilization of People and Resources** focuses on organizing diverse actors, such as communities, NGOs, and government agencies, during fast-changing emergencies. This category addresses coordination gaps and the need to keep the public engaged. Hasse and De Rolt [2017] reinforce this by identifying the synchronization of resources in dynamic contexts as an essential challenge for effective mobilization and collective action.

A comprehensive summary of this data can be found in the following subsections.

4.1 Quality and Reliability of Data

The issue of data quality and reliability is crucial in crisis communication systems, where inaccurate data can hinder decision-making and response efforts. Various solutions have been proposed to address data integrity and improve the accuracy of information during crises, particularly focusing on natural disasters.

Câmara *et al*. [2017] addressed offline operational challenges and user-generated data quality in volunteered geographic systems. Brown *et al*. [2016] tackled the issues of precision and public trust in radiation measurement through citizen science. Tserstou *et al*. [2017] proposed SCENT, aiming for reliable citizen-sourced data in diverse areas. Ernst *et al*. [2017] reviewed quality control in the collection and integration of emergency management data. Garcia *et al*. [2018] emphasized accurate behavior detection in smart cities and efficient data transmission.

Samir *et al*. [2019] explored blockchain-based systems for distributed disaster management, focusing on ensuring trust and information accuracy despite limited infrastructure. They proposed a blockchain framework and system, conducting simulated experiments. Their solution focuses primarily on affected communities and local assistance centers. The study investigated disaster scenarios where community members, help requesters, and help providers were key actors. Animas and Gunay [2022] developed PEERS to improve information validation in collaborative frameworks.

Table 5. Quality and Reliability of Data describing the collaboration problems.

Authors	Title	Collaboration Problem
Samir *et al*. [2019]	Blockchain Guided Trustworthy Interactions for Distributed Disaster Management	Ensuring network trust and verifying information accuracy under limited infrastructure conditions.
Câmara *et al*. [2017]	ClickOnMap: A Platform for Volunteered Geographic Information Systems	Offline operation during emergencies and ensuring the quality of user-generated information.
Brown *et al*. [2016]	Safecast: Citizen Science for Radiation Measurement and Communication	Ensuring data accuracy and maintaining public trust in a skeptical environment.
Garcia *et al*. [2018]	System for Detection of Emergency Situations in Smart City Environments	Ensuring accurate behavior detection and efficiency in data transmission.
Tserstou *et al*. [2017]	SCENT: Citizen Sourced Data for Environmental Monitoring	Ensuring reliable and valid data collection from citizens in diverse areas.
Ernst *et al*. [2017]	Collaboration and Crowdsourcing in Emergency Management	Managing the quality of collected data and integrating social networks into emergency management systems.
Animas and Gunay [2022]	PEERS: A Community-based Geo-social Information Collaboration Framework for Public Safety and Security	Ensuring precise validation of information in a collaborative framework.

4.2 Interoperability of Systems

Interoperability refers to the ability of different crisis communication systems and platforms to seamlessly exchange and process information during emergencies. Several studies address the challenge of ensuring that various systems can communicate effectively during disaster scenarios.

Quintanilha *et al*. [2011] focused on integrating unstructured social media data into command rooms during urban crises. Kuehn *et al*. [2011] discussed bridging fragmented public safety systems and overcoming jurisdictional conflicts. Shih *et al*. [2012] emphasized efficient communication during disasters using dynamic communication networks. Pradhan [2021] addressed interoperability challenges between systems in disaster recovery operations via MQTT-based federation.

Table 6. Summary of studies in Interoperability of Systems describing collaboration problems found.

Authors	Title	Collaboration Problem
Kuehn *et al*. [2011]	Interoperability and Information Brokers in Public Safety	Overcoming fragmented public safety systems and jurisdictional conflicts between agencies.
Pradhan [2021]	Federation Based on MQTT for Urban Humanitarian Assistance and Disaster Recovery Operations	Managing interoperability between different systems and agencies in the context of disaster recovery.
Shih *et al*. [2012]	Open Information Gateway for Disaster Management	Ensuring efficient communication during disasters using diverse and dynamic communication networks.
Quintanilha *et al*. [2011]	Social Networks and Emergency: From Society to the Command Room	Handling unstructured social media data and integrating this information effectively in the command room during urban disasters.

4.3 Overload and Scalability of Data Volume

During a crisis, large volumes of data can overwhelm communication systems. Effective solutions for managing this data load, ensuring it does not cause delays in response efforts, are crucial for maintaining an effective communication strategy during emergencies.

Farber *et al*. [2012] examined user education on reporting standards and combating misinformation. Calderon *et al*. [2014] introduced IntCris, designed to handle information overload and build effective coalitions during crises.

Pezzica *et al*. [2019] focus on scaling methodologies and improving stakeholder communication for disaster management using OpenStreetMap (OSM) data. The solution published in Pezzica *et al*. [2019] presented an angular segment analysis workflow tailored for crisis managers involved in post-disaster planning decisions. Communication in their solution is facilitated through an urban grid.

