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A Mixed Methods Approach to Technology Acceptance Research

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Abstract

The aim of this paper is to discuss the significance and potential of a mixed methods approach in technology acceptance research. After critically reviewing the dominance of the quantitative survey method in TAM-based research, this paper reports a mixed methods study of user acceptance of emergency alert technology in order to illustrate the benefits of combining qualitative and quantitative techniques in a single study. The main conclusion is that a mixed methods approach provides opportunities to move beyond the vague conceptualizations of "usefulness" and "ease of use" and to advance our understanding of user acceptance of technology in context.

Keywords: *Technology acceptance, TAM, mixed methods, emergency response system*

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1. Introduction

User acceptance of technology has been a central theme in information systems (IS) research. While there are quite a few established theories about technology acceptance, the technology acceptance model (TAM) is perhaps the most popular. Based on the theory of reasoned action (TRA) (Ajzen & Fishbein, 1980), TAM posits that an individual's intention to use a technology is jointly determined by his or her perception of the technology's usefulness (Perceived Usefulness, PU) and his or her perception of its ease of use (Perceived Ease of Use, PEoU). Over the course of two decades, numerous studies have been conducted in order to validate, extend, and apply TAM in various research settings. At the time of this writing, Google Scholar shows that Fred Davis' (1989) seminal paper in *MIS Quarterly* and Davis, Bagozzi, & Warshaw's (1989) paper in *Management Science* have been the subject of 12,055 and 6,866 citations, respectively.

The popularity of TAM may result from its theoretical simplicity and the robustness of its standardized measurement. Prior acceptance studies confirm that the model consistently explains more than 50 percent of variance in acceptance (Dillon, 2001; King & He, 2006; Venkatesh, Morris, Davis, & Davis, 2003). Moreover, IS scholars appreciate such a parsimonious model because it provides not only an initial road map for planning empirical studies, but also a common discourse with which scholarly dialogues and meaningful comparisons across different studies may be conducted.

Nevertheless, parsimony is also an "Achilles' heel" of TAM, insofar as generic constructs such as PU and PEoU in TAM have "seduced researchers into overlooking the fallacy of simplicity" (Bagozzi, 2007, p. 244). As Benbasat and Barki (2007) state, "Study after study has reiterated the importance of PU, with very little research effort going into investigating what actually makes a system useful. In other words, PU and PEoU have largely been treated as black boxes that very few have tried to pry open" (p. 212).

Through a critical review of literature and by reference to recently completed empirical work, this paper aims to showcase the importance of methodological pluralism in "opening the black boxes" of TAM. More specifically, through criticizing the IS field's overuse of quantitative survey method, it advocates a mixed methods approach to deepening our understanding of technology acceptance.

2. A Survey-Dominated Tradition of Technology Acceptance Research

Given the fact that TAM originated from a quantitative survey study, it is not surprising that quantitative methodology – in particular, the questionnaire-based survey method – dominates TAM-based IS research. Of the 101 TAM articles reviewed by Lee, Kozar, and Larsen (2003), all but three studies use quantitative survey data only. Another meta-analysis of TAM by King and He (2006) goes so far as to completely ignore the methodology issue because of the lack of variety in methods used. Palvia, Mao, Salam, and Soliman (2003) examine 13 methodologies, as used by seven MIS journals during a five-year period (1993-1997), and conclude that the survey method consistently ranked highest, despite the increasing use of other methods.

Rooted in empirical sociological research, quantitative survey methods seem well suited to investigating socio-psychological factors involved in user acceptance of technology systems. The survey-based studies have produced a rich set of findings concerning different user groups and a variety of technologies. Many factors – endogenous and exogenous, antecedent and consequent – have been explored and empirically tested using survey instruments. Without a doubt, these studies have contributed a great deal to our understanding of user/technology relations and human behavior, in general.

While survey-based studies of technology acceptance have been a fruitful stream of research, the over-reliance on survey method creates some potential problems. First, all the data gathered from questionnaires are self-reported, and therefore, prone to some well-known biases associated with

acquiescence, social desirability, and non-response (Converse & Presser, 1986). As a result, some TAM studies have found that self-reported use intention might not lead to actual use behavior (Manfredo & Shelby, 1988; Sharma, Yetton, & Crawford, 2004). Second, quantitative data analysis often follows the principle of data reduction, using statistical techniques (e.g., factor analysis and structural equation modeling), which reduces complex and inter-dependent human-technology interactions to quantifiable, linear, and deterministic relations. Third, closed survey instruments are inflexible to *ad-hoc* changes during the research process, which might lead the researcher to overlook unexpected but potentially important new discoveries.

