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Emergent Technical Teams: Mechanics and Social Dynamics of Volunteer Disaster Response

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Introduction

The increasing frequency and intensity of natural disasters have created an increased need for disaster service response involving the deployment of teams of technical experts working in a voluntary capacity in both national and international settings. These teams usually operate under the umbrella of an existing organization (e.g., the Red Cross) and have a specific mission that defines the needed skills and expertise of team members. These teams are "emergent" in that they are formed and organized in response to a disaster and are not themselves established, stable, institutions (Vigo and Wegner 2013).

Emergent Technical Teams (ETTs) provide voluntary disaster response and reconnaissance services (observation and evaluation) following a natural or man-made disaster. ETTs are characterized by the professional education, training, skills, expertise, and previous experience of their members, yet emergent in the rapidity and nature of response. ETT members come together voluntarily and rapidly from a mix of organizations to act outside of their employee capacities. Successful, high-performing ETTs exhibit emergent behaviors (such as improvisation, creativity, quick adaptation, and short-term decision making) (Drabek 2007) based on a shared latent knowledge base (Vigo and Wegner 2013) that is grounded in technical experience.

We distinguish between an ETT and a volunteer citizen team (VCT), which consists of members from the general public, whose tasks and roles are defined and managed by staff who work for established organizations, and are trained to manage members of the general public (Campbell 2009). This research is focused on ETTs involving civil engineers, whose shared knowledge is rooted in their engineering expertise and whose role is becoming more important as extreme events are increasingly affecting the built environment. This analysis also includes emergency response teams (ERTs) managed and deployed by a local government or a search-and-rescue brigade following a disaster, whose members may have shared knowledge rooted in disaster response training.

Awareness of the increasing importance of civil engineers in ETTs is reflected in the formation of research networks or extreme event reconnaissance networks (EERs) whose mission is to deepen the engineering community's capacity for reliable post-event reconnaissance by: (a) promoting community-driven standards, best practices, and training for disaster response field work; (b) coordinating official event responses in collaboration with other stakeholders and reconnaissance groups; and (c) fostering the potential for truly interdisciplinary reconnaissance among engineers and other technical experts who participate in disaster response service. Examples include: Geotechnical Extreme Events Reconnaissance (GEER), the newly formed Structural Extreme Events Reconnaissance (StEER), and a complementary group the Social Sciences Extreme Event Reconnaissance (SSEER) (NSF 2018).

The teams deployed by these EER networks emerge post disaster to conduct initial reconnaissance activities considered to be an important means to understand the effects of natural hazards on the nation's built environment (NSF 2018). They consist of volunteer technical experts who are deployed rapidly following a hazard event and usually have little or no prior history of working together or hazard response training. We consider these teams to be ETTs and they serve as the primary unit of analysis in our research. Also participating in the deployment of ETT-type teams, and informing this research, are teams deployed by professional technical societies including the American Society of Civil Engineers (ASCE) and the American Institute of Architects (AIA) who serve post-disaster safety assessment and research roles.

In this paper, we identify factors that may increase the effectiveness of ETTs and, ideally, result in the members of an ETT working not just as a team but as a high-performing team. We discuss the importance of both the mechanics (how and what) and the social dynamics (who and why) required to turn a group of experts into a team. We draw on a psychometric instrument called The Birkman Method to provide quantitative data to describe how team members operate individually and in working groups. Such tools are widely used in team-building programs and provide an effective methodology for exploring and evaluating team performance. The goal is to understand at the level of individual team members why ETTs are or are not effective. The analysis can also be used to suggest how ETTs can be improved.

This paper makes a case for considering ETTs as an important part of the future of engineering project teams in general. The Engineering Project Organization (EPO) community is taking a wider view of engineering project teams within a "Grand Challenges" (GC) framework, as conceptualized by Sakhrani et al. (2017). By studying ETTs, the EPO community will move beyond the confines of more traditional engineering project topics. Framing ETT activities as a system of drivers and grand challenges within the context of disaster service response encourages the continued growth of the EPO community by strengthening links between the study of engineering projects and natural hazards research.

