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Abstract

Within certain industries there is an increasing prevalence toward computerizing work practices and mandating specific tasks performed using an Information System (IS). This trend is unlikely to diminish the need for stakeholders, involved in the implementation of an IS, to identify the determinants of successful use. Yet, to date, there is a paucity of research that has considered the issues specific to predicting and explaining user behavior in these situations. In this paper, we identify the relevant issues necessary for applying the technology acceptance model and the theory of planned behavior to the prediction and explanation of mandated IS usage, and we assess the value of these models to the task. The results of a longitudinal study conducted in a hospital setting are presented and we suggest the direction that future research might take.

Keywords: User behavior, IS use, adoption, user attitudes, research methodology, measurement, health IS

1. INTRODUCTION

Socio-cognitive models have provided researchers with a theoretical framework to guide many of the studies that have sought to predict and explain end-user adoption and acceptance of information systems (IS). Of these models, the most prevalent in the IS literature is the theory of reasoned action (TRA) (Ajzen and Fishbein 1980), and its derivative, the technology acceptance Model (TAM) (Davis 1985; Davis et al. 1989). One assumption shared by the TRA and TAM is that, given sufficient time and knowledge about a particular behavioral activity, an individual's stated preference to perform the activity (usually declared in the form of an intention) will, in fact, closely resemble the way they do behave. This assumption only applies, however, when the behavior is under a person's volitional control (Ajzen and Fishbein 1980).

1.1 Volitional Control

According to Ajzen and Fishbein, volitional control is achieved when a person is reasonably able to express their will, usually measured in the form of an intention to perform the given action. When volitional control is low, the intention-behavior relationship is reduced because the person's will is more difficult to achieve. The TRA is ill equipped to predict situations in which individuals have low levels of volitional control (Ajzen 1985).

In order to expand the scope of the TRA to be applicable for behaviors or situations in which there is low or no volitional control, Ajzen (1985; 1991) developed the theory of planned behavior (TPB). The TPB modifies the TRA by including the variable perceived behavioral control (PBC). This measures a person's perception of control over performing a given behavior. PBC was theorized to directly predict and explain both *intention* and *behavior* and was purported to explain more variance than the TRA for behaviors not entirely under a person's volitional control (Ajzen 1985).

There have been very few studies (for exceptions, see Mathieson 1991; Taylor and Todd 1995) that have utilized the TPB in IS research, so it is unclear whether the TPB is capable of predicting or explaining situations characterized by low volitional control any better than the TRA or the TAM. The benefits of using the TPB over the TRA seem to be only modest if the results of a meta-analytic study, in the general Psychology literature, by Conner and Armitage (1989) are an accurate gauge. These authors found that the TPB added about 4% to 5% to the variance explained in intention and about 1% to the variance explained in behavior.

1.2 Prediction and Explanation

The TAM, TRA, and TPB were developed to explain and predict behavior. Explanation and prediction mean different things. If these models were solely concerned with prediction, then they would need only to include the immediate determinants of behavior. As these models also aim to explain intentions and behavior, they each identify the determinants of *intention* and *behavior* and detail the pattern and direction of the causal influences among the variables (Sutton 1998). Although prediction in these models can occur independently of explanation, the same cannot be true about explanation itself. The explanatory power of the TRA, TAM, and TPB can only be shown once prediction is established as being accurate (Sutton 1998).

Many studies in the IS literature have failed to show that these models accurately predict user behavior and, therefore, explanation may not be valid. This failure is due to (1) the research inquiry being limited to predicting intention and not behavior, (2) issues in measuring the dependant variable and, (3) operationalizing variables, sometimes inconsistent with theory.

1.2.1 Limitation in Line of Inquiry

Many of the studies incorporating the TAM and TRA have focused solely on the determinants of intentions to use an information system (e.g., Agarwal and Prasad 1998; Chau 1996). By doing so, these studies have not validated their models in respect to the prediction of actual behavior and are consequently unable to show that the explanation is valid for the behavior of interest.

1.2.2 Issues in Measuring Usage Behavior as the Dependent Variable

In studies that have measured actual behavior, it has usually been done at the same time that the predictor variables were measured (see Adams et al. 1992; Al-Gahtani and King 1999; Green 1998; Igbaria et al. 1996; Levine and Donitsa-Schmidt 1998), or in a cross sectional analysis (see Karahanna 1993). Neither design is able to verify accurate prediction across time. Longitudinal designs are rare (see Brosnan 1999; Szajna 1996) and there appear to be none conducted in a predominantly mandatory context.