Recognizing the limitations of quantitative methods, advocates of grounded theory and qualitative research have suggested building theory through an inductive approach, arguing that social science studies involve so many uncontrollable variables that "scientific" methods resembling natural sciences are unable to capture the complexity of human behavior in social systems (for a thorough discussion of the inductive research approach, see Denzin & Lincoln, 2005). Some scholars even hold the belief that social sciences cannot advance through the continual utilization of statistical significance testing (Meehl, 1978).

These criticisms often lead to the longstanding debate concerning positivism versus interpretivism in the broader context of social science research. In IS literature, the dichotomy between these two epistemological paradigms has also been extensively discussed (see, for example, Lee, 1991; Mingers, 2001; Trauth & Jessup, 2000), with the general consensus being that positivism dominates the IS field. Orlikowski and Baroudi (1991) examined 155 articles published between 1985 and 1989 in major IS journals and found that positivism overwhelmingly dominated the IS research community (96.8 percent) and that little attention was paid to interpretivism (3.2 percent). A follow-up study by Chen and Hirschheim (2004) examined IS publications from 1991 to 2001 and found that the imbalance in research paradigms still existed despite years of advocacy of paradigmatic pluralism (81 percent of empirical studies are positivist in nature). The dominance of the quantitative survey method in TAM research accords with this positivist tradition.

The reasons behind the strength of positivism in IS are multi-fold and too complicated to be covered in this paper. What needs to be noted here, however, is that IS, as a relatively new field, tends to focus on maximizing the external validity of a particular theory rather than on refining the theory in depth in various contexts (Palvia et al., 2003; Scandura & Williams, 2000). TAM is an example of this, in that it represents the field's eagerness to establish its identity through one "universal theory". As a result, when it comes to refining the model, the general approach is to "extend" the model rather than to revisit its original constructs. Two common extension strategies include: 1) introducing additional constructs to the model so that more statistical prediction power can be gained, and 2) including antecedents or contextual factors while adhering to the two central constructs (PU and PEoU). The need for extension usually results from a changing technology and/or from the use context. For example, when studying computer use in the workplace, Davis, Bagozzi, and Warshaw (1992) introduced the "perceived enjoyment" construct to TAM. The so-called TAM2 introduced the subjective norm (SN) as an additional predictor of intention in mandatory settings (Venkatesh & Davis, 2000). Venkatesh and Davis (1996) found that PEoU is influenced by an individual user's computer self-efficacy and by the system's usability, and that the latter is further influenced by the user's prior experience with the system. Chang, Li, Hung, and Hwang (2005) postulated that PU is influenced by "quality antecedents", such as information quality and credibility in physicians' acceptance of telemedicine technology. Among all these "extending" efforts, the most notable is perhaps that of Venkatesh et al. (2003) in their UTAUT model, which includes 41 independent variables for predicting intentions and at least eight independent variables for predicting behavior.

Nevertheless, apart from the original theorization by Fred Davis and our common-sense understanding, the meanings of PU and PEoU are still elusive. Located within the positivist paradigm, TAM studies generally assume that system features and user characteristics are static and independent of contexts, which leads to the conceptualization of PU and PEoU in closed surveys as fixed, transferrable, and quantifiable. Many studies have adhered to the following path of empirical investigation: review previous literature → select relevant factors such as PU and PEoU for the study → propose hypotheses/model →

collect empirical data from a quantitative survey → test the hypotheses and validate the model. Despite the abundance of TAM-based studies, there are few that have included qualitative investigations into the local meanings of PU and PEoU prior to using the constructs in hypothesis formulation and testing. It is not uncommon to see IS researchers adapt close-ended questions from other TAM publications without contemplating what the questions mean to users or non-users in the specific use context. Statistical validity tests using quantitative data have largely overshadowed survey questions, the construction of which constitutes a vital element in ensuring the validity of empirical research.

3. A Mixed Methods Approach

In light of the above mentioned issues resulting from the over-reliance on quantitative survey methodology in TAM studies, we argue that a mixed methods approach combining both qualitative and quantitative techniques deserves more attention from IS researchers. Mixed methods is not a new concept in the IS field, but its advantages have not been fully appreciated in the technology acceptance domain. Mixed methods offer not only "new tricks" for collecting and analyzing data; more importantly, they have the potential to foster theory building.