We begin with a literature review outlining the theory of emergent organizations that is relevant for understanding ETTs. We focus on how ETTs fit within a broader typology of emergent organizations. We then describe an approach to measuring the characteristics of teams, focusing on personality characteristics measured at the individual level. Finally, we consider how the GC framework can be used to widen the analysis and understanding of ETTs.

Literature Review

ETTs and Emergent Theory

The literature on emergence (groups, teams, and organizations) has developed rapidly and there is now a mix of terminology that can be confusing. Within the literature reference is made to "emergent groups" (Stallings and Quarentalli 1985) and "emergent organizations" (Vigo and Wenger 2013), and these terms are often used interchangeably. The discussion of "disaster response organizations" is also not uniform. Some refer to a "disaster response organization," (Harrald 2006) while others refer to an "emergency response organization" (Drabek 2007). Some refer to "disaster service work" (USNRC 2018) while others refer to "post-disaster response" (Lietmann 2007).

In this paper, we adopt a specific language in speaking about ETTs. We define an emergent technical "team" as a collection of individuals with expertise organized to function as a team with a specific mission. These teams generally operate under a parent "organization" that is an established institution that may provide support, management services, and mission guidance. The emergence literature uses the term emergent "organization" as a general descriptor while we will focus on teams. Views of emergent organizations have evolved over time providing an opportunity to characterize ETTs within the existing body of knowledge concerning disaster service response organizations.

ETTs represent a new form of collective in terms of structure and activity, and are composed of professional volunteers who self-organize to offer a spontaneous response and improvisation in times of crisis (Twigg and Mosel 2017). ETT members may be dealing with tasks and roles that are often new to them, unfamiliar, unplanned, and unanticipated, which likely differs markedly from the way they work in their professional jobs. According to Twigg and Mosel (2017) in general, ETT members are recruited or volunteer because their professional education, skills, expertise, and experience are urgently needed to respond to an emergency. To be successful in responding to an emergency, members of an ETT will:

- Contribute their professional education, skills, expertise, and experience and are able to bring that professional judgment to addressing problems that are likely not clearly defined;
- Have a high comfort level with making both quick decisions to achieve an immediate tactical response (e.g., a quick fix) as well as making strategic decisions that provide the foundation for longer-term actions and solutions;
- Trust and draw on their own professional judgment as well as the judgment of other members of their ETT in order to work effectively as a member of an ETT; and
- Adapt their problem-solving approaches quickly to address the situation (e.g., be creative and improvise).

Studies of the role of organizations in catastrophes date back to the 1970s. Dynes (1970) defined the role of organizations in the aftermath of a disaster along two axes (tasks and structure). He defines four types of organizational categories: (I) established, (II) extending, (III) expanding, and (IV) emergent. Type I, established organizations, are viewed as executing old tasks and possessing old structures (e.g., fire departments). Type II extending organizations are viewed as possessing old structures while executing new tasks (e.g., schools that operate as a shelter). Type III expanding organizations possess new structures and perform old task (e.g., the Red Cross). Type IV: emergent organizations possess new structures and execute new tasks (e.g., search and rescue and bucket brigades).

According to Wenger and Prater (1994.) "emergent organizations arise post-disaster either to fulfill a short-term need or to form a collective and informal network of community organizations to direct long-term recovery efforts. Such organizations often fill in the gaps that are left by the other three types of organizations and have the ability to start from scratch and define tasks in accordance with the interests of the group members that have formed the organization in the first place." Emergent groups represent a new form of collective in terms of structure and activity and in general did not exist before the disaster; group members in general carry out tasks that are new, and unfamiliar, unplanned and unanticipated (Twigg and Mosel 2017). Twigg and Mosel (2017) further describe emergent groups as volunteer groups that self-organize to offer a spontaneous response and improvisation in times of crisis. The initial focus of emergent theory was on private citizens who worked together to pursue collective goals. However, later developments of emergent theory note that emergent groups may consist of a mix of members of the general public and individuals recruited based on specific knowledge or expertise. Stallings and Quarantelli (1985) argue that the development of new relationships and tasks within the collective in response to a disaster, the linkage between traditional structures/functions and new ones, and the background of the group members are critical to the nature of an emergent organization.

