Review



# Tactical Approaches to Protection and Rescue in Traffic Accident-Induced Disasters

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*Article*

# Tactical Approaches to Protection and Rescue in Traffic Accident-Induced Disasters

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**Abstract:** This study delves into the complex challenges that arise when managing rescue operations in the aftermath of traffic accidents spanning various forms of transportation, including roads, railways, aviation, and waterways. Given the inherent complexity of traffic-related disasters, these events typically necessitate well-coordinated rescue strategies, involving the collaboration of multiple emergency services and the use of specialized equipment. The legal framework set forth by the Republic of Serbia plays a pivotal role in shaping the procedures and responsibilities within these rescue efforts, guiding the allocation of resources, enforcing safety protocols, and ensuring effective coordination between different agencies. Moreover, the incorporation of innovative technical solutions is critical in successfully extricating victims from perilous situations. This paper also underscores the vital importance of preventive measures, particularly in road traffic, which are mandated by national legislation. The establishment of specialized investigative bodies, such as the Traffic Accident Investigation Center, has greatly enhanced the systematic approach to preventing future incidents. By examining the various components of rescue operations, this research highlights the essential role of timely and efficient interventions in minimizing casualties and mitigating the broader impacts of traffic disasters.

**Keywords:** traffic accidents; disaster management; rescue operations; emergency response; transportation safety; legal framework; accident investigation; Serbia

## 1. Introduction

Traffic-related disasters encompass a broad spectrum of incidents that can be both severe and extensive, spanning across roadways, rail systems, air travel, and water transportation networks (Cvetković, 2020; Cvetković, 2024b; Sam, Blay, Antwi, Anaafi, & Adoma, 2019). These disasters can lead to significant and widespread repercussions, affecting not only the individuals directly involved but also broader societal structures (Cvetković, 2023; Cvetković & Nikolić, 2023; Cvetković et al., 2023; Cvetković & Šišović, 2024; Zheng, Wang, Zhu, & Jiang, 2020). Transportation is undeniably a fundamental pillar of everyday life, playing a vital role in the continuity and functionality of any living environment (Qin, Zhang, Jiang, Du, & Liu). This necessity is on par with other critical aspects of life, such as employment, housing, and recreation, all of which contribute to the overall well-being and survival of communities (Cvetković, 2020, p. 123). Furthermore, Lipovac (2008, p. 4) provides a specific definition of road traffic accidents, describing them as events occurring on roads or other areas accessible to traffic, involving at least one moving vehicle. These incidents result in either physical injury to individuals or damage to property (Cvetković & 2013; Cvetković & Milašinović, 2017; Cvetković & Svrdlin, 2020; Kumar, Lang, Ziar, & Singh, 2022). While many accidents might have limited effects in terms of health, economic consequences, and social impact, there are certain events, by virtue of their severity, that escalate to the level of full-scale disasters Grozdanić & Cvetković, 2024; Sretenović, Cvetković, & Milkovski, 2024).

The Law on the Investigation of Accidents in Air, Railway, and Waterway Transport (Official Gazette of the Republic of Serbia, 83/2018) delineates definitions for various traffic-related disasters

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(Article 3). Specifically: a) a railway traffic accident pertains to an incident connected with train operations or shunting activities that compromises traffic safety. These incidents are often characterized by unexpected or undesired events, or even a series of such occurrences, leading to detrimental outcomes such as collisions, derailments, level crossing incidents, accidents involving individuals struck by moving railway vehicles, fires, and other similar consequences; b) a serious air traffic incident is defined by the presence of circumstances that suggest a high probability of an accident occurring. This definition applies to crewed aircraft from the moment an individual boards with the intention to fly until all passengers have disembarked. In the case of uncrewed aircraft, the incident timeframe extends from when the aircraft is ready to commence takeoff until it comes to a complete stop and the propulsion system has been shut down; c) a serious maritime accident refers to incidents that transpire at sea and may involve fires, explosions, collisions, groundings, impacts, or structural failures. These incidents result in severe operational disruptions, extensive damage to the vessel's superstructure or hull, rendering the vessel unseaworthy, or causing significant environmental contamination through the release of over 50 tons of oil, petroleum derivatives, or other hazardous materials. Such damage often necessitates towing or other forms of assistance from shore-based facilities; d) a serious inland waterway accident describes an extraordinary event occurring on navigable inland waters. Such incidents take place during navigation or the utilization of a vessel, waterway, or related infrastructure, leading to the total loss of the vessel, fatalities, serious injuries, or significant environmental damage, often due to the release of over 50 tons of oil, petroleum products, or other dangerous substances; e) an air traffic accident involves any event related to aircraft operations. For crewed aircraft, this period extends from the time an individual boards the aircraft with the intention of flying until all passengers have disembarked. For uncrewed aircraft, it encompasses the timeframe from when the aircraft is prepared for movement before takeoff until it has come to a full stop, and the propulsion system has been deactivated (Cvetković, 2024b).

