

인터넷 기반의 정보시스템이  
경영과학 교육성과에 미치는 영향에 관한 연구  
- 수정된 정보기술수용모형과 자기효능을 중심으로 -

김진성\*

The Contribution of Internet-Based Information Systems to  
the MS Education Performance

- An Extension to the Revised Technology Acceptance Model and Self Efficacy -

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■ Abstract ■

This study suggests a revised TAM (Technology Acceptance Model)-based performance evaluation model in MS (management science) education. Recently, many MS education programs are developed on the basis of computer and Internet communication technology. Previous researchers used TAM as an individual performance evaluation model, and proved that perceived usefulness and perceived ease of use are the substantive successful factors.

This study provides a revised TAM-based conceptual framework for understanding what is involved in improving university MS education and what might be implied by conducting research on its improvement. It is argued in this research that three sets of forces and conditions have a direct and indirect impact on MS education : first, each student has self efficacy and it is a critical determinant of behavior : next, the use of Internet-based information system at MS education affects on the renewal of MS education : and finally, perceived usefulness and perceived ease of use have impacts on behavioral intention and actual system usage. This research concludes with suggestions for which direction this framework provides for future research on the promise and limits of efforts to renew MS education in university.

Keyword : TAM, Management Science, Education, Usefulness, Ease of Use, Self Efficacy

## 1. Introduction

The Internet and World Wide Web have grown phenomenally since its inception in 1990. Existing universities, start-up cyber-universities, and private educational organizations are now investing considerable resources in it. Universities are building Intranets and Extranets to help them accomplish their educational objectives by assisting their personnel in doing their job better. Successful investment in Internet-based education can lead to enhanced productivity, while failed systems can lead to undesirable consequences such as dissatisfaction among students. Despite significant technological advances and increasing organizational investment in these technologies, the problem of underutilized systems plagues education. Thus, an understanding of the predictors of Internet-based education tools and Internet-based information systems usage could serve a multitude of educators by helping them recognized how to promote that usage and performance.

Previous researchers outlined some of the main philosophical positions of the protagonists with regard to methodology in the social sciences and operational research (Lehaney, 1989 ; Lehaney & Clarke, 1995 ; Lehaney & Vinten, 1994). They provided an insight into the main areas of debate surrounding research paradigms. Other researchers have conducted several studies to examine the relationship between subjective norm, self efficacy, perceived ease of use, perceived usefulness, attitudes, and the usage of other information technologies in recent years (Adams et al., 1992 ; Bagozzi et al., 1992 ; Chau, 1996 ; Davis, 1989 ; Davis et al., 1989 ; Gefen & Straub, 1997 ; Haynes, 1991 ; Hendrickson & Collins, 1996 ;

Igbaria et al., 1995 ; Mathieson, 1991 ; Staples et al., 1999 ; Straub et al., 1995 ; Szajna, 1996 ; Taylor & Todd, 1995 ; Teo et al., 1999 ; Thompson, 1998 ; Venkatesh, 2000). TAM posits that perceived ease of use and perceived usefulness can predict attitudes toward new information technology that then can predict the usage of that technology. Several researchers have thus validated TAM (or revised TAM) using several different applications including primarily e-mail, voice mail, word processing, and spreadsheets. Other researchers have recommended the investigation of Web user behavior (Shaw et al., 1997 ; Lederer et al., 2000). However, such papers provide no guide to Internet-based education tools.

The first purpose of the current research was to validate revised TAM with the Internet-based information systems as the lecturers' MS education support systems. Second, the current research attempts to further our understanding of the determinants of perceived ease of use and perceived usefulness of an Internet-based information system by focusing on how these perceptions form and change over time with increasing students' experience and self efficacy with the system. It could thus provide implications about ease of use and usefulness for Internet-based MS education program developers and managers.

