



Replication Research: Campus Emergency Notification Systems

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Abstract:

This paper is an exact replication of the Han, Ada, Sharman and Rao (2015) article on Campus Emergency Notification Systems (ENS). In their study, Information Quality Trust and Subjective Norm were the factors which most commonly induced recipients of ENS notifications to comply with the information and instructions in the notification; Perceived Safety Threat, Perceived Financial Threat, and Past Experience also played a role for some types of ENS notifications. We found essentially the same results, although there were some differences. In our study, Information Quality Trust was again the most important determinant. Subjective norms played a role, but were not a fundamentally important factor as they were in the Han, et al. study; we speculate this may be due to different cultures between our participants and theirs. The other three factors were important for some types of ENS notifications but not others. Our research also suggests that future research should consider past experience with ENS notifications, such as the frequency, location relevance, and the timeliness of past ENS notifications received.

Keywords: Compliance, campus alerts, emergency notification systems, information quality trust, study replication

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1 Introduction

In recent years, there have been a number of emergency incidents such as crimes, extreme weather conditions, and accidents, on university campuses all across United States (Mittroff, Diamond and Alpaslam, 2006). The United States Federal Bureau of Investigation (FBI) reports crime and security statistics on US university campuses as required under the Clery Act. Data from 2013-2015 indicate that on average across all of the universities in the US there are about 2000 fires, 14500 burglaries/robberies/thefts, 20 murders, 2300 aggravated assaults, and 5000 sexual assaults each year¹. In response to these events, many universities have adopted Emergency Notification Systems (ENS) to either warn or inform students, faculty and staff affiliated with the university about such incidents (Han, Ada, Sharman, and Rao, 2015). Yet, merely having such systems in place does not persuade the recipients to believe in and comply with the information and instructions provided by the system.

A recent study by Han, et al. (2015) showed that while most students said they would comply with most ENS notifications, about 40% said they would verify the information in the ENS notification before acting. In certain time-sensitive situations, if the user fails to comply immediately, precious time is wasted (Han, et al., 2015) and the risk may be similar to non-compliance (e.g., waiting until you see the shooter in an active shooter situation before seeking shelter). If a substantial minority of recipients choose to not comply immediately, it defeats the purpose of employing ENS. Hence, it is important to understand what factors influence the decision to comply with ENS notifications.

Han, et al. (2015) examined three fundamentally different theoretical routes that organizations can use to influence organizational members to comply with its requests (Etzioni, 1961; Parsons, 1957). The first is coercive power, such as sanctions. Few universities will choose to impose sanctions for non-compliance, but one way to use coercive power is to emphasize threats to physical safety in the ENS notification (Han, et al. 2015). The second route is remunerative power, such as rewards. Once again, few universities will choose to offer rewards for compliance, but one way to use remunerative power is to emphasize threats to finances in the ENS notification (Han, et al. 2015). The third route is norms; universities can exert pressure to change the subjective norms around the compliance decision (Han, et al. 2015).

The Han, et al. (2015) study provides some initial understanding of the factors that influence whether students will pay attention to ENS notifications. They found that subjective norms and the extent to which students trusted the information quality of the ENS dominated the decision to comply or not. Safety and financial concerns played a role in only a few specific circumstances. Thus the take-aways from this initial study are for universities to focus on providing good quality, timely information via the ENS and to change organizational culture, so that subjective norms are to immediately comply with ENS notifications. But, these conclusions are based on only one study of students living in one specific region of the US. To what extent are these conclusions replicable? Should we ignore safety and financial issues as sources of influence is all but a few specific situations?

1.1 The Original Study

The Han, et al., (2015) study used a “survey-collecting service company” to distribute an online survey to university students in “the northern region of the United States” (p. 917), and received 821 responses. They presented each participant with one of five scenarios that described an incident (snowstorm, active shooter, building-related (fire), health-related (epidemic), and robbery) and an ENS notification with a call to action. Participants were asked whether they would comply immediately, verify the information in the ENS notification before complying, or ignore the ENS notification. Less than 1% of participants reported they would ignore the ENS notification, so those responses were omitted from the analysis.

The study examined the effects of five factors that influenced the decision to comply with the ENS notification. Table 1 presents the results of their study. In general, information quality trust and subjective norm increased compliance in most situations. A perceived safety threat was important for fast developing situations (i.e., active shooter and building fire) but not for slow developing incidents such as snowstorms, health, or robbery (students reported that ENS notifications for robberies were often sent long after the

¹ see <https://ope.ed.gov/campusafety/#/datafile/list>

incident, so they were not perceived to be fast developing incidents). Perceived financial safety was important for a building fire situation, perhaps because a fire has the potential to harm property (but not for a robbery because ENS notifications for robberies were perceived to be after the fact). Past experience with an incident was also a factor, likely because students have more experience with fires from fire drills than other situations (Han, et al., 2015).

