Disaster Response: An Examination of Resource Management in the Early Hours

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During the early hours of a disaster, resource management can be chaotic as the scope of the disaster is unfolding. Decisions must be made quickly with limited information to preserve life and property. This study identifies key characteristics of chaos during the early hours of a disaster by analyzing seven after action reports for wildfires. Employing a framework rooted in operations strategy, we classify characteristics of resource management chaos into structural and infrastructural resources. Study results provide insights for emergency managers to be better prepared to proactively minimize the possible complications resulting from resource management decisions made under pressing circumstances.

INTRODUCTION

Emergency situations require assistance with very short notice or lead time. Often times the emergency escalates to disaster level in seconds. Sometimes the emergency turns out to be a disaster without responders realizing it is a fully developed disaster until they have arrived on scene. Regardless, once the disaster is assessed additional resources are likely to be needed. The additional resources can be acquired from coordinating agencies based on mutual aid agreements, different levels of government agencies, charity organizations, and donations. During the initial phases of a disaster, resource management can be chaotic due to the volume and variety of resources called for in a short period of time. Resource needs are uncertain as the scope of a disaster is unfolding. Decisions often must be made quickly with limited information to preserve life and property. The number and the different types of organizations involved in the initial hours of a disaster further complicates the resource management task.

A good example of the scenario established above was seen recently in Colorado Springs, Colorado, where Black Forest Fire started in the northern part of El Paso County in 2013. On June 11th, at 13:42 hours, 911 calls reported smoke in northern Colorado Springs. Within 8 minutes, 2 fire agencies

responded. Within the next 20 minutes, four more area agencies responded including the El Paso County wildland team. Requests were made for air resources. Within less than 10 hours, incident command changed several times. At 14:12 hours, the County Emergency Operations Center was set up. At 15:45 hours, emergency command was turned over from the local fire districts to El Paso County. At 20:23 hours, emergency command was turned to the State of Colorado. On June 12th, at 06:00 hours, command transitioned to a Type 1 incident management team. This is the team that has the highest level of emergency management expertise. Requested additional resources begin arriving from state-wide fire districts. For the Black Forest Fire, over 100 organizations were involved in the disaster response (El Paso County Sheriff's Office, 2014).

The San Diego County wildfires also provide a great example of the volume and the variety of the resources engaged. Three recent southern California wildfires have the unfortunate distinction of being labeled among the worst in California history. The three fires occurred in 2003, 2007, and 2014. The first in 2003 burned in 5 counties and caused 24 deaths, 246 injuries, and it destroyed over 3,600 buildings and over 739,000 acres. It lasted from October 21st through November 5th of that year. It required over 15,600 personnel to combat it, and it caused over $3 billion in damages (Governor's Office of Emergency Services Planning & Technological Assistance Branch, 2004). In the 2007 fire, over 400 structures were damaged, and it burned almost 200,000 acres. In this fire, over 200,000 people were evacuated (California Fire After Action Report, 2007). In the 2014 fire, about 26,000 acres were burned, and about 65 structures were destroyed. The costs of this fire were estimated at about $60 million (California Fire After Action Report, 2014). In all three cases, the after action reports (AARs) were examined and analyzed to understand points of confusion and chaos in the early hours of the fire. It is clear that the AAR mechanism has resulted in recommendations and ultimately improvements that worked to control the damage of each disastrous fire because groups and efforts were better organized with each subsequent fire to minimize damages.

Although anecdotal evidence is abundant in describing the resource management chaos in the early hours of a disaster response, there is a lack of empirical studies on the characteristics of these chaos. Such void in the literature limits the ability to identify resource management areas that tend to incur problems when a disaster initially strikes. To fill this void, this study aims to identify the characteristics of resource management chaos when a disaster poses unexpected challenges that may shock the emergency response system. The research question we aim to address is "*What are the characteristics of resource management chaos in the early hours of a disaster response?*"

During these early hours, decisions need to be rushed to acquire, coordinate, and allocate critical resources. More importantly, such decisions often need to be adjusted to accommodate the ever-changing disastrous situations. Although made in the early hours of a disaster response, resource management decisions can have significant implications for the operations in later hours of the response. This can further impact the other stages of disaster response. We expect the current study would provide a comprehensive understanding of the characteristics of resource management chaos. With these potential challenges in mind, emergency response personnel can be better prepared and can proactively minimize the possible complications resulting from the resource management decisions made under pressing circumstances.

The remainder of the paper is organized as follows: The Literature Review section surveys the relevant literature on the types of emergencies, stages of disaster response and resource management from operations strategy perspective. The Research Methodology section describes the sources of the qualitative data. In addition, this section reports the demographics of the fire incidents under study and the analysis procedures utilized in the study. Further, the analysis results of the characteristics of the resource management chaos are reported in the Results section. The paper concludes with a summary of the findings and recommendations based on the study results, as well as contributions and limitations of the study.

LITERATURE REVIEW

Area Disasters vs. Catastrophes

Quarantelli (2006) and Wachtendorf et al. (2012) lay out seven characteristics of a catastrophic event: "1. Most or all of the community-build structure is heavily impacted. Facilities and operational bases of most emergency organizations are hit; 2. Local officials are unable to undertake their usual work role; 3. Help from nearby communities cannot be provided; 4. Most of the everyday community functions are sharply and concurrently interrupted; 5. The mass media system especially in recent times socially constructs catastrophes even more than they do disasters; 6. There are mass out migration for protracted periods of time. 7. Because of the previous six impacts, the political arena becomes even more important."

Holguín-Veras et al. (2012) further distinguish area disasters from catastrophes. They contend that a non-catastrophic disaster remains internal to a system where local emergency services, residents, government authorities and humanitarian organizations can still function to respond to the event and cope with the consequences (Wisner, Blaikie, Cannon, & Davis, 2004). In comparison, catastrophes result in devastating consequences that cripple and severely compromise the ability of the local community as a whole to respond (Holguín-Veras et al. 2012). Under such circumstances, outside assistance from other regions or countries may be necessary. The current study focuses on the impact of area disaster, where local emergency services play a key role in the groups of first responders.

Stages of Disaster Response

Four phases of emergency response operations unfold in sequence as a disaster occurs: mitigation, preparedness, response, and recovery (Altay & Green, 2006; Gyöngyi Kovács & Spens, 2009; Van Wassenhove, 2006). Mitigation involves applying preventive measures that are designed to alleviate the impacts of an incident or a disaster in case it happens or to prevent it from occurring. Preparedness activities involve training, allocating resources, developing emergency response plans, building communication networks, or preparing the community to respond when an event occurs (Altay and Green, 2006). Response activities are real-time actions taken immediately upon the onset of the event to preserve human life and minimize economic and environmental damages by utilizing resources rallied from government agencies, donors, or NGOs (Beamon, 2004). Recovery involves post-disaster relief activities that help to bring back the normalcy of the affected community by minimizing the long-term effects of the disaster (Gyöngyi Kovács & Spens, 2007). Each stage of the disaster response requires numerous decisions being made to assemble and coordinate resources. The current study focuses on the early hours of the "response" stage, when efficient and effective resource management is in dire need.

