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Emergency Communication and Crowdsourced Information: challenges and potential

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INTRODUCTION

In recent decades, the increasing use of **mobile technologies** and **social media** has significantly transformed how information circulates during emergencies. These tools enable individuals to share real-time updates with both the public and authorities (e.g., police, fire, and medical services), thus fostering **participatory forms of emergency communication**.

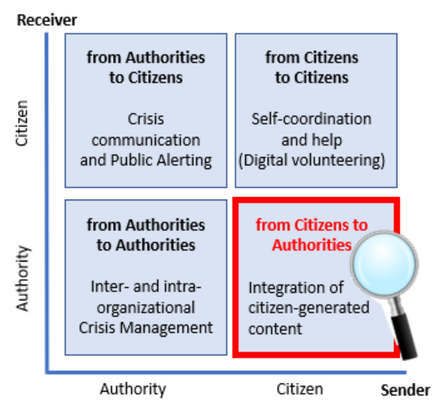
In this context, citizens transcend the role of passive recipients of information and act as ***"human sensors"***, actively contributing to the collection of valuable situational data, based on their direct experiences [1].

LIMITS TO THE USE OF CROWDSOURCED DATA

The Crisis Communication Matrix provides a useful framework to understand the interaction between citizens and authorities on social media, identifying four key informational flows [2]. The highlighted quadrant focuses on the flow from citizens to authorities. This remains a critical issue, as **citizen-generated content from social platforms is still inadequately integrated into official crisis management processes** [3].

Several barriers hinder the effective use of this crowdsourced information, including concerns about the **reliability** of social media posts and difficulties in processing **unstructured data** [4].

THE CRISIS COMMUNICATION MATRIX



A "NOVEL" DATA SOURCE: 1-1-2 EMERGENCY CALL DATA

The **European Emergency Number 112** is a hotline designed to simplify access to emergency services across Europe. It enables citizens to quickly reach the appropriate authorities – police, fire, or medical services – through **a single phone number**.

Italy is among the last European countries in the process of completing the nationwide activation of 112 emergency call centers [5]. This transitional phase offers a timely opportunity to examine the potential of emergency call data to **address the challenges associated with the use of crowdsourced information in emergency management**.

IMPLEMENTATION STATUS OF THE 112 NUMBER IN ITALY

The main hypothesis to be tested is that crowdsourced information from social media and emergency calls to the European Emergency Number 112 can strengthen the Civil Protection System, enhancing situational awareness and decision-making during large-scale emergencies

The overarching goal of this Ph.D. project is to explore the challenges and potential in leveraging these data sources for crisis management