Table 1. Results from the original Han, et al. (2015 study)

	Test Statistics	Regression Model 1: DV – Snowstorm Incident	Regression Model 2: DV – Active Shooter Incident	Regression Model 3: DV – Building-Related Incident	Regression Model 4: DV – Health-Related Incident	Regression Model 5: DV – Robbery Incident
Past Experience	β	0.10	-0.32	1.02	-0.32	0.38
	SE_{β}	0.38	0.42	0.48	0.35	0.57
	Wald's χ^2	0.06	0.58	4.64	0.81	0.45
	Odd's Ratio	1.10	0.73	2.58*	0.73	1.47
	95% CI	0.52-2.32	0.32-1.64	1.02-6.47	0.36-1.46	0.48-4.50
Subjective Norm	β	0.01	0.01	-0.01	0.01	0.02
	SE_{β}	0.01	0.01	0.01	0.01	0.01
	Wald's χ^2	3.87	7.60	0.92	4.19	6.29
	Odd's Ratio	1.01*	1.01**	0.99	1.01*	1.02*
	95% CI	1.01-1.02	1.00-1.02	0.98-1.01	1.01-1.02	1.00-1.03
Perceived Safety Threat	β	0.42	0.60	0.63	-0.14	-0.90
	SE_{β}	0.28	0.29	0.31	0.28	0.50
	Wald's χ^2	2.32	4.22	4.06	0.24	3.21
	Odd's Ratio	1.53	1.83*	1.87*	0.87	0.41
	95% CI	0.89-2.64	1.03-3.25	1.02-3.45	0.50-1.51	0.15-1.09
Perceived Financial Threat	β	-0.35	0.08	0.54	0.22	0.27
	SE_{β}	0.26	0.22	0.26	0.25	0.35
	Wald's χ^2	1.72	0.12	4.32	0.76	0.60
	Odd's Ratio	0.72	1.08	1.71*	1.25	1.32
	95% CI	0.43-1.18	0.70-1.65	1.03-2.83	0.76-2.05	0.66-2.63
Information Quality Trust	β	0.60	0.66	0.76	1.13	0.91
	SE_{β}	0.27	0.30	0.34	0.32	0.43
	Wald's χ^2	4.80	4.87	4.93	12.31	4.40
	Odd's Ratio	1.81*	1.93*	2.15*	3.11**	2.49*
	95% CI	1.07-3.09	1.08-3.47	1.10-4.23	1.65-5.86	1.06-5.82
Response Ratio (Comply Immediately: Verify First)		90:74	101:63	105:59	78:86	104:61
-2LL		167.67	148.09	142.03	162.70	94.36
χ^2		26.94**	40.03**	36.68**	37.76**	24.00**
Nagelkerke R ²		0.23	0.32	0.32	0.31	0.28
Overall Correct Classification		68.1%	78.3%	78.8%	66.9%	90.0%

*p < 0.05; **p < 0.01

2 Methodology

In this study, we replicated the Han, et al. (2015) study almost exactly. We invited undergraduate students enrolled in a large section business course at a large US state university in the Midwest to participate in an online survey. We invited 699 students to participate in the survey and we received 538 total responses (a response rate of 77%). 64% were male, with 38% 19 years of age or less, 61% 20 to 24, and 1% 25 or older. 80% were US citizens, with 68% being Caucasian, 25% Asian, 4% Hispanic, and 1% black, native American or other ethnicity. Students received extra credit for participating.

The survey was conducted online through the Qualtrics software. Each student was presented with all five incident descriptions in a random order to minimize order effects; the Han, et al., (2015) study was a between-subjects study in which each subject received only one incident description. The median time taken to complete the survey was 9.2 minutes. The five incident descriptions were taken directly from Han, et al. (2015) and adapted slightly for our context (e.g., by using names of buildings on our campus). The incident descriptions can be found in Table 2.

Incident	Explanation
Incident 1: Snowstorm	Snowstorms are storms where large amounts of snow fall. Two inches (5 cm) of snow is enough to create serious disruptions to traffic and school transport in many school districts across the United States. There may be power loss in a snowstorm. Roads may be rendered impassable. Students may be alerted to stay indoors and avoid driving. Jeff and Tom are roommates who live a 40-minute drive away from school. One morning, they were going to university campus together to study for their final exam. Jeff was driving, and Tom received a notification message from campus alert on his phone. It said, "A snowstorm is approaching campus. A driving ban is in effect. Shelter in place and avoid driving until further notice."
Incident 2: Active shooter	These incidents involve one or more shooters on campus or suspects with weapons on campus. Examples of such incidents include the Virginia Tech campus shooting incident, which took place on April 16, 2007. Thirty-two students were affected in that incident. During such incidents, students may be alerted to find a safe place and lock the door or take other action. One day, Jeff was studying in the _____ Hall when he received a campus emergency notification: "A suspected gunman is on campus. Immediately go to the nearest room and lock the door. Keep quiet until further notice."
Incident 3: Building-related incident	These incidents include fires and gas leaks and typically require evacuation of the premises or buildings. Building fires are quite common on college campuses. Examples: One student died due to a fire incident at the University of California–Los Angeles on December 29, 2009; two students were injured in a fire incident on January, 30, 2010, at Western State College of Colorado. Students may be required to evacuate the building immediately. One day, Jeff was going to meet his classmate to discuss a project at 3:00 p.m. At 2:55 p.m., while he was waiting for the classmate on the second floor in the _____ Library, he received a campus emergency notification: "Smoke was observed on the third floor in the _____ Library. All personnel should leave the building immediately using stairs."
Incident 4: Health-related incident	These incidents include outbreaks such as the swine flu epidemic and water contamination. Students may be required to contact health care providers if they notice any symptoms. Jeff was working on campus one day when he received a message from the campus alert system: "Disease outbreak reported in _____ city. If you are coughing, sneezing, or having a fever, see a health care provider immediately." Jeff had been coughing for a couple of days.
Incident 5: Robbery incident	These incidents involve the taking of or attempt to take anything of value from the care, custody, or control of a person or persons by force or threat of force or violence and/or by putting the victim in a state of fear. Example: A student was robbed at gunpoint on the main campus of the University at Buffalo. Students may be advised to avoid walking alone in the area. Jeff was preparing to walk home from the _____ Library to his dorm when he received a message: "A robbery incident was reported at 9 p.m. near _____ Library. Please be cautious and avoid poorly lit areas."
Note: Specific building and city names were redacted for review purposes	

The survey used exactly the same three-part item to measure compliance with the ENS notification (comply immediately, verify first before complying, or ignore) as well as the same items to create the five factors

(information quality trust, subjective norm, perceived safety threat, perceive financial threat, and past experience). The items are presented in the Appendix A. The Cronbach's alpha for all the indicated adequate reliability (>0.7); see Table 3.

