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An Empirical Examination of IT-Enabled Emergency Response: The Cases of Hurricane Katrina and Hurricane Rita

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Communications of the Association for Information Systems

An Empirical Examination of IT-Enabled Emergency Response: The Cases of Hurricane Katrina and Hurricane Rita

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Abstract:

This paper reports the results of an empirical study that analyzes emergency incident response. The paper studies how information systems (IS) complement other organizational assets to help emergency responders achieve satisfactory response performance. We test the research model using empirical data collected from responses to Hurricane Katrina and Hurricane Rita. The results show that IS-enabled asset allocation support directly improves emergency response performance and also positively interacts with non-IS response assets in achieving response success. The results also confirm the value of dispatch systems, interagency communications, and knowledge repositories in developing asset allocation support for an emergency response organization.

Keywords: Emergency management, information systems, resource based view

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I. INTRODUCTION

Emergency response is “*the process of gathering resources and acting upon problems immediately after an incident happens*” (p. 2210) [Shen and Shaw 2004]. Emergency incidents may be either natural or manmade cases such as traffic accidents, fire and explosion, floods, tornado, earthquakes, nuclear or biological attacks, chemical leakage, and cyber attacks. As emergency incidents pose immediate threat to human lives and properties, an effective and efficient management of incident response is critical to bring the affected community back to normal. Emergency response, however, is managed under a variety of challenges. The limited information, unpredictable development, and high risks and impact, among others, all make incidents difficult to control. Failures of incident response are frequently documented in incidents such as the 9/11 attack and Hurricane Katrina [Townsend 2006]. Thus, much work is warranted to better understand the factors and practices that contribute to effective emergency management.

While “*neither a complete theory of crisis nor a complete theory of crisis management has been proposed to date*” [Pauchant and Mitroff 1992], emergency management has gained increasing interest. Despite the progress, existing literature is scant [Turoff 2002; Van de Walle and Turoff 2007]. A vast majority of the literature explores the technical designs of emergency response information systems; however, the literature does not provide adequate accounts that explain success or failure in emergency management. The research reported in this article provides preliminary answers to this research question by conducting an empirical study that investigates emergency response in the context of Hurricanes Katrina and Rita.

The current study makes a threefold contribution. First, IS literature has suggested that information systems may influence organizations through interactions with non-IS organizational assets [Bharadwaj 2000; Wade and Hulland 2004]. The need to explore the potential interactions is “*a top priority of researchers interested in applying RBV in an IS context*” [Wade and Hulland 2004]. Empirical results in this area are scanty, however. The results reported in this paper clearly show that the positive interaction between IS-enabled asset allocation support and non-IS response assets is important in order to assist responders in achieving satisfactory incident management. These findings are in accordance with anecdotal evidence collected during the response to Hurricane Katrina and Rita: some of the affected areas received large amounts of response assets, but the assets failed to successfully mitigate the effects of the incident due to lack of support for the asset allocation process. Second, this paper theorizes dispatch systems, interagency communications, and knowledge repositories as important building blocks of asset allocation support. Factors such as dispatch systems have been overlooked in the literature of technology-enabled emergency response and have received little empirical examination. They are examples of *inside-out* and *outside-in* IS resources which have been suggested to be critical for organizations in turbulent and complex environments [Wade and Hulland 2004]. Our results attest to the importance of these systems and offer insights to understand the roles of inside-out and outside-in IS resources in challenging conditions. Third, our paper contributes to the RBV literature in explaining organizational performance within contexts characterized by high levels of uncertainty, ambiguity, and risks. Recent reviews of RBV literature have also recognized the lack of research that examines the potential interactive relationships between asset and capability factors and suggest that “*the opportunity to contribute to the development of RBV exists with tests of this relatively under-examined theoretical approach*” [Newbert 2007]. Our findings of the interaction effect between asset and capability factors thus generate new insights for RBV literature.

Our study has implications for emergency management practice. First, it offers empirical evidence to explain the phenomena that response assets do not necessarily add up to response success. We suggest that the contribution of response assets to response performance is moderated by support of asset allocation capability. Second, the paper gives evidence of the vital role of information systems in facilitating incident response. It justifies the use of technologies in disaster management and calls for advancements in this area.

This paper proceeds as follows: the subsequent section reviews the theoretical background of the research. It is followed by the development of the research model and hypotheses. Next we describe the research design and present the analyses of the results. Finally we conclude the paper with discussion of theoretical contribution and implications to practice.

II. THEORETICAL FOUNDATION

What factors contribute to emergency response performance? The research in emergency management is still too recent to draw a definite conclusion. In this paper, we explore this understudied area using a resource-based view (RBV) of an organization. RBV is an influential theoretical framework that explains how organizations achieve competitive advantage and operational excellence [Barney 1991; Eisenhardt and Martin 2000]. RBV started to appear in IS research in the mid-1990s when researchers developed the topology of IT resources [Ross et al. 1996; Feeny and Willcocks 1998] and built links between IT resources and organizational performance [Mata 1995; Powell and Dent-Micallef 1997]. RBV views an organization as a collection of resources and argues that organizations appropriate these resources to create value and achieve success. RBV has received strong support from empirical studies [McGrath et al. 1995; Miller and Shamsie 1996; Zaheer and Zaheer 1997]. Resources are at the heart of RBV and they are physical (e.g., transportation system), human (e.g., expertise), organizational (e.g., reporting policy), or technical (e.g., information and communication technologies). Resources form the basis of the value-adding process in an organization and affect organizational performance. RBV literature views resources as assets and capabilities that are available and useful in detecting and responding to threats and opportunities [Christianse and Venkatraman 2002; Wade and Hulland 2004]. Assets are, in general, defined as anything tangible/intangible that an organization uses to create products and offer services. Capabilities, on the other hand, refer to the patterns of organizational actions in the use of assets. Hence, assets serve as inputs or outputs of organizational processes, whereas capabilities consume and transform assets to create value. IS resources may be categorized as outside-in, spanning, and inside-out types and help organizations improve business process, external relationships, and market responsiveness [Wade and Hulland 2004].