Another significant contribution is described in Norris *et al*. [2022], who introduced a framework for temporal sensemaking under time-critical and safety-sensitive conditions. This approach provides collaborative insights aimed at resolving the challenging issue of time synchronization in crowdsourced data. Their research involved interviews with humanitarian teams actively engaged in the collection of information during crises, such as hurricanes.

In 2022, Zhang et al. Zhang *et al*. [2022] conducted an experiment focused on "Image classification accuracy" utilizing video content from social media platforms. Their tool primarily serves social media users and emergency response agencies involved in disaster-related incidents. The crisis scenario in their study describes a disaster event, and communication between the public and agencies was facilitated through data transmission via social media streaming. Zhang et al. Zhang *et al*. [2022] optimized real-time neural networks for damage assessments using imperfect crowd intelligence.

Table 7. Summary of studies about Overload and Scalability of Data Volume, describing the collaboration problems.

Authors	Title	Collaboration Problem
Calderon *et al*. [2014]	IntCris: A Tool for Enhanced Communication and Collective Decision-Making During Crises	Dealing with information overload and building effective coalitions during crises.
Norris *et al*. [2022]	People Talk in Stories. Responders Talk in Data: A Framework for Temporal Sensemaking in Time- and Safety-critical Work	Distant collaborators struggle to make fragmented information useful in a fast-paced, time-pressured context.
Zhang *et al*. [2022]	On Streaming Disaster Damage Assessment in Social Sensing	Leveraging imperfect crowd intelligence by optimizing neural networks for real-time damage assessment.
Farber *et al*. [2012]	Riskr: A Low-Technological Web2.0 Disaster Service to Monitor and Share Information	Educating users on reporting standards and addressing the spread of false information.
Pezzica *et al*. [2019]	Rapid Configurational Analysis Using OSM Data	Scaling methodology to different disaster types and improving communication among stakeholders.

4.4 Integration of Emerging Technologies (AI and IoT)

The integration of emerging technologies such as Artificial Intelligence (AI) and the Internet of Things (IoT) plays a pivotal role in modern crisis communication systems. These technologies provide real-time data collection, analysis, and response capabilities that improve crisis management efforts.

Zelenkauskaite *et al*. [2012] focused on IoT integration for decision-making in crisis management. Mizushima *et al*. [2012] explored tacit knowledge transfer and collaborative improvements within volunteer networks during disasters. Later, in 2017, Preece *et al*. [2017] evaluated a conversational agent (Sherlock) designed to support mobile information-gathering tasks in emergency and tactical contexts. The scenario studied indicated that conversational agents can be effective in obtaining information under time-pressured conditions, but further optimization is needed.

In 2018, Fulco *et al*. [2018] highlighted challenges in integrating new technologies and practical applications in chaotic scenarios. They introduced Crow4U, a cyber solution tailored for physical disaster evacuation drills. They evaluated their solution through simulations involving crowd workers addressing issues such as damaged areas. Key actors in this crisis included the community, rescuers, and local government entities. Crow4U served as a platform for crisis communication, and remote assistance from crowd workers played an important role in assessing and providing crucial information to rescuers. In 2023, MacRi *et al*. [2023] addressed effective human-AI interaction in disaster recovery via IoT.

4.5 Coordination, Synchronization, Engagement, and Mobilization of People and Resources

Effective coordination, synchronization, and mobilization of both people and resources during a crisis are essential for rapid and efficient response. Ensuring that all stakeholders are engaged and working toward a common goal is a central challenge in crisis communication systems.

In 2014, Monares *et al*. [2014] explored effective representation of interactions in dynamic, mobile, heterogeneous environments using human-centric sensor networks. In 2015, van den Homberg and Neef [2015] presented difficulties in coordination between communities, NGOs, and governments

Table 8. Summary of Integration of Emerging Technologies (AI and IoT) studies and collaboration problems.

Authors	Title	Collaboration Problem
Fulco *et al.* [2018]	Cyber-Physical Disaster Drill	Integration of new technologies and practical application in a real, chaotic scenario.
MacRi *et al.* [2023]	An IoT-based Approach to Expert Recommendation in Community Question Answering for Disaster Recovery	Ensuring effective interaction between human expertise and AI-generated responses in crisis contexts.
Preece *et al.* [2017]	Sherlock: Experimental Evaluation of a Conversational Agent for Mobile Information Tasks	Ensuring effective human–machine interaction, machine interpretability of natural-language reports, and the fusion of information collected collaboratively under time-constrained conditions.
Zelenkauskaite *et al.* [2012]	Disaster Management and Profile Modelling of IoT Objects	Efficient integration of IoT for resource discovery and decision-making in crisis scenarios.
Mizushima *et al.* [2012]	Knowledge Management in a Volunteer Community at the Time of Disaster	Managing tacit knowledge transfer and enhancing volunteer collaboration using communication tools.

for disaster management.

In 2016, El Abdallaoui *et al.* [2016] emphasized community engagement and crowd mobilization to locate missing children, followed by improved frameworks for sustained engagement. Their paper approached the technical aspects of addressing child disappearances efficiently. They introduced a framework that leverages human intervention based on the CS concept, fostering close collaboration between the public and government agencies by encouraging people to assist in the search process using mobile device features. However, a potential drawback of this solution is the possibility of diverse individuals providing less relevant results. Contributors may inadvertently provide inaccurate data, such as location and time, or become demotivated to contribute. Additionally, Ludwig *et al.* [2016] discussed CS challenges due to a lack of centralized coordination points and infrastructure.

