Alert Networks of ICTs and Sources in Campus Emergencies

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ABSTRACT

This study contributes an understanding of how ICTs and varying information sources work together during emergency alerts. It builds on the prior work on campus active shooter events by examining an organization that used a range of ICTs including mobile devices, social media, organizational tools, and news media, to notify their stakeholders about an emergency. The study design used a survey to capture the responses from a random sample of over 1000 stakeholders—students, faculty, and staff—who were notified of an active shooter emergency. The findings from the first three notifications suggest that messages reaching the most stakeholders were (a) sent by official sources through ICTs like mobile phones; (b) official email communication, and (c) messages that included face-to-face communication. While 11 different ICTs were included in the study, mass media (i.e., television and radio), and social media (Twitter and Facebook) did not function substantially in the emergency alert process.

Keywords

ICTs, Emergency management, Social media, Emergency alerts, Safety Communication, Mobile devices.

INTRODUCTION

During the past several decades, sociologists of disaster have generated considerable knowledge concerning emergency alerts, evacuations, and of particular relevance here, the importance of using multiple information and communication technologies (ICTs) to reach constituents (e.g., Lindell and Perry, 1987; Mileti and Beck, 1975; Quarantelli, 1998; Sorenson 1991). While there are various terms used to define the media and channels that provide information, here we use ICTs as the broad category that encompasses information channels, like the internet, face-to-face as a technology (Stephens, Sørnes, Rice, Browning, and Sætre, 2008), and specific tools like social media. Since this body of research has accumulated, there has been a surge in the number of ICT options available for communication (Stephens, Barrett, and Mahometa, 2013). A simple Google search for "community mobile phone notification alerts" reveals that schools, towns, counties, and universities are all grappling to find ways to reach their constituents when an emergency strikes. Organizations know they need to notify their stakeholders, however, they need guidance in understanding how to incorporate the ever-growing types of ICTs into alert practices.

Recently, several scholars began examining the use of ICTs—social media in particular—for emergency planning, post-emergency sensemaking, and community building (Palen et al., 2010; Sutton, Palen, and Shklovski, 2008; Veil, Buehner, and Palanchar, 2011). But when organizations notify stakeholders of an emergency, they have myriad options other than just social media. In many cases, organizations provide employees ICTs like email, but they do not provide the mobile communication technology used to access these messages (Kim, Chan, and Gupta, 2007; PC Today, 2012). Given the capacity for mobile ICTs to provide perpetual contact to friends, family, co-workers, and news sources on a global scale (Katz and Aakhus, 2002), it is important to examine how these technologies work in conjunction with people to facilitate the emergency alert process.

Including ICTs and People as Parts of the Emergency Notification Network

Recent theoretical work suggests that it is fruitful to view ICTs on an equal playing field with people when we examine how information is communicated through networks (Contractor, Monge, and Leonardi, 2011). These researchers distinguish between networks that only consider people part of the communication process, called unidimensional networks, and those networks that recognize how ICTs are often embedded with people in networks (Contractor et al., 2011). Increasingly, people rely on technologies and other non-human practices, much like they rely on colleagues or interpersonal contacts (Su, Huang, and Contractor, 2010).

This re-conceptualization and consideration of technology being equally central in emergency notification is important for two reasons. First, most emergency communication best practices include recommendations to use multiple technologies to alert mobile, dispersed stakeholders (Lindell and Perry, 1989; Mileti and Beck, 1975, Mileti and Peek, 2000). Since stakeholders often use multiple ICTs simultaneously and sequentially (Contractor et al., 2011; Stephens et al., 2008), it is important to use theoretical perspectives that embrace combinatorial ICT use. Yet as organizations implement this combinatorial ICT reality, having relevant ways to group types of ICTs can simplify the alert process.