Constructs For Cronbach's alpha	Incident 1 : Snowstorm	Incident 2 : Active Shooter	Incident 3 : Building Related	Incident 4 : Health Related	Incident 5 : Robbery
Motivation to Comply	0.855	0.914	0.898	0.884	0.910
Normative Belief	0.843	0.947	0.922	0.894	0.905
Perceived Safety Threat	0.938	0.900	0.948	0.863	0.947
Perceived Financial Threat	0.949	0.968	0.970	0.939	0.930
Information Reliability Trust	0.868	0.870	0.858	0.883	0.879
Information Action-ability Trust	0.871	0.802	0.888	0.871	0.853
Information Criticality Trust	0.896	0.892	0.871	0.867	0.880

The correlations among the factors are presented in Table 4. We note that some of the correlations are high, indicating the potential for multicollinearity. We present one test for this in the Post-Hoc Tests section of the Results.

Pearson Correlation	Variable	(1) Subjective Norm	(2) Perceived Safety Threat	(3) Perceived Financial Threat	(4) Information Quality Trust
Incident 1: Snowstorm	(1) Subjective Norm	1			
	(2) Perceived Safety Threat	0.605	1		
	(3) Perceived Financial Threat	0.298	0.387	1	
	(4) Information Quality Trust	0.719	0.700	0.372	1
Incident 2: Active Shooter	(1) Subjective Norm	1			
	(2) Perceived Safety Threat	0.605	1		
	(3) Perceived Financial Threat	0.117	0.076	1	
	(4) Information Quality Trust	0.626	0.615	0.107	1
Incident 3: Building Related	(1) Subjective Norm	1			
	(2) Perceived Safety Threat	0.608	1		
	(3) Perceived Financial Threat	0.176	0.257	1	
	(4) Information Quality Trust	0.639	0.625	0.195	1
Incident 4: Health Related	(1) Subjective Norm	1			
	(2) Perceived Safety Threat	0.555	1		
	(3) Perceived Financial Threat	0.329	0.446	1	
	(4) Information Quality Trust	0.707	0.639	0.414	1
Incident 5: Robbery	(1) Subjective Norm	1			
	(2) Perceived Safety Threat	0.662	1		
	(3) Perceived Financial Threat	0.341	0.451	1	
	(4) Information Quality Trust	0.710	0.720	0.423	1

3 Results

The dependent variable has three actions choices: comply immediately, verify first, or ignore. In the original study, less than 1% of participants reported they would ignore the notification, so Han, et al., (2015) chose to omit those data and focus only on participants who reported they would comply immediately or verify first. In our study, a meaningful number of participants chose to ignore the notifications (14.10% for snowstorm, 1.80% for active shooter, 3.90% for building-related, 15.50% for health-related, and 12.50% for Robbery). Therefore, we present our results in two separate analyses. The first is following the approach of Han, et al., (2015) and omitting those who chose to ignore the notification (a two-outcome model using only comply and verify). The second is including those who chose to ignore the notification (a three-outcome model including comply, verify, and ignore).

Table 5 presents the two outcome model results. Han, et al. used five separate logistic regressions (one for each incident), as did we. These analyses indicate that Information Quality Trust was the most important factor influencing intention to comply, as it was significant for four of the five incidents (at $p=.05$). Perceived Safety Threat was significant for three incidents (active shooter, building fire, robbery). Subjective Norm was significant for snowstorm and active shooter. Perceived Financial Threat was significant for the snowstorm and the health incident. Past Experience with an incident was not significant for any of the incidents.

	Test Statistics	S1: Snowstorm	S2: Active Shooter	S3: Building Related	S4: Health Related	S5: Robbery
Past Experience	β	-0.136	0.031	-0.077	-0.234	0.130
	SE_{β}	0.380	0.466	0.393	0.409	0.408
	Wald's χ^2	0.127	0.004	0.038	0.328	0.101
	Odds Ratio	0.873	1.032	0.926	0.791	1.139
	95% CI	0.414-1.840	0.414-2.571	0.429-2.000	0.355-1.764	0.512-2.534
Subjective Norm	β	-0.038	-0.034	-0.015	0.007	-0.023
	SE_{β}	0.015	0.014	0.013	0.015	0.015
	Wald's χ^2	6.014	5.676	1.219	0.232	2.301
	Odds Ratio	0.963	0.967	0.985	1.007	0.977
	95% CI	0.934-0.992	0.940-0.994	0.960-1.011	0.978-1.038	0.949-1.007
Perceived Safety Threat	β	-0.092	-0.316	-0.652	-0.081	-0.357
	SE_{β}	0.129	0.154	0.126	0.119	0.125
	Wald's χ^2	0.508	4.240	26.922	0.466	8.104
	Odds Ratio	0.912	0.729	0.521	0.922	0.700
	95% CI	0.708-1.175	0.540-0.985	0.407-0.666	0.730-1.164	0.547-0.895
Perceived Financial Threat	β	-0.172	0.009	-0.003	-0.319	-0.053
	SE_{β}	0.065	0.070	0.063	.079	0.068
	Wald's χ^2	6.988	0.018	0.003	16.518	0.608
	Odds Ratio	0.842	1.010	0.997	0.727	0.949
	95% CI	0.741-0.956	0.880-1.158	0.881-1.128	0.623-0.848	0.831-1.083
Information Quality Trust	β	-0.280	-0.960	-0.370	-0.657	-0.404
	SE_{β}	0.178	0.181	0.149	0.185	0.163
	Wald's χ^2	2.491	28.029	6.170	12.565	6.175
	Odds Ratio	0.756	0.383	0.691	0.519	0.668
	95% CI	0.538-1.070	0.268-0.546	0.519-0.925	0.361-0.746	0.485-0.918
Response Ratio (Comply Immediately : Verify First)		164:273	388:112	307:184	152:280	291:155
-2LL		528.048	412.162	549.338	490.839	508.301
χ^2		50.285	119.762	100.189	69.539	67.848
Nagelkerke R^2		0.148	0.325	0.252	0.205	0.195
Overall Correct Classification		68.60%	77.60%	72.90%	72.50%	72.20%