In this purpose, we assume the three sets of forces and conditions would inevitably be encountered that, we argue, drive events in MS classrooms and, indeed, in MS education more generally :

- 1) Self efficacy impinges on students' perception, behavior and actual system usage.
- 2) Students' self efficacy and perceptions will be changed over time with increasing ex-

perience with the system.

- 3) Perceived usefulness and ease of use have strong effect on students' intention and actual system usage.

## 2. Theoretical Foundations and Research Model

What causes students to accept or reject internet-based information technologies in MS education? Many variables may influence system usage. Previous researchers suggests two determinants that are especially important in information technology acceptance (Chau, 1996 ; Davis, 1989 ; Gefen & Straub, 1997 ; Hendrickson & Collins, 1996 ; Igarria et al., 1995 ; Staples et al., 1999 ; Straub et al., 1995 ; Szajna, 1996 ; Taylor & Todd, 1995 ; Teo et al., 1999 ; Thompson, 1998 ; Venkatesh, 2000).

First, students tend to use or not use an application to perform their studies better. We should call this first variable as *perceived usefulness*. Second, even if potential users believe that a given application is useful, they may, at the same time, believe that the systems is too hard to use and that performance benefits of usage are outweighed by the effort of using the application. So, we named this variable as *perceived ease of use*. That is, in addition to perceived usefulness, usage is influenced by *perceived ease of use*.

### 2.1 Perceived Usefulness

Perceived usefulness has been found to have a significant influence upon system utilization (Agarwal & Karahanna, 2000). Perceived usefulness is defined here as the "degree to which a student believes that using a particular system

would enhance his or her study performance."

This follows from the definition of the word useful : "capable of being used advantageously (Davis et al., 1989)." Within an organizational context, people are generally reinforced for good performance by raises, promotions, bonuses, and other rewards (Pfeffer, 1982 ; Schein, 1980 ; Vroom, 1964). This implication was that once students has been using an information systems, their subsequent intentions are formed from their perceptions of its usefulness. Intentions then are expected to predict future technology acceptance behavior. Therefore, an Internet-based information system high in *perceived usefulness* is one for which a student believes in the existence of a strong positive use-performance relationship. Drawing upon this literature we test :

**H 1** : Perceived usefulness of an Internet-based information system has a positive effect on behavioral intention to use the system.

### 2.2 Perceived Ease of Use

Perceived ease of use refers to the "degree to which a student believes that using a particular information system would be free of effort." Effort is a finite resource that a person may allocate to the various activities for which he or she is responsible (Radner & Rothschild, 1975). Perceived ease of use follows from the definition of "ease : freedom from difficulty or great effort (Davis et al., 1989)." This is an student's assessment that Internet-based technology interaction will be relatively free of cognitive burden, i.e., ease of use reflects the facility with which the student is able to interact with a particular Internet-based information system or software package. Perceived ease of use represents an

intrinsically motivating aspect of human-computer interactions. We assume, therefore, an Internet-based information system perceived to be easier to use than another is more likely to be accepted by students. Perceived ease of use and perceived usefulness are thought to be potentially important determinants of system usage. Also, intentions then predict user's behavior (Adams et al., 1992 ; Davis, 1989 ; Rogers, 1983). Drawing upon this literature we test :