It is worth noting that mixed methods research does not mean simply conducting two separate strands of quantitative and qualitative studies. The studies and their findings must in some way follow a logic of integration (Creswell & Tashakkori, 2007). There exist different ways of mixing quantitative and qualitative methods within or across different stages of research (Tashakkori & Teddlie, 2003; Creswell, 2003). Two common dimensions of viewing mixed methods are 1) the time ordering (concurrent or sequential) of the qualitative and quantitative phases, and 2) the degree of dominance of either quantitative or qualitative methods. Johnson and Onwuegbuzie (2004) provide a matrix for illustrating the nine possible combinations of the mixture:

	Concurrent	Sequential
Equal Status	QUAL + QUAN	QUAL → QUAN QUAN → QUAL
Dominant Status	QUAL + quan QUAN + qual	QUAL → quan qual → QUAN QUAN → qual quan → QUAL

Figure 1. A Matrix of Mixed Methods Design (Johnson & Onwuegbuzie, 2004, p. 22)

In the matrix figure above, "quan" stands for quantitative and "qual" for qualitative. Capital letters denote high priority or weight. The sign "+" stands for concurrent, and "→" stands for sequential. In the same vein, Creswell (2003) described six mixed methods designs: 1) sequential explanatory design ("QUAN → qual"); 2) sequential exploratory design ("QUAL → quan"); 3) sequential transformative design (move

between qualitative and quantitative without clear priority); 4) concurrent triangulation strategy ("QUAN + QUAL"); 5) concurrent nested strategy (qualitative embedded in quantitative, or vice versa); and 6) concurrent transformative strategy (qualitative and quantitative methods used concurrently without clear priority). Certainly, a researcher should choose a single combination that best suits his or her research needs in a study. No matter what design a researcher adopts, the purpose of the mixture is either to examine the same phenomenon through a different lens with each method, bringing out distinctive insights, or to use one method to develop and validate the constructs used in another method, or both of these. The case study described in the following section serves as an example of mixed methods research on technology acceptance.

4. A Mixed Methods Case Study

This section briefly describes a recently completed case study[1] of user acceptance of emergency alert technology. The purpose of the project was to investigate factors that influenced the acceptance of Campus Alerts – an SMS (short message service)-based emergency notification system currently employed at Eastcoast University[2]. The study illustrates how different methods may be integrated into one study in order to facilitate a deep understanding of "usefulness" and "ease of use". Following a sequential design, the study comprises three phases and employs a total of four different data collection methods. The three phases roughly mirror the "three levels of understanding" proposed by Lee (1991).

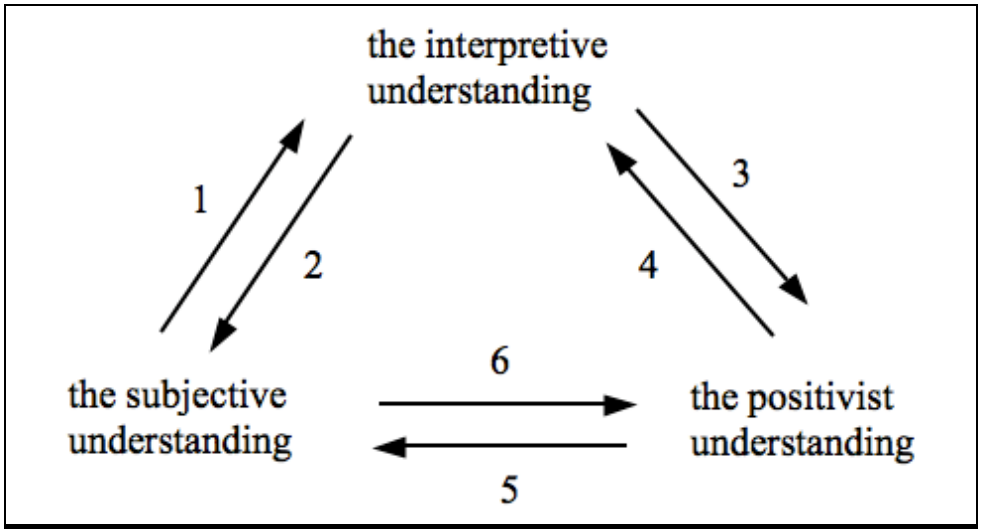

Figure 2. Three Levels of Understanding (Lee, 1991, p. 351)

In an attempt to integrate positivism and interpretivism in organizational research, Lee proposed the above framework in which different research paradigms coexist in order to facilitate an iterative development of integrated understanding. According to Lee, the first level of understanding is *subjective understanding*, which consists of the common-sense and everyday meaning of reality; the second level of understanding is *interpretive understanding*, which consists of the researcher's systematic interpretation of the first-level meaning; and the third level is *positivist understanding*, which tests the researcher's propositions in a manner similar to, or modeled on, the way in which propositions are tested in the natural sciences. The six arrows in Figure 2 depict the progressive iterations in the research process. The mapping among the study phases, the levels of understanding, and the research methods is summarized in Table 1 below. I discuss the arrows and their implications after presenting the case study.

[1] In the IS literature, it is not uncommon for "case study" to be viewed as a synonym of "qualitative research", or at least as a typical qualitative method (e.g., Gable, 1994). However, the case study is a research strategy whose method can be either qualitative or quantitative in nature, or a mixture of both. For detailed discussions of methodological paradigms and the case study approach, see (Lee, 1989; Myers, 2009; Yin, 2003).

[2] Both "Campus Alerts" and "Eastcoast University" are pseudonyms.

