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Improving Emergency Response Performance: Contingency Effects of Environmental Uncertainty

(Full Paper Submission)

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ABSTRACT

To improve emergency services, this research investigates emergency management using a contingency approach and develops a conceptual framework linking training to response time under differing conditions of environmental uncertainty. Using archival data, regression was conducted to test the hypothesized framework with 11,270 incidents. This study finds that when incident type and location uncertainty are analyzed together, training has a significant relationship with response time. The analysis results imply that training is instrumental in improving the effectiveness of emergency response under varying types of environmental uncertainty. Environmental uncertainty is an important factor when assessing training results in routine emergency response.

KEYWORDS: Emergency services management, Response time, Environmental uncertainty, Training

INTRODUCTION

First responders, including firefighters, police, and medical emergency response personnel strive to deliver effective emergency services to save human lives and minimize economic losses. The detrimental effects of emergency incidents and disasters call upon emergency services to make continuous improvement of their operations. According to a recent report released by the United States Fire Administration (USFA), fire related incidents caused 3,430 deaths, 17,675 injuries, and nearly $15 billion dollars in losses in 2007 USFA (2009).

One of the key indicators for effective emergency response operations is response time, defined as the time from when a call is received by the emergency communications center to the arrival of the first apparatus on scene (Larson, Metzger, & Cahn, 2006). Analysis conducted on structure fire incidents documented in the National Fire Incident Reporting System shows that response times were less than 5 minutes nearly 50% of the time. The national average response time was less than 8 minutes. Ninety percent of incidents reported response times of less than 11 minutes (USFA, 2006). The report reveals that longer response time is related to more flame spread and acknowledges that factors influencing response times are not clear. This study seeks to better understand critical factors influencing emergency service response measures. It is expected that findings can be used to improve emergency response performance.
To explore critical factors influencing emergency response measures, this study focuses on training and the environmental factors that may impact it. Training has been identified in the operations literature as a key factor impacting an organization’s continuous improvement and operational performance (Adam et al., 1997; Choi, 1995). Further, the quality management literature has investigated contextual factors that moderate the training-performance relationship (Jayaram, Ahire, & Dreyfus, 2010; Sila, 2007). The importance of training for emergency response is reflected by the emphasis placed on training programs by Federal Emergency Management Agency (FEMA), USFA (within FEMA), and the National Fire Protection Association (NFPA). For example, USFA has established the “Training, Resources, and Data Exchange” (TRADE) program with the objectives of identifying training needs at the regional level, identifying and exchanging training programs and resources within regions, identifying national trends that impact training and education, and providing the National Fire Academy with an annual assessment of training resource needs and recommendations of how TRADE can better support federal, state, and local fire training systems (USFA).

While the importance of training is clear, the contextual variables that influence the relationship with performance may not be. Contingency theory provides a framework for studying the impact of contextual variables on the effectiveness of training for emergency services. An emerging stream of research in operations management has identified key contextual variables in four categories: “national context and culture, firm size, strategic context, and other organizational contextual variables” (Sousa & Voss, 2008; pg. 703). While strategic context centers on environmental uncertainty and scope of operations, organizational context focuses on variables such as industry, plant age, and unionization (Sousa & Voss, 2008).

This study makes a first attempt at investigating the role of context in emergency services. While other contextual variables may be relevant, due to the nature of emergency services, environmental uncertainty is particularly relevant. This initial study focuses on environmental uncertainty variables important in emergency services. In the operations field, environmental uncertainty includes such factors as number of competitors, changing production practices, technological turbulence, and market volatility (Benson, Saraph, & Schroeder, 1991); however, in the emergency services context, these factors are not applicable. The contributions of this study are both its identification of environmental uncertainty variables that are important in emergency services and its investigation of their impact on the effectiveness of training.

The analysis uses data recorded in a fire program database maintained by a southern Colorado fire district. The district operates in a complex setting. It is in an area that encompasses both suburban and rural areas and adjoins National Forest land. Given that it operates in an urban-wildland interface, the district experiences operational challenges and a
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A mix of incident types that may not be faced by strictly urban departments, which have been the focus of a majority of the emergency response research. Additionally, it owns and operates its own ambulance service along with fire apparatus. Due to the location, in addition to fire engines and trucks, their fire apparatus includes tenders to provide water for non-hydranted areas and brush trucks for wildland response. The study results provide insights to guide emergency services managers in developing effective training programs and in improving resource allocation in complex environments.

