

AidSphere- Integrated Crisis Management System

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Abstract - Effective communication and well integrated emergency response systems are critical for reducing human and infrastructure losses. However, the standard disaster response systems are mostly ad hoc, dependent on manual reporting practices as well slow notifications on disparate tracking of incidents or received donation or volunteers engaged. They too lead to slow response, misuse of scarce resources and lack of transparency during emergencies.

In this paper, we present AidSphere - an all-in-one emergency response hub: including emergency incident reporting, resource dispatching and volunteer management onto a unified web-based portal. The technology encourages the flow of incident report information from citizens, directly to public authorities and NGOs with geo-reference included to make more informed decisions quicker on the scene. AidSphere also includes a category for structured donation management, where they can help organize, track, distribute and deliver vital aid such as food, water, medicine and clothing in an open manner. What is more, it allows enabling mobilization of volunteers and deployment of their skills in matching human resources with incidents based on location and required skill-sets.

Integrated, AidSphere enhances the efficiency and effectiveness of response through real-time reporting, centralized resource management & workload aware coordination. The modular and scalable nature of the system enables practical deployment in real world crisis situations and facilitates cooperation between civilians, emergency services, and relief organizations.

Keywords - *Disaster Response, Emergency Coordination, Crisis Management System, Volunteer Management, Real-Time Incident Reporting, Resource Allocation, Web-Based Platform.*

I. INTRODUCTION

Disasters and emergencies stretch public safety, critical infrastructure, and community resilience. Natural disasters, major accidents and unexpected crises require quick response, smooth flow of information and well prepared full-scale operations. In the real world, lack of cooperation among response teams causes communication delay as well as inefficient resource deployment and longer time for solving emergencies, which all exaggerate damages and lose lives.

While digital communications technologies have greatly evolved, mechanisms to respond to emergencies are still largely based on manual

reporting and disparate digital platforms. Monitoring incidents is likely to be by phone call or social media and the information may be sketchy, delayed or inaccurate when received by response agencies. Likewise, NGOs which run volunteers and donations and field operations on their own systems find it hard to co-ordinate activity, when fast action may be crucial.

To mitigate these limitations, we present AidSphere as an integrated Crisis Management System with a structure. Citizens can now connect with volunteers, NGOs and authorities through a single digital medium allowing real-time reporting of incidents with GPS locations for faster response. AidSphere also incorporates transparent control of life-saving

resources (food, water, clothes and medications), leading to immediate distribution in a crisis.

AidSphere aims at improving the response time, and the coordination efficiency by bundling incident reporting, resource management and volunteer coordination in one central framework. It is intended to be scalable, real and ready for deployment in any emergency scenario. By means of an updated information system and a coordinated decision-making process, AidSphere expands the level of trustworthiness, orderliness and efficiency in disaster response.

II. LITERATURE REVIEW

Digital platforms and cloud-based systems have been increasingly studied to enhance disaster management and emergency response coordination. Cloud computing has been recognized extensively as one of the key technologies to support scalable, reliable crisis response volume, and distributed systems. Studies by Buyya et al. [1] and Chen et al. [2] showed that emergency management required cloud infrastructure to realize real-time data sharing, centralized control, and high availability [2]. But a lot of the cloud disaster platforms are limited information sharing and do not have communication coordination built into them.

Artificial intelligence is increasingly supporting disaster response through smart data analysis and decision support. Research by Bobadilla et al. [3] and Ahmed et al. [4] showed that AI methods can successfully prioritize emergency alerts and classify the severity of an incident. Even though those methods made the responses more accurate, they are typically treated as independent modules of crisis management systems. Meanwhile, NLP and image incident analysis methods recommended in recent works [5], [6] enhance situational awareness but fail to implement coordinated response.

Collaborations on volunteerism organization and resource management are also common. Kumar and Sharma [7] presented intelligent volunteer matching methods, in [8] and [9], Ong et al concentrated on relief resources allocation. Although these techniques

enhance individual components, they lack real-time workload balance and multi-stakeholder collaboration. Some geospatial and simple proximity-based forms of response medialization was addressed in [10], [11] emphasizing faster responding but poor system integration.

Integrated and AI-based crisis platforms have also been recently stressed in several works. Cloud native architectures and event-driven systems as discussed in [12], [13] facilitate scale out system architecture with responsiveness, whereas models for predictive workload representation and adaptive response are discussed in [14] indicating a forward looking strategy for disaster management. On the other hand, available work is focused on individual functionalities, indicating the necessity of an integrated intelligent and workload-aware structure for crisis management like the proposed system.

