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Enhancing Capacity for Emergency Evacuation through Resource Matching and Coordinated Volunteerism

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Abstract

Many disaster-related large-scale evacuations occur each year, however, most local governments do not have the necessary resources, training or plans to transport individuals without a personal automobile out of a disaster zone. An analysis of previous research suggests that this risk could be addressed by a volunteer-supported, community-based disaster organization coordinating regional multi-modal transportation resources for disaster response. This study introduces and tests the idea of a Transportation Reserve Corps (TRC) by refining its objectives and functions while assessing its value and feasibility. Due to an assortment of potential challenges, a TRC as proposed may not be suitable or sustainable in all geographic or political contexts. Key challenges and other considerations are detailed and synthesized to yield key action steps for further inquiry. This research asserts that, if properly organized, a TRC could be an effective means of evacuating those who cannot self-evacuate during an emergency.

Keywords: *Multi-modal transportation planning, coordinated volunteerism, emergency evacuation, disaster response, disaster preparedness, carless households*

1. Introduction

Mandatory emergency evacuations, which occur hundreds of times each year [15], require all people, not only those with vehicular access, to be transported safely out of a disaster zone. Though local governments usually possess emergency plans with evacuation components, evidence suggests they do not have the organized vehicles and drivers, or the logistical capacity necessary to collect large numbers of people with buses and other vehicles under time constraints and distribute them to secure receiving destinations. This reality was revealed by the events following Hurricanes Katrina and Rita (2005) [28]. In recent years, the use of multi-modal transportation to execute large-scale evacuations has been seen as a potential solution. Several studies validate the benefits of maximizing multi-modal transportation for large-scale evacuation, but social, legal, institutional and logistical impediments have prevented thorough coordination and implementation of multiple transportation modes in large-scale evacuations [1, 2, 9, 35, 36, 48, 60].

Many local governments do not have the appropriate plans, training, and resources to evacuate households without automobiles [21]. As a result, there is an opportunity for emergency officials, planners and governments at all levels, as well as communities at large, to better coordinate transportation resources, both vehicles and operators, in the event of a

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large-scale emergency. However, a multitude of obstacles contribute to a region-wide logistical inability to gather the equipment and personnel needed to fully execute a large-scale evacuation called for by an emergency plan of a singular jurisdiction. When evacuees require specialized vehicles such as ambulances, accessible buses or vans for transport, evacuation procedures become more complex. Merely identifying, locating and acquiring the information necessary to provide transportation to special needs evacuees is a daunting task under the existing configuration of local emergency management [58].

A unique combination of elements is examined in this research project—disaster planning, large-scale evacuation, coordinated volunteerism and transportation planning for carless households—to identify and evaluate planning approaches for enhancing coordination and management of resources for multi-modal evacuation. Scholarly publications along with government plans and reports are analyzed to gain insight about current and best practices in evacuation transportation management and existing models of coordinated volunteerism and emergency response. Further research reveals a series of logistical, legal and geographical factors that influence local emergency response organizations.

Information gathered in this study suggests a missed opportunity for more robust integration of distinct approaches to disaster planning, large-scale evacuation, coordinated volunteerism and transportation planning for carless households as they relate to disaster preparedness, response, and recovery. This knowledge is used to test the efficacy of a model organization built to sustain emergency transportation needs through resource coordination in the event of a disaster. In doing so, this research bridges a divide between conceptual and practical research by providing a theoretical framework for a new volunteer evacuation corps that is grounded in a real-world context and transferable to a variety of settings.

2. Barriers to multi-modal Evacuation: A Review and Synthesis

In a review of emergency plans of the fifty U.S. states and seventy-five U.S. metropolitan areas, only five states and nine urban areas adequately addressed evacuation of households without automobiles [53]. The assessment also found that eighteen percent of states and only seven percent of metropolitan areas had incorporated all available modes of transportation into emergency plans [53]. Moreover, most plans failed to explicate how suitable transportation for the disabled would be ensured and managed during a large-scale evacuation [53]. In sum, findings suggest that the majority of emergency operations plans for large urbanized areas are only partially adequate in describing in specific and measurable terms how a major evacuation could be conducted for an entire population. Without detailed emergency plans, officials and responders must deploy resources in an ad hoc fashion; this has proven challenging and detrimental in past large-scale evacuations of carless populations [28].

The many factors stymying effective use of multi-modal transport resources for emergency evacuation can be categorized into five themes; the first is (1) *identifying and communicating with carless populations* [23]. Characteristics common among carless populations—including disability, isolation, age, poverty and language barriers—often impede communication between community leaders, government officials and individuals [29, 31]. Secondly, (2) *inventorying available transportation resources and matching these resources with evacuation demand* at a regional scale is necessary to systematically execute a large-scale evacuation [23], but is typically not undertaken by local officials [43]. A range of (3) *legal and practical constraints* that consistently arise when attempting to share valuable resources between organizations and jurisdictions (while producing emergency plans or executing a response to a disaster) forms a third grouping of barriers to multi-modal evacuation [23]. A fourth category of barriers to multi-modal evacuation pertains to (4) *inadequate funding for*

evacuation planning [23], which can be attributed to insufficient emergency preparedness funding for transportation agencies [19, 44], or an oversight of local jurisdictions to request such financial support [58]. The final category of barriers to multi-modal evacuation, (5) *lack of coordination and deficiencies in command structure*, is a two-fold challenge [23] involving (a) a lack of coordination between local and regional transportation providers in providing disaster response support [20, 50] and (b) a lack of collaborative intergovernmental processes in executing these resources [44].