The second reason that this re-conceptualization is helpful concerns the use of official sources, organizations experiencing the emergency. The growing research on ICTs and sources of emergency messages finds that official sources are not necessarily better or preferred in emergencies (Palen, Vieweg, Liu, and Hughes, 2009; Palen et al., 2010; Stephens et al., 2013; Sutton, Palen, and Shklovski, 2008). While credibility and trust in sources often matters, timeliness and first-hand accounts may be even more important now that people can access emergency information from multiple ICTs. The proliferation of personalized mobile communication devices has led to claims that our society might be shifting from an age of mass broadcast media to one where information is sought differently because ICTs are personal (Campbell and Park, 2008). With a mobile device in hand, it is easier for friends and family to share the latest emergency information that they have heard.

UNDERSTANDING ICTs AND SOURCES IN EDUCATION AND SCHOOL CONTEXTS

The tragedy that heightened the awareness of campus emergencies was the Virginia Tech active shooter emergency. While Virginia Tech activated an emergency alert system that included many types of ICTs, they were criticized because they failed to meet the needs *mobile* communities (Hamblen, 2008). Since that time, colleges and universities in the US have improved campus safety by enhancing their emergency alert systems and proactively preparing for "on-campus shooters" (Fox and Savage, 2009; Hamblen, 2008), but the voluntary nature of these message subscriptions still leaves many off the radar (Wu, Qu, and Preece, 2008).

Social Media and Emergency Notifications

In addition to using emergency alert systems and text messaging, the growth in mobile device use—especially smartphones—allows people more regular contact with the internet. This trend has garnered attention from crisis informatics researchers as they now actively study how social media play an important role in crisis and emergency communication (e.g., Hughes and Palen, 2009; Schultz, et al., 2011; Veil, et al., 2011). Twitter has been studied in crisis and emergency communication (see Veil et al., 2011 for a summary), and it is often cited, along with Facebook, as being a timely channel during urgent communication messages (Hughes and Palen, 2009; Palen et al., 2009). The broader understanding of using a mix of ICTs for emergency notification, along with the specific role that social media play, forms the basis of our first research question:

RQ1: How can we categorize the mix of ICTs used today for emergency alerts?

RQ1a: What role do social media play in emergency alerts?

Evaluating Message Sources

Message sources often play a key role in emergency communication. Official sources, those coming from the organization experiencing the emergency, typically have more credibility and relevance than other types of sources (Mileti and Beck, 1975). Yet sources come in many forms and include organizations, friends and family, government organizations, and news media. In an unfolding crisis, people can scrutinize sources and even consider whether the information is timely; a benchmark of effective emergency alert messages (Palen et al., 2009; Sutton et al., 2008). For example, in their study of communication during the California Wildfires, Sutton and colleagues (2008) found that some people involved in the emergency viewed official sources as helpful, but others considered them slow and out-of-date. News sources also offer another information source during an emergency. Past research indicates that traditional news outlets accessed through radio or television might be perceived as more credible, accurate, and neutral than information posted on social media sites and the

internet (Schultz et al, 2011; Wright and Hinson, 2009). The combined knowledge of their perceived credibility, in addition to the concerns of timeliness in an emergency, help justify including a variety of sources when studying emergency alerts. This forms our second research question:

RQ2: What role do official notification sources play when compared to interpersonal and news media during the emergency alerts?

Relationships with Key Demographics

Producing research that informs a more current understanding of how ICTs and sources are used for emergency alerts also requires that we focus on some key demographics of the message recipients. Organizations often characterize their major constituents as stakeholders (Freeman, 1984), and these diverse groupings of people often have different needs. In addition to identifying relevant stakeholders in an emergency, the location or proximity to the emergency is often considered an important variable to include (Lindell and Perry, 1987; Quarantelli, 1998; Sorenson 1991). Finally, considering that research on mobile phone use has found significant age and gender differences (e.g., Katz and Aakhus, 2002; Leung, and Wei, 2000), including these variables is prudent. Therefore, our last two research questions expand on demographics important for emergency *alerts*:

RQ1b: How are the various types of ICTs used in the alert process affected by stakeholder grouping, location, age, and gender?

RQ2a: How are the various sources used in the alert process affected by stakeholder grouping, location, age, and gender?