We propose that RBV can be applied to studies of emergency management as a referent theoretical foundation. RBV has been used to explain the performance of organizations in dynamic environments [Grant 1996; Teece et al. 1997]. In the U.S., management of incident response has recently become a common organizational practice. Incident management follows the principles of incident command systems (ICS) as defined by U.S. Department of Homeland Security (DHS). ICS creates specialization and differentiation by dividing response management into departments. Each department is further divided into other multi-layered structures. In ICS, the decision and information flows are clearly structured following the organizational hierarchies. The set of management roles, skills, functions, accountabilities, and typical job assignments are also prescribed in ICS. It also establishes protocols for reporting, meeting, and making cross-boundary adjustments for fast coordination. Emergency response is a well-organized management practice, and it closely resembles project-based organizations [Constantien and Lockwood 1993] or temporal organizations [Lundin and Soderholm 1995].

The tenets of RBV have important implications for our study. First, emergency management consumes a large amount of assets [Turoff et al. 2004; Van de Walle and Turoff 2008]. The U.S. DHS defines emergency response assets as *“personnel, teams, facilities, supplies, and major items of equipment available for assignment to or use during incidents”* [DHS 2004]. Typical response assets are non-IS artifacts such as fire engines, ambulances, and patrol cars. These assets may be described in detail in terms of category, kind, components, metrics, and type. They may be deployed in configurations of single asset, task forces, or strike teams. Prior literature has suggested the importance of response assets in emergency management, yet only anecdotal evidence exists [Auf der Heide 1989; Green and Kolesar 2000; Carafano 2003]. Second, emergency management demands responders' high capabilities in managing response assets [Turner 1995; Green and Kolesar 2000]. RBV considers the core capability as the ability to integrate, reconfigure, gain, and release assets to match the organizational objectives [Eisenhardt and Martin 2000]. These abilities are most important in trying conditions such as emergency response. Emergency management capabilities are frequently supported by information systems, through which responders strategically plan for, mobilize, and distribute the assets in support of the complex and difficult response tasks [Cope et al. 2005]. Prior studies have suggested that asset management capabilities may help cut waste in response assets, increase the resilience of response operations, and maximize operation output [Auf der Heide 1989; DOT et al. 2004].

In this paper we analyze emergency response management through perspectives of RBV. Incident response is threatened by uncertainty, sudden and unexpected events, risks of possible mass casualty, high time pressure and urgency, large-scale impact and damage, and the disruption of infrastructure support necessary for coordination. This is complicated by factors such as infrastructure interdependencies; multi-authority and massive personal involvement; conflict of interest; and the high demand for timely information. We are interested to understand how information systems contribute to organizational performance in extreme and challenging environments as such. Other than direct impact on organizations, information systems may also complement other organizational assets, as suggested by prior IS literature [Wade and Hulland 2004]. In Hurricane Katrina, for example, accumulation of response assets did not lead to satisfactory response performance [Herbert 2005; Stuver 2005; Shane 2006]; it is postulated that factors such as information systems may play a role [Murphy and Jennex 2006; Townsend 2006]. In addition, capability has been theorized as the source of resilience in dynamic environments and received much

validation [Grant 1996; Teece et al. 1997]; however, it is unclear what factors foster the support to capability in extreme contexts such as emergency response. New knowledge in this regard will make noticeable contributions to improvement of response practices in the field. In the next section, we present a research model that takes on these issues.

III. CONCEPTUAL MODEL AND RESEARCH HYPOTHESES

We develop a theoretical model to explain emergency response in Figure 1. The theoretical model suggests that emergency management includes response asset and asset allocation capability support as critical factors to achieve satisfactory performance. The model further points out that there may exist interactions between the two; and, thus, asset alone is not sufficient to guarantee the outcome of emergency response. Finally, this model recognizes the important antecedents to asset allocation capability support as knowledge repositories, dispatch systems, and interagency communications.

Figure 1: Emergency Response Management.

In line with RBV, response assets act as the input to management of an incident [Turoff et al. 2004; Van de Walle and Turoff 2008]. Due to the high cost incurred in purchase and maintenance, response asset availability is constrained in any given geographic region [DHS 2004]. For medium to large incidents (e.g., Hurricane Katrina), the local response assets may be exhausted, calling for mobilization of external assets from neighboring regions. When response assets are sufficient, emergency management may develop appropriate mitigation strategies that attack the incident threats with full capacity. On the other hand, emergency operations may be hampered or even disabled due to the lack of task critical assets. For example, a lack of sandbag supplies in a flooded area may dramatically decrease the strength of mitigation efforts, allowing water to inundate the neighborhood. Without the necessary assets, emergency responders also lose the opportunity to detect and prevent incident occurrence and to contain the incident from escalating and spreading. Ultimately, the degraded response will cost human lives and properties, signaling a failure of emergency response.

Hypothesis 1: Response asset availability will positively relate to emergency response performance.

Existing literature has identified response asset allocation as a key capability of emergency management; however, prior studies are scarce in their findings regarding the support available to asset allocation [Green and Kolesar 2000; Mendonca et al. 2001]. Anecdotal evidence reveals that support to asset allocation through technology-enabled information systems is important [Turoff et al. 2004; Chen et al. 2008; Van de Walle and Turoff 2008]. Computer-based systems provide foundations to support asset allocation during emergency response, and they are widely available in commercial off-the shelf (COTS) emergency response information systems such as DisasterLAN, E-Team, and WebEOC. These systems manage personnel and organizational contacts, training, certification, and special skills, equipment inventory for organizations, departments, and facilities, and NIMS-typed equipment description and specification. They may also match available assets with requests, schedule transportation and delivery, and track the deployed asset through integrated Geographic Information Systems (GIS). By identifying, mobilizing, and dispatching response assets, they optimize the asset allocation. With the aid of allocation systems, emergency responders analyze individual allocation problems and search for optimal solutions [Rees and Koehler

2002; Rees and Koehler 2004]. Responders may rely on expertise accumulated through training and experience and also follow organizational routines prescribed by standard operating procedures (SOPs). To cope with time constraints, responders adopt decision strategies such as primed decision making [Klein 1999], and they improvise whenever necessary [Mendonca 2007]. With a high level of support in asset allocation, emergency management leverages the limited response assets to avoid both over- and under-allocation and to maximize the response performance.