Clearly, there is an opportunity to revise emergency plans produced by local governments so that they better provide travel accommodations for the carless during disasters [15, 58]. Government leaders have recognized that the involvement and cooperation of community members can be used as a critical resource in disaster preparedness and recovery [16]. A community engagement approach to disaster planning has brought about a new paradigm in emergency management that has been endorsed by such initiatives as the U.S. Presidential Policy Directive 8 and the Federal Emergency Management Agency (FEMA) "Whole Community" system [14]. This approach signifies a departure from an emergency management framework predominantly reliant on government assistance and instead strategically embraces the powerful, irrepressible relief that communities, when organized and authorized, can provide in disaster response [3]. Applying this model to multi-modal transportation support for disasters suggests a new organizational approach for enhancing community capacity to execute a large-scale evacuation. In the following sections of this article, we examine whether the formation of a community-based organization powered by volunteers is an effective model for providing evacuation transportation to those in need of such services.

2.1. Current Practices in Large-Scale Evacuation Transportation Support

Currently, although the potential benefits of coordinating multi-modal transportation resources for evacuation planning have been shown through scholarly research [1, 2, 9, 35, 36, 48, 60], plans incorporating such practices have not been sufficiently developed or rehearsed to establish a consensus set of best practices. Most states and cities in the U.S. (ninety percent and eighty-eight percent, respectively), according to the Department of Homeland Security, do not adequately describe in written emergency plans how to provide evacuation transportation to people without personal automobiles [53]. Consequently, many local emergency planning efforts rely on external transportation resources to effectively evacuate the entire population within a jurisdiction during an extreme event; but higher levels of governance typically do not provide assistance until local resources are overwhelmed by a disaster. This weakness in emergency planning has persisted despite a wealth of transportation providers capable of transporting significant volumes of people out of a disaster zone, including private entities, public transit authorities, local emergency services and the military if requested by local government leadership.

Private transportation companies operating ambulances, coaches or school buses possess many favorably-located, high-capacity transportation assets which often remain untapped during disaster response without a central decision-maker to align these resources with needs [7], likely due to a lack of interagency mutual assistance agreements and an absence of drivers to operate equipment [20, 21, 50]. These companies may have contracts with individual facilities, such as hospitals, prisons and nursing homes, which often do not adequately self-evacuate [58], complicating the potential for the employment of many transportation providers in an evacuation of the broader population.

Public transit agencies also possess ample drivers and vehicles that could be viable assets for large-scale emergency evacuation [24]. Many drivers, however, by understandably

prioritizing the lives of themselves or loved ones over duties, may be inoperable during an emergency, thereby seriously limiting the emergency transportation capacity of public transit providers. Furthermore, labor laws may limit the number of hours a vehicle driver can work without rest, inciting a need for replacement drivers. While public transit providers of many large cities do not possess enough buses to evacuate all those who cannot self-evacuate in a timely manner, let alone all residents [61], if a jurisdiction overcame the aforementioned obstacles, public transit could prove an invaluable resource during an evacuation

Military personnel and equipment could be used to evacuate those either unwilling or incapable of evacuating themselves from an affected area, conduct search and rescue missions, and provide essential needs (*e.g.*, food, water, medicine) to victims. The military can be activated by the elected official of an affected nation or jurisdiction to provide disaster relief to impacted areas, which could entail transportation support for evacuation [61]. Considering the amount of devastation an impacted area would likely have sustained in order for an executive branch of government or other properly appointed agency to request support from the military, using the military for providing disaster response transportation could possibly intensify the inherent chaos in transportation following a disaster by further congesting traffic [50].

Members of carless households may also flee a disaster zone with compassionate friends, family or neighbors who have access to a vehicle. Some community-based efforts, such as the "Good Samaritan" and "Evacuteer" programs in New Orleans, Louisiana, encourage evacuees to provide transportation to neighbors who lack means of self-evacuating [13, 51, 61]. In practice however, many carless individuals are still unable or unwilling to comply with orders to evacuate when disaster strikes [6, 10, 12]. When helpful neighbors with vehicular access or programs like "Evacuteer" are not an option, many individuals are forced to assume the risks of sheltering in place during a disaster [61].

2.2. Citizen Support for Disaster Response

"Spontaneous volunteers", without any affiliation to an emergency response organization and acting upon a natural impulse to assist in disaster response, are frequently not incorporated by first responders and emergency planners in formal emergency planning efforts and disaster response operations [27, 38]. Various extreme events, most notably the events of September 11, 2001, which motivated an estimated 40,000 unaffiliated community volunteers to offer help, demonstrate that spontaneous volunteerism provides insuppressible and valuable disaster response [38]. Without acknowledgement or proper management of these spontaneous volunteers by emergency services, disorder may ensue, thereby complicating the delivery of disaster response by both parties [38]. In order to deliver an operative level of disaster response, spontaneous volunteers should be involved in every phase of a disaster cycle through careful integration with clearly defined responsibilities [41], possibly through a community-based, non-governmental organization that is well-suited for volunteer involvement in disaster response [38]. Previous research suggests doing so would transform communities from "victims" to "resources" [27]. This creates opportunities to increase participation in new and expanding community-based disaster response groups to make otherwise unaffiliated individuals responding to a disaster more competent, allowing for a much greater chance of proper inclusion of spontaneous volunteers in disaster relief efforts.

The paradigm shift in disaster response from a reliance on government assistance to a community-based, volunteer-supported model is in evidence in the U.S. in the form of the federally-endorsed Citizen Corps. The Medical Reserve Corps (MRC), a Citizen Corps partner, provides more effective deployment of medical and public health professionals

during emergency response. MRC units are community-based organizations which enlist credentialed, trained medical personnel to support emergency response and promote public health year-round. MRC units find benefit in local partnerships with related organizations, especially emergency services, departments of health, or the American Red Cross [8].

