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Revisiting Technology Acceptance Model with Social Influence Factors

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REVISITING TECHNOLOGY ACCEPTANCE MODEL WITH SOCIAL INFLUENCE FACTORS

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Abstract

Despite many numbers of studies in Technology Acceptance Model (TAM), the social influence construct has not been recognized, nor handled clearly. This study includes the social influence construct in TAM and tests the robustness of the model for different information systems contexts: office automation (spreadsheet) and Internet usage. Study findings include that 1) social influence has a direct impact on the usage of spreadsheet, but not on Internet usage, and 2) social influence has a stronger indirect impact on IS use through PEU than through PU (for both Internet and spreadsheet).

Keyword: Technology acceptance model, Social Influence, Structural Equation Modeling

1. Introduction

Studies and models are abundant in explaining IS acceptance or use. Due to the long history of this stream of research, several meta-models have been developed as the cumulative of previous studies: Lucas, Ginzberg & Schultz (1990), Davis (1989, 1993), and Moore & Benbasat (1991). Lucas, Ginzberg and Schultz (1990) developed and tested empirically the structural model of information systems implementation, distinguishing the models for managers and general users. In common, three factors were found important for the acceptance of information systems: decision style, job characteristics, and demographics. Organizational support was found important only for managers, whereas three other factors were important only for users: knowledge of system, assessment of system & support, and system characteristics.

Technology Acceptance Model (TAM), based on the Theory of Reasoned Action (TRA: Ajzen and Fishbein, 1980), has been widely used for predicting the adoption and use of information technologies (Davis, Bagozzi, and Warshaw, 1989). The beliefs determining attitude and intention posited by TAM are perceived ease of use (PEU) and perceived usefulness (PU). Davis (1989, 1993) regressed onto these two important cognitive factors regarding IS acceptance. Numerous IS literature has followed to retest the construct validity of these two concepts, and confirmed it (e.g., Adams, Nelson & Todd, 1992; Chin & Todd, 1995; Hendrickson, Massey & Cronan, 1993; Subramanian, 1994). In his Technology Acceptance Model, Davis found that attitude was just a mediating factor of PU on IS use, and that social norm does not influence on IS use.

Moore and Benbasat (1991) developed an instrument to measure the perceptual factors influencing information technology innovation, and identified eight important factors: voluntariness, relative advantage, compatibility, image, ease of use, result demonstrability, visibility, and trialability.

These three meta-studies have different perspectives: Lucas, Ginzberg and Schultz (1990) take the organizational change perspective, Davis (1989, 1993) focuses on individual's perception of systems characteristics, and Moore and Benbasat (1991) take the innovation standpoint which concerns about the diffusion (spread) of technology across organization.

Commonly in these studies, social influence has not been recognized, nor handled clearly. Recently, the social influence on the adoption of information systems is getting more attention of researchers (e.g., Fulk, 1993; Markus, 1990; Orlikowski, 1992; Weick, 1990). However, it still remains as a subtle and vague construct. Therefore, we conduct an empirical study to make a clear understanding of this concept: i.e., "what kind of social perceptual factors influence IS adoption, and how?"

Especially, this study focuses on tapping on TAM with social influence issues. This study contributes to the TAM research streams in the following couple of issues. First, this study includes social influence factors that have been disregarded in this research stream. TAM is an individual IS usage model. Identifying social influence on individual IS adoption or use could help improve the power of this model. Second, this study tests this expanded TAM model for two different information systems contexts: office automation (spreadsheet) and Internet usage (visiting and using web sites). Office automation software such as spreadsheet and word processor has been popular domains of TAM model research (e.g., Adams, Nelson & Todd, 1992; Chau, 1996; Davis et al., 1989; Hendrickson et al., 1993; Mathieson, 1991; Venkatesh & Davis, 1996). These products have alternative and competitive products, which means users may have chosen certain products voluntarily. However, it's not sure whether TAM can have robustness in explaining acceptance of Internet technology, which must be different from office automation tools. Internet is being used not only as an instrument to conduct tasks, but also as an instrument to communicate with virtual community relating to affective aspect of life (Armstrong & Hagel, 1996; Riggins & Rhee, 1999). Due to its exponential popularity and telecommunication characteristics, social or peer pressure may come to work on accepting Internet technology. Our study taps on the effectiveness of the expanded TAM model for both contexts of office automation and Internet.