Hypothesis 2: Asset allocation capability support will positively relate to emergency response performance.

Prior studies have examined individual effects of asset and capability factors on organizational performance. Limited knowledge has been gained about the potential relationships between the two groups of factors [Hitt et al. 2001; Zhu and Kraemer 2002]. In the context of emergency response, it is argued that the direct impact of response assets may be significantly weakened by the lack of asset allocation capability support. Take Hurricane Katrina for example. The incident response initiative received great amount of assets in the form of money (\$62.3 billion from government and \$4.25 billion from the public), equipment (e.g., food, water, and shelter), and personnel (e.g., responders, volunteers, and the National Guard). Despite the abundance of assets, there was no systematic support (e.g., people, process, and technology) for the asset allocation process. Numerous occasions were documented where critical assets were either idle for days, displaced to incorrect locations, or demobilized by mistakes [Herbert 2005; Stuver 2005; Shane 2006]. Responders from outside the affected areas were also stymied in their efforts to send help to the area. Therefore, low level support in asset allocation hampered the contribution of assets on Katrina response. On the other hand, the high level of support in asset allocation capability may leverage the size of available assets and maximize their contributions through optimization strategies.

Hypothesis 3: Asset allocation capability support will positively moderate the relationship between response asset availability and emergency response performance.

Systematic support for asset allocation may arise from aspects pertaining to people, process, and organizations. RVB literature suggests a number of factors as potential sources. In the context of emergency response, we identify knowledge repositories, dispatch systems, and interagency communications as the important ones that jointly build asset allocation support for emergency management.

Support for asset allocation capability may be improved by knowledge repositories that transfer knowledge pertaining to assets [Turoff et al. 2004]. Emergency incidents are characterized by unexpectedness; and thus the responders are likely to encounter situations in which they lack the right amount of knowledge and expertise. To reach an informed decision on asset allocation, emergency responders resort to computer-based knowledge repositories for asset factsheets, allocation lessons learned, guidelines for best practice, etc. Through the access to public and private knowledge repositories (e.g., ChemTrac), responders obtain the stock of knowledge that is cumulated over time and consequently transfer and apply it to the current asset allocation. For example, responders who are concerned about flooding in a given area may consult knowledge repositories of local emergency response services, Center for Disease Control (CDC), Environmental Protection Agency (EPA), and National Weather Service, etc. These repositories help the responders understand the terrain (e.g., river bank), weather (e.g. tide), construction (e.g., overflow spillways), and the likely water-borne disease (e.g., typhoid fever). Subsequently, the responders identify the response assets that are required, learn the attributes and properties, estimate the size of demand, and allocate them properly among the potential hazard sites. So the access to knowledge repository may improve the systematic support of asset allocation.

Hypothesis 4: Knowledge repository access will positively relate to asset allocation capability support.

Prior studies of RBV theorize situation-specific knowledge as imperative sources in building capability support in the face of high-velocity environments [Eisenhardt and Martin 2000; Wade and Hulland 2004]. Onsite responders are characterized with “local mindsets.” To increase situational awareness, teams query the dispatch system for situation specific knowledge. The dispatch systems are typically located at offsite response facilities such as an emergency operating center (EOC). The EOC constantly collects and analyzes response intelligence from multiple sources (e.g., sensors, surveillance cameras, victims, and participating agencies). New knowledge is generated and stored in the form of response reports, analysis, and forecasts. Through queries, onsite responders are able to develop a “global operating picture” of how the incident unfolds and what the progress of collective responses is. This knowledge allows responders to adjust their resource allocation strategies and avoid sub optimization [Turoff et al. 2004; Chen et al. 2007]. Unlike systems operating under nonemergency conditions, dispatch systems for emergency management are likely to be challenged by the high volume of incoming requests when an incident takes place. A response dispatch system with sufficient capacity is, therefore, necessary to ensure that queries and responses flow smoothly so as to increase the systematic support on asset allocation.

Hypothesis 5: Dispatch system capacity will positively relate to asset allocation capability support.

For organizations in a dynamic environment, RVB suggests that support for asset capability may benefit from “intensive communication among those involved in the process” (p. 1112) [Eisenhardt and Martin 2000]. Emergency incidents unfold in an unpredictable way and create unplanned-for contingencies. Improvisation is the activity that requires creativity under time constraint to meet performance objectives [Mendonca 2007]; it offers response management flexibility in the face of changing conditions. Through interagency communication, response groups generate synergy to improvise new strategies of asset allocation, when existing plans and SOP fail. Geographically dispersed, emergency responders adopt a variety of communication systems to share knowledge [Turoff et al. 2004; Chen et al. 2007]. When interagency communication is conducted in a timely manner, synergy and improvisation takes pace and ultimately improves the systematic support for asset allocation.

Hypothesis 6: Interagency communications will positively relate to asset allocation capability support.

Dispatch systems also facilitate responder interagency communication, as it creates an organizational memory [Wegner 1987]. This organizational memory maintains the shared conceptualization among members of “who knows what” [Wegner et al. 1985; Wegner 1987]. Thus, it contributes to successful emergency management by enabling individual teams to identify the knowledge available to each other. Through queries with the dispatch system, an organizational memory is cultivated among the responders. They gradually learn about the other participating agencies with respect to their expertise and asset availability, allowing them to know with whom to communicate, what to communicate, and when to communicate when they need support [Brandon and Hollingshead 2004]. Eventually communication inefficiencies (e.g., bad contact, delay, and no response) are eliminated. Dispatch systems thus ensure that interagency communication is conducted in a timely manner when it is most needed.

Hypothesis 7: Dispatch system capacity will positively relate to interagency communication.

IV. RESEARCH DESIGN

The research model was tested in the context of emergency response to Hurricane Katrina and Hurricane Rita. Hurricane Katrina of the 2005 Atlantic hurricane season was the costliest hurricane in the history of the United States. It made landfall as a Category 3 storm on August 29 in southeast Louisiana and caused severe destruction along the Gulf coast from central Florida to Texas. At least 1,836 people lost their lives during the actual hurricane and in the subsequent floods. The storm is estimated to have been responsible for \$81.2 billion in damage. Hurricane Rita, also of the 2005 hurricane season, made landfall on September 24 at the border of Louisiana and Texas. It caused around \$11.3 billion in damage and claimed 120 lives. Both hurricanes occurred around the similar time period, and they shared similar characteristics in terms of incident scenario and impacts. Therefore, this was a great opportunity for us to investigate the emergency response phenomena.