A volunteer-supported, community-based model has proven effective for other forms of disaster relief and may have the capacity to relieve demand for evacuation assistance by engaging and coordinating a wealth of underutilized regional transportation assets during a disaster. Such a model has already been applied specifically to evacuation transportation assistance in the form of the "Evacuteer" program in New Orleans, LA [13]. Recognizing the severity of risks stemming from a lack of auxiliary emergency transportation, the establishment of an organization akin to the "Evacuteer" program has been recommended by various scholars [21, 23, 30, 50]. The Center for Disease Control now recognizes "Evacuteer" and its model for citizen-led evacuation as a potential archetype of the Whole Community approach to emergency management endorsed by the U.S. federal government [39].

2.3. Quantifying the Usefulness of an Existing Volunteer-Backed Evacuation Support Organization

Before Hurricane Katrina, the Comprehensive Emergency Management Plan of New Orleans acknowledged the city's responsibility to provide safe evacuation to carless citizens, but did not detail or test how these residents would be transported in an emergency situation [18, 28]. While vehicles and resources were available, they were unorganized, and there was no coordinated volunteer-based group to provide support in evacuation [28, 39]. As a result people who could not self-evacuate relied on shelters of last resort; this includes the nearly 25,000 New Orleanians who took refuge under unsanitary conditions at the Ernest N. Morial Convention Center [52], and the 60,000 Gulf Coast residents who required emergency rescue from flooded homes in the weeks following Hurricane Katrina [57]. The "Evacuteer" program was subsequently formed in 2008 to provide the supplemental human resources needed to effectively execute the City-Assisted Evacuation (CAE) Plan which was adopted by the City of New Orleans in response to the aftermath of Hurricane Katrina [39].

"Evacuteer" has demonstrated the possible effectiveness of a volunteer-led organization to assist in large-scale evacuation when coordinated by a comprehensive, tested urban evacuation plan. When Hurricane Gustav struck the Gulf Coast in 2008, the program, still in its formative stages, mobilized 375 volunteers to assist in the evacuation of approximately 18,000 individuals using public transit vehicles in New Orleans, Louisiana over a 35-hour timeframe [18, 39]. This means that approximately 48 residents were evacuated for every "Evacuteer" volunteer deployed, accounting for breaks and shift changes. In 2008, there were 17,706 households holding an estimated 49,881 people that did not have access to a personal vehicle in New Orleans [56], suggesting that "Evacuteer" assisted in the evacuation of over one-third of these residents. Today the "Evacuteer" program has trained a total of approximately 700 volunteers since 2008 and boasts a capacity of evacuating 30,000 city residents in a 24-hour period [18]. Depending on circumstances like the efficiency of volunteers deployed and the capacity of vehicles used, "Evacuteer" estimates it can register, evaluate and load people onto public transit at rates between 8 and 22 evacuees for every volunteer-hour worked [39].

The demonstrated capacity of the CAE plan and the "Evacuteer" program clearly show how events could have gone differently if the program was active when Hurricane Katrina struck in 2005. The number of people living in households without a personal vehicle dropped by an estimated 67% (72,093 individuals), from 107,192 people in 2005 to 35,099 in 2006 [54, 55], proving that a substantial portion of the city's surviving carless population had

to be relocated on more than a short-term basis. If the program was employed with the same effectiveness it demonstrated in Hurricane Gustav (18,000 individuals evacuated), approximately 17 percent of the total carless population in the city, or nearly 25 percent of the 72,093 carless individuals who left the city between 2005 and 2006, could have been evacuated before Hurricane Katrina made landfall. If "Evacuteer" achieved its full current capacity and evacuated 30,000 individuals, the program could have assisted in the evacuation of approximately 28 percent of the city's carless population in 2005, or nearly 42 percent of the 72,093 carless individuals estimated to have been displaced by the storm. While these figures quantify the value of such an organizational model, this article further argues through qualitative reasoning, that this effectiveness could be heightened with more experience, added resources and enhanced coordination with partnering organizations.

3. Enhancing Evacuation Capacity with a Transportation Reserve Corps

Previous disasters have suggested the need for a transportation system better poised to coordinate large-scale evacuation for an entire population [45]. One potential facet of this more resilient transportation system could be a community-based organization to manage volunteers, inventory resources and deploy them to people in need, supplementing existing transportation capacity during disasters. The key objective of the organization would be to assemble trained and licensed transportation coordinators and drivers to conduct evacuations of buildings, neighborhoods, districts, cities or even entire metropolitan regions. A goal would be to integrate planning for multi-modal evacuation, households without automobiles, and coordinated volunteerism with disaster preparedness, response and recovery, through collaborative, community-based approaches. In this way, a **Transportation Reserve Corps** (**TRC**) is envisioned to be a volunteer-driven, community-supported organization for assisting primarily with the movement of people, but also supplies and goods during an extreme event or disaster—large or small. These functions would be carried out by four key inter-related components of a **TRC**; (1) volunteers, (2) vehicles, (3) cooperation and (4) communications.

3.1 Objective

During disaster response, a **TRC** would optimize coordination and deployment of resources for the movement of people and goods, paying special attention to those who cannot self-evacuate. A **TRC** would raise awareness among transportation providers about existing vehicle fleets, equipment, communication systems and volunteer drivers in a region to aid in better coordination of local, state and regional transportation resources. Support functions other than urban evacuation for disaster preparedness, response, and recovery could also be provided by a **TRC**. These functions could include managing traffic, removing debris (employing volunteers trained to operate heavy machinery), delivering food, care and resources to displaced residents or those still within the disaster zone, and assisting people in their return home after a disaster zone is secure.