A thorough analysis of numerous traffic accidents across road, rail, air, and water transportation systems reveals several critical factors that are essential for protection and rescue operations. These factors include: a) the occurrence of a large number of injuries and fatalities; b) the necessity of strictly adhering to established protection and rescue protocols due to the inherent complexity and danger of such situations; c) the presence of multiple hazards that pose risks to both victims and rescuers within the accident area; d) the deployment of a wide range of general and specialized equipment to effectively address the situation; e) the need for efficient and coordinated collaboration among various emergency response and rescue services; f) the provision of logistical, administrative, and technical support to ensure the success of operations; and g) the importance of implementing innovative technical solutions to facilitate the rescue of individuals, among other considerations (Cvetković, 2024b).

## 2. Comprehensive Organizational Strategies and Protective Measures for Traffic Accident Induced Disasters

The Law on Road Traffic Safety (Official Gazette of the Republic of Serbia, 128/2020, Article 1) defines preventive and protective measures in road traffic within a comprehensive legal framework. This legislation is designed to ensure the secure functioning of road transportation systems. It thoroughly regulates every aspect of road safety, covering the organization of traffic systems, the application of traffic laws, and the expected behavior of all participants in road traffic. The law also specifies the duties and responsibilities of authorities responsible for traffic safety. Additionally, it addresses various traffic restrictions, the proper utilization of traffic signals and signs, and the adherence to rules established for all road users. The law outlines the criteria that drivers must satisfy to legally operate vehicles, the processes for driver education and licensing, and the technical standards vehicles need to meet. It also governs vehicle registration and inspection procedures. Moreover, it includes special measures and grants specific powers to traffic safety officers, alongside other critical aspects necessary for maintaining safety on the roads (Cvetković, 2024b).

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Beyond these legal measures, contemporary passenger vehicles come equipped with sophisticated safety technologies aimed at minimizing the impact of traffic accidents (Wang, Zhong, Ma, Abdel-Aty, & Park, 2020). For example, reinforced components within the wheels and chassis are designed to redirect and absorb impact forces during collisions. Additionally, vehicles are fitted with crumple zones that efficiently distribute crash energy, reducing the force felt by passengers. Reinforcements in the roof, doors, and structural pillars provide further protection in case of accidents. Other advanced safety systems, such as airbags and seatbelt pretensioners, play crucial roles in enhancing passenger protection. The use of specialized laminated glass helps to reduce the risk of injuries from shattered windows. These innovations in automotive safety represent significant strides toward reducing both the frequency and severity of injuries in traffic incidents (Cvetković, 2024b).

The creation of the Traffic Accident Investigation Center in Serbia marked a pivotal step forward in establishing a systematic approach to accident investigation and prevention. This Center operates as an independent entity with the authority to conduct thorough investigations into serious incidents across multiple transportation modes, including air, rail, and water transport, as well as significant maritime accidents. Located in Belgrade, the Center operates independently, both financially and operationally, from the government bodies that oversee air, rail, and waterway traffic. Furthermore, it maintains independence from any legal or natural persons whose interests could potentially conflict with the Center's mandate to conduct unbiased investigations. This autonomy allows the Center to carry out its work free from external influences, focusing on enhancing transportation safety through its investigative efforts (Official Gazette of the Republic of Serbia, 29/2018) (Cvetković, 2024b).