2. Social Influence Factors

We looked into the major theories regarding IS adoption (or use), such as TAM, TRA, TPB (Theory of Planned Behavior: Ajzen, 1985), the decomposed TPB (Taylor & Todd, 1995), and innovation theory (Moore & Benbasat, 1991), to identify what kind of constructs in these models can be grouped as social influence. Three constructs were found associated with social influence: subjective norm, visibility, and image.

Among these three, the subjective norm of TRA is the representative construct in regards to social influence. Even though Davis et al. (1989) included the subjective norm in the original model as an external variable, they dropped it from the model due to the uncertain theoretical and psychometric status. Subjective norm is defined as "the individual's perception of a referent other's opinion about the individual's performance of the behavior."(Fishbein and Ajzen, 1975, p.302). Subjective norm is determined by a multiplication of individual's normative beliefs and motivation to comply.

Two other social influence factors can be identified from Moore & Benbasat's (1991) study: image and visibility. Image is defined as "the degree to which adoption/usage of the innovation is perceived to enhance one's image or status in one's social system." (Moore & Benbasat, 1991: p.195). This is close to Chau's (1996) long-term PU and Tornatzky & Klein's (1982) social approval. Chau (1996) distinguished between near-term PU and long-term PU, stating the former relates to functionality of computer systems on improving job performance or enhancing job satisfaction, whereas the latter relates to improving one's social status. Tornatzky & Klein (1982) identified social approval as one of the ten characteristics addressed most frequently in over 100 innovation studies.

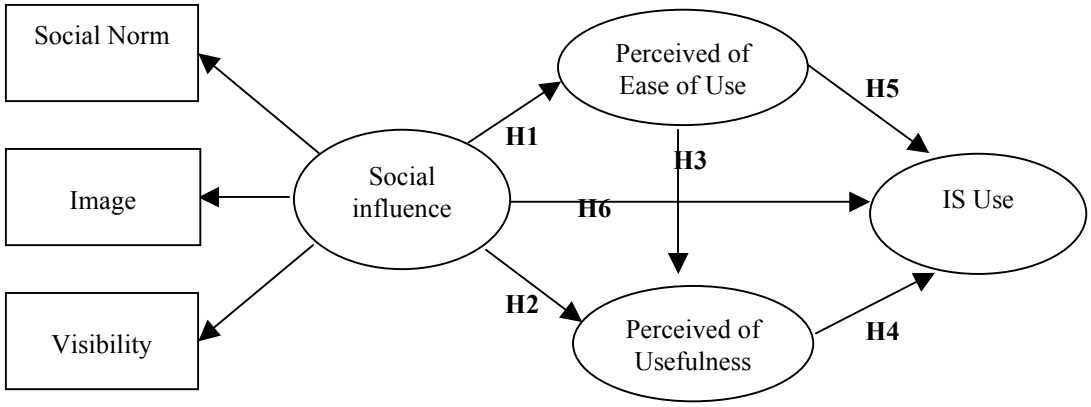
Visibility means "the degree to which the innovation is visible in the organization," which means the more a potential adopter can see an innovation, the more likely he is to adopt it

(Moore & Benbasat, 1991: p.195). Visibility is the very close concept to "critical mass" (Markus, 1990) and "network externality" (Riggins, Kriebel & Mukhopadhyay, 1994) that assert the usefulness of a network is primarily a function of the number of participants in the network. Compared to other social influence constructs, visibility is related to non-significant others because of the nature of critical mass theory. Therefore, we assume that these three constructs are different manifestations of social influence.