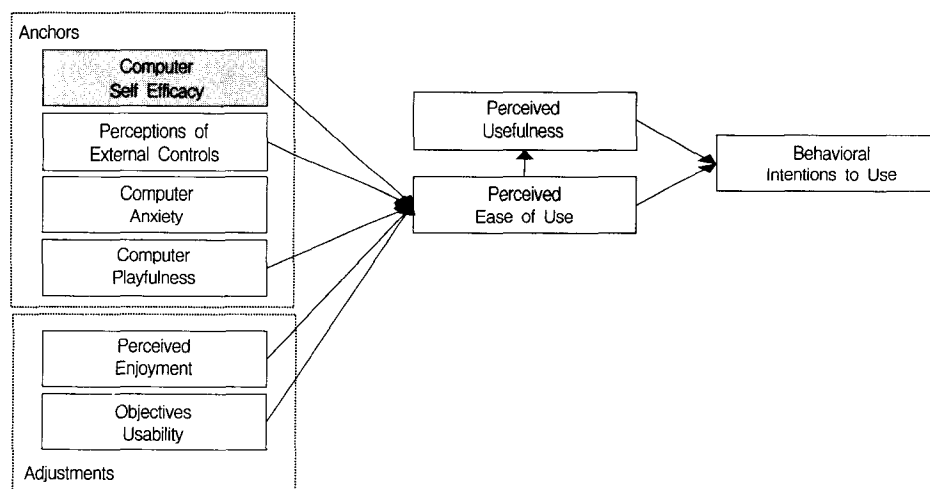
- H 2** : Perceived ease of use of an Internet-based information system has a positive effect on behavioral intention to use the system.
- H 3** : Perceived ease of use of an Internet-based information system has a positive effect on the perceived usefulness of the system.

### 2.3 Self Efficacy

Self efficacy is similar to perceived ease of use. In some different, however, self efficacy is defined as the "judgments of how well one can execute courses of action required to deal with

perspective situations (Davis, 1986)." The importance of perceived ease of use and perceived usefulness is supported by Bandura's (1982) extensive research on self efficacy and Davis' (1986) research. Therefore, we claim, self efficacy has a direct relationships with perceived ease of use and perceived usefulness. Bandura's (1982) research distinguishes self efficacy judgments from outcome judgements, the latter being concerned with the extent to which a behavior, once successfully executed, is believed to be linked to valued outcomes. Also, Hill et al. (1987) find that both self efficacy and outcome beliefs exert an influence on decisions to learn a computer language. This result is very similar to that of Bandura (1982).

Venkatesh (2000) presented the theoretical model of the antecedents of perceived ease of use and tested. In this research, he used self efficacy as an antecedents of perceived ease of use. <Figure 1> presents the Venkatesh's (2000) research model.



<Figure 1> Venkatesh's (2000) research model

Stapels et al. (1999) indicated that remote employees' self efficacy assessments play a critical role in influencing their remote work effectiveness, perceived productivity, job satisfaction, and ability to cope. Furthermore, strong relationships were observed between employees' remote work self efficacy judgments and several antecedents, including remote work experience and training, best practices modeling by management, computer anxiety, and IT capabilities. These findings suggest important ways in which a remote employee's or student's work performance can be enhanced, through the intermediary effect of improved remote work self efficacy (Staples et al., 1999).

Agarwal and Karahanna (2000) suggested a multidimensional construct labeled cognitive absorption and defined as a state of deep involvement with software. They proposed that the individual traits of playfulness and personal innovativeness are important determinants of cognitive absorption. Also, they proposed the individual self efficacy is important determinant of perceived usefulness and perceived ease of use. <Figure 2> presents the cognitive absorption model.

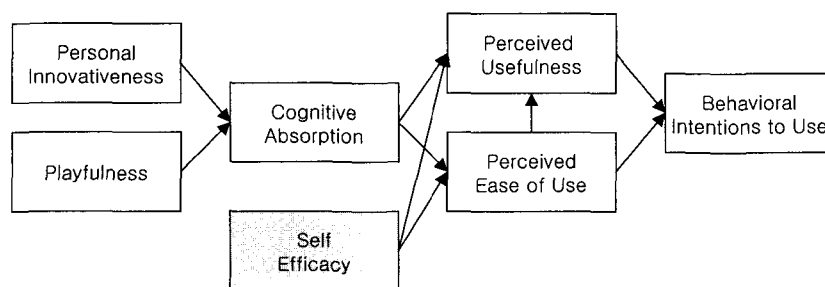
Therefore, self efficacy research does provide one several theoretical perspectives suggesting that perceived ease of use and perceived useful-

ness function as basis determinants of user's behavior (Agarwal & Karahanna, 2000). Drawing upon this literature we test :