There are two major problems associated with measuring intention and behavior at the same time. The first problem is that when people complete questionnaires comprising measures of *intention* and self-reported *behavior*, there are psychological influences that ensure strong correlation between the measures. Self perception theory (Bem 1967), for example, would support the view that an individual's perception of their usage behavior could quite easily be induced from their perception of their *intention,* and vice versa. Cognitive dissonance theory (Festinger 1957) would also suggest a strong correlation between *intention* and *behavior*, because of the tendency for individuals to avoid psychological discomfort that regularly accompanies discrepant feelings and/or thoughts.

A further problem in measuring *intention* and *behavior* at the same time is that it is not a true test of the model's power to predict behavior in the future, but rather a test of the model's power to predict current behavior. Predicting future behavior is more

difficult to achieve, due to the time interval between the *intention* and the *behavior*, during which unforeseen events or other factors may disturb the relationship (Ajzen and Fishbein 1980). Karahanna has suggested the need for more longitudinal research to better understand the changes that occur in the process of adopting technology.

In describing the TRA and how to apply the theory to predict and explain behavior, Ajzen and Fishbein stipulated that all measured variables ought to be compatible for action, context, target, and time. This prescription was made to ensure, essentially, that apples are predicting apples and not oranges. In the prediction of IS usage behavior, studies have tended to include *frequency and/or duration of use* (see Al-Gahtani and King 1999; Brosnan 1999; Igbaria et al. 1996), as dependent variables often without maintaining consistency of action, context, target, and time across the measures. There are also related problems with these dependent outcome measures that would be more readily solved if consistency of measures were adhered to. For example, does greater use and frequency indicate more acceptance, or inefficient usage, or something else? Answers to these questions remain unclear.

Until valid measures are developed and consistently used in this area of research, it will remain difficult for researchers to determine whether the models are to blame for poor prediction or whether results are based on incompatible dependent variables, faulty methodology, or faulty measurement.

1.2.3 Operationalizing Variables

There has been some debate about the relative advantages and disadvantages associated with deriving scales from elicited beliefs, as proposed by Ajzen and Fishbein, or to use general (Moore and Benbasat use the term "generic ways" for this method of belief elicitation) beliefs similar to those identified by Davis and by Moore and Benbasat (1991). The latter authors argued that IT researchers should use a generic set of beliefs about using IT to make the approach to the study of IT implementation consistent and cumulative.

The major advantages of eliciting beliefs from a sample of the population of interest are that there is a greater guarantee that the beliefs will be relevant to the population (Ajzen and Fishbein 1980) and that intervention strategies may be properly targeted at the key issues. The use of general beliefs, on the other hand, saves the researcher valuable time (Karahanna 1993) and provides the opportunity for more direct comparison of findings across studies (Moore and Benbasat 1991). The majority of studies using the TRA in the IS literature have not derived their measures from elicited beliefs. The debate over which method is better remains open and may depend largely on whether the researcher's prime focus is with prediction or explanation. Karahanna, for instance, used both methods and found that the general measures were as good, if not better, at predicting behavior than beliefs elicited for a specific situation. Mathieson (1991), however, compared the TAM with the TPB and found that while the TAM was a slightly better predictor of *intention,* the TPB showed better explanatory power due to the specific beliefs that were derived. While the general beliefs may be relevant across a range of technology and situations, we argue that research studies using these models in new contexts, such as mandatory adoption, should elicit beliefs in order to ensure that all relevant beliefs are identified.

1.3 Mandatory Usage

There is an increasing prevalence within certain industries, such as Banking and Health, to computerize work practices that were previously performed manually. Whether or not an employee complies with the mandate is, of course, a separate issue. However, failure to comply will often bring negative consequences upon the individual. Given the likelihood of more organizations mandating the use of IS in the future, it seems important for the IS community to assess whether models such as the TPB and the TAM are suitably equipped to predict and explain behavior when usage is mandated.