Table 6 presents the three outcome model results. Because we had three outcomes, we used five separate multinomial logistic regressions with a base case of ignore the ENS notifications. These analyses indicate that Information Quality Trust was the most important factor influencing intention to comply, as it was significant for all five incidents (at $p=.05$). Perceived Safety Threat was significant for three incidents (active shooter, building fire, robbery). Past Experience with an incident was significant for snowstorm and building

fire. Subjective Norm was significant for snowstorm and robbery. Perceived Financial Threat was significant for the health incident.

**Table 6. Three-Outcome Results (Comply Immediately vs. Verify First vs. Ignore).
Gray cells are statistically significant at p=.05**

	Test Statistics	S1: Snowstorm		S2: Active Shooter		S3: Building Related		S4: Health Related		S5: Robbery	
		CIm	VFTC	CIm	VFTC	CIm	VFTC	CIm	VFTC	CIm	VFTC
Past Experience	β	-1.878	-1.819	-0.956	-0.964	-14.827	-14.748	-0.182	0.096	-0.438	-0.558
	SE β	0.934	0.833	1.444	1.389	0.393	0.000	0.603	0.518	0.691	0.640
	Wald's χ^2	4.044	4.247	0.438	0.482	1421.741	-	0.091	0.034	0.402	0.760
	Odd's Ratio	0.153	0.162	0.384	0.381	3.64E-07	3.94E-07	0.834	1.100	0.645	0.572
	95% CI	0.025-0.954	0.029-0.915	0.023-6.518	0.025-5.801	1.68E-7-7.86E-7	3.93E-7-3.93E-7	0.256-2.716	0.399-3.038	0.167-2.498	0.163-2.007
Subjective Norm	β	0.107	0.068	-0.041	-0.076	-0.012	-0.027	-0.023	-0.016	0.058	0.034
	SE β	0.024	0.021	0.056	0.055	0.034	0.033	0.023	0.020	0.022	0.021
	Wald's χ^2	20.171	10.787	0.528	1.887	0.124	0.640	0.969	0.624	6.730	2.562
	Odd's Ratio	1.113	1.070	0.960	0.927	0.988	0.974	0.978	0.955	1.060	1.034
	95% CI	1.062-1.166	1.028-1.114	0.861-1.071	0.832-1.033	0.924-1.057	0.912-1.040	0.935-1.023	0.947-1.023	1.014-1.107	0.992-1.078
Perceived Safety Threat	β	0.213	0.150	1.320	0.974	1.142	0.480	0.300	0.201	0.700	0.341
	SE β	0.172	0.142	0.426	0.416	0.244	0.220	0.164	0.134	0.179	0.162
	Wald's χ^2	1.525	1.116	9.591	5.477	21.972	4.768	3.337	2.254	15.286	4.416
	Odd's Ratio	1.237	1.162	3.744	2.648	3.132	1.616	1.350	1.223	2.013	1.407
	95% CI	0.882-1.735	0.879-1.537	1.624-8.633	1.171-5.984	1.943-5.049	1.050-2.485	0.978-1.864	0.940-1.589	1.418-2.859	1.023-1.934
Perceived Financial Threat	β	0.167	-0.006	0.019	0.032	-0.155	-0.161	0.361	0.059	-0.046	-0.090
	SE β	0.111	0.101	0.321	0.320	0.177	0.173	0.126	0.111	0.123	0.121
	Wald's χ^2	2.266	0.004	0.004	0.010	0.770	0.869	8.263	0.285	0.137	0.557
	Odd's Ratio	1.182	0.994	1.019	1.033	0.856	0.851	1.435	1.061	0.955	0.914
	95% CI	0.951-1.470	0.816-1.210	0.544-1.911	0.552-1.932	0.606-1.271	0.607-1.194	1.122-1.836	0.854-1.318	0.750-1.217	0.721-1.158
Information Quality Trust	β	0.684	0.364	1.818	0.885	1.200	0.842	1.646	1.001	1.029	0.631
	SE β	0.244	0.198	0.414	0.389	0.275	0.259	0.259	0.208	0.232	0.213
	Wald's χ^2	7.892	3.364	19.269	5.166	19.003	10.588	40.306	23.139	19.662	8.816
	Odd's Ratio	1.982	1.439	6.161	2.423	3.321	2.320	5.185	2.722	2.798	1.880
	95% CI	1.230-3.195	0.975-2.122	2.736-13.876	1.130-5.196	1.936-5.697	1.398-3.852	3.119-8.617	1.810-4.093	1.776-4.409	1.239-2.852
Response Ratio*	164:273:72		388:112:9		307:184:20		152:280:79		291:155:64		
Ignore percentage	14.10%		1.80%		3.90%		15.50%		12.50%		
-2LL	805.004		433.870		610.090		767.602		706.000		
χ^2	150.539		160.649		157.903		178.455		203.221		
Nagelkerke R ²	0.298		0.384		0.333		0.343		0.387		
Overall Correct classification	60.30%		80.00%		71.20%		64.80%		66.30%		

