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RESEARCH ARTICLE

Disaster Experience and Hospital Information Systems: An Examination of Perceived Information Assurance, Risk, Resilience, and HIS Usefulness[1]

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This paper examines how an individual's disaster experience affects his or her perceptions of sociotechnical safety factors (risk, information assurance, resilience) and perceived usefulness of hospital information systems (HIS). This paper consists of two studies focusing on different aspects: a quasi-field experiment conducted with employees in three hospitals affected by a severe snowstorm (labeled a federal disaster) (N = 103), where we compare the perceptual factors in the context of the disaster experience (with versus without recall), and a comparative study between a first sample group (with disaster experience) and a second, contrast sample group (with no disaster experience) of hospital employees (N= 179) from two similar hospitals. The results show that the disaster experience changes the relationships among the perceptual factors that affect perceived usefulness. Individuals tend to perceive negative factors (such as risk) as having greater effects when they actually have direct experience in a disaster situation than in a normal situation. Positive factors (such as information assurance and resilience) have a lesser impact among individuals who have disaster experience (with versus without recall).

Keywords: Disaster experience, information assurance, perceived system risk, perceived resilience, quasi-experiment, comparative study, hospital information systems usefulness

Introduction

The primary job of most organizations in the context of disruptions (small or large) is to manage uncertainty to achieve performance (Leach 2006) through the development of strategies to reduce the probabilities of negative events and/or the consequences should they occur (Heal and Kunreuther 2007). Sheffi (2007) points out that when thinking about reducing an organization's vulnerability to disruption, it is important to look at both increasing information assurance (thus reducing the likelihood of disruption) as well as resilience (thus increasing the capabilities for rebounding quickly). Past studies have shown that risk captures the negative consequences of an event in using a product, service, or system, while information assurance and resilience help in the reduction of the consequences of negative events (Heal and Kunreuther 2007). In

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fact, resilience and risk have been considered as two sides of the same coin in dealing with uncertainty in organizations (Haeffel and Grigorenko 2007). The perceptions regarding these three frontline safety-critical issues—perceived risk, information assurance, and resilience—seem inevitably to come to the fore in disruptions and disaster contexts where individuals face stressful emotions (Dillon et al. 2011), and have an impact on performance. A principal criterion for assessing performance that is derived from IS use is the concept of perceived IS usefulness (Rai et al. 2002).

Although the relationship between perceived risk and perceived usefulness (in the context of e-service adoption) has been investigated in prior literature (Featherman and Pavlou 2003), to date, little has been confirmed about how an individual's perceptions regarding the three frontline issues (Zolli and Healy 2012) affect his or her perceptions regarding IS usefulness, especially in disaster situations. Perhaps, since the issue of risk and resilience and its interaction with information assurance is manifest mostly in the event of disruptions or disasters, prior research might have had a limited opportunity to address the issue above. Further, while past research (in a different context) has shown that people are heavily influenced by prior experience (Baron and Hershey 1988; Mazzocco et al. 2004; McKillip and Posavac 1975; Tinsley et al. 2012), the specific context of disaster experience has not been studied.

Disaster contexts demand that IS have a high level of agility and responsiveness to respond to uncertain situations. Since disasters are unexpected, low-probability events (Carley and Harrald 1997), people lose their sense of safety and predictability (Kroon and Overdijk 1999). Disasters also exact a considerable toll on the work life of individuals (Weems et al. 2007). Furthermore, because disasters highlight and amplify personal insecurities and feelings of vulnerability, they may serve to decrease the perceived self-competence and self-esteem of those affected by them (Wolfenstein 1957).

In order to understand perceptual issues that are influenced by disaster experience and why and how these issues are important to IS usefulness, the present study seeks to explore two research issues regarding perceived IS usefulness in the context of hospital information systems (HIS):

1. What are the relationships between individuals' perceptions of the factors of risk, information assurance, and resilience, and perceived usefulness of hospital information systems?

2. How does the disaster experience affect individual's perceptions regarding risk, information assurance, and resilience in relation to perceived usefulness?

To set the research focus, the paper centers on the HIS context. A well-functioning HIS should produce reliable and timely information on health determinants, for example, health status and health system performance. It should be capable of analyzing this information to guide activities by health decision makers at different levels of the health system to identify progress, problems, and needs, and to make evidence-based decisions and optimally allocate scarce resources (Mutale et al. 2013). The perception of usefulness of am HIS by a hospital employee is an important aspect of the HIS functioning. Improving such functioning is important for high quality health care services. Approaches to improving HIS vary; they require engaging various types of users from frontline health workers to data managers and also include technological interventions designed for increasing information assurance.

The contribution of this paper to the literature on perceived HIS usefulness is twofold. First, it demonstrates the importance of perceptions of risk, information assurance, and resilience as factors impacting perceived usefulness. Second, this paper provides a conceptual framework allowing integration of insights in the context of disasters, extending the body of research on perceived IS usefulness. In order to examine the impact of the disaster experience, we carried out a quasi-field experiment of hospital employees who had been through a federal disaster—the October 2006 snowstorm in western New York—and also subsequently studied a contrast group of hospital employees who had not been affected by the storm. The findings of this paper show that while perceived risk and resilience determine the extent to which HIS users believe the HIS to be useful, perceived information assurance does not directly impact perceived HIS usefulness but it has a very significant impact on perceived system resilience. The study also shows empirically, that disaster experience has an impact on user's positive and negative perceptions (i.e., with regard to information assurance/resilience and perceived risk) on HIS usefulness.

This paper is organized as follows. The next section reviews the pertinent literature. Subsequently, the hypotheses are explicated. The proposed methodology for the analysis is included in the methods section, while results and discussion are presented in the final section.

Related Background and Literature Review

The successful use of information systems (IS) by employees is crucial for business practices because organizations are heavily dependent upon such human–machine participatory systems. A great deal of research has been conducted in the

IS community over the past two decades that explores issues regarding successful implementation and operation of IS and the perceptions of users regarding their usefulness (see DeLone and McLean 2003; Rai et al. 2002; Seddon 1997). However, such research has focused primarily on business and corporate IS and has, to a large extent, neglected the context of disruptions and disasters.[2] Given that organizations have been facing various disruptions both large and small, including natural and human-made disasters[3] (e.g., the September 11, 2001, terrorist attacks, Hurricane Katrina in 2005, and Hurricane Sandy in 2012), there is a clear need for understanding the issues regarding IS usefulness in such situations.

Understanding an individual's perceptions of sociotechnical factors is important because it captures psychologically important aspects of the work environment. Such perceptions are crucial determinants of individual behavior in organizations because they serve as the link between the working conditions and the individual's working behavior (Schneider 2000). We suggest that these would in turn further influence the individual's future actions at times of disasters as well.

We present some examples from hospitals that were affected by the October 2006 snowstorm of western New York, and that illustrate the concepts we discuss in subsequent sections. Each of these was based on personal conversations (on September 26, 2004) with the COOs/CIOs of the hospitals.

> Chief Operating Officer of Hospital A: "Hospital employees with access to information regarding certain patients did not report to work because the snow storm caused the roads to become unpliable and a driving ban went into effect. Employees who were in the hospital at the time had to treat these patients and needed to access the patient data. They shared passwords among themselves. The habits from such practices among users remained for a time after the event. This was in part a reason for a loss of confidence [by HIS users] about the IT department's ability to stick to HIPAA guidelines. It also had an adverse impact on the perceptions of HIS users regarding the effective recovery and rebounding to the normal workflow models by the IT department at the time of disaster recovery."

> Chief Information Officer of Hospital B: "When the employees felt that perceived resilience was low and the risk to the system was high, it impacted the perception of the usefulness of the systems and caused users to switch to manual systems much earlier [on receipt of the impending snowstorm warning—which later turned into an unanticipated disaster] and after the storm, they did not believe the IT department's notifications that the disaster recovery process had been completed and they did not switch back to the HIS even though they were repeatedly reminded. This consequently had an impact on the efficiency of patient care and slowed patient care for days after the snowstorm."

> Chief Information Officer of Hospital C: "Having strong security processes may not help or may even hinder access to data during disaster situations. However, having a strong security posture would make people realize the hospital has good processes in managing the system at the data center and clinical levels for business continuity. This would result in positive perception about the hospital's ability to rebound faster [perceived resilience] *in the aftermath of the disaster* leading to positive perceptions about the usefulness of the system which in turn would foster more use of the HIS and consequently result in more efficient patient care."

In the following subsections we concentrate on the perceptions of hospital information systems users regarding the sociotechnical safety factors of risk, resilience, and information assurance, along with their relationship with perceived usefulness.

Perceived Usefulness: A Proxy of Information Systems Success

The concept of IS success has been widely accepted in IS research as a principal criterion for assessing the impact resulting from the usage of information systems. Indeed, it is a critical aspect of participatory systems. To capture IS success, IS researchers have developed a broad range of constructs (DeLone and McLean 2003; Rai et al. 2002; Seddon 1997) that indicate the positive impact of information systems on an individual's performance. Several concepts have been used to evaluate IS success—for example, net benefits, perceived usefulness, individual job performance, and individual productivity. Seddon (1997) used *perceived usefulness* instead of individual impact. Rai et al. (2002) considered *perceived usefulness* to be more or less equivalent to individual impact because it is based on constructs that DeLone and McLean (1992) had linked to IS success, such as improved

[2]Zolli and Healy (2012) point out that most present-day U.S. organizations have been largely insulated from shocks and disruptions, thus resulting in an emphasis on efficiency and effectiveness rather than response to vulnerabilities, volatilities, and unorthodox challenges.

[3]According to the Federal Emergency Management Agency (FEMA; www.fema.gov), major disaster declarations in the United States increased from 45 in 2001 to 99 in 2011.

individual productivity. Therefore, consistent with past research (see Rai et al. 2002; Sabherwal et al. 2006; Seddon 1997), this study uses perceived *HIS usefulness*[4] as the dependent variable in lieu of IS success, as the goal of this study is to investigate psychologically important aspects of the hospital IS work environment. Our study considers system users' perception of IS usefulness as an outcome of the underlying psychological processes.

Perceived Risk and Perceived System Risk

Past research on risk has shown that whether a risk is real is often irrelevant; rather, it is the *perception* of risk that prevents positive action, creates barriers to successful deployment of participatory systems (Jiang and Klein 1999), and could have enormous impact on individual and group behavior (Heal and Kunreuther 2007). Perceived risk comprises a collection of notions that people form concerning risk sources (or sources of uncertainty) relative to the information available to them (Jaeger et al. 2002). When people perceive risks, there is an expectation of some loss or other negative impact associated with the risk (Stone and Winter 1987).

Perceived risk has been known to have a negative influence on individual performances. It gives rise to low levels of expectation and pessimism regarding information systems' capabilities in supporting employees' jobs. This results in employees' avoidance of these systems and ineffective use of the organization's information systems. Further, in the wake of a disaster, people's experiences could lead them to become aware of disasters generally and eventually might change their perceptions of risk, thereby affecting their job performance. Prior literature has not studied the effect of perceived risk on perceived IS usefulness in the context of disasters. Müller et al. (2013) point out that a key aspect of assessing operational risk is based on threat probabilities—that is, the potential for failure of system components that are often interdependent. In this study, we focus on perceived system risk in the context of hospital information systems. *Perceived system risk* (SR) is employees' subjective expectations and assessments of the risk caused by damage or loss to information systems (Straub and Welke 1998); we consider that it arises when individuals perceive that their hospital's information systems are detrimentally affected (Heal and Kunreuther 2007). When network facilities are disrupted or telecommunications facilities are disrupted, system risk would be impacted.

In this study, we focus on system risk—a specific concept that has not been discussed in the context of HIS usefulness in prior IS literature, although the general concept of risk has been discussed with regard to IS usefulness (Pavlou and Gefen 2004). In the context of HIS, it could have a detrimental effect on employees' perception of HIS usefulness, as system risk may hinder the use of HIS.

Perceived Resilience

According to Masten and Obradović (2006), "Resilience is a broad conceptual umbrella, covering many concepts related to positive patterns of adaptation in the context of adversity" (p. 14). Diverse definitions of resilience have appeared in the historical literature, with the specific definition being determined by the field of context. For example, psychology and organization perspectives consider the resilience concept as a personal characteristic/trait of individuals' ability, whereas the infrastructure perspective focuses more on the capacity of an entity or system. Table 1 summarizes various perspectives that capture the concept of resilience.

Recent research has focused on the detrimental physical impact of disaster on critical infrastructure (Barton 2006; Calhoun and Tedeschi 2004) and has identified the issue of how psychological resilience helps in business coping behavior and community response (Tierney 1997), as well as systems performance (Petak 2002). Resilience has been associated with overcoming threats to a system's adaptation as they unfold. It is especially important within a disaster context because it encompasses the capability to bounce back (Wildavsky 1988), and this bounce-back ability is needed whenever unexpected events, such as disasters and other crises, occur. The concept of resilience is associated with reduced failure probability, reduced consequences from failure, and reduced time to recover as experienced by individuals, small groups, and organizations (Bruneau et al. 2003; Sutcliffe and Vogus 2003). Caralli et al. (2010) define resilience as a sociotechnical concept encompassing people, information, technology, and facilities that work interdependently for developing strategies and processes for protecting high-value services and associated assets. Comfort et al. (2010) have defined resilience as the "capacity of a social system to proactively adapt to and recover from disturbances that are perceived within the system to fall outside the range of normal and expected disturbances" (p. 9).