METHOD

Participants and Procedure

In September of 2010 The University of Texas at Austin initiated an active shooter emergency response plan that resulted in a day-long campus closure and a student taking his own life. This crisis was one of the first to utilize text messaging and social media for emergency alerts, therefore, it was chosen as a focus for this study on multiple ICTs and sources used during emergency communication. The participants in this study (N =1318) represented the three major stakeholders on the campus: students, faculty, and staff. To create the sample, a random list of 15% of each of the three stakeholder groups was sent email invitations to participate in the study. There was only one email invitation sent to reduce the burden on those sampled. The resulting sample consisted of 65.5% (N= 886) students, 6.6% (N = 89) faculty, and 27.9% (N = 377) staff (response rate ranged from 10.9-18.3%). The complete sample was 66% (N = 892) female and had an average age of 30.4 (SD = 13.19). Thirty-nine and two tenths percent of the sample (N = 597) responded that they were located on campus the day the shooting event occurred, 12.3% (N = 166) were traveling to campus, and 43.6% (N = 589) were off campus.

Procedure

The day after the shooting incident was resolved on campus, one of the researchers met with an IRB proposal reviewer and successfully obtained a rapid review. The primary researcher had extensive knowledge of the campus emergency and crisis communication plans, and had conducted related studies concerning campus safety and security. In addition, this researcher met with University staff to understand how the University used their own mix of official communication channels. The official communication practices that occurred during the four-hour campus emergency included: sounding campus sirens every 10 minutes, sending five different text messages, having the police department provide a Facebook update, providing two official Twitter updates, sending two email messages, and updating the University website three different times. At the end of the event, the University sent an all-clear message using multiple ICTs.

Within one week of the campus shooting incident, the randomly selected faculty and staff were invited to participate, and 12 days after the incident occurred the students were invited to complete an on-line questionnaire. In this organization, 99% of all members have an email account, so this was an appropriate method to reach the participant sample pool. When the participants clicked on the link embedded in the email, they were directed to a web site containing an informed consent form and the anonymous questionnaire.

Instrument

The instrument used for the study specifically was designed to ask about the ICTs used first, second, and third when the participants first learned about the on-campus shooting. This was a categorical variable and contained twelve possible choices: no notification, text message, email, Facebook, Twitter, face-to-face, sirens, radio, TV news, University website, phone, and other. At each of the three points in time, the participant also indicated the

source of the message. This included three options: news media, an interpersonal source (identified as friend, family, or coworker), and the official organizational source (identified as the University).

Data Analysis

Latent Class Analysis. Latent class analysis has been applied to hazard mitigation to better understand audiences in more comprehensive ways (e.g. Goldsworthy, Mayhorn, and Meade, 2010), thus it is appropriate for an elaboration on emergency communication. This type of analysis offers a way to identify homogenous subsets by examining multiple variables in a single analysis. For example, instead of simply comparing one ICT to another, this analysis allows us to consider all ICTs used in a given context and identify the underlying patterns of use. Latent class analysis was performed for both the ICT and source of the message. The ICT options for the message reception contained a total of 11 variables ranging from "face-to-face" to "text message." Source of message originally contained five possible sources, but was reduced to three general classifications of interpersonal, official, or news media. All latent class analyses were performed using Mplus version 6. Models were evaluated using the Vuong-Lo-Mendell-Rubin Likelihood Ratio Test and the Lo-Mendel-Rubin Adjusted Likelihood Ratio Test. In addition, average latent class probabilities were also examined to determine the most appropriate number of classes for both the ICT and source questions.

Logistic Regression. Multinomial logistic regression was used to test the impact of gender, stakeholder group, location at the time of the shooting, and age on the latent class membership for both the ICT and source question. Stakeholder group was designated as "students," "faculty," or "staff." Location at the time of the shooting was designated as "outside of city," "off campus," "traveling to campus," or "on campus." Age of the subjects was categorized into three groups: "30 and under," "31 to 48," and "49 and older" to reflect categories of generational differences. All models were run using SPSS version 18, and evaluated for model fit using likelihood ratio tests.

RESULTS

Preliminary Analyses

Prior to analyses, descriptive and frequency analyses were performed and the data were examined for outliers and missing data. Participants were removed from inclusion if they failed to complete both the ICT used and the source of the message for each notification time point. In addition, respondents with missing ICTs on any of the notification times were also removed. Only four subjects indicated 'other ICT' and they were dropped from the analysis. In total, 35 subjects were removed leaving a final subject count of 1318.