The remainder of the paper is organized as follows. The conceptual framework and hypothesis development section reviews relevant literature and presents the hypotheses. The methodology is discussed in the next section followed by analysis and results. Discussion and managerial implications of the study are presented next. The paper concludes with study limitations and future research.

CONCEPTUAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

Research in emergency response historically has focused on mathematical modelling techniques addressing such issues as station location, ambulance queuing models, and routing problems for routine or everyday emergencies in urban settings; however, empirical studies have been limited (Simpson & Hancock, 2009). Simpson & Hancock (2009) provide an extensive literature review of these areas. More recently an emerging stream of work has focused more specifically on disaster response and has defined emergency management in that context. Altay & Green (2006) provide an extensive review of the research in that area.

Altay & Green (2006) define routine emergencies from previous literature as those that can be managed by resources from a single agency and using standard procedures. This study focuses specifically on response to routine emergencies, but takes an empirical approach to better understand the emergency response environment, the factors impacting response, and how emergency managers might improve.

Based on the review of the literature and interviews with key district personnel, factors are identified that impact response to emergency incidents. In-person interviews were conducted with the Chief, Battalion Chief, and Fire Marshall to determine the influencing factors for effective emergency service performance. Each of these individuals have over 15 to 20 years of experience in the fire service, thus were considered to be field experts. A conceptual model that links these critical factors is proposed. The model is presented below in Figure 1. It is proposed that in preparation for emergency response, training is an important factor impacting response time. The impact of training on this dependent variable will depend on the uncontrollable environmental factors: incident type and location uncertainty.
Training in Emergency Response

Training has long been studied as a key human resource management practice. Youndt et al. (1996) studied the impact of HR practices on performance and identified training as one of the four most commonly recognized areas of HRM. They measured four aspects of training: comprehensiveness, policies and procedural training, training for technical skills, and training for problem-solving skills. All of these aspects are important in emergency response. Vidal-Gomel, Delgoulet, and Gebai (2012) argue that fire truck training, unlike other types of truck training, is critical to saving lives, minimizing risk, and “optimizing trajectories” because it is a multidimensional activity.

Training-Performance Relationship

Researchers recognize the value of training to fighting fires. Such training may include driver training, area familiarity training, and emergency response tactics geared to specific incident types. Previous research supports that different aspects of training play a key role in delivering effective emergency services. Meehan (2008) describes the importance of management strategy relative to firefighting, emphasizing chain of command, yet specificity to incident type. Balcik et al. (2010) argue that coordination mechanisms are imperative for assimilating a relief response. Prior knowledge of location has been identified in the literature as a factor that impacts response time (Subramaniam, Hassan, & Shamsudin, 2012). Andersson and Varbrand (2006) highlight preparedness as a criterion for EMS operations. One criterion they support is a dispatcher’s ability to prioritize the call based on severity and knowledge of the emergency scenario. While all emergency service organizations enforce training to ensure personnel safety and improve emergency response performance, it is not clear whether increasing training hours in general will help to achieve such goals. This study seeks to better understand the effect of
training on emergency service performance under the dynamic circumstances often faced by first responders.

Performance in the emergency services context is different from other service operations given that the ultimate goal is to save lives and minimize property damage. In terms of fire emergencies, USFA collected outcome measures such as number of deaths, number of injuries, and the dollar value due to property losses (USFA, 2006, USFA, 2009). Medical emergency response research uses patient survival rate as a common outcome measure (Blackwell & Kaufman, 2008). This study focuses on operational measures.

Previous emergency response research has examined operational measures such as cost, response time, coverage defined by fraction of calls responded to within some standard of time, and workload balance among personnel and stations (Budge, Ingolfsson, & Erkut, 2009; Carter, Chaiken, & Ignall, 1972; K. G. Zografos, Douligeris, & Tsoumpas, 1998). There is extensive research focusing on response time. Zografos, Douligeris, and Chaoxi (1992) suggest determining the important times to be measured as a first step in establishing measures for a framework. Other suggested time measures include the following: dispatch time, emergency response team (ERT) assignment time, travel time, time tending to victims, assignment, and travel time to the hospital (Fitzsimmons & Srikar, 1982).

Although training and emergency services performance have not been linked in previous studies, the direct and indirect impacts of training on organizational performance have been extensively documented in the quality management literature. Flynn et al. (1994) identified that quality-related training, both in the classroom and on-the-job, helps workers develop quality control skills and teamwork and problem-solving capabilities, which directly impact customer satisfaction performance. Das et al. (2000) found that quality training on awareness and statistical skills helped to improve quality performance. The relationship was strengthened under intense international competition. Other streams of quality management research support that training influences performance indirectly. Kaynak and Hartley (2008) found that training enhanced employee relations, which in turn, helped to improve quality data reporting and process management, and ultimately quality performance.