Table 1. Project Phases, Levels of Understanding and Research Methods

Project Phase	Levels of Understanding	Research Methods
Phase 1. Participant Observation Observing the deployment and the acceptance of the technology system.	1st level - Subjective understanding	Participant observation
Phase 2. Qualitative Interviewing Conducting in-depth interviews with users and non-users of the technology system.	2nd level - Interpretive understanding	- Individual interview - Focus group
Phase 3: Quantitative Survey Collecting quantitative data from a large sample of the user population.	3rd level - Positivist understanding	Questionnaire survey

4.1. Phase 1: Participant Observation

On April 16, 2007, a gunman massacred 32 people on the campus of Virginia Polytechnic Institute and State University (Virginia Tech) in Blacksburg, Virginia, United States. After the university was criticized for a slow response to the shooting, immediate alerts became a priority for many American universities. It was widely believed that SMS on mobile devices would allow authorities to communicate with students in a more timely fashion when such emergencies occur (e.g., Yuan, Dade, & Prada, 2007). In this context, Eastcoast University introduced Campus Alerts to its students in late April 2007. Since the University is located in a metropolitan area where the crime rate is one of the highest in the nation and SMS is a popular technology used by college students, one would expect a rapid adoption of the alert service. Using the TAM framework, the researcher expected that students would embrace the technology system because a system for the students' personal safety has "perceived usefulness" and SMS is a technology with "perceived ease of use". This was the researcher's reading of the "first-level, common-sense understanding" (Lee, 1991, p. 351), where this reading resulted from the opening perspective taken by the researcher, based on the positivist theory of TAM.

As a member of the university community, the researcher conducted a one-year participant-observation study of student acceptance of Campus Alerts. The participant observation led to the researcher's initial reading of "the subjective understanding" that the students themselves had of the SMS service: The technology was familiar and the service could be potentially helpful. The researcher had close access to the physical campus environment, the electronic communication systems (university email, website, and Campus Alerts service), the student group, and the university's public safety officials. During the one-year period, the university put tremendous effort into advertising and promoting the alert technology. Advertisements were placed in both paper (pamphlets, flyers) and digital formats (emails, web pages). The public safety officials also organized campaigns such as "Emergency Awareness Week" in order to increase awareness of the alert service. Despite all these efforts, by July 2008 the adoption rate among students was only 21 percent.

4.2. Phase 2: Qualitative Interviewing

From the perspective of TAM, the PU and PEoU of the alert system seem quite obvious because personal safety is everyone's concern in such a high-risk community, and SMS is a simple technology. Thus, the observation of the low acceptance rate suggests an "apparent absurdity" (Kuhn, 1977, p. xii), which poses challenges to the researcher's reading of student subjects' subjective understanding. In order to resolve the "apparent absurdity" and advance to the second-level interpretive understanding of the phenomenon, I conducted a series of qualitative interviews in order to further explore users' (students') perceptions and experiences with the alert system.

Using purposive sampling, I recruited a total of 13 students with "maximum variation" (Patton, 1987) for interviews. The strategy of maximum variation attempts to cut across participant variation so that a great deal of information can be obtained from a limited number of participants. The sample included both users and non-users of Campus Alerts, female and male, and undergraduate and graduate students from a variety of departments. Of the 13 participants, I interviewed nine individually, and four participated in a focus group. The interviews and the focus group were semi-structured, with open-ended questions. The purpose of the interviews was three-fold. First, qualitative interviews provide a holistic view of the alert technology as it is perceived by its users or potential users. A holistic picture needs to be drawn before one can proceed to select interesting theoretical constructs on which to focus the study. Second, the codes and themes developed from qualitative data analysis inform the design of the questionnaire drawn up for the subsequent quantitative data collection. Finally, qualitative data collected from interviews can be used to cross-validate, explain, and enrich data obtained through other methods, as such “triangulation between methods” is able to cancel out the bias inherent in one particular method and give us a “convergence upon truth” (Losee, 2003, p.98).

Some key interview questions included:

- *Why did you sign up for Campus Alerts?*
- *Why haven’t you signed up for Campus Alerts?*
- *Based on what you know and what you’ve learned about Campus Alerts, what do you think about this service?*

One thing to be noted here is that the interview instrument was used more as a guideline for conversation than as a rigid questioning protocol. In fact, I constantly refined the interview protocol as the interviews accumulated. This type of open-ended inquiry allowed me to elicit responses in a non-leading, natural manner (Kvale, 1996; Rubin & Rubin, 2005). The main points covered in each interview were the same, but the wording and order of questions were spontaneous in order to accommodate the flow of the conversation. The length of interviews ranged from 30 minutes to 90 minutes, with an average of 45 minutes. I imported all the interview and focus-group transcripts into the NVivo 7 software program for coding and analysis (Bazeley, 2007). I labeled segments of transcripts with keywords (codes), and then categorized codes into the evolving coding scheme. If the integration failed, I revised the coding scheme to accommodate the new codes.