A key word in the definition is *perceived*. Based on past research (Block and Kremen 1996; Bruneau et al. 2003; Rose 2004; Sutcliffe and Vogus 2003), in this study we define resilience in terms of employees' perceptions regarding (1) responsiveness of people in the organization to critical incidents and organizational business continuity plans and

[4]Various authors have also used system usage as a component of IS success. However, because system usage may be mandated by management (Ginzberg 1978; Livari 1987), and because employees of institutions such as hospitals (and banks) do not actually have a choice in the matter, system usage is excluded in this study.

Table 1. Definitions of Resilience in Various Research Areas	
Research Area	**Definitions**
Development Perspective	• A judgment that an entity is doing okay (or better than okay) with respect to a certain set of expectations for behavior and that an entity has faced extenuating circumstances that posed a threat to good outcomes (Masten and Obradović 2006; Masten and Reed 2002). • The capacity for adaptability, positive functioning, or competence following chronic stress or prolonged trauma (Eisenhardt and Martin 2000; Levinthal and March 1981; Sitkin and Pablo1992; Wildavsky 1988). • The continuing ability to use internal and external resources successfully to resolve issues.
Psychology Perspective	• The "positive psychological capacity to rebound, to 'bounce back' from adversity, uncertainty, conflict, failure, or even positive change, progress and increased responsibility" (Luthans 2002, p. 702). • A personal characteristic or relatively stable trait characterized by the ability to bounce back from negative experiences and by flexible adaptation to the ever-changing demands of life (Block and Kremen 1996).
Organization Perspective	• A characteristic or capacity of an individual or organization specifically (Wildavsky 1988). • The ability to absorb strain and preserve (or improve) functioning despite the presence of adversity (Meyer 1982). • An ability to recover or bounce back from untoward events (Sutcliffe and Vogus 2003; Wanberg and Banas 2000).
Infrastructure Perspective	• A characteristic of resistance to future negative events. • The capacity of an entity or system to maintain and renew itself particularly in the presence of stressors, or the ability or capacity of a system to absorb or cushion against damage or loss (Rose 2004).

(2) the ability of systems to recover quickly from negative experiences of management crisis, adversity, or disaster, which would include business continuity and disaster recovery for the purposes of coping with the adverse event (Omer et al. 2009).

In examining the effect of resilience on perceived usefulness of IS, we focus on the potential impact of *experience* versus *no experience* with disasters—a distinction that has received little attention in the past. Specifically, we suggest that past experience with disasters is an important factor in influencing people's perceptions of hazards.

Perceived Information Assurance

Ezingeard et al. (2007) describe information assurance as the certainty that within an organization, information assets are reliable, secure, private, accurate, and available. They suggest that information assurance typically defines how these assets (i.e., data and information within both the tangible and the virtual bounds of the organization) should be secured to provide maximum benefit. This involves protecting and defending both information and IS, by ensuring their availability, integrity, confidentiality, identification, authentication, and non-repudiation (Shelton 1998)

In the context of HIS, these capabilities produce the kind of defense required to comply with legislation such as the Health Insurance Portability and Accountability Act (HIPAA). One major aspect of HIPAA deals with disaster recovery plans, where the primary function is to rebuild the IT resource in HIS, thereby providing access to the necessary information immediately after a major disaster or other business interruption (Murphy 2004). HIPAA requires health care organizations to pay strict attention to protected health information so as to ensure stronger protection and defense of information assets for patient care.

Disasters may lead to a breakdown in civil infrastructure, resulting in many hospital employees not being able to report to work. Such an issue has the potential to cause data access problems, as those system users who do manage to report to work may not be able to access all of the data that they need. As organizations move away from paper-based systems and begin to depend on information technology (IT), breaks in dependency chains start to affect the provisioning of products and services. The critical nature of electronic data or information, the dependency on electronically stored information, and the need for that information to be readily available while preserving the confidentiality of customer information collectively create an environment (see Jensen and Aanestad 2007) that requires successful functioning of IS—that is, an environment in which IS is vital to maintaining the patients (Currie and Guah 2006). The perceptions of information assurance—in other words, the perceptions surrounding the guarantee that the security system will behave as expected—would have an impact on the perceived usefulness of human–machine participatory systems.

Hypothesis Development

In this section, we outline (1) the three relationships regarding individuals' perceptions of risk, information assurance, and resilience on perceived HIS usefulness, and (2) the effect of disaster experience on those relationships. Risk perception is a concept that includes *uncertainty* or *loss*; thus it reflects a belief that may result in a negative assessment of IS. By comparison, the perception of information assurance reflects the assessment of the confidentiality, integrity, and availability of the system and results in positive assessment of system usefulness (Havlena and DeSarbo 1991). Haeffel and Grigorenko (2007) suggest that risk and resilience are like two sides of the same coin. Safety is the coin that is considered to have two faces (Carthey et al. 2001). One side is the negative aspect that is revealed by the risks that the system experiences, which are exposed by mishaps, disruptions, disturbances, and other unexpected events. On the other side, its positive face is expressed by the system's resilience to hazards, which results in robustness of coping with human and technical dangers associated with the adverse event. Even though the two factors (risk and resilience) have opposite faces, there has been no study that examines how they jointly influence perceived usefulness.

We synthesize the relevant literature (Bhatnagar et al. 2000; Cox and Rich 1964; Featherman and Fuller 2003; Featherman and Pavlou 2003; Szajna and Scamell 1993) to suggest that perceived HIS usefulness is a function of the factors of (1) risk regarding negative appraisal regarding usage of a system and (2) the factors of both information assurance and resilience regarding the positive appraisal of a HIS.

The Effect of Perceived System Risk

Perceived risk could appear when people face feelings of discomfort or anxiety (Dowling and Staelin 1994), concern (Zaltman and Wallendorf 1983), uncertainty (Engel et al. 1986), and cognitive dissonance (Festinger 1957). Prior research has highlighted the negative relationship between perceived risks and perceived usefulness (Escobar-Rodríguez et al. 2012; Horst et al. 2007; Im et al. 2008; Pavlou 2003).

Such perceptions could raise concerns about system instability. Individuals might feel that their organizational IS is at risk, or that it would be disrupted when faced with uncertain situations. As the interdependence of various types of infrastructures increases, individuals tend to perceive that restoration efforts or uncertainties experienced by one sector could adversely affect the operations or restoration efforts of another sector, thereby contributing to further service disruptions (Saxton 2002).

Such perceived system risk would affect HIS users' perception of whether their IS can deliver the expected level of service. Specifically, system risk perceptions would cause individuals to devalue the perceived usefulness of their IS. Thus we predict that hospital employees who perceive high risk are likely to hold a conservative perception of HIS usefulness. Therefore, we suggest the following hypothesis:

H1: *Perceived systems risk will be negatively associated with perceived usefulness.*

As mentioned earlier, we argue that the perception of the negative factor of risk would be countered by the perceptions of the positive factors related to information assurance and resilience in the evaluation of perceived usefulness of the HIS system by the employee.

The Effect of Information Assurance

Information assurance implies the ability to protect information and information systems from unauthorized access, use, disclosure, disruption, modification, or destruction, and to respond and recover in case of a fault or incident; *resilience* focuses more on the ability of a system (e.g., network, service, infrastructure) to rebound from the extreme event and provide and maintain an acceptable level of service in the face of various faults and challenges to normal operation (Omer et al. 2009).

In this study, we define information assurance as employees' perception that information security and privacy for HIS (i.e., medical and patient) data are assured (Kim et al. 2004). Sharing or using sensitive patient information in a large, distributed, and heterogeneous hospital could lead to security and privacy vulnerabilities (Braghin et al. 2008), which is to say that the information might be compromised or threatened by attackers, or inadvertently exposed by HIS users. In hospital organization settings, resilience is engendered when those employees who are most likely to have the relevant and specific knowledge necessary to make a decision and resolve a problem are given decision-making authority (Wruck and Jensen 1994). These employees will have confidence in themselves and the ability of their systems to withstand disruptions and disasters if, as a result of prior experience, training, and information campaigns, they develop a positive view of HIS and the protections that such systems afford. This leads us to the next hypothesis:

H2a: *Perceived information assurance will be positively associated with perceived resilience.*

Past research (Chan 2002; Chandler-Wilde and McFadzean 2004) suggests that a link exists between employees' perceptions of information assurance and goal achievement. We suggest that the link also exists in the context of effective use of HIS. Psychological decline of performance is most likely to stem from an internal source, such as employees who are aware of the insecure systems within their hospitals. Such a scenario is especially plausible when a hospital has volumes of data to protect from inside or outside breach. For example, hospital employees would perceive their system's assurance with greater sensitivity, owing to the data that they must protect from breaches and privacy invasion, because the objective of the HIS is to produce relevant and quality information to support decision making (Network 2006). If hospital employees feel confident about the safeguards that are in place, they are likely to feel more confident about their ability to use the HIS more effectively and to accomplish the task of providing effective health care to patients. That is, the more strongly people perceive an organization's IS (i.e., HIS) as being highly assured, the greater the degree to which employees will use HIS effectively.

Positive perception of information often implies positive beliefs that information is more likely to be available for employees to use and, in turn, that the information entered in the HIS will be secure. Eventually, the perception of high information assurance will positively motivate employees to use the HIS despite any unexpected events that occur, which has implications for the hospital as a whole. We therefore offer the following hypothesis:

H2b: *Perceived information assurance will be positively associated with perceived usefulness.*

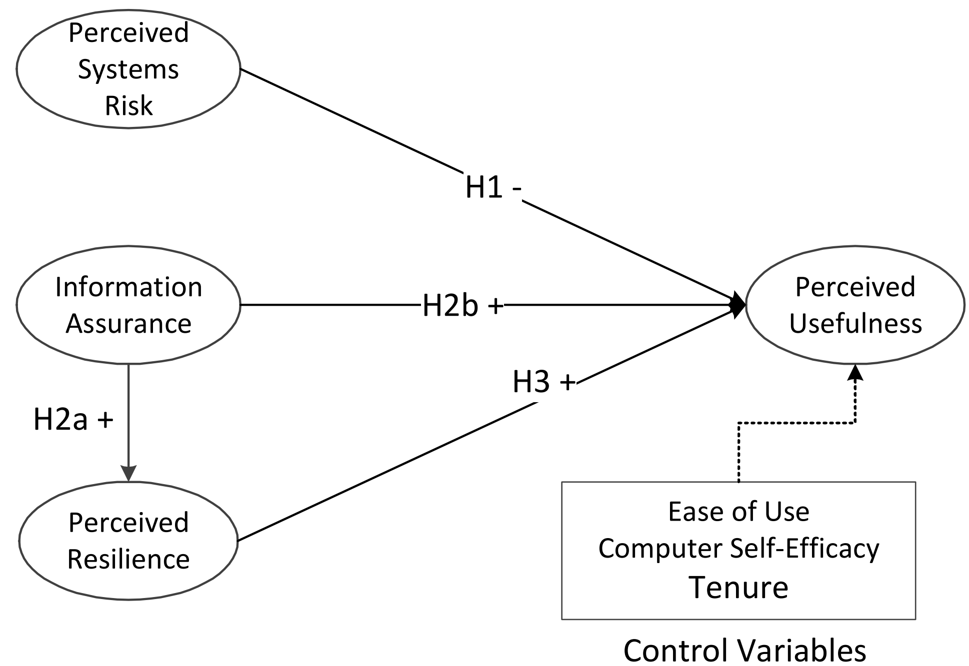
The Effect of Perceived Resilience

In the health care area, successful management of HIS infrastructure is crucial for health practices. Within the context of today's HIS, beyond basic preparedness, it is important to develop resilience at both the hospital and individual levels. The state of resilience of hospitals can be vulnerable if stakeholders are psychologically affected by the disasters. Resilience implies that not only can a system, hospital, or person recoup after a disaster, but that the disaster experience ultimately improves the entity's functioning (Bartone 2006; Gregerson 2007). As pointed out by Müller et al. (2013), within the areas of IS risk and security management, the tension between IT/IS-enabled productivity (*IS usefulness* in our paper) and the various vulnerabilities has been long recognized. However, the concept of interdependent resilience, which can affect the running of organizations and systems in the context of hazards, has not been explored. We argue that resilience is an important issue for IS research and must be taken into account in the study of safety-critical sociotechnological systems characterized by high uncertainty, as in the case of disasters (Müller et al. 2013). Resilience combines social, organizational, and technical qualities; thus the three dimensions of people, process, and technology must be considered. These dimensions are interdependent: If one of them fails, then the likelihood of poor resiliency and overall system failure increases.

This study posits that, if employees perceive their hospital as being resilient enough to handle unexpected events, then they would perceive their HIS as useful in dealing with their jobs and, eventually, this belief will enhance their work performance. Although to date little research has been conducted regarding resilience and HIS in the workplace at hospitals, interesting work has been done in framing the relationship between resilience and performance in difficult situations. Findings in this area include a significant relationship between the resilience of Chinese workers and their rated performance (Luthans et al. 2005) as well as resilient employees in a massive downsizing, who maintained their health, happiness, and performance (Maddi 1987). Further, Sutcliffe and Vogus (2003) have pointed out that organizations with resilient infrastructure have the ability to "maintain positive adjustment under challenging conditions" (p. 95).