Resource Management in Operations Strategy

As it relates to operations strategy, manufacturing decisions can be categorized into two categories: the structure of the manufacturing process such as technology process, plant capacity and location, and the infrastructure of the manufacturing process such as quality management system, inventory management, work force management and organizational design (Hill & Hill, 2009; Swink, Narasimhan, & Kim, 2005). Structure of the manufacturing process refers to the operations decisions related to the design of the manufacturing process, while the infrastructure of the manufacturing process refers to the operations decisions related to the planning and control systems of the operation (Reid & Sanders, 2005). The combination of the structure and the infrastructure of the manufacturing process influence a firm's abilities to support its competitive priorities such as cost, quality, delivery and flexibility (Ward, Duray, Leong, & Sum, 1994).

From a theoretical perspective, decisions associated with operations strategy can shed light on our understanding of the resource management decisions involved in the early hours of disaster response. By identifying and classifying these resource management challenges, emergency response leadership and personnel can better target their efforts to the types of structural resources that are at great stake and to improve infrastructural resource management related to staffing/volunteers and supporting systems.

RESEARCH METHODOLOGY

Data Collection

The research question of the study investigates the key characteristics of chaos during the early hours of disaster response. It is considered that After Action Reports (AARs) are an appropriate source for data collection. Used intensively in the military field, AARs were originally defined as "*a professional discussion of an event, focusing on performance standards, that enables soldiers to discover for themselves what happened, why it happened, and how to sustain strengths and improve on weaknesses*" (US Department of Army, 1993). When it comes to disaster response, Federal Emergency Management Agency (FEMA) views AARs as one of the key components of the preparedness cycle (FEMA, 2014a). During the last phase of the preparedness cycle, organizations collect lessons learned, develop improvement plans, and track corrective actions to address gaps and deficiencies identified in events. AARs are one of the key content areas in the Lessons Learned and Continuous Improvement Program (LL/CIP) developed by FEMA (FEMA LL/CIP, 2014).

Although there are no universal format and content requirements, AARs generally provide detailed information tracking regarding the actions taken and organizations involved along with the timeline of the disaster. It is contended that these detailed tracking records provide substantial evidence for issues related to resource management during the early hours of disaster response. Therefore, this study launches data collection by searching AARs publicly available online. Seven relatively recent AARs were found to be substantial representatives of the available AARs online. These seven AARs cover the wildfire disasters that occurred in Colorado and California. Four AARs in Colorado include the Waldo Canyon Fire in 2012 and the Black Forest Fire in 2013. Because the Waldo Canyon Fire affected large areas in Colorado, AARs were developed by three different jurisdictions: the City of Colorado Springs, the City of Woodland Park, and the El Paso County Sherriff's Office. These will hereafter be referred to as WaldoCOS, WaldoWP, and Waldo EPSO, respectively. The Black Forest Fire will be referred to as BF2013. The three AARs reviewed for California concern the wild fire disaster responses in the San Diego area in 2003, 2007 and 2014. These will be referred to as SD2003, SD2007, and SD2014.

General Description of the Fires

Colorado Fires

In June of 2012, what became known as the Waldo Canyon Fire essentially began with an initial smoke report in Pike National Forest on the evening on June 22nd, 2012. The fire itself was not actually located until about noon on June 23rd. By 0600 on June 25th, transition was made to a Type 1 incident management team (IMT). There are 5 levels of IMTs depending on the jurisdictional level. Generally, the more wide-spread or complex the incident, the higher level of IMT will be used. Table 1 defines the different levels of IMT (International Association of Fire Chiefs; National Fire Protection Association, 2011). An incident may start at lower levels, but as it grows in scale and complexity, a higher level team may be requested. Although the fire was not completely "out", it was considered "ended" by FEMA on July 7th when transition was made back to a Type 3 team. During the fire, severe fire weather conditions resulted in its "blowing up" and raging into Colorado Springs neighborhoods. Losses from the fire are detailed in Table 2, which shows the losses from all five fires from most to least recent (City of Colorado Springs, 2013).

TABLE 1
TYPES OF INCIDENT MANAGEMENT TEAMS

IMT Types	Jurisdiction Level	Description
Type 4/5	Single Jurisdiction or County-Level Team	Normally used for events that exceed the local jurisdiction's on-scene command resources and last a minimal number of hours after dispatch Examples include a multi-alarm structure fire, a hazardous materials leak, or a school violence event.
Type 3	State or Regional Multiagency/ Multijurisdictional Team	Usually used for incidents that extend beyond a single operational period. Type 3 teams typically contain trained individuals from multiple agencies with the team developed at the state, regional, or metropolitan level. Deployments of type 3 teams usually involve 10—20 trained members to fill the various command and general staff positions within the ICS organization. Major incidents that extend into multiple operational periods, require a large commitment of resources from a regional or state level, and require a written IAP. Typical events include tornadoes, earthquakes, floods, or even a preplanned, large, public event. Because they are regionally or state based, type 3 teams are quicker to deploy to major, complex events, placing them in a position to be the initial event manager until transitioning to a type 2 or type 1 1MT.
Type 2	National or State Team (Regional)	Type 2 teams are self-contained and authorized at the national or state level for incidents of regional significance. These teams can be organized as either an all- hazard or wildland team and coordinated through the state, geographic area coordination center, or National Interagency Fire Center. All type 2 level personnel must meet National Wildfire Coordinating Group (NWCG) training requirements for the assigned ICS position. Typical deployments of type 2 teams involve 20—35 trained members used to support management functions at incidents impacting regional areas or requiring a large number of local, regional, state, and national resources. The US Forest Service currently operates several dozen type 2 1MTs.
Type 1	National or State Team (National)	Organized and operated like type 2 teams, type 1 teams are often deployed using 35—50 team members to manage incidents of national significance. The NWCG sets training requirements for the ICS positions at the type 1 level. It is not uncommon for incidents involving type 1 teams to have more than 500 operations section personnel in a single operational period. A total of 18 type 1 IMTs currently operate through the U.S. Forest Service.