Although the content of training in emergency response is different from that in quality management, the goal is the same: to improve performance. A reduction in response time represents improved performance and effective utilization of resources. This provides support for our first hypothesis, which reflects improvement in these measures:

H1: Training hours has a negative, direct effect on response time.

Contingency Effects of Environmental Uncertainty

Generally, uncertainty refers to the inability to assign probability of future events or predict the outcomes of certain decisions due to limited information (Duncan, 1972). Environmental uncertainty has been defined as the uncertainty resulting from the external environment of a
focal organization (Wong, Boon-Itt, & Wong, 2011). The degree of environmental uncertainty can be assessed by two dimensions: the simple-complex dimension and the stable-unstable dimension (Daft, 2012). A greater number of diversified factors affecting an organization’s operation and dynamic changes with such factors indicate a high degree of environmental uncertainty (Closs, Jacobs, Swink, & Webb, 2008). Research in operations management has generally investigated the stable-unstable dimension of environmental uncertainty, focusing on the rate of changes with competition, customer needs, and product/process (Benson et al., 1991; Zhang, Linderman, & Schroeder, 2012).

In the context of emergency services, environmental uncertainty reflects both the complexity and dynamism inherent in emergency incidents. The external environment where emergency services operate is highly complex in that there is a wide variety of incidents. Meanwhile, the environment is highly dynamic, where situations can change drastically in a short time period. With limited information, the highly complex and dynamic operating environment make it a challenging task for emergency services to allocate resources and effectively respond. The study focuses on the complexity aspect of environmental uncertainty that is associated with the emergency incidents.

Environmental uncertainty has been considered a critical contingency factor in OM research (Sila, 2007; Sousa and Voss, 2008; Wong et al., 2011). Sousa and Voss (2008) consider environmental uncertainty as one of the contextual variables that form the environment in which an organization operates. Mostly exogenous, environmental uncertainty to a great extent is not controllable by management; therefore, it makes events hard to predict and challenging for decision-makers. This is true in particular in the context of emergency response, where the type and the location of incidents are unpredictable.

As a contingency variable, environmental uncertainty has been intensively studied in areas such as supply chain management, quality management, and new product development (NPD) (Koufteros, Vonderembse, & Jayaram, 2005; Sila, 2007; Wong et al., 2011). Wong et al, (2011) used supply, demand, competitive, and technological uncertainties to measure environmental uncertainty. They found that high environmental uncertainty strengthens the positive effect of supply chain integration on delivery and flexibility performance. In comparison, Koufteros et al. (2005) did not detect the moderating effects of environmental uncertainty on the relationship between supply chain integration and NPD performance. In Sila (2007), environmental uncertainty is represented by firms’ scope of operation, with domestic operations indicating low uncertainty and international operations indicating high uncertainty. The study did not find contingency effects of environmental uncertainty on the relationship between TQM practices and key organizational performance. In comparison, Nair (2006) supports the presence of a moderating effect of environmental uncertainty on the quality management practice – performance relationship.

Although the contingency role of environmental uncertainty in affecting practice-performance is inconclusive, research has considered such factors indispensable for better understanding how OM practices can improve performance. In the emergency services context, it is intuitive to assume increasing training hours would improve response time. Less is known about whether and how environmental uncertainty affects the effectiveness of training in improving response time. To help emergency managers allocate their training resources more effectively, this study
investigates the effect of training on response time under different degrees of environmental uncertainty characterized by types of incidents and location uncertainty. Research literature supporting the contingency effects of environmental uncertainty generally contend that the practice-performance relationship would be strengthened under high degree of uncertainty. In emergency services, responders can face different levels of environmental uncertainty depending on the types of incidents and where they occur. Therefore, it is hypothesized that the training-performance relationship would be different under varying levels of environmental uncertainty.

H2: Training improves performance under varying degrees of environmental uncertainty.

  H2a: The relationship between training hours and response time varies across incident types.

  H2b: The relationship between training hours and response time varies across levels of location uncertainty.