As each notification time point only allowed for a single ICT or source selection, responses were aggregated across notification times. Prior research has shown that after three separate notifications through a mix of ICTs, people's sense of urgency is the same regardless of the composition of the ICT mix (Stephens et al., 2013). Responses for both ICTs and sources were kept at yes/no responses allowing for multiple dichotomous variables to be used in the latent class analysis.

Research Question 1: Patterns in ICT use

RQ1 asked how to categorize the mix of ICTs used today for emergency alerts. To address this question, we employed latent class analysis because we were interested in characterizing data from multiple ICT uses. All likelihood ratio tests indicated the continuation of class additions until reaching the four-class structure. Table 1 shows the average latent class probabilities for the four ICT classes. Figure 1 shows the probabilities for each of the four classes on all 11 ICT responses. Examination of the figure shows a "smartphone" class (0.947 and 1.000), a "FtF" class (0.717), an "email" class (1.000), and a "text message" class (1.00). Posterior probabilities for each class are also indicated on the figure.

Table 1: Average Latent Class Probabilities for Most Likely ICT Latent Class Membership (Row) by Latent Class (Column)

Membership	Class 1	Class 2	Class 3	Class 4
1	**0.999**	0.001	0.000	0.000
2	0.052	**0.948**	0.000	0.000
3	0.006	0.000	**0.994**	0.000
4	0.000	0.000	0.000	**1.000**

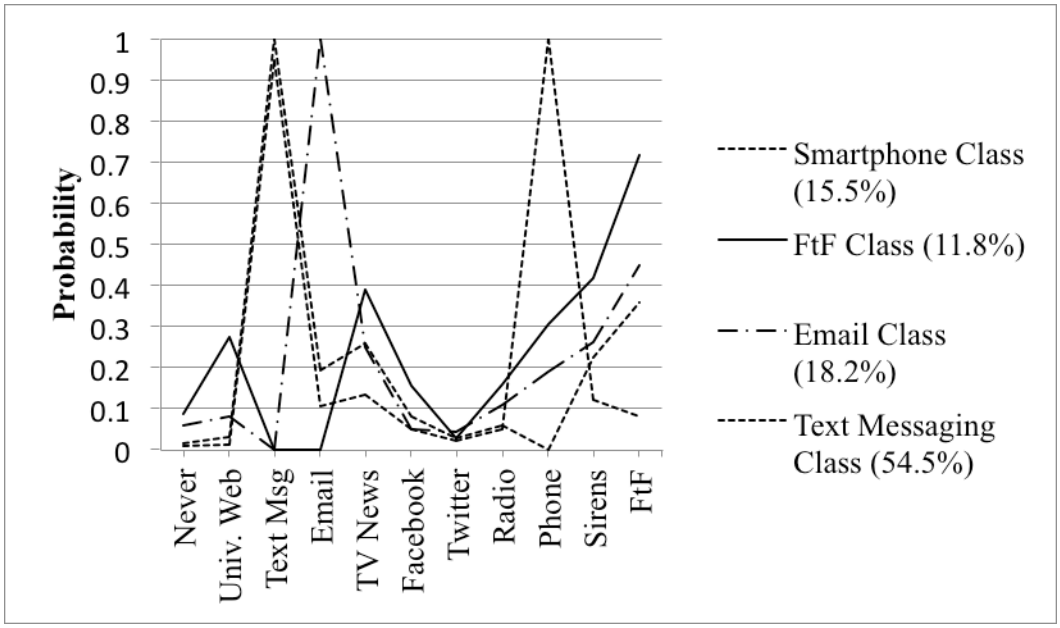

Figure 1. Probabilities of ICT Latent Classes. This figure illustrates the probabilities for each of the four classes on all 11 ICT responses

Research Question 1a: Social Media Use

RQ1a asked specifically about the role that social media plays in the patterns of emergency alert ICT use. The results from the latent class analysis discussed above reveals that the two social media included in this study, Facebook and Twitter, did not play a significant role in how ICT use patterns were characterized in the alert process. Examination of the frequency data for all three alert time periods revealed very few mentions of these social media. A frequency graph (see Figure 2) indicates that social media are increasing in use over time, but they are well below the other ICTs examined in this study. It appears that social media were not playing a key role in the alert or critical period phase of this emergency.