III. PROBLEM STATEMENT & RESEARCH GAP

3.1 Problem Statement

Existing disaster response systems do not have a common point of coordination involving citizens, NGOs, volunteers and authorities. Report on incidents is delayed, resources are not utilized efficiently and volunteer deployment is inefficient due to disconnected systems and manual coordination.

3.2 Research Gap

The studies available discuss individual features like alerts, volunteer registration or predictions in disasters but they do not combine different features together under a single common platform. Workload-aware coordination, transparent donation management, and real-time multi-stakeholder emergency response systems lack study.

IV. PROPOSED SYSTEM OVERVIEW

AidSphere is a web-based crisis management system designed to support coordinated disaster response operations. The main goal of the proposed system is to overcome the communication and coordination gap between individuals, volunteer team, non-governmental organization (NGO) and government

entities in the case of emergency and disaster. By combining several response efforts in one system, AidSphere transforms previously fragmented disaster response processes into a unified and structured digital workflow.

At the citizen level, affected individuals or witnesses can report incidents directly through the platform. Each incident report can have an exact geo-location, place descriptions, and visual evidence. This blended approach enriches situational awareness by providing 'on-the-ground' reporting perspective which is typically absent in alert-based solutions. The extensive and specific information on incidents in real-time makes it possible to more rapidly assess the intensity of urgency, enabling timely decisions.

The AidSphere to allow NGOs and first responders to collaborate directly while still in the field by tracking live operations, resources on hand, and tasks allocated. In addition, the system helps co-ordinate donations by categorizing vital relief goods like food, water, clothing and medicine. Donations of any amount will be kept in a central, transparent repository so there is no duplication or inefficiency during large-scale crises.

and donate their resources (free time, location, basic skills). This information updates live against current events, and provides the means for authorities and none governmental organizations to plug in volunteers according to distance and active load. And the major difference is that our proposed system can centralized and load-aware volunteer distribution, which is impossible for those manual volunteers' coordination-based all systems.

Furthermore, AidSphere incorporates smart prioritization strategies to decide on task assignment taking into account realizing the severity of the incident, availability of a responder and resource constraints. This load-aware strategy can prevent some specific NGOs or virtual volunteer groups from being overloaded and ensure that the workload of responders is distributed equally. During / After the Relief Response: On-the-fly monitoring of incident status, resource consumptions and response evolution will maintain continuous accountability of relief effort performance over time as conditions may evolve.

In this way, the proposed system offers a uniform and scalable but also practical approach to disaster management. Using real-time incident reporting, trackable resource management, centralized volunteer coordination and intelligent decision support AidSphere dramatically increases response efficiency, accountability and cooperation across all participants in emergency response.

V. METHODOLOGY

The AidSphere platform was founded on a system wide integrated data approach to make crisis response quick and coordinated. The proposed approach treats the disaster response as multi-stage decision support system consisting of real-time incident analysis, intelligent responder force coordination, workload-aware resource allocation and dynamic monitoring. This section describes the full-method workflow and delves in detail to the techniques and mathematical formulations that lie under decision making process.

A. Overall Methodological Framework

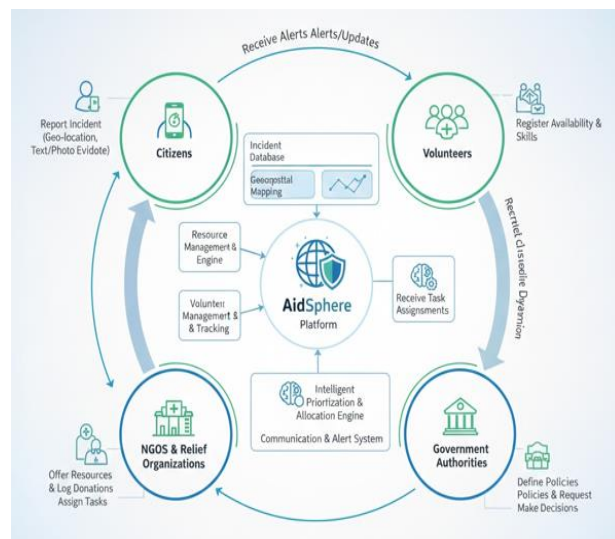


Fig. 1. AidSphere integrated crisis management: Architecture and operational description of the proposed system

Volunteers also play a very important role in the proposed scheme. Volunteers can log in aidSphere

The approach starts with data collection on incidents as they are reported by citizens, and then goes through validation, prioritization, locating of the responder, estimate of how to split the workload between responders and selecting an optimal set of responders for any task. In contrast with conventional rules-based schemes, the proposed approach integrates quantitative analyzing and optimizing mechanism to consider the tradeoff among emergency level, real-time resource proximity and available responders.

