The Impact of Information and System Quality on Emergency Notification Systems Adoption

Emergent Research Forum Paper

Mohamed Abdelhamid
California State University, Long Beach
mohamed.abdelhamid@csulb.edu

Pamella Howell
University at Buffalo - SUNY
pamellah@buffalo.edu

Raj Sharman
University at Buffalo - SUNY
rsharman@buffalo.edu

Abstract

Campus Emergency Notification Systems (ENS) are deployed to inform and direct students when extreme events occur. Numerous schools have deployed emergency notification systems; however, student adoption of the artifact is very low. In this study, we investigate factors that drive students’ adoption building on the DeLone and McLean model of information systems (IS) success. We contribute to the emergency management and IS success theory by adding new contextually relevant constructs associated with information and system quality. Utilizing a survey we collected data from 867 participants and analyzed data using generalized structural equation modeling (GSEM). Results indicate that information timeliness and system credibility positively impact student’s adoption of emergency management systems. Our research aims to improve the adoption rate of ENS and thus save lives.

Keywords


Introduction

In recent years, we as a society have witnessed a large number of reported extreme events on college campuses. To ensure student safety college administrators have deployed Campus Emergency Notification Systems (ENS). These systems use Short Message Service (SMS) to inform and direct students when extreme events occur. When incidents occur, those closest to the danger act based on the available information. The dissemination of information is, therefore, critical to reducing the numbers of casualties and injuries originating from an event (Walker, 2012). The Emergency notification systems received prominence after the Virginia Tech shooting in 2007; where a breakdown in communication lead to what experts believe were preventable injuries. In 2008 the U.S. House of Representatives introduced the Clery Act; legislation that required higher education institutions to immediately notify students and staff of emergency events (House of Representatives 2008). Campus Emergency Notification Systems (ENS) are deployed to inform and direct students when extreme events occur (Stuver 2006). ENS are typically easy to use and implement and allow for multiple communications mediums such as emails, text messages, and alerts through online social networking platforms.

The advantage of implementing an ENS is that it enhances the ability of University officials to disseminate information related to extreme events to a large number of students instantaneously and reliably (Stuver 2006). Despite improved warning mechanisms, in the last ten years, approximately 227 individuals were killed in shootings on school campuses (Infoplease 2016). In 2016, the Center for Disease Control reports that on average 1.5 % of violent deaths occur at or near school campuses. Notifying people at the right time is, therefore, an important aspect of emergency management (Janssen et al. 2010). A lack of communication between university officials and students might be the difference between life and death (Gulum and Murray 2009).
Numerous schools have deployed emergency notification systems (Lee et al. 2013); however, student adoption of the artifact is very low (Katsouros 2014). About 89% of all the campus emergency notification systems are opt-in; this means students sign-up at will (Gray 2011). In general, opt-in systems have a near zero subscriber base, this forces the university to persuade students to adopt the system (Katsouros 2014; Keller et al. 2011; Schneider 2010). For example Johnson and Goldstein (2003) show that organ donation rates are as low as four percent in opt-in countries and as high as 99.97 percent in opt-out countries. People accept default options unless they are motivated to do otherwise (Cheema and Bagchi 2011).

The success of the campus notification systems is dependent on students' adoption of the technology. A keen understanding of the factors motivating students' adoption will ultimately determine ENS survival. In this study, we investigate factors that drive students' adoption building on the DeLone and McLean model of information systems success (Delone & McLean, 2003). Our theoretical contribution is adapting the D&M model of IS success in the context of emergency notification systems. We refine the model adding new and contextually relevant constructs associated with information and system quality. Our practical contribution appeals to university officials who now have additional options for motivating student adoption of Emergency Notification Systems.