At the heart of the Center's organizational structure is the position of the Chief Investigator, who acts as the head of this specialized institution. The Chief Investigator is appointed by the Government for a five-year term based on the Prime Minister's recommendation. To be considered for this role, candidates must possess substantial experience—at least nine years of professional work in air, rail, or water transport, with a minimum of three years dedicated specifically to safety operations and accident investigations. Supporting the Chief Investigator is a team of specialized deputies, each concentrating on a different transportation mode—air, rail, and water. This hierarchical structure ensures that the Center is equipped with the necessary expertise across all sectors of transportation, enabling it to effectively address the complex challenges posed by various types of accidents and incidents (Official Gazette of the Republic of Serbia, 29/2018, Article 6).

The Center is tasked with a broad array of responsibilities, as stipulated in the relevant legislation (Official Gazette of the Republic of Serbia, 29/2018, Article 7). In the realm of air transport, the Center's primary duty is to uncover the root causes of accidents and serious incidents. By identifying these causes, the Center can offer targeted safety recommendations designed to prevent similar occurrences in the future, thereby enhancing overall air traffic safety. The Center maintains an extensive database of air traffic accidents and incidents, which it analyzes in detail. The results of these analyses are shared with the European Commission's central database and other relevant national and international investigative bodies, ensuring that safety lessons are widely disseminated. Additionally, the Center actively participates in international conferences and seminars, sharing its research findings and continuously engaging in professional development (Cvetković, 2024b).

In railway transport, the Center's role involves investigating major accidents within the railway system to determine their underlying causes and recommend improvements for enhancing safety. The Center is also responsible for examining other incidents that, while not immediately serious, have the potential to escalate into more severe accidents if left unaddressed. By compiling a comprehensive database of railway accidents and incidents, the Center is able to identify trends, produce detailed reports, and issue safety recommendations. These findings are shared with the European Railway Agency (ERA) and made publicly available, contributing to broader efforts to enhance railway safety across Europe. The Center's involvement in international safety forums and professional development activities ensures that it stays at the forefront of best practices in railway accident investigation (Cvetković, 2024b).

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In the maritime and inland waterway sectors, the Center carries out safety investigations into serious maritime accidents and incidents with the aim of identifying their causes and proposing preventive measures. The Center's work focuses particularly on very serious maritime accidents, especially those that pose significant threats to safety and the environment. The Center collaborates with international organizations by sharing findings through the European Marine Casualty Information Platform (EMCIP) and contributing to global efforts to improve maritime safety. In the context of inland waterway transport, the Center's investigations target serious accidents, with an emphasis on preventing future incidents through the issuance of safety recommendations. The Center's reports and findings are made available to the relevant authorities, ensuring transparency and accountability in its investigative work (Cvetković, 2024b).

As part of its mission, the Center issues safety recommendations based on the data analysis and results of its investigations. These recommendations are intended to improve safety practices across all transportation sectors but are not used to assign legal liability for accidents or incidents. The recommendations are directed to the Directorate and, when necessary, to other relevant authorities and organizations in Serbia, as well as to international bodies. It is the responsibility of the Directorate and these entities to consider and act upon the recommendations. Furthermore, organizations receiving safety recommendations are required to submit annual reports to the Center, detailing the measures they have implemented or plan to implement based on the recommendations made in the previous year (Official Gazette of the Republic of Serbia, 29/2018, Article 35) (Cvetković, 2024b).

## 3. Coordinated Rescue Operations Management in Traffic Accident-Induced Disasters

Rescue operations that involve freeing individuals from severely damaged vehicles are recognized as some of the most intricate and demanding tasks faced by emergency responders. The Law on the Investigation of Accidents in Air, Railway, and Water Transport (Official Gazette of the Republic of Serbia, 83/2018) establishes a detailed legal framework that governs the investigation of accidents and significant incidents across various modes of transport. This framework defines the scope of responsibilities and the authority granted to investigative bodies, as well as the procedures to be followed during investigations involving air, rail, and water transport accidents, including serious maritime and inland waterway incidents (Cvetković, 2024b).