In our paper, we adapt this resilience and performance relationship to the context of HIS usefulness. We argue that perceived resilience would impact the perception of usefulness of a HIS by a hospital employee. In doing so, we broadly follow a recent study that shows perceptions, beliefs, and even emotions can play a critical role affecting users' IS use behavior (Beaudry and Pinsonneault, 2010). Perceptions of strong resilience would affect the perceptions regarding HIS capability in approaching difficult tasks and activities. Therefore, individuals' perceived resilience can enhance their overall competence and growth, help restore efficacy by increasing the ability to quickly process feedback, and transfer knowledge and resources to deal with various situations (Sutcliffe and Vogus 2003). Employees with a high resilience perception will possess a positive view of their hospital as well as an optimistic outlook on the future. Thus, the more strongly they perceive resilience, the more likely they would be to recover from setbacks at work (Luthans et al. 2007), and the more likely they would be to assess their HIS positively. Based on this reasoning, we propose the following hypothesis:

H3: *Perceived resilience will be positively associated with perceived usefulness.*



Notes: CSE: computer self-efficacy; Tenure: number of working years.
The organizational characteristic was used as a fixed-effect factor but does not appear in the model.

Figure 1. The Theoretical Model

Figure 1 captures the model and hypothesized relationships for our study. In the next subsection, we discuss the rest of the hypotheses that pertain to the effect of disasters on the related psychological process.

Perceptions and Disaster Experiences

Fritz (1961) defines disasters as

> concentrated in time and space, in which a society or relatively self-sufficient subdivision of society undergoes severe danger and incurs such losses to its members and physical appurtenances that the social structure is disrupted and the fulfillment of all or some of the essential functions of society is prevented (p. 652).

People construct their own reality and evaluate risks based on their subjective perceptions. On the one hand, according to the availability heuristic (i.e., a cognitive strategy in which people rely upon knowledge that is readily available rather than examine other alternatives or procedures; Tversky and Kahneman 1982), people rely on the ease with which examples of a disaster can be recollected as a cue for estimating the probability of a hazard (Dillon and Tinsley 2008; Dillon et al. 2011). On the other hand, experience has an effect on people's work, either positively or negatively, depending on the circumstances. In fact, past research has demonstrated that direct experience results in greater attitude strength than indirect experience (Marks and Kamins 1988; Rajagopal and Montgomery 2011; Regan and Fazio 1977; Smith and Swinyard 1983).

For example, Lagadec (1993) has mentioned that "the extreme event can in some ways be considered as an abrupt and brutal audit" (p. 54); that is, the experience with rare events enriches the organization's response repertoire for coping with interruptions and enables people to swing into action more quickly when faced with other rare events (Christianson et al. 2009). Experience facilitates the cognitive simplification of job-related routines and behaviors (Earley et al. 1990). Direct experience with an object has also been reported to increase confidence in judgment (Smith and Swinyard 1983). In addition, Tinsley et al. (2012) explain that prior experiences shape the domain knowledge associated with the hazard. For instance, those employees who have disaster experience would be expected to more accurately judge the actual relationship between perceived system risk and perceived usefulness and to take steps to mitigate adverse impact. In contrast, employees without disaster experience would view perceived system risk and usefulness against the backdrop of a threat with uncertainty due to lack of real experience.

As such, past experience with disasters is an important factor in influencing people's perceptions of hazards (Jackson 1981; Li et al. 2013). Specifically, we argue that disaster experiences would help employees generate a sense of threat anticipation regarding future uncertain events and encourage them to better prepare their HIS for such incidents. Those employees who have not experienced disasters may sometimes ignore the possibility of disaster (Camerer and Kunreuther 1989) or even "create a sense of complacency around a previously calculated level of statistical risk (i.e., a lowering of perceived system risk)" (Dillon and Tinlsey 2008, p. 1436). In such a case, hospital employees would tend to be less concerned about whether the disaster risk would affect their HIS. However, when employees actually experience a disaster, they may believe that the perceived system risks will have a relatively stronger impact on their organization. Therefore,

H4: *The negative effect of perceived systems risk on perceived usefulness will be stronger for HIS users with disaster experience than otherwise.*

We believe that individuals who have experienced disasters tend to gain greater understanding of how to deal with their work under difficult circumstances. In essence, disaster-experienced individuals have a broader and richer frame of reference (Weick 1979) on which to draw, in gauging their own knowledge about securely operating their information systems in hospitals. Exposure to disaster might change individuals' perceptions of systems assurance by leading them to recognize security and privacy issues that existed in the past but have not yet inspired much concern because their perceptions and actions are guided by the expectations resulting from their previous experience (Weick 1979). It has been found in many cases that the perceived dependence on current protective artifacts is usually greater in anticipation of an adverse event. This relationship often derives from the mistaken assumption that the outcomes of hazards are certain, and hence anticipatory measures can be employed. With increasing uncertainty, however, systems may become more susceptible to disturbances and attempts at adapting may fail (Handmer and Dovers 1996).

Given that the expectation is that the future will look much like the past, new developments and new risks that do not fit with existing interpretations may be overlooked or ignored. Therefore, the hospital employees with disaster experience would hold relatively accurate perceptions about the effect of information assurance on the usefulness of HIS. In contrast, employees without disaster experience might anticipate that the organization's security and privacy would be in less danger (i.e., the strong perception of information assurance) during a disaster context (Kunreuther et al. 2004) and therefore be able to withstand anticipated disruptions, resulting in perceptions of greater usefulness of the HIS at hand (Zolli and Healy 2012). Therefore, when hospital employees consider the effect of information assurance without prior experience of such an event, they might inappropriately overvalue the impact of information assurance on perceived usefulness (Kunreuther and Pauly 2004). When disruptions are detected and internalized, long-held assumptions about what is possible are questioned (Sheffi 2007), with a concomitant realization that other existing interdependencies may have an impact on perceived usefulness. We argue that once an adverse event has happened, employees would learn about the inadequacies of the protective abilities of information assurance artifacts in the HIS. Based on the preceding logic, we suggest the following hypothesis:

H5: *The positive effect of perceived information assurance on perceived usefulness will be weaker for HIS users with disaster experience than otherwise.*

It is highly likely that hospital employees would adopt behaviors to reduce psychological threats and would continue fulfilling their duties using their disaster experience, thereby positively affecting the performance of the participatory system. A strong belief in resilience may lead employees to avoid or reduce the potentially negative psychological impact stemming from a disaster when they have prior disaster experience. In fact, past research has shown that job-related experience has a positive moderating effect on performance, in that the experience helps employees accumulate skills relevant to their jobs (Cohen 1991; Riketta 2002; Wright and Bonett 2002). It has also been found that more experienced individuals have better-developed response repertoires for coping with extreme events[5] (e.g., Weick 1988).

The disaster experience would lead to a more realistic understanding of the relationship between perceived resilience and perceived usefulness than before the disaster experience. Those employees with disaster experience may have a system of early detection in place that enables them to avoid low-probability disruptions and, therefore, rely more on other

[5]We have used the terms *disasters* and *extreme events* interchangeably because *extreme events* covers a variety of disasters, including both natural and human-made disasters.

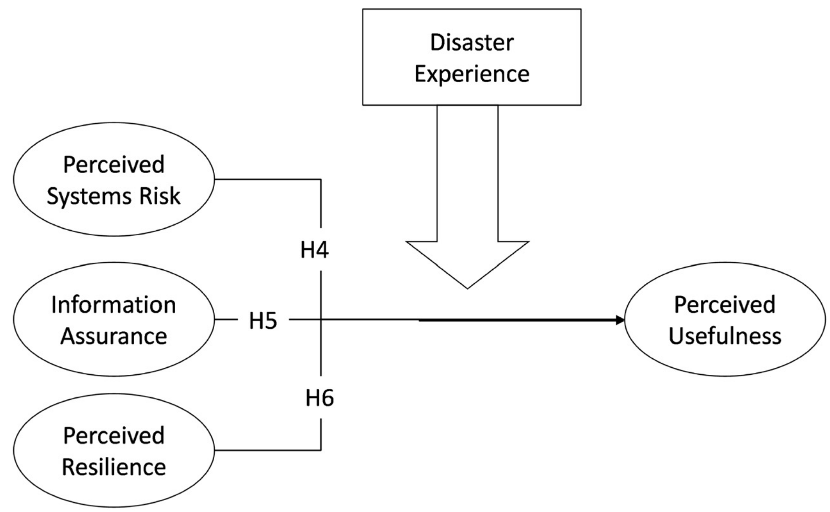


Figure 2. The Effect of a Disaster

methods (i.e., response repertoires) and less on resilience (through either redundancy or enhanced flexibility) affecting usefulness (Sheffi 2007). Employees who do not have actual disaster experience (e.g., resilient near misses) are more likely to consider their HIS to be resilient and to ignore disaster warnings because they believe that their HIS is resilient enough to cope with the disaster (or that the disaster would not affect them) (Tinsley et al. 2012). Early positive perception is possible because individuals' perception or judgment can be affected by a general tendency called *unrealistic optimism* or *optimistic bias* (Weinstein 1980, 1987). In addition, people tend to judge future risk based on what has happened in the past and, therefore, often don't truly grasp the effect a new threat could have (Watson 2013).

As a consequence, people are more likely to recognize the value of resilience, which supports their belief in the utility of their HIS. However, because people with prior experience have seen the amount of revealed uncertainty from a disaster that must be coped with, they are less likely to recognize the value of resilience compared to people with no disaster experience. In this environment, resilience may not be openly valued, reducing its effect on perceived usefulness. Further, as Le Blanc (2012) has pointed out, "the memory of disasters mostly means pain" (p. 9), which would attenuate positive perceptions of resilience on usefulness. Therefore,

H6: *The positive effect of perceived resilience on perceived usefulness will be weaker for HIS users with disaster experience than otherwise.*

Figure 2 summarizes the arguments about the effects of a disaster.

Research Context and Method

Hospital information systems (HIS) can be defined as a set of components and procedures organized with the objective of generating information which will improve health care management decisions at all levels of the health system (Lippeveld et al. 2000). HIS can be broadly classified either as administrative systems (including billing systems) or as systems that support clinical aspects (including electronic health record systems) of hospital operations (Reddy et al. 2008).

For the disaster experience, three hospitals, all of which were affected by a disaster (a snowstorm in October 2006 that was labeled a federal disaster), were selected to participate in this study. These hospitals were deemed attractive for the purposes of the study for several reasons. First, the selected hospitals have their own HIS in terms of the basic functions performed (see Table 2). In addition, even though the hospitals differ in size and type, the underlying security and privacy issues in using the HIS are common to all three. Finally, the hospitals are mandated to securely store health and administrative information in their HIS. The October 2006 snowstorm, despite its immense scale, did not disrupt the hospitals' HIS technology in terms of hardware or software, but did affect their IS in terms of (1) both clinical and

Table 2. Hospital Characteristics and Applications					
Panel A: Characteristics					
Hospital Number	**Hospital 1**	**Hospital 2**	**Hospital 3**	**Hospital 4**	**Hospital 5**
Number of Beds	133	184	550	387	175
Hospital Type	Single Specialty—Cancer	Multispecialty	Multispecialty	Multispecialty	Multispecialty
Affiliation Type	No faith based affiliation	Catholic Health System	No faith based affiliation	Catholic Health System	Part of Catholic Health System
Emergency Department	No	Yes	Yes – Level 3 Trauma Center	Yes	Yes
Panel B: Applications in the Various Hospitals					
EMR/EHR Systems; Pharmacy Information Systems; Radiation Medicine System; Laboratory Information Management Suite; Patient Record System; PACS for Radiology, etc.					
Panel C: Administrative and Support Applications					
Accounts Receivable; Billing; E-Time Time and Attendance System; Payroll Software; On-Call Calendaring System					

Note: RBAC: role-based access control is the primary mechanism for access control in all hospitals.

administrative staff not reporting to work due to disruptions in the civil infrastructure and (2) physical workflows being modified to deal with patient surges, as a result of decreased levels of available staff.

We explore our proposed model, both in the context of the disaster experience and outside of it. Since this study carries out disaster-oriented research, there is no way that a researcher can establish randomized control groups in studying responses to disasters (Bourque et al. 1997). For this reason, quasi-experiment design was one of the options and the next best thing that the study could use. The two different quantitative designs—that is, quasi-field experiment in Study 1 (henceforth known as Study QFE) and comparative study of a contrast group in Study 2 (henceforth known as Study CCG), discussed later—could minimize methodological limitations and by doing so, provide an opportunity to develop a deeper understanding of changes in the employees' perceptions across the situations.

Study QFE: Study for Robustness Check: Method Design

We first used a *quasi-experimental field research*—specifically, one group with repeated tests design (Cook and Campbell 1979)—using the *retrospective survey* method (see Appendix A). The participants in this study were subjected to the disaster experience of the snowstorm of October 2006. The first test (hereafter *experience group,* before recall was administered) represents *the hospital employees* eight months after the disaster, while the second test (the experience with recall stimulus group, hereafter *recall group*) represents *the same hospital employee group* at the time when they were reminded about the disaster, which was immediately after the employees were administered the first survey.