Let, I set of incidents (i_1, i_2, \dots, i_n) reported.

$V = \{v_1, v_2, \dots, v_m\}$: set of volunteers to be available

$N = \{n_1, n_2, \dots, n_k\}$ be the set of NGOs

$R = \{r_1, r_2, \dots, r_l\}$ represent the set of resources available

The purpose of the methodology is to establish an optimal matching of incidents, responders and resources that minimizes response time and workload imbalance.

B. Incident Severity and Priority Assessment

All the incidents $i \in I$ in I are examined to assess their severity and urgency. The severity is calculated in relation to the reported indicators including the type, description of damage, and keywords in the context.

The priority score P_i of an incident is defined as follows:

$$P_i = \alpha S_i + \beta U_i + \gamma D_i$$

Where:

- S_i denotes the level of severity.
- U_i is indicator of urgency.
- D_i shows possible impact of damage.
- α, β, γ are weighting coefficients in that,

$$\alpha + \beta + \gamma = 1$$

Incidents with higher P_i values are processed with higher priority.

C. Location-Based Responder Identification

In order to reduce delay in response, short listing of the responders in terms of spatial proximity is done.

Distance is a distance measure that determines the geographical distance between the incident site and a responder.

The distance d_{ir} of an incident, i , and a responder, r , at the location (x_i, y_i) , is:

$$d_{ir} = \sqrt{(x_i - x_r)^2 + (y_i - y_r)^2}$$

Responders having minimum distance values are given priority to be assigned, based on availability constraint.

D. Workload Estimation Model

To avoid flooding of responders, AidSphere makes use of a workload-based coordination scheme. W_r is the workload of a responder r which is defined as:

$$W_r = \sum w_j \text{ for } j = 1 \text{ to } T_r$$

Where:

T_r = Number of active tasks

w_j = Workload weight of task j

A responder is considered eligible only if:

$$W_r \leq W_{\max}$$

Where W_{\max} is the maximum allowable workload threshold.

E. Resource Availability Analysis

Resource allocation cannot exceed availability. Then A_r and D_r are, respectively, the amount of resource type r that is available and the predicted demand for it.

We define the following feasibility condition:

$$A_r \geq D_r$$

Where:

- A_r = Available resource quantity
- D_r = Required resource demand

In coordination, only possible resource allocations are considered in order to provide practical and viable relief operations.

F. Optimization-Based Allocation Strategy

It is a multi-objective optimization problem, which models the allocation problem. The objective

purpose will serve to reduce workload imbalance and response time with maximizing coverage efficiency.

The objective function is expressed as follows:

$$\min F = \lambda_1 \sum d_{ir} + \lambda_2 \sum W_r + \lambda_3 \sum R_u$$

Where:

- ✓ d_{ir} = Distance incident responder.
- ✓ W_r = Responder workload
- ✓ R_u = Unmet resource demand
- ✓ $\lambda_1, \lambda_2, \lambda_3$ are weighting factors

This expression maintains a healthy trade-off between speed, workload and utilization of resources.

G. Integrated Coordination Algorithm

The complete coordination algorithm is below.

Algorithm 1: Integrated Algorithm for Emergency Coordination in the AidSphere

1. Input: From the domain of I (Incident set), V (Volunteer Set), N (NGOSet) and R (Resource Set).
2. Validate and preprocess incident data
3. Compute the priority score P_i of each event
4. Order incidents by descending priority
5. For each incident i :
 - ✓ Measuring distances from other responders
 - ✓ Estimate current responder workloads
 - ✓ Evaluate resource feasibility
 - ✓ Solve allocation objective function
 - ✓ Assign responders and resources
6. Update response status and workloads
7. Monitor progress and collect feedback

Output: Optimized incident-responder-resource assignments

H. Feedback-Driven Adaptation

The system runs after assignment by checking the operation. Lag responses, deviations in workloads

and resource constraints are observed to correct control parameters. Such adaptation mechanism enables the model to augment the collaboration strategies over time and respond intelligently to changing disaster situations.

I. Methodological Significance

The framework integrates methodologies, algorithms and mathematical formulations: AidSphere allows to use:

- Priority-driven emergency handling
- Proximity-based and workload-aware coordination
- Optimized resource utilization
- Scalable and adaptive disaster response

This integrative method significantly enhances emergency coordinated efficiency and robustness as compared with traditional disaster response systems.