Source: Chief Officer: Principles and Practice

TABLE 2
STATISTICS FOR SOUTHERN CALIFORNIA AND COLORADO FIRES

Event/Location	Date	Size (Acres)	Structures Destroyed	Fatalities	Costs
San Diego California	May 2014	26000[1]	65[1]	2[1]	$28.5M (Fire-fighting only, structure damage TBD, expected to exceed $29.8M)[1]
Black Forest Colorado	June 2013	14,280[2]	685[2]	2[2]	$500.0M[2]
Waldo Canyon, Colorado Springs	June-July 2012	18,247[3]	347[3]	2[3]	$365.2M[3]
Southern California	October 2007	517,937[4]	3069[4]	10[4]	$155.0M[4]
Southern California	October 2003	739,597[5]	3631[5]	24[5]	Over $3.0B[5]

1 San Diego 2014 After Action Report (California Fire After Action Report, 2014)
2 Black Forest EPSO After Action Report (El Paso County Sheriff's Office, 2014)
3 Waldo Canyon Fire City of Colorado Springs After Action Report (City of Colorado Springs, 2013)
4. California Fire After Action Report (California Fire After Action Report, 2007)
5. San Diego 2003 After Action Report (Governor's Office of Emergency Services Planning & Technological Assistance Branch, 2004)

Residents and the city spent the next year recovering as well as pre-planning for and subsequently enduring the flash flooding that occurred as a result of storms in the burn area. Then in 2013, the unthinkable happened. Slightly less than one year later, the Black Forest Fire began with a smoke report on June 11th, 2013. A fire was located burning on a resident's property in a semi-rural area that quickly escalated as fire weather conditions prevented initial responders from containing it. By 0600 the following morning, transition was made to a Type 1 incident management team (IMT). It was not until June 21st, that the fire as considered "ended" by FEMA as transition was made to a Type 4 IMT. See Table 2 for the losses during this time frame (El Paso County Sheriff's Office, 2014).

Further complicating resource issues and fire-fighting efforts, the Waldo Canyon Fire drew wild fire-fighting assets and personnel from around the country. However, at the same time Waldo was burning, there was a wild fire burning in Fort Collins, Colorado named the High Park Fire. The High Park Fire burned from 9 June to 1 July 2012. As an example of how some assets were taken away from Waldo and sent to High Park, the Air Force Modular Airborne Firefighting System (MAFS) C-130s split missions between the two Colorado Fires (Gazette Staff, 2012). Similarly, in 2013, at the time of the Black Forest Fire there was another fire in the region that also required fire assets, the Royal Gorge Fire to the south in Colorado (from June 11th-June 16th) (InciWeb, 2013). As the Black Forest fire exploded that June day, the initial requests for airborne assets could not be filled because they were being utilized at the Royal Gorge (Black Forrest Fire/Rescue Protection District, 2014).

California Fires

Unlike the situation in Colorado, the California wildfires are considered as multiple separate fires. On October 21st, 2003 the worst wildfire season, exceeding the 1993 record, began in southern California. There were 14 different fires in five counties, with the last not ended until November 5th and all five counties were declared disasters. Local, state, and federal resources were employed in the fire-fighting efforts. Similar to the aftermath of the Waldo Canyon fires, residents later endured flash floods and

mudflows due to storms in the burn areas (Governor's Office of Emergency Services Planning & Technological Assistance Branch, 2004).

Only four years later, on October 21st, 2007, the Witch Creek Fire began in that area of San Diego County. Extreme fire weather conditions resulted in additional fires and fires merging. A total of 17 significant fires and "dozens" of smaller ones were burning. By October 26th, most residents returned home. As in 2003, local, state, and federal resources were used in fire-fighting efforts with engines and crews provided from 13 different states that were in use through October 31st (California Fire After Action Report, 2007).

The May 2014 San Diego County wildfires were the largest in the region since the 2007 fires. The fires began with the Bernardo fire in the Camino Del Sur area at 1100 Pacific Daylight Time (PDT) on May 13th. Eventually, there were 14 fires burning, over 149,000 evacuation orders, and approximately 121,000 people actually evacuated. It was not until May 18th at 1430 that the fires could be considered "ended" as the San Diego Emergency Operations Center (EOC) deactivated and personnel returned to "staff duty officer status". Losses from all three of these fire seasons are detailed in Table 2 (California Fire After Action Report, 2014).

Analysis Procedures

The exploratory nature of our research question lends itself to a qualitative research approach based on grounded theory (Glaser & Strauss, 2009). A grounded theory approach is a methodology used to denote theoretical constructs derived from qualitative analysis of data (Corbin & Strauss, 2008). Barratt et al. (2011) contended that priori constructs or ideas can provide insights on the new research design and data collection. With this notion in mind, the study was launched with tentative categories including chaos related to structural resources and infrastructural resources, applying the hierarchical coding approach outlined by Corbin and Strauss (2008) to analyze the collected AARs.

Following the analytic process outlined by Corbin and Strauss (1990), the analysis employed three types of coding approaches, open, axial, and selective coding (Corbin & Strauss, 1990). Starting with open coding, the authors read through the AARs, considered the possible meanings, and examined the context and timelines carefully. Focusing on the activities logged within approximately 48 hours of the disaster, the study gave interpretive labels to the content by coding the text into broad categories and subcategories. For example, texts in an AAR that describe the loss of cell phone towers were coded as a subcategory "communication structure damage" under the "capacity and facilities" dimension of structural resources. Furthermore, axial coding was used to crosscut or relate these individual categories to each other. Axial coding is done by relating the elements identified in open coding to the broader categories. The processes of open coding and axial coding were intertwined because categories were constantly added, deleted, revised or integrated as texts in the AARs were analyzed. During the coding processes, researchers communicated frequently to cross-validate their coding of the AARs. As the final stage of the analysis, selective coding was used to unify and summarize the categories identified by open and axial coding. The following section reports the analysis results.

RESULTS: CHARACTERISTICS OF RESOURCE MANAGEMENT CHAOS

The AARs reveal that the early hours of disaster response are chaotic. Chaos can be viewed as it relates to both structural and infrastructural resources. Three key subcategories of chaos concerning structural resources emerged based on the analysis of the AARs: 1) technology, 2) capacity and facilities, and 3) inventory and service capacity. Meanwhile, five subcategories of chaos related to infrastructural resources were identified: 1) workforce and volunteers, 2) operating plans and control systems, 3) organizational structure, 4) compensation systems, and 5) support services.

Structural Resources

Technology

In the emergency response context, technology is concerned with the tools used for communication and the information systems used for tracking resources and activities. This includes the use of social media and reverse 9-1-1 types of telecommunication systems. Within the technology category, challenges occurred in the following areas: interoperability, technological capability, information systems for resource tracking, and communication and social media.

Interoperability problems. Both the SD2003 fire and BF2013 indicated general interoperability issues in communication between state and local agencies. Interoperability occurs when the information and communication systems of separate organizations are not able to work together. This is particularly an issue with radio systems when multiple agencies involved in an incident are unable to communicate. This can severely undermine disaster response efforts and can result in loss of life and property in a dynamic situation.

Technological capability issues. For the SD2007 fires, video conferencing and video streaming of aerial feeds were available to Emergency Operations Centers (EOC), but not to Incident Commanders (ICs) due to incident command not having access to the necessary equipment. Incident commanders could have benefited from these aerial feeds in managing the fire response. However, while the EOC had access, the location of the fires sometimes inhibited the receiving of video feeds. The AARs do not provide any information regarding the source of the aerial video. One would suspect that this was from helicopters, especially in the earlier fires. As drones are increasingly being used for nonmilitary and humanitarian applications, perhaps they can be used in fire management in situations and areas where lower altitudes views would be useful.