3.2 Volunteers

TRC volunteers would supplement and/or relieve first responders when capacity of personnel is exceeded during a large-scale disaster. A volunteer could be any person trained to operate a high-capacity vehicle [such as a train (light rail, commuter rail, or Amtrak), school bus, coach or tour bus, public transit bus, taxi, commercial van, church or community

van, rental car, or emergency vehicle] with the proper licensure to do so. Volunteers could include current or former employees of transit agencies, private transportation companies, first responders, and licensed persons who drive high-capacity vehicles on a part-time basis. A **TRC** would also require volunteers for logistical and communication support to coordinate drivers and vehicles. These volunteers might include information technology specialists, administrative support staff, mechanics, or others qualified to carry out auxiliary support duties necessary for a **TRC** to operate.

Many members of a **TRC** would presumably be current or former first responders or transportation professionals; therefore building relationships with employers would be a first step in enlisting volunteers. Volunteer recruitment would involve networking with organizations that represent current and retired transit employees, including transportation unions and retiree associations as well as non-transportation unions, such as longshoremens' unions and stagehands' unions whose members are trained to quickly move heavy materials and likely are licensed to drive a high-capacity vehicle. A **TRC** may offer incentives for volunteers such as valuable emergency management training, tuition reimbursement, or gifts.

A simple online process could supply **TRC** management with the necessary information for preliminarily enrollment of applicants. A **TRC** would also use this system to conduct licensure and background checks on all potential volunteers. This credentialing process would require an objective validation of the current driver's license, historical record, experience and demonstrated proficiency for each volunteer applicant [22]. This is a crucial step that should be carefully iterated prior to enrollment if service is to remain unthreatened by safety, security or legal issues [22]. The level of credentialing required may vary between applicants; for instance, credential checks would be more straightforward for currently employed drivers who update qualifications to maintain job status. It could be cost prohibitive for a **TRC** to finance the licensure credentialing of its volunteers.

Inadequately trained volunteers may further burden the already strained existing organizational structure of disaster response operations, compelling some emergency management officials to forgo deploying volunteer groups [22, 47]. Therefore, a **TRC** should also require its volunteers to meet a minimum level of training, such as completion of certified disaster response training courses like those of the National Incident Management System (NIMS) offered through FEMA which are required for any organization to receive federal preparedness assistance (such as grants) in the U.S. This precedent has been set by other community-based disaster response organizations [47]. Some standardized NIMS training courses covering the structure and operational coordination processes are offered online, but more advanced, role-specific training would also be required. These exercises would be taught by emergency management experts able to incorporate lessons learned from real world experiences.

For **TRC** volunteers, proper training may include courses or exercises in first aid, search and rescue, disaster psychology, procedures for establishing communication or other individual responsibilities. Classroom training in disaster response or exercises for fleet owners of participating transportation providers could also be used by a **TRC** [32]. **TRC** volunteers should engage in realistic exercises – including inter-organizational, multijurisdictional rehearsals of local emergency response plans, or shadowing exercises – to heighten performance, interoperability and allow **TRC** volunteers and management with less experience an opportunity to observe those with more experience during an actual incident.

To successfully coordinate volunteers and resources when a **TRC** is activated in an emergency, a variety of procedures and protocols would need to be established. These could include but may not be limited to (1) mechanisms for maintaining communications between command units, transportation organizations and volunteers (2) processes for acquiring

vehicles and auxiliary resources including protocols for entering into mutual aid agreements, and (3) establishing routes, pick-up points, sheltering, and check-in locations in coordination with existing emergency plans. In the event that a chief elected official declares a state of emergency in a jurisdiction, a **TRC** would prepare by establishing its own independent Emergency Operations Center (EOC). Then, when a request for resources from a **TRC** is made, a **TRC** would coordinate with cooperating transportation agencies and its volunteers using tested communication systems with established protocols to effectively mobilize the resources requested.

3.3. Preparedness for Multi-Modal Transport and Evacuation

As a disaster preparedness organization, a **TRC** would undertake several key tasks: (1) work to establish protocols that promote interoperability and consideration for responder safety; (2) identify, inventory and assess resources; (3) adopt standards, guidelines, and procedures for requesting and providing resources; (4) provide training, exercises, evaluation, and corrective action programs; (5) ensure the establishment and maintenance of necessary mutual aid agreements and assistance agreements and outreach to NGOs and the private sector; (6) contribute ideas to ongoing research and development of new technologies; and (7) conduct after-action reviews to strengthen future preparedness actions [23]. Possible methods and other important considerations to successfully carry out these tasks are detailed below.

Establishing an electronic database of volunteers complete with their credentials, level of training, place of employment and residence, is the first level of resource management for a **TRC**. A **TRC** would use a similar scheme to gather knowledge about vehicle resources from private and public transportation providers at a local and regional level. An electronic master-list of available high-capacity and specialized transport vehicles and their usual parked locations throughout a region would "type" vehicles by their capabilities through measurable performance standards to facilitate deployment of vehicles in response to an emergency [23]. Fuel, emergency repair, and other support services are just as important as coordination of high-capacity vehicles [28] and should be inventoried in the same manner as the vehicles themselves. Coordination with larger government or non-government agencies possessing a significant number of high-capacity or specialized transport vehicles would facilitate the development of a **TRC** vehicle database.

The need to safeguard funding agreements is a prerequisite to secure resources, especially volunteer drivers, vehicles, fuel and equipment necessary to sustain disaster response operations of a **TRC**. Contrary to common belief, local governments do not have the legal authority to commandeer vehicles during a catastrophic event [22]. For example, private transportation providers likely have clients that would be a first priority during an emergency making it unlikely for managers to offer resources for a general evacuation. Furthermore, during a large-scale evacuation, most transportation resources, especially ambulances, will be in use and services will not be available to all those in need [22]. Such factors suggest that pre-arranged agreements should be established between emergency response organizations and transportation providers. Such partnerships, commonly referred to as mutual aid agreements, would range from informal reciprocity arrangements to binding legal agreements for reimbursement. The "Evacuteer" program in New Orleans, LA, has demonstrated that forming partnerships with other community-based organizations is a legitimate, feasible way to enable the sharing of resources across organizations needed to execute a local evacuation plan [13].