*Response Ratio = comply immediately : verify first and then comply : ignore

3.1 Post-Hoc Tests

We had some concerns about the potential for multicollinearity given the high correlations in Table 4, but logistic regression provides no statistics for this. However, standard linear regression provides the variance inflation factor (VIF). A VIF greater than 10 indicates multicollinearity may be an issue (Kutner, Nachtsheim, and Neter, 2004). Standard linear regression can be used to approximate logistic regression when the dependent variable has only two outcomes (Kutner, et al, 2004). As a post-hoc test of the potential impact of multicollinearity, we ran five standard linear regression analyses on our two-outcome data and found all VIFs to be below 2.5, indicating no multicollinearity issues.

As another post-hoc test, we re-ran all 10 models again (5 two-outcome and 5 three-outcome) but this time using only Information Quality Trust as the sole independent variable and found that the correct classification

percentages decreased by an average of only 3.1 percentage points. In other words, the information trust only models were able to correctly predict students' compliance intentions within three percentage points; all other factors combined improved the classification accuracy by only three percentage points.

An inspection of the information quality trust data suggested that there might be some differences in trust for different scenarios, so we used a repeated measures general linear model to check for differences. We found that there were significant differences in information quality trust due to the scenario ($F(1,508)=23,876.74, p<.000$). Table 7 presents the means and the groups that were significantly different (using LSD pairwise comparison). Students had the greatest trust in the information quality of the ENS for active shooter incidents and building related incidents (i.e., fire). They had less trust in ENS reports of robbery or snowstorm incidents and less again in reports of health-related incidents.

Scenario	Mean	Group
S2 Active Shooter	6.105	a
S3 Building Related	5.767	b
S5 Robbery	5.578	c
S1 Snowstorm	5.550	c
S4 Health Related	5.416	d

We also compared the means and standard deviations in our study to those in the Han et al. study. Table 8 shows that in general our means and standard deviations are comparable to those in the original study (See Appendix B).

	S1 Snowstorm	S2 Active Shooter	S3 Building Related	S4 Health Related	S5 Robbery
	Mean (Std)	Mean (Std)	Mean (Std)	Mean (Std)	Mean (Std)
Subjective Norm	5.77 (1.06)	6.39 (0.92)	6.09 (0.95)	5.69 (1.03)	5.96 (0.99)
Perceived Safety Threat	5.21 (1.37)	6.37 (1.02)	5.79 (1.23)	5.59 (1.30)	5.60 (1.35)
Perceived Financial Threat	4.03 (1.63)	3.75 (1.89)	3.53 (1.78)	4.00 (1.72)	4.28 (1.79)
Information Quality Trust	5.41 (1.10)	6.11 (0.93)	5.77 (1.02)	5.55 (1.09)	5.58 (1.12)

4 DISCUSSION

In general, the results of our study match those of Han, et al. (2015). Table 9 compares the findings of the original study of Han, et al. (2015) and the results of our two analyses (the two-outcome model, and the three-outcome model). It also presents the two dimensions on which Han et al. categorized the nature of incidents: the speed of development (fast or slow) and the area affected (a large area or one limited part of campus). The table shows that our results match well with the Han et al. results, but there are some differences.

	S1 Snowstorm			S2 Active Shooter			S3 Building Related			S4 Health Related			S5 Robbery		
Speed	Slow			Fast			Fast			Slow			Fast		
Area	Large			Limited			Limited			Large			Limited		
	Orig	Two	Three	Orig	Two	Three	Orig	Two	Three	Orig	Two	Three	Orig	Two	Three
Past Experience															

Subjective Norm															
Perceived Safety Threat															
Perceived Financial Threat															
Information Quality Trust															

The dominant factor influencing the compliance decision in the original study and both of our analyses was Information Quality Trust. Information quality trust was significant in almost all situations. Thus this replication confirms one of the major takeaways from the original Han, et al. (2015) study: students respond to ENS notifications when they believe they can trust the information they contain. Our post-hoc analyses show that information trust is the dominant factor driving our findings. They also show that students' trust in the ENS is different for different scenarios. So rather than some general overall level of trust in the ENS, students' trust is specific to the type of incident.