Participants

In total, 250 questionnaires composed of repeated-measure items were distributed to hospital employees; 111 completed questionnaires were returned. The participants included hospital administrators, nurses, physicians, IT support staff, and laboratory technicians, among other personnel. The surveys were administered using a treatment design with experience, treatment presentation, and treatment elements. After eliminating surveys that had relatively high numbers of missing responses, 103 surveys were considered usable, leading to an effective response rate of 40.1 percent (see Table 3).[6]

Procedure

All participants in Study QFE had experience with the October snowstorm and were affected by the disaster when working with their HIS. As prior research has shown that responses are affected by people's experiences (Jackson 1981), we believed that the participants' responses to the survey questions would reflect their experience with the snowstorm. The survey was administered in three steps.

[6]Appendix B presents the additional tests related to the nonindependence of observations included in this study.

Table 3. Descriptive Statistics of Disaster Experience Participants (N = 103)

Contents		Minimum	Maximum	Mean	S.D.
Total years of working		1	40	17.40	10.50
Organization tenure		10 (month)	38	11.99	10.23
Years using MIS		1	30	7.10	7.80
Profession		**Frequency**		**Subtotals**	
Main user group	M.D. Nurse Therapist	5 39 2		46 (45%)	
Support user group	IT-Technologist Administrator	25 33		58 (55%)	

First, participants were asked to answer questions for all constructs in the absence of any cues regarding disasters. The first test intent was to capture employees' perceptions after their experience with the disaster (eight months after the disaster). Subsequently, after the first test was completed, the participants looked at a stimulus treatment (recall message); they were then asked to complete the survey with the same questions. There was minimal time lag between the first and second administrations of questions.

Stimulus Treatment (Recall Message)

The experiment required each participant to read a news article (Figure 3) and answer a set of questions as part of the survey. The package that was presented to respondents included both a picture and a news article from *The New York Times*. This news article was intended to stimulate recollection of only what had happened at that precise moment in the Buffalo area during the October 2006 storm. Thus employees could clearly draw on their memories about how the city coped with the disaster. In addition, the package of information was designed to focus respondents on the disaster itself, rather than to add any recollection regarding employees' memories related to their HIS, work performance, or perceptions of the HIS. We believe that the package that was presented as a stimulus was simple and clear for the purposes of this study.

Stimulus Check

After receiving the disaster recall stimulus, participants were asked to respond to two *stimulus checks*: "Did the news article help in recalling details about the storm?" and "How much do you remember about the 2006 October storm?" The first question was queried on a seven-point Likert-type scale (1 = strongly disagree to 7 = strongly agree) and the second question was queried with a five-point Likert-type scale (1 = no recollection of the event to 5 = very clearly).

Measure Development[7]

Perceived Usefulness

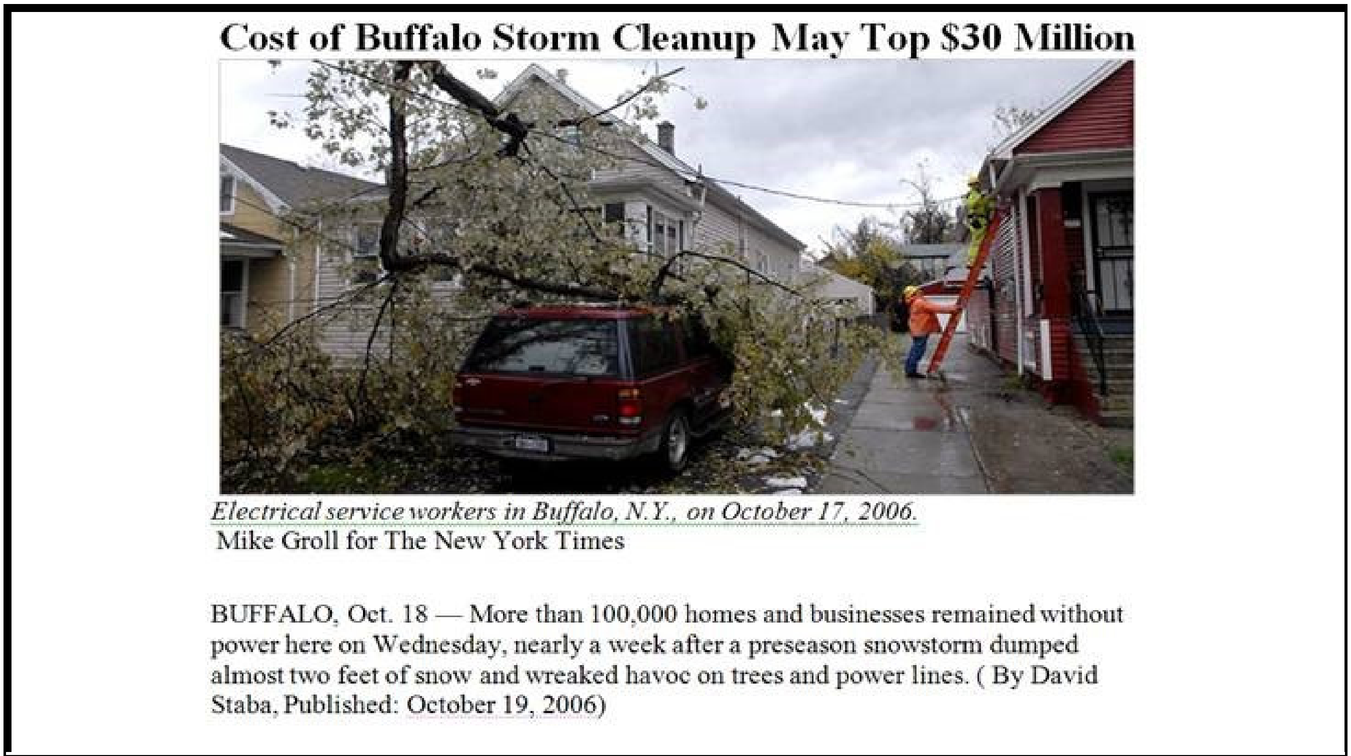
Consistent with arguments made earlier, *perceived usefulness* is a *general perceptual measure of IS success* (Seddon 1997). We used three items developed by Davis (1989) and adapted by Rai et al. (2002), tapping into individual productivity, time saving on the job, and individual effectiveness on the job. However, in a departure from the original items, the orientation of Davis's instrument was changed to better reflect past usage (see Appendix F). Items were designed to be scored on a seven-point scale (1 = strongly disagree to 7 = strongly agree).

Perceived Systems Risk

The perceived systems risk construct was measured using two items. Any IS faces a certain risk of disruption that could render it nonfunctional to its primary clients. In our study, *perceived systems risk* arose from the negative feelings brought

[7] We developed *perceived resilience* and *information assurance* items for this study. At the outset, we developed an initial survey based on the literature. We interviewed the Deputy Commissioner of Emergency Management at the county level and IT executives from hospitals in a disaster area (including chief information officers and chief security officers of the local hospitals, as well as the director of medical emergency services) in an effort to understand how stakeholders perceived their (organizational) ability to recover from disasters and the factors that affected their risks and resilience. Because participants' perceptions on those factors differed depending on their usage of HIS, this study tried to include their various viewpoints by encouraging stakeholders to participate in this survey. This approach allowed us to deal with face validity for the construct components.

Second, after we developed items, a pilot study with 50 employees from one of three hospitals was conducted to validate the survey instrument and establish that the survey items portrayed their intended meaning. Feedback was also sought on the survey's length, its overall appearance, and participants' expected reaction to its receipt in the mail. Comments and suggestions from interviewees were used to revise the survey.



Cost of Buffalo Storm Cleanup May Top $30 Million

Electrical service workers in Buffalo, N.Y., on October 17, 2006.
Mike Groll for The New York Times

BUFFALO, Oct. 18 — More than 100,000 homes and businesses remained without power here on Wednesday, nearly a week after a preseason snowstorm dumped almost two feet of snow and wreaked havoc on trees and power lines. (By David Staba, Published: October 19, 2006)

Figure 3. Disaster Recall Stimulus

about by the organization's disruption that might detrimentally affect the hospitals' IS (Heal and Kunreuther 2007).

Perceived Resilience

This construct was measured using four items covering organizational infrastructure: hospital information systems, personnel availability, organization's business continuity plans, and systems recovery plan. Items were designed to be scored on a seven-point scale (1 = strongly disagree to 7 = strongly agree).

Perceived Information Assurance

Five items were used for measuring the construct of perceived information assurance, defined for the purposes of this study as the degree of perceived availability, confidentiality, and integrity of IS. Those items were designed to cover both clinical and nonclinical IS aspects.

Control Variables

The subjects of the survey were employees in three hospitals in the Buffalo, New York, area that were affected by the October 2006 snowstorm (see Tables 2 and 3). Because this study was based on individual-level units, we needed to determine whether some effects occurred across the hospitals. To identify a *possible organization-specific effect*, we controlled for hospital category as a *fixed effect* in our analyses, because hospital-specific effects might have an impact on the dependent variable. These organization-level fixed effects could reflect many factors, such as the regulated nature of the health care industry's pricing policies, the inherited infrastructure, and the location-specific cost structures of individual hospitals. Therefore, we needed to be able to control for organization-level fixed effects to isolate the influence of different employees' perception levels on perceived usefulness (see Appendix E).

In addition, we used *computer self-efficacy* (CSE) as a control variable, as this factor is a major behavioral predictor (Compeau and Higgins 1995b; Igbaria and Iivari 1995). Computer self-efficacy refers to an individual's belief about his or her capabilities to operate either a computer in general or a specific task-oriented computer program (Compeau and Higgins 1995a). CSE items were taken from the work of Compeau and Higgins (1995b; Compeau et al., 1999) and modified to fit the HIS context. Three of ten items were chosen randomly but referred to factor loading values from past research (Compeau et al. 1999).

Table 4. Results of Paired *t*-Tests (*N* = 103)

Construct	Mean: Experience	Mean: Recall	Mean Difference	*t*-Value
Perceived Systems Risk	4.61	4.83	–0.22	–3.01***
Perceived Resilience	4.83	5.09	–0.25	–3.49***
Perceived Information Assurance	5.56	5.71	–0.15	–2.61**

Please define *** and **

Ease of use also was used as a control variable. In addition, the *tenure* in years of each respondent was used as a proxy for his or her work experience. Respondents' tenure at their current hospitals was used to tap into perceptions of organization-specific knowledge and learning processes that occur within their own organizations (Bontis et al. 2002).

Data Analyses

Partial least squares (PLS), as implemented in PLS Graph version 3.0, was used for data analysis. The PLS approach allows researchers to assess measurement model parameters and structural path coefficients simultaneously (Barclay et al. 1995). PLS was used for several reasons: (1) this study was primarily intended for causal-predictive analysis; (2) PLS requires fewer statistical specifications and constraints on the data than the covariance-based strategy of LISREL (e.g., assumptions of normality); and (3) PLS is effective for those early-theory testing situations that characterized this study. Therefore, PLS was an appropriate statistical analysis tool for the current study. It provides a prediction-oriented and data-analytic method, seeking to maximize the variances that are explained in the constructs (Barclay et al. 1995).

Before testing the hypotheses, preliminary analysis was undertaken to examine the availability of the pooled sample and construct validity. Table 4 reports the result of *t*-test for the subgroups.

Manipulation Check

For Study QFE, the results indicated that the stimulus worked as intended. To identify how much the stimulus affected participants' recall and memory, we conducted an analysis of variance (ANOVA) using two questions: "Did the news article help in recalling details about the storm?" and "How much do you remember about the October storm in 2006?" The results indicated that the stimulus significantly affected participants' memory of the disaster ($F = 5.452$, $p < 0.001$). Participants who responded that the news article helped in recall also indicated that they remembered the disaster clearly. These results lend credence to the argument that the stimulus was successful.

Study QFE: Result

Measurement Model Estimation

Examining the correlations between our marker items and other substantive variables provides evidence that common method bias is not a serious threat (see Appendix C).

The measurement model for all measures in the three different data sets in the PLS analysis was assessed by examining internal consistency and convergent and discriminant validity (Barclay et al. 1995; Chin 1998). An internal consistency reliability of 0.7 or higher is considered adequate (Barclay et al. 1995). Convergent and discriminant validity was assessed with the average variance extracted (AVE) for each construct from its indicators and item loadings. AVE should be greater than 0.50 to justify using a construct.

Table 5 shows the scale means, standard deviations, and Pearson's correlations. Appendix G also shows composite reliability (C.R.), and AVE among the measures, in two contexts: *experience* and *recall* (i.e., before and after the stimulus was administered). Further, confirmatory factor analysis revealed that each construct explains the variance substantially. The aforementioned results suggest that the constructs in the study exhibited good psychometric properties. Factor loadings for the indicators associated with each construct are reported in Appendix E; each exceeded 0.70, indicating adequate reliability.