VI. RESULTS & DISCUSSION

To assess the performance of our proposed system AidSphere, we conducted a series of simulations for challenging disaster scenarios under four aspects: prioritization of incidents' names, cooperative work on tasks among responders, load balancing and effectiveness of action responses. The conventional ways of disaster management such as manual coordination and static rule based response are compared with the presented system. The emphasis is on response accuracy, workload equilibrium and mean response time.

A. Experimental Setup

These were simulated disasters of varying densities, availability of responders and resources enabled the study of the dynamics of the system. Reports had different types of emergencies and their level. Limited volunteer and NGO capacities were set to simulate practical operational limitations. Performance evaluation were performed while monitoring the system behavior with concurrent incident handling.

The primary evaluation metrics include:

- ✓ Incident-responder matching accuracy
- ✓ Workload imbalance index
- ✓ Average response time

B. Quantitative Performance Analysis

The performance of the proposed AidSphere system is compared with traditional disaster response methods in Table 1. Matching accuracy measures how correctly appropriate responders are assigned to the corresponding events. Workload imbalance is an indicator of inequity in the distribution of responsibilities between responders, whereas response time as a measure for coordination effectiveness.

Table 1: Comparative Performance Analysis

Method	Matching Accuracy (%)	Workload Imbalance Index	Average Response Time (min)
Static Responder Listing	61.5	0.43	18.7
Manual Coordination	71.2	0.38	14.2
Rule-Based Prioritization	76.3	0.36	12.5
Proposed AidSphere System	88.6	0.33	9.1

From **Table 1**, AidSphere can provide much higher matching accuracy with lower response time and balanced workloads.

C. Discussion of Results

It is apparent that the AidSphere system shows superior performance compared to conventional disaster management approaches based on all evaluated measurements. The more accurate matching of the incident responders is due to the incorporation of severity-oriented prioritization, geographic-proximity-based coordination, and

workload-bounded allocation. Unlike the static or rule based ones, AidSphere adjusts assignments in a dynamic manner according to real-time information.

The workload imbalance index is much lower in the proposed system, thus indicating its capability for equitable assignment of duties to the NGOs and volunteers. This is especially critical during major incidents where responder fatigue, and saturation can impair the efficacy of a response.

The decrease in average response time also demonstrates the effectiveness of locality-based responder identification and optimal allocation strategies. AidSphere offers quicker emergency response and enhanced operational dependability simply by reducing unnecessary delays and reallocation.

D. Visual Performance Comparison

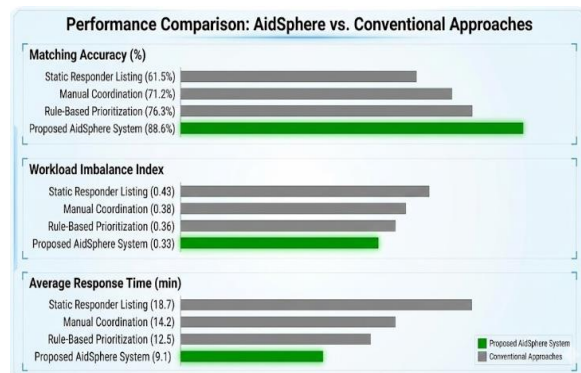


Fig. 2. Performance comparison of the proposed AidSphere system

Fig.2 illustrates the comparative performance trends of different disaster response approaches. The proposed system consistently achieves higher matching accuracy and lower response time while maintaining balanced workload distribution, validating the effectiveness of the integrated methodology and optimization-driven coordination framework.

E. Overall Observations

The experimental results support our conclusion that real-time incident analysis, workload aware coordination and optimized allocation integrated into one architecture bring significant performance

improvement. While there is much work to do in order to operationalize an AidSphere system, we believe our tool has the potential for application in real-world scenarios with a high level of parallel crises and scarce responding ability.

VII. CONCLUSION

This article described AidSphere, a system for crisis and emergency coordination that is designed to provide real-time support and up-to-date, detailed information about the utilization of resources provided by individuals or organizations in response to natural disasters. By integrating real-time incident report, structured resource allocation, centralized volunteer planning and administrative decision-making into one platform, the proposed system addresses several shortcomings of traditional disaster management mechanisms. Experimental results show that AidSphere can improve the accuracy of incident-responder matching, decrease the time for response and balance a workload than those traditional approach. The robust and modular architecture of the system allows practical use in real emergency situations.

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