Table 8 shows that our students have more trust in the ENS for active shooter and building related incidents, which are fast moving incidents where students have less time to verify the information provided by the ENS before needing to take action, compared to slower moving incidents such as a snowstorm or a health-related incident (Han et al. 2015). The odd one out is the robbery, which is a slow moving incident due to the time it takes for notifications to come in, but our students had less trust in it. Our students reported receiving about two ENS notifications per month during the academic year in which the data were collected, the majority of which were robberies or sexual assaults. In all of these cases, the ENS notification was sent hours after the incident, meaning it had little value as a call to immediate action. In contrast, one ENS notification about a building related incident (a gas leak) occurred in real time while the building was being evacuated, so it provided timely knowledge to act on. We speculate that our students had less trust in ENS about a fast moving robbery event because of their experience with the untimely nature of robbery-related ENS notifications at our campus. Additionally, we note that the ENS notifications on our campus tend to be more detailed than those used in this experiment, as used in Han et al. (2015). While the ENS notifications studied in the original report may have been appropriate for their sample due to similarities between the study ENS and experienced ENS, we speculate that difference in details between the notifications may have caused students to ignore the message. Alerts issued on our campus range from five sentences to multiple paragraphs, while the ENS notifications in the study were one sentence. Research suggests that detailed information is beneficial to users when dealing with emergencies (Sutton et al. 2018). However, given the nature of the five scenarios, providing detailed information in a timely manner may not be always possible (e.g.: detailed investigation by law enforcement agencies for robbery and active shooter scenarios, extent of damage to property for building related incidents and snowstorms).

Additionally, a prior version of the original paper suggested that media richness would positively influence compliance intention (Han et al., 2011). However, at this Midwest university, notifications are often sent out in three different ways – via call, text, and email. When students receive the ENS through these three different routes each time there is an incident, it may actually make the students worry less about the incident, as they perceive that they receive more incidents than actually occur. It is known that habituation to security warnings occurs (Vance et al., 2018), but it not clear how habituation influences attention to warnings when the warnings occur in the ENS context and are related to personal safety.

The implications from this for university administrators are clear. First and foremost, focus on the quality and timeliness of ENS notifications so students learn to trust the information they contain. The other factors in Table 9 may play a role in students' compliance intentions, but the most important lever to influence student compliance is information quality trust.

Table 9 also highlights one difference from the Han, et al. (2015) study. Han, et al., conclude that subjective norms are a "critical" factor (p. 923), especially the norms from parents and university officials, not friends. We found subjective norms to play a role in some situations, but not others, and the pattern was not completely consistent across both the two-outcome and three-outcome models we tested. The relative importance of norms is influenced by culture (Abrams, Ando, and Hinkle, 1998; Fisher, et al., 2009). Some

cultures put greater emphasis on subjective norms, but there are others which encourage individual perception and discretion (Abrams, et al., 1998; Fisher, et al., 2009). The university studied here has approximately 30 percent more white students than the university that was likely studied in the original paper (Data USA, 2019). This difference in diversity suggests that there may be cultural differences between the two universities. Given the differences in the demographics of the two samples, it is reasonable to assume that cultural differences may have an influence on the importance of subjective norms for these two groups.

Subjective norms were not an overly important factor for our student population, yet they were for Han, et al.'s students. So what's different here? Again, with our university located in the US Midwest, and Han, et al.'s (2015) university in US Northern states, it may be that the difference in diversity influences the concern for subjective norms. The large difference in minority representation may be correlated to a difference in cultural norms for the students. Secondly, past experience with the ENS is an important determinant in creation of subjective norms. Many of our students reported having had a poor past experience with our ENS system, which might have engendered a greater reliance on individual perception and discretion. In our study, since the percentage of students who chose to ignore ENS notifications was higher as compared to that of the original study, we conclude that in emergency situations, our students were less likely to consider subjective norms when making decisions. Also, past experience with ENS not only affects the compliance behavior of students (our subjects) but also affects the compliance behavior of the referents (faculty, staff, etc.). If the referents display less motivation to comply (via informal discussions or as part of general organizational culture), so will the students.

Thus, the second major takeaway from our replication study is that counter to the Han, et al. study, subjective norms are not always "critical." The importance of the subjective norms depends on the students; norms are important for some groups of students, but not for others. One implication for future ENS research is that we need research to better understand students' norms pertaining to ENS, how norms are created, and how norms can be used to make ENS more effective. It may also be relevant to study how the ENS may be better designed to accommodate those of varying cultural and economic background.

The other two ENS levers suggested by Han, et al. that might influence compliance are coercive (safety threats) and remunerative (financial threats). In both the Han, et al. study and in our analyses, Perceived Safety Threat was significant for the Active Shooter and Building fire incidents, both of which present inherent threats to personal safety and are fast moving. In our study, Perceived Safety Threat was also significant for Robbery incidents. On big campuses like ours, there are incidents of robbery reported by our ENS and in the news which may make the students wary of such incidents. However, this particular campus boasts far lower robbery rates than the surrounding municipality, with the city having a lower robbery rate than the US average (Uniform Crime Reporting Statistics, 2019). This (and the lateness of the ENS compared to the event) may also explain the reason why 12.50% of the participants chose to ignore notifications related to robbery, given the comparatively low frequency of such incidents on this campus.

In both the original study and in our study, perceived financial threat and past experiences with security incidents were noticeably less important than other factors. In the original study, past experience was significant only for building related incidents. In our study, past experience was significant for both snowstorm and building related incidents. Since our study was conducted in the Midwest, the students have some experience with snowstorms, but they especially have experience with the unpredictable nature of our weather. Their previous experience with unpredictable Midwest weather and false alarms for snowstorms is likely what influences their belief in and memory of prior warning messages. Additionally, our campus is quite large with about 125 buildings, so there tends to be a number of building related incidents each year.

