

Empowering Coastal Communities: A Strategic Framework for Volunteer Integration in Maritime Search and Rescue Operations

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The integration of volunteers into coastal Search and Rescue (SAR) operations in Croatia is analysed through a strategic framework aligned with established practices within the Norwegian SAR system. Although Croatia formally recognises volunteer involvement in its maritime legislation, the absence of practical structures—such as standardized training, formal protocols, and coordination mechanisms—limits effective participation. Building on successful elements from the Norwegian model, the proposed framework, adapted to Croatian conditions, is designed to strengthen SAR performance by improving response times, expanding coverage, and drawing on local knowledge. The study employs a qualitative comparative case study design structured around a cross-national analytical framework, providing an evidence-based analysis of the gap between legislative recognition and operational implementation of volunteer SAR integration. The findings identify the institutional conditions under which volunteer integration becomes operationally viable, and offer a transferable framework for coastal states facing similar challenges.

KEYWORDS

- ~ Search and rescue
- ~ Volunteer integration
- ~ Maritime safety
- ~ Community resilience
- ~ Emergency response

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1. INTRODUCTION

Volunteer integration has become a critical element in maritime Search and Rescue (SAR) (Hong and Kim, 2025; Huapu, 2013; Prytz et al., 2023). In this research, a volunteer is defined as a person who willingly offers assistance to an SAR organisation without compensation, to help others or support a cause. Volunteers are distinct from bystanders or professionals involved in such actions (Curd et al., 2025). Bystanders are simply present near an incident and choose to help of their own accord, without any assumed skill set, while professionals are paid and trained employees of SAR organisations. Unlike bystanders, volunteers are expected to have some level of training or expertise relevant to SAR operations.

Research indicates that organised volunteer initiatives can significantly reduce response times and improve rescue outcomes in emergencies (Prytz et al., 2023). Disaster responses are more efficient when clear procedures exist for engaging informal volunteers (Nahkur et al., 2022). Despite technological advances in communication, navigation, and detection – including the use of drones and advanced sensors – the human element, especially community volunteers, remains indispensable (Prytz et al., 2023). Coastal regions, which are hubs for recreation and commerce and frequently the sites of maritime emergencies, depend heavily on efficient SAR services. However, the extent of volunteer integration into these systems varies significantly across countries.

Northern European countries such as Norway have developed sophisticated systems for volunteer integration, characterised by comprehensive training programmes and strong governmental and organisational support (Wollebæk, 2025). These systems are often cited as exemplary in leveraging volunteer capabilities to enhance SAR effectiveness, for example through better coverage and local knowledge (Enjolras et al., 2024). In contrast, regions such as the Mediterranean and parts of Eastern Europe, including Croatia, face persistent challenges in fully incorporating volunteers into SAR. Studies highlight issues such as inadequate training and support for volunteers, unclear legal frameworks, and fragmented coordination among agencies (Graffin et al., 2025). These challenges contribute to a disparity in SAR effectiveness between countries like Norway and those where volunteer integration is less developed. Although Croatian laws theoretically support volunteer involvement, bureaucratic inertia and a lack of implementing regulations hinder effective integration. Furthermore, Croatia lacks a centralised framework for volunteer training, resulting in regional inconsistencies in volunteer skill levels. Its SAR coordination also remains fragmented compared to Norway's centralised approach. Nevertheless, some countries in Eastern Europe have made progress – Hungary's voluntary rescue service is one example of an organised community SAR initiative – illustrating that with proper support, volunteer capacity can be systematically developed even in challenging contexts (Hábermayer and Horváth, 2020).

To bridge the identified gaps, a new strategic framework is proposed to enhance the integration of volunteers into coastal SAR operations in Croatia. Drawing inspiration from Norway's successful model, the framework is tailored to local Croatian conditions and needs. It focuses on improving training programmes, providing legal and operational support, and fostering a culture of collaboration between professional rescuers and volunteers (cf. similar recommendations in prior studies) (Wollebæk, 2025; Breen et al., 2024). By leveraging volunteers' strengths and ensuring they are well integrated and supported, the efficiency and resilience of SAR operations can be improved (evidence from prior marine rescue analyses shows that well-prepared volunteer involvement boosts operational performance) (Prytz et al., 2023; Enjolras et al., 2024). This study addresses the following research questions: (1) How are volunteers formally and operationally integrated into the maritime SAR systems of Norway and Croatia? (2) What are the critical gaps between legislative intent and operational reality in the Croatian SAR system? (3) Which elements of the Norwegian model are transferable to the Croatian context, and under what structural conditions? By addressing these questions, the study contributes to the academic literature on civil security systems and volunteer management in emergency response by providing a systematic cross-national analysis that moves beyond descriptive policy recommendations towards a theoretically grounded framework for institutional change (Nahkur et al., 2022; Enjolras et al., 2024). The findings may further inform policy and institutional reform in other coastal states facing similar gaps between legislative recognition of volunteers and their operational integration into maritime SAR systems.