The SD 2014 fires indicated a need for technology for better fire perimeter maps and faster updates of hotspots that develop. This would provide important information for protection of firefighters and civilians as well as for management of the fire.

The WaldoEPSO AAR indicates the establishment and provision of county IT data support on Day 1; however it was not until Day 2 that county IT provided for broader communication with phone service and additional monitors. The provision of support without enough equipment limited the effective use of this important resource. Disaster planning should provide for the capability for quick sourcing of necessary communication equipment, whether this involves caches of stored equipment or detailed inventories of resources available in each jurisdiction that could be appropriated for disaster management. The SD2007 AAR suggested that telecommunications vendor resource availability should be documented to be used for preplanning for future events.

According to the WaldoCOS AAR, when the incident command post was moved as the fire progressed, radio and cellular connectivity was poor. Both the Colorado Springs police department (CSPD) and the Colorado Springs fire department (CSFD) were working from their command vehicles and could not tie into existing infrastructure. They had to relocate the vehicles until the infrastructure was established. The pace of the fire progression required a quick decision on where to relocate command, without information beforehand regarding connectivity.

The WaldoWP AAR documents the purchase of a smart TV for the City of Woodland Park EOC, at the end of the second full day of the fire. This indicates that the EOC may have had limited information about the progress of the fire as well as limited communication capability during the critical early hours.

Limited information systems for resource tracking. The SD2007 fires revealed that technology is needed for tracking arriving and assigned resources, both personnel and apparatus. It is important to have real-time information about the resource flow: what resources have been ordered, have arrived, and where they are at any given time. This is important not only for fire management but safety as well. Resource tracking as part of the emergency response operations were found to be an issue for all the fires reported in the AARs.

Communication and social media issues. In the SD 2014 fires, a Joint Information Center monitored social media and verified information posted, then used social media to correct misinformation. While social media can be valuable for providing real-time information, often incorrect information will be

disseminated before it can be verified. Similarly, the COSWaldo AAR indicated that twitter notifications of park and trail closures were posted, then later confirmed by the EOC. Further highlighting the necessity to ensure accurate information, the WaldoWP AAR reported that a Nixle communication (Nixle is an E-mail and text message emergency message system with voluntary sign-up that was used in the Waldo Canyon Fire) initially communicated incorrect information regarding road closures that had to be corrected.

For WaldoCOS, the media briefings included multiple agencies – city, county, US Forest Service (USFS), and the IMT. Further, the Joint Information Center (JIC) was not established until the beginning of the second full day of the fire. The delay could undermine communication among agencies and hinder data tracking related to resource allocation. Given the nature of the AARs for San Diego, there is no information about when the JIC was established for the California fires.

For the Waldo Canyon fire, the WaldoEPSO AAR indicates that Geocast (a reverse 9-1-1 system that sends automated messages based on resident addresses) was used to notify residents of mandatory evacuation of small towns within the county, but not parts of Colorado Springs. One concern with Geocast is that cell phone numbers would only be included if the resident had registered that number with the county, so for those residents with no land-line, it is possible the evacuation information would not be received. Similarly, the SD2014 AAR indicates that an "Alert San Diego" system was used for communication and as an "opt-in" system, many residents may not be reached with critical information.

The WaldoWP AAR indicates that the Teller County Sheriff's Office (TCSO) used Geocast to send evacuation notices. However, Nixle was also used by both TCSO and the Woodland Park Police Department to notify residents of wildland fire burning but not threatening, evacuation orders, road closures, shelter locations, evacuation status changes (evacuation status includes "pre-evacuation", voluntary evacuation, or mandatory evacuation), and whether the hospital emergency department remained opened or closed. Two different scenarios are represented here that raise concerns about coordination of information: multiple agencies issuing the same technology (Nixle) to communicate information to the same geographic area and the same agency (TCSO) using multiple technologies for the same information.

A comment from the SD2007 AAR indicates a rather frightening communication issue. The comment: "The AlertSanDiego and Reverse 911® systems are part of the overall public notification process and should not be solely depended upon for situational awareness" implies that some personnel involved with the incident were relying on these communications with the public as a primary information source. Fortunately, a similar comment was not found in the SD2014 report.

Multiple communication channels were used during the early hours of fire. Based on the AARs, we observe that the communication channels used include Twitter, Emails, text messages, Geocast and webEOC. While multiple communication channels may enhance the efficient distribution of real-time disaster response information, it may be detrimental to the effectiveness of the communication. Information needs to be verified and confirmed to ensure the accuracy and credibility of the message posted.

Capacity and Facilities

In the context of disaster response, capacity and facilities include physical equipment and structures such as buildings, radio towers, communication equipment, and apparatus. Challenges identified center on communication equipment shortages, communication structure damage, apparatus issues, and shelter capacity shortage.

Communication equipment shortage. In SD2003 fire, a need for additional caches of communication equipment was identified. In SD2007, a shortage of portable radios impacted deployment of firefighters, so an emergency purchase of additional radios was made. This indicates the need for additional radios for disaster situations. In WaldoCOS fire, the Joint Information Center location did not have a bank of telephones, so cell phones were provided by a Denver vendor. These phones then had a Denver area code making them long-distance for area residents and personnel. This lack of equipment made communication inconvenient and costly due to the usage of long-distance calls.

Communication structure damage. In the BF2013 fire, loss of cell phone towers near the fire line impacted service capacity for communication by cell phone, indicating the need to ensure adequate radio support. In WaldoCOS, communication towers and water supply were threatened by the fire which would have compromised radio communication for fire-fighting operations. Alternative radio communication methods or additional portable towers would have limited capacity should this infrastructure fail.

Apparatus issues. Prominent apparatus issues reflected in the AARs center on the volume and the variety of apparatus needed in the early hours of disaster response. In WaldoEPSO, a county wildland fire officer ordered an air tanker and other resources. Colorado Springs Fire department also ordered air support. This caused confusion as to who was in command; who was "in charge" of ordering air tanker resources. The fire was on county land, not within city jurisdiction. In SD2007, military apparatus were also involved in firefighting efforts. Military helicopters used for water drops and information gathering. These military helicopters were heavier and less impacted by erratic winds than smaller, local fire helicopters. Coordinating with military resources adds complexity to EOC resource management when the fire situation calls.

Commonly reflected in the AARs is the shortage of apparatus in the early hours of disaster response. In SD 2007, local fire apparatus were over-committed to the fire, resulting in insufficient units for routine incidents. Insufficient apparatus for the available firefighters indicated a need for additional reserves. SD2014 further highlighted the need for staging air support apparatus during high-fire danger conditions.