  H2c: The relationship between training hours and response time varies across incident types under different levels of location uncertainty

METHODOLOGY

Data Source

This paper utilizes a database maintained by a southern Colorado fire district. The database, Fire Programs, is extensive and tracks many different attributes related to emergency service operations. Fire Programs is a vendor for the National Fire Incident Reporting System (Department of Homeland Security, 2013) developed by the USFA. NFIRS, thus Fire Programs, uses standardized coding for reporting fire incidents that was developed by the National Fire Protection Association (NFPA). According to the National Fire Incident Reporting System Complete Reference Guide (2013), more than 15,000 fire departments have participated in NFIRS and over 600,000 fire incidents and 5 million non-fire incidents are added to the database each year. This paper conducts exploratory analysis on incident attributes from the database covering time periods from 2005 through January of 2012 to test the proposed hypotheses.

The district studied has three fire stations serving 24,000 residents and covering 68 square miles. Approximately 50 personnel serve the district, with daily operational staffing of 13 personnel, including four firefighters/medics at each station and one Battalion Chief. There are three shifts of 13 that rotate daily coverage for 24 hours periods.

Variable Measures
Baseline Model Variables

Training: Given that the level of analysis is incidents, training hours were compiled and assigned to the different incident types based on the training categories and descriptions included in the database. For example, some training is specifically structure-fire related and other is wild-land fire related. Some training is specifically medical, while driver training would apply to any incident. Hours were compiled for each incident type for each year. It was necessary to select a time-frame for applying the total training hours to future incidents. Given the assumption that knowledge gained is reinforced in the field and that many trainings are repeated in a given year, one year was chosen. Total training hours for each incident type for a given year were applied to incidents for the following year. Incident codes were missing for four incidents, resulting in no training hours being assigned. Descriptive statistics for all continuous variables are included in Table 1.

<table>
<thead>
<tr>
<th>Training Hours</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response Time</td>
<td>11270</td>
<td>0</td>
<td>1627.5</td>
<td>328.72</td>
<td>341.96</td>
</tr>
</tbody>
</table>

Response time: This variable is the response time as reported in the database. Consistent with the literature, it is the time from when the district was notified of the call by dispatch to when the first vehicle arrived on the scene.

Environmental Uncertainty Variables

Incident type: The National Fire Incident Report System (NFIRS) codes used to identify incidents are 3-digit codes organized in series from 100 to 900. The district responded to 132 different incident types during the time period covered by the database. These codes are used as a nominal variable grouped by series. Due to the low frequency of some incident types, the series was condensed slightly: series 100 and 200 were combined, as were 800 and 900, resulting in seven categories. These combinations were considered reasonable by the field experts. Incident codes, the corresponding descriptions, and the frequency distribution are reported in Table 2.

<table>
<thead>
<tr>
<th>Code</th>
<th>Incident Description</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>Fire</td>
<td>514</td>
<td>4.6</td>
</tr>
</tbody>
</table>
Location uncertainty: This variable reflects the degree of difficulty responders will have in locating the site of a reported incident. For each incident in the database, the provided address is rated based on how it represents increasing difficulty, with the highest level of uncertainty being rated one. Incidents with incomplete addresses are rated one; incidents with complete addresses that occur only once in a given year are rated two; and incident with complete addresses that are repeated more than once per year are rated three. The frequency distribution is shown in Table 3.

### Table 3: Frequency Distribution: Location Uncertainty

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Incomplete addresses</td>
<td>3059</td>
<td>27.1</td>
</tr>
<tr>
<td>2</td>
<td>Complete addresses, once in a calendar year</td>
<td>4491</td>
<td>39.8</td>
</tr>
<tr>
<td>3</td>
<td>Complete addresses, more than once in a calendar year</td>
<td>3724</td>
<td>33</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>11274</td>
<td>100.00</td>
</tr>
</tbody>
</table>

**ANALYSIS AND RESULTS**

Given that the baseline model variables are continuous variables, linear regression analysis was used to test the hypotheses. The analysis was conducted in three steps. First, the baseline model of the training/response time relationship was tested to evaluate hypothesis 1. Next, the contingency effects of the environmental uncertainty variables were evaluated using split group analysis, given the categorical nature of these variables. The relationship for training and response time was developed for each incident type to determine if different incident types resulted in different models, hypothesis 2a. The same process was used for location uncertainty to test hypothesis 2b. Lastly, the regression was run for each incident type at each level of uncertainty.
Analysis of Baseline Model: Training and Response Time

The direct relationship between training and response times was not significant (p-value 0.550), thus hypothesis 1 was not supported. Despite the literature support for the importance of training on performance, in this emergency response context, training does not impact response time across all data points. This result seems to contradict literature pointing to a relationship between training and response time. However, this baseline model includes all incident types and uncertainty levels, thus emphasizing the importance of considering the contextual variables to evaluate the impact of environmental uncertainty.