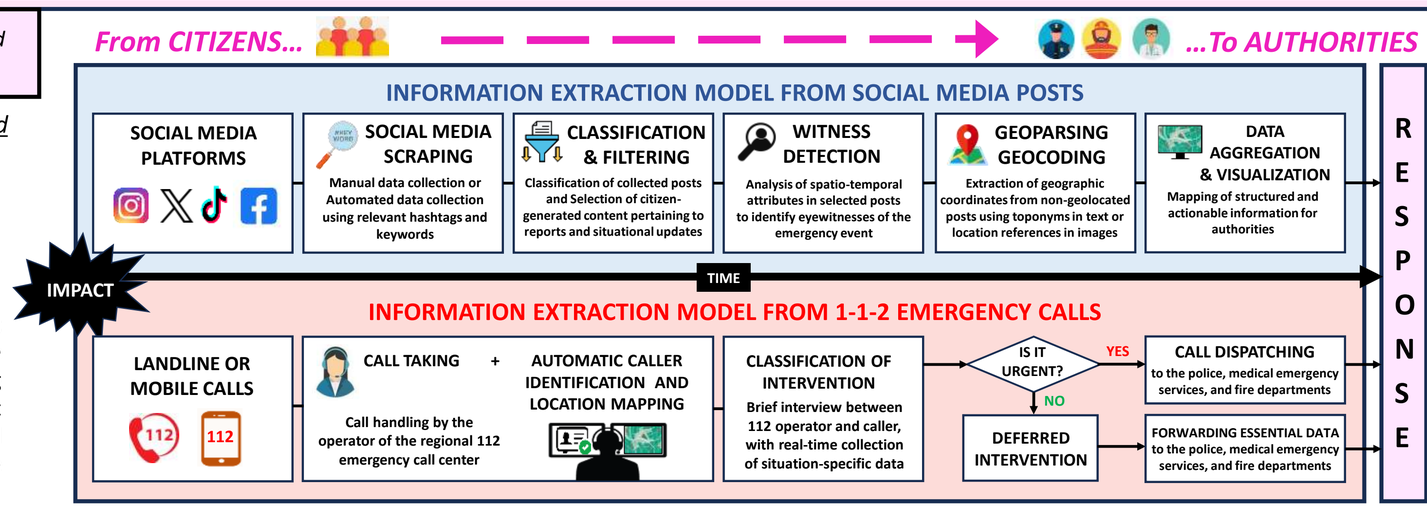
Work Package 1
DATA EXTRACTION MODELS

Research Question: *What key information from social media and 112 calls supports effective emergency response? How is it extracted?*

Objective: *Defining models for extracting actionable information from social media posts and emergency calls to the European Emergency Number 112*

Methods:
1. Analysis of the scientific literature in the field of crisis informatics aimed at identifying the most advanced techniques for validating content published on social media;
2. Analysis of the grey literature on the 112 system to examine emergency call management processes

Key Results: Both social media and emergency calls to 112 can provide valuable information during crises; however, the methods of data extraction differ significantly. Social media relies on the spontaneous sharing of unstructured information by unverified sources. As a result, extracting actionable data for authorities can be a resource-intensive process, requiring both content validation and geolocation. In contrast, data extraction from 112 calls follows a standardized and participatory framework. Citizens actively engage with 112 call-taker, providing real-time identification and location information that is immediately relevant to emergency services



Work Package 2
TESTING THE MODELS

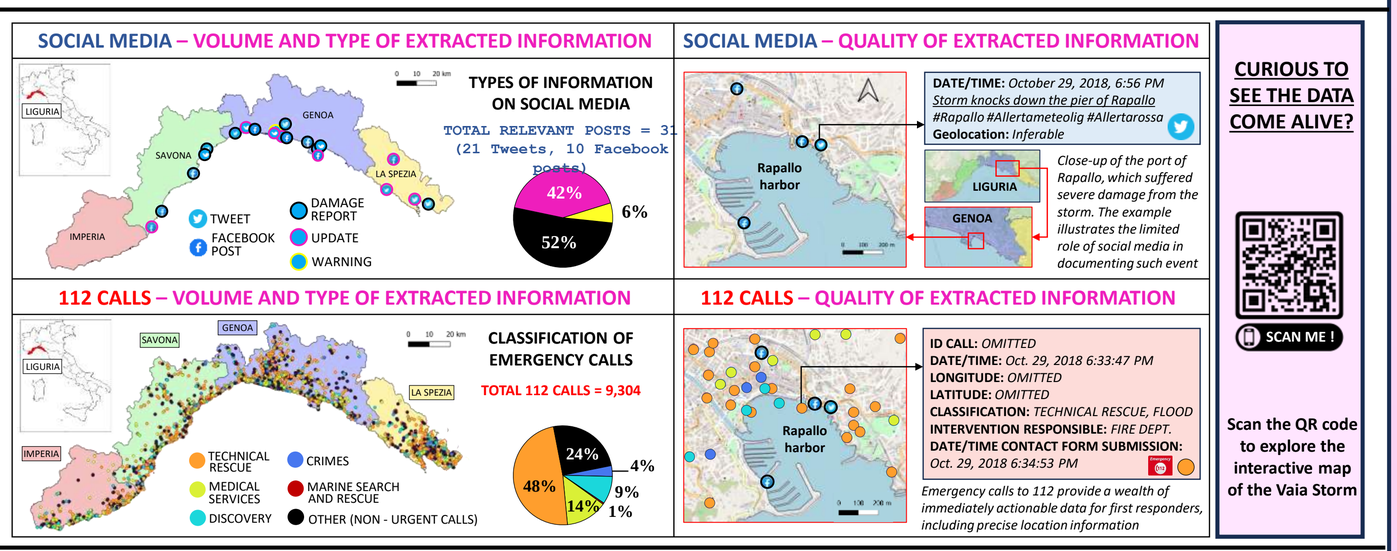
Research Question: *How do social media posts and 112 emergency calls compare in terms of volume and quality of information they provide?*