Later, Hasse and De Rolt [2017] focused on resource synchronization in dynamic emergencies. In 2019, Dixon and Johns [2019] proposed solutions to integrate socioeconomic and geospatial data to tackle inequalities in smart city planning. The authors introduced a smart city solution and a community resilience information system (CRIS). Their target audience comprises local communities and policymakers dealing with crises linked to natural disasters. Their paper underscores the importance of providing the local community with access to pertinent information to actively engage residents in resilience planning and recovery efforts. By doing so, they establish a productive collaboration between government agencies and non-governmental organizations.

5 Analysis of CS Support for Collaborative Crisis Communication

In this section, we analyze the results and answer the research questions proposed in the systematic review. Additionally, we discuss the entities and requirements found in the analyzed articles.

5.1 Research Question Results

The following subsections address the research questions based on the findings obtained from the systematic literature review.

Table 9. Summary of studies about Coordination, Synchronization, Engagement, and Mobilization of People and Resources, describing the collaboration problems.

Authors	Title	Collaboration Problem
Dixon and Johns [2019]	Vision for a Holistic Smart City - CRIS	Overcoming socioeconomic inequalities and building local capacity to integrate socioeconomic and geospatial data.
Hasse and De Rolt [2017]	COLLEGA Semantic Middleware	Synchronization of resources and integration in dynamic emergency contexts.
Ludwig *et al.* [2016]	Situated Crowdsourcing During Disasters	Lack of a central meeting point and inadequate infrastructure to coordinate volunteers.
van den Homberg and Neef [2015]	Community-Based Collaborative Disaster Management	Inadequate local capacities and difficulties in coordination among communities, NGOs, and governments.
El Alaoui El Abdallaoui *et al.* [2016]	Crowdsourcing in Crisis Situations: Missing Kids Case Study	Effectively engaging communities and mobilizing crowds using technology to locate missing children.
El Abdallaoui *et al.* [2016]	Finding a Lost Child Using a Crowdsourcing Framework	Sustaining public engagement and improving the accuracy of location reports.
Monares *et al.* [2014]	Modeling Interactions in Human-centric Wireless Sensor Networks	Representing effective interactions in heterogeneous, dynamic, and mobile environments.

RQ1: What are the key challenges encountered in collaboration during crisis communication, particularly when coordinating diverse stakeholders? Key challenges include ensuring trust between users and organizations, validating information accuracy, and fostering efficient collaboration among diverse stakeholders. From a technical perspective, trust between aid providers and requesters, as well as network connectivity, are critical challenges [Samir *et al.*, 2019], alongside the essential challenge of synchronizing resources in dynamic contexts [Hasse and De Rolt, 2017]. Regarding social and organizational barriers, issues such as eliminating false reports and managing rapid responses in chaotic scenarios are central, while the fragmentation of public safety systems and jurisdictional conflicts represent significant barriers [Kuehn *et al.*, 2011].

RQ2: How does CS contribute to enhancing collaboration in crisis communication processes?

CS fosters collaboration by enabling communities to contribute real-time data and supporting formal organizations with validated, actionable information. Technically, CS facilitates real-time collaborative tracking, efficiently mobilizing the public [El Alaoui El Abdallaoui *et al.*, 2016], and utilizes techniques like blockchain and robust coordination frameworks to improve trust. From a social standpoint, projects like Safecast promote transparency and increase public trust during crises by using open and reliable platforms [Brown *et al.*, 2016], while social networks and CS tools enhance situational awareness and improve resource allocation among stakeholders [Ernst *et al.*, 2017].

RQ3: What methods are used to evaluate CS solutions for crisis communication?

Evaluations rely on simulations and user-centered studies [Preece *et al.*, 2017], with some studies focusing on presenting conceptual frameworks to analyze collaboration and decision-making in emergency management [Ernst *et al.*, 2017]. In terms of technical evaluation, crowdsourced image algorithms are assessed for their effectiveness in estimating disaster damage [Zhang *et al.*, 2022]. From a social and practical perspective, case studies and user feedback have been utilized to test applications such as “City-Share” and its task coordination

presented in [Ludwig *et al.*, 2016], while pilot studies, in [Tserstou *et al.*, 2017], conducted in flood-prone areas help test and validate the reliability of crowdsourced data.

RQ4: Who are the intended users or beneficiaries of the CS solutions studied in the context of crisis communication? The beneficiaries include both contributors and receivers of information: citizens, volunteers, social media users, and formal organizations such as rescue teams and government authorities. Technically, urban planners rely on spatial analyses enabled by these platforms to improve decision-making [Pezzica *et al.*, 2019]. On a social level, local communities and volunteers benefit by sharing both tacit and explicit knowledge [Mizushima *et al.*, 2012], while NGOs and local governments use crowdsourced data to respond more effectively to disasters [van den Homberg and Neef, 2015].