Karahanna has mentioned the need to include PBC in models that aim to identify the determinants of mandated usage and, by doing so, has implied that mandated IS use is a type of non-volitional behavior. It is, however, a different type of non-volitional control than that discussed by Ajzen (1985, 1991) when he described his list of the internal and external factors that influence volitional control. The major difference between Ajzen's (1985) volitional control and the volitional control associated with mandatory behavior is that, in the former category, the absence of volitional control hinders a person's will to *perform the behavior*, whereas mandatory use of technology hinders a person's will *not to perform the behavior.* This distinction is subtle but important because the variable that Ajzen (1985, 1991) added to the TRA to take account of non-volitional behavior, PBC, is, by definition, a measure of the extent to which the individual feels control over *performing the behavior,* rather than *not performing the behavior.* These issues raise the question of the usefulness of the TPB for explaining and predicting mandated IS usage.

If the TAM or TPB are to predict and explain mandatory usage behavior then, of course, there must be variation in the behavior. Researchers (Hartwick and Barki 1994; Moore and Benbasat 1991; Rawstorne et al. 1998) have supported the notion of variance within the constraints of mandated use, yet there is still a paucity of research to confirm or deny the issue. One dependent variable that is rendered redundant for prediction in contexts of mandatory use is whether or not an individual uses the technology, because they almost certainly will use it (Rawstorne et al. 1998). A better dependent variable is specific usage behaviors for which there is likely to be variance in a mandatory context. The difficulty is in actually predicting multiple types of behavior, as the TRA, TAM, and TPB are primarily geared toward predicting one type of behavior, or a behavioral category, rather than a few specific behaviors.

Ajzen and Fishbein outlined how a behavioral category, such as dieting, could be inferred from the measurement of specific behaviors; however, they did not indicate how more than one specific behavior can be measured when those behaviors are not obviously from the same category. This issue is important to address, as organizations would benefit from the prediction of a range of usage behaviors rather than just one. The challenge is to achieve this aim without constructing a different set of questionnaire items for distinct behaviors, as that would be unacceptable to organizations and participants alike.

Sample constituency is another important consideration in research on mandatory use, as studies which have acknowledged a mandatory component to IS use have tended to include quite a heterogenous sample of individuals from many organizations, occupying different positions or using different systems (see Hartwick and Barki 1994; Moore and Benbasat 1991). In order to isolate the extraneous effects of other variables on mandatory usage, we consider it important to conduct research in a context in which the use of the IS has been mandated in respect to all research participants.

Based on the issues identified in the existing literature, a study was conducted to address the need:

1. to keep the measurement of intention and behavior separate using a longitudinal design.
2. to operationalism measures consistent with theory and in action, context, target and time
3. to carry out research in a homogenous population using the same technology
4. to carry out research in a mandatory environment and therefore predict multiple behaviors of relevance.

2. RESEARCH METHODOLOGY

Our current research was conducted as a longitudinal study, set in one organization (a hospital environment) in respect to one type of IS (a Patient Care Information System, PCIS), and one type of worker (nurses).

A hospital context was chosen as the research site because the proliferation of IT in the health sector has already reached the point at which it is now almost impossible to practice as a clinician without the use of IT (Hovenga 1996). Furthermore, in many health institutions, the use of the IT is compulsory (Cesnik 1996).

PCIS was being installed in hospitals to deliver on certain administrative outcomes (e.g., more efficient staff rostering), while also promising benefits to nurses in the form of more efficient patient care. Nurses were not given a choice about whether they would use the system or not; they simply had to integrate the operation of PCIS into their work practice. Nurses were able to access PCIS through networked microcomputers located in the nurses' station

Data were collected via questionnaires from the same nurses on two different occasions. An anonymous code enabled each person's data to be matched across time. Data at time 1 were collected within two weeks of PCIS being officially mandated in each ward. Prior to that time, PCIS had been accessible in each ward for a period of two months to enable nurses to familiarize themselves with the system and to be trained in an informal way. Data at time 2 were collected between two and four months after PCIS was mandated in each ward.

The dependent variable (actual behavior) was derived in consultation with the nursing management at the Hospital site where the research was conducted. Three distinct uses of the system were identified. These related to nurses' use of the Nursing Care Plans (NCP) in PCIS. An NCP is a planned action of a patient's care based on diagnostic classifications. A computerized NCP draws upon stored electronic information to develop a plan of care for each patient.

The three distinctive uses of the system were in respect to using the NCP in the following ways:

1. updating the care plans as changes occurred,

2. using the care plans for planning care delivery, and

3. using the care plans as an educational tool for students and new graduates.