Mutual aid agreements established between agencies, organizations, and jurisdictions facilitate rapid, short-term deployment of emergency support, in the form of personnel, equipment, materials, and services, preceding, during, and after an extreme event. These

signed agreements do not guarantee the provision or receipt of aid; they simply enable resource sharing during an emergency incident [23]. Because a **TRC** would not own resources, it should form mutual aid agreements with private transport companies and other organizations that do own vehicles as well as other entities that can provide necessary support services, such as communication systems. When entering into mutual aid agreements, a **TRC** should be cognizant of the possibility that, under some legal frameworks, any law obstructing the operations of an authorized disaster response organization could be lawfully disobeyed during a state of emergency [22].

Mutual aid agreements for a **TRC** should detail the following: responsibilities of the parties involved; procedures for requesting and providing assistance; rules for payment, reimbursement, and allocation of costs; protocols for interoperable communications; relationships with other agreements among jurisdictions; treatment of liability and immunity; recognition of qualifications, licensure, and certifications; other sharing agreements; and length of agreement and termination clause [22]. A **TRC** could engage in several types of mutual aid agreements depending on the size of the jurisdiction involved, the types of resources being requested and the willingness of a second party to cooperate with a **TRC**. Agreements can reflect automatic mutual aid (usually generic contracts) or informal accords that permit the dispatch and response of requested resources without incident-specific approvals, or local mutual aid agreements that involve a formal request for assistance and generally cover a larger geographic area than automatic mutual aid [22].

A **TRC** would need to coordinate with existing disaster-related mutual aid agreements between public and private parties within its jurisdiction. These could be local, regional, national, international, or other mutual aid agreements, either formal or informal. In establishing mutual aid agreements with private employers, it is important for a **TRC** to become familiar with the collective bargaining agreements (CBAs) these agencies have made with their employees. When setting up a **TRC**, it may be necessary to lawfully circumvent these CBAs in order to ensure full functionality. Some community-based disaster response units have overcome mutual aid by granting exemptions from all CBAs for their volunteers in their bylaws [17].

3.4. Responding to Evacuation Demand with a Transportation Reserve Corps

The ability of a **TRC** to mobilize resources belonging to other entities during a disaster is dependent on thorough coordination with these entities and with local emergency service professionals. Since resource availability and location will constantly change as an emergency event evolves, this requisite coordination necessitates instant communications. A **TRC** would therefore need to employ a resource-tracking system to locate mobilized resources continuously from deployment through demobilization. The communication information systems (CIS) used to mobilize resources would also track resources by the date, time and place of their departure; the expected time and location of their arrival; an assigned reporting site, and a resource order number. A **TRC** would adopt procedures, including tracking systems to identify the location and status of mobilized vehicles continuously from deployment through demobilization [22] to help safeguard volunteers and resources while enabling a more efficient use of multi-modal transportation assets.

Maintaining communication channels between agencies remains one of the biggest challenges for disaster response organizations, as communication systems are routinely compromised during extreme events [22]. Enhanced community outreach for the identification and engagement of the carless population is therefore necessary for a **TRC**. With the assistance of local service providers and community-based organizations, **TRC** staff would collect and maintain data that could be integrated into a broader community-based CIS

which would engage government agencies, first responders, community groups and the general population in order to increase community disaster preparedness [3].

The CIS used by a **TRC** should be designed to be multi-purposed, flexible, reliable and scalable in order to function in various types of disasters, regardless of cause, size, location, or complexity [22]. When multi-modal transportation resources (*i.e.*, vehicles and volunteers) are requested by a local elected official or an emergency services organization during an extreme event, a **TRC** would use a CIS to place a vehicle order with an appropriate resource provider. To activate volunteers, a **TRC** would use a CIS to send an automated message followed by more explicit instructions via text message, phone call, email, social media or a smart phone application to activate local **TRC** volunteers with the desired qualifications. Communications to **TRC** volunteers *during* disaster response may also include two-way radio communication, mobile telephones, or digital communication possibly through a community-based CIS. A representative of the volunteers' respective transit organization could be used to facilitate the information exchange between a **TRC** and its volunteers. Judging from the experience of Hurricane Katrina when thousands did not evacuate New Orleans for a variety of reasons [12], a **TRC** could also have used a community-based CIS to provide direct, reliable information to carless residents during an emergency in order to enable their evacuation when it is in their best interest.

Resiliency and redundancy are key to the communication strategies of a **TRC**. Resiliency—the ability to withstand and maintain performance levels after suffering damage or loss of infrastructure—demands that communications systems avoid relying solely on overly-complex or vulnerable communication systems. Redundancy—the duplication of identical services in order to communicate through alternative methods if one mode is debilitated—is a method to achieve resiliency. When preparing communication protocol and procedures, it is important to remember that volunteers may be asked to respond to a distant incident and consider operability of extra-jurisdictional communications systems [22].

A **TRC** would begin preparing for demobilization and recovery as soon as resources are activated [22]. Additional services would be provided for the recuperation of **TRC** volunteers and may include medical treatment and mental health support. **TRC** vehicular resources are nonexpendable and must be fully accounted for during and after an incident, however a **TRC** may not have the financial capacity to restore damaged vehicles to full functionality. A **TRC** could extend its service to more prolonged disaster recovery efforts as long as the proper mutual aid agreements are in place.