In any study, each construct is expected to share more variance with its own items than with the items of other constructs in the model, thereby demonstrating convergent and discriminant validity. As shown in Table 5, the square root of AVE for every construct exceeded the suggested criterion of 0.70 for all measures.[8] Therefore, adequate convergent and discriminant validity was obtained.

[8]See the diagonal elements in the matrix; note that the AVE of each construct is greater than its correlation with other constructs.

Table 5. Interconstruct Correlations by Contexts

Contexts and Construct	Mean	S.D.	Correlations of Constructs				
Experience Subject			**1**	**2**	**3**	**4**	**5**
PU (1)	4.73	1.61	1.000				
Resilience (2)	4.83	1.35	0.260**	1.000			
IA (3)	5.56	1.09	0.148*	0.249**	1.000		
SR (4)	4.61	1.34	–0.332***	0.070	–0.174*	1.000	
Ease of Use (5)	4.49	1.36	0.542***	0.523**	0.208*	–0.060	1.000
CSE (6)	4.67	1.77	0.264**	0.169*	–0.068	–0.033	0.123
Recall Subject			1	2	3	4	5
PU (1)	4.73	1.61	1.000				
Resilience (2)	5.09	1.28	0.278**	1.000			
IA (3)	5.71	1.03	0.258**	0.318***	1.000		
SR (4)	4.83	1.34	–0.233**	–0.178*	–0.236**	1.000	
Ease of Use (5)	4.51	1.32	0.637***	0.508***	0.321**	–0.093	1.000
CSE (6)	5.14	1.03	0.376***	0.314**	0.143	–0.168**	0.512***

Note: PU: perceived usefulness; IA: information assurance; SR: perceived systems risk; CSE: computer self-efficacy.
**p* < 0.05 (two-tailed). ***p* < 0.01 (two-tailed), ****p* < 0.001(two-tailed).

Table 11 (found later in this paper) displays the results of comparing the base model and *fixed effect* model analyses in which perceived usefulness is the dependent construct. The baseline model, which we call Model 1, includes only main constructs: information assurance, perceived systems risk, perceived resilience, and control variables. Organization indicators were included as *a fixed effect* in Model 2. Consistent with the baseline model results, organizational effect as a fixed effect did not affect the relationships among constructs.

Testing the Structural Model

Figure 4 presents the path coefficients for each of the experience and recall group subsamples across each of the constructs. In this paragraph, we report the betas in the following forms: $\beta = \beta$ (experience) and β (recall). First, as we hypothesized in H1, systems risk had negative effects on perceived usefulness ($\beta = -0.240$, $p < 0.001$ and –0.160, $p < 0.01$).

The effect of perceived information assurance (H2) was also significant for the perceived resilience ($\beta = 0.249$, $p < 0.001$ and 0.318, $p < 0.001$) in both the experience and recall groups. There were no significant results regarding information assurance and the perceived usefulness ($\beta = 0.013^{ns}$ and 0.080^{ns}). Finally, for H3, which deals with the effect of resilience on perceived usefulness, the results were statistically significant only for the recall group ($\beta = 0.034^{ns}$ and 0.123, $p < 0.05$).

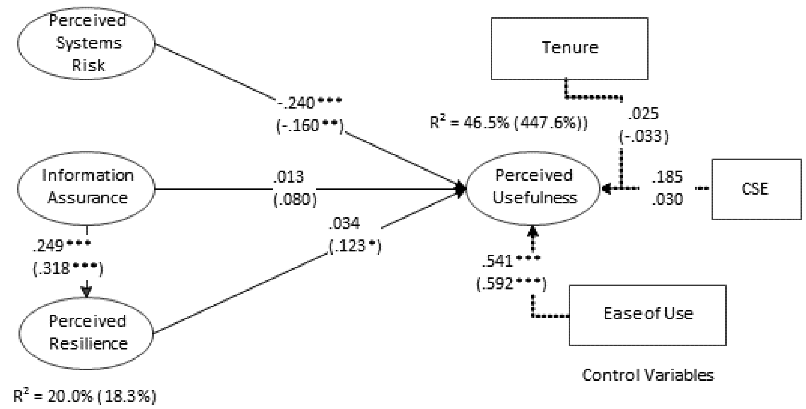
Comparison of Experience and Recall Groups

Following the model testing, we conducted a multigroup analysis. We computed the differences in path coefficients in the contexts of the disaster experience and the moment when study participants recalled the disaster. We then compared the two subgroups (experience versus recall) using the test for differences suggested by Chin (2004) and implemented by Hsieh et al. (2008). We used the same subjects to compare the two different contexts. The *t*-tests compare responses within participants.

The results shown in Table 6 (see the "Comparison of E and R" column) indicate that the differences between the two path coefficients of the experience and recall groups for the same subjects can be divided into two directions[9] based on the impact of the disaster: (1) the negative effects of perceived system risk and (2) the positive effects of information assurance and resilience on perceived usefulness.

---

[9] $Spooled = \sqrt{\left[(N_1-1)^2/(N_1+N_2-2)\right] \times SE_1^2 + \left[(N_2-1)^2/(N_1+N_2)\right] \times SE_2^2}$, $t = (PC_1 - PC_2)/\left[Spooled \times \sqrt{(1/N_1 + /N_2)}\right]$, where spooled indicates the pooled estimator for the variance, N_i is the sample size for the data set of group *i*, SE_i is the standard error of path in the structural model for group *i*, and PC_i is the path coefficient in the structural model of group *i*. In this study, the sample size was 103 for both experienced with, and without, recall groups.



Notes: The display order for path coefficients is experience and Recall group in parenthesis.
Fixed-effect coefficients are included but not displayed.
Tenure: number of working years; CSE: computer self-efficiency.
**p* < 0.05; ***p* < 0.01; ****p* < 0.001

Figure 4. Results of Data Analysis: Experience Group and Recall Group

Table 6. Differences Between Experienced and Recall Groups

Path	*N* = 103				Comparison of E and R	
	Experience		Recall			
Direct Effect	**Path**	**S.D.**	**Path**	**S.D.**	**P.Diff.$**	***T*-Value**
SR ⇨ PU	–0.240**	0.025	–0.160**	0.031	–0.080*	–2.019
IA ⇨ PU	0.013	0.036	0.080	0.032	—	—
RES ⇨ PU	0.034	0.031	0.123*	0.024	–0.089*	–2.262
CSE ⇨ PU	0.185*	0.033	0.030	0.032	0.155**	3.377
EOU ⇨ PU	0.541***	0.050	0.592***	0.056	—	—
Tenure ⇨ PU	0.025	0.054	–0.033	0.046	—	—

Notes: SR: perceived systems risk; PU: perceived usefulness; IA: information assurance; RES: perceived systems resilience; CSE: computer self-efficacy; EOU: ease of use. The recall group is the same experience group that had experienced the October 2006 snowstorm and was shown pictures and news articles to recall the disaster.
$P.Diff.: Differences of path coefficients among the groups.
**p* < 0.05; ***p* < 0.01; ****p* < 0.001.

The results showed that risk had a weaker effect on perceived usefulness for the recall group than for those participants with experience but before recall (experience group) (*T*-value = 2.019). Finally, the positive effects of resilience on the perceived usefulness were stronger for the recall group than for the experience group (*T*-value = 2.262).

Study QFE: Discussion

This study examined how perceptual factors related to a disaster affect individuals' perceptions of usefulness of HIS when they have disaster experience (i.e., the October 2006 snowstorm). In addition, it compared perceptions of individuals before and after receiving treatment (experience with and without recall) for recalling the disaster. The results revealed that in both situations (with and without recall), the independent variables had similar effects on the dependent construct. The only unique relationship was the one between perceived resilience and perceived usefulness, which was significant in the recall group. The difference between the two situations showed that the effect of systems risk was stronger in the experience group, while the effect of perceived resilience was stronger in the recall group than in the experience group. These findings indicate that hospital employees consider those perceptions to be important factors in utilizing

HIS as participatory systems. By first testing these relationships in a controlled quasi-experiment, we were able to establish the associations among perceptual factors in our model.

Study CCG: Comparative Study with a Contrast (No-Experience) Group

Method

To extend our analyses, we evaluated the same hypotheses using a comparative survey study (contrast group). Study CCG considered hospital employees who were not in the disaster zone, but close to it. The goal was comparing data for these disaster-naïve individuals with the disaster-experienced subjects from Study QFE. This investigation focused on the extent to which disaster experience changes individuals' perceptions of the relationship between factors and perceived HIS usefulness. Study QFE was thus used as a proxy of *robustness check* for Study CCG.

Data Collection

The field survey for a no-experience group was conducted at two hospitals from August 10, 2011, to September 13, 2011, in regions close to, but not immediately affected by, the October 2006 snowstorm. We chose these hospitals for consistency. Because this survey was conducted for the purpose of making a comparison between a group of employees with disaster experience and a group without such disaster experience, no special recall treatment was given. Participants were provided with the same questionnaire as the group members who had experienced the disaster. The participants were asked to indicate whether they had any disaster experience before they started answering the questions. Only five participants answered "yes," and they were excluded for this data analysis.

In the second survey, 450 questionnaires were distributed to hospital employees in a disaster-free area; 210 completed questionnaires were returned. Ultimately, 179 completed surveys were used for this study (42.6% response rate). Table 7 presents the descriptive statistics of the responses. Nonresponse bias did not appear to be a major concern. An analysis of early versus late respondents (Armstrong and Overton 1977) indicated no significant differences between the two groups.[10]

Data Analysis

As in Study QFE, we used partial least squares to test Hypotheses 1 through 3. The analysis process was the same as that used in Study QFE. First we checked path coefficients using PLS for both data sets, and then we conducted a paired comparison for both the experience and recall groups with the no-experience group. Doing so enabled us to clearly identify the differences between groups in terms of disaster experience. Table 8 provides the means and standard deviations for the subgroups as well as the results of Levene's test for homoscedasticity with SPSS.

Study CCG: Results

Model Fit

We conducted a CFA to assess the fit of our full measurement model and compared our primary measurement model against alternative models. The results suggest that the four-factor model, which included system risk, information assurance, perceived resilience, and computer self-efficacy, provided the best fit with our data. Fit indexes for our primary measurement model (χ^2/df = 2.459; CFI = 0.99; NFI = 0.98; RMSEA = 0.062) indicate that this model provided a good fit with the data. All factor loadings for this model were significant. We then compared the fit of our primary, four-factor model with that of the alternative models incorporating only two and three factors.

To compare our primary measurement model with these alternatives, we used three methods to determine whether our primary measurement model attained the lowest value, which would be an indication that it provided the best fit with the data of the four models we tested. Those methods were (1) a series of sequential chi-square difference tests, (2) checking for lack of overlap in the 90 percent confidence intervals of the RMSEA parameters, and (3) the Akaike information criteria (AICs). Table 9 provides the key metrics of each tested measurement model.

Table 10 also replicates the scale means, standard deviations, Pearson's correlations, composite reliability (C.R.), and AVE among the measures in the group. Factor loadings (Appendix G) showed adequate reliability.

[10]The following results of performing these independent t-tests were obtained (where ER = early responders [15%] and LR = late responders [15%]): perceived external risk (ER = 3.28, LR = 3.18, $t = |0.144|$), perceived internal risk (ER = 4.56, LR = 3.98, $t = |1.156|$), perceived information assurance (ER = 5.12, LR = 5.56, $t = |0.996|$), and perceived organizational resilience (ER = 4.83, LR = 4.80, $t = |0.065|$). The t-tests (independent samples) indicated that there were no statistically significant differences.

Table 7. Descriptive Statistics of No-Experience Group (N = 179)

Contents		Minimum	Maximum	Mean	S.D.
Total years of working		1	49	17.0	11.3
Organization tenure in years		1	40	13.2	10.7
Years using MIS		1	40	8.3	6.9
Profession		**Frequency**		**Subtotals**	
Main user group	M.D. Nurse Therapist	2 77 3		82 (46%)	
Support user group	IT Technologist Administrator	25 72		97 (54%)	

Table 8. Results of t-Tests of Total Sample (N = 282)

Construct	Mean		Mean Difference	t-Value	Levene's Test for Equality of Variances	
	No-Experience (N = 179)	Experience (N = 103)			F-score	Sig.
SR	3.79	4.57	–0.786	–3.783	1.517	0.197
Resilience	5.30	5.13	0.171	1.317	2.170	0.142
IA	5.78	5.57	0.210	1.573	4.433	0.036
PU	5.45	4.90	0.551	3.157	1.430	0.233

Note: SR: perceived systems risk; PU: perceived usefulness; IA: information assurance; CSE: computer self-efficacy.