2. LITERATURE REVIEW

The organisation and effectiveness of intersectoral collaborative search and rescue (SAR) operations have been extensively studied, providing significant insights into decision-making, collaboration, and training (Da et al., 2023). Collaboration in SAR is defined as a horizontal process requiring frequent interaction, mutual trust, and a willingness to share risks – far beyond basic coordination or cooperation (Murphy et al., 2015; Martin et al., 2016). Stakeholders must continually assess the benefits and drawbacks of working together, motivated by shared goals, improved individual and collective outcomes, and the distribution of personal and institutional risk in high-stakes environments (Rivera, 2016). These dynamics align with organisational theories that view collective crisis response as a continuous process of social organising under uncertainty. Additionally, the pursuit of individual or collective gains and risk-sharing considerations drive collaborative

processes (Berlin and Carlström, 2009). In the Nordic countries, collaboration between public, NGO, and volunteer stakeholders is essential for large-scale crises and disaster response and is embedded in the legal framework (Drabek and McEntire, 2003). Integrating local communities and volunteers into SAR operations has been shown to enhance the overall effectiveness and reach of emergency response efforts (Raisio et al., 2019). Proactively involving volunteers in SAR operations supplements the workforce and brings diverse perspectives and local insights. Volunteers' intimate knowledge of their communities enables them to identify and address unique challenges that external responders may overlook. This is particularly evident during social crises, where spontaneous volunteers often self-organise to fill gaps left by formal response systems, highlighting the need for coordination structures to manage such efforts effectively and prevent operational disruptions (Simsa et al., 2019). Volunteer integration in SAR operations can also promote social cohesion and strengthen communal bonds, building trust and solidarity essential for collective resilience.

To maximise volunteer integration, standardised training programmes, clear communication protocols, and structured recognition and reward systems are necessary. Legal and safety concerns should also be addressed through a comprehensive legal framework and adequate insurance coverage to ensure a safe working environment for volunteers. The level of volunteer involvement in disaster management varies across Europe, often influenced by differing policies, institutional frameworks, and cultural contexts (Hustinx et al., 2010). In Sweden and Norway, where volunteering is widespread, informal volunteer integration is somewhat regulated, facilitating formal insurance (Nahkur et al., 2022). In contrast, Belgium and Italy favour formal organisations, discouraging informal volunteerism (Nowakowska et al., 2024). Germany, Hungary, Finland, and Estonia manage volunteer involvement on an ad hoc basis without comprehensive institutional structures. Most countries, except Italy, run crisis-preparedness campaigns promoting community support, often combined with first-aid training (Roth and Prior, 2019). Social media is used sporadically to engage volunteers, except in Germany, where it is more systematically integrated. Thus, volunteer integration benefits from established policies and proactive planning to address coordination, safety, and information accuracy (Nahkur et al., 2022).

Another important aspect to consider when developing collaboration between public and volunteer emergency responders is the sensemaking process (Weick, 1969). Research has shown that when public emergency operators engage in collaboration and reach out to NGO and volunteer stakeholders, their actions are often shaped by historical experiences and established routines regarding which type of response organisation they choose to involve (Magnussen et al., 2018). However, while experience and personal contacts are often effective, reliance on familiar resources can hinder decision-making in new or unfamiliar crisis scenarios.

Research also indicates that past exercise experience impacts perceived learning and usefulness during collaboration exercises. Experienced participants reported higher levels of collaboration and utility, while perceived learning was highest among those with little or no prior experience (Sorensen et al., 2018).

This suggests that standardised exercises focusing on sequential and parallel methodologies may not foster sufficient collaborative learning (Berlin and Carlström, 2011). Further, strict adherence to predetermined scripts limits improvisation and spontaneous assessments, resulting in less effective exercises (Carlström et al., 2020). Exercises emphasising variation, improvisation, and unforeseen events are recommended to ensure continuous learning for all public, NGO, and volunteer participants (Torgersen, 2018).

It is therefore essential to adopt flexible and adaptive training approaches, develop robust collaboration protocols, and invest in educational programmes. These measures optimise SAR operations across sectors, enhance immediate response capabilities, and foster resilient communities. A dynamic and adaptable framework for volunteer integration in SAR operations will evolve to address new challenges and provide new insights. Continuous evaluation and feedback mechanisms will identify areas for improvement, inform the development of more effective strategies, and maintain the relevance and effectiveness of volunteer integration initiatives.