4. Challenges in Establishing a Transportation Reserve Corps

A disaster destructive enough to require the deployment of a **TRC**—a disaster requiring a large-scale evacuation of an entire metropolitan area—may not occur within the lifetime of its members. With such an infrequent primary purpose, it may be difficult for a **TRC** to procure funding or sustain the effectiveness of its operations. Therefore, a **TRC** should be aggressive in efforts to secure funding and diversify its responsibilities in order to ensure long-term viability. A **TRC** must also incorporate disaster preparedness and recovery efforts in addition to its response activities, including day-to-day operations such as updating databases and coordinating with other entities. Demonstrating abilities in all stages of disaster planning should enhance the vitality of a disaster response organization like the **TRC** and increase the likelihood of procuring financial support.

4.1. Insurance and Liability

For local governments and nonprofit organizations, the high cost of insurance premiums and large numbers of workers often prohibit community-based disaster response groups from insuring their responders [47]. In the case of volunteer responders, liability coverage is commonly granted only to those directly volunteering for a local government [37]. Immunity from liability is already provided by the laws of some states to responders of certain organizations, or, as in the state of California, to any emergency volunteer, essentially granting any volunteer working for a registered organization the same liability as a state-employed first responder. However, even if volunteering emergency responders are somehow provided with insurance coverage, this does not guarantee that the insurer will actually uphold these protections as the scale of an emergency may exceed the capacity of an insurer [22, 47].

Legislation often protects emergency volunteers and the entities they represent from incurring damages resulting from volunteer oversight or error that is not criminal or grossly negligent [4, 47]. For instance, the Volunteer Protection Act (VPA) passed by U.S. Congress in 1997 guarantees these provisions to emergency volunteers [37]. Lawsuits pertaining to volunteer malfeasance have persisted however, as protections provided by the VPA do not certify insurance coverage to uninsured volunteers and often require that organizations meet certain conditions in order to qualify for liability exemptions [47]. Immunity coverage for motor vehicle operators is rare, and unless liability coverage is granted by meeting certain pre-conditions [37], a **TRC** might be expected to provide coverage to volunteer drivers. Good Samaritan laws—restricting the ability of victims assisted by another to file a lawsuit against the person giving them assistance if injury occurs—may be a possible avenue for additional liability indemnity, though some Good Samaritan laws only grant liability immunity to licensed medical professionals [37, 47].

4.2. Funding and Reimbursement

Funding for **TRC** start-up, capital costs, and operations would depend greatly on the administrative structure of a **TRC**. A **TRC** should explore grant programs that offer benefits such as mileage reimbursement for vehicle use during emergencies or training exercises. Funding opportunities for a **TRC** may be enlarged if a **TRC** is able to validate that it provides a public health benefit to the community it serves. Government offices of emergency management, departments of transportation, and international or community foundations may also be able to provide funding for a **TRC**. A **TRC** could also explore local fundraising efforts and possible mutually-beneficial partnerships with local nuclear power plants; the nuclear power industry may fund safety exercises, and it could benefit from an emergency management organization focused on evacuation [22].

A network of insurance providers and government agencies providing financial reimbursement for disaster victims and affected jurisdictions typically follows a bottom-up approach [33]. Due to this organization, proactive disaster planning by local authorities, such as a clerk or municipal attorney, represents the first line of defense a jurisdiction has in preventing financial incapacitation from a disaster [26]. However, unlike individual households and firms—who risk total financial annihilation if they do not prepare by purchasing insurance—governments likely only risk losing a fraction of their assets and may therefore be less compelled than households to enter into insurance contracts [5]. Furthermore, elected officials, in prioritizing politics over disaster preparedness investments, may be reluctant to compensate affected individuals and local governments during the aftermath of a disaster [49]. For these and other reasons, a **TRC**, like hospitals and local

offices of emergency management, should prepare for an extended period of self-preservation during an emergency while maintaining complete records of all expenses incurred [22, 55].

4.3. Volunteer Engagement and Response

The commitment and enthusiasm of volunteers must be maintained if a **TRC** is to be viable over the long-term; but of course, this is an innate challenge when personnel are not financially compensated. Other volunteer disaster organizations often are not entirely successful at keeping members active and engaged [22]. Emergency volunteer organizations must plan training and engagement activities so that volunteers do not disengage during the indefinite and likely prolonged lapse between events requiring their services. Training and exercises for volunteer emergency workers should be engaging instead of routine; if not, volunteers may fail to attend. Other community-based disaster volunteer organizations use a number of communication tools to boost volunteer involvement, including email, phone calls, pagers and social media, to reach out to registered volunteers regarding day-to-day operations [13, 22]. These groups also organize recruitment and outreach events in order to increase volunteer participation and support. A **TRC** should look to provide volunteers with recognition for participation, possibly in the form of souvenir gifts or appreciation events.

Like other emergency responders, **TRC** volunteers may prioritize their own safety and the safety of their loved ones over their volunteer responsibilities and in so doing may fail to respond when a disaster strikes [22]. To ensure that **TRC** volunteers are able and willing to respond, each volunteer should craft and rehearse a reliable family emergency plan complete with evacuation and sheltering arrangements. When knowing that loved ones are safe, volunteers will be more able to focus on their job and do it to the best of their ability.

5. Additional Considerations for a Transportation Reserve Corps

A set of additional dynamics impact the functioning of a **TRC** but may not exist as explicit challenges. For instance, the nature and context of the disaster, socioeconomic factors, such as the share of households with vehicular access, along with the political setting and legal system of a jurisdiction, have a profound effect on the suitability and role of a **TRC** [22]. Here we investigate the range of additional considerations for a **TRC** into three categories; (1) administrative factors, (2) coordination with other entities and (3) geographical context and setting.