3. Research Model

Figure 1 depicts the research model of this study. A couple of ponderous decisions were made *a priori* in this model. First, like other studies of TAM (e.g., Adams et al., 1992; Chau, 1996), the attitude construct is taken out to simplify the model. Second, IS use, not early adoption, is chosen for the dependent variable. The reason why we are more interested in IS use is that it may be the more appropriate measure of technology innovation diffusion rather than the early adoption or acquisition (Fichman & Kemerer, 1999). Also, our interest in the prediction of actual behavior adds to the reason why "intention" is dropped from the model. A number of TAM studies excluded attitude and used actual usage behavior instead of intention in their TAM studies (e.g., Adams et al. 1992, Gefen and Straub, 1997; Igbaria et al., 1995; Straub et al. 1995; Cheung et al. 2000). The following discussions will proceed with respect to each path of figure 1.

[Figure 1] Research Model



3.1 Impact of social influence on PU & PEU

In TRA, all the external stimuli are assumed to influence behavior only indirectly via attitude or subjective norm (Fishbein & Ajzen, 1975: 396). TAM inserts two cognitive factors (PU and PEU) on the path between external stimuli and attitude, and insists that external stimuli influence a person's attitude toward a behavior indirectly by influencing PU and PEU. In TAM, external stimuli have been conceptualized diversely such as the various individual differences, situational constraints, and managerially controllable interventions (Davis et al., 1989: 988), as system design features (Davis, 1993: 476), or as the task, user characteristics, political influences, organizational factors, and the development process (Szajna, 1996: 86).
TAM is focused on individual psychological status. Moving beyond a concern with one user and an interface, the socio-technical perspective argues that a network of social relationships surrounds all working practices (e.g., Orlikowski, 1992; Weick, 1990). Technology historian Carl Mitcham (1994) recognizes the "unintended intentions" (symbolic import) in individual's adoption of technology artifacts, which address various styles and usage. This perspective

insinuates that individual's beliefs are socially constructed through interactions with other members. Therefore, the social influence must have significant impact on the individual PU and PEU over the characteristics of computer systems.

H1: Social influence will have significant impact on determining PEU of a system.
H2: Social influence will have significant impact on determining PU of a system.

3.2 Relationship between PEU and PU

Davis (1993) provides a theoretical rationale regarding the relationship between PU and PEU as follows:

> "PU concerns the expected overall impact of system use on job performance (process and outcome), whereas PEU pertains only to those performance impacts related to the process of using the system *per se*. … Consider a hypothetical new forecasting model, which although equally easy to use as the model it supersedes, provides a more accurate forecast. Moving from the old model to the new one, PU goes up with no effect on PEU. Thus, PEU influences PU but not vice versa." (Davis, 1993: 477-8).

This theoretical relationship has been supported by empirical evidences (e.g., Chau, 1996; Davis, 1989, 1993; Davis et al., 1989; Mathieson, 1991; Szajna, 1996; Taylor & Todd, 1995; Venkatesh & Davis, 1996). Consistent with these theoretical and empirical arguments, our study also assumes that PEU influences PU, not vise versa.

H3: Perceive ease of use of a system will have significant impact on determining PU of a system.

3.3 Influence of PU & PEU on IS Use

Davis (1989) assumed that PEU does not influence IS use, even though it influences PU, stating "PEU may actually be a causal antecedent to PU, as opposed to a parallel, direct determinant of system usage."(p. 319). Adams, Nelson & Todd (1992) warned not to focus on PEU in identifying the antecedents to IS use, saying "A heavy emphasis on PEU, particularly at the cost of functionality, is not advisable"(p. 237). Keil, Beranek and Konsynski (1995) nixed PEU-focused efforts such as developing a good user interface, stating "No amount of PEU will compensate for low usefulness" (p. 89). Even though the influence of these two constructs (PU & PEU) on IS use has not been consistent in empirical studies, most of TAM research share the common conclusion: PU influences on use, whereas PEU does not (Chau, 1996; Davis et al. 1989; Davis, 1989, 1993; Straub et al. 1997; Szajna, 1996). Our study takes this majority's opinion that PU leads to use, whereas PEU does not.