Vigo and Wenger (2013) develop additional categories of emergence by proposing a type of response organization called Type V: Emergent groups with latent knowledge. Emergent groups with latent knowledge include groups that are fully emergent (as they have no previous knowledge of each other and perform non-regular tasks) but share the common characteristic of being trained in a specialized area (Vigo and Wenger 2013). Drabek and McEntire (2002) identified additional categories of emergence (including quasi-emergence, structural emergence, task emergence, and group emergence) and further examined emergence based on latent knowledge. ETTs fit well in their framework. They are a special case under Type V.The idea of a team embodying latent knowledge is relevant for ETTs, since they often include members with extensive experience in their technical fields of expertise.

Further linking the notion of emergence and knowledge, Majchrzak et al. (2007) likened transactive memory system (TMS) theory, or the study of collective memories achieved through group transactions, to emergence. Historically applied to stable groups operating under routine conditions, TMS indicators include expertise specialization, credibility in member specialization, and knowledge creation. Under routine operating conditions, within an organization, task-relevant expertise serves as the basis for task assignment. Expertise must be validated to achieve effective group functioning, and shared mental models are needed for effective group functioning (Majchrzak et al. 2007). However, when applied to emergent response groups, TMS indicators take on a different form namely task-expertise is replaced by a knowledge of relationships and a willingness to act; member credibility is replaced by trust in action, and simple coordination methods are developed to support rapid knowledge exchange (Majchrzak et al. 2007). These concepts are certainly relevant for high-functioning ETTs and will be discussed below in the discussion of the use of psychometric instruments to analyze team mechanics and social dynamics.

Types of Emergent Teams

We can view emergent teams along a continuum that runs from informal teams of volunteers to professionals in emergency response teams to ETTs consisting of technical experts. In Table 1, we describe the characteristics of three representative team types: Volunteer Citizen Team (VCT), Emergency Response Team (ERT), and Emergent Technical Team (ETT).

Table 1: Comparison of VCTs, ERTs and ETTs

Team Characteristic	Volunteer Citizen Team (VCT)	Emergency Response Team (ERT)	Emergent Technical Team (ETT)
Tasks and activity	Non-regular	Pre-defined, familiar, planned and directed	Less defined, unfamiliar, unplanned, and unanticipated
Member origin	General public	Professionals and/or trained volunteers	Volunteers with professional expertise

Role management	Managers trained in emergency response and dealing with volunteers	Managed by professionals with specific training	Self-managed and coordinates with other teams and organizations
Team organization	Hierarchical	Hierarchical	Ad-hoc
Disaster management response phase	Emergency	Emergency	Reconnaissance, restoration and reconstruction
Team origin and assembly	Local, assembled at time of emergency	Standing team or assembled at time of emergency	National and international, assembled post emergency
Member working knowledge of teammates	None or minimal	Usually prior working knowledge of one another	Working professional knowledge of teammates
Training in emergency response	Unskilled	Extensive	Minimal
History of volunteer disaster service	One-time or repeat volunteers	Repeat volunteers	Engage in single hazard/disaster events; non-repeat participants
Scope of disaster response	Varied	Varied or specific	Limited scope of response to a single type of event that aligns with professional expertise
Reason for participation	Motivated volunteers	Professionals or trained volunteers	Recruited or volunteer: professional education, skills, expertise
Formal team-building	None	Extensive	Limited

A VCT is composed of members of the general public who are willing and able to respond quickly to an emergency by offering their assistance. VCTs are not self-managed and may not have existed before the emergency. VCT members show up to be of general assistance and be deployed. The VCTs tasks and roles are defined and managed by staff who have been trained in emergency response, work for established organizations that provide emergency response (and often disaster recovery assistance), and are trained in managing members of the general public who want to join a VCT. VCT members may, or may not, have had training in emergency response; volunteered in other emergencies; or known one another from working together on other VCTs.[1]