These three uses were grouped together so that each questionnaire item made reference to using "the PCIS care plans in the prescribed ways." In accordance with Ajzen and Fishbein (1980), items were worded to reflect the *action* (use of the care plans in the prescribed ways), *context* (at work), *target* (PCIS), and *time* (upon the system being mandated at work) of the predicted behavior. In categorizing the three behaviors as one group, we were aware that it could compromise the consistency of *action*, but would not affect context, target and time.

Variables Measured at Time 1:

TAM
- *Perceived usefulness* (PU)
- *Perceived ease of use* (PEU)

These measures were adapted from studies (Davis 1985; Igbaria et al. 1995; Venkatesh and Davis 1996) to reflect the action, context, target, and time of interest in the study.

TPB
- *Attitude toward the behavior*
- *Subjective norm*
- *Perceived behavioral control*

These measures were derived from elicited beliefs in accordance with Ajzen and Fishbein.

Variables Common to Both Models
- *Behavioral intention*

Measured by three items, one for each of the predicted behaviors.

Other Measured Variables
- *Perceived voluntariness*

Based on modifications of the items developed by Moore and Benbasat (1991) to reflect the relevant action, context, target and time for the current study.

Variables Measured at Time 2:

TAM and TPB
- *Behavior*

Measured by three self-report items, one for each of the three specified behaviors.

3. RESULTS

Data from 61 nurses with a mean age 37.74 (SD = 8.76) were matched longitudinally. Another 77 nurses participated in the study (N = 138) but their data was unable to be matched due, primarily, to attrition rates in nursing staff. Attrition was attributed to a number of factors, including maternity leave associated with a predominantly female workforce, transfers between hospital wards, resignations, and unavailability due to the time of shift being worked during data collection. The matched data comprised 55 females and five males.

The measure of voluntariness indicated that the sample perceived their use of PCIS as predominantly mandatory (M = 1.95). The modal score was 1 on a scale ranging from 1 to 5, with higher scores indicative of voluntary use.

4. MODEL TESTING

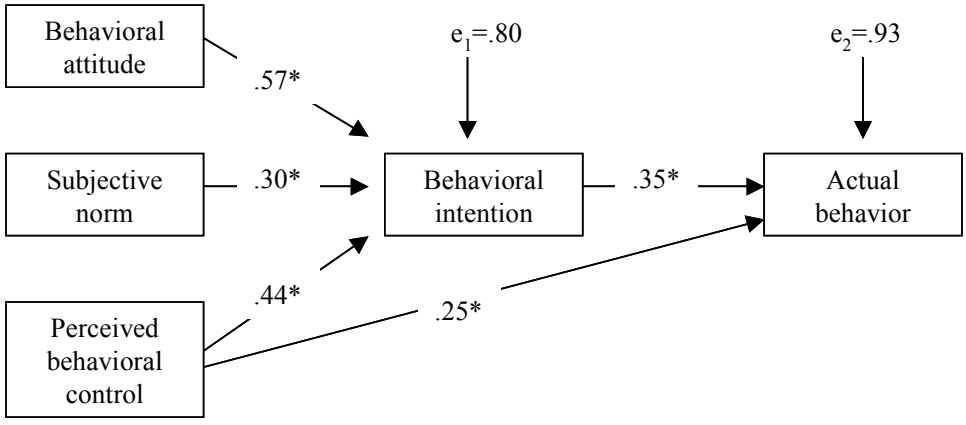
Path analysis, based on regression equations, was used to test the validity of the TPB and TAM models. While models using all three behaviors were tested, path diagrams are presented for Behavior 2 only (using the care plans to plan care delivery) and the results for the other two behaviors are discussed in the text. The TPB model is reported on first.

4.1 Theory of Planned Behavior (TPB)

The path diagram for the TPB model is illustrated in Figure 1. All direct paths in the model were statistically significant, reflecting positive relationships (standardized path coefficients appear in the diagram). Attitude, subjective norm (SN), and PBC explained 36.7% of the variance in intention, while intention and PBC explained 13.6% of the variance in Behavior 2. Mediation was tested using the approach outlined by Baron and Kenny (1986). There were no direct relationships between attitude and behavior 2 ($\beta = .21$, $\underline{p} > .05$) or between SN and behavior 2 ($\beta = -.02$, $\underline{p} > .05$), suggesting that intention cannot be mediating these relationships, as there is no relationship there to mediate. A significant link was found, however, between PBC and Behavior 2, as expected by the model (see Figure 1). When Behavior 2 was regressed on intention and PBC, the effect of PBC on Behavior 2, controlling for intention, became non-significant ($\beta = .12$, $\underline{p} > .05$). Intention, therefore, mediates the relationship between PBC and Behavior 2.