In the context of rail transport, managing incidents can be particularly challenging for those directing rescue operations, especially when large numbers of passengers are involved and when the structural steel components of trains become heavily deformed, making them difficult to cut or manipulate. A notable example of such complexity is the tragic derailment of a passenger train near Bioča, Montenegro, in 2006, which resulted in 47 fatalities and approximately 200 injuries. Incidents of this magnitude necessitate the deployment of extensive emergency response and rescue teams, armed with a broad array of general and specialized tools (Cvetković, 2024b).

Rail accidents become even more complex when they occur in challenging environments, such as tunnels, bridges, or other hard-to-reach locations, significantly complicating rescue efforts. The presence of hazardous materials transported by train introduces additional risks, requiring not only the execution of rescue operations but also the identification and neutralization of dangerous substances. Safety protocols must be strictly adhered to, and timely communication with the public about potential dangers is crucial. Before any rescue operation can commence, it is essential that responders ensure the proper use of personal protective equipment and take measures to prevent further harm to the injured. It is also vital to confirm that the electrical power has been disconnected, the contact network de-energized, and adequate grounding established (Cvetković, 2024b).

The Regulation on the Investigation of Accidents in Railway Transport (Official Gazette of the Republic of Serbia, 58/2019) provides detailed guidelines for reporting rail accidents and incidents and outlines the steps involved in the investigation process, which is overseen by the Traffic Accident Investigation Center. This regulation also addresses the implementation of safety recommendations and the ongoing monitoring of their effectiveness. When an accident or incident is reported, a decision is made regarding the necessity of an on-site investigation, based on the initial report's details. The Traffic Accident Investigation Center and relevant authorities are tasked with completing

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the on-site investigation as efficiently as possible, allowing the infrastructure manager to quickly repair any damage and restore normal rail operations (Articles 6 and 7).

Investigating railway transport accidents involves several critical tasks. In the event of a collision or near-collision of trains, investigators document all locomotives and rail cars involved, assess the condition of the braking systems—including indicators, whether brake pads are engaged or released, and their positioning on the wheels—and evaluate the braking methods used by the train. Additionally, speedometers on locomotives are inspected to verify functionality, and speedometer recordings are analyzed to determine if any emergency braking or abrupt movements occurred during the journey. The condition of the locomotives prior to the accident is assessed, along with the number of individuals present in the control cabin with the train operator, among other factors (Cvetković, 2024b).

During traffic accidents, the leaders of rescue operations must be thoroughly acquainted with the safety and protective features of modern vehicle technologies. When extricating individuals from vehicles, hydraulic shears must be correctly positioned with the blades fully opened. Special care should be taken regarding airbags that may deploy post-collision if they have not yet activated. To mitigate this risk, rescuers should secure the steering wheel with protective covers. When using hydraulic cutting tools, it is recommended to cut at a 90-degree angle relative to the axis of the object being cut. Strict safety protocols must be observed, including: a) only one person should operate the hydraulic tool at a time; b) rescue teams must be well-trained and familiar with general safety procedures when using cutting tools; and c) after the rescue operation is completed, all tools must be thoroughly cleaned, lubricated, and stored properly for future use (Cvetković, 2024b).

Various scenarios necessitate rescue operations to mitigate the consequences of traffic accidents, including vehicle collisions, rollovers, accidents at rail crossings, hazardous material spills, vehicle fires, vehicles that have fallen off steep slopes, vehicles buried by avalanches, and vehicles submerged in water. Conducting emergency rescue operations at vehicle accident sites requires specialized equipment, such as fire extinguishers, tools, and machinery for lifting and moving heavy objects, cutting metal, and freeing trapped structures. Additional equipment includes tools for locating victims and vehicles, lighting and communication devices, first aid kits, evacuation equipment, life support systems for underwater operations, and tools for collecting and decontaminating hazardous materials. Depending on the accident's specific circumstances, equipment for rescuing people from heights or difficult terrain may also be necessary. Different rescue teams may be deployed based on the incident's characteristics (Kusainov, 2013). In traffic accidents, emergency rescue sites are typically divided into three zones. The first zone, within a 5-meter radius of the accident, is where specialists involved in direct victim assistance are positioned. The second zone, extending to a 10-meter radius, houses other rescue team members who ensure the readiness of emergency equipment. The third zone, located beyond 10 meters from the accident, contains transport vehicles for rescuers, lighting, fencing, and additional emergency technical equipment (Cvetković, 2024b; Кусаинов, 2013).