In the original study, perceived financial threat was significant only for building related incidents. In our study, perceived financial threat was significant for both snowstorm and health related incidents, but not for building related incidents. We attribute the significance of perceived financial threat for snowstorm incidents to the fact that the liability for the damage to personal property such as cars falls squarely on the individual owners (in our case, students). Also, given the sharp rise in health-care costs in the last 3 years, we expect a natural increase in the significance of perceived financial threat for health related incidents. Thus, past experience and finances may play a role in some situations, but they are not major factors. Additionally, the difference in results for building related incidents is not likely due to the number of students living off campus, as it seems that similar percentages of students live off campus for the North and Midwest universities (US News, 2019). An alternate explanation may be due to perceptions of financial independence between these two groups. Perceptions of financial independence can be influenced by family economic factors (Xiao et al. 2014). If the two groups of students are as different demographically as reports on similar universities

suggests, then their differences in financial independence may be influencing their perceived financial threat. Financial threat likely is not influenced by the large number of buildings on the campus, as students know they are not responsible for building damage.

In the Han, et al. study, the most common response was to comply immediately; only in the case of health-related incidents did a majority of recipients chose to verify first. In our study, the most common response was also to comply immediately, except for health related and snowstorm where the majority of participants chose to first verify the information before complying (54.79% for health related and 53.63% for snowstorm related). The participants in the Han, et al. study noted that the snowstorm and health-related incidents were slower moving, thus suggesting they had more time to watch and respond, so the same may be true of our participants as well.

One other potential explanation for the difference in the results may be past experience for snowstorm incidents in our study. The original study was conducted in the northern states of the US where they may experience greater number of severe snowstorms. In our part of the Midwest, snowstorms tend to be less severe than snowstorms in the northern US, so our recipients may be less likely to comply immediately. Additionally, this part of the Midwest is known for having inaccurate weather reports, with actual weather forecast accuracy 6% lower across the three most accurate weather providers compared to Buffalo, New York, where the authors of the original paper reside (Forecast Advisor, 2019). The relative inaccuracy of weather forecasts in the area where this campus is located may cause the students to be less trusting of any individual warning. Although, we note that public schools in our town (not the university) were closed twice in the academic year following our study due to snowstorms, so snowstorms are not unknown.

One other interesting difference between the original study and our analyses is the proportion of participants who chose to ignore the notifications. In the original study, less than one percent of all the participants chose to ignore the notifications. In contrast, our study participants said they would ignore the ENS notification about 10% of the time. This number was significantly higher in three incidents: 15.50% for health-related, 14.10% for snowstorm related, and 12.50% of robbery related. In contrast, participants were less likely to ignore the ENS notification for the two most potentially dangerous, fast-moving events (active shooter: 1.80%; building fire: 3.90%).

We included an open-ended question asking participants about other thoughts of our campus ENS, and the responses suggest that there were two main reasons to ignore the notifications: irrelevant information in past ENS notifications and a high frequency of ENS notifications in the past. Participants reported receiving so many ENS notifications that they have become inured to them. This past academic year, our campus averaged two events per month that triggered multiple ENS notifications (e.g., initial notification, one or more situation updates, and an all clear). In many cases, the ENS notifications pertained to a location not near the recipient, so that the notification contained no actionable information. Also, the comments indicated that while ENS notifications informed them about emergency incidents, the notifications (quite rightly) failed to follow-up with regards to the causes or consequences of the incidents, so participants were uncertain as to whether events reported in ENS notifications were actually important. There was a sense of “the boy who cried wolf” among some participants. Therefore, we suggest that future research delve into past experience *with ENS notifications* (in addition to past experience with emergency events) to better understand how this influences the intention to comply.

The open-ended comments also indicated that some participants believed that government regulations required the university to disclose information through ENS, so the notifications focused more on being correct and equitable over being prompt and in time for action. They cited numerous examples when ENS notifications arrived far too late to enable them to take any meaningful action, suggesting that the ENS notifications were not useful, but were instead intended to protect the university. Therefore, we suggest that future research consider the *timeliness* of past ENS notifications to better understand how ENS notifications influence the intention to comply.

The results of this replication suggest that there is substantial opportunity to better understand how culture may affect response to ENS. These results suggest that culture may have a large impact on response to ENS warnings, leading to the conclusion that the ENS needs to be designed toward the population of interest. Additionally, there is opportunity to bridge the research on ENS with recent research on security warnings to better present the ENS warnings to be maximally effective for the target population, whether students at a university or residents in an area with possible natural disasters.

5 Conclusion

Han, et al. (2015) concluded that compliance with campus ENS notifications was driven primarily by two factors: trust in the quality of the ENS information, and subjective norms. Our replication also concludes that information quality trust is important, but found less support for subjective norms. Our participants were drawn from a different part of the US, so we speculate that the importance of subjective norms may depend upon culture, which may differ from region to region, and also upon a general organizational disposition towards ENS systems.

As in the Han, et al. study, past experience with security incidents, personal safety and financial threats played a more modest role, influencing compliance in some situations – those that are fast-moving and highly dangerous (e.g., building fire, active shooter) – but lacking a strong effect in all situations.

Our study suggests one additional factor that should be included in future research – the nature of ENS notifications that students have experienced, and especially their timeliness. Also, with the sharp increase in the variety of communication systems preferred by the students and other members of educational institutions, it is important to study the most efficient mode of communication especially during emergency situations. If authorities fail to have a real-time presence in modern and preferred modes of communication, there is a higher risk of dissemination of illegitimate and panic-causing information. With advancement in technology and social media, students now have access to real-time resources for obtaining information. In the future, increased access to information may lead to increased propensity to verify first before complying, which may become a universal and inevitable new normal. As a corollary, the ability of social media to capture “unreported” incidents poses further challenges for campus authorities to improve information quality trust in ENS notifications. Lastly, for big campuses and campuses spread out within the cities, the consideration of proximity of the recipients to the location of emergency incidents hold higher importance. The study of the relevance of using Geographical Information Systems in tandem with ENSs could help optimize the reach of the ENSs to the correct recipients in a timelier manner.