An ERT is established to deal with particular emergencies such as fire fighting. It is the more traditional form of disaster response team and provides a baseline comparison for the

[1] In the advent of social media, there has been increased participation of non-technically trained citizens in disaster response. For example, private boaters responding during Hurricane Harvey.

contributions of VCTs and ETTs. An ERT may consist of professionals or a mix of professionals and trained volunteers. ERTs and VCTs respond during the emergency phase of a disaster, while ETTs often respond during reconstruction and restoration when rebuilding activites are underway. The timing of ERT and VCT response is immediate, while that of an ETT is delayed or exhibits lag. VCTs are organized at the time of a disaster while ERTs are often in place, allowing for immediate response during the emergency phase of disaster management. ETTs are often assembled post disaster, and may not have existed prior to the event. ERTs in general have extensive training in emergency response. VCTs and ETTs have limited to no training in emergency response, but ETTs are technically proficient in areas that support reconstruction and restoration. ERT team members likely have a working knowledge of one another, have responded to multiple disasters together as repeat volunteers and therefore likely possess a strong sense of team, while VCTs and ETTs consist of volunteers with little or no team training.

The singular or infrequent nature of the ETT response makes formal team-building and member knowledge of one another in an emergency reponse role less likely. ETT members may know of one another in a technical role or capacity but have likely not served together on a disaster response team. Finally, ERT and VCT voluntary members serve because of a sense of social responsibility and a willingness to help, while ETT members are sought because of their technical expertise and the contirbutions they can make to the post-disaster reconstruction and restoration phase.

Ideas originally presented by Drabek and McIntire (2002) and Majchrzak et al. (2007), have been expanded upon and used to situate the ETT within the broader landscape of response organizations. Drabek and McIntire (2003) outlined the characteristics of emergent teams, while Majchrzak et al. (2007) further extended these characteristics by outlining the implications for knowledge exchange. Additional, team characteristics identified as relevant to an ETT include task and assignment definition, team purpose and perspective, nature of membership, geographical origin of the team, and familiarity of membership (Drabek and McEntire 2003). The knowledge implications of ETT activities can be characterized as action-based, learning by doing, and opportunistic coordination (Majchrzak 2007).

This literature provides a starting point for analysis of the nature of ETT organization and of how its members function together. Further work on knowledge exchange and effective team operation can draw on methodologies concerned with the operation of networks and provide a deeper understanding of how individuals operate in a team environment. In the next section, we consider these issues drawing on the fields of social network analysis (SNA) and psychometrics to quantify how effective teams work.

Theoretical Foundation: ETT Formation and Performance

The formation of ETTs is the specific focus of this research effort. Based on the literature, there is specific evidence about how to measure team formation and how to characterize teams. However, this does not always explain why teams form and why they stay together for the duration of a task. The current research is focused on filling this knowledge gap by understanding the issues of why and how emergent teams form and operate. These questions will help to build a theoretical foundation for the further study of ETTs.

Developing the analytical framework for ETTs will focus on the mechanics and social dynamics that drive the formation and performance of ETTs. See Table 2. The mechanics, or the "how" and "what" of ETTs, describes the organizational infrastructure (i.e., the flow of information between and among individuals in a given social network) that reflects how the operational work, conducted by the ETTs, gets done. The type, size, and frequency of information flows within the social networks of ETTs describe how that team's organizational infrastructure operates (Sengooba 2017). Stronger organizational infrastructure bonds can generate wider benefits, increased performance and the accomplishment of common goals (Wasche 2015). The methodology used to describe and quantify these information flows is social network analysis.