Shelter capacity shortage. As the fire progresses drastically in the early hours of a disaster, shelter capacity may run out quickly. In WaldoEPSO, the American Red Cross opened shelters for evacuees. However, there are imminent needs for shelters not only for evacuated humans but also animals. In WaldoCOS, animals other than service animals were not permitted at shelters. As a result, there is a lack of capacity for pets of those evacuated from the fire. Local residents and businesses volunteered to provide space for those in need. This situation was complicated because the Humane Society was out of shelter capacity for pets. Because the affected area has lots of farms, shelters were needed not only for pet animals but livestock. As reported in WaldoEPSO AAR, large animal shelters were opened for evacuated livestock. Such additional needs add challenges to shelter capacity because livestock needs larger space, higher quantities of food, and a higher amount of work was required for feeding and cleaning than pet animals.

Further complicating the situation, disaster may spread dramatically and affect a significantly higher amount of area and residents than expected. The establishment of a shelter faces the challenges of having to open earlier than expected, having to relocate due to the fire or requiring a massive space to accommodate affected residents. For instance, in SD2007, the rapid pace of the fire forced the evacuation timelines to move forward, which required an early opening of the evacuation shelter. Also in SD2007, temporary shelters were set up as the shelters already set up by Red Cross had run out of space. Some evacuees had to be evaluated again from the shelters where they were staying because these shelters were in the path of the fire. To accommodate larger numbers of potential evacuees and avoid being in the path of the fires, the city chose Qualcomm Stadium as the primary shelter facility.

Inventory and Service Capacity

Service capacity in the context of disaster response reflects primarily the technological capacity required for communication during the disaster. Insufficient radio channels, insufficient network capacity, too few phone lines, and limited dispatch capability to receive calls in the early hours are all service capacity issues indicative of the chaotic aspects of this critical period.

Insufficient radio channels. In the SD2007 fire, as a result of too few radio channels, combined with a very large incident, too many units were assigned to a single channel. With so many units on one channel, communication for firefighting was severely impacted. This would be a deadly situation in the event that fire conditions and direction change rapidly.

Insufficient network capacity. In SD2007, an Internet network slowdown due to too many users accessing live data feeds coupled with a power outage prevented the GIS technicians from accessing information necessary for fighting the fire.

Insufficient phone lines. In the BF2013 fire, when a resident called the CSPD (rather than 9-1-1), to report a grass fire, too few phone lines coupled with a high volume of calls prevented transfer of the call.

Limited dispatch capability. The WaldoCOS AAR indicated that dispatch became so inundated with 9-1-1 calls about smoke, that it requested citizens be notified through variable message boards NOT to call 9-1-1 to report it. Limited 9-1-1 service capacity during the early hours of disaster resulting in any restriction of incoming calls reporting the fire may inhibit valuable live information concerning the fire spread spotted by residents. During the preparation stage of a disaster, emergency services should ensure backup dispatch capacity be available to avoid restricting calls from residents reporting real-time fire information.

Infrastructural Resources

Workforce and Volunteers

Disaster response involves a variety of workforce and volunteers, including those involved in the primary response as well as a variety of support services. This particular dimension includes the workforce and volunteers involved in the primary response, which in this case, is fire-fighting. The common theme observed from the AARs involved concerns over personnel tracking.

Personnel tracking concerns. While each fire is unique with respect to the number of agencies responding, resource needs, and pace of progression, a key concern that is evident in all AARs is the need for technology to track arriving and assigned resources, both personnel and apparatus. SD2007 specifically mentioned this issue and it is discussed in the technology section above. However, this is also an infrastructural issue as the resource tracking of personnel is critical to effective management of the fire-fighting effort.

The WaldoEPSO AAR indicated that fire crews from five agencies including Colorado Springs Utilities and the county wildland fire crew responded the first night to try to locate the fire. When it was not located that night, crews were released, but by noon the next day, the wildland fire crew was paged out and worked through the day and night to protect towns as the fire grew quickly to 4000 acres. During this same time frame, the WaldoWP AAR indicated that in neighboring Teller County, another fire agency responded to provide protection of critical water infrastructure in a remote area of the county. Also, during this chaotic period, a fire elsewhere in the county was reported which required fire resources. The variety and volume of personnel involved during this short-time frame highlights the critical need to have a tracking system for all resources involved in the disaster response effort. Similar to the structural technology resource area, it is critical to know what personnel resources have been requested, what have arrived, and where they are at any given time.

Operating Plans and Control Systems

In the context of emergency response, the operations plans dimension involves the infrastructural components involved directly with incident response. This was the largest category identified in the analysis. Challenges include resource tracking and coordination issues, poor information sharing, fire-fighting effort challenges, and evacuation execution issues.

Resource tracking issues. A large variety of resources are involved in disaster response, from the personnel, equipment, and apparatus needed for the direct incident response to large volumes of donations from well-meaning citizens. During the initial chaotic period, this can be overwhelming and a method of tracking these resources must be established quickly. This is particularly critical for those resources required for the response.

In the BF2013 fire, fire-fighting resources were ordered by the Fire Marshall while he was still enroute to the scene. These resources were never acknowledged by the Chief in command. It is important that there be a method during the initial chaotic period for being sure of what resources have already been requested. In the Waldo Canyon fire in 2012, the Waldo COS AAR indicates that initially resource requests were handled by individual departments. This was later centralized within the City EOC. This reflects at the early hours of disaster response, there is a lack of integrated resource management system. Given that a fire is initially a “routine” response that escalates into a disaster, it makes sense that resource

management is not centralized from the start; however, a mechanism should be established for tracking all resources ordered by different agencies. It should be a system that can be implemented as soon as a second request for resources is made.

A related issue is the need for a uniform system for tracking resources. The BF2013 AAR reported an IT observation that there was no unified resource tracking across the event. Many different resources were pulled from other locations during the course of the first week, (e.g. trucks, people, supplies, etc.), and there was no consolidated tracking and reporting of these resources. This not only hinders fire-fighting efforts if command does not really know what is available, but also results in challenges for reporting and cost recovery. An example of this was overtime tracking. Each operational area tracked overtime (or maybe did not in some cases) according to their normal practices. So submitting time sheets and accounting for overtime was difficult.

Personnel tracking is a specific area that must be proactively handled from the start of the incident. Both the WaldoCOS and WaldoWP AARs included situations where this was a problem. The WaldoCOS AAR reported that personnel accountability was not achieved until the full day 2 of the fire. CSFD used those early morning hours to conduct a full accountability check of personnel. Personnel accountability was managed out of the CSFD Mobile Command Post, located at the staging area. Full personnel accountability was achieved and, a plan was finalized to rotate CSFD staffing in the Cedar Heights neighborhood. This rotation plan would keep the apparatus in the neighborhood and would allow assigned personnel the ability to work the fire without disruption, until rotated. While the early hours are chaotic, a rotation plan should be established as early as possible. This is critical not only to ensure that there is no disruption in coverage in the area, but also to ensure the fire-fighters get relieved so they can rest. In the WaldoWP AAR, it was the evening of full day 2 of the fire that telephone lists for city employees were updated to include both home and cell numbers. Employee information should be kept up-to-date in the event that a disaster requires being able to contact or locate them quickly.