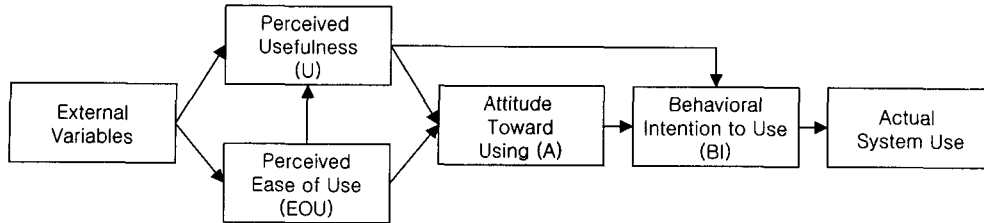
- H4** : Self efficacy perception with an Internet-based information system has a positive effect on the perceived usefulness of the system.
- H5** : Self efficacy perception with an Internet-based information system has a positive effect on the perceived ease of use of the system.
- H6** : Behavioral intention to use of an Internet-based information system has a positive effect on the actual system use.

#### 2.4 The Revised Technology Acceptance Model

A student's acceptance of an Internet-based information system is determined by his or her intention to accept it. In previous researches, these hypotheses are validated using TAM. The original TAM explained the causal links between beliefs (usefulness and ease of use) and user's attitudes, intentions and actual system usage (Davis et al., 1989). The theoretical importance of perceived usefulness and perceived ease of use as determinants of user's behavior is indicated by several previous researches (Davis, 1989 ; Robey, 1979 ; Schultz & Slevin, 1975). The original TAM



<Figure 2> Cognitive absorption model



<Figure 3> Original Technology Acceptance Model (Davis et al., 1989)

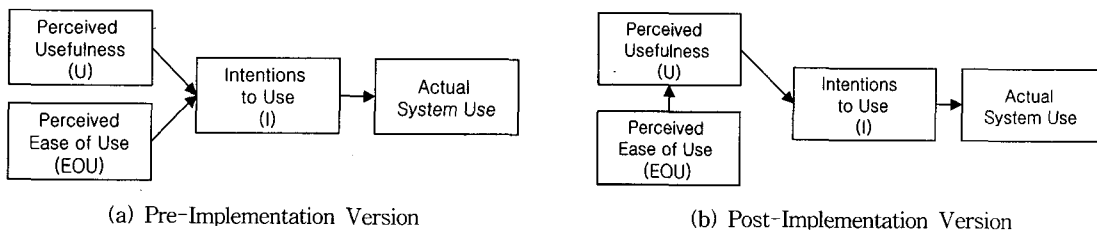
is depicted in <Figure 3>.

The revised TAM is presented in <Figure 4>. The model has two versions : one concerning pre-implementation beliefs about usefulness and ease of use and the other implying post-implementation beliefs about usefulness and ease of use. The pre-implementation version of the TAM uses perceptions of ease of use and usefulness as determinants of technology acceptance before its actual implementation. The post-implementation model predicts the acceptance of technology with perceptions of usefulness and ease of use of the technology measured after implementation of the technology. Notable difference

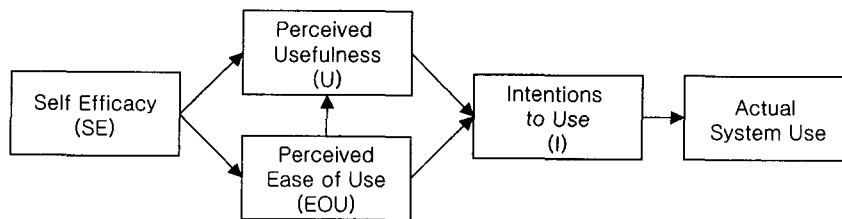
between the original and revised TAM models is the lack of the attitude construct. In addition, it is expected that beliefs or attitudes differ or change with experience (Adams et al., 1992 ; Davis et al., 1989).