The interviews confirmed that “usefulness” and “ease of use” are still the main factors affecting people’s intention to use a technology. However, the interviews clarified what exactly these broad terms meant in the use context. Briefly, the thematic analysis of the interview transcripts suggested that a “useful” alert system should be accessible “anytime anywhere” and deliver timely, relevant, and the right amount of information. The following excerpts from the interview transcripts are illustrative:

> Subject #1: *Now they employed the text message thing so they can send it out really quickly to alert people. I think it’s good. I think it works. It’s instant access to the students, right away. Everyone has a cell phone basically. … I mean, even if they send emails, it gets a little faster I think. People are always by their phones, word would spread faster.*
>
> Subject #5: *Some people don’t want to be alerted for certain things. … If there is a tornado coming through my neighborhood, I’d like to know about it. But I don’t want to get, you know, a text message telling me that we’re having ice on this day. I personally don’t need it, I don’t have a car.*

While all interviewees stated that using Campus Alerts was "easy", they desired a certain extent of controllability over such aspects as when they received alert messages and what type of messages they received. The following quote is illustrative:

> Subject #4: *When it comes to a point though, you're getting a lot of messages but you are right by your computer and you're connected anyway, and if you could like reply "Stop" [through SMS on your cell phone], let's say. … So, set up a system where you can go and customize it. You can say – of course, you don't have to do that – alert me to natural disasters, alert me to guns. You can pick which one.*

In a nutshell, this phase of the study gave me an improved interpretive understanding of what motivated students to adopt the technology or prevented them from adopting it. The "emerging interpretive understanding" encompasses two aspects: 1) the usefulness of the system depends not just on a vague, general perception of "enhanced safety", but also on the individual user's or non-user's perception of the timeliness, relevance, and amount of safety information provided; 2) "ease of use" depends not just on familiarity with SMS technology itself, but on the extent to which the user has control over the system's behavior. Consequently, the qualitative data gave rise to a new set of important constructs that might not have been discovered through using "standardized" TAM survey instruments. In other words, my interpretive understanding of the interviewees' subjective understanding of technology use forced me to firmly situate the two core constructs, PU and PEoU, in the use context rather than rushing to utilize any existing instruments of measurement.

4.3. Phase 3: Quantitative Survey

Although qualitative interviewing offered an in-depth view of the local meanings of PU and PEoU, this level of understanding has its limitations. The qualitative analysis aimed to interpret existing reality from the viewpoint of the subjects (the current level of acceptance) rather than to predict future acceptance. Indeed, generalizability (representativeness of the sample) and "hypothetico-deductive logic" (predictions from sample) are the very strengths of the positivist approach (Lee, 1991). In order to expand and verify the findings from Phase 2 to the student population, I conducted a quantitative survey following the interviews. The survey instrument included a series of Likert-scale items (with 1 = "Strongly Disagree", 4 = "Neutral", and 7 = "Strongly Agree") adapted from the TAM2 instrument (Venkatesh & Davis, 2000), with newly developed concepts (e.g., relevance of information, customizability of service, and so forth) from the interview findings incorporated. Two slightly different survey instruments were implemented: one (35 items) for current Campus Alerts users and the other (38 items) for non-users.

The survey questionnaire (in electronic format) was sent to several university email listservs. A total of 331 usable responses were collected. After verifying the sampling adequacy with a KMO and Bartlett test, I performed a principal component analysis (PCA) in SPSS in order to identify orthogonal factors that appear to represent the underlying latent variables. I excluded the dependent variables from the PCA (Straub, Boudreau, & Gefen, 2004). The PCA resulted in six factors using the default Guttman-Kaiser criterion (i.e., eigenvalue <1.0) and a scree plot parallel analysis. The resulting scale for each of the six constructs was then examined for internal consistency using the criterion of Cronbach's alpha greater than .70 (Nunnally, 1978). In accordance with this criterion, only factors 1, 2, and 3 were retained in subsequent analyses. For the three factors, each variable loaded highly (greater than .70) on its assigned factor and low (less than .40) on other factors, indicating convergent and discriminant validity of the constructs. Upon examining the items that loaded together, the three constructs were identified as "perceived utility", "perceived controllability", and "subjective norm". The retained questionnaire items and their relationships to the previous phases of research are presented in Table 2 below.