Data was collected through field surveys from responders who had participated in the response to Hurricane Katrina or Hurricane Rita. We partnered with the local emergency response community in Louisiana, including Vermillion, Jefferson, Calcasieu, and Cameron parishes. These parishes were hard hit by the hurricanes. The data was gathered during the summer of 2006 when the response and recovery process was close to concluding.

Sample Selection

Emergency respondents in Vermillion, Jefferson, Calcasieu, and Cameron parishes of Louisiana State participated in the study. These responders worked for emergency services at varying government administrative levels, including village, city, town, and parish levels. These municipal governments operate response services with diverse objectives, rule systems, and funding sources. As a consequence, the respondents differ in their response tasks, performance, asset availability, and adoption of emergency information systems during the response to Hurricanes Katrina and Rita. The sample, therefore, is heterogeneous.

Responders with management roles in the four parishes were mailed a copy of the survey (after IRB approval) questions with a cover letter from their supervisors encouraging their participation. They were guaranteed both confidentiality and access to the aggregated survey results. Participation was voluntary. Each one of the participants received a \$10 gift card. Out of 261 surveys mailed, we received 108 completed responses. The survey response rate was 41.35 percent with the following respondent distribution. Table 1 presents the demographic information.

Table 1. Demographic Information

	Parish	Vermillion	Jefferson	Calcasieu	Cameron
Response jurisdiction	Survey response	30	22	41	15
	Total	108			
Management rank (multiple roles possible)	On-scene incident command (51%), remote incident commander (28%), city-wide incident commander (19%), and state/county/regional incident commander (11%), etc.				
Professional training	Longer than 10 years—73%, 6–10 years—15%, 3–5 years—7%, less than 3 years—5%				

Measurement of Variables

Most measurement items for the principal constructs in this study were borrowed directly from existing measures to ensure validity. The others were adapted to fit the current research context and the sources of the principal constructs are shown in Table 2. The preliminary instruments were first pilot tested for comprehensiveness and clarity following Churchill [Churchill 1979]. Second, face validity was assessed by domain experts, including the director of homeland security, incident commanders, police chiefs, fire department chiefs, and chiefs of medical organizations. Following these pretests, the measurement instrument was shortened, refined, and validated for its statistical properties. Many of the measurements were empirically validated in a prior study [Kim et al. 2007]. Measurements are detailed in Appendix A.

Table 2: Principal Constructs and Measurements

Principal Construct	Item	Source of Literature
Response asset availability	3	Tushman and Nadler [Tushman and Nadler 1978]; Turoff [Turoff 2002]
Asset allocation capability support	4	Kornai [Kornai 1980]; Qian [Qian 1994]
Emergency response performance	4	Yuthas and Young [Yuthas and Young 1998], Pitt et al. [Pitt et al. 1995], Chang and King [Chang and King 2005]
Interagency communication	3	Shen and Shaw [Shen and Shaw 2004]
Knowledge repository access	2	Gilbert et al. [Gilbert et al. 2003]
Dispatch system capacity	2	Shen and Shaw [Shen and Shaw 2004]

V. ANALYSIS AND RESULT

We tested the research model using structural equation modeling analysis. We employed partial least squares (PLS), which employs a component-based approach for estimation and places minimal restrictions on sample size and residual distributions. PLS is best suited for testing complex relationships by avoiding inadmissible solutions and factor indeterminacy [Chin 1998]. PLS also supports exploratory research. Our paper studies an important, yet understudied, research perspective in the context of emergency management; therefore, PLS is appropriate.

Measurement Model

Table 1 reports the correlation matrix, the AVEs, and the descriptive statistics of the principal constructs. Measurement reliability was assessed using composite reliability [Werts et al. 1974] and Cronbach's alpha [Cronbach 1971]. Fornell and Larcker suggested that a composite reliability of .70 or greater is considered acceptable for research [Fornell and Larcker 1981]. Nunnally suggested that a Cronbach's alpha of .70 or greater is considered acceptable for research [Nunnally 1978]. As in Table 3, the internal consistencies of all variables are considered acceptable since they exceed .70, signifying satisfactory reliability.

Table 3: Descriptive Statistics, Correlations, and Average Variance Extracted

	Principal Construct	Mean	Std	CR	CA	1	2	3	4	5	6
1	Asset allocation capability support	3.61	.71	.95	.93	.91					
2	Response asset availability	3.35	.84	.89	.80	.47	.85				
3	Dispatch system capacity	3.46	.80	.89	.78	.44	.57	.90			
4	Interagency communication	3.54	.88	.86	.77	.36	.39	.27	.93		
5	Knowledge repository access	3.86	.58	.91	.80	.30	.11	.17	.09	.91	
6	Emergency response performance	3.53	.54	.87	.81	.62	.45	.49	.30	.18	.80
CR: Composite Reliability, CA: Cronbach's Alpha The diagonal elements (in bold) represent the square root of AVE											

Convergent and discriminant validity are inferred when (1) the square root of each construct is larger than its correlations with the other constructs (i.e., the AVE shared between the construct and its indicators is larger than the AVE shared between the construct and the other items); (2) all AVEs are greater than .50; and (3) the PLS indicators load much higher on their hypothesized construct than on other constructs (i.e., own loadings are higher than cross loadings) [Chin 1998]. As shown in Table 1, the square roots of the AVE are all greater than 0.5 and greater than all other cross correlations, indicating that the variance explained by each construct is much larger than the measurement error variance. As in Appendix B, all items loaded high on their own constructs. These tests validated the measurement properties of principal constructs.