The TPB failed to significantly predict Behavior 1 (updating the care plans in Excelcare as changes occur), $\underline{F}(2, 59) = .55$, $p > .05$, with only 1.9% of the variance in Behavior 1 being explained by PBC and intention. The respective paths between PBC ($\beta = .12$, $\underline{p} > .05$) and Intention ($\beta = .02$, $\underline{p} > .05$) to Behavior 1 were both non-significant. The model did, however, explain 55% of the variance in intention. Higher scores in Attitude ($\beta = .50$, $\underline{p} < .05$) and PBC ($\beta = .25$, $\underline{p} < .05$) were associated with a stronger Intention score, whereas SN was non-significant ($\beta = .18$, $\underline{p} > .05$). There were no significant relationships between the exogenous variables, attitude, SN, and PBC, with Behavior 1, indicating that there cannot be any indirect effects of these variables upon Behavior 1 through the mediating effects of intention.

The TPB predicted and explained Behavior 3 (use of the care plans in Excelcare as an educational tool for students and new graduates) slightly better that it did for Behavior 1. The model predicted Behavior 3 at the .05 level of significance, $\underline{F}(2, 59) = 3.17$, $p = .05$, but only with 10% of the variance in behavior explained by intention and PBC. In fact, PBC failed to contribute significantly to the prediction of Behavior 3 ($\beta = .04$, $\underline{p} > .05$), whereas stronger scores in Intention were indicative of a greater likelihood to perform this behavior ($\beta = .30$, $\underline{p} < .05$). The model successfully predicted Intention, $\underline{F}(3, 59) = 2.19$, $\underline{p} > .05$, explaining 30.4% of it variance. Most of the variance was explained by attitude, with higher scores being associated with a stronger intention to perform the behavior ($\beta = .54$, $\underline{p} < .05$). Neither SN ($\beta = .20$, $\underline{p} > .05$) or PBC ($\beta = .10$, $\underline{p} > .05$) predicted intention. Attitude also directly predicted Behavior 3 ($\beta = .31$, $\underline{p} < .05$), the effect of which was totally mediated by intention. Given that the model accounted for only a small amount of variance in Behavior 3, the TPB was just satisfactory in its prediction and explanation of this behavior.



*$\underline{p} < 0.05$

Figure 1. Path Diagram for TPB in Respect to Behavior 2

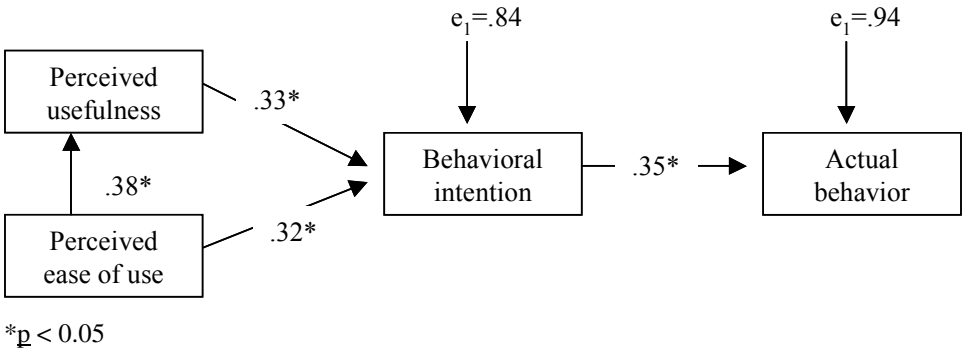


Figure 2. Path Diagram for TAM in Respect to Behavior 2

4.2 The Technology Acceptance Model (TAM)

As for the TPB, results for the TAM in respect to Behavior 2 are diagrammatically presented, while results for the two other behaviors will be written into the text. Given that the TPB and the TAM both specify intention as a direct predictor of behavior, and that the same intention measure was applied to both models, the predictive capacity of the two models will only vary as a function of the contribution from PBC. The contribution of PBC, as described above, was fairly small. The path diagram for the TAM-based model, and the standardized path coefficients in respect to Behavior 2, is shown in Figure 2.