Table 2: Team Mechanics and Social Dynamics

Mechanics: "How" and "What"	Social Dynamics: "Who" and "Why"

• Cognitive/intellectual relationships
• Coordination and timelines
    o Management oversight
    o Supervisory oversight
• Communication & information flow
    o Social Network Analysis (SNA)
• Inputs: professional education, skills, expertise, and experience
• Information/knowledge exchange and sharing
• Outputs and outcomes
	• Social relationships/cohesion
	    o Reliability
	    o Reliance
	    o Respect and trust
	• Emotional intelligence
	    o Know yourself and coworkers
	• Insights about:
	    o Intense interests and disinterests
	    o Work styles
	    o Organizational focus
	    o Underlying motivation and stress
	• Cohesion/collaboration
	• Outcomes: creativity, innovation, productivity, fulfilling work

The social dynamics, or the "who" and "why" of ETTs, drives the mechanics of ETTs. "Who" the individual members of the ETT are, defined in terms of their individual personality and behavioral characteristics, provides insights about "why" they each approach their work and interact with one another the way they do. Insights about how to make one another more productive and enjoy the work more, can result in increasing the ETT's effectiveness and team performance. (Chinowsky et al. 2018).

How and What: The Mechanics of ETT Formation and Performance

SNA has been an instrumental tool for researchers focused on studying the interactions of teams since the concept was introduced by Moreno in 1934 (Moreno 1960). As a subset of structural functionalism, SNA provides a structured approach to analyzing complex systems through a combination of graphical and mathematical techniques. In the original concept formulation, sociograms were considered a formal representation of the patterns of interpersonal relationships upon which larger social aggregates are created. This sociology basis was extended to team dynamics, building on the concept that individuals or organizations exchange information during the performance of any activity (Scott 1991; Haythornthwaite 1996). The connections within a given network represent the differing nature of the working relationships, including communication and content; communication frequency; information transfer; and knowledge exchange and sharing (Chinowsky et al. 2018). SNA provides both a mathematical and visual representation of the actors and their relationships. Specifically, the ability to apply mathematical analysis to network information exchange provides researchers with established measurements for analyzing the effectiveness and weaknesses of the team being studied (Alba 1982). Table 3 identifies questions relevant to the study of ETT mechanics and the SNA measures that could be used to assess performance. SNA uses density to explain the variation in capacity and performance of organizations, degree centrality the level of activity within the team, betweenness centrality to determine where authority rests within the team, and power to identify the most influentional members of the team.

Table 3: ETT mechanics and the SNA measures that could be used to assess performance

ETT Question	Measure	Graphical Focus	What it tells us?
How connected are the members of an ETT?	Density	Network	What is the general level of connectedness within a specific social network?
Who are the most connected individuals in an ETT; and who holds the most information in an ETT?	Degree centrality	Node	How many direct, 'one hop' connections does each node have to other nodes within the network? How are relationships structured?
Which individuals hold authority or control within an ETT?	Betweenness centrality	Node	Who influences the flow in the network?
How connected are individual teams members in a given network?	Power	Node	How influential are team members?
Do different types of ETTs engage in different patterns of communication and knowledge exchange?	Density	Network	How information flow characteristics differ between networks?

Who and Why: The Social Dynamics of ETT Formation and Performance

We know that effective teams have a high level of cohesion and collaboration and are built on reliance and trust (Chinowsky et al. 2018). See Table 2. Others have analyzed networks within the engineering and construction field where concepts such as trust between project participants receive significant attention (Morton et al. 2006; Katsanis 2006).

Given that ETTs are composed of technical experts, assembled quickly to address post-emergency reconnaissance, restoration and reconstruction activities, they are likely to have only minimal working knowledge of their teammates (they may never have met before, or worked together before) how does that affect the social dynamics of the ETT and its performance? We know that even intact teams that have worked together over time may not work well together, in part, because they do not fully understand how to support one another and to ensure that every member of the team is making a contribution to the work that is driven by his or her personality and behavioral characteristics. Specifically, "who" each of the team members are and "why" they would choose to participate in a team helps understand what drives each of the team members to be productive and collaborate.

The Study Methodology

To answer the overall questions of how ETTs form, the authors have established the following questions to guide the study methodology:

- Would members of an ETT work more effectively with one another, if they understood what made them and their teammates productive? Would having hard quantitative psychometric data that describes the personality and behaviors of their teammates accelerate team cohesion and collaboration and foster reliance and trust? Would knowing more about the "who" and the "why" of each ETT provide clarity about who should play which roles in the ETT?
- Is it possible to identify specific behavioral and personality characteristics of individuals, who have performed well on an ETT, that could be generalized and used as predictors for recruiting and selecting future members of ETTs?