Objective:
a. Testing emergency information extraction models
b. Assessing the granularity and reliability of data from social media and 112 calls

Case study: *Vaia Storm in Liguria, Italy (October 29 – 30, 2018)*
Vaia was an extreme meteorological event that caused severe damage across northern Italy and resulted in the highest volume of emergency calls ever recorded by the 112 Emergency Response Center of the Liguria Region. This event provided an ideal testbed for analyzing crowdsourced emergency information and evaluating its effectiveness in crisis situations

Methods:
1. Collaboration with the Liguria Region 112 Center to access emergency call data;
2. Extraction of Facebook posts and tweets related to the same case study;
3. Application of the models developed in WP1 to the crowdsourced data;
4. Comparative analysis of the results

Key Results: Data from 112 emergency calls surpasses social media in both quantity and quality, serving as a robust complement to conventional territorial monitoring systems.



CURIOUS TO SEE THE DATA COME ALIVE?

SCAN ME !

Scan the QR code to explore the interactive map of the Vaia Storm

Work Package 3
LEVERAGING "CALL INTELLIGENCE"

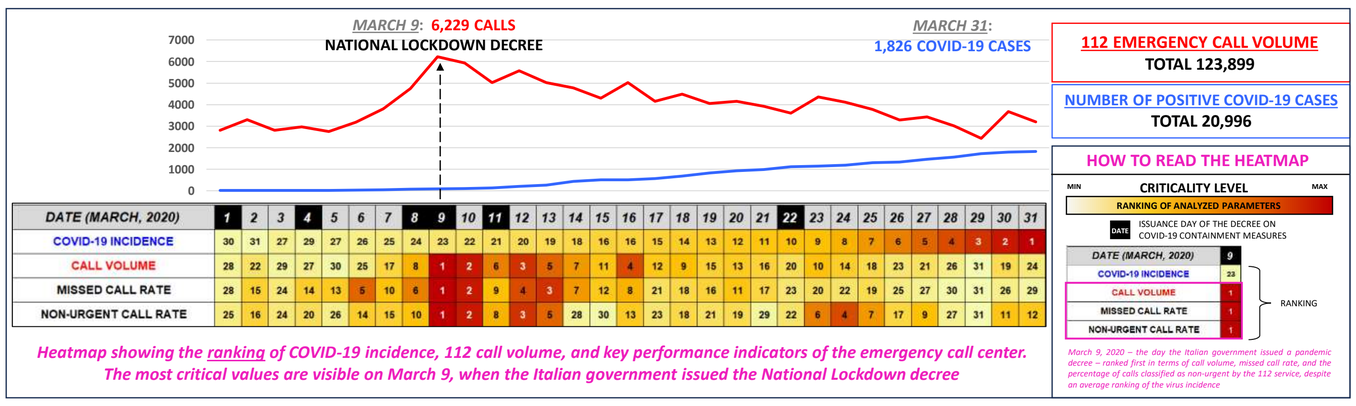
Research Question: *To what extent can emergency call data reveal behavioral patterns of the public and enhance emergency monitoring?*

Objective: *Linking temporal spikes in emergency call volumes to specific concerns of the population along the different phases of the ongoing emergency*

Case study: *The outbreak of the COVID-19 pandemic in Liguria in March 2020*
Liguria was one of the Italian regions that experienced the highest increases in 112 call volumes during the early stages of the pandemic. This unprecedented scenario prompted an in-depth analysis of the causes behind the 112 system overloads and provided an opportunity to assess the potential of emergency calls in capturing public concerns, as well as supporting health surveillance

Methods:
1. Analysis of emergency calls received by the Ligurian 112 center from March 1 to March 31;
2. Analysis of the temporal relationship between trends in emergency call volumes and the increase in confirmed COVID-19 cases during the same period;
3. Analysis of the temporal relationship between peaks in emergency call volumes and the dates of government-issued pandemic containment measures;
4. Semi-structured interviews with 112 center coordinators to validate the analytical findings

Key Results: The peak in call volume aligned with the days the government issued the decrees on pandemic containment measures. Performance indicators suggest that the system overload was predominantly driven by informational calls rather than medical emergencies. Interviews further confirm that the infodemic, propagated through traditional and social media, contributed to heightened public concern