3. METHODOLOGY

This study employs a qualitative comparative case study design. Data were collected through systematic document analysis of: (1) primary legal sources, including the Croatian Maritime Code (Pomorski zakonik, 2019), the Norwegian Royal Decree on SAR organisation (Organisasjonsplan for redningstjenesten, 2019), and international SAR conventions (SAR Convention, 1979; Convention on International Civil Aviation - Doc 7300, 1944); (2) official institutional reports and operational statistics from the Norwegian Society for Sea Rescue (Welcome to the Norwegian Society for Sea Rescue, n.d.; None shall drown - Redningsselskapet, n.d.) and the Croatian Ministry of Maritime Affairs (Ministarstvo mora, prometa i infrastrukture Republike Hrvatske - Traganje i spašavanje na moru 195 / Ustrojstvo / nIS, n.d.); and (3) peer-reviewed academic literature on volunteer integration in emergency management (Prytz et al., 2023; Nahkur et al., 2022; Wollebæk, 2025; Enjolras et al., 2024; Raisio et al., 2019; Simsa et al., 2019).

Case selection followed a most-different-systems logic: Norway was selected as a paradigmatic case of well-institutionalised volunteer SAR integration, characterised by formalised coordination through the Joint Rescue Coordination Centres (JRCC) and publicly documented operational outcomes (Search and rescue - Norwegian Maritime Authority, n.d.; Hovedredningsentralen, n.d.). Croatia was selected as a contrasting case where legislative recognition of volunteers exists (Pomorski zakonik, 2019) but operational implementation is absent, creating a theoretically significant gap between legal intent and practice.

Following the analytical logic of Kuipers et al. (2015), who compare civil security systems across dimensions of governance, institutional structure, and operational practice, this study applies an analogous framework adapted to the maritime SAR domain. Three dimensions structure the comparative analysis: (1) legal and institutional framework, including the formal role of volunteers and authority arrangements; (2) operational coordination and command structures; and (3) volunteer integration, training, and resourcing. This adaptation was chosen because Kuipers et al.'s framework has been validated across 22 European states and provides a transparent basis for cross-national comparison of civil security systems.

4. COMPARATIVE ANALYSIS OF COASTAL SAR OPERATIONS IN NORWAY AND CROATIA

Comparative characteristics of coastal search and rescue (SAR) systems in Norway and Croatia reveal key differences in legal frameworks, operational structures, and the institutionalisation of volunteer participation. The Norwegian system is based on formalised coordination mechanisms and standardised training procedures, while the Croatian model remains fragmented, with limited integration of spontaneous or organised volunteers.

4.1. Legal and Institutional Framework — Norway

The organisation of Norwegian search and rescue (SAR) services is dictated by a Norwegian royal decree (2019) (Organisasjonsplan for Redningstjenesten - Lovdata [Organizational Plan for the Search and Rescue Services], 2019). Additionally, Norway's maritime and aeronautical SAR services are governed by international obligations under agreements such as the 1979 International Convention on Maritime Search and Rescue (SAR Convention) and the 1944 Convention on International Civil Aviation (Chicago Convention) (SAR Convention, 1979; Convention on International Civil Aviation - Doc 7300, 1944). SAR services in Norway are defined as publicly organised, immediate responses aimed at saving individuals from death or injury resulting from acute accidents or hazardous situations not managed by specially established agencies or through specific measures. The execution of SAR services involves a collaborative effort among public agencies, voluntary humanitarian organisations, private enterprises, and individuals. During SAR incidents, all available resources – volunteer and professional – are coordinated through the two JRCC located in Sola, Stavanger, and in Bodø, ensuring efficient deployment and unified communication with rescue sub-centres such as fire departments, police services, and voluntary organisations (Search and Rescue - Norwegian Maritime Authority, n.d.; Hovedredningsentralen, n.d.). The Norwegian SAR framework is underpinned by four key principles (The Norwegian Search and Rescue Service, n.d.):

1. Principle of Cooperation: SAR services are performed through a collaborative effort among public agencies, voluntary organisations, private enterprises, and individuals. Public agencies with the capacity, information, or expertise relevant to rescue operations are expected to contribute using their available resources, competencies, and authorities. This principle reflects the cooperative and consensual model emphasised in the Norwegian SAR system, in which all actors bear responsibility for ensuring effective collaboration both in preparedness activities and during actual rescue operations.
2. Principle of Responsibility: The agency that holds responsibility for specific functions or tasks during regular operations retains this responsibility during rescue operations, regardless of the incident's scale or cause. This ensures continuity and accountability within SAR operations.
3. Principle of Integrated Service: The Norwegian SAR Service is organised as an integrated system capable of managing all types of rescue operations across land, sea, and air. The integrated coordination structure enables joint rescue coordination centres to handle diverse rescue scenarios within a single framework, ensuring a comprehensive and cohesive approach to lifesaving operations.
4. Principle of Coordination: SAR activities are coordinated both in the preparedness phase and during operational response through the Joint Rescue Coordination Centres and their subordinate Rescue Sub-centres. This multi-level coordination structure facilitates efficient management of resources, clear command relationships, and effective response during major and complex emergencies.