2.5 Our Research Model

Consistently, previous researches show us that both perceived usefulness and perceived ease of use beliefs are depicted as having a direct effect on intentions concerning the technology. According to these previous researches, we can guess a student would rely on both their perceptions of



<Figure 4> Revised Technology Acceptance Model (Davis et al., 1989)



<Figure 5> Our research model focused on self efficacy and TAM

usefulness and ease of use to form their intentions. According to previous research, we suggest our research model focused on self efficacy and TAM as shown in <Figure 5>.

### 3. Methodology

Data to test the model and hypotheses were drawn from subject (student) enrolled at a large private university (more than 15,000 students) in Korea. The level of analysis of the study is the individuals participated in MS class, since the intent of the study is to explain the behavior and attitudes of individuals. This MS course is required of all school of business juniors and, thus, it represents a cross-section of all the majors in the university. Given the nature of the sample, we chose the Internet-based decision support system as the target innovation. Students were instructed to respond to the survey as candidly as possible, that there were no right or wrong answers, and that we were interested primarily in their perception about the Internet-based decision support system.<sup>1)</sup>

This Internet-based decision support system technology is appropriate for at least two reasons : first, it is a volitional technology in the sense that students use it of their own accord, and second, the technology exemplifies the characteristics of contemporary MS education information technology. The proposed model was tested in two different classes among 73 students taken over a 16-week period. A total of 63 completed surveys were returned, representing all students who were present in class on the day

data were collected. This sample size is generally accepted as being sufficient to perform statistical analysis (Kerlinger & Pedhazur, 1973 ; Nelson & Cooprider, 1996).

All of respondents are undergraduate students and most of them majored in business administration. Undergraduate students who received a three-hour instruction every week, hands-on demonstration on the Internet-based decision support system that would be available for their voluntary use during the course of the undergraduate MS education program. Following the demonstration, the students completed the 10-item usefulness/ease of use instrument (Davis, 1989). To validate the changes in students' perceptions over time, we used two-step validation process as shown below.

#### [Step 1] Pre-adoption

At the beginning of the semester, we gathered questionnaire data and validated our revised TAM. Participating students were asked, to identify distinct self efficacy for Internet-based information systems. Each question in the questionnaire was customized to include the learning place and spending time. During the subsequent 4-week semester, the subjects freely used the Internet-based decision support system to complete their own class project.

#### [Step 2] Post-adoption

At the end of the semester, questionnaire data were drawn again from subjects and our research model was validated. Subjects were free to choose either Internet-based information systems. At the end of the 16-week session, the subjects again completed the usefulness/ease of use instrument, indicated their intentions to continue using Internet-based decision support system,

1) Internet-based linear programming, simulations, matrix-driven remote negotiation mechanisms.

and reported the frequency of usage they perceived using over the past 16-weeks. Actual system usage was measured as frequency of usage and computer logs over the 16-week semester.

## 4. Results

To validate the causal relationships associated with the revised TAM <Figure 5>, we used the path analysis as one of the confirmatory factor analysis. The subjects were juniors and seniors in an optional management course at a university. There were 39 males and 24 females in the sample. Their average age was 22.3 years. It can be completed using a spreadsheet. The randomness and multiple correlations among variables were validated by the pilot test and factor analysis. <Table 1> gives means and standard deviations

for students' self efficacy, perceived usefulness, perceived ease of use, behavioral intentions to use, and actual system use.