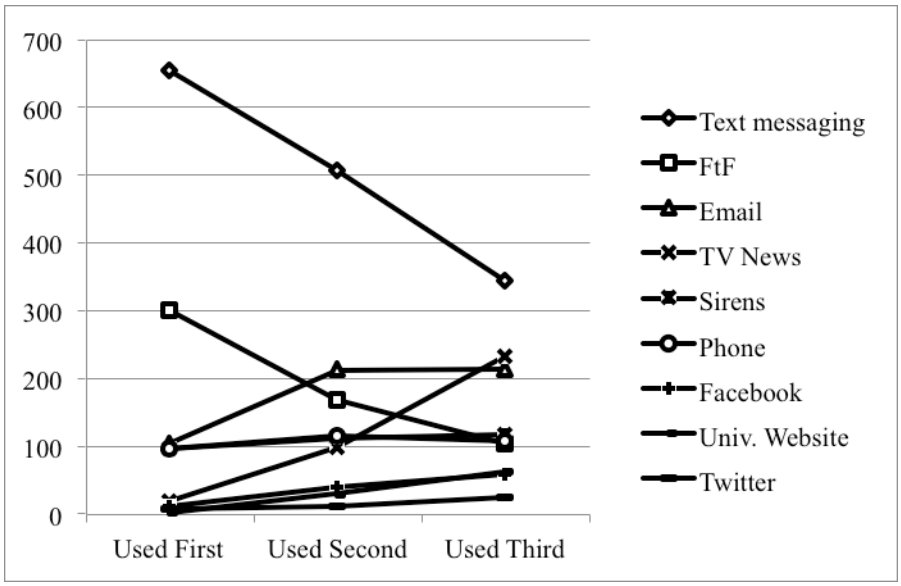

Figure 2. Frequency of ICT Use During Attention-Getting Phase of Emergency

Research Question 1b: ICT Patterns including the four demographic variables

Prior to the nominal logistic regression analysis, the four latent classes of ICTs were condensed to three by combining the text message class with the phone class to create what we term the personal communication technology (PCT) group, a term also used by other mobile device scholars (Campbell and Park, 2008). This seemed like an accurate term because quite often the same device—a mobile phone—is used for text messaging and phone, especially within the students and highly mobile populations. The three latent classes of ICTs

showed good overall model fit for the four included categorical independent variables of gender, stakeholder, location, and age. The likelihood ratio test for the overall model showed a significant effect, $\chi^2(16) = 121.23$, $p < .05$. The goodness-of-fit test was non-significant, indicating good data fit to the overall model, Pearson, $\chi^2(108) = 89.69$, $p = .71$. Likelihood ratio tests also revealed significant effects for three of the four independents in the model: stakeholder ($\chi^2(4) = 22.27$, $p < .05$), location ($\chi^2(6) = 17.52$, $p < .05$), and gender ($\chi^2(2) = 8.34$, $p < .05$). The effect of age was not significant for the model ($\chi^2(4) = 4.28$, $p = .37$). Estimates for each independent are not included in the manuscript, but they are available from the first author.

Findings for Specific ICT Differences

Stakeholders. Students also showed a significant class membership difference to faculty and staff when comparing email versus PCT. The odds of a student being in the PCT class were 3.69 times greater than the odds of a faculty member ($p = .001$) and 3.16 times greater than the odds of a staff member ($p = .001$). The odds of a staff member using face-to-face communication over PCT were 1.93 times greater than a student ($p = .04$), yet the relationship was insignificant when students were compared to faculty (Exp(B) = 1.97, $p = .17$).

Location. Location was also a general predictor of ICT latent class distinction. The odds of subjects on campus having FtF latent class membership over a PCT membership were 1.76 times greater than someone off campus ($p = .02$).