Table 9. The Results of Comparative Confirmatory Factor Analyses

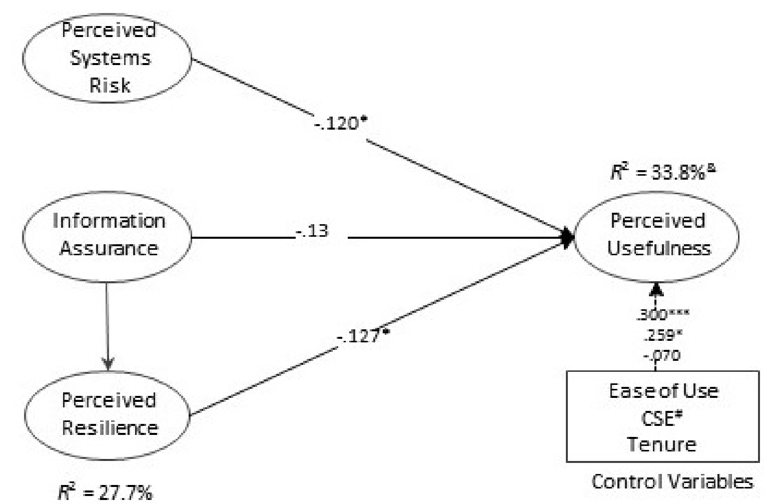
Structure Model	χ^2	df	χ^2/df	$\Delta\chi^{a}p^{a}$	CFI	NFI	RMSEA	RMSEA CI	AIC
One factor	1790.84	151	11.86	$p < 0.001$	0.92	0.91	0.17	0.16–0.18	1906.84
Two factor	1092.60	150	7.28	$p < 0.001$	0.95	0.95	0.13	0.12–0.14	1210.60
Three factor	770.88	149	5.17	$p < 0.05$	0.97	0.96	0.11	0.09–0.11	890.88
Four factor	363.99	148	2.46	$p < 0.05$	0.99	0.98	0.06	0.05–0.07	485.99

Note: Compared to the four-factor model.
The two-factor model: systems risk perceptions and the combination of information assurance, resilience, and computer self-efficacy; the three-factor model: systems risk perception, the combination of information assurance and resilience, and computer self-efficacy; the four-fatcor model: system risk perception, information assurance, resilience, and computer self-efficacy.

Table 10. Interconstruct Correlations by Contexts

Contexts and Construct	Mean	S.D.	Correlations of Constructs				
No-Experience Group (N = 179)			**1**	**2**	**3**	**4**	**5**
PU (1)	5.46	1.41	1				
Resilience (2)	5.34	0.97	0.313**	1.000			
IA (3)	5.81	1.02	0.357**	0.526***	1.000		
SR (4)	5.45	1.14	–0.172*	–0.139	–0.256**	1.000	
Ease of Use (5)	4.78	1.10	0.458***	0.363**	0.467***	–0.053	1.000
CSE (6)	4.91	1.42	0.387***	0.155*	0.360**	–0.058	0.450***

Note: PU: perceived usefulness; IA: information assurance; SR: perceived systems risk; CSE: computer self-efficacy.
*$p < 0.05$ (two-tailed). **$p < 0.01$ (two-tailed), ***$p < 0.001$(two-tailed).



Notes: R^2 was 30.2% in Base Model.
Fixed-effects coefficients are included but not displayed.
#CSE: computer self-efficacy; Tenure: number of working years
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Figure 5. Results of Data Analysis: No-Experience Group

Testing the Structural Model

Figure 5 presents the path coefficients for the no-experience group in the proposed model.

Results of the PLS analysis mostly replicate the support for hypotheses that we found in our quasi-experimental field study (see Figure 4). Regarding H1, there was a significant negative effect of perceived system risk on perceived usefulness ($\beta = -0.120$, $p < 0.05$). The results also partly replicate the positive effects of employees' perceptions of information assurance on resilience ($\beta = 0.526$, $p < 0.001$) and on perceived usefulness ($\beta = 0.013^{ns}$), a finding that statistically supports H2a but not H2b. Finally, in support of H3, the results indicate that resilience has a statistically significant positive effect on perceived usefulness ($\beta = 0.127$, $p < 0.05$).

Testing the Effect of Disaster

Table 11 provides the results of multigroup analysis. Comparison 1 shows the difference between the no-experience and experience groups, whereas Comparison 2 shows the difference between the no-experience and recall groups.

With respect to Hypothesis 4, which focuses on the effect of disaster experience on the relationship between perceived system risk and perceived usefulness, the negative effect of perceived systems risk on perceived usefulness was consistently stronger than the no-experience group. However, only the relationship for the experience group was statistically significant (T-value = 2.01). This result met our expectation; thus H4 was supported. For Hypothesis 5, the results showed that the differences were not statistically significant; H5 was not supported. For Hypothesis 6, the results showed that the no-experience group demonstrated a greater effect of perceived resilience on perceived usefulness than both the experience and the recall groups but the difference was statistically significant for the experience group (T-value = 2.245). H6, therefore, was supported. The discussion section will address the implications of this finding.

Study CCG: Discussion

The results of our comparative study, Study CCG, extend our findings from the quasi-experimental study, Study QFE, in several ways. First, our analyses of the matching hypotheses generally replicate the directions of most of the relationships we observed in Study QFE, indicating the relationships among the factors are solid and clear regardless of disaster experience. This outcome could imply that the risk and resilience-related perceptual factors would consistently affect systems users' view of perceived usefulness in general. The

Table 11. Differences Between No-Experience Group and the Experience and Recall Groups

Path	*N* = 179		*N* = 103		Comparison 1:		Comparison 2:	
	No-Experience Group		Experience Group	Recall Group	No-Experience vs. Experience		No-Experience vs. Recall	
Direct Effect	Path	S.D.	Path	Path	P. Diff.[$]	*T*-Value	P. Diff.[$]	*T*-Value
SR ⇨ PU	–0.120*	0.043	–0.240**	–0.160**	0.120*	2.013	0.040	0.654
IA ⇨ PU	–0.013	0.071	0.013	0.080	–0.026	–0.267	–0.093	–0.964
RES ⇨ PU	0.127**	0.026	0.034	0.123*	0.093*	2.245	0.004	0.103
CSE ⇨ PU	0.259**	0.060	0.541***	0.592***	–0.282**	–3.360	0.229**	2.907
EOU ⇨ PU	0.300**	0.068	0.025	–0.033	0.275**	2.868	–0.292**	–3.024
Tenure ⇨ PU	–0.070	0.042	–0.240**	–0.160**	0.170	1.968	–0.037	–0.429

Notes: SR: perceived systems risk; PU: perceived usefulness; IA: information assurance; RES: perceived systems resilience; CSE: computer self-efficacy; EOU: ease of use.
[$] P. Diff.: Differences of path coefficients among the groups.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

resilience perception generally positively impacts individuals' perception of HIS usefulness.

This study also attempted to determine how information assurance affects HIS use by showing the positive relationship between information assurance and perceived IS usefulness. Contrary to our hypothesis, however, the findings for information assurance did not show a solid direct relationship with perceived usefulness in any circumstances. One possible explanation for this result is that perceived resilience fully mediated the direct effect of information assurance. We could also interpret this outcome as indicating that individuals may recognize that they should focus more on risk and resilience perceptions than on information assurance to enhance perceived usefulness.

Second, by incorporating new data (from a no-disaster area) in our analyses in Study CCG, we provide evidence that disaster experience has an impact on individuals' perceptions of HIS usefulness. The comparison *between* the no-experience and experience groups and the comparison *within* the experience group (experience versus recall) provided interesting results regarding directions as well as effects in many cases. Unlike the within-group comparison, which showed the expected results in directions and significance, the between-groups comparison revealed that disaster experience had a greater impact on perceived system risk and perceived usefulness, and information assurance had less of an impact on perceived resilience. Furthermore, the effects of perceived resilience and information assurance were weaker in the same context. We suggest that this outcome may occur in such extreme situations because impending threats or crises invariably lead to cognitive narrowing—that is, a restriction in information processing and a constriction of control (Staw et al. 1981). In addition, the unconscious effect of the disaster experience might lead individuals to overestimate *negative perception* (i.e., risk perception) or underestimate *positive perception* (information assurance). Therefore, perceived system risk could be experienced more significantly in the recall group, and this increased risk perception might lead individuals to perceive information assurance as less important and, therefore, less effective.

In addition, the findings suggest that the cue (stimulus) about the prior experience is important. Thus, by revealing the different inclinations through comparisons between groups, this study sheds light on the methodological characteristics of retrospective study and comparative research.

General Discussion

The two studies described in this paper help us understand how disasters interact with individuals' perceptions to influence IS outcomes. In past studies, scholars have described disaster and IS as a central topic in the IS realm (Loch et al. 1992; Straub and Welke 1998) but have not empirically explored theoretical models about how disasters directly or indirectly influence individuals' perceptual processes regarding IS outcomes. By focusing on employees' perceptual changes, the present studies shed light on how employees actually perceive uncertain situations such as disasters, crises, and other types of adversity as maintaining or enhancing perceived usefulness. Our research shows, consistent with past research (Camerer and Kunreuther 1989), that individuals tend to perceive the negative and positive factors related to disasters as having greater or lesser effects when they actually

Table 12. Summary of Hypothesis Testing

Hypothesis	Testing Samples			Findings and Implications
	No-Experience	Disaster Group		
		Experience	Recall	
H1a	S	S	S	• Individuals' perceptions of the effects of perceptual factors (i.e., perceptions of risks, information assurance, and resilience) can be changed by a disaster experience. • Individuals could be encouraged to realize that they have overestimated perceptions or beliefs regarding positive factors and underestimated negative ones when they do not experience extreme events directly. • Individuals' memory resulting from direct experience could unconsciously affect their estimation of systems performances. • The two studies bolster the internal validity of any assessment of the effects of the factors.
H2a	S	S	S	
H2b	NS	NS	NS	
H3	S	NS	S	
Comparison				
	No-Experience vs. Experience			
H2a (IA ⇨ RES)	S			
H4	S			
H5	NS			
H6	S			

Note: S: supported, NS: not supported.
This comparison result shows the same directions that Hypotheses 4, 5, and 6 argued for, indicating that positive factors would be weaker in the experience group, and negative factors otherwise.

face a disaster situation (see Table 11). Perhaps, when disaster probabilities fall below a certain threshold, individuals tend to assume that an unfavorable outcome is not likely; in turn, they have a limited interest in taking protective actions (including emergency preparedness, hazard mitigation measures, and insurance). Table 12 presents a summary of the results, showing that data from the hospitals supported several proposed hypotheses. This research is an addition to the body of literature on information systems and disasters. It informs both research and practice.

Research on Perception Changes Caused by Experience

Perception-experience research helps us explain the way that individuals deal with their perceptions to maintain their systems' success in response to a disaster context. By focusing on system users' perceptual elements, we have shown how various individuals' perceptions can be changed based on an individual's experience. The results we obtained demonstrate the significant value of investigating how employees' subjective disaster experiences relate to their views of perceived system risk, information assurance, resilience, and perceived usefulness. This finding extends past research on the effect of experience (Carley and Harrald 1997; Marks and Kamins 1988; Pezdek et al. 1997; Regan and Fazio 1977). Our study shows that individuals' perceptions of factors such as systems risk and information assurance change in both positive and negative ways when they are faced with unexpected events such as disasters.

Research on Perceptions of Information Systems Usefulness

This study highlights the roles of perceptual factors (i.e., risk, information assurance, and resilience) on perceived usefulness within a disaster context. By exploring employees' interactions with technology and with one another in participatory systems, this research draws attention to the role of perceptions and actions during disasters. Those perceptions could help us understand what people really care about in terms of their perceptual IS use when they are faced with disasters and, after the disaster, having added their disaster experiences to their personal arsenal, how they deal with future negative events. As Weick (1979) noted, individuals' perceptions control what they see. Individuals with no disaster experience tend to have low perceptions of the impact of risk on effectiveness (Weick 1995). This situation arises not only because disasters are unexpected and relatively low-probability events (Carley and Harrald 1997), but also because people seem to weight low-probability events as "zero probability" events (Dillon et al. 2011). By comparison, individuals with experience exhibit a strong negative relationship between perceived system risk and perceived usefulness.

Introducing Resilience

Our research introduces the concept of resilience into—and thereby extends—the IS usefulness literature (Barton 2006; Bigley and Roberts 2001; Calhoun and Tedeschi 2004). Resilience is a critical concept in various areas (Sutcliffe and

Vogus 2003), and in this paper we bring it into the IS world. In complex environments, where the unexpected accounts for an increasing portion of everyday life, individuals may have limited capacities to anticipate every challenge that could potentially arise (Carley and Harrald 1997). Little empirical work has been done in this area to date. Our studies show that resilience is worthy of more research attention, as it can provide insight into the IS area under challenging conditions such as disasters.

Practical Implications

Many companies want their employees to be aware that their organization has formalized business continuity plans so as to minimize the negative perceptions of organizational risks and to improve the firm's performance through resilience. Often, details of those plans may not be widely known to employees, except to those belonging to disaster response teams. Disaster itself results in physical and psychological impacts that lead to elevated stress levels and higher perceived system risk, which in turn generates a negative image of the organization's capabilities. Thus preparing for disasters and training employees to manage in such crises are means of helping employees cope with the stressors that are a natural consequence of disasters. Proper coping strategies need to be developed, and employees should be encouraged to avail themselves of these strategies. The findings of our studies suggest that employees' perceptions of risks and information assurance are important not only for maintaining resilience and effective operation of HIS, but also for facilitating employees' HIS-related work. The findings show that employees' perceptions of specific positive factors are overestimated. Consequently, they suggest that hospitals seeking to increase their successful HIS implementation may pursue the following strategies.