In parallel with this legal and structural framework, Norway has developed a practical model for integrating volunteers effectively. The country has a long-standing tradition of volunteerism in maritime rescue, embodied by humanitarian organisations such as the Norwegian Society for Sea Rescue (NSSR) (No. Redningsselskapet) and the Red Cross, which work closely with official services. These voluntary organisations can field a large number of people with the

necessary training and knowledge of the local environment and terrain to assist in SAR missions (The Norwegian Search and Rescue Service, n.d.). For example, in 2024 the NSSR handled about 70% of the sea rescue missions in Norway that were coordinated through the joint rescue coordination centres; it conducted 9,674 missions, of which 887 were directed SAR missions (Welcome to the Norwegian Society for Sea Rescue - Redningsselskapet, n.d.). A total of 30 lives were saved through these missions. At the end of the year, the NSSR had more than 1,450 volunteers actively involved in crewing the 58 rescue boats stationed around the coastline at 49 different stations (None Shall Drown - Redningsselskapet, n.d.). The NSSR also conducts training and certification courses for children, the general population, and volunteers in sea safety, resuscitation, navigation with motor vessels, as well as Standards of Training, Certification and Watchkeeping (STCW) courses for seafarers (Kurskalender - RS Sjøredningsskolen, n.d.).

4.2. Legal and Institutional Framework — Croatia

In contrast to Norway's structured integration of volunteers into coastal SAR operations, Croatia's approach remains largely underdeveloped in practice, despite a formal legal foundation. The Croatian Maritime Code (Pomorski zakonik, NN 17/19) formally recognises volunteers (cro. dobrovoljci) as potential participants in maritime search and rescue (SAR) missions (Pomorski Zakonik, n.d.). Articles 55.c to 55.e of the Code specify the possibility of volunteer integration through written agreements, provide the right to state-backed insurance in case of death or injury during SAR actions, and define the conditions under which volunteers may operate.

However, these provisions have not been operationalised. To date, no structured volunteer SAR programme exists, and no formal contracts, training protocols, insurance mechanisms, or coordination frameworks have been implemented for maritime volunteers. In practice, SAR operations remain centralised within state institutions such as the Coast Guard, Navy, and Civil Protection, while volunteer participation occurs only sporadically and informally, often at the discretion of local actors or in spontaneous emergency situations (Ministarstvo Mora, Prometa i Infrastrukture Republike Hrvatske - Traganje i Spašavanje Na Moru 195 / Ustrojstvo / NIS, n.d.).

Examples of volunteer-based organisations such as the Croatian Mountain Rescue Service (HGSS) and some local civil protection units demonstrate the potential for structured volunteer integration, but these primarily operate inland, with no equivalent national maritime volunteer force (About Us - HGSS, n.d.). It is necessary to distinguish between three categories of civilian involvement in the Croatian SAR context: (1) formal volunteers (dobrovoljci) as defined in Articles 55c–55e of the Maritime Code (Pomorski zakonik, 2019), who may enter written agreements with SAR authorities and are the primary target of this paper's framework; (2) spontaneous volunteers, who act at the scene of maritime incidents without any formal role or authorisation (Simsa et al., 2019); and (3) organised civilian responders, such as members of the HGSS, who operate under structured command frameworks but primarily in non-maritime contexts. The proposed framework targets the first category — operationalising existing legal provisions — while drawing on the HGSS organisational model as a domestic reference point for structured volunteer integration. As a result, several critical challenges persist in the institutional integration of volunteers into Croatia's maritime SAR system. These challenges can be grouped into three interrelated areas: (1) regulatory inaction; (2) lack of standardised training and material support for volunteers; and (3) fragmented coordination mechanisms that fail to formally include civilian responders within established command and communication structures.

Regulatory inaction, the first of these challenges, means that although the legal basis for volunteer SAR engagement exists, it remains ineffective in practice. Without implementing acts, standardised contracts, or practical guidelines, authorities lack a reliable framework for mobilising or managing volunteers. Croatia's legislation should be amended to formally recognise accredited volunteer organisations in maritime rescue and clearly define their roles during emergencies, including insurance coverage and command structure. Establishing clear legal guidelines and protections for SAR volunteers in Croatia would provide legal certainty and legitimacy, thereby encouraging greater volunteer participation.