Table 2. Questionnaire Items and Item Sources

Factor	Item	Source
Perceived Utility	Signing up for Campus Alerts makes me more prepared for emergencies.	New item. Subjective understanding of PU in Phase 1.
	Signing up for Campus Alerts makes me feel safer.	New item. Subjective understanding of PU in Phase 1.
	The information that I receive from Campus Alerts will be relevant to my personal safety.	New item. Interpretive understanding of PU in Phase 2.
	I believe I will receive timely information from Campus Alerts.	New item. Interpretive understanding of PU in Phase 2.
	With Campus Alerts, I can get emergency information anywhere anytime.	New item. Interpretive understanding of PU in Phase 2.
	Overall, Campus Alerts is a useful system.	Adapted from TAM2.
Perceived Controllability	I want to have the option to choose what type of emergency messages I receive from Campus Alerts.	New item. Interpretive understanding of PU in Phase 2.
	I want to have control over the volume of text messages to be sent to me from Campus Alerts.	New item. Interpretive understanding of PU in Phase 2.
	I may get a lot of text messages from Campus Alerts.	New item. Interpretive understanding of PU in Phase 2.
	I may get some unwanted messages from Campus Alerts.	New item. Interpretive understanding of PU in Phase 2.
	Receiving Campus Alerts messages can be costly.	New item. Interpretive understanding of PU in Phase 2.
Subjective Norm	My friends think I should use Campus Alerts.	Adapted from TAM2.
	Other people who are important to me think I should use Campus Alerts.	Adapted from TAM2.
	The University officials think I should use Campus Alerts.	Adapted from TAM2.

To further test the validity of these constructs, a revised survey instrument was distributed to six randomly selected undergraduate classes. Of the responses received, 207 were usable . A confirmatory factor analysis (CFA) of the data in AMOS indicated goodness-of-fit of the measurement model (CFI = .91, GFI = .95, RMSEA = .06). Finally, I performed two sets of regression analyses to determine how well the factors were able to predict the user acceptance *intention* and *behavior*. The first analysis was a logistic regression test in which the independent variables were the three factor scales that were found to have adequate validity and consistency, and the dependent variable was the acceptance *behavior* (a dummy variable). The second analysis was an OLS linear regression with the same set of independent variables and a dependent variable acceptance *intention* (a 7-point Likert scale measuring the likelihood of joining the alert service). The analysis results[3] showed that "perceived controllability" ($p < 0.01$) was a

[3] The associations between subjective norm and dependent variables were weak and are, therefore, excluded from discussions here.

significant predictor of acceptance *behavior*, while "perceived utility" (p = .181) was not; on the other hand, "perceived utility" was significantly associated with the intention of acceptance (p < 0.01), whereas "perceived controllability" was not (p = .337). The research model and the hypothesis testing results are illustrated in Figure 3. In summary, **the positivist understanding** obtained from the survey results was that "perceived utility" (a PU construct) affects the acceptance intention, and "perceived controllability" (a PEoU construct) affects the acceptance behavior. The following section of this paper offers possible explanations for these results in the light of method triangulation.

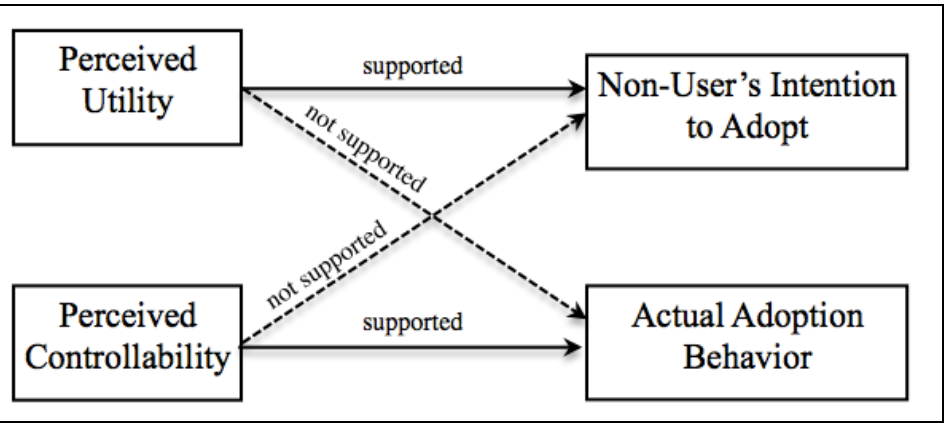

Figure 3. Research Model for the Quantitative Phase

4.4. Methodological Implications of the Empirical Study

The sequence, priority, and integration of the three phases of research are illustrated in Figure 4 below.