All specified paths in the model were statistically significant. Intention explained 12% of the variance in Behavior 2, with higher scores on intention being associated with greater compliance of the behavior. PU also predicted Behavior 2 directly ($\beta = .28$, $p < .05$), and that relationship was fully mediated by intention. On the other hand, PEU did not predict Behavior 2 directly, and hence no mediation was possible. PU and PEU together explained 29.7% of the variance in intention, with higher scores indicative of a stronger intention to perform the behavior. Higher scores in PEU were also associated with greater perceptions of usefulness of the particular behavior and, as expected, PU only partially mediated the relationship between PEU and intention. These findings suggest that the TAM was useful in predicting and explaining Behavior 2.

The TAM failed to predict Behavior 1, $F(1, 59) = .02$, $p > .05$) and explained none of its variance. The model successfully predicted Intention, $F(2, 60) = 11.81$, $p < .05$, with PU and PEU explaining 28.9% of the variance. Individuals perceiving the use of the system as useful ($\beta = .40$, $p < .05$) and easy to use ($\beta = .24$, $p < .05$) were more likely to have a stronger intention to perform the behavior. However, the prediction of intention is redundant when behavior is unable to be predicted by intention, as it is impossible to conclude that the determinants of intention are factors influencing behavior. Furthermore, neither PU ($\beta = .17$, $p > .05$) nor PEU ($\beta = .08$, $p > .05$) directly predicted behavior, so Intention did not mediate these relationships. This finding is contrary to the final model of TAM proposed by Davis et al. (1989). As an aside, higher scores in PEU were associated with higher scores in PU. Consistent with the model, PU partially mediated the relationship between PEU and intention.

Behavior 3 was successfully predicted by the TAM, $F(1, 59) = 6.36$, $p < .05$), with Intention explaining 10% of the variance in behavior. Nearly 24% of the variance in intention was explained by PU ($\beta = .42$, $p < .05$) and, less so, by the non-significant path from PEU ($\beta = .14$, $p > .05$). Higher scores on PU were associated with a stronger intention to perform the behavior. PU, but not PEU, predicted Behavior 3 directly ($\beta = .35$, $p < .05$) and that relationship was mediated by intention to the extent that neither variable predicted behavior when included in the same analysis. Stronger PEU was associated with higher PU ($\beta = .38$, $p < .05$).

5. DISCUSSION AND CONCLUSION

In the present study, we set out to test whether the TAM and TPB are useful predictive and explanatory tools in the context of mandatory use. We also identified four areas relevant to this aim, which we wanted to address in this study. The results suggest that both the TAM and TPB predicted and explained two of the three behaviors (using care plans for planning care delivery and using care plans an educational tool). Their failure to predict Behavior 1 (updating the care plans as changes occur) is quite possibly associated with the formation of an intention. It has been stated in the past (Davis 1985) that an intention to use IS is only formed given sufficient time and knowledge to understand the system. While both prerequisites were present in the current study, it is probable that nurses found it difficult to envisage how this behavior could integrate into their current work practices,

and so their intentions were poor predictors of behavior. We have some evidence, from interviews with nurses, that care plans were not updated until the end of their shift, as they perceived that to be more efficient. That perception seems to have been formed after nurses started using the system.

Another plausible explanation for the failure of the models to predict Behavior 1 is tied to the measurement issues in respect to predicting multiple behaviors. If different types of usage behaviors are acted upon in distinct ways, it could be argued that it is unlikely for all of the behaviors to be successfully predicted by the same predictor items. This is, in many ways, a fatal flaw in the capacity of the TAM and TPB to measure multiple behaviors that are similar, yet different. An alternative way of overcoming this issue is to adopt the approach of Ajzen and Fishbein (1980), who suggested that behavioral categories could be measured by obtaining scores on specific behaviors, similar to those measured in the current study, which are then used as inferences of the behavioral category. For example, in the current study, we might have aimed to determine *user acceptance* and then inferred instances of it from a single score based on the sum of compliance with performing the three behaviors. A problem with this approach, however, is that what would constitute *user acceptance* in one study may be quite different to that in another and, if many studies proceeded in this fashion, this could result in a plethora of studies showing contradictory results.

The evidenced lack of support of the models to predict Behavior 1 while successfully predicting intention to perform that behavior highlights another issue, namely, there is a danger in predicting intention only and making subsequent conclusions about the determinants of that behavior. Although these findings are based on a small and predominantly female sample, they cast some doubt on the utility of the TPB and TAM to predict and explain multiple types of usage.