Reliability coefficients, as determined by Cronbach's alpha, are 0.72~0.93, respectively, for the pre-adoption and post-adoption version. Our research model was tested empirically using path analysis. Path analysis was chosen as the analytic technique in this study because it assesses causal relationships (Kerlinger & Pedhazur, 1973 ; Wright 1971). It is regression-based technique that permits the testing of causal models using cross-sectional data (Baroudi, 1985). Normalized path coefficients (betas) are used to determine the strength and direction of causal paths or relations. These betas represent the fraction of the standard deviation of the dependent variable for which the independent or mediating variable is responsible (Kerlinger &

<Table 1> Descriptive statistics and correlation matrix

(A) [Step 1] Pre-adoption version

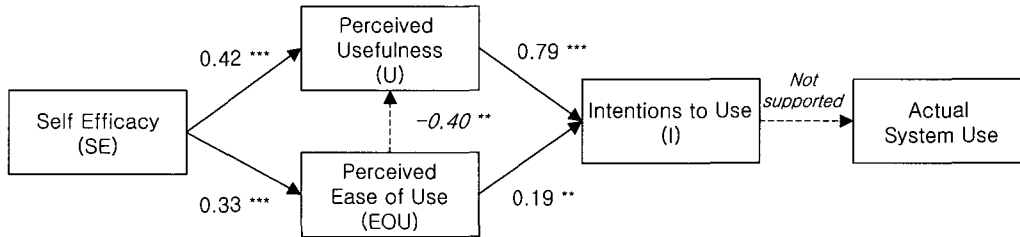
	Mean	Std. Dev.	Usefulness	Ease of Use	Self efficacy	Intentions to use
Usefulness	4.94	1.31				
Ease of use	4.99	1.04	-0.17			
Self efficacy	5.12	1.26	0.23*	0.38**		
Intentions to use	5.17	1.31	0.76**	0.02	0.33**	
Actual system use	3.79	1.30	-0.11	0.01	0.12	-0.07

(B) [Step 2] Post-adoption version

	Mean	Std. Dev.	Usefulness	Ease of use	Self efficacy	Intentions to use
Usefulness	5.86	0.75				
Ease of use	5.38	0.99	0.32*			
Self efficacy	4.87	1.05	0.47**	0.28*		
Intentions to use	5.87	0.85	0.55**	0.42**	0.43**	
Actual system use	3.86	1.32	0.16	0.17	0.25	0.29*

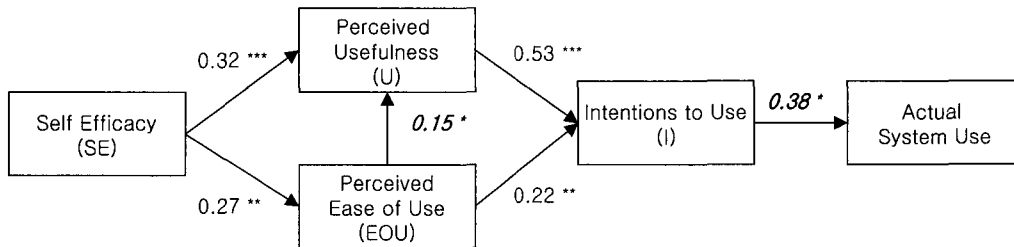
Note) \*  $p < 0.05$ , \*\*  $p < 0.01$





Note) GFI = 0.98, AGFI = 0.93

(A) [Step-1] Pre-adoption version



Note) GFI = 0.98, AGFI = 0.90, \*\*\*  $p < 0.001$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

(B) [Step 2] Post-adoption version

<Figure 6> Result of path analysis

Pedhazur, 1973). <Figure 6> shows the results of path analysis. Paths are interpreted as standardized beta weights in a regression analysis. To eliminate the confounding of results based on specific individual characteristics, a respondent's major and Web experience were included in the analysis as controls. As none of the controls were significant, they were dropped from the model.

For the pre-adoption version, self efficacy has significant, direct effect ( $\beta = 0.42$ ) on perceived usefulness and ease of use ( $\beta = 0.33$ ). Intentions absolutely predicted by perceived usefulness ( $\beta = 0.79$ ) and ease of use ( $\beta = 0.19$ ). But, ease of use has negative significant direct effect ( $\beta = -0.40$ ) on perceived usefulness because of students' low experience in using Internet-based decision support system. This is very different result with Davis et al. (1989) and other previous literature.

One of the most notable findings for the pre-adoption version of the revised TAM is that intentions do not predict actual system usage.