Second, the lack of standardised training and resources is evident in the absence of a national SAR volunteer training system. Where training occurs, it is fragmented and typically informal, conducted by local sailing or diving associations, with no quality assurance or certification standards. Volunteers are not provided with equipment, nor do they participate in joint exercises with professional units. Norway's approach of training volunteers and providing standardised certification ensures that volunteers can be trusted to perform to a certain standard; Croatia could implement a similar curriculum, perhaps in partnership with experienced NGOs or international SAR bodies (Kurskalender - RS Sjøredningsskolen, n.d.).

The final challenge relates to fragmented coordination, as operational structures fail to include volunteers in official command hierarchies. This was evident during the 2024 grounding of the catamaran *Princ Zadra* near Premuda, where islanders spontaneously launched rescue efforts without official coordination (Hancock, 2024; Magaš, 2024). While commendable, such ad hoc responses reveal the absence of a system that could formally activate and direct civilian responders. Croatia could improve coordination mechanisms by creating a volunteer coordination unit within its existing

Maritime Rescue Coordination Centre (MRCC). During SAR operations, this unit would liaise with registered volunteer teams, ensuring they receive tasks and communicate on the same channels as professional units. A more centralised and inclusive coordination system would prevent the delays and inefficiencies caused by the current fragmented approach.

These three gaps highlight a significant lack of connection between legal intent and operational reality, underscoring the need not only for legal provisions but also for a functioning, institutionalised system to develop, train, and deploy volunteers as an integrated component of Croatia's maritime SAR strategy.

4.3. Comparative Findings

The analysis of the two cases reveals a consistent pattern across all three analytical dimensions. Norway demonstrates systemic coherence between its legal framework, coordination structures, and volunteer integration mechanisms, while Croatia shows progressive institutional divergence — legal provisions exist in isolation, unsupported by the operational and training infrastructure necessary to activate them. Table 1 maps these differences across the three dimensions examined.

Dimension	Norway	Croatia
Legal and institutional framework	Royal Decree (2019); SAR Convention (1979); volunteers formally recognised as operational participants	Maritime Code Art. 55c–55e (Pomorski zakonik, 2019); no implementing regulations; provisions legally envisaged but unactivated
Operational coordination and command structures	2 JRCC + Rescue Sub-centres; volunteers formally integrated as operational assets; NSSR handles ~70% of SAR missions with 1,450 active volunteers (Hovedredningssentralen, n.d.; Welcome to the Norwegian Society for Sea Rescue, n.d.)	MRCC operational; volunteers absent from command hierarchy; participation informal and sporadic (Ministarstvo mora..., n.d.)
Volunteer integration, training, and resourcing	Standardised national programmes via NSSR; formal insurance regulated (Kurskalender - RS Sjøredningsskolen, n.d.; Nahkur et al., 2022)	Fragmented training; no national curriculum or quality assurance; insurance legally envisaged but unimplemented (Pomorski zakonik, 2019)

Table 1. Comparative overview of volunteer integration in Norwegian and Croatian maritime SAR systems.

This pattern is consistent with Kuipers et al.'s (2015) finding that civil security systems in Europe differ not only in their legal frameworks but in how those frameworks translate — or fail to translate — into operational practice. In the Norwegian case, effective volunteer integration rests on the coherence between all dimensions examined: legislation creates the obligation, coordination structures provide the mechanism, and standardised training makes participation viable. Croatia has taken the first step through the Maritime Code, but without the supporting infrastructure, that step remains largely symbolic. It is this gap — between what the law permits and what institutions currently enable — that the following framework seeks to close.

5. FRAMEWORK PROPOSAL FOR STRUCTURED VOLUNTEER INTEGRATION IN COASTAL SAR OPERATIONS

The proposed framework draws on the theoretical insights from the preceding analysis to inform its institutional design. Three theoretical strands shape its components. First, collaborative governance principles underpin the legal and coordination components — volunteer roles are formally embedded within the SAR command structure as a precondition for operational effectiveness (Enjolras et al., 2024). Second, sensemaking theory guides the communication and exercise design components, allowing professional and volunteer responders to build shared situational awareness before actual incidents occur (Weick, 1969; Magnussen et al., 2018). Third, evidence that adaptive exercises yield stronger learning outcomes for mixed professional-volunteer teams has shaped the training component and the continuous evaluation mechanisms embedded in the framework (Carlström et al., 2020; Torgersen, 2018).

5.1. Rationale for a New Framework

The need for a new framework arises from clear gaps in the current system. Croatia's existing SAR setup lacks cohesive strategies for involving volunteers, resulting in underutilisation of willing human resources during emergencies. International experiences, including Norway's, have shown that structured volunteer integration can significantly enhance SAR outcomes. Formalising volunteer roles and training not only increases the manpower available for rescues but also builds resilience within communities. The proposed framework is based on the idea that every coastal community member can be an asset in an emergency if properly prepared. Practical benefits include faster local response, broader search coverage, and potential cost savings through early intervention. The framework therefore aims to cultivate such a pool in Croatia. It focuses on establishing clear protocols, providing consistent training and support, and fostering effective teamwork between volunteers and professionals. In doing so, it aims to elevate Croatia's SAR effectiveness to a level comparable to high-performing systems internationally.