A secondary aim of the study was to determine whether PBC, within the TPB, would make a substantial contribution to the prediction and explanation of mandated usage. Excluding Behavior 1, for which both models failed to predict, PBC did enhance prediction and explanation, albeit only a small enhancement, for Behavior 2 only. In our view, however, the benefits of including PBC are no greater in the context of mandatory use than it would be for IS use that is voluntary. We base this view on the fact that none of the salient beliefs that were elicited from nurses, and used to derive the measure of PBC in this study, made reference to the mandatory nature of the behavior. The salient beliefs, instead, were about issues associated with external and internal factors that would hinder nurses' usage of the system.

A necessary assumption in expecting to predict and explain mandated usage is that there is variance in such behavior. The current findings provide support for this position. When IS use is mandated, it is likely that behavior will vary as a function of three aspects of the use. These include (1) the extent to which an individual wishes to comply with the mandate, (2) the extent to which the organization enforces its mandate, and (3) individual differences in using the technology. Given variation in behavior is likely to be present in most situations of mandated use, we think that the TPB and TAM are models that can be used to predict and explain such variation.

While this study was not aimed specifically at comparing the TAM and TPB, the TPB did marginally outperform the TAM in predicting both intention and behavior, and this was achieved with the use of measures of attitude, SN, and PBC derived from salient beliefs. The use of salient beliefs may have enabled superior explanation of behavior because the beliefs were specifically relevant to the population of interest. The process of eliciting beliefs, however, is time consuming and scales constructed from elicited beliefs may not have good psychometric properties.

Another important issue arising from the current study is one that has been brewing for some years now. That is, the issue about whether determinants of intentions and the underlying beliefs of such determinants are associated with future usage and, if so, for how much time into the future does the association last? There is growing evidence that beliefs and determinants of current use are somewhat different to ongoing usage (see Karahanna et al. 1999) and perhaps even future usage. The results from this study indicate that usage behavior can be predicted to a reasonable degree between two to four months after the commencement of use. However, there was certainly a large amount of unexplained variance in behavior and a useful avenue for future research might be to determine the speed and extent to which individuals change their beliefs about a new IS.

Finally, this study had some limitations. The major limitations were the sample size and the disproportionate number of males in the study. Although the current research design was established for a larger sample, the context in which data collection occurred made it difficult to obtain longitudinal measures. Furthermore, a disproportionate gender ratio was inevitable in a profession in which females predominate. These limitations restrict the generalizability of the findings, power of the statistical results, and construct validation of the scales derived from elicited beliefs. A further limitation was that we were unable to determine perceptions of voluntariness for each of the behaviors separately, as that measure was taken together for the three usage

behaviors. It is suggested that this study be cross validated using a larger sample with a more even gender ratio and separate measures of user perceptions of voluntariness for each usage behavior.

On the other hand, the strengths of the study were that it was longitudinal and conducted on one organization with one type of worker, in order to ensure a similar adoption context for all participants. The use of measuring scales that were consistent for action, context, target, and time, and, in the case of the TPB, scales derived from elicited beliefs, were other strengths of the study. Further research on predicting and explaining mandated usage of IS is required as mandated use becomes increasingly prevalent in organizations.

References

Adams, D. A., Nelson, R. R., and Todd, P. A. "Perceived Usefulness, Ease of Use, and Usage of Information Technology: A Replication," *MIS Quarterly*, 1992, pp. 227-247.

Ajzen I. "From Intentions to Actions: A Theory of Planned Behavior," in *Action-Control: From Cognition to Behavior*, J. Kuhl and J Beckmann (eds.), Heidelberg: Springer, 1985, pp. 11-39.

Ajzen, I. "The Theory of Planned Behavior," *Organizational Behavior and Human Decision Processes* (50), 1991, pp. 179-211.

Ajzen I., and Fishbein, M. *Understanding Attitudes and Predicting Social Behavior*, Englewood Cliffs, NJ: Prentice Hall, NJ, 1980

Al-Gahtani, S. S., and King, M. "Attitudes, Satisfaction and Usage: Factors Contributing to Each in the Acceptance of Information Technology," *Behavior and Information Technology* (18:4), 1999, pp. 277-297.

Agarwal, R., and Prasad, J. A. "Conceptual and Operational Definition of Personal Innovativeness in the Domain of Information Technology," *Information Systems Research* (19:2), 1998, pp. 204-215.

Baron, R. M., and Kenny, D. A. "The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic and Statistical Considerations," *Journal of Personality and Social Psychology* (51), 1986, pp. 1173-1182.