Tracking and managing of donations received is another concern. SD2007 used a resource manager board to track resources but found that it was not effective for tracking donations inventory. The WaldoCOS AAR reported that effective logistics is lacking during the early hours. Donations inundated the staging area, and there were insufficient staff and storage space to manage them. A proactive approach is needed early to ensure adequate storage space and to request additional volunteer assistance. One key problem here is that it is possible that well-meaning citizens will donate items requiring refrigeration. There will not necessarily be refrigeration available at the staging area, so a system needs to be in place to re-route these donations to another location where they may be useful.

Resource coordination problems. In addition to tracking resources, poor coordination of resources causes confusion in the early hours of disaster response. SD2003 indicated that there is a need for streamlined methods for coordinating local and state with federal, out-of-state, and military resources. This is particularly important because of long resource acquisition time.

The WaldoEPSO AAR revealed that the rapid growth of the fire necessitated the activation of the EOC quickly. This required that resources in terms of personnel, supplies, and information systems be pulled together in a short period of time. Poor coordination would delay the establishment of this important support center.

The WaldoWP AAR revealed another coordination issue that created confusion: the variety of entities involved in the early hours. Multiple personnel from Woodland Park (mayor, police personnel, public works personnel, the city emergency manager, and Teller County Sheriff met within two hours of their awareness of the fire to discuss fire issues such as phase lines and trigger points and agreed to reconvene the next day. This highlighted the potential complexity of the incident and also raised the issue of who should make these types of decisions. Further, their decision to reconvene the next day was premature as the fire advanced at such a rapid rate, that they were forced to reconvene earlier.

Poor information sharing. WaldoEPSO AAR reported that at about 0750 the morning after the initial smoke report, El Paso County Sheriff's Office Communications received a call from a citizen who reported that he observed a fire smoldering off a dogleg on Waldo Canyon Trail while he was hiking. He was advised that responding agencies were aware of the report. The reporting party's contact information

or specific location was not captured or reported to responding agencies as the dispatcher believed responding agencies were aware of the location of the fire. Poor communication of status with dispatch resulted in missing key information about fire location, thus allowing the fire to spread further before it was located.

The WaldoWP AAR also revealed information sharing concerns: "About 12 noon City Manager David Buttery receives call from his wife who is travelling eastbound on US Hwy 24 near Cascade reporting large column of smoke in the Waldo Canyon area. Buttery contacts Woodland Park Police Department (WPPD) Dispatch to see what information is available. Minimal information available." This is the 2nd day of the fire. Woodland Park had no knowledge of the smoke report and investigation the previous day. One would expect that neighboring areas potentially in the path of any fire would have been notified of the initial smoke reports and be informed of the potential hazardous situation. This was especially critical in this particular situation given the high fire conditions present and the history of the area having had high fire danger conditions for the previous several years.

Fire-firefighting effort challenges. The AARs for all fires revealed issues involved in the fire-fighting operations. In SD2007, it was determined that helicopter water drops were only effective on structures just beginning to burn. If a structure was more fully involved, they were ineffective. Prior to this discovery, valuable resources may have been used for situations where they were not effective.

In BF2013, the pace of the fire's advance created challenges for fire management. In one instance, command did not have information on the number of structures involved, implying that real-time information not available to assist fire-fighting efforts. Further, due to the blow-up of the fire, at one point a radio transmission came through in which emergency traffic was requested. Given the urgency of the situation, the unit did not identify themselves, thus not following proper protocols. The multiple statements in the AAR of "an unknown unit" reveal the chaotic situation at the early hours of the fire.

The WaldoEPSO AAR described the initial difficulty in locating the fire itself. The initial smoke report was in Pike National Forest, near Pyramid Mountain, so the USFS took command and established "Pyramid Command". USFS personnel were unable to locate the fire and Command released the resources for the night. Given that fire lays down at night, it is harder to detect at night or in early morning, so it is not surprising that the resources were released. However, the following events revealed that the fire was actually in a completely different location than the initial smoke report indicated. At approximately 0750 hours the next morning, smoke was reported in the Waldo Canyon area and county fire personnel were notified and wildland crews paged. This is in a different area than the original search by the USFS.

Evacuation execution issues. The analysis of the AARs unveiled several concerns involved in evacuation efforts. As the fire was progressing rapidly resulting in the need for multiple evacuations, several phases of the process became evident: before evacuation, during evacuation, and after evacuation. Prior to evacuation, communication with residents was a critical concern as evidenced by the issues mentioned previously for the technology structural resource component. The infrastructural piece involves who would be involved in the notification process, what information would be communicated, what kind of assistance would be needed, and who would provide that assistance.

In the WaldoEPSO AAR, the evacuation status was changing fairly rapidly and timing was late at night, raising the question about not only how to notify residents, but how to ensure that they received the notification. As soon as smoke was reported in Waldo Canyon, voluntary evacuation was ordered for certain areas at 12:03; by 15:44, the status was changed to mandatory. At 0742 the next morning, deputies began evacuating those areas. More resources were needed to assist with evacuations to ensure residents had left. More law enforcement resources were also needed after the evacuation to block roads to prevent residents from returning and to protect against looting.

The WaldoEPSO AAR reported that as the fire continued to spread, Woodland Park and the Air Force Academy were put on "pre-evacuation" Status. Evacuation status progressed from pre-evacuation to voluntary to mandatory. The differences in these may be confusing to residents and communication is critical.

The WaldoWP AAR indicated that a proactive approach was taken in that evacuation notices were prepared in advance and included travel routes to help minimize traffic issues and to inform residents of road closures. In the BF2013 fire, the advance was so rapid that this was not possible.

Organizational Structure

Establishment of clear lines of authority is essential to effective emergency response. Multiple lines of authority and changes in command can create confusion particularly in the early hours of a disaster. Analysis of the AARs indicated that in addition to some general organizational challenges, all fire responses experienced problems related to command confusion and issues related to transitions of command.

General organizational challenges. In the WaldoCOS, it was reported that the EOC wanted to establish logistics, operations, finance, and planning, but did not have the personnel to staff the positions. This reflects the shortage of the personnel during the early hours. This shortage affects the establishment and execution of this important support function.

As the fire progressed (still full day 1 of the fire), the WaldoEPSO AAR indicated that the decision was made to order a Type 1 IMT. The WaldoWP AAR indicated 7 PM as timing for request of a Type 1 team indicating the pace of fire spread was such that the highest expertise for fire management was needed within 7 hours of locating the fire. The Woodland Park personnel had originally not intended to meet again until 1100 the next morning.