Work Package 4
UNLOCKING "CALL POTENTIAL"

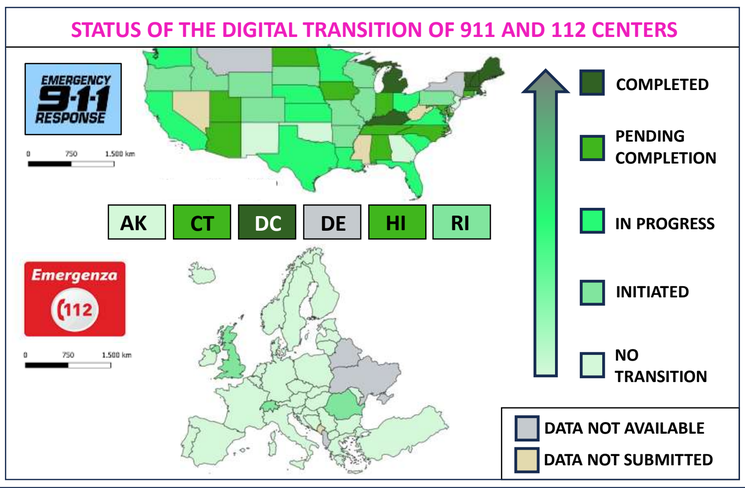
Research Question: *Are emergency call centers prepared to leverage Big Data from multimedia communications to enhance decision-making?*

Objective: *Assessing the readiness of emergency call centers to incorporate new technologies (e.g., Artificial Intelligence) in their protocols better to handle multimedia data*

Methods:
1. Research trip to the United States to study the 911 emergency call system, from which the European 112 system is derived;
2. Analysis of official reports on the digital transition of the 911 and 112 systems;
3. Comparative analysis of the technological maturity level of both systems;
4. Semi-structured interviews with directors of 911 and 112 emergency centers to assess their perceptions regarding the use of Artificial Intelligence in operational processes

Key Results: The United States is leading technological innovation, with the digital transition of 911 centers already underway in most states. In contrast, Europe is expected to initiate the process in the coming years. Interviews highlight these differences, with U.S. respondents demonstrating greater confidence regarding emerging technologies such as Artificial Intelligence

STATUS OF THE DIGITAL TRANSITION OF 911 AND 112 CENTERS



FINDINGS FROM THE INTERVIEWS WITH DIRECTORS

UNITED STATES (13 centers across 11 states)	*EUROPE* (3 centers: BE, DE, FI)	*ITALY* (5 Regional centers)
Applications of Artificial Intelligence deemed the most useful		
Automatic call triage	*Handling of hoax calls*	*System performance monitoring*
Handling of hoax calls	*System performance monitoring*	*Automatic call translation*
Perceived risks of Artificial Intelligence		
Challenges in managing the costs of technologies	*Reduction of the human role in decision-making*	*Limited trust in the reliability of algorithms*
Increased vulnerability to cyber attacks	*Cost-related challenges in upskilling operators*	*Reduction of the human role in decision-making*

CONCLUSIONS AND FUTURE PERSPECTIVES

1. *The 112 emergency call system employs **standardized processes** that ensure the **real-time validation** of crowdsourced information, thereby overcoming key limitations inherent in social media*
2. *The information gathered from 112 emergency calls appears more effective – than social media sources – in supporting situational awareness for authorities, offering a **higher volume of detailed**, **structured**, and **geolocated data**.*
3. *The experience gathered by 112 during the COVID-19 crisis highlighted the crucial role of the system not only in managing emergency calls but also in **filtering crowdsourced information**, thus **reducing infodemic***
4. *The US 911 and EU 112 emergency call systems are guiding the technological revolution to also handle **Social Big Data** and fully take advanced of the community's **collective intelligence***

The 112 system can evolve beyond call dispatch to become a comprehensive emergency management tool. Additional case studies will further refine this approach

References

[1] Avvenuti et al. SpringerPlus 5, 2016
[2] Reuter et al. J. Contingencies Crisis Manag. 26, 2018
[3] Reuter et al. Int. J. Human-Computer Studied 95, 2016
[4] Lovari et al. J. Public Affairs 20, 2019
[5] European Emergency Number Association, Public Safety Answering Points Global Edition, 2024

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