Bem, D. J. "Self-Perception: An Alternative Interpretation of Cognitive Dissonance Phenomena." *Psychological Review* (74), 1967, pp. 183-200.

Brosnan, M. J. "Modeling Technophobia: A Case for Word Processing," *Computers in Human Behavior* (15), 1999, pp. 105-121.

Cesnik, B. "History of Health Informatics," in *Health Informatics: An Overview*, E. Hovenga, M. Kidd, and B. Cesnik (eds.)., Melbourne: Churchill Livingstone, 1996.

Chau, P. Y. K. "An Empirical Assessment of a Modified Technology Acceptance Model," *Journal of Management Information Systems* (13:2), 1996, pp. 185-204.

Conner, M., and Armitage, C. J. "Extending the Theory of Planned Behavior: A Review and Avenues for Further Research," *Journal of Applied Social Psychology* (28:15), 1998, pp. 1429-1464.

Davis, F. D. *A Technology Acceptance Model for Empirically Testing New End-User Information Systems: Theory and Results*, Unpublished Ph.D. Dissertation, Massachusetts Institute of Technology, 1985.

Davis, F. D., Bagozzi, R. P., and Warshaw, P. R. "User Acceptance of Computer Technology: A Comparison of Two Theoretical Models," *Management Science* (35:8), 1989, pp. 982-1003.

Festinger, L. *A Theory of Cognitive Dissonance*, London: Travistock Publications. 1957.

Green, C. W. "Normative Influence on the Acceptance of Information Technology," *Small Group Research* (29:1), 1998, pp. 85-123.

Hartwick, J., and Barki, H. "Explaining the Role of User Participation in Information System Use," *Management Science* (40:4), 1994, pp. 440-465.

Hovenga, E. J. S. "Health Care Services and Information Systems" in *Health Informatics: An Overview,* E. Hovenga, M. Kidd, and B. Cesnik (eds.), Melbourne: Churchill Livingstone, 1996.

Igbaria, M., Iivari, J., and Maragahh, H. "Why Do Individuals Use Computer Technology? A Finnish Case Study," *Information and Management* (29), 1995, pp. 227-238.

Igbaria, M., Parasuraman, S., and Baroudi, J .J. "A Motivational Model of Microcomputer Usage," *Journal of Management Information Systems* (13:1), 1996, pp. 27-143.

Karahanna, E. *Evaluative Criteria and User Acceptance of End-User Information Technology: A Study of End-User Cognitive and Normative Pre-Adoption Beliefs*, Unpublished Ph.D. Dissertation, University of Minnesota, 1993.

Karahanna, E., Straub, D. W., and Chervany, N. L. "Information Technology Adoption Across Time: A Cross-Sectional Comparison of Pre-Adoption and Post-Adoption Beliefs," *MIS Quarterly* (23:2), 1999.

Levine, T., and Donitsa-Schmidt, S. "Computer Use, Confidence, Attitudes, and Knowledge: A Causal Analysis," *Computers in Human Behavior* (14:1), 1998, pp. 125-146.

Mathieson, K. "Predicting User Intentions: Comparing the Technology Acceptance Model with the Theory of Planned Behavior," *Information Systems Research* (2:3), 1991, pp. 173-191.

Moore, G. C., and Benbasat, I. "Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation," *Information Systems Research* (2:3), 1991, pp. 192-221.

Rawstorne, P., Jayasuriya, R., and Caputi, P. "An Integrative Model of Information Systems Use in Mandatory Environments," in *Proceedings of the Nineteenth International Conference on Information Systems,* R. Hirschheim, M. Newman, and J. I. DeGross (eds.), Helsinki, Finland, 1998, pp. 325-330.

Sutton, S. "Predicting and Explaining Intentions and Behavior: How Well Are We Doing?," *Journal of Applied Social Psychology* (28:15), 1998, pp. 1317-1338.

Szajna, B. "Empirical Evaluation of the Revised Technology Acceptance Model," *Management Science* (42:1), 1996, pp. 85-92.

Taylor, S., and Todd, P. A. "Understanding Information Technology Usage: A Test of Competing Models," *Information System Research* (6), 1995, pp. 144-176.

Venkatesh, V., and Davis, F. D. "A Model of the Antecedents of Perceived Ease of Use: Development and Test," *Decision Sciences* (27:3), 1996, pp. 451-481.