Command confusion. Command needs to be firmly established immediately. In the BF2013 fire, command was not clearly stated by the Chief who assumed initial command. During the early hours, it was not clear who should be in command since the affected area belonged to different levels of jurisdictions.

The BF2013 AAR also reported a long discussion involving multiple agencies about transitioning from the district to county or state. During this lengthy process, another chief assumed interim command "for a few minutes". This chief was unsure when to relinquish command (based on a question regarding this prior to the final transition being determined). This raised the question of whether anyone was really managing the fire during this time.

The WaldoCOS AAR reported confusion about who was in command although fire watching started at 7am in the morning. It was not until 1pm that USFS took command. Additionally, the WaldoCOS AAR revealed that confusion about command and command location created issues in the transition process to a Type 1 IMT. After a Type 1 team is requested, involved agencies needed to formally delegate authority. Due to the confusion, CSFD was unable to deliver the official delegation, possibly delaying formal transition.

As reported in the WaldoEPSO AAR, early in the Waldo Canyon Fire progression, CSFD established a command and staging area. However, given that Waldo Canyon is not in the city limits, this could create confusion about command structure. The USFS was in command, working with the county, as of the first smoke report. However, CSFD established their own command post, implying that unified command was not being used at this point. Multiple agencies were managing the fire separately. In the Incident Command System (ICS), with unified command, all agencies and jurisdictions involved share command (FEMA, 2014b).

For the Waldo Canyon Fire in 2012, given that the initial smoke reports were on Pyramid Mountain, the fire was initially called the Pyramid Mountain fire, but this was changed once the fire itself was located. This created some confusion as to where incident command was located. CSFD reported to Pyramid Mountain Road to provide Delegation of Authority to the IC in preparation for transition to a Type 1 IMT. The Fire Marshall understood that CSFD thought Pyramid Mountain was Incident Command and advised CSFD that Incident Command was already established and requested CSFD report back to Cedar Heights as the fire was progressing in that direction.

The WaldoEPSO AAR reported that the Incident Command Post (ICP) for the Type 3 IMT consisted of USFS and the El Paso County wildland fire team and was established at 1500 hours on the first full day of the fire at a specific location. It appears that the actual ICP may not have initially been physically

established. Later, as the fire progressed, the physical location of the ICP had to be moved due to fire spread. As command is moved, this creates additional confusion. A transition to a Type 1 IMT had already been requested and personnel were arriving. Both Type 1 and Type 3 personnel needed to know where to go. Having multiple levels of IMT involved further complicated the situation.

From the WaldoWP AAR, it is unclear whether the City of Woodland Park and Teller County were included in the unified command of the incident that had been established in El Paso County. Even though the fire had not crossed into Teller County, given the proximity to the fire and typical wind direction, one would expect them to be included. By 1000 hours on the second full day of the fire, the utilities director and chief water plant operator met to identify the specific location of a critical pump station to provide that information to the fire agency for the area to ensure it would be protected as the fire spread. This indicated the increasing complexity of the incidents and there are more personnel involved than at the initial meeting. This raised questions about whether information is being coordinated with fire command and whether Woodland Park and Teller County were not included in any unified command structure. The question of whether they were involved in the unified command was further highlighted as the discussion began about identifying evacuation areas and needing to bring in the hospital CEO. It was not clear who was discussing these issues, where they were getting the information needed to make decisions, and who was making these decisions. Other meetings with city and county personnel involved discussion about fire protection and it was again not clear who was involved in these meetings and whether they were participation in the unified command structure.

Further confusion is created due to the establishment of multiple EOCs. There were EOCs for the city of Colorado Springs, El Paso County and City of Woodland Park. As the EOCs provide incident support, this increases the complexity of resource management issues.

Command transition issues. Transitioning to the Type 1 IMT required a specific process requiring delegations of authority from participating agencies. The WaldoEPSO AAR indicated that in preparation, participating agencies began submitting them. All were received promptly except for City of Colorado Springs; although it was received the next day, prior to the official transition. It is not clear why there was a delay. As the fire spread, requiring more evacuation notices, more agencies were involved. Once the Air Force Academy was put on pre-evacuation status, they signed a Delegation of Authority to facilitate the transition to the Type 1 IMT.

The WaldoEPSO AAR indicated that prior to transitioning to the Type 1 IMT, unified command would continue with the participating agencies. This could cause issues as different people may have different opinions about how the incident should be managed. Also during this interim period, as Type 1 team members arrived, they assisted the Type 3 team even though the official transition had not taken place. This could cause confusion about the command structure and as new personnel take over, there could be continuity issues.

In addition to the transition between overall IMTs, the IC can change between operational periods resulting in a transfer of command. According to the WaldoEPSO AAR, this did occur during the initial days of the Waldo Canyon fire in 2012. Clear processes must be in place and carefully followed to assure continuity.

Transition issues in the BF2013 fire involved a lengthy discussion that took place to make the decision about transitioning from district level to county or state. Rather than using unified command, the state fire management officer insisted on single command at the state level. It was finally decided to establish Type 3 command with the county Fire Marshall in command. The reorganization and command exchanging process took about 1.5 hours. This time frame is long considering the fast changing fire spread. It is a chaotic period, where the "one" command system is not clear. This was during a highly active period of the fire.

Compensation Systems

Reimbursement issues are the primary compensation issue that arises in the disaster response context. Reimbursement would be necessary for both personnel and equipment usage. It is a concern both for

mutual aid deployments and other organizations involved. The method of disbursement was unclear for SD2003 and participating organizations did not know how to proceed to be reimbursed.

One potential complicating factor is that in the early hours, a fire may be contained by the responding agency and additional resources not needed. It is only as the incident grows to require outside resources and other entities that the IC would establish a finance function to handle the reimbursement issues. It is unlikely to be present from the start. Also, when an incident progresses quickly, and the volume and variety of arriving resources increases rapidly, tracking those resources is difficult. In the early hours, arriving resources may be tracked using a manual process with paper-based forms and resource logs. As the incident progresses in complexity, these documents can accumulate rapidly and must be processed after the fact once a formal system is established. The length of the delay in getting a formal system established and the pace of incident growth during this time determine the amount of work required to process the backlog.

The WaldoCOS AAR reported that a code category was established to track city employee time late in the day – this was hours after the staff started to work on the disaster response. Such coding categories should be in place during the preparation stage for disaster response and be ready to be used once the disaster response is initiated.

The BF2013 AAR included a compensation issue that was mentioned above as an example of a resource tracking issue. There was no uniform system for tracking hours. Each operational area tracked overtime (or maybe did not in some cases) according to their normal practices. So submitting time sheets and accounting for overtime to facilitate reimbursement was difficult.

Support Services

Disaster response involves a variety of workforce and volunteers. This particular dimension includes the workforce and volunteers involved in support services to the primary response and as such involves any workforce and volunteers not specifically involved with the fire-fighting effort. The AAR analysis indicated issues related specifically to personnel needed for evacuation and shelters as well as a variety of other volunteer issues.