Theoretical Background and Model Development

Information systems research in the context emergency systems focuses on the efficient design of systems (Chen et al. 2013; Malizia et al. 2010), or factors that impact students to adopt of notification technology. In the latter stream of work, subjective norms are associated with an increase in student’s adoption of the technology. Whereas, perceived ease of use and usefulness have no direct impact on the adoption of technology (Lee et al. 2013). Malizia et al. (2010) evaluate the value of ENS for people with disabilities and various other profiles. The results suggest that messages during extreme events don’t help disabled people. They propose designs that are useful for more vulnerable groups. Leonidis et al. (2009) investigate how to construct personalized messages based on students preferences such as messages about class cancellations. Han et al. (2015) examine factors that motivate students’ compliance with messages they receive via emergency notification systems and how the importance of those factors change under different emergency scenarios such fire, snowstorm, active shooter, robbery, and health related incidents. The study reports that perceived threat have a different influence on compliance depending on the event. Information quality trust is a significant factor affecting compliance in all types of incidents. Notwithstanding the finding of current studies; additional research is needed in the area of emergency notification systems (Janssen et al. 2010). Compliance with messages sent and the design of the system are important factors in the study of emergency systems. One question requires further probing; how do universities get more students to sign-up for ENS based on specific characteristics of the message and perceptions of system value? In this study, we focus specifically on engaging users as the first step towards promoting the system success.

Figure 1. Conceptual Model
DeLone and McLean model of Information Systems Success was first proposed in 1992 and later updated in 2003 (DeLone and McLean 1992; Delone and McLean 2003). The model suggests that the intention to use is influenced by two main factors; system quality and information quality. Following a process, these factors in turn impact the system success. The success or net benefit of the notification system is realized by the University, the students who adopt the system and the society on a whole who are often traumatized by acts of violence on university campuses. A preliminary study (that we conducted) supported system and information quality as key factors to understanding student adoption of the technology. Students were surveyed to understand the factors that might increase subscription rate of emergency notification systems. Participants – 72% - indicated the need to enhance student’s awareness of the system. They further highlighted the necessity of knowledge of system benefits among students. Surprisingly, speed and ease of subscription were the least influential. The first two factors reported can be categorized as information or message quality as they relate to familiarizing the students with the existence of the system and its benefits. On the other hand, the third and fourth categories describe technological features or processes of the system. Based on the IS success model supported by preliminary results we derived the following conceptual model (Figure 1).

Information quality defines the content of the notice sent. The elements of information quality in the context of emergency systems are timeliness, relevance, and actionability of information. Timeliness of notification is a critical aspect of emergency management (Janssen et al. 2010), it could mean the difference between life and death. To keep consumers engaged any information disseminated must be pertinent to the type system (Miller (1996). Finally, actionability means the information communicated should have directions on which students can act (Han et al. 2015). We hypothesize all three factors will have a positive impact on ENS adoption. System quality refers to the desired characteristics of the system. Credibility is associated with user’s engagement in the system (Pavlou and Fygenson 2006). Trust in judgment of systems officials is an influential factor when people make decisions in groups (Levine and Moreland 2008). System quality are represented by the credibility and trust in judgment, we hypothesize both elements have a positive impact on adoption.

**Methodology**

STATA 14.1 is used to recode, clean, and analyze the data. To assess the validity of our measures, we performed confirmatory factor analyses on all multi-items questions. Data was collected from 867 participants in a large university in the United States. Among participants 61% were males, and approximately half (52%) were US Citizens. Undergraduate students represented 54% of the participants, and 43% were graduate students. Students were asked to indicate the operation system of their phones, 58% owned iPhones, 39% owned Android, and the remainder had other systems.

**Variables**

Multi-item constructs were operationalized using existing scales from previous studies. The items from the original scale were slightly modified to be suitable in emergency notification systems context. Demographic, experience with the event, and campus-related questions were included as controls. The questionnaire consisted of items measuring constructs in the conceptual model; respondents scored each of these questions on a seven-point Likert-type scale (1 = strongly disagree to 7 = strongly agree). The items for information timeliness and system credibility were adapted from Brackett and Carr (2001). Items for information relevance and information actionability were adapted from Han et al. (2015). The items for trust in judgment were adapted from Price and Arnould (1999). The dependent variable is a binary variable representing whether the participants have signed up for the campus emergency notification system.