5.1. Administrative Considerations for a TRC

While other volunteer disaster response organizations operate through a national top-down structure, a **TRC** may be better coordinated at the local level [22]. Local government is primarily responsible for emergency management, but disasters that provoke large-scale evacuations likely exceed local capacity to respond effectively [34]. Therefore state governments, granted power by the federal government to respond to emergencies and evacuations, may be most effective in providing oversight for a system of regional or county-based **TRC** units [22]. The main federal interest in working with a **TRC** may come from groups/individuals/programs that advise states on emergency and evacuation planning.

A **TRC** could be modeled under one of three possible administrative models: (1) an independent organization that shares resources or partners with other emergency response and planning organizations, (2) an add-on to an existing regional governmental agency (*i.e.*, a emergency services department of a local government, regional transportation organization or metropolitan planning organization), or (3) a cooperative organization, integrating with

established community-based volunteer organizations associated with extreme events, disasters, or health and medicine, such as the MRC. **TRC** establishment may be simplified by pursuing an independent administrative structure, but a model that builds linkages with related organizations would better enable the comprehensive inter-organizational coordination necessary to conduct **TRC** operations and avoid redundancy in existing infrastructure such as communication systems. The MRC, given the proven success of its operational structure, serves as a model for the **TRC** and stands out as a prospective organization for the **TRC** to link with. The **TRC**, like the MRC which also activates and organizes credentialed professionals to assist in disaster response, may similarly benefit from being administered as independent local units organized under a common national organization. The mission of the MRC, however, to provide emergency health services and public health awareness, does not necessarily coincide with all **TRC** objectives.

While a MRC may be unprepared or unwilling to completely absorb a **TRC** into its operations, a **TRC** would benefit from mimicking the MRC's administrative structure by dividing its volunteers into sectors based on their duties. A local **TRC** management and staff is envisioned to be headed by a Board of Directors or Executive Steering Committee and managed by an Executive Director. Under the Executive Director would be three departments, likely volunteer led: Volunteer, Resource Management, and Communications with various roles and responsibilities (See Figure 1). As exemplified by the "Evacuteer" program and the CAE plan of New Orleans, it is essential that **TRC** leadership is integrated into the decision-making and communications framework of a local evacuation plan and collaborates proactively with other response groups and local emergency services [18].

5.2. Coordination with other Entities

Collaboration and knowledge-sharing with a range of existing community-based volunteer partners, disaster response and readiness organizations and governmental agencies is essential for a **TRC** to be sustainable [22]. When disasters occur, authorities may be hesitant to call on volunteer responders since other community-based disaster response groups often do not fully integrate with emergency management officials. In recognition of this, **TRC** leadership should be prepared to engage local emergency management in a continued collaboration to demonstrate its value and maintain organizational credibility. Recruiting volunteers employed through other organizations, or those others who are credentialed (which limits the need for

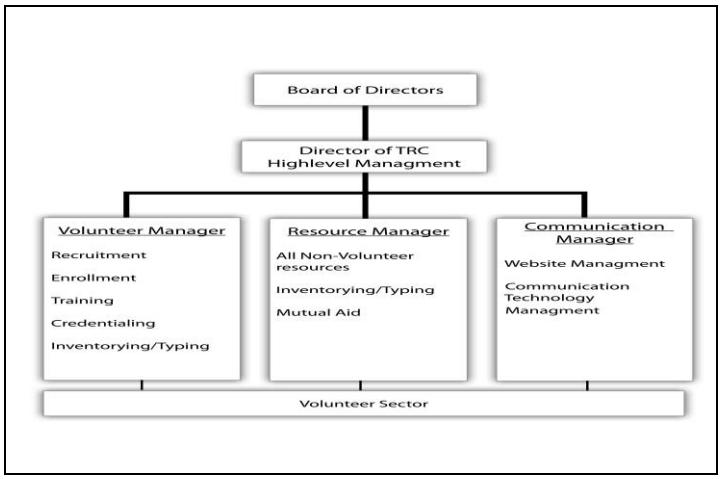

Figure 1. Transportation Reserve Corps Administrative Structure

funding and increases the effectiveness of an organization) would also reinforce the long-term viability of a **TRC**.

Most mutual aid agreements between private, public, nongovernmental and volunteer organizations offer some level of indemnity or compensation to deployed volunteers, essentially ensuring that neither entity will sue the other if an unlawful act occurs [47]. Certain organizations that collect and exchange critical disaster-related information for insurance and reimbursement purposes [25] present an opportunity for a **TRC** to share critical information with its partners in disaster response while serving its own insurance and reimbursement needs. The emergency services of the affected locality, acting as a central contributor to an insurance coalition, could also be relied upon for pertinent information, by maintaining detailed records of disaster operations, including transportation assistance provided to victims [22].

5.3. Geographical Context and Setting

A **TRC** could be tailored to serve any geographic extent—from entire regions to individual facilities or segments of the population. Location will largely determine the extent to which a **TRC** unit must prepare for any given disaster type; therefore, the **TRC** model will have to be adjusted to fit various organizational contexts and geographic settings. The impact and nature of the disaster encountered would demand modifications in **TRC** response. A stipulation of the necessary adjustments in **TRC** structure based on geographical factors reveals which locations would be most appropriate for the implementation of a **TRC**.

The size of a city or region is the most instrumental geographical factor in determining the emergency evacuation logistical capacity and demand of an area. In general, metropolitan areas with smaller populations are less threatened by human-induced disasters. Due to this perceived lack of risk, these cities may lack the community support and political will necessary to establish a community-based volunteer organization like a **TRC** [42]. When coupled with a lower tax base, this lack of public endorsement may prohibit local politicians of small metropolitan regions from pursuing supplemental emergency program funding [59]. It is therefore imperative for **TRC** units in smaller communities to be proactive in securing funding, recruiting volunteers and collaborating with other emergency response organizations in order to be viable and effective. While major metropolitan centers likely possess the political and financial ability necessary to establish a **TRC**, they may already be equipped with high-capacity public transit systems and an established disaster response structure, thus limiting the need for emergency transportation volunteers in these areas [22].