The incident commander, who manages all personnel and technical resources during the operation, plays a crucial role in coordinating the response. This individual is usually appointed at the start of the operation, and all units reporting to the scene are required to coordinate with them. The incident commander organizes the workflow, ensures personnel safety, and secures the necessary rescue equipment. If a rescue team leader or traffic police officer arrives at the scene before the designated commander, they take temporary control of the operation until the commander arrives. Key responsibilities of the commander include conducting an on-site assessment, organizing the immediate rescue of victims while preventing panic, utilizing resources effectively, determining the course of action, allocating tasks to sub-units, and ensuring the completion of all assigned tasks. The primary goal is to extricate the injured from the vehicle and provide first aid. If necessary, a medical aid station should be established at the scene. The commander must also maintain communication with the dispatch center, providing updates on the situation and the resources used or needed, with ongoing communication throughout the operation (Cvetković, 2024b; Кусаинов, 2013).

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In the early stages of rescue operations, efforts focus on helping victims who are not fully trapped but are stuck in deformed vehicle cabins and can be extracted through open windows, hatches, or doors, either independently or with the aid of rescuers. Bent vehicle parts are then loosened, and metal components are cut or removed as necessary (Yue, Abdel-Aty, Wu, & Wang, 2018). Openings may be created in the vehicle's body, roof, or floor, and in some cases, the entire roof may be removed. The vehicle might also be lifted with jacks or excavated from beneath to free trapped victims. Rescuers must remain alert throughout the operation and ready to extinguish any fires that may ignite, particularly when using powered tools (Cvetković, 2024b; Кусаинов, 2013).

In railway accidents, once rescuers have entered a train car—whether passenger or freight—they access the interior through secured entry doors that can be opened from the inside or outside. If doors are jammed, metal cutting tools and specialized equipment are used to clear a path. Rescuers use ladders or aerial ladders to enter through windows, employing other suitable tools as needed. In some situations, rescuers may be pulled through windows, while in others, sharp glass fragments must first be cleared. Once inside, rescuers begin locating and aiding injured passengers. When victims are trapped under vehicles, heavy-duty cranes may be employed to lift the vehicles and free the individuals beneath. In some cases, tunnels must be dug, or structural barriers cut through to access victims. Fires in train cars pose significant risks to passengers, as flames can spread quickly through the interior, structural voids, and ventilation systems (Cvetković, 2024b; Кусаинов, 2013).

Rescuers have several critical duties when responding to fires in passenger trains. These include quickly locating and evacuating passengers to a safe location, searching for any passengers who may have fled the train, and extinguishing the fire. Snow, landslides, rockslides, avalanches, mud, and water can also cause passenger trains to halt unexpectedly. In such instances, rescuers must locate the victims, free them, and provide necessary assistance. When firefighters and rescuers are dispatched to railway fire incidents, their main responsibilities are assisting victims, extinguishing the fire, protecting nearby trains and infrastructure, and preventing environmental damage (Cvetković, 2024b).

When tankers containing flammable liquids catch fire, flames can reach heights of 40-50 meters, and the fire may spread over an area of more than 150 square meters. In these situations, it is essential to cool the tanks with water. The tank's lid should be secured beneath the barrel cover, or a tarp placed over it if vapors ignite above the tank's open throat. Spilled liquids should be directed into trenches or absorbed into the ground to mitigate risk, after which they can be safely collected. If multiple tanks are burning simultaneously, the focus must be on cooling the tanks and ensuring the safety of nearby vehicles and structures (Cvetković, 2024b; Кусаинов, 2013).

If there is a risk of fire spreading to adjacent trains, the burning tank must be relocated to a safe area and promptly neutralized. Firefighting efforts should be conducted from protected positions, especially when dealing with compressed or liquid gas cylinders. While it may be difficult to prevent gas flare-ups entirely, controlled burning is permissible as long as the tank is continuously cooled with water to reduce the risk of explosion. When fires involve trains carrying toxic, poisonous, or explosive materials, specific actions must be taken: relocate the burning train to a safe area, extinguish the fire with powerful water jets, coordinate efforts with those overseeing the cargo, and cover the barrel with a tarp. When multiple tanks are burning, cooling and protecting nearby vehicles and tanks are the priorities (Cvetković, 2024b; Кусаинов, 2013).