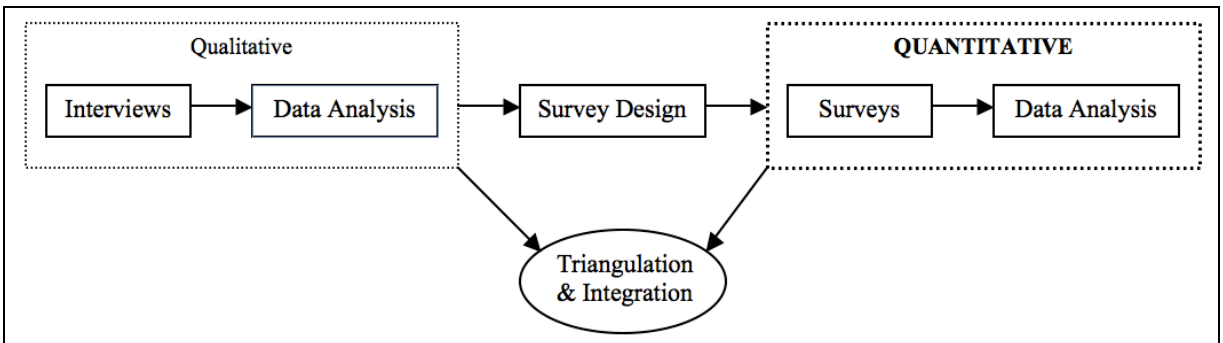

Figure 4. Sequential Exploratory Mixed Methods Design (Emphasis on the Quantitative Phase)

The design is adapted from the "sequential exploratory design" described by Creswell (2003), except that Creswell's original model places priority on the initial qualitative data collection. The sequential exploratory design is characterized by the collection and analysis of qualitative data followed by the collection and analysis of quantitative data. In this study, priority was given to the quantitative element, and the main purpose of the qualitative element was to assist in forming hypotheses and in triangulating the survey results. I integrated the analyses from the three phases at the stage of result interpretation and discussion.

As previously described, each of the three phases offered a unique perspective for viewing the acceptance problem, and my understanding of the issue progressed as different methods brought out different types of data. Using Lee's (1991) terminology and framework depicted in Figure 2, the empirical study can be described as follows:

Arrow 5: From the perspective of a TAM-based positivist understanding, the researcher develops

predictions of what to expect in the subjects' acceptance behavior in terms of PU (perceived enhancement of safety) and PEoU (perceived ease of using SMS).

Arrow 6: However, the low acceptance rate of the alert system – a manifestation of subjective understanding – failed to confirm the researcher's predictions of what to expect in subjects' acceptance behavior in terms of PU (perceived enhancement of safety) and PEoU (perceived ease of using SMS).

Arrow 4: The lack of confirmation of the positivist understanding then called for a revision of the antecedent interpretive understanding.

Arrow 2: In order to improve the researcher's interpretive understanding of acceptance behavior, a fresh reading of users' subjective understanding was obtained through qualitative interviews with both users and non-users.

Arrow 1: The new reading of the user's subjective understanding then provided the basis for formulating a fresh interpretive understanding.

Arrow 3: The fresh interpretive understanding included an improved interpretation of PU (the individual user's and non-user's perceptions of the timeliness, relevance, and amount of safety information provided by the system) and PEoU (the individual user's and non-user's perceptions of the controllability of the system), which, in turn, provided the basis for an improved positivist understanding.

Arrow 5: The improved positivist understanding guided the survey instrument design, and the quantitative survey solicited the predicted subjective understanding of the alert system's "usefulness" (perceived utility) and "ease of use" (perceived controllability).

Arrow 1: The researcher interpreted the subjective understanding observed in the survey responses.

Arrow 3: The researcher's interpretive understanding of the survey results gave rise to a rethinking of the original TAM constructs.

Through the iterations described above, the "apparent absurdities" of the reality were gradually explained by interview findings and then by the survey results. In the absence of interview data, the survey study might have led to a confusing view of PU and PEoU in predicting intention of and behavior in adopting the alert system. However, by triangulating the qualitative interpretations with the survey data analysis, I was able to reconcile the contradictions and provide a new interpretation of PU and PEoU.

Specifically, the quantitative study triangulates with the qualitative phase in several ways. First, the factor analysis confirms that technology acceptance centers on PU and PEoU, although the meanings of these concepts are more specific in this context. Second, the qualitative data help to explain the seemingly confusing results from regression analysis: on the one hand, non-users generally believed that a system like Campus Alerts might be "useful" in terms of improving the University's emergency preparedness (hence, a significant predictor for the *intention* of acceptance); on the other hand, existing users had doubts about Campus Alerts based on their usage experiences (relevance, accessibility, etc.) of the system (hence, the insignificance of association between PU and *behavior*). Third, system controllability was a factor identified in both qualitative and quantitative phases, but the quantitative study highlights the critical importance of this factor as a strong predictor of acceptance behavior.

The empirical findings prompted me to rethink the meaning of PU and PEoU in the context of emergency alert systems. Since the "usefulness" of an emergency alert technology is usually assumed but not tried (unless a real emergency strikes), the PU of the technology is inevitably vague (Rogers, 2002). In fact, the lack of "triability" reveals a limitation inherent in many current emergency response systems: The implementation of systems is still grounded in the traditional Command & Control model of crisis management and only functions when there is "chaos" (Wu et al., 2008). Such

systems are intended to deal with chaos and completely ignore the importance of continuity in emergency response (Dynes, 1994).