Geographic location would in large part determine the role and demand for a **TRC** unit. For instance, if a **TRC** served an area located along a coast, near critical infrastructure, a border or anywhere with a high concentration of people or industrial activities, no-notice human-induced disasters would be intrinsically more likely. It would therefore be prudent for **TRC** units in these areas to focus on disaster recovery. This also applies especially to parts of the world where certain natural disasters such as earthquakes, tsunamis and wildfires are more likely. **TRC** units serving communities in tropical climates along the coast would have to prepare for tropical storms, a disaster type that occurs with advanced warning but causes the greatest number of evacuations [11]. If a metropolitan area is closely linked with other cities, there may be an increased ability to form reciprocal agreements for inter-jurisdictional resource sharing during evacuation.

A **TRC** may be more operable in city centers that typically possess higher concentrations of mobility-dependent residents and are at greater risk for human-induced disasters than surrounding areas. According to a nationwide study conducted in the U.S., rural residents are more likely to own vehicles than urban residents [40] and therefore are less likely to require

emergency evacuation assistance. However, natural disasters are just as likely in rural towns as in big cities and household vulnerability to natural hazards is generally heightened by increased geographic dispersion of individuals and communities in more isolated rural areas. A rural **TRC** may therefore experience increased difficulty conducting many of its vital operations, such as resource gathering and mobilization. If a target population is geographically dispersed, the logistics of an evacuation would become particularly onerous, reinforcing the need to pre-establish mutual aid agreements. The formation of a **TRC** unit would be more practical in a rural area if evacuation routes and sheltering sites have been established through formal emergency plans.

6. Conclusion and Action Steps

As illustrated by Hurricane Katrina, the inherent complexity of establishing emergency services relationships between neighboring jurisdictions and the transportation agencies serving them may render transportation management in the event of disaster exceptionally difficult [50]. Failure to supply adequate evacuation transportation to those who lack the ability to self-evacuate, as many local emergency planning efforts often do, contradicts the very principle of evacuation and puts people at risk. Without proper planning and collaboration, organizations at all levels are quickly overwhelmed when disasters occur, making it unlikely that a sufficient number of vehicles will be deployed for those in need.

Recommendations to enhance resource coordination through best practices research and more investment are not sufficient. In fact, the importance of identifying improvements that are possible within reasonable expectations for funding has been stressed [50]. A community-based, disaster response organization designed to coordinate transportation resources during all phases of the disaster cycle, most notably disaster response, therefore arises as an economical, justifiable and powerful means of alleviating these "transportation assignment" problems [50]. This organization, the **Transportation Reserve Corps**, is intended to become a brain center for multi-modal evacuation—a new organization providing transportation to everyone, especially those most vulnerable, via high-capacity vehicles and volunteer drivers, during a large-scale evacuation. The "Evacuteer" program proved the value of such a model enterprise by assisting in the evacuation of 18,000 city residents using public transit prior to Hurricane Gustav in 2008 [39].

Through this research, a number of key considerations have been revealed which would enhance the sustainability and effectiveness of a **TRC**. Firstly, a **TRC** is a preparedness, response, and recovery organization, though the majority of its activities necessarily have a preparedness focus. A **TRC** coordinates existing multi-modal transportation resources (especially for the carless), employing volunteers intended to supplement, not replace, first responders or professional vehicle operators. To avoid the effort and expense involved with establishing a new organization, a **TRC** should instead fall under an existing umbrella volunteer, emergency management, planning, or transportation organization. A **TRC** should have state-of-the-art and interactive resource management technology linked with a multifaceted communication system that could be used to communicate with volunteers and other organizations and to form an inventory of existing high-capacity vehicles. Additional recommended research for supporting the establishment of a **TRC** should emphasize four key topics; (1) organizational structure and business plan, (2) identification of permanent funding sources, (3) the use of mutual aid to maximize the use of resources and (4) the use of vehicle modifications and technological additions, most especially communication information systems (CIS), that could assist multi-modal evacuation of the carless population during large-scale disasters.

There are several recommended actions steps to begin implementation of a **TRC**. First is to simply increase advocacy for the inclusion of multi-modalism in emergency planning. The second is to develop a plan for broad recruitment of volunteers for emergency transportation during disasters. The final action step is to launch a pilot test of a **TRC**, preferably in a locality that has an existing evacuation plan that incorporates multi-modal transportation, a certain level of vehicle inventorying, and adequate technology and communication systems in place. A **TRC** may be best suited, at least initially, to mid-sized metropolitan areas which likely own the greatest need for multi-modal evacuation support and also the most favorable conditions for long-term success of a **TRC**.

A **TRC** will not own, nor can it acquire transportation assets; instead, its primary role is coordinator of high-capacity vehicles, drivers, equipment and fuel that already exist in a community during an evacuation. With this in mind, in order to provide multi-modal evacuation transportation to all affected people, especially those most vulnerable, during a large-scale emergency event, a **TRC** must be intrinsically linked to and guided by a jurisdiction's greater emergency management system and hierarchy of existing transportation providers (both public and private). Therefore, the success of a **TRC** as an organization is dependent upon the effectiveness of the relationships it establishes with these entities and specifically, the degree to which these partnerships foster the ample coordination of external resources by the **TRC** in preparation for and response to large-scale emergency events. Establishing mutual aid agreements with these related emergency response and transportation organizations along with other preparedness activities of a **TRC**, such as training volunteers, identifying vehicle fleets and locating carless populations, are the most potent way to begin to address the fundamental barriers that community's face in transporting the carless during a large-scale evacuation.

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