5.2. Key Components of the Proposed Framework

The proposed framework brings together core elements that address the institutional, operational, and community-related dimensions of volunteer integration in maritime SAR operations. These elements include: (1) a legal and policy structure; (2) standardised training and certification; (3) a centralised coordination mechanism; (4) equipment and resources allocation; (5) integration into emergency plans; and (6) community engagement and continuous improvement.

The first component is a legal and policy structure that would formalise the National SAR Volunteer Corps through legislation or a government directive. This designation would grant volunteers recognised status during operations. Policies under this component include volunteer activation protocols, integration into the command hierarchy (e.g., volunteers fall under the tactical command of the SAR incident commander when deployed), and safety regulations (such as requiring volunteers to wear identifiable protective gear and follow commands immediately). This component ensures all stakeholders understand the rules when volunteers are involved. A critical precondition for any volunteer activation is the resolution of liability and insurance. The Croatian Maritime Code already establishes the right to state-backed insurance in the event of death or injury during SAR actions (Pomorski zakonik, 2019); however, this provision remains practically unimplemented. The framework requires that implementing regulations formally activate this insurance mechanism prior to any pilot deployment. This mirrors the practice in Nordic countries, where formal insurance coverage is treated as a structural prerequisite for volunteer participation rather than an administrative afterthought (Nahkur et al., 2022).

A standardised training programme, administered by a central entity, ensures that all SAR volunteers meet consistent competency standards. The programme will offer courses at multiple levels, from basic SAR introduction for new volunteers to advanced specialisation modules. Training includes theoretical modules and practical exercises aligned with international SAR standards. Upon completion, volunteers receive certification and are entered into the national SAR volunteer database. This approach ensures uniform competency levels across all regions, addressing the current inconsistent preparedness. It also gives professionals confidence that any certified volunteer has a verified skill set (Prytz et al., 2023).

The framework introduces an integrated coordination system for volunteer deployment by establishing a Volunteer Coordination Centre (VCC) within Croatia's MRCC. All communications and operational integration of volunteers will be managed through this dedicated channel. In practice, when an incident occurs, the MRCC's incident manager will be able (via the VCC liaison) to dispatch volunteer teams just as they dispatch coast guard vessels or helicopters. Volunteers will be grouped into units (with team leaders) for organisational purposes. For example, a "Coastal Volunteer Team A" could consist of 5–10 volunteers in Split with one designated leader; when mobilised, they report as a unit. The integrated coordination mechanism ensures that every volunteer action is logged and guided, preventing uncoordinated efforts. It also prevents duplication of effort (volunteers and professionals unknowingly covering the same area) and fills gaps (directing volunteers to areas professionals cannot cover immediately). A centralised system can also coordinate inter-regional support: if a major incident overwhelms one region, volunteer teams from elsewhere can be routed to assist, much like fire brigades are mobilised nationally for large wildfires.

Access to suitable vessels and basic safety equipment is essential for volunteers operating at sea. The framework calls for volunteer teams to be equipped with standard kits supplied or funded by the state. It would establish caches of SAR volunteer equipment at strategic locations (e.g., coastguard stations or local fire stations in coastal towns). Additionally, volunteer boat owners who join the programme could receive subsidies or equipment (such as marine radios and GPS devices) to enhance their vessels' SAR capability. By investing in equipment, the framework recognises volunteers as a formal part of the SAR resource pool. This component will likely require budget allocations, but public–private partnerships may be possible (for example, local maritime businesses donating equipment, or EU resilience funds covering costs). In

Hungary's HUSZÁR team case, support from authorities in providing resources was key to their operation. Likewise, Croatia must ensure volunteers are not left to acquire gear on their own (Hábermayer and Horváth, 2020).

Beyond equipment, volunteers must be integrated into emergency plans at all levels of SAR planning. National and local SAR response plans should include sections on volunteer utilisation. During annual SAR drills or exercises, volunteer participation should be included as standard practice. This normalises volunteers as part of the SAR ecosystem. The framework could also encourage the inclusion of volunteers in related domains, such as search and rescue in disaster scenarios (earthquakes, floods), since many skills overlap. This would maximise the utility of the trained volunteer force.

Finally, the framework emphasises building a positive feedback loop with the community through continuous improvement mechanisms. It will establish channels for volunteers and citizens to provide feedback after incidents. "Lessons learned" sessions can be conducted that include volunteer perspectives. Data collected through the coordination mechanism (e.g., volunteer response times, number of volunteer hours contributed, outcomes) will be analysed to demonstrate impact and identify areas for improvement. Documenting and sharing volunteer contributions can foster public support and volunteer motivation. The framework encourages periodic review and adaptation, evolving with experience and as new technologies emerge.