Analysis of Environmental Uncertainty Variables

Incident Type

Hypothesis 2a proposes that the training/performance relationship will be different for each incident type. Findings are reported in Table 4. This hypothesis was supported in that while the direct relationship was not significant, a positive relationship with response time was found for incident type 100200, fires and explosions. This is a troubling result in that the positive relationship indicates that training actually increases response time for this incident type. One would expect improvement in performance as a result of training. The types of training that would impact response time would be driving-related training and area familiarity training. As driver training was allocated in the same manner to all incident types, the dataset does not allow for distinctions on driving training. One would anticipate more variation due to other types of training, but these other variations appear not to be significant. Therefore, although one incident type showed significance between training and response time, training alone may not account for the difference in response time across incident types. Incident type is only one component of environmental uncertainty in emergency response situations.

Table 4: Regression Results for Training and Response Time for each Incident Type

<table>
<thead>
<tr>
<th>Incident Type</th>
<th>N</th>
<th>Regression Coefficient</th>
<th>p-value</th>
<th>R-Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>100200</td>
<td>514</td>
<td>+0.002</td>
<td>*0.084</td>
<td>0.006</td>
</tr>
<tr>
<td>300</td>
<td>7924</td>
<td>0.180</td>
<td></td>
<td></td>
</tr>
<tr>
<td>400</td>
<td>428</td>
<td>0.874</td>
<td></td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>773</td>
<td>0.923</td>
<td></td>
<td></td>
</tr>
<tr>
<td>600</td>
<td>438</td>
<td>0.821</td>
<td></td>
<td></td>
</tr>
<tr>
<td>700</td>
<td>1106</td>
<td>0.769</td>
<td></td>
<td></td>
</tr>
<tr>
<td>800900</td>
<td>87</td>
<td>0.376</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at Alpha = 0.1
Location Uncertainty

There are no significant relationships between training and response time when location uncertainty is considered. Therefore, hypothesis 2b is not supported. Results are provided in Table 5. The relationship between training hours and response time is not significant at all levels of location uncertainty. Once again, this finding is surprising. Literature and common sense would assume that increased certainty of the location would improve response time. If you had been to a location previously within the same year, one would assume that would decrease response time. Location uncertainty as a component of environmental uncertainty on its own does not show a contingency effect.

<table>
<thead>
<tr>
<th>Location Uncertainty</th>
<th>N</th>
<th>Regression Coefficient</th>
<th>p-value</th>
<th>R-Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3057</td>
<td>0.902</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>4489</td>
<td>0.187</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3724</td>
<td>0.488</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Incident Type*Location Uncertainty

The most interesting results are found in the analysis of Hypothesis 2c. When incident type and location uncertainty are analyzed together, training has a significant relationship with response time. When considered separately, both components of environmental uncertainty do not show contingency effects on the training/performance relationship. In combination, we find significant relationships at different levels of location uncertainty for different incident types. This regression analysis was performed across 21 different levels of environmental uncertainty derived from each of seven incident types across three levels of environmental uncertainty. We find significant relationships between training and response time from four of the 21 incident type/location uncertainty categories representing four of the seven incident types and all three location uncertainty categories. We find a significant positive relationship for the highest level of uncertainty for 100200, fires and explosions. Also, for level 300, EMS and medical, and 700, false alarms and false calls, we find a negative relationship for the moderate level of location uncertainty. For incident type 400, hazardous condition (no fire), we find a negative significant relationship at the lowest level of uncertainty. Results are below in Table 6.

<table>
<thead>
<tr>
<th>Incident Type</th>
<th>Location Uncertainty</th>
<th>N</th>
<th>Regression Coefficient</th>
<th>p-value</th>
<th>R-Square</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
For fires and explosions, when location uncertainty is highest, the training hours actually increases response time, but for the other levels, the relationship is not significant. This result upholds the result from testing Hypotheses 2a where a positive result was found combining all location uncertainty levels. A majority of the training allocated to fires may be more operational and geared toward firefighting and safety, rather than driving or area familiarization training which would be expected to improve response time. In addition, driver training cannot be separately assessed with this dataset. However, it also may be that more driver training may increase caution among drivers in avoiding accidents in “racing” to a fire.