**Analysis**

**Measurement Model**

The Cronbach Alpha values are between 0.88 and 0.95, above the threshold value of point 0.70 (Nunnally and Bernstein 1994) suggesting excellent reliability. The composite reliability varied between 0.88 and 0.95, above the threshold of 0.70 (Joreskog and Sorbom 1989) an additional indication strong reliability.
Convergent validity was assessed by calculating the average variance extracted (AVE) where each indicator is related to only one construct. The AVE values for all constructs exceeded 0.5 which is the desirable cutoff suggesting convergent validity (Fornell and Larcker 1981), with the minimum average variance extracted of 0.74. Discriminant validity was established for the study because the AVE values for any two constructs exceeded the squared construct inter-correlation for each pair (Fornell and Larcker 1981). The factor loadings of the exploratory factor analysis (EFA) showed strong loadings for items: information actionability (0.9, 0.78, & 0.94), trust in judgement (0.79, 0.93 & 0.95), information timeliness (0.89, 0.86 & 0.89), system credibility (0.89, 0.93 & 0.87) and information relevance (0.86 & 0.84); thus establishing discriminant and convergent validity. The variable inflation factor (VIF) was calculated to ensure that there is no collinearity. Tabachnick and Fidell (2013) states that a VIF greater than 10 suggests an existence of collinearity problem. None of the VIFs exceeds 2.5, and thus the results do not suffer from collinearity issues. Data collected through survey may suffer from common method variance (CMV), there we assessed through the marker variable technique (Lindell and Whitney 2001).

**Results**

Since our predictor variables in our conceptual model are latent multi-item constructs and the outcome variable binary (Yes/No), Generalized Structural Equation Modeling (GSEM) is used (Guardabascio and Ventura 2014). GSEM refers to a structural equation model with generalized response variable in which we fit a logistic of Bernoulli family. Models with latent multi-item constructs are best modeled with structural equation modeling (SEM) (Blunch 2012); however, a disadvantage of SEM is its inability to handle dichotomous dependent variables. Models with binary outcome are usually analyzed using logistic regression. Logistic regression may provide biased results when the predictor variables are latent unobserved variables (Kupek 2006). Table 5 shows the results of the GSEM model.

Our findings indicate that of the information quality factors only information timeliness positively affects the likelihood to adopt ENS ($\beta_{IT}= 0.27$, OR=1.31, p<0.001). Both information relevance and information actionability have no significant influence on adoption of ENS. Our results also show that of the system quality factors only system credibility is significantly associated with the increase in the likelihood of adoption ($\beta_{IT}= 0.27$, OR=1.49, p<0.001). Trust in judgment has no significant effect on the likelihood to adopt ENS this is interesting and counterintuitive and warrants further study.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Odds Ratio (OR)</th>
</tr>
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<tbody>
<tr>
<td>Information Timeliness (IT)</td>
<td>0.27***</td>
<td>1.31</td>
</tr>
<tr>
<td>Information Relevance (IR)</td>
<td>0.17</td>
<td>1.18</td>
</tr>
<tr>
<td>Information Actionability (IA)</td>
<td>0.19</td>
<td>1.21</td>
</tr>
<tr>
<td>System Credibility (SC)</td>
<td>0.40***</td>
<td>1.49</td>
</tr>
<tr>
<td>Trust in Judgment (TJ)</td>
<td>-0.04</td>
<td>0.96</td>
</tr>
<tr>
<td>Covariates (awareness, past experience, gender, citizenship)</td>
<td></td>
<td></td>
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<tr>
<td>-2LL</td>
<td>883.55</td>
<td></td>
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</tbody>
</table>

Table 1. Generalized Structural Equation Model – Family: Bernoulli, Link: Logit

**Conclusion and Future Work**

This study evaluates a message driven system using constructs that are formulated to access particular dimensions of information broadcasted to students. The results suggest information timeliness and system credibility are important factors to incorporate in promoting emergency notification systems to students. Further, the findings indicate that students give more weight to the timing of the communication than the information disseminated. This study provides theoretical contribution by adapting the D&M model of IS success in the context of ENS. As a practical implication, this knowledge provides university officials with options on how to prioritize messages delivered to students. An
understanding of the impact of information timeliness and system credibility also contribute to the extant literature on emergency management.

Our preliminary results in this research in progress aim to improve the adoption rate of ENS and thus save more lives. Innovative techniques are a necessity to engage students who have failed to subscribe to opt-in emergency management systems. They may be aware of the advantages; however, a key factor must be supplied to convert simple interest to the adoption of the artifact. Researchers must help guide students the last mile; therefore, future studies should evaluate students’ attitude towards ENS using information timeliness as the main benefit of the system.

REFERENCES