5.3. Implementation Strategy

Implementing this comprehensive framework is a multi-step process that can be analytically structured into a sequence of implementation phases:

Phase 1: Planning and stakeholder alignment: a dedicated task force comprising SAR authorities, volunteer organisations, and legal experts should develop the framework's operational details. During this phase, the necessary legal changes will be drafted. Partnerships can also be explored – for example, with Norway or other countries for knowledge exchange, or with NGOs experienced in volunteer training (Welcome to the Norwegian Society for Sea Rescue - Redningssekskapet, n.d.; Forside - Hovedredningsentralen, n.d.). By the end of this phase, there should be a clear roadmap, including pilot region selection and resource estimates.

Phase 2: Pilot programme rollout: Croatia's maritime search and rescue (SAR) service is coordinated nationally by the MRCC Rijeka, supported by regional Maritime Rescue Sub-Centres (MRSCs) in key coastal cities, including Split (Ministarstvo Mora, Prometa i Infrastrukture Republike Hrvatske - Traganje i Spašavanje Na Moru 195 / Ustrojstvo / NIS, n.d.). To evaluate the proposed volunteer integration framework under operational conditions, pilot implementations should be conducted in two strategically selected regions aligned with the existing SAR structure. The central Adriatic, coordinated through MRSC Split, is characterised by dense maritime traffic, numerous islands, and intense recreational boating activity. A pilot in this region would integrate trained volunteer units into MRCC-directed operations to test alerting procedures, command communication, and joint exercises. The northern Adriatic, under the jurisdiction of MRCC Rijeka, includes busy port approaches and frequent cross-border traffic. A pilot in this region would assess volunteer participation in a complex coordination environment, focusing on mobilisation procedures, communication with professional units, and operational responsiveness.

Phase 3: Evaluation and refinement: after an initial period (e.g., one year of pilots), an evaluation should be conducted. This includes hard metrics (number of incidents where volunteers were used, reduction in response times, etc.) and soft feedback (surveys or interviews with professional SAR personnel about volunteer performance, and with volunteers about their experience). For example, if the evaluation finds that volunteers significantly sped up search operations in two cases of missing swimmers, but that certain communication protocols were unclear or inefficient, the framework can then be refined to address these shortcomings before broader deployment. Scalability will also be assessed: what resources are needed to replicate the pilot's success across the entire coastline? A scalability analysis will consider factors such as how many full-time staff the VCC needs when covering all regions, ongoing training throughput required, and costs for equipment if expanding from 100 volunteers to 1,000. Evaluation should track both quantitative and qualitative indicators. Quantitative metrics include: volunteer mobilisation time from alert to on-scene arrival; number of SAR missions with documented volunteer involvement; incident response times in pilot areas compared to pre-pilot baseline; and volunteer retention rates at 12 and 24 months. Qualitative indicators include: structured feedback from MRCC personnel and volunteer team leaders on communication effectiveness and command integration; and participant assessments from joint exercises. Feasibility metrics should additionally cover cost per trained volunteer, incident reports related to volunteer safety, and documentation of data-processing procedures compliant with applicable data protection legislation, including Regulation (EU) 2016/679 (GDPR), particularly regarding the processing of personal data for public interest tasks. This phase ensures that when the framework is implemented nationally, it is robust and adjusted for any region-specific differences.

Phase 4: Nationwide Implementation: with refined protocols and demonstrated pilot success, the framework can be rolled out to all coastal counties in Croatia. This likely involves establishing regional volunteer coordination structures aligned with existing SAR infrastructure. National databases and communication systems will become fully operational. A public launch could recruit more volunteers nationwide, leveraging media to highlight positive outcomes from the pilot phase. As the framework becomes operational nationwide, continuous monitoring will remain in place. Over the years, as the volunteer network grows and matures, it will be important to maintain quality. Periodic retraining and strict adherence to standards will prevent complacency.

5.4. Anticipated Challenges and Solutions

Anticipating potential implementation challenges is essential to ensure that the proposed framework remains effective and adaptable in practice. Several institutional, organisational, and operational issues may arise during deployment, each requiring targeted mitigation measures.

A central challenge is resource allocation, which includes securing sufficient funding and resources for training, equipment, and coordination personnel. Given current government budget constraints, innovative funding approaches may be necessary. Potential solutions include accessing European Union funding instruments, particularly those supporting civil protection capacity building, and engaging corporate partners to support specific infrastructure elements, such as communication systems. Emphasising the relatively low cost of volunteer integration compared to its potential benefits (e.g., lives saved and reduced damage) may further justify public expenditure. Public-private partnerships could also play a complementary role.