The research data was collected from a single survey that was administered to emergency response personnel. We checked for the extent of common method bias. First, the Harman's one-factor test was performed by including all the variables in a principal components factor analysis [Podsakoff et al. 2003]. Common method bias exists when one single factor emerges or when one factor accounts for the majority of the covariance among the variables. The results showed that none of emergent factors explain the majority of the covariance. Second, we conducted Lindell and Whitney's test that uses a theoretically unrelated construct to adjust the correlations among the principal construct [Lindell and Whitney 2001]. We used "family importance" as an unrelated construct in this test and this construct measures how importantly one views family in his/her life. High correlations among any of the items of the study's principal constructs and "family importance" will indicate common method bias, since the "family importance" should be weakly, or not at all, related to the principal constructs in this study. The results showed that none of the correlations was significant: the average correlation $r = -.04$ and average p -value = .50. Third, the correlation matrix was examined for highly correlated factors. The common method bias exists when there exist extremely high correlations ($r > .9$). Table 3 did not reveal such evidence.

Structural Model

The PLS path coefficients are shown in Figure 2. All the paths are statistically significant. The structural model explains 41 percent of the variance in response performance, 30 percent of variance in asset allocation capability support, and 7 percent of variance in interagency communication respectively.

The PLS results find that response asset availability has a direct positive impact on response performance ($b = .20$, $p < .05$). The results also find that asset allocation capability support improves emergency response performance ($b = .52$, $p < 0.001$). Hypothesis 1 and 2 are thus supported. The PLS results further confirm that knowledge repository ($b = .22$, $p < .05$), dispatch system capacity ($b = .34$, $p < .001$), and interagency communication ($b = .25$, $p < .05$) jointly contribute to asset allocation capability support. Additionally, results show that dispatch system capacity ($b = .27$, $p < .01$) positively influences interagency communication. Hypothesis 4, 5, 6, and 7 are, therefore, supported as shown in Figure 2.

We test the moderating effect of asset allocation capability support in three ways. First, we follow the PLS product-indicator approach that was developed by Chin et al [Chin et al. 2003]. The newly created interaction construct is found to significantly strengthen the relationship between asset availability and response performance ($b = .17$, $p < 0.01$). Second, we test the moderating effect following [Carte and Russell 2003]. We examine whether the variance explained by the moderating effect is significant beyond the main effects using the F-statistic below. The F-statics for the moderating effect is 5.36 ($p < 0.025$), thereby also supporting the significant role of the proposed moderating effect.

Figure 2: Emergency Response Management—PLS Results.

$$F(df_{interaction} - df_{main}, N - df_{interaction} - 1) = \frac{\Delta R^2 / (df_{interaction} - df_{main})}{(1 - R^2_{interaction}) / (N - df_{interaction} - 1)}$$

Third, we validate the moderating effect using Cohen's f^2 which compares the R^2 value of the interaction effect over the main effect using the following equation [Chin et al. 2003]. Cohen's f^2 for the interaction is .05, showing a medium effect.

$$f^2 = (R^2_{interaction} - R^2_{main}) / (1 - R^2_{main})$$

We summarize the research hypotheses in Table 4. All seven hypotheses receive strong support.

Table 4: Summary of Research Hypotheses

H1: Response asset availability will be positively related to emergency response performance.	<i>supported</i>
H2: Asset allocation capability support will be positively related to emergency response performance.	<i>supported</i>
H3: Asset allocation capability support will positively moderate the relationship between response asset availability and emergency response performance.	<i>supported</i>
H4: Knowledge repository access will be positively related to asset allocation capability support.	<i>supported</i>
H5: Dispatch system capacity will be positively related to asset allocation capability support.	<i>supported</i>
H6: Interagency communication will be positively related to asset allocation capability support.	<i>supported</i>
H7: Dispatch system capacity will be positively related to interagency communication.	<i>supported</i>

VI. DISCUSSION AND CONCLUSION

Emergency incidents such as Hurricane Katrina and Rita greatly interrupt socioeconomic dynamics and cause enormous losses of human lives and property. Effective and efficient response plays an important role in the mitigation of immediate threats and bring normalcy back to the affected community [Arens and Rosenbloom 2003]. Despite the increasing level of awareness nationwide, current practices in incident response are suboptimal and failures have been frequently documented [Townsend 2006]. This paper presents rich accounts of emergency management and explores the factors that contribute to response performance. From the first responders'

perspective, we explore how response asset and asset allocation capability support contribute to the outcome of incident management. Our results show that interagency communication, dispatch system, and knowledge repository improves the systematic support to asset allocation capability.

The contributions of this paper are threefold. First, IS literature has suggested that information systems may complement and interact with other organizational assets [Bharadwaj 2000; Wade and Hulland 2004]. While literature has postulated interactions with organization and environment factors, empirical evidence is scanty. In the case of emergency response, our results confirm the presence of interactive relationships between information systems and other organizational assets (i.e., response asset). Information systems enabled support to asset allocation has been found to positively moderate the relationship between response asset and emergency management performance. These findings are also in accordance with anecdotal evidence collected during the response to Hurricane Katrina and Rita.

Second, the paper also captures the set of key antecedents that support response asset allocation. RBV has been extended to explain organizational performance in dynamic environments [Grant 1996; Teece et al. 1997]. However, little is known to date with respect to what really supports organizational capability in managing valuable assets. In the emergency context, we theorize interagency communications, dispatch systems, and knowledge repositories as important building blocks of capability support. These systems have not been studied thoroughly in the existing literature of emergency management. An example is the dispatch system about which prior studies have not yielded solid understanding as to whether it may affect emergency response performance. Our study fills this gap by uncovering the underlying logic and by offering the empirical evidence that attests to the true value of these systems. These information systems are examples of inside-out and outside-in IS resources which have been suggested to be critical for organizations in turbulent and complex environments [Wade and Hulland 2004]. Our results confirm the roles of inside-out and outside-in IS resources in challenging conditions.

Third, our paper contributes to the RBV literature as the paper validates its theoretical importance in explaining organizational performance within contexts characterized by high levels of uncertainty, ambiguity, and risks. Also the existing literature of RBV has largely ignored the interaction effect and "*empirical work in this area is still in its infancy and is still evolving*" [Newbert 2007]. Among the pioneer works, results on the interaction effect are mixed [Hitt et al. 2001; Zhu and Kraemer 2002; Zhu 2004]. Taking a dual-aspect approach, this paper presents strong evidence that asset and capability related factors indeed interact with each other in the context of emergency response. The level of asset allocation capability support is found to strengthen the contribution from response asset to response performance. Therefore, this research adds new knowledge to RBV studies.