In the event of an aircraft accident near an airport, the airport management is immediately responsible for organizing search and rescue operations for the crew and passengers, involving aviation units and other relevant services, such as fire-rescue, medical, engineering, transport, and police teams. The primary action typically involves evacuating passengers from the aircraft. According to the International Civil Aviation Organization (ICAO), during an aircraft accident, all passengers must use emergency exits on one side of the aircraft's fuselage, and they must complete the evacuation within 90 seconds (Cvetković, 2024b).

Planning rescue operations for aircraft fires requires consideration of several critical factors, such as the rapid increase in carbon dioxide levels inside the cabin, which can reach fatal concentrations within 2-3 minutes of the fire starting (Furlan et al., 2020). Cabin temperatures can also rise sharply,

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necessitating firefighting operations to be conducted using protective insulation gear. It is crucial to evacuate passengers while simultaneously fighting the fire from the windward side. Due to the permeability of various openings, it is recommended to remove the aircraft doors first. If an aircraft emits a distress signal or an emergency beacon is triggered by the radio station, search and rescue operations are initiated. The same applies if the aircraft fails to reach its destination within 10 minutes of the scheduled arrival time and loses radio contact with the ground (Cvetković, 2024b; Кусаинов, 2013).

Search and rescue operations begin once orders are given for the aircraft to take off, and instructions are issued to start ground search and rescue efforts (Cvetković & Miljković, 2024; Cvetković & Miljković, 2024a, 2024b). Rescuers locate the crash site of the airplane or helicopter, and once on the ground, they start searching for survivors and transporting them to safe locations. These efforts can be complicated, as rescuers must ensure the survival of victims, protect them from the elements, and provide basic medical care. Once the bodies of the deceased are cleared from the disaster area, recovery operations, including the collection of remains for identification, can commence. If all passengers perished in the crash, rescuers are also responsible for locating and securing the bodies, recovering the "black boxes," and safeguarding any valuables. Apart from external inspections, confirming the aircraft's presence on the ground, and evacuating the injured and deceased, no further activities should occur at the crash site until the chief investigator arrives and initiates the accident investigation. Moving the aircraft before the investigative commission arrives is only permitted if the wreckage obstructs a railway, highway, river, or airport, hindering the safe movement of vehicles or aircraft on essential infrastructure (Cvetković, 2024b; Кусаинов, 2013).

Water-based accidents present unique challenges, given the variety of vessels with differing purposes, performance characteristics, and speeds; the dynamic nature of water as an element; the transportation of hazardous and harmful substances; and the difficulty of locating vessels in distress, often far from emergency rescue services. Rescue operations in waterborne accidents require coordinated efforts between various specialized teams, including search and rescue services and units that are specially trained and certified. Common causes of accidents in water transport include loss of stability, which can lead to capsizing, loss of buoyancy, collisions with other vessels or obstacles (such as reefs, underwater rocks, platforms, or icebergs), fires and explosions, and the release of hazardous materials from damaged vessels (Cvetković, 2024b; Кусаинов, 2013).

Each specific rescue operation requires the appointment of a search and rescue coordinator, who is responsible for overseeing the entire operation until it is completed or until it becomes evident that further efforts would be futile. This ensures unity of command throughout the process. The coordinator's duties include receiving and analyzing all available accident data, identifying the type of emergency equipment on the affected vessels, providing operational information regarding the water area and weather conditions, developing a detailed rescue plan, assigning commanders to the scene, coordinating search and rescue efforts, and organizing communication channels at the search site. The coordinator is also responsible for informing the head of the rescue coordination center about the action plan and ensuring coordination with neighboring rescue services. Additionally, they must oversee the delivery of necessary resources to the victims and maintain a chronological record of the rescue operation (Cvetković, 2024b; Кусаинов, 2013).