Hence, emergency response systems such as Campus Alerts should integrate more peripheral functions so that continuous use of the system can be guaranteed. As Helsloot and Ruitenberg (2004) suggested, existing systems used in daily life are more effective in emergencies than "artificial" response systems. For example, Campus Alerts can be used to notify students about unusual events such as school closure and icy road conditions. A system that deals only with future emergencies may be perceived as "useful", but this future utility might not be a strong motivator for potential adopters. PU, therefore, refers not only to the central and intended utility, but also to the perceived utilities in dealing with peripheral or even remotely related tasks.

The multi-facet usefulness of emergency alert technologies also links with the technologies' multi-level ease of use. Although "controllable user interface" (Shneiderman, 1997) is now widely accepted in interaction design, users of emergency alert systems are hardly viewed as active agents with a desire to be in control. In many situations it is true that average citizens have common needs when an emergency strikes; nevertheless, for emergency notification systems deployed in a community with a large number of users, information needs may vary depending on the nature of the emergency and on contextual factors related to the user. In the case of Campus Alerts, PEoU is an important factor that goes beyond the superficial conceptualization of technical experience or skills. The results of the case study suggest that there are higher levels of usability issues for information technologies, which need to be considered when evaluating ease of use.

Conclusions

This paper advocates a mixed methods approach to technology acceptance research and describes how such an approach was used in an empirical study of emergency alert system adoption. It illustrates four methodological points: 1) the need to advance technology acceptance research by changing the methodological dominance of the survey study; 2) the value of a mixed methods approach in technology acceptance research; 3) the need for evaluation of TAM constructs in both positivist and interpretive paradigms; and 4) the importance of method triangulation. The case study highlights the iterative nature of a mixed-method design in which different methodological techniques were called upon in order to confirm or not confirm the three levels of understanding.

Aside from the sequential exploratory design presented in this paper, there are other research designs in which quantitative and qualitative phases are given different weights and/or temporal orders. For example, in the sequential explanatory design (Creswell, 2003) (illustrated in Figure 5), researchers collect and analyze quantitative data first, and then use qualitative methods to probe, explain, or triangulate the quantitative results.

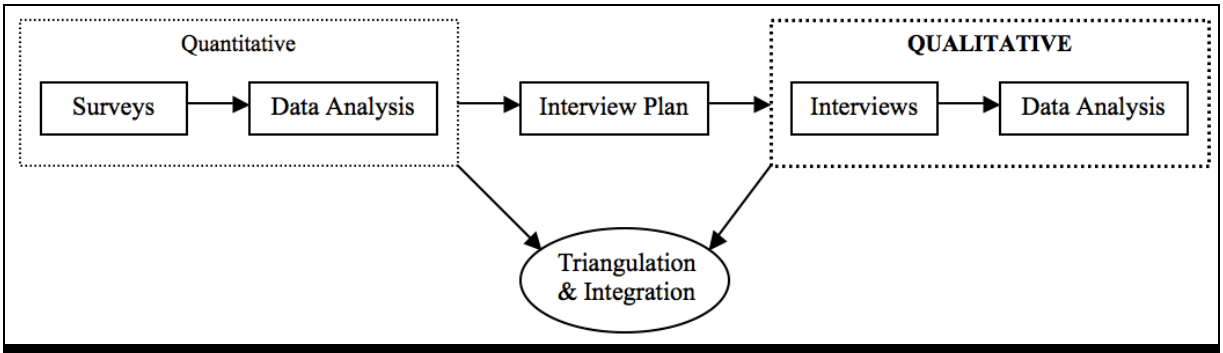

Figure 5. Sequential Explanatory Mixed Methods Design (Emphasis on the Qualitative Phase)

The selection of a particular research design deserves careful thinking and is usually driven by the research aim and availability of resources. A creative and well-designed mixed methods study will

produce findings from each set of data that complement each other in terms of solving the research problems. If findings are corroborated across different methods, then greater confidence can be placed in conclusions; if the findings conflict, then the complexity of the phenomenon may be appreciated and our understanding of the problem advanced.

It must be stressed that the researcher recognizes the legitimacy of using only quantitative or only qualitative methods and makes no claim that the mixed methods approach proposed in this paper is the best or the only one that can be employed in IS studies. The empirical study merely provides a demonstration of the feasibility of integrating multiple methods in order to further the theories and understanding of user acceptance of technology. It is also hoped that, by introducing mixed methods into TAM-based acceptance research, researchers will be encouraged to revisit the constructs of PU and PEoU in greater depth so that "actionable advice" (Benbasat & Barki, 2007) may be offered to information system managers and system designers.

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