For the post-adoption version of the revised TAM, self efficacy again has a direct effect on perceived usefulness ( $\beta = 0.32$ ) and ease of use ( $\beta = 0.27$ ). Perceived usefulness ( $\beta = 0.53$ ) and ease of use ( $\beta = 0.22$ ) again has a direct effect on intentions as hypothesized. Unlike with pre-adoption version, perceived ease of use also has a direct effect ( $\beta = 0.15$ ) on perceived usefulness. Although it has not a great effect ( $\beta = 0.15$ ,  $p < 0.05$ ) on usefulness, we have confirmed that student's experience in using Internet-based information systems changed the behavioral intentions. The most important findings for the post-adoption version is that intentions has a direct effect ( $\beta = 0.38$ ,  $p < 0.05$ ) on actual system use.

〈Table 2〉 Direct and indirect effects

(A) [Step 1] Pre-adoption version

	Perceived Ease of Use			Perceived Usefulness			Intentions to Use			Actual System Use		
	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total
Self Efficacy	a. 0.33*** b. (0.07) c. 4.55	-	0.33 (0.07) 4.55	0.42*** (0.10) 4.20	-0.13	0.29	-	0.29	0.29	-	-	-
Perceived Ease of Use	-	-	-	-0.40** (0.11) -3.47	-	-0.40 (0.11) -3.47	0.19** (0.07) 2.54	-0.32	-0.13	-	-	-
Perceived Usefulness	-	-	-	-	-	-	0.79*** (0.06) 13.21	-	0.79 (0.06) 13.21	-	-	-
Intentions to Use	-	-	-	-	-	-	-	-	-	-	-	-

Note) a : factor loading( $\beta$ ), b : standard error, c : t-value, \*\*\*  $p < 0.001$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

(B) [Step 2] Post-adoption version

	Perceived Ease of Use			Perceived Usefulness			Intentions to Use			Actual System Use		
	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total
Self Efficacy	0.27** (0.13) 2.05	-	0.27 (0.13) 2.05	0.32*** (0.09) 3.50	0.04	0.36	-	0.25	0.25	-	0.09	0.09
Perceived Ease of Use	-	-	-	0.15* (0.09) 1.70	-	0.15 (0.09) 1.70	0.22** (0.09) 2.34	0.08	0.30	-	0.12	0.12
Perceived Usefulness	-	-	-	-	-	-	0.53*** (0.12) 4.15	-	0.53 (0.12) 4.15	-	0.19	0.19
Intentions to Use	-	-	-	-	-	-	-	-	-	0.38* (0.20) 1.85	-	0.38 (0.20) 1.85

## 5. Discussion

The significant, direct effect of usefulness on intentions in the pre-adoption and post-adoption version was hypothesized by the revised TAM. The implications are that, when a student becomes more experienced with the internet-based information system, usefulness directly determines not only behavioral intentions but also the

actual usage behavior.

An Interesting finding in pre-adoption version was the lack of a direct relationship of behavioral intention to use on actual system use. While the post-adoption version predicted that relationship, the pre-adoption version did not. Another finding was the consistent presence of a direct relationship of ease of use on usefulness. The implication is that if students perceive an Internet-based

information system as being useful first, its ease of use has effect on the formation of intentions. Therefore, the easier Internet-based MS education tool (i.e., Internet-based decision support system) is to use, the more useful it is perceived to be. In post-adoption version, there was a significant direct path from perceived usefulness and perceived ease of use to behavioral intentions to use. This result is very similar to that of Agarwal and Karahanna (2000).

Summarized results for the hypotheses test are shown in <Table 3>. As shown in <Table 3>, the significant, direct effect of self efficacy was hypothesized by the revised TAM (Figure 6).