Information Systems succeed when they are created as a result of high demand for consumption of information. ENS systems may be different because they are created not as a result of demand for consumption of information, but as a result of a regulatory requirement. Regulatory requirements typically mandate creation of descriptive reports and not necessarily mandate providing actionable insights. It is our hope that this unique case of ENS systems instigates further research on success of regulatory requirements of information systems.

Lastly, it will be interesting to study if the compliance behavior of students (subjects) changes if they are made party during the decision making process for information dissemination. For starters, students can be given options to choose their preferred medium of communication for specific type of emergency incidents. For example, a student not living on campus may choose to not receive phone calls for incidents that happen on campus. In which case, if a student does receive a phone call from the ENS for other emergency situations, their level of compliance may increase.

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Appendix A: Constructs and Items

Construct	Incident Questions
Subjective Norm (Motivation to Comply with the Referent x Normative Belief)	
Motivation to Comply with the Referent	Given the scenario above, I would care what _____ think I should do.
Motivation to Comply with the Referent 1	my friends
Motivation to Comply with the Referent 2	my parents
Motivation to Comply with the Referent 3	university officials
Motivation to Comply with the Referent 4	my professors
Motivation to Comply with the Referent 5	other people who are important to me
Normative Belief	Given the scenario above _____ would want me to comply immediately with the campus alert.
Normative Belief 1	my friends
Normative Belief 2	my parents
Normative Belief 3	university officials
Normative Belief 4	my professors
Normative Belief 5	other people who are important to me
Perceived Safety Threat	The scenario above could ...
Perceived Self Safety Threat 1	have a severe impact on my safety.
Perceived Self Safety Threat 2	get me hurt or injured.
Perceived Financial Threat	It is likely to ...
Perceived Financial Threat 1	have a serious impact on my finances.
Perceived Financial Threat 2	cause me monetary loss.

Construct	Question
Information Quality Trust	Given the above scenario, how much would you agree with the following statements regarding campus alerts?
Information Relevance Trust 1	The alert would be relevant to me.
Information Relevance Trust 2	The alert would be sent only when necessary.
Information Relevance Trust 3	The alert would be important for me to make decisions about the situation.
Information Actionability Trust 1	I can act on the information that I received in the alert.
Information Actionability Trust 2	If I follow the instructions in the alert, I will be protected.
Information Actionability Trust 3	The directions in the alert will help me plan my next step.
Information Criticality Trust 1	The timing of the alert would be appropriate
Information Criticality Trust 2	The alert I received conveys the urgency for taking action.
Information Criticality Trust 3	The alert I received conveys the severity of the incident.
ENS-Message Compliance Intention	Given the above scenario with the emergency notification message asking you to take an action, what are you likely to do first? Comply immediately Verify first and then comply Ignore

Note: Subjective Norm, Perceived Safety Threat, Perceived Financial Threat, and Information Quality Trust are measured on a seven-point Likert scale. The scales are fully anchored (strongly disagree, disagree, somewhat disagree, neither agree nor disagree, somewhat agree, agree, strongly agree).

Construct	Demographic Questions
Gender	What is your gender? Male Female
Age	What is your age?
Ethnicity	Would you describe yourself as: White/Caucasian (not Hispanic) Hispanic Black/African American Asian Native American Pacific Islander Other
Citizenship	Are you a US Citizen Non-US Citizen
Student type	Are you an Undergraduate Student Graduate Student Other
Past Experience 1	How many campus emergency alerts have you received since you became a student at IU? 0 1-5 5-10 more than 10
Past Experience 2	Have you ever experienced any type of incident on campus? Yes No
Past Experience 3	Do you have any comments on the IU campus emergency alert system?

Appendix B

To obtain overall means for the constructs in Han et al. 2016, we averaged the means and standard deviations for the items within each construct. See the comparison between those means and the means from this study in the table below.

	S1 Snow- storm	Han et al. S1	S2 Active Shooter	Han et al. S2	S3 Building Related	Han et al. S3	S4 Health Related	Han et al. S4	S5 Robbery	Han et al. S5
	Mean (Std)	Mean (Std)	Mean (Std)	Mean (Std)	Mean (Std)	Mean (Std)	Mean (Std)	Mean (Std)	Mean (Std)	Mean (Std)
Subjective Norm	5.77 (1.06)	5.82 (1.18)	6.39 (0.92)	5.85 (1.12)	6.09 (0.95)	5.68 (1.26)	5.69 (1.03)	5.92 (1.19)	5.96 (0.99)	5.76 (1.26)
Perceived Safety Threat	5.21 (1.37)	5.84 (1.3)	6.37 (1.02)	6.46 (0.95)	5.79 (1.23)	5.87 (1.15)	5.59 (1.30)	5.39 (1.59)	5.60 (1.35)	5.92 (1.19)
Perceived Financial Threat	4.03 (1.63)	4.36 (1.68)	3.75 (1.89)	3.90 (1.92)	3.53 (1.78)	4.58 (1.77)	4.00 (1.72)	4.56 (1.74)	4.28 (1.79)	4.81 (1.78)
Information Quality Trust	5.41 (1.10)	6.05 (1.12)	6.11 (0.93)	6.23 (1.05)	5.77 (1.02)	6.14 (1.00)	5.55 (1.09)	6.06 (0.94)	5.58 (1.12)	6.03 (1.15)

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