RQ5: What types or categories of crises are addressed by CS solutions in the analyzed studies? CS solutions address general disasters, natural crises, and health-related emergencies, with an adaptability that enhances response strategies across various contexts. It was observed that the majority of the analyzed papers focus on the response phase of the crisis cycle. Regarding the crisis type, natural disasters are the most frequent contexts in the studies. Technical applications include monitoring nuclear disasters, such as Fukushima [Brown *et al.*, 2016], and responding to extreme weather events such as hurricanes [Zhang *et al.*, 2022]. Socially and environmentally, these tools address flooding and environmental issues [Tserstou *et al.*, 2017], demonstrating a versatility that allows them to be applied in different crisis scenarios.

RQ6: What are the roles and functions of the key actors involved in the crisis communication process? The crisis communication ecosystem involves multiple actors with complementary functions: affected communities, local government authorities, and professionals such as rescue teams and experts. Technically, command room operators play a crucial role in integrating social media and structured data to support decision-making [Quintanilha *et al.*, 2011], while decentralized systems actively contribute by generating relevant information [Samir *et al.*, 2019]. Organizationally, crisis communication actors include public safety agencies and emergency response teams that coordinate operations to ensure efficient management [Kuehn *et al.*, 2011].

RQ7: What communication strategies or methods are applied in CS solutions for crisis scenarios? The tools developed include mobile apps, web portals, and visual tools that improve data accessibility, analysis, and interaction. Technically, simplified Volunteered Geographic Information (VGI) systems facilitate the collection of geospatial data [Câmara *et al.*, 2017], Web2.0 technologies provide real-time information sharing [Farber *et al.*, 2012], and conversational agents enable natural-language mobile reporting Preece *et al.* [2017]. Socially, alerts such as AMBER and other mobile applications help engage the public and improve collaboration [El Alaoui El Abdallaoui *et al.*, 2016], promoting coordinated responses through accessible platforms.

5.2 CS Entities and Requirements for Crisis Communication

The analysis of the articles returned by the systematic review yielded solutions for crisis communication. These solutions were analyzed by CS and collaboration aspects and organized as entities in a diagram illustrated in Figure 2. The entities are identified as Crowd, Agents, Environment, Requirements, and Experiments.

In the analyzed solutions, the **Crowd** refers to those who primarily contribute information, such as citizens, volunteers, and social media users. The crowd is able to volunteer data through media production, sensing data, answering tasks, giving feedback, and validating information. This crowd-generated data must be coordinated with **Crisis Agents**, who primarily operate on the contributed information to support response, including local help centers, rescuers, professionals, operational teams, command and control units, emergency managers, organizations, safety agencies, and government authorities, as well as automated components when applicable.

The relationship between Crowd and Agents is central to collaboration in crisis communication. While the Crowd generates large volumes of heterogeneous inputs, Agents are responsible for filtering, validating, and acting upon these inputs under time pressure. This interaction directly impacts **coordination**, as Agents must synchronize tasks and resources across multiple stakeholders while managing information flows from the Crowd. It also affects **data quality**, since platforms must implement mechanisms that increase trust and reduce misinformation, such as validation workflows, redundancy checks, or reputation mechanisms.

CS and collaborative solutions are usually supported by innovative advances in information technologies. The analyzed **Environment** captures the crisis context and operational constraints, including disaster type and infrastructure availability, and encompasses mobile applications, portals, web services, geographic maps, and social media platforms. Derived from this environment, the identified **Requirements** include providing rapid responses in emergencies, enabling effective coordination between Agents and the Crowd, and ensuring trustworthy data through validation processes.

Finally, the analyzed entities (Crowd, Agents, Environment, and Requirements) are examined through **Experiments**, which are commonly conducted as simulations and user-centered studies to evaluate system behavior, coordination

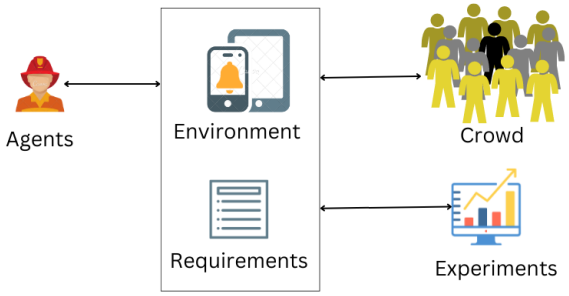

Figure 2. Entities identified in the studied papers: Crowd, Agents, Environment, Requirements, and Experiments; *Crowd* includes citizens and volunteers contributing data; *Agents* encompasses both human responders and automated systems; *Environment* refers to the crisis context; *Requirements* are derived from the challenges found; *Experiments* represent evaluation methods

effectiveness, and user interaction under crisis conditions.

To consolidate the findings from the SLR, we organized the recurrent challenges and the corresponding strategies reported across studies into a single mapping. Table 10 translates the categories into design implications and proposed strategies for crisis-oriented CS platforms. As a synthesis artifact, it clarifies how each problem category motivates specific platform-level interventions.

Table 10. Problem-to-Solution Mapping in Collaborative Crisis Communication.