Gender. General patterns can be seen looking at the prediction of each latent class compared to the PCT class. The only significant gender difference was for the prediction of email versus PCT. The odds of a female being in the text class over the email class was 1.64 times greater than the odds for a male ($p = .01$).

Expanding on Personal Communication Technologies

While the latent class analysis and logistic regression provided much of the picture to explain the use of PCTs, several additional analyses offer insight into how PCTs are used. First, the frequency data suggest that text messaging stands clearly above all other ICTs because it was most frequency used during this attention-getting phase of the emergency (see Figure 2 for a graphic representation of this pattern). Over half of everyone in the dataset reported receiving a text message as their initial warning concerning the emergency ($N = 655$). For the second and third warning, text messaging dropped, but still 508 people received a text message as the second notification, and 345 people received one as their third notification. Second, during an examination of the combinations of ICTs used over the three notifications, the most common three-ICT pattern was three repetitive text messages in sequence, 8.79% ($N = 112$), and 27.86% ($N = 367$) of the subjects relied on at least two repetitive text messages. Further examination of those people reporting the three repetitive uses of text messaging reveals that 75% of them were students ($N = 84$) and that represents a higher percentage than the 66.5% of the entire dataset that were students. Furthermore, 18.8% ($N = 21$) of them were trapped in a classroom during the emergency lock-down, 42% ($N = 47$) were off campus, and 16.1% ($N = 18$) were traveling to campus. This suggests that repetitive text users may have had few options for getting information about the unfolding situation using other ICTs.

Research Question Two: Source

RQ2 asked about the role that message source played in class membership. Latent class analysis and likelihood ratio tests for the source of the message yielded a three-class structure. Figure 3 shows the probabilities for each class on the three possible source responses. Examination of the figure shows an "interpersonal and official combination" class (0.827 and 1.000), an "interpersonal" class (0.959), and an "official source" class (1.00). Posterior probabilities for each class are also indicated on Table 2, which shows the average latent class probabilities for the three message source classes.

Table 2: Average Latent Class Probabilities for Most Likely Latent Class Membership (Row) by Latent Class (Column)

Membership	Class 1	Class 2	Class 3
1	**1.000**	0.000	0.000
2	0.002	**0.824**	0.175
3	0.003	0.343	**0.654**