What was the most and best significant difference between pre-adoption version and post-adoption version? Pre-adoption version shows the negative relationship between perceived ease of use and ease of use. However, post-adoption version shows the positive relationship between usefulness and ease of use. The implication is that once student begin to actually use an Internet-based MS education tool, ease of use rationally becomes more important overall in determining usefulness. The most prominent findings involved the actual system use : (1) the significant effect of intentions on actual system use in the post-adoption version of the revised

TAM, (2) relatively weak effect of intentions on actual system use in the pre-adoption version, compared to its much stronger effect in the post-adoption version.

### 5.1 Limitations of the Study

Prior to concluding the implications of our findings, limitations that circumscribe their interpretation must be acknowledged. The study has some potential limitations. First, the results of this research may be limited by the type of technology used, Internet-based decision support system.

Second, the setting for the study was an educational institution and respondents were students in a business school. Thus, the generalizability of the respondents' behavior to a more general workforce may be somewhat limited.

The third potential limitation is the sample and the task. Student use many different Internet-based education systems in a wide variety of settings. No single task with a single group of users can fully represent this diversity, regardless of whether the subjects are students or educators, and regardless of whether the task is linear programming, simulation, or sales forecasting (Mathieson, 1991).

<Table 3> Summary of hypotheses tests

Hypotheses	Support	
	Pre-adoption version	Post-adoption version
H 1 : U → I	Yes	Yes
H 2 : EOU → I	Yes	Yes
H 3 : EOU → U	No	Yes
H 4 : SE → U	Yes	Yes
H 5 : SE → EOU	Yes	Yes
H 6 : I → Actual System Use	No	Yes

## 6. Conclusion

This study was motivated by a strong interest in understanding student behavior toward Internet-based MS education tools. The revised TAM was tested using actual system use as surrogates for Internet-based information system acceptance in a longitudinal study. This study supports revised TAM. It thus helps MS educators understand the relationships among self efficacy, perceived ease of use, perceived usefulness, and acceptance of Internet-based education systems. It confirms that use of Internet-based information systems depends on the student's self efficacy, usefulness, and ease of use of the system. This study identified several areas for improvement under Internet-based MS education tool criterion, of which the most critical were "self efficacy, ease of use, usefulness". These results courage the consistent direct relationship of ease of use to usefulness in MS education area. Further, the differences in the intention-usage relationship for the pre-adoption and post-adoption versions make an argument for the consideration of an experience component associated with the revised TAM.

From the perspective of MS education researchers, this study provides two new instruments tailored to the Internet. First, future researchers could use these instruments for assessing the ease of use and usefulness of Internet-based education systems. Second, these instruments could stimulate future researchers to develop better instruments for assessing those characteristics of Internet-based education systems.

This research has potential for practical MS education in the development and use of Internet-

based information systems. By confirming revised TAM, it suggests that Internet-based information system developer should provide ease of use and usefulness for their system to encourage student to reuse their systems. This research has also provided two instruments that could be useful to Internet-based education system developers and managers in universities that encourage students to use specific Internet-based information systems.

From the perspective of MS education practice, three important implications follow. First, our results point to the importance of experience-focused long-term education and eschewing a strictly utilitarian perspective on the usage of Internet-based MS education tools. As MS education tool developments continue to focus on more appealing interfaces, pleasurable and enjoyment might be more important factors to predict the usage intentions. Second, a key implication for teachers relates to design of MS education course. Self efficacy is likely to be formed by experience with technologies that are visually rich and appealing. Moreover, the MS education program should provide students with a sense of being in command of the interaction through judicious use of help menus and hot keys that support easy and intuitive navigation (Agarwal & Karahanna, 2000). Third, the needs for cyber-education programs are increased (Kalakota & Robinson, 1999). Therefore, educators would find the value in keeping students on their site for longer periods of time. The ability of the site to induce a state of cognitive absorption provides some indication of how compelling it is for the user (Agarwal & Karahanna, 2000).

Regarding to further research, an interesting and important future research area for the MS

education lies in improving the value and status of an experience component. Another area of important potential future research is using TAM to other Web-based educational programs.

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