To provide the data needed to address these two questions, members of a number of ETTs would be invited to volunteer to complete The Birkman Method questionnaire online. Once completed, Birkman International arrays the data in a dashboard format for each individual, or compiles it into a report for the team as a whole.

The Birkman Method is an excellent tool to use for this analysis. It provides individuals with scores on a scale of 1(low) to 99 (high) to convey the intensity of their **needs** (i.e., motivators) their **usual, socialized behavior** (i.e., how they are perceived by their team members), and their counter-productive **stress reactions** if their needs are not met, for the following nine variables: **social energy, physical energy, emotional energy, self-consciousness, assertiveness, insistence, incentives, restlessness and thought.** Note that The Birkman refers to strengths but never to weaknesses so that data and the reports are easy to share with teammates.

The Birkman also provides data that is particularly relevant given our focus on the technical experts, who are members of an ETT:

- Intense job-related **Interests** (and disinterests) also scored on a scale of 1(low) to 99 (high): **musical, scientific, technical, artistic, literary, persuasive, outdoor, numerical, administrative, and social service**
- **Preferred work styles**, scored on a scale of 1 (low) to 10 (high), which includes a number of variables that are relevant to technical experts, including **preferred style of managing: directing, delegating, or being a "knowledge specialist," who leads by expertise and example**
- **Organization focus**, which describes graphically, using a bar chart, the best fit for the individual in an organizational environment
- **Job Families and Job Titles**, which arrays the individual's highest/lowest matches with 18 job families in the US Department of Labor's O*NET database with others who share his or her scores

The combination of the data obtained from the Birkman study and the data that can be obtained through traditional SNA will provide the insights needed to develop answers as to why ETTs form and why some are more successful than others.

The Grand Challenges and the Study of Emergent Technical Teams

Answering the questions surrounding ETTs serves to support the larger questions put forward by the Grand Challenges (GC) framework outlined by Sakhrani et al. (2017). It provides a synthesis of topics impacting the global project environment of the future. Global project opportunities and international teams (drivers) and the new project manager and project networks (grand challenges) were identified as receiving little attention in comparison to other areas of the synthesis. The disaster response services undertaken by ETTs can be viewed as a system of drivers and grand challenges. ETTs respond to national and international hazards and consist of members who often represent a broader global community of experts (drivers). The temporary nature of ETTs, reconstituted for each disaster event or project, creates a need for the new project manager and redefines the project network (grand challenges).

The study of ETTs offers the potential to broaden the research agenda of the EPO community, by building knowledge beyond the confines of more traditional engineering project topics, while offering the opportunity to track the evolution of drivers including international teams and global project opportunities (Sakhrani et al., 2017). Framing the disaster response services of ETTs as a system of drivers and grand challenges, also strengthens the bridges between the EPO community and the hazards and natural disaster research community. Based on the Grand Challenges synthesis framework outlined by Sakhrani et al. (2017), the study of ETTs advances knowledge and contributes scholarship to impact Grand Challenge 1 (GC 1): New Project Manager, and Grand Challenge 2 (GC 2): Project Networks. The study of ETTs also allows the EPO community to track the evolution of international team and global project opportunities drivers or umbrella constructs that set the stage for investigating these grand challenges.

The Drivers: Teams and Projects

The first driver or umbrella construct that the study of ETTs addresses is the international team. ETTs, as discussed, are created by the coming together of individuals with technical expertise from the engineering profession and related technical fields, to offer volunteer disaster response services. ETT members often represent a broader global community of experts. These team members respond to global events and thus can be viewed as international teams in terms of membership and response.

The influencing and differing phenomena (Sakhrani et al. 2017) linked to international teams in the GC framework, can be adopted to capture the unique considerations of ETTs. Differences within these teams may stem from differences in nationalities, sources of motivation, leadership styles, culture, and leadership perspectives (Sakhrani et al. 2017). Additionally, it is anticipated that the diversity of backgrounds created by disciplinary and professional training will create differences within these teams. With respect to areas of influence, ETTs can be national or international, determined by both the nationality and background of members, and the location and geography of hazard response. Additionally, local and national priorities may influence ETT operations. Particularly relevant to ETTs are the potential influence of professional standards and laws on ETT member roles and responsibilities.