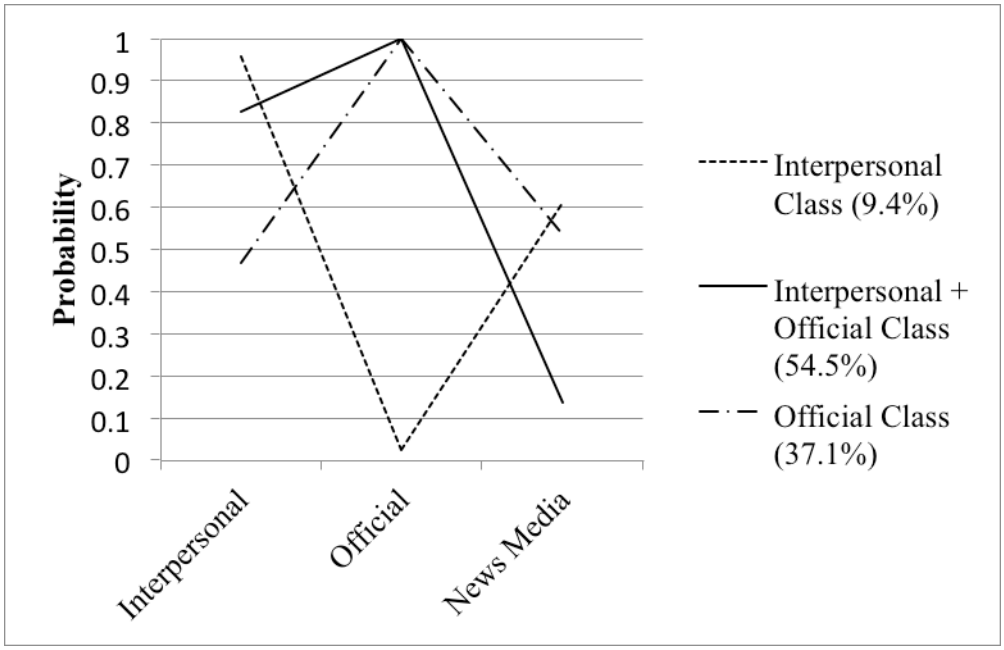

Figure 3. Probabilities of Sources for Latent Classes

The three latent classes were used in a nominal logistic regression analysis, using "official" as the reference category. The three latent classes showed good overall model fit for the four included categorical independents of gender, stakeholder, location, and age. The likelihood ratio test for the overall model showed a significant effect, $\chi^2(16) = 43.54$, $p < .05$. The goodness-of-fit test was non-significant, indicating moderate data fit to the overall model, Pearson , $\chi^2(108) = 124.54$, $p = .13$. Moderate data fit is indicated by a lower rejection p-value of .13 rather than a more typical .25. Likewise, the Pseudo R^2 Nagelkerke statistic showed the overall model accounting for only 4.7% of the variance. Likelihood ratio tests revealed significant main effects for two of the four independents in the model: Stakeholder group ($\chi^2(4) = 11.13$, $p < .05$) and location ($\chi^2(6) = 25.08$, $p < .05$). The effects of gender ($\chi^2(2) = 0.70$, $p = .70$) and age ($\chi^2(4) = 6.46$, $p = .17$) were not significant for the model. Estimates for each independent are available from the first author.

Findings for Specific Source Differences

Stakeholder. The odds of a staff member being classified as using a combination of sources over just official sources were 1.70 times greater than a student ($p = .02$). However, that same pattern was not significant for the comparison of faculty to students (Exp(B) = 1.03, $p = .92$). This finding also reflects a pattern of communication access by location since faculty and students are not required to be on campus whereas staff is bound to campus.

Location. The odds of a subject "off campus" being classified as receiving interpersonal sources over official sources were 1.90 times greater than a subject "on campus" ($p = .02$). However, the odds of a subject "off campus" being classified as receiving a combination of sources over official sources were 0.67 times greater than a subject "on campus" ($p = .01$). Similarly, the odds of a subject "traveling to campus" being classified as receiving combination sources over official sources were 0.51 times greater than a subject "on campus" ($p = .01$). This could indicate a difference in how people received messages through their interpersonal sources and it appears that this varies by location.

DISCUSSION

The findings from this study highlight the important role that mobile devices, sources, stakeholder groupings, and location play when trying to provide emergency alerts quickly. With an increasingly mobile workforce, organizations will not necessarily be aware of where their members are when an emergency strikes. In this emergency, it appears that (a) messages sent through official sources that utilize PCTs, (b) official email communication, and (c) messages including FtF communication concerning the emergency, reached the most people. These findings support the claims of Contractor and colleagues (2011) that ICTs and sources should be considered together, and this claim can be extended to emergency alert networks.

Text Messaging is Vital

The findings from this study clearly support the inclusion of text messaging into any campus crisis communication plan and into other organizations' emergency contact plans as well. The clearest evidence for this claim is found in Figure 2. Across all three alerts, text messaging is the most prominent ICT, and while its dominance decreased over time, it was the main ICT that first informed the stakeholders on this campus. Yet this finding is not without some concern. Because this ICT is so dominant and it is reliant on the availability of a communication network to supply access to the text messaging systems, it is also capable of causing devastating effects, especially with mobile populations, should these systems fail during an emergency,.

Social Media and Mass Media are not Alerting Organizational Stakeholders

This study was the first, to our knowledge, to include a host of social and mass media including Facebook, Twitter, TV news, and radio along with more organizational and interpersonal ICTs (i.e., campus sirens, University website, email, text messaging, phone and FtF conversations) to examine emergency *alert* communication. Every analysis and the frequency trend data suggest that social and mass media were not playing a dominant role in the early stages of emergency communication. However, Figure 2 illustrates an important trend indicating that different ICTs might be more helpful as an emergency progresses. Our findings, combined with recent research on social media use in emergencies, provides support for the claim that different ICTs are used to *alert* or notify organizational members about the emergency, from those used in a *sensemaking* process (e.g., Palen et al., 2010; Tapia, Moore, and Johnson, 2013) of an emergency.