Category	Requirement	Proposed Strategies	Key Studies
Trust & Validation	Systems must provide transparent data verification and reputation mechanisms.	Blockchain, peer-validation, and quality control protocols.	[Samir *et al*., 2019], [Animas and Gunay, 2022]
Interoperability	Architecture must support heterogeneous data standards and cross-agency protocols.	Semantic middleware, MQTT federation, and info-brokers.	[Hasse and De Rolt, 2017], [Pradhan, 2021]
Data Overload	Interfaces must prioritize critical alerts and filter redundant crowd-sourced inputs.	Real-time streaming analysis and temporal sensemaking.	[Zhang *et al*., 2022], [Norris *et al*., 2022]
Emerging Tech (AI & IoT)	Systems must integrate automated sensing and intelligent data processing for resource discovery.	IoT-based sensing, AI-driven analysis, and expert recommendation systems.	[Zelenkauskaite *et al*., 2012], [MacRi *et al*., 2023]
Coordination & Mobilization	Platforms must facilitate active engagement and clear task allocation for volunteers.	Public displays, mobile engagement, and task management.	[Ludwig *et al*., 2016], [El Alaoui El Abdallaoui *et al*., 2016]

6 Empirical Validation

To verify if these theoretical needs align with the actual experiences of those involved in crisis scenarios, this study performs a survey based on the public's experience with crowdfunding, which is a consolidated form of CS in the Brazilian context.

This UX evaluation serves as a practical validation of the challenges categorized in the previous section. We specifically focus on crisis relief, rather than immediate crisis response, as the former provides a more accessible environment for empirical evaluation while sharing the same core requirements of mobilization and resource allocation. By analyzing crowdfunding, we aim to observe how the Trust and Validation, and Coordination requirements identified in the SLR manifest in real-world user interactions and decision-making processes.

7 Analyzing Crowdfunding as a Collaborative Solution for Crisis Relief

Crowdfunding is an innovative way to overcome traditional forms of financing. These platforms are addressing and solving emergent financial problems using the power of the collective contributions of crowds [Mollick, 2014]. Crowdfunding is described by Behl *et al*. [2023] as the practice of funding a project or venture by raising small amounts of money from a large number of people, typically via the Internet. The relationship between CS and crowdfunding holds for the subsets of CS defined by Estellés-Arolas *et al*. [2015]: crowdcasting, crowd collaboration, crowd content, crowdfunding, and crowd opinion. The notion of crowdfunding is naturally derived from previous CS, which itself is a novel phenomenon, as described by Bannerman [2013]. European Commission and Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs [2015] define crowdfunding "as a way of raising money to finance projects and businesses. It enables fundraisers to collect money from a large number of people via online platforms."

In the present research, we choose the crowdfunding platform as the object of study since it is globally used as an aid resource to recover communities affected by crises, and it is a successful and established system used by volunteers to make donations in humanitarian campaigns. The choice of crowdfunding (popularly known in Brazil as "vaquinhas virtuais") as the central object of this analysis is justified by its consolidation as a recurring social technology with broad public adoption in emergency scenarios. While specialized CS and collaborative mapping platforms (e.g., Ushahidi) offer robust technical functionalities for data management, their penetration into the crisis response ecosystem in Brazil remains limited to technical or academic niches [Google Trends, 2024].

Communities that were already in crisis before being struck by natural disasters become a priority for humanitarian assistance and usually receive donations that can improve their conditions. However, often these improvements are not sufficient, as these communities already faced significant challenges. The management of these donations can be complex, as there is often inadequate infrastructure to handle the large amount of donations received. Studying this situation is crucial, as it shares similarities with the reality of some Brazilian communities facing critical conditions; when they become a priority for assistance, they may encounter challenges in managing the resources received. The aim of this survey is to analyze user experience in supporting (fundraising, donating, or volunteering) crisis campaigns, from the perspective of both profiles: donors and campaign creators.

In the context of human-computer interaction, understanding the nature of interaction begins with understanding how interaction occurs today, such as comprehending the dynamics among participants in a collaboration process. The next step after this analysis is to identify the challenges present in this interaction. Understanding the nature of interaction is achieved through the study of usage context, human characteristics, devices, computational architecture, and the development process.

7.1 User Experience Design

The focus of UX (User Experience) is not only the product; it includes the experiences and emotions that come into contact with them or are impacted by them. This is the perspective expressed in ISO 9241-210 (2019), which states that UX is a set of user perceptions and responses resulting from using a system, product, or service. Thus, the objects of study in UX include users' emotions, beliefs, preferences, perceptions, comfort, behaviors, and achievements that occur before, during, and after interaction. It also studies the user's internal and physical state resulting from previous experiences, attitudes, skills, personality, and the context of use.

In summary, UX considers the scope of experiences we can have with digital technology and offers explanations and design principles drawn from philosophy, psychology, and cognitive sciences [Turner, 2017]. The objects of study in UX emphasize the subjective, evaluative, and primarily psychological nature of interactive technology in digital products,

from the perspective of the people who interact with them.

This study focuses predominantly on the pragmatic dimension of UX, investigating how the transparency and functionality of crowdfunding platforms impact the effectiveness of humanitarian aid. To operationalize this evaluation, we adopt Hassenzahl's framework Hassenzahl [2004], focusing on the **pragmatic dimension**—utility and task efficiency—rather than hedonic aspects. Furthermore, user experience is analyzed through the lens of computer-mediated trust, where interface elements (e.g., financial reports) act as triggers for donor decision-making. By grounding our analysis in McKnight's trust model McKnight *et al*. [2002], we investigate how platform credibility mediates engagement in crisis scenarios, allowing us to identify the specific functional requirements necessary for effective humanitarian aid platforms.