First, hospitals may focus on managing employees' attitudes toward and perceptions of risk and resilience in a normal context. A disaster experience may bring to light the positive effects of information assurance on resilience and the effect of resilience on perceived usefulness. Such an experience fortifies the perceived resilience of the organization (for example, its ability to maintain business continuity); in turn, the greater resilience reinforces employees in a manner that enhances perceived usefulness.

Hospital management should adopt one process to enhance resilience, and a separate process to reduce perceived system risk to properly respond to unexpected events in early business continuity planning stages. An understanding of such processes by HIS users will help in enhancing perceptions of usefulness which in turn will help in enhancing patient care. Therefore, coordinating resilience and risk management in hospitals should be a top priority and be part of every hospital's first stage of preparedness plans.

Given that disasters expose employees to tasks that are physically and psychologically complex, ambiguous, and difficult to assimilate (Paton and Johnston 2001), the perception of resilience—that is, the perception that systems are powerful, resourceful, and capable of dealing with the demands employees may face—makes employees use hospital IS more effectively to enhance their performance and to overcome the challenges associated with the disaster.

Second, to enhance employees' perceptions of resilience, hospital managers can enhance the organization's information assurance through technological interventions that improve security and privacy practices. Information assurance plays an important role in influencing perceived resilience in both normal and disaster contexts. As the results of the present study show, perception of the strength of information assurance increases belief in resilience. This finding is consistent with Ezingeard et al.'s (2007) suggestion that information assurance is an important function within organizations, and a factor critical to organizational success. In hospitals, thus, by developing emergency action plans or emergency response plans (monitoring systems, using electronic key locks, using incident tracking software, or developing an emergency notification protocol) that strengthen the information assurance program in the area of security management, resilience could be enhanced and this will eventually help in coping with unexpected events regarding hospital information systems.

In our *post hoc* study (see Appendix D), the main HIS users (i.e., physicians and nurses, acting as consumers using the IS for clinical purposes) were more concerned about the effect of risk on their effective use of IS, regardless of the disaster context. In contrast, support users (i.e., IT technologists and administrators, working as suppliers to keep the IS running) tended to focus more on information assurance (e.g., security and privacy concerns). This difference arose because the two groups used the IS with different purposes in mind. On the one hand, the main users are deeply involved in using systems applications (i.e., software applications, database software) that typically relate to patients' care, which might be detrimentally affected by inoperable systems in the wake of a disaster. On the other hand, support users are more concerned about keeping technical/system hardware and billing/scheduling systems safe, as well as guarding the patient records from threats.

Based on this finding, we suggest that hospitals may adopt a strategy geared toward different types of users. Although exploratory, the findings of this study suggest that the IT-related goals of different systems user groups may be influenced by different aspects of IS. The *post hoc* study showed that different types of users focus on different factors. For example, the IT support staff can be supported through technological interventions to enhance information assurance, comply with regulations regarding health information, and protect the privacy and security of patient health information. Medical users can be supported in terms of reducing their system risk perception by ensuring that health record information is complete and accurate through having backups available in the case of infrastructure failures, preparing for availability of emergency supplies, and developing emergency notification protocols for utilization during disasters.

The perceptual process and disaster experience may serve to enhance employees' perceptions and beliefs that were either over- or under-valued before the disaster struck. This study focused on the experience following from a disaster—not just the disaster experience itself. It suggests that hospital managers should let employees know how psychological effects can lead employees to exaggerate their perceptions and beliefs negatively. As a baseline plan, knowledge and awareness based on disaster experiences should be taught as part of business continuity plans and documented for employees. This step is important for hospitals to successfully manage their business continuity concerns under both normal and disaster contexts.

Limitations and Future Research

Some limitations should be considered in interpreting our findings in this study. First, in our quasi-experimental study (Study QFE), the critical incident (disaster) did not occur during the procedure, making it necessary to collect retrospective data. There is a possibility that the treatment might have biased the results through memory error. We did, however, follow a highly structured and delineated process to ensure accuracy and objectivity, and studies have shown that such methods produce very high levels of agreement when self-reported, retrospective data are compared with data from outside observation so long as the information provided is "full, clear, and detailed" (Butterfield et al. 2005, p. 481). However, we believe that the respondents from whom we gathered our data are appropriate choices for this study because they are frontline employees facing extreme events and are more sensitive to disasters because they must care for patients under the harsh circumstances of a disaster. This is one of the conditions for getting good objective data, as Starbuck and Mezias (1996) suggested. A second limitation is that different people in the contrast group who did not suffer from the disaster were surveyed about four years later than the time that people in the treatment group who suffered from the disaster were surveyed. Hence, differences in the relationships among groups may be caused by disaster experience and/or something else that transpired across four years. However we find the results are largely consistent.

Further, in disaster research, it is important to note that, in general, the experience tends to decay over time (Starbuck and Mezias 1996) depending on what has been experienced, as the individuals become further removed from the object and the composition of the organization changes over time. In fact, the disaster experience could produce traumatic stress unconsciously over time (Bharosa et al. 2010; Janssen et al. 2010). Even though employees might forget the disaster effect, they might nevertheless continue to harbor its traumatic effects, which might then consistently affect their performance. However, an organization could mitigate the disaster effects by transferring those employees or reorganizing the structure of the organization.

Further, for Hypotheses 4, 5, and 6, we assume that employees would perceive that an organization would have good information practices in place and that the systems are likely to be available and the data protected during normal situations. It is, of course, possible for hospitals not to have good information assurance practices in place. Even so, we argue that in the context of normal day-to-day operations, if information assurance practices were not good initially, they \would have been corrected over time by the hospitals. As we note from the descriptive statistics tables, the mean organization tenure of employees was 13.2 years for the "no experience" group and 11.9 years for the "experienced" group, and the mean number of years using MIS was 8.3 years and 7.1 years for these groups, respectively. Hence it is highly likely that these employees would believe that the systems would have had all major kinks corrected or fixed for normal operations. Further, because of the optimism bias, even if problems with the systems arose, employees would assume that problematic events would strike others rather than themselves (Meyer 2006). It is only when there is a brutal audit, as mentioned by Lagadec (1993), that people would realize the inadequacies of the systems. As this change in perception has not been explicitly measured, we include it as a limitation.

In addition, in this paper, we do not differentiate between nonpremeditated (natural) disasters and premeditated disasters (e.g., sabotage, crime, terrorism), or between disasters that are externally generated versus those that emanate from within the organization. These distinctions need to be considered in future research. Finally, demographic characteristics should be taken into consideration.

Conclusion

In the studies described in this paper, we examined the roles of three safety-critical perceptual factors in accessing IS perceived usefulness and considered how the disaster experience changes individuals' perceptions regarding information system success. Most importantly, the changes in perceptual factors we elucidated among two participant groups from different data sets of respondents help clarify how individuals with disaster experience perceive IS usefulness. This study design enabled us to link individuals' experiences with their perceptions in a framework that demonstrates how these perceptual objectives may complement each other. At a high level, our paper provides evidence that disasters interact with individuals' perceptions to influence IS outcomes. Individuals tend to perceive negative factors (such as risk) as having greater effects when they actually face a disaster situation. Positive factors, by comparison, have lesser impacts when individuals face a disaster situation. Disasters result in physical and psychological impacts that lead to elevated stress levels and higher perceived system risk, which in turn generate a negative image of the organization's capabilities. Consistent with past research, our studies suggest that individuals with no disaster experience tend to have low perceptions of the impact of risk on perceived usefulness because disasters are unexpected and low-probability events, whereas individuals with prior disaster experience exhibit a strong negative relationship between perceived system risk and perceived usefulness.

In summary, we recommend that managers establish realistic and achievable strategies regarding employees' perceptions of safety-critical factors that might affect perceived HIS usefulness. Beyond the context-specific findings and implications, our work suggests the contextual examination of sociotechnical issues affecting perceived usefulness as critical to deepen our understanding of other important IS phenomena. Our intention was to provide some preliminary, yet fundamental, work that would stimulate IS researchers' ongoing endeavors in investigating organizational features of the IS arena. We hope that our work encourages future researchers in participatory systems to seek out further insights into the potential roles of risk perception, resilience, and information assurance in various IS contexts.

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MIS Quarterly

RESEARCH ARTICLE

DISASTER EXPERIENCE AND HOSPITAL INFORMATION SYSTEMS: AN EXAMINATION OF PERCEIVED INFORMATION ASSURANCE, RISK, RESILIENCE, AND HIS USEFULNESS

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Appendix A

Retrospective Survey Method

It is important to understand both the usefulness and the inherent limitations of utilizing retrospective recall memory. Retrospective recall has several potential sources of bias. First, compared with concurrent evaluations that rely on short-term memory, recall that utilizes long-term memory may lead to biases such as selectivity of recall, rationality bias, and so forth (East and Uncles 2008; Glick et al. 1990). Second, respondents' post-event recall may potentially bias their recall of pre-event experiences, and vice versa, most likely producing consistency of recall between the two. In other words, relying on long-term memory may introduce some biases, resulting in potential differences between consumers' recalled and actual experiences.

Even though most researchers agree that consumers' actual information processing is different from their recall (Ericsson and Simon 1980; Nisbett and Wilson 1977), there are several reasons why memory data might still be quite useful and insightful. According to Lynch and Srull (1982), for the value of recall data, the "recall protocol is assumed to be representative of the underlying [memory] structure with respect to both content and organization" (p. 24). In turn, these structures provide insight into previous processing (see Biehal and Chakravarti 1986).

In addition, memory may be particularly predictive of future behaviors (Cox and Hassard 2007). The vast majority of consumer decisions are either totally memory-based or a "mixed" combination of available and memory information (Alba et al. 1991). Thus, employees typically assign ratings and make evaluations by accessing their memories of disaster experiences, regardless of the "accuracy" of this information.

Finally, memory data may be the basis for most consumer "word of mouth" communications, as people are more likely to relate memories of their experiences (what they think occurred) than the actual experience itself. In specifically considering the factors that require recalling the disaster experiences, to the extent that such biases occur, there should be consistency across employees' memories of the specific and concrete disaster. Thus, if anything, differences found in this study between the experience group, recall group, and IS effectiveness evaluations are likely to be understated.

In terms of internal validity, the retrospective method has strong statistical power (Shadish and Luellen 2005). Howard et al. (1979) found the retrospective method to yield higher statistical power and to be more highly correlated with external measures of constructs of interest than their respective initial tests (Bray et al. 1984). Researchers have also found that retrospective methods may provide a more sensitive and valid measure of effects (Skeff 1992).

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Appendix B

Nonindependence Test

To ensure that concepts were addressed by the same unit of analysis, two tests were performed. First, we calculated within-group agreement (inter-rater reliability; R_{wg}[1]) indexes[2] (James et al. 1984) for the systems resilience scale. The R_{wg} value has been employed to justify the appropriateness of aggregating data to higher levels of analysis. For this analysis, all employees of five hospitals (three disaster area and two no-disaster area) were included. Results showed that within-group variances were not homogenous (R_{wg} = 0.34), which indicates that the concept of resilience should not be aggregated to a higher level. Second, we used ANOVA for testing equality of variances (Levene 1960), which indicates homogeneity of group variance to compare organizations. Results of this test were consistent with the R_{wg} analysis, showing that organizations' variances were independent ($F = 5.100$, $p < 0.05$).

[1] $R_{wg}(J) = \{J[1 - (\text{mean of } S_x^2/\sigma_E^2)]\}/\{J[1 - (\text{mean of } S_x^2/\sigma_E^2)] + \text{mean of } S_x^2/\sigma_E^2\}$, where J is the number of items rated, mean of S_x^2 is the observed item-wise variance across individuals and averaged over items, and σ_E^2 is the expected variance.

[2] An index of the observed variance divided by the expected variance due to random measurement errors, which indicates the extent of within-group agreement as opposed to reliability (Kozlowski and Hattrup 1992). It reflects the perceptual congruence of a group of individuals who are assessing the same behavioral characteristic with respect to the target manager.

Tale B1. Data Set Independence Test: Disaster Data Set (*n* =103)

Constructs	Hospitals	Mean	Standard Deviation	Mean Square	*F*-Value*	Sig
Perceived systems risk	1 2 3	4.35 4.88 4.65	1.06 1.67 1.44	1.982	.999	.372
Information assurance	1 2 3	5.66 5.76 5.42	.88 1.06 1.23	1.158	.959	.387
Perceived resilience	1 2 3	5.38 4.78 5.17	.94 1.66 .78	2.484	2.026	.137
Perceived usefulness	1 2 3	5.30 4.74 4.75	1.26 1.51 1.39	3.051	1.578	.212

*Between-groups mean squares.

Table B2. Data Set Independence Test: Non - Disaster Data Set (*n* =179)

Constructs	Hospitals	Mean	Standard Deviation	Mean Square	*F*-Value*	Sig
Perceived systems risk	1 2	3.76 3.76	1.94 2.21	0.001	.000	1.00
Information assurance	1 2	5.95 5.57	0.99 1.01	2.018	1.861	0.159
Perceived resilience	1 2	5.42 5.16	0.93 1.01	0.886	0.948	0.390
Perceived usefulness	1 2	5.75 5.31	1.14 1.29	4.398	2.490	0.086

*Between-groups mean squares.