The findings of this research can improve practice as well. First, this study offers empirical evidence to resolve the issue where response assets do not add up to response success. Take the incident response to Hurricane Katrina, for example. Anecdotal evidence shows that the sheer accumulation of response assets was found insufficient to ensure a satisfactory performance of the overall response efforts. The findings of our study suggest that the contribution of response assets to response performance is positively moderated by support to asset allocation capability. When emergency management lacks systematic support (e.g., lack of information or knowledge), the contribution of response assets is weakened. It is therefore crucial that emergency responders prioritize the asset allocation support and improve this capability through manipulation of interagency communications, dispatch systems, and knowledge repositories.

Second, the paper shows that the response performance heavily relies on information technology such as asset allocation systems, knowledge repositories, and dispatch systems. There has been a growing number of literature that studies information technology in emergency management [Turoff et al. 2004; Chen et al. 2007; Van de Walle and Turoff 2007]. Empirical evidence on the value of technology is scanty, however. Results of this study fill this gap and validate the investment in modern information technology for emergency management purposes. It is important to recognize that the existing emergency information systems are still constrained with respect to technology design, implementation, and management. Communication technologies, for example, are often under criticism. An April 2004 report by the Government Accounting Office suggests that "*communications used today by many public officers, firefighters, emergency medical personnel, and other public safety agencies do not provide [the ability] ... to effectively carry out their normal duties and respond to extraordinary events.*" Therefore, future research to leverage emergency management information system is warranted.

In this study we assess response performance by surveying key informants who had management positions in emergency response organizations. Future research may evaluate response performance through multiple sources. An example strategy is the 360-degree global assessment where a response is evaluated by supervisors, peers, subordinates, or victims around the respondents [Chen et al. 2007]. Such a strategy also helps curtail the common method bias [King et al. 2007]. Since different stakeholders apply incompatible evaluation criteria, it will be hard to

reach a consistent assessment of any given response. The victims, for example, may judge an incident response based on the sheer loss of personal properties and disregard the fact that responders have followed appropriate protocols and exhausted their options. Since different stakeholders may possess incomplete understanding of the incident, they may also form inaccurate assessment of the response. For example, victims may not be aware of all the facts of the incident and consequently misunderstand the response strategies developed by incident managers. The current paper assesses response performance through dimensions such as timeliness (e.g., "quick") and quality (e.g., "good") from the viewpoint of the emergency response managers and commanders. Future studies may develop and use a richer set of performance metrics, such as cost (e.g., expenses on equipments and materials) and benefit (e.g., lives and properties that are saved).

Future studies may also examine the role of knowledge-sharing culture [De Long and Fahey 2000], swift interpersonal trust in temporal groups [Meyerson and Weick 1996], training in the use of response information systems [Yi and Davis 2003], emergency communication information quality [Fisher et al. 2003; Price et al. 2008], response system security [Choobineh et al. 2007; Mishra and Gurpreet 2007], and improved human-computer interface (HCI) for higher level of ease of use and usefulness [Chen et al. 2008].

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REFERENCES

- Arens, Y., and P. Rosenbloom (2003) "Responding to the Unexpected", *Communication of ACM* 46(9).
- Auf der Heide, E. (1989) *Disaster Response: Principles of Preparation and Coordination*, F.A.C.E.P.
- Barney, J.B. (1991) "Firm Resources and Sustained Competitive Advantage", *Journal of Management* (17)1.
- Bharadwaj, A.S. (2000) "A Resource Based Perspective on Information Technology Capability and Firm Performance: An Empirical Investigation", *MIS Quarterly* (24)1.
- Brandon, D.P. and A.B. Hollingshead (2004) "Transactive Memory Systems in Organizations: Matching Tasks, Expertise, and People", *Organization Science* (15)6.
- Carafano, J.J. "Preparing Responders to Respond: The Challenges to Emergency Preparedness in the 21st Century", *Heritage Lectures* (812) 2003.
- Carte, T. and C. Russell (2003) "In Pursuit of Moderation: Nine Common Errors and Their Solutions", *MIS Quarterly* (27)3.
- Chang, J.C.-J. and W.R. King (2005) "Measuring the Performance of Information Systems: A Functional Scorecard", *Journal of Management Information Systems* (22)1.
- Chen, R., et al. (2007) "Design Principles for Critical Incident Response Systems", *Information Systems and E-Business Management* (5)3.
- Chen, R., et al. (2007) *Emergency Response Coordination and IT Support: Contingency and Strategies*, Keystone, CO: AMCIS.
- Chen, R., et al. (2008) "Information Theoretic Approach to Design of Emergency Response Systems", The 14th Americas Conference on Information Systems, Toronto, ON.
- Chen, R., et al. (2008) "Coordination of Emergency Management: Case Study of October '06 Snowstorm in Western New York", *Information Systems for Emergency Management*, M. Turoff, et al.
- Chin, W. (1998) "Issues and opinions on structural equation modeling", *MIS Quarterly* (22)1.