In the event of an air traffic accident, the Regulation on the Investigation of Accidents and Serious Incidents in Air Traffic outlines the procedures for conducting investigations, reporting accidents or serious incidents, providing information about individuals and hazardous materials aboard the aircraft, and maintaining databases of such incidents. The regulation also details the process for monitoring and implementing safety recommendations. When an investigation is initiated, details such as the location, date, and time of the accident or serious incident, the aircraft type and model, state of registration, registration number, crew information, fatalities, injuries, a brief description of the accident, probable cause, and safety recommendations (if applicable) are all included in the notification (Cvetković, 2024b).

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If an aircraft accident or serious incident occurs in a foreign country, and Serbia is the state of registration, design, manufacture, or operation, the Traffic Accident Investigation Center promptly acknowledges receipt of the notification and, upon request, provides the foreign country's competent authority with all available information about the aircraft and crew involved, as well as details about the designated authorized representative from the Center (Regulation, Article 5). The Center takes all necessary measures to read the aircraft's flight data recorders as soon as possible following the accident. If Serbia does not have the appropriate equipment for reading the flight data recorders, the Center will use equipment from a foreign country, considering the equipment's capabilities, the time required for the readings, and the equipment's location (Article 6).

## 4. Conclusion

Effectively managing rescue operations in the wake of traffic accident-induced disasters requires a multifaceted and well-coordinated approach. This approach integrates legal frameworks, cutting-edge technical solutions, and the combined efforts of various emergency response agencies. Whether these disasters occur on roads, railways, in the air, or on waterways, they present a complex array of challenges. The sheer scale of potential casualties, coupled with hazardous conditions, makes these situations particularly difficult to handle. Therefore, the strict observance of safety protocols, the readiness of well-prepared rescue teams, and the deployment of specialized equipment are all crucial elements that cannot be overlooked.

In the Republic of Serbia, the legal foundation for organizing and executing rescue operations is laid out in the Law on the Investigation of Accidents in Air, Railway, and Waterway Transport. This legal structure defines the roles and responsibilities of various agencies, sets out clear investigative procedures, and ensures that accountability is maintained throughout the rescue and recovery process. Such a legal framework is indispensable for ensuring that all stakeholders work together seamlessly during high-stress, time-sensitive situations.

This paper also highlights the pivotal role of preventive measures, especially in road traffic, which remains the most frequent and dangerous mode of transportation. National laws not only dictate the safety standards that must be adhered to but also enforce the adoption of advanced safety technologies in vehicles. These innovations—ranging from reinforced vehicle structures to sophisticated airbag systems—have proven instrumental in reducing the severity of injuries and fatalities when accidents occur. However, despite these technological advancements, the unpredictable nature of traffic accidents underscores the ongoing need for preparedness and quick, well-coordinated responses to minimize harm.

The creation of specialized entities, such as the Traffic Accident Investigation Center, represents a major advancement in the systematic approach to accident investigation and prevention. These organizations play a crucial role in strengthening safety protocols across all modes of transport. Additionally, they provide key insights into the causes of accidents, which can then be used to inform future prevention strategies. By maintaining their operational independence and focusing on thorough investigations, these centers contribute to meaningful improvements in transportation safety. However, the effectiveness of rescue operations extends beyond legal frameworks and technical innovations. Success hinges on having well-trained and well-equipped rescue teams that can respond efficiently and effectively to a wide range of disaster scenarios. The deployment of these teams, often in hazardous and unpredictable environments, requires careful coordination to avoid adding further risks to both the rescuers and the victims. Strong inter-agency collaboration, clear communication channels, and robust logistical support are fundamental components of any successful rescue effort.

Moreover, this paper emphasizes the ongoing need for innovation in rescue operations. New technologies, such as advanced extrication tools and enhanced protective gear, are vital for addressing increasingly complex accident situations, particularly those involving hazardous materials. Incorporating these technologies into standard rescue practices can significantly improve the effectiveness of response efforts and lead to better outcomes for those affected by accidents.

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traffic accident-induced disasters demand a strong and adaptable approach to rescue operations. By continually refining legal frameworks, advancing technical capabilities, and fostering collaboration among emergency response agencies, we can build a more resilient disaster management system capable of protecting lives and reducing the devastating impacts of these incidents. The lessons learned from past disasters should guide ongoing efforts to enhance disaster preparedness, response, and recovery, ultimately contributing to safer and more resilient transportation networks.

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