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Appendix C

Common Method Bias

To address common method bias in our measures, we employed two statistical and procedural methodologies recommended by Podsakoff et al. (2003) using Harman's single-factor test. In Harman's test, common method bias is an issue if results from an exploratory factor analysis reveal that (1) a single factor emerges, or (2) the first factor accounts for the majority of the covariance among the variables. In our study, the results from Harman's test suggested that common method bias was not a serious issue among these variables, as more than one factor emerged from the unrotated solution. All indicators showed high factor loadings and low cross-loadings. The principal components explained almost an equal amount of the 74% total variance, ranging from 3.98% to 30.46%. The first factor accounted for 30.46% of the variance; the second for 14.16%. This indicates that our data do not suffer from common method bias.

However, because Harman's one-factor test is increasingly being contested in terms of its ability to detect common method bias (Podsakoff et al. 2003), we applied the Marker technique in confirmatory factor analysis (CFA) to verify the extent to which the inclusion of a method construct affects the correlations among latent variables (Richardson et al. 2009; Williams et al. 1989). Four models were estimated for each simulated independent–dependent construct pair: a baseline model, a Method-C model, a Method-U model, and a Method-R model.

The comparison of the Method-C model with the baseline model provides a test of the method variance associated with the marker variable. A comparison of the Method-C and Method-U models tests the key difference between the CMV and UMV models and the assumption of equal method effects. The comparison of the Method-C model with the Method-R model provides the statistical test of the biasing effects of our marker variable on substantive relations.

The model fit results of the analyses for each model are shown in Table C1, including the chi-square, degrees of freedom, and X^2/df values. The comparison of the baseline model and Method-C model yields a chi-square difference of 4.714 with one degree of freedom, which exceeds the 0.05 chi-square critical value. This result shows that the chi-square difference test comparing these two models supports rejecting the restriction to 0 of the 22 method factor loadings in the baseline model. A model comparison between the Method-U and Method-C models shows that the chi-square difference testing provides support for rejecting the restrictions in the Method-C model. The comparison yielded a chi-square difference of 13.84 with 17 degrees of freedom, which does not exceed the 0.05 critical value of 0.678. The Method-U and Method-R models reveal the chi-square difference test resulted in a nonsignificant difference of 15.419 at 10 degrees of freedom. The result of the Method-U and Method-R models indicates that the effects of the marker variable did not significantly bias factor correlation estimates. Thus, as a set, there was not a significant difference between the baseline model factor correlations and the Method-U factor correlations.

Table C1. Chi-Square, Goodness-of-Fit Values, And Model Comparison Tests

Model	χ^2	*df*	*CFI*
CFA	324.199	194	0.972
Baseline	352.262	202	0.968
Model-C	347.547	201	0.968
Model-U	333.703	184	0.968
Model-R	349.122	194	0.966
Chi-square model comparison tests			
ΔModels	**$\Delta\chi^2$**	**Δ*df***	**Critical Value**
Baseline vs. Model-C	4.714	1	0.030
Model-C vs. Model-U	13.845	17	0.678
Model-U vs. Model-R	15.419	10	0.118

Table C2. Baseline and Model Factor Correlations

Factor Correlations	Baseline Model	Method-C Model	Method-U Model	Method-R Model
Systems risk to PU	–0.236	–0.24	–0.234	–0.115
IA to RES	0.305	0.304	0.304	0.307
IA to PU	0.167	0.169	0.169	0.134
RES to PU	0.360	0.362	0.362	0.267

References

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Appendix D

Post Hoc Analysis

We tested the impact of a possible explanatory factor for our findings—namely, usage by different groups based on different systems. This *post hoc* analysis relates to the differential effect of both business resilience and information assurance on perceived usefulness between main (clinical system) users and support (administrative system) users.

In our study, we analyzed the different effects on HIS based on two systems. HIS can be classified into two major systems: clinical systems and administrative systems; accordingly, main users who are consumers of the clinical information system, such as physicians and nurses, and support users who use administrative systems, such as hospital and IT support personnel. Members of the two groups have different goals when using the systems. As consumers, main users are deeply involved with systems applications (i.e., software applications, database software) that typically relate to EMR. In the no-experience group, support users focus more on the technical and system hardware and billing/scheduling systems.

Given these differing purposes, the type of the user can moderate the effect of two factors on the relationship between risk, resilience, and information assurance and the consequence. Notably, the reasons for using HIS differs between main users, who are involved in data and information relating to the provisioning of care for patients, and support users, who focus on keeping the systems constantly available. For example, comparably stressful perceptions (i.e., perceived risk) can have a more serious influence on main users, such as physicians and nurses, than on administrators, such as IT support personnel. Put simply, perceived risk has a stronger negative impact on users of clinical information systems (such as nurses and physicians) than on the users of administration systems. In addition, the effects of information assurance and perceived resilience are greater for clinical systems users than for administration systems users. Interestingly, the effect of computer self-efficacy on perceived usefulness is greater for administration systems users, while the effect of perceived resilience is greater for clinical systems users. The differences between two path coefficients for clinical systems and administration users are shown in Table D1.

Table D1. Differences Between User Type (Two Systems) Groups

Path	Clinical System User (N = 168)		Administration System User (N = 114)		Comparison of Clinical and Administration Users	
Direct Effect	**Path**	**S.D.**	**Path**	**S.D.**	**P.Diff.[$]**	***T*-Value**
SR ⇨ PU	-0.028	0.033	-0.136	0.031	0.108*	2.281
IA ⇨ PU	0.051	0.043	0.095	0.040	-0.044	-0.715
RES ⇨ PU	0.136	0.039	0.057	0.057	0.079	1.189
Tenure ⇨ PU	0.381	0.051	0.422	0.041	-0.041	-0.583
EOU ⇨ PU	0.088	0.047	0.115	0.050	-0.027	-0.385
CSE ⇨ PU	-0.147	0.052	0.072	0.051	-0.219**	-2.898

Notes: SR: perceived systems risk; PU: perceived usefulness; IA: information assurance; RES: perceived systems resilience; CSE: computer self-efficacy; EOU: ease of use.
[$]P.Diff.: differences of path coefficients among the groups.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table D2. Sobel's Test Significance of Indirect Effects of Mediators

Path[a]	Mediated Paths	Indirect Effect	*Z* Statistic[b]
IA → RES → PU	*No experience situation*	0.067*	2.39
	Experience situation	0.011	1.13
	Recall situation	0.034*	2.33

Note: PU: perceived usefulness; IA: information assurance; RES: perceived systems resilience.
[a]Standardized path coefficients without direct paths (Indirect path).
[b]The standard errors are approximated as $Sqrt(\sigma_a^2\beta^2 + \sigma_b^2a^2 + \sigma_a^2\sigma_b^2)$ for a single mediated path, where, σ_j^2 is variance with j denoting α_i and β_i path coefficients, α_i and β_i are path coefficients with i denoting first and second mediators, and $\sigma_{\beta1\beta2}$ is covariance between β_1 and β_2, which is adapted from MacKinnon et al. (2002).
***$p < 0.001$, **$p < 0.01$, *$p < 0.05$

Reference

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Appendix E

Mixed Model Results

Table E1. Results of Mixed-Model Analyses Predicting Perceived Usefulness

Path to Perceived Usefulness	(*N* = 103)				No-Experience (*N* = 179)	
	Experience		*Recall*			
Direct Effect	Base Model	Fixed-Effect Model	Base Model	Fixed-Effect Model	Base Model	Fixed-Effect Model
SR	-0.310***	-0.240*	-0.174*	-0.160*	-0.129*	-0.120*
IA	0.006	0.013	0.037	0.080	0.037	-0.013
RES	0.097	0.034	0.104	0.123*	0.122*	0.127*
Ease of Use	0.506***	0.541***	0.641***	0.592	0.295***	0.300***
CSE	0.094	0.185*	0.044	0.030	0.228**	0.259***
Tenure	-0.093	0.025	0.010	-0.033	-0.081	-0.070
Hospital 1	0	0.278**	0	0.033	0	0.138*
Hospital 2	0	-0.095	0	-0.020	0	0.229*
Hospital 3	0	-1.014	0	-0.140	0	0.034
Hospital 4	0	-0.159*	0	-0.127	0	0.163*
R2	39.1%	46.5%	44.5%	47.6%	30.1%	33.8%
#*f*2 value *(Pseudo F)*	0.119 (12.068)		0.059 (5.97)		0.056 (9.89)	

Notes: SR: perceived systems risk; PU: perceived usefulness; IA: information assurance; RES: perceived systems resilience; CSE: computer self-efficacy.

Hospital1~Hospital 4: dummy variables for fixed effects.

#f^2 value is calculated as (R^2 full–R^2 excluded)/(1– R^2 full). The *pseudo f* statistic is calculated as $f^2 \cdot$ (n–k–1), with l, (n–k) degree of freedom when n = sample size, k = the number of constructs in the model (Subramani 2003).

*p < 0.05; **p < 0.01; ***p < 0.001

Appendix F

Survey Questions

Latent Variables	Items	Scale
Perceived usefulness (PU)	The hospital information system … 1. increases my productivity (requires less effort than would have been required without it). 2. saves my time (i.e., allows me to accomplish more work than what would have been possible without it). 3. helps me meet patient needs effectively.	7-point adapted and modified from Rai et al. (2002)
Perceived Resilience (RES)	1. Our information systems can handle many critical incidents at a time. 2. People in the organization are well prepared to respond during critical incidents. 3. Our organization has business continuity plans to handle unfamiliar situations. 4. Our information systems recover quickly after critical incidents.	7-point scale developed
Perceived System Risk (SR)	1. When network facilities (e.g., network/cable plant) are disrupted, the hospital information systems are affected. 2. When the internal telecommunications system is disrupted, the hospital information systems are affected.	7-point adapted and modified from Carreras et al. (2007)
Information Assurance (IA)	1. Hospital information systems are accessible only to those authorized to have access. 2. Information is securely shared in our hospital. 3. Legitimate users are never denied access to the hospital information whenever it is required. 4. Our primary database system (i.e., medical records) is stable and safe against tampering. 5. Our information systems protect the privacy of the patients (i.e., sensitive patient data are not shared or released without permission).	7-point adapted from Kim et al.(2004)
Computer self-efficacy	I could complete my job using the hospital information system (even) if ... 1. I had seen someone else using it before trying it myself. 2. I had only the software manuals for reference 3. I had used similar systems like this one before.	
Ease of Use	How would you rate the… 1. degree to which the information systems easy to use 2. reliability of the hospital information systems (i.e., does the system perform its functions in routine as well as unexpected circumstances)? 3. ability of the hospital information system to transmit data between systems servicing different functional areas (i.e., can the system pull out data from the systems in other functional areas efficiently)	Rai et al (2002)

References

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Appendix G

Cross-Loadings

Table G. PLS Component-Based Analysis: Cross-Loadings

		Experience Group											
		Experience Group				Recall Group				No-Experience Group			
Constructs	Items	Cross-Loadings*	C.R.	C.A.	AVE	Cross-Loadings	C.R.	C.A.	AVE	Cross-Loadings	C.R.	C.A.	AVE
Perceived Systems Risk	IR1	0.870				0.904				0.964			
	IR2	0.866	0.859	0.812	0.718	0.912	0.903	0.787	0.824	0.967	0.971	0.855	0.917
Perceived Resilience	RES1	0.864				0.912				0.869			
	RES2	0.869				0.622				0.894			
	RES3	0.802				0.780				0.913			
	RES4	0.739	0.891	0.851	0.673	0.750	0.854	0.769	0.597	0.910	0.943	0.919	0.804
Information Assurance	IA1	0.902				0.887				0.857			
	IA2	0.894				0.887				0.849			
	IA3	0.873				0.870				0.776			
	IA4	0.878				0.806				0.813			
	IA5	0.883	0.948	0.932	0.785	0.862	0.936	0.915	0.745	0.855	0.917	0.888	0.690
Perceived Usefulness	PU 1	0.971				0.975				0.921			
	PU 2	0.973				0.965				0.919			
	PU 3	0.952	0.976	0.963	0.931	0.943	0.973	0.958	0.923	0.820	0.919	0.865	0.792
Computer Self-efficacy	CSE1	0.790				0.791				0.928			
	CSE2	0.765				0.765				0.869			
	CSE3	0.644	0.778	0.791	0.562	0.641	0.863	0.789	0.615	0.918	0.941	0.919	0.799
Ease of Use	EOU1	0.817				0.865				0.938			
	EOU2	0.883	0.864	0.763	0.680	0.852	0.856	0.747	0.667	0.947		0.920	0.863
	EOU3	0.771				0.726				0.901	0.950		

Notes: To calculate cross-loadings, a factor score for each construct was calculated based on the weighted sum, provided by PLS Graph, of that factor's standardized and normalized indicators. Factor scores were correlated with individual items to calculate cross-loadings.
*We included two items for organization impact and perceived resilience, even though such items showed slightly lower factor loading scores than the recommended cut-off of .70 in further analyses. As Barclay et al. (1995) mention, some of the scales do not show the same psychometric properties when used in different theoretical and research contexts from those in which they were first developed. Thus it is important to retain as many items as possible from the original scale to preserve the integrity of the original research design, as well as the comparability of the results with other studies that used the same scales, even though some of the factor loadings are slightly less than .70.

Reference

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