- Chin, W., et al. (2003) "A Partial Least Squares Latent Variable Modeling Approach for Measuring Interaction Effects: Results from a Monte Carlo Simulation Study and an Electronci Mail Emotion/Adoption Study", *Information Systems Research* (14)2.
- Chin, W.W., et al. (2003) "A partial least squares latent variable modeling approach for measuring interaction effects: Results from a Monte Carlo simulation study and an electronic mail adoption study", *Information Systems Research* (14)2.
- Choobineh, J., et al. (2007) "Management of Information Security: Challenges and Research Directions", *Communications of the Association for Information Systems* (20)1.
- Christianse, E., and N. Venkatraman (2002) "Beyond Sabre: An Empirical Test of Expertise Exploitation in Electronic Channels", *MIS Quarterly* (26)1.
- Churchill, G. (1979) "A Paradigm for Developing Better Measures of Marketing Constructs", *Journal of Marketing Research* (16)1.
- Constantien, L.L., and L.A.D. Lockwood (1993) "Orchestrating Project Organization and Management", *Communication of the ACM* (36)10.
- Cope, R.F., et al. (2005) "Felxible Resource Allocation: A Comparison of Linear Diophantine Analysis and Integer Programming", *The Journal of Applied Business Research* (21)4.
- Cronbach, L.J., (1971) "Test validation" in Thorndike, R.L. (ed) *Educational Measurement, 2nd edition*, Washington, DC: American Council on Education.
- De Long, D.W., and L. Fahey (2000) "Diagnosing Cultural Barriers To Knowledge Management", *Academy of Management Executive* (14)4.
- DHS (2004) *National Incident Management System*, Department of Homeland Security, Washington, DC: Government Printing Office.
- DOT, T. Canada, et al. (2004) *Emergency Response Guidebook*, Department of Transportation, Washington, DC: Government Printing Office.
- Eisenhardt, K.M., and J.A. Martin (2000) "Dynamic Capabilities: Why Are They?" *Strategic Management Journal* (21).
- Feeny, D.F., and L.P. Willcocks (1998) "Core IS Capabilities for Exploiting Information Technology", *Sloan Management Review* (39)3.
- Fisher, C.W., et al. (2003) "The Impact of Experience and Time on the Use of Data Quality Information in Decision Making", *Information Systems Research* (14)2.
- Fornell, C., and D. Larcker (1981) "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error", *Journal of Marketing Research* (18)3.
- Gilbert, P.H., et al. (2003) "Infrastructure Issues for Cities—Countering Terrorist Threat", *Journal of Infrastructure Systems*, 9:1.
- Grant, R.M. 1996 "Prospering in Dynamically-competitive Environments: Organizational Capability as Knowledge Integration", *Organization Science* 74.
- Green, L., and P.J. Kolesar (2000) "Improving Emergency Responsiveness with Management Science", *Management Science* (50)8.
- Herbert, B. (2005) "Sick and Abandoned", *The New York Times*.
- Hitt, M.A., et al. (2001) "Direct and Moderating Effects of Human Capatial on Strategy and Performance in Professional Service Firms: A Resource-Based Perspective", *Academy of Management Journal* (44)1.
- Kim, J.K., et al. (2007) "Efficiency of Critical Incident Management Systems: Instrument Development and Validation", *Decision Support Systems* (44)1.
- King, W.R., et al. (2007) "Method Effects in IS Survey Research: An Assessment and Recommendations", *Communications of the Association for Information Systems* (20).
- Klein, G. (1999) *Sources of Power*, Cambridge, MA: MIT Press.
- Kornai, J. (1980) *Economics of Shortage*, Amsterdam: North-Holland.
- Lindell, M.K., and D.J. Whitney (2001) "Accounting for Common Method Variance in Cross-Sectional Research Designs", *Journal of Applied Psychology* (86)1.

- Lundin, R.A., and A. Soderholm (1995) "A Theory of the Temporary Organization", *Scandinavian Journal of Management* (11)4.
- Mata, F., J. Barney, W. Fuerst (1995) "Information Technology and Sustained Competitive Advantage: A Resource Based Analysis", *MIS Quarterly* (19)4.
- McGrath, R.G., et al. (1995) "Defining and Developing Competence: A Strategic Process Paradigm", *Strategic Management Journal* (16).
- Mendonca, D. (2007) "Decision Support for Improvisation in Response to Extreme Events: Learning from the Response to the 2001 World Trade Center Attack", *Decision Support Systems* (43)3.
- Mendonca, D., et al. (2001) "Decision Support for Improvisation during Emergency Response Operations", *International Journal of Emergency Management* (1)1.
- Meyerson, D., and K.E. Weick (1996) *Trust in Organizations: Frontiers of Theory and Research*, Swift Trust and Temporary Groups.
- Miller, D., and J. Shamsie (1996) "The Resource-Based View of the Firm in Two Environments", *Academy of Management Journal* (39)3.
- Mishra, S., and D. Gurpreet (2007) *A Theoretical Basis for Defining Internal Control Objectives for Information Systems Security*, Keystone, CO: AMCIS.
- Murphy, T., and M.E. Jennex (2006) "Knowledge Management, Emergency Response, and Hurricane Katrina", *International Journal of Intelligent Control and Systems* (11)4.
- Newbert, S.L. (2007) "Empirical Research on the Resource-Based View of the Firm: An Assessment and Suggestions for Future Research", *Strategic Management Journal*, (28).
- Nunnally, J.C. (1978) *Psychometric Theory*, New York: McGraw-Hill.
- Pauchant, T.C., and I.I. Mitroff (1992) *Transforming the Crisis-Prone Organization: Preventing Individual, Organizational, and Eventual Tragedies*, San Francisco: Jossey-Bass.
- Pitt, L.F., et al. (1995) "Service Quality: A Measure of Information Systems Effectiveness", *MIS Quarterly* (19)2.
- Podsakoff, P.M., et al. (2003) "Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies", *Journal of Applied Psychology* (88)5.
- Powell, T.C., and A. Dent-Micallef (1997) "Information Technology As Competitive Advantage: The Role of Human, Business, And Technology Resources", *Strategic Management Journal* (1986–1998), (18)5.
- Price, R., et al. (2008) "Developing a Measurement Instrument for Subjective Aspects of Information Quality", *Communications of the Association for Information Systems* (22)1.
- Qian, Y. (1994) "A Theory of Shortage in Socialist Economics Based on the "Soft Budget Constraint", *The American Economic Review* (84)1.
- Rees, J., and G.J. Koehler (2002) "An Evolutionary Approach to Group Decision Making", *INFORMS Journal on Computing* (14)3.
- Rees, J., and G.J. Koehler (2004) "Modeling Search in Group Decision Support Systems", *IEEE Transactions on Systems, Man & Cybernetics: Part C—Applications & Reviews* (34)3.
- Ross, J.W., et al. (1996) "Develop Long-Term Competitiveness Through IT Assets", *Sloan Management Review* (38)1.
- Shane, S. (2006) "After Failure, Government Officials Play Blame Game", *The New York Times*.
- Shen, S.Y., and M.J. Shaw (2004) *Managing Coordination in Emergency Response Systems with Information Technologies*, New York: Tenth American Conference on Information Systems.
- Stuver, P. (2005) *Maximizing Emergency Communication*, New York: Risk and Insurance Management Society.
- Teece, D.J., et al. (1997) "Dynamic Capabilities and Strategic Management". *Strategic Management Journal*, (1986–1998) (18)7.
- Townsend, F.F. (2006) *The Federal Response to Hurricane Katrina: Lessons Learned*, The White House, Washington, DC: Government Printing Office.
- Turner, B.A. (1995) *The Role of Flexibility and Improvisation in Emergency Response. Natural Risk and Civil Protection*, T. Horlick-Jones, A. Amendola, and R. Casale, Sponsor, London: E. & F., pp. 463–475.