To address these pragmatic and trust dimensions, this study evaluates the following aspects of user experience, operationalized through a questionnaire-based investigation into the specific dynamics of crowdfunding platforms:

- Crowdfunding Platform: we examined which crowdfunding platform is the most used by users.
- Challenges and Concerns: we studied the challenges and concerns that users encountered while engaging with crowdfunding platforms. This encompassed issues related to trust, security, accountability, and any barriers that hindered a positive user experience.
- Decision-Making Factors: we analyzed the factors that influence users' decisions when it comes to making donations on crowdfunding platforms. This involved investigating the role of campaign authenticity and the perceived impact of their contributions on affected communities.
- Access to Information: we investigated how effectively users could access information about the utilization of their donated resources and the tangible impact achieved by their contributions. This information transparency was a vital component of the user experience.
- Volunteer Participation: we also examined user engagement in terms of volunteering efforts facilitated through crowdfunding platforms. This involved understanding the motivations and experiences of users who actively participated in volunteer work to support affected communities.

7.2 Method Description

Questionnaires were submitted to individuals from the general public in a survey format to obtain a comprehensive collection of information able to explain knowledge, attitudes, and behavior regarding crowdfunding users. Our survey follows the guidelines defined by Pfleeger and Kitchenham [2001], which include: setting specific, measurable objectives; planning and scheduling the survey; ensuring that appropriate resources are available; designing the survey; preparing the data collection instrument; validating the instrument; selecting participants; administering and scoring the instrument; analyzing the data; and reporting the results.

The primary aim of this survey is to assess the utilization of traditional crowdfunding platforms. More specifically, we aim to highlight elements of the user experience, particularly among volunteers, related to collaborative aspects that facilitate communication, cooperation, and coordination. User experience will be assessed by surveying the issues and challenges these volunteers encounter when providing humanitarian aid in disaster and emergency recovery efforts. The data will be analyzed concerning its relationship with collaboration mechanisms, which include communication, cooperation, and coordination among the entities involved in the disaster and emergency recovery process.

Cooperation encompasses the actions of assistance that transpire between humanitarian institutions and the general public. Here, the public engages by contributing through voluntary tasks, monetary donations, or the provision of material resources. In turn, these institutions reciprocate by furnishing assistance and disclosing information about the allocation of these resources. Coordination pertains to the platform's role in overseeing tasks, managing the allocation of resources and funds, and supervising recovery efforts. Communication provisions afford the public the means to reach out to institution representatives and facilitate internal communication networks for task execution teams.

The questions explore the use of established platforms for crisis recovery, such as crowdfunding, aiming to comprehend the user experience. From the perspective of campaign creators, we seek to understand issues related to donation receipt, communication for donation requests, how requests are received, whether there is any financial accountability for monetary donations, how resources are utilized, and how the seriousness of the work is demonstrated. On the contributors' side, the questions aim to delve into the challenges they face when attempting to make a donation and their contributions to projects and volunteer efforts dedicated to crisis management.

Participants were recruited via convenience sampling through social media platforms such as Instagram and WhatsApp groups on August 3rd (2023) and received responses until August 8th (2023). The target audience was characterized as general users of these platforms since they have internet access and are familiar with crowdfunding platform content. The questions are available online [7]

To align with the study's focus on pragmatic UX and trust, we prioritized a behavioral profiling approach over traditional sociodemographic data. This allowed us to categorize respondents based on their roles (donors vs. organizers) and their prior crowdfunding experience in crisis contexts, which are more direct mediators of the interaction challenges investigated.

Before answering the questionnaire, participants were presented with an informed consent statement (TCLE) and only proceeded after explicitly agreeing. Responses were collected anonymously and analyzed in aggregate.

7.3 Results

This section presents the findings derived from our survey, focusing on participants' use of crowdfunding platforms, the challenges they face, and the factors influencing their decision-making processes. The results also explore the importance of access to information, preferences for volunteer participa-

[7] Questionnaire; Available at: `https://zenodo.org/records/21955188?preview_file=questionario-1.pdf`; accessed on 01 August 2026.

tion, and barriers limiting the effectiveness of crowdfunding platforms. These insights provide a foundation for understanding how these platforms can be enhanced to better support humanitarian aid campaigns in times of crisis.

7.3.1 Crowdfunding Platform

The survey revealed that among the 57 participants in the study, the most used platform was the virtual fundraiser (Vaquinha Virtual),the most frequently reported platform, mentioned by 29 participants (53.7%). The remaining platforms had lower but non-negligible use, ranging from 3.7% to 7.4%.

7.3.2 Challenges and Concerns

Our research showed that only 17 people, or 29.8% of the participants, have used a crowdfunding platform to help communities affected by emergencies and disasters, such as floods, earthquakes, or forest fires. The remaining 40 participants (70.2%) reported having never used such a platform for this specific purpose.