Each deployment of an ETT in response to a natural hazard or extreme event can be viewed as a global project opportunity. Global losses as a result of natural hazards, including geophysical hazards such as earthquakes, tsunamis and landslides, as well as hydrometeorological hazards, including hurricanes, floods, droughts and wildfires, have amounted to $1 billion USD over the last four years (FAO 2018). Natural hazards are only expected to become more damaging due to global warming, land subsidence, and projected socio-economic changes in cities worldwide (Hallegatte et al. 2013). These events therefore motivate technical professionals to "pursue project opportunities….to partner in differing locations and geographies" (Sakhrani et al. 2017), to inform how communities can cultivate and engage a broad range of physical, social and other resources to ensure improved quality of life.

The Challenges: Networks and Managers

As interlinked teams that form broader reconnaissance networks, ETTs offer the opportunity to study project networks and the connections between them at multiple scales. An individual ETT can be viewed as a project network and its connections evaluated as described earlier. Additionally, an EER network can also be studied, the teams within it evaluated as nodes, and the links between them studied as connections, recognizing that the success of each individual team defines success for the broader EER network. Finally, the broad landscape of EER networks can be studied as a project network. Here each EER network can be evaluated as a node, and the interactions and connections between each EER studied as links. As such, beyond the examination of self-contained EER networks (e.g., teams within GEER), of great interest are the opportunities for interdisciplinary coordination that exist at the intersection of each EER network (e.g., GEER between StEER). Additionally, intersections between ETTs and local stakeholders, as well as intersections between the broader disaster response community including emergent organizations (volunteer citizen teams) and emergency response teams can contribute to the application of the GC framework.

As noted in the GC framework, each network is likely characterized by anchor tenants, peripheral actors or boundary spanning agents, unique governance and hierarchical structures, communication tools, and written and unwritten rules (Sakhrani et al. 2017). The increasing frequency and intensity of natural disasters (Slater and Villarini 2016), has created opportunities for EER in different national and international locations, and created a need for the deployment of ETTs composed of technical experts of different nationalities, cultures, professional backgrounds, and training. Advances in the educational and training needs of project managers or designated leaders functioning within these rapid response environments creates a need for the new project manager discussed in the GC framework. The study of ETTs offers the opportunity to focus on the education and experience of these managers, the decision-making tools and technology used, and the co-curricular and extra-curricular experiences (Sakhrani et al. 2017) invoked to achieve high-performing teams.

Conclusion

This paper discusses the need, theoretical argument, and proposed analytical approach for evaluating the performance of emergent technical teams (ETTs). ETTs are characterized as providing disaster response services following a natural or man-made event. The ability of an ETT to perform at a high standard is a function of its mechanics or organizational structure and its social dynamics or relationships within the team. ETTs can be usefully compared with other types of emergent organizations: Volunteer Citizen Teams (VCTs) and Emergency Response Teams (ERTs). They differ in a variety of ways, including member skills, missions, timing of operations, and training.

Findings in the literature relevant to emergent theory describe areas of theoretical relevance to the study and evaluation of ETTs:

- The introduction of structural theory into the analysis of emergent response teams and the exploration of structural emergence;
- An examination of trust, team dynamics, collaboration, and the role and nature of human and social capital;
- The mapping of knowledge coordination and exchange within emergent response teams; and
- The investigation of groups with latent knowledge (domain training) or as described in this research technical expertise and the performance of such groups.

Examination of the Grand Challenges framework indicates alignment between the role and function of ETTs, which is relevant to future engineering project teams. The next phase of this research program will involve comparative analysis of Extreme Event Reconnaissance (EER) networks and the ETTs they deploy. Similarities and differences between EER networks and related ETTs will be investigated using interviews, survey instruments, and a psychometric tool. Strategies for improving ETT performance will also be identified.

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