Cultural resistance from professional SAR personnel or administrative structures may arise, particularly where volunteer involvement is seen as a challenge to established practices. Addressing such resistance requires structured change-management strategies, including transparent communication of the rationale for volunteer integration, reliance on empirical evidence and comparative experiences, and the active involvement of sceptical stakeholders in planning processes. Targeted training for professional responders on working with volunteers, along with the visibility of early successes, can further support cultural acceptance.

While attracting volunteers is an important initial step, maintaining long-term engagement presents an equally significant challenge. Volunteers may lose motivation if they feel under-utilised or unappreciated, or conversely if the demands become excessive. The framework therefore incorporates mechanisms to support volunteer well-being and motivation, including regular meetings, opportunities for skill development, and formal recognition of service. Careful task assignment – aligned with volunteer training and capabilities – is essential to prevent burnout and ensure safety. Research consistently shows that a sense of belonging and visible impact are key motivators for sustained volunteer participation, underscoring the importance of feedback and recognition (Breen et al., 2024).

Finally, logistical complexities must be addressed. Croatia's extensive and geographically diverse coastline introduces additional logistical challenges. Implementing uniform operational arrangements across mainland and island regions may be complicated by connectivity limitations, transportation constraints, and uneven volunteer availability. To address these issues, the framework emphasises flexibility in operational design. In remote areas, radio communication may remain the primary coordination tool, while training delivery may require mobile teams capable of reaching island communities. Although the scale of response may vary by location, maintaining a structured and predictable operational model remains essential.

5.5. Operational Implementation Considerations for Croatia

Transitioning the proposed volunteer integration framework from pilot implementation to sustained practice entails operational considerations related to deployment, interoperability, and scalability in the Croatian maritime SAR context.

Geographic deployment should follow a phased approach. Following validation through pilot implementation, volunteer units could be progressively deployed along the Adriatic coast using a standardised density-based model (e.g., one unit per defined coastal segment). Deployment would be anchored to existing SAR infrastructure, ensuring alignment with MRCC and MRSC command structures. Priority would be given to geographically embedded volunteer pools, particularly island and coastal communities and existing maritime or rescue-related associations, to leverage local knowledge and ensure rapid initial response capability.

Standardised interoperability and system integration are essential for sustainable volunteer involvement, requiring full interoperability with existing SAR communication and dispatch systems. Certified volunteer units should operate under standardised radio protocols, share real-time positioning data, and be fully integrated into MRCC-led coordination workflows.

From an operational perspective, volunteers must be treated as formal SAR assets once activated, operating within established command hierarchies and communication channels to ensure safety, accountability, and efficiency.

Scalability and adaptability must be considered for national rollout. Expansion planning should account for regional variations in geography, population density, volunteer availability, and seasonal traffic intensity. Logistical models may differ between island-dominated regions and major port areas, requiring flexible deployment strategies. The overarching objective is to enhance system-wide SAR capacity through volunteer integration without imposing disproportionate coordination or resource burdens on professional services.

6. CONCLUSION

This study examined volunteer integration in coastal Search and Rescue (SAR) operations, contrasting Norway's well-established model with Croatia's evolving system. Through this comparative analysis, the benefits of structured volunteer involvement were identified, as well as the gaps and challenges hindering such integration in the Croatian context. These insights informed the development of an operationally grounded framework designed to bridge legal provisions and real-world SAR practice in Croatia by strategically engaging community volunteers.

Although the Croatian Maritime Code (cro. Pomorski zakonik, NN 17/19) formally recognises volunteers as participants in maritime SAR operations, this legal framework remains largely unimplemented. National protocols, formal agreements, standardised training programmes, and coordination mechanisms are currently lacking, rendering the legal provisions ineffective in practice. Consequently, volunteer involvement remains sporadic and informal. This discrepancy between legal intent and operational reality underscores the need to translate policy into actionable measures – a core focus of the proposed framework. Norway's model demonstrates that with supportive legislation, standardised training, and cohesive coordination, volunteers can serve as a highly effective extension of official SAR services. Inspired by these lessons, the comparative analysis led to the development of a targeted framework for Croatia to institutionalise volunteer integration. The framework includes legal protections, national training standards, and a centralised coordination mechanism to align volunteers with professional responders. Pilot implementation is expected to demonstrate the feasibility of the framework and generate operational insights applicable across diverse coastal conditions. Once implemented across Croatia's entire coastline, the model could significantly enhance SAR performance by leveraging local knowledge, improving coverage, and accelerating emergency response. Future research should evaluate the outcomes of pilot implementations, assess long-term volunteer retention, and explore the applicability of the framework in other maritime regions with similar challenges.

CONFLICT OF INTEREST

Authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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