Analyzing the participants' responses regarding challenges or concerns when making monetary donations through crowdfunding platforms, we identified some trends in the concerns raised by the survey participants. To analyze these trends, we grouped keywords based on their frequency in the written responses. The counts indicate how often these specific keywords appear in the text, highlighting the significance of these themes in the donors' concerns.

Participants expressed concern about the authenticity of campaigns created on crowdfunding platforms and the allocation of resources and accountability. The following keywords found in the texts illustrate this trend:

Translated keywords (count): authenticity (10), truly (11), destination (11), utilization (6), goal (5), used (3), directed (3), diverted (2), necessity (2), use (5), true (2), transparency (1), accountability (1), resource arrival (1), value arrival (1), return (1).

Participants also showed concerns about scams and security. It is noticeable that there is apprehension regarding trust in the institutions launching campaigns on crowdfunding platforms and their credibility. The following keywords found in the texts demonstrate this trend:

Translated keywords (count): scams (4), security (2), secure (1), data (2), apprehension (3), reliability (1), fake news (1), credibility (3), institutions (2).

These trends reflect common concerns and issues related to monetary donations through crowdfunding platforms.

Twelve participants (21.1%) revealed having organized donation campaigns through communication platforms. Among them, five people mentioned using WhatsApp to create and promote campaigns, four used social media platforms such as Instagram, and three used crowdfunding platforms such as Kickante and the virtual fundraiser (Vaquinha virtual).

Among the challenges faced in using these platforms, participants reported difficulty in promoting, gaining visibility, and reaching a larger number of people. Another difficulty mentioned was the compensation of expected results and returns from the campaign. Some crowdfunding platforms either charge fees to withdraw the collected amount or have delayed disbursements.

7.3.3 Decision-Making Factors

The survey participants selected the decisive factors for making a donation. The items in Table 11 represent the percentage of participants who chose each reason as decisive for donating.

Table 11. Decisive Factors in Donation Decision-Making

Decisive Factor	Percentage
Institution's reputation	67%
Publishing financial reports	61%
Importance of the recovery action to be taken	54%
Platform's reputation	47%
Donation cost	35%
Magnitude of the damage caused	33%
Being active on social media	16%

7.3.4 Access to Information

On a scale of 1 to 5, regarding how necessary it is to have access to updated information about the use of donated resources and the impact of donations on communities affected by emergencies or disasters, 82% of participants rated it between 4 and 5 (necessary).

On a scale of 1 to 5, regarding how necessary it is to have a communication channel with the humanitarian institution to which the donation will be made, 73% of participants rated it as 4 or 5 (necessary).

Eighty-six percent (86%) of respondents indicated they would like to be notified about the need for donation materials at collection points. The most donated items by people are clothing, hygiene materials, and non-perishable food.

7.3.5 Volunteer Participation

The most attractive volunteer tasks for participants are selecting donation materials and storing the collected donations. Two participants stated they could do any necessary work, while nine participants (16%) declared no interest in volunteer work.

7.4 System Requirements for a Collaborative Platform in Crisis Relief Support

The survey reveals that the following system requirements are necessary for a humanitarian aid campaign platform, based on the identified user experience results:

- **Authenticity and Transparency**: The platform must include tools to verify the authenticity of campaigns, as well as provide clear and up-to-date financial reports on the use of donated resources. These reports should be accessible to donors and highlight the allocation and impact of the funds, reinforcing trust.
- **Communication Mechanism**: The need for effective communication channels was emphasized. This includes:
  - A direct channel between the public (such as donors) and humanitarian institutions for inquiries and clarifications.
  - Automated notifications about needs or campaign updates.
  - Constant feedback on campaign progress and the impact of donations.

- **Cooperation Mechanisms**: It is important that the platform offers means to facilitate cooperation between the involved entities and the public. This involves efficient supervision and management of activities with tools that allow tracking the progress of actions.
- **Coordination Mechanisms for Volunteer Tasks and Donations**: Features to coordinate volunteer tasks and allow active participation of volunteers who wish to help.
- **Easy Access to Information**: Quick and easy access to relevant information, such as the destination of donated resources, updates on campaign progress, and the impact of volunteer activities and donations on affected communities.
- **Promotion and Visibility**: Mechanisms to increase the visibility of campaigns, such as integration with social media and publicity or marketing strategies, to facilitate the promotion of campaigns and reach a larger audience.
- **Security and Reliability**: Implementation of security measures to prevent fraud, protect donor data, and ensure that donations are correctly allocated, including authentication and validation of campaigns.

7.5 Potential Limitations in Study Validity

This study presents potential limitations that may influence findings and generalization. First, the sample size of 57 participants may not sufficiently represent the diverse demographics and behaviors of global crowdfunding platform users, particularly in varying cultural and economic contexts.

Participants were recruited via convenience sampling through social media and WhatsApp groups, which may overrepresent individuals with regular internet access and familiarity with online platforms. In addition, because most respondents had not previously used crowdfunding specifically in disaster contexts, our results should be interpreted as capturing perceived requirements and trust expectations, rather than expert assessments from frequent crisis-donation users.

Additionally, the findings are largely specific to the platforms and regions analyzed, such as the predominance of "Vaquinha Virtual," which could limit their applicability to other platforms or international users.