When a complete address is available, for EMS and medical (300s) and false alarms and false calls (700s), higher training hours improves response time performance. At this level of uncertainty, the complete address is known but the address has not been visited in the past year, therefore, the crew may be less familiar with the area. This result is expected for EMS and medical (300s) incidents. Increased training in medical, driving and location awareness should improve response time. EMS and medical (300s) is the largest incident type represented in this study. The significant result in this category provides a practical finding of a potential for
increased area familiarity training to improve response times. It should be noted that False Alarms are recorded after the incident is completed. The actual response assumes an active incident, therefore, response time is still deemed critical. However, multiple initial incident types that prove to be false alarms will be included in this category.

For hazardous condition (no fire), type 400, the lowest level of uncertainty, when complete addresses are repeated more than once in a calendar year, shows improved performance with increased training hours. Even with the lowest level of uncertainty, training can impact response time. We can show that incident type and location uncertainty work together because overall we have different results with different incident types at all three levels of location uncertainty. Therefore, these results indicate that both variables are components of environmental uncertainty.

DISCUSSION AND MANAGERIAL IMPLICATIONS

This study finds that environmental uncertainty plays a role in determining the relationship between training hours and response time in emergency management. The application of environmental uncertainty defined as organizational task environment as a contingency variable is new to the study of emergency response. This study provides a new finding and understanding of environmental uncertainty. Both location uncertainty and incident type need to be included when discussing the effects of training on response in emergency management.

Hypotheses 2a, 2b, and 2c investigate the influence of training hours on response time using incident type (2a) and location uncertainty (2b) separately and then exploring the two variables together (2c). The overall findings indicate that training improves response time under specific levels of environmental uncertainty. Response time is affected by training hours for multiple incident types across three levels of location uncertainty. At the lowest levels of location uncertainty, more training hours leads to faster response time for hazardous conditions (400). When location uncertainty is moderate, more training hours leads to faster response time for rescue and emergency medical incidents (300) and false alarms (700). However, at the highest level of location uncertainty, a marginally significant result for fire and explosions (100/200) indicates that lower training hours result in faster response time. These findings are summarized in Table 7.

<table>
<thead>
<tr>
<th>Location Uncertainty</th>
<th>Incomplete address</th>
<th>Complete address; one occurrence</th>
<th>Complete address; multiple occurrences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 7: Summary of Significant Effects of Increasing Training Hours on Response Time (RT) for Different Levels of Environmental Uncertainty</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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| Incident Type | Increased RT | Reduced RT
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>100200</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>300</td>
<td>--</td>
<td>Reduced RT</td>
</tr>
<tr>
<td>400</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>700</td>
<td>--</td>
<td>Reduced RT</td>
</tr>
</tbody>
</table>

While one would intuitively expect that training improves performance, these findings show that the environmental context affects whether that is true. In some cases, increasing training hours does not have an impact on improving performance from a response time perspective. There are limited resources, including time and finances, for training. Managers need to closely investigate those circumstances for which training has an impact and target training specifically in order to train effectively. The mix of types of training should be investigated so that training resources are allocated appropriately. As previously discussed, some training is tactical for actions taken on scene while other training is more geared toward response time performance. The training that can improve response time should be identified and incorporated into training programs. These results clearly indicate that location uncertainty is a key component of the task environment for emergency response. While the mix of incidents that are received is not within managerial control, area familiarity training could be developed to enhance response performance. For this particular case, managers should investigate why training was beneficial for these particular incident types and not for others.

STUDY LIMITATIONS AND FUTURE RESEARCH

Generalizability is a concern with many studies because of the constraints and boundaries imposed by the researchers. In this study, while only one fire district was studied, data from separate coverage areas was included. The characteristics of the different areas of the district are not unique in terms of population density, proportion of urban versus suburban versus rural areas, etc. This allows for extension to future studies investigating how these variables and the model may apply to other emergency service organizations.

Other limitations include the attributes studied and limitations inherent in the data collected. The data was collected through a nationally accepted software provider of fire protection districts. This is not data that is normally collected for evaluating emergency service performance. It also prevents researchers from creating their own measurement categories. While researchers are constrained in one sense by the variables resident in the software, this also allows transferability of conclusions to other emergency service organizations that record the same data.

This study provides an initial foray into the identification and understanding of the environmental context of emergency service operations. Much more work is needed. We address the complexity dimension of environmental context, but the dynamism dimension likely plays a role as well. Also, the only performance measure considered here is response
time; however, other aspects of performance should be investigated. For example, training that is incident-type specific, such as firefighting tactics and medical training, would not impact response time performance, but would be expected to impact other performance measures. Future research can extend the current study by exploring the effect of training on other measures key to emergency services.

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