Evacuation issues. There were a variety of evacuation issues evident in the AARs contributing to the chaos in the early hours. In SD2007, residents would not evacuate until specifically called, which meant that personnel resources were needed to ensure that mandatory evacuations were followed. Similarly, the WaldoCOS AAR indicated that police and National Guard personnel were used for security in evacuated areas as well as for going door-to-door to ensure that the mandatory evacuation orders were being followed. In the event a resident refused to leave, the information was recorded with dispatch to track the residents.

Security was a major concern during the process of evacuation. The WaldoCOS AAR reported that the police force was overburdened with the clearance of the evacuation area. In the BF2013 fire, after residents had evacuated, security system alarms in homes indicated break-ins and that looting was beginning. A proactive approach needs to be in place instead of the reactive approach. During the early hours of disaster response, law enforcement need to be in place from the start to prevent burglary and crime. Collaboration between contracted security services, other law enforcement agencies, or community volunteers should be used to ensure the security of the evacuated area. These types of arrangements should be included in the preparation phase of disaster response.

The WaldoEPSO AAR included that the closure of highways required State Patrol resources. This resulted not only in those resources not being available for other law enforcement concerns, but the road closures themselves would have complicated evacuation.

BF2013 indicated that effective communication and information updates was lacking during the evacuation process. “Civilians were calling with questions: “How can I get back in; how do I get out; who can help me in evacuating?” This reveals a need both for preparation to include planning for volunteers to answer these types of questions as well as an effective communication plan.

Shelter problems. In SD2007, a professional baseball field was opened as a shelter. The AAR also reported that the Local Red Cross chapter did not have enough volunteers to staff the number of shelters needed. The incident was larger than could be handled with local resources.

Community general volunteer issues. While the SD2007 AAR indicated insufficient volunteers to operate the shelters, both the SD2007 and SD2014 AARs indicate that the Red Cross had difficulty dealing with the surge of volunteers. SD2007 also reported that extremely high volunteer support overwhelmed the ICP contributing to initial confusion and disorder. Also, community emergency response volunteer teams (CERT) served as runners, drivers and performed other logistical functions. There is clearly some disconnect related to the volunteer situation in the 2007 fires.

WaldoCOS reported a need for volunteers to staff JIC. Given the insufficient staff and call for volunteers, a concern is raised about whether these volunteers trained to do the job. Also, during early hours of the disaster, many city personnel much needed for emergency response were affected by the fire, which makes the "short of staff" situation even worse. Cross-training, mutual aid and community network need to be developed during the preparation stage to mitigate the staff shortage in the wake of the disaster.

WaldoEPSO reported that a non-emergency call center was set up and the notification sent out via twitter. While this provided residents with a place to call for non-emergent help, this required additional trained volunteers. During the early hours of the disaster, the situation may change dramatically in a short period of time. Affected residents need real-time live updates about the disaster. Additional communication channels can help to keep residents updated.

In the BF2013 fire, citizens offered resources such as horse trailers to help with evacuation, water tanks to help fight the fire, and 4WD vehicles. The resources from volunteers can be better organized for use to meet the needs of affected areas. During the critical early hours, a system must be quickly established to track and manage these important resources. In preparing for a disaster, a website or social media site could be developed that can be deployed quickly to connect volunteers with resources to those in need.

DISCUSSION AND CONCLUSION

To address our research question, the study analyzed seven after action reports developed for five wildfires in Colorado and California with the goal of identifying resource management challenges that were encountered in the chaotic early hours of the disaster. A framework adapted from the operations strategy literature was used to categorize and better understand the issues encountered. Structural and infrastructural challenges were delineated in a variety of sub-categories. These are summarized in Table 3.

This framework provided a systematic approach in addressing the research question: "*What are the characteristics of resource management chaos in the early hours of a disaster response?*" This approach provides a foundational organization by which to categorize the information and sources of confusion, and certain overarching themes begin to emerge that provide managerial insight. Common characteristics of the resource management chaos included communications issues that resulted in problems of tracking and coordinating resources or in safely evacuating people and animals. In most cases, poor or wrong information was disseminated. Even if the information was just very slightly wrong, the result of that misinformation magnified the misfortune and caused a wide variety significant managerial repercussions. Some of the more significant repercussions included examples like sending crews home for the night or not properly locating sources of smoke in early stages of disastrous fires.

Sources of chaos tended to occur in both structural and infrastructural resources. Technological advancements have occurred, which creates new and ever changing communications challenges. The AAR's provide insight on issues that started out with such items as bandwidth and interoperability of equipment, but just like with a fast spread of a wildfire, the advancing technological capabilities in such cases as social media spreading misinformation, the new challenges have risen exponentially in verifying and validating information (or misinformation) very quickly and efficiently in a disaster scenario.

TABLE 3
CHARACTERISTIC OF RESOURCE MANAGEMENT CHAOS IN THE EARLY HOURS

Structural Resources		Infrastructural Resources	
Technology	Interoperability problems Technological capability issues Limited information systems for resource tracking Communication and social media Issues	Workforce and Volunteers	Personnel tracking concerns
Capacity and Facilities	Communication equipment shortage Communication structure damage Apparatus issues Shelter capacity shortage	Operating Plans and Control Systems	Resource tracking issues Resource coordination problems Poor information sharing Fire-fighting effort challenges Evacuation execution issues
Inventory and Service Capacity	Insufficient radio channels Insufficient network capacity Insufficient phone lines Limited dispatch capability	Organizational Structure	General organizational issues Command confusion Command transition issues
		Compensation Systems	Reimbursement issues
		Support Services	Evacuation issues Shelter problems General volunteer issues

Coordination of people and resources is another overarching theme. While volunteers, for example, are a welcome and a necessary part of each of these firefighting rescue operations, they do present a very unique set of challenges. The challenges span the gambit from what needs to be done if not enough volunteers are available to what needs to be done when too many are present; or what needs to be done when the shelters and volunteers are directly in the line of the fire and need to be moved to safety. Another example of coordination confusion was seen in the establishment of command structures. Questions include at what points of progression would the command be passed between governing organizations or basically who's in charge and when do they assume command. These are two examples among others of the overarching theme of resource coordination.

In summary, by extending the framework from existing operations strategy literature to categorize the sources of chaos, a better managerial understanding of the *characteristics of resource management chaos in the early hours* is provided in this study. The regional lessons learned from wildfire AAR's can be extended from these applications to a broader and more global audience to improve the resource management in the early hours of a disaster. Continued research is necessary to realize the evolving potential of the benefits from such a framework. While the limitations of this study are bounded by the seven specific AARs utilized in this research, it is the potential global application of lessons learned from these reports that provides a strong managerial motivation to research more deeply into the application of the proposed framework in this study.

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