The focus on established platforms potentially excludes insights into emerging or alternative systems that may better address specific user concerns. Furthermore, the evaluation of user experience involves subjective interpretations, including emotions and trust perceptions, which are difficult to measure uniformly and might lead to inconsistent results.

Another limitation lies in the data on volunteer participation, which provides a narrow view of user motivations and barriers, potentially overlooking the broader spectrum of engagement in crisis relief activities. Finally, the surveyed users' experiences may be heavily influenced by the technological usability of platforms, which can vary widely across devices and levels of internet access, introducing additional variability into the findings.

8 Discussion

When comparing the results of the literature review with the UX experiment results, there is a clear alignment between what the studies highlight and what participants report in practice. While the literature emphasizes that trust and data validation are essential, the UX findings confirm that most people decide to donate when there is transparency and clear reporting about how the money is used. Another shared point is coordination: the literature indicates that platforms should support the mobilization of volunteers, and the UX experiment shows that users want direct channels to understand exactly how they can help. In addition, the literature points to the role of emerging technologies, such as AI and IoT, to support resource discovery and intelligent data processing, which connects to participants' interest in automatic notifications and timely updates about needs and campaign progress. Finally, although the literature discusses issues such as information overload and system fragmentation in more technical terms, the UX results reflect these challenges in users' experiences of relying on multiple tools and channels to follow and support campaigns. Overall, the discussion suggests that effective crisis-relief platforms depend on turning these technical and organizational requirements into practical features that strengthen transparency, communication, and coordinated action.

9 Conclusion

In emergency situations, crowd collaboration plays a critical role in supporting organizations and professionals involved in crisis management. This paper investigates how existing literature utilizes CS to enhance collaborative practices for crisis communication. The methodology applied in this study was a systematic literature review.

From the analysis of 28 selected papers sourced from three distinct scientific databases, we found that this study contributes to a deeper understanding of the intersection between CS, collaboration, and crisis communication.

The open research areas in the field of CS for crisis communication include improving data quality and reliability, enhancing system interoperability, and addressing data overload and scalability. Additionally, integrating emerging technologies such as AI and IoT, and developing methods for efficient coordination, synchronization, and mobilization of people and resources are crucial topics. Research on CS platforms for resource mobilization, collaborative decision-making frameworks, and understanding crowd behavior in crisis scenarios also presents important opportunities for future exploration.

Future studies should also aim to broaden the demographic and geographic scope of empirical evaluations. Specifically, it is essential to investigate the challenges faced by underdeveloped countries and marginalized groups, such as women, to ensure that collaborative platforms are inclusive and effective across different social and economic realities.

The analysis of CS solutions for crisis communication identifies challenges related to collaboration, such as ensuring trust, validating information, and managing rapid responses in chaotic environments. CS enhances collaboration by enabling real-time data contribution, fostering transparency, and improving resource allocation through platforms and social networks. Evaluation methods include simulations and user feedback to validate the effectiveness of these tools. The beneficiaries include citizens, volunteers, and emergency responders, while the solutions address various crises, including

natural disasters and health emergencies. Key actors involved are local communities, government authorities, and professionals, with communication strategies relying on mobile apps, web portals, and social media to facilitate coordination and real-time information sharing.

With the development of the survey based on crowdfunding as a solution for crisis support, we can conclude that the challenges to the success of campaigns created on crowdfunding platforms are primarily associated with campaign promotion, such as gaining visibility, and difficulties related to platform fees, as well as payment delays.

Regarding support for communities affected by disasters, donors expressed concerns about the authenticity of campaigns and the allocation of raised funds. Terms like "authenticity," "allocation," "use," "purpose," "transparency," and "accountability" were frequently mentioned by respondents.

These concerns are reflected in the key factors influencing donation decisions, including the institution's reputation and the publication of accountability reports.

Participants also emphasized the importance of access to information, particularly updated reports on the use of donated resources and the impact of donations on affected communities. In addition, the need for a communication channel with humanitarian organizations was highlighted, which could also be used to send notifications of the need for materials at collection points and the most donated items.

The barriers found in this survey directly affect the collaborative potential of crowdfunding platforms due to the limitations found in communication, cooperation, and coordination mechanisms. If these mechanisms are properly integrated, platforms could become more effective for individuals seeking to create serious campaigns and assist communities affected by crises.

Declarations

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AI tools were used for: content generation in initial drafts and text refinement; data analysis and processing, such as synthesis and categorization of information extracted from the papers.

All AI-generated content was reviewed and validated by the authors for accuracy and validity.

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Authors' Contributions

MCP contributed to the writing (original draft), data curation, investigation, and methodology. AR was responsible for the conceptualization and writing (review and editing). VV contributed to the writing (review and editing) and supervision.

All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests that could have influenced the research reported in this paper.

Availability of data and materials

In accordance with open data principles, the datasets and supplementary materials generated and analyzed during this study are openly available in the Zenodo repository: `https://zenodo.org/records/21955188`, accessed on 15 August 2026. The repository includes the systematic literature review dataset, the anonymized user-experience survey dataset, the survey questionnaire, and a summary of the responses with graphical results.

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