- Turoff, M. (2002) "Past and Future Emergency Response Information Systems", *Communications of the ACM* (45)4.
- Turoff, M., et al. (2004) "The Design of a Dynamic Emergency Response Management Information System (DERMIS)", *Journal of Information Technology Theory and Application* (5)4.
- Tushman, M.L., and D.A. Nadler (1978) "Information Processing as an Integrating Concept in Organizational Design", *Academy of Management Review* (3)3.
- Van de Walle, B., and M. Turoff (2007) "Emergency Response Information Systems: Emerging Trends and Technologies", *Communications of the ACM* (50)3.
- Van de Walle, B., and M. Turoff (2008) "Decision Support for Emergency Situations", *Information Systems and E-Business Management* (6)3.
- Wade, M., and J. Hulland (2004) "Review: The Resource-Based View And Information Systems Research: Review, Extension, and Suggestions for Future Research[1]", *MIS Quarterly* 28:1.
- Wegner, D.M. (1987) "Transactive Memory: A Contemporary Analysis of the Group Mind" in *Theories of Group Behavior*, Mullen, B., and G.R. Goethals, New York: Springer-Verlag.
- Wegner, D.M., et al. (1985) "Cognitive Interdependence in Close Relationships" in *Compatible and Incompatible Relationships*, W.J. Ickes, New York: Springer-Verlag.
- Werts, C.E., et al. (1974) "Interclass Reliability Estimates: Testing Structural Assumptions", *Educational and Psychological Measurement* (34)1.
- Yi, M.Y., and F.D. Davis (2003) "Developing and Validating an Observational Learning Model of Computer Software Training and Skill Acquisition", *Information Systems Research* (14)2.
- Yuthas, K., and S.T. Young (1998) "Material Matters: Assessing the Effectiveness of Materials Management IS", *Information & Management*,(33)3.
- Zaheer, A., and S. Zaheer (1997) "Catching the Wave: Alertness, Responsiveness, and Market Influence in Global Electronic Networks", *Management Science* (43)11.
- Zhu, K. (2004) "The Complementarity of Information Technology Infrastructure and E-Commerce Capability: A Resource-Based Assessment of Their Business Value", *Journal of Management Information Systems*:(21)1.
- Zhu, K., and K.L. Kraemer (2002) "E-commerce Metrics for Net-Enhanced Organizations: Assessing the Value of E-Commerce to Firm Performance in the Manufacturing Sector", *Information Systems Research* (13)3.

APPENDIX A. MEASUREMENT ITEMS FOR PRINCIPAL CONSTRUCTS

CIMS is defined on the front page of the survey sheet as "the system that includes people, processes, and technologies for managing critical incidents."

Asset Allocation Capability Support

Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly Agree (5)

1. The CIMS helps in the decision process to optimally allocate equipment to an incident.
2. The CIMS helps in the decision process to optimally allocate first responders to an incident.
3. The CIMS helps in the decision process to optimally allocate resources to multiple simultaneously occurring incidents.

Response Asset Availability

Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly Agree (5)

1. There will be enough equipment for everyone to use in an emergency situation.
2. The appropriate equipment is available for use in an emergency situation.
3. There will be adequate number of regular personnel.

Dispatch System Capacity

Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly Agree (5)

1. Dispatch system has sufficient and adequate capacity to overcome call flooding.
2. Dispatch system has a backup call handling facility

Interagency Communication

Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly Agree (5)

1. Information sharing among first responders is timely.

2. Information sharing with other agencies is timely.

Knowledge Repository Access

Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly Agree (5)

1. The CIMS has access to ChemTrac or other similar systems
2. The CIMS has access to databases of the HazMat bank or other similar systems.

Emergency Response Performance

Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly Agree (5)

1. The system allows for good management of mitigation.
2. The system enables quick and correct decision making.
3. Victims are satisfied with the mitigation actions.

Very Ineffective (1), Ineffective (2), Neutral (3), Effective (4), Very Effective (5)

4. Overall effectiveness of execution.

APPENDIX B. PLS ITEM CROSS-CORRELATION

	Asset Allocation Capability Support (AS)	Response Asset Availability (AA)	Dispatch System Capacity (DS)	Interagency Communication (IC)	Knowledge Repository Access (KR)	Emergency Response Performance (RP)
AS1	0.91	0.47	0.46	0.28	0.23	0.55
AS2	0.91	0.40	0.34	0.29	0.23	0.54
AS3	0.91	0.41	0.40	0.40	0.35	0.59
AA1	0.41	0.92	0.55	0.42	0.14	0.40
AA2	0.47	0.90	0.56	0.28	0.14	0.42
AA3	0.28	0.71	0.30	0.31	-0.03	0.31
DS1	0.46	0.52	0.96	0.34	0.21	0.46
DS2	0.31	0.52	0.83	0.06	0.06	0.42
IC1	0.32	0.37	0.23	0.92	0.06	0.27
IC2	0.35	0.37	0.27	0.94	0.10	0.28
KR1	0.23	0.04	0.08	0.10	0.88	0.12
KR2	0.31	0.14	0.22	0.06	0.94	0.20
RP1	0.48	0.38	0.45	0.29	0.22	0.84
RP2	0.50	0.31	0.34	0.20	0.03	0.81
RP3	0.54	0.41	0.46	0.23	0.04	0.81
RP4	0.43	0.32	0.28	0.23	0.31	0.72

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