It is plausible that after people receive text messages or in-person notifications, they subsequently turn to a social or mass medium to learn more information. This is likely what occurred to generate the Facebook-related findings in the Vieweg et al. (2008) study. In this way, the TV, Twitter, and the University website, could all function more prominently as the emergency progresses. People are using a combination of ICTs to confirm, understand, and ultimately communicate with others. Facebook use could also climb as people update their status to let their friends and family know that they are safe.

Importance of Understanding Organizational Stakeholder Needs and Proximity

Several findings in this study reinforce that students differ from faculty and staff in how they use ICTs and this is *not* a generational finding. In every regression model, age is not a significant predictor of how people used ICTs. However, data from this study confirm what has also been demonstrated in recent research (e.g., Junco and Mastrodiscasa, 2007), that students are not using email as their dominant form of communication.

Staff relied on a combination of interpersonal and official sources while students and faculty relied more on official sources. This finding can be explained by the fact that most staff are located on campus and they work around co-workers. When staff received an email or a text message, they likely shared that information with their co-workers. Because they work at the same organization, they are likely viewed as knowledgeable and believable in an emergency situation. Staff can be considered tightly connected interpersonally with others in this organization, while students and faculty are more mobile and interpersonally fluid because their work and learning environment does not necessarily connect them directly to knowledgeable interpersonal sources.

Implications of Mobile Populations and Emergency Communication

The importance of knowing where people were physically located during the emergency shed considerable light on why people are using various ICTs and relying on different sources. It is fairly obvious that people on campus are more likely to be notified by an in-person conversation than people off-campus. Yet emergency proximity revealed some helpful distinctions considering how location relates to the sources people use during an emergency. In general, people on campus relied on official sources more than those off campus. The group of people traveling to campus was in a void and they relied on official sources significantly more than people on campus. For example, many people travel to campus by bus or car and those people likely learned about the urgent situation through official text messages. This is further supported by the text message findings that 16.1% of the people who were traveling to campus were notified by three text messages and no other ICTs.

Limitations

This study offers a solid account of how ICTs and sources were used together to alert people during an emergency, yet there are limitations to this study that should be considered as we interpret these findings. First, we do not know the duration of time represented by these three ICT use and source data points, we have assumed they occurred in a short period of time. A second set of limitations concerns decisions for how to condense and analyze a large amount of data. First, we decided to use the most prominent latent class as the

reference category for the ICT analysis and we combined two of the ICT classes because they were both so heavily influenced by the prolific use of text messaging. There were also limits with the specificity of several demographic categories, such as on-campus being a very broad category and the high percentage of respondents who were female. Finally, this was self-report retrospective account data, and while that can be limited by memory, in this situation all respondents provided data within one to two weeks of the actual incident.

Future Research Directions and Conclusions

This study leads in several promising directions as researchers consider expanding on what we have learned here. First, the rise of personal communication technologies should not be overlooked, especially in emergency communication. While the findings suggest that organizations should find ways to use peoples' personal devices for emergency communication, this also introduces a host of concerns. Historically, organizations bore the cost of technology adoption, but increasingly, this is shifting to individuals (Kim et al., 2007; PC Today, 2012) and we need to study the effects of using employees' ICTs. Another area of research concerns the potential organizational digital divide created when some employees have access to mobile devices and others do not. Organizations should not forget to include all employees and stakeholders in alerts.

While proximity and threat perception are well documented in prior research (e.g., Mileti and Peek, 2000), the incorporation of our data on ICT and source use sheds considerable light on emergency alerts. Additionally, future research should further examine our findings regarding the delayed use of social media during emergency events when the affected organization responds immediately through multiple-channel message alerts.

Taken together, these finding support claims that people and ICTs should be considered together as part of communication networks (Contractor et al., 2011), even in emergencies. The study also reminds us that official sources can be important as emergency information is communicated through different ICTs over time.

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