H4: PU of a system will have significant impact on system use.
H5: PEU of a system won't have significant impact on system use.

3.4 Impact of Social Influence on IS Use

Adams, Nelson & Todd (1992) and Subramanian (1994) reported that PU and PEU explain only marginal variances of IS use. In their studies, those two factors explain around 30% of the variance of IS use. These results imply that there must be additional factors that influence individual usage of IS. We can find a possible answer (i.e., missing factor) from other IS use

theories: TRA, TPB, and Innovation perspective. In common, these alternative theories include the "social influence" factors as antecedents of individual IS use. TRA and TPB contain "subjective norms" in their models. Moore & Benbasat's (1991) Innovation perspective includes two other social influence constructs, visibility and image.
Meanwhile, the debate regarding the direct influence of social factors on IS use has not been clearly settled. TRA, TPB, and Decomposed TPB in common assumed and empirically found that subjective norms are directly linked to IS use or adoption. Numerous studies also reported subjective norm is an important determinant of IS adoption or use (e.g., Cooper & Zmud, 1990; Hartwick & Barki, 1994; Laudon, 1985). Some studies delicately tested the influence of subjective norm by differentiating IS adoption and continuous use in terms of chronological diffusion of technology, and identified subjective norm influences only on early IS adoption (Hartwick & Barki, 1994; Karahanna, Straub & Chervany, 1999). On the contrary, Davis, Bagozzi and Warshaw (1989) and Mathieson (1991) reported non-significant path from subjective norms to the intention of IS use. Our study includes visibility and image with subjective norm as social influence constructs and tests if the expanded TAM has significant impact on system use.

H6: Social influence will have significant impact on system use.

Hypothesis 3, 4, and 5 may not sound new because previous TAM studies empirically conducted numerous hypotheses regarding PU and PEU, including the relationship between PU and PEU, and the relative importance of PU and PEU on IS use. Structural equation modeling estimates a series of separate, but interdependent, multiple regression equations simultaneously (Hair, Anderson, Tatham and Black, 1998). Therefore, the inclusion of social influence factors onto TAM must influence the strength of paths surrounding PU and PEU.

4. Methodology

4.1 Data Collection

Data was collected from under-graduate students who major in MIS (management information systems) in a college of management in New England area. Samples are regarded homogeneous in terms of demographic features such as age, grade and major. Students who were asked for survey already took or were taking the MIS courses such as the introduction to computers, database management, business network, programming languages. The questionnaires were handed out purposely late November, so that students are familiar with the MIS courses that they were taking. Students were asked to fill out both spreadsheet and Internet usage surveys anonymously and submit them to the class instructors on the voluntary basis. It took 9 weeks to finish collecting surveys. In total, 211 valid questionnaires were returned for spreadsheet usage, and 206 perfect questionnaires were returned for Internet usage out of 420 handouts, recording 50.2% and 49.0% of return ratio, respectively.

4.2 Questionnaire

All of measurement items are taken from the related research. Davis, Bagozzi & Warshaw (1989) measurement items regarding PU, PEU, and system use are taken. Measurement items of subjective norms came from Mathieson (1991) and Taylor & Todd (1995). Measurement items of visibility and image came from Moore and Benbasat (1991). Among the original

four items for the visibility scale, the statement "PWS are not very visible in my organization" is excluded because the word "visible" is used redundantly to measure "visibility".

4.3 Assessment of reliability and validity

The reliabilities for each scale are shown in Table 1. The measurement scales used in the study show high levels of reliability - Cronbach's alpha is above 0.60 for both software use and Internet use.

[Table 1] Reliability Estimates

Construct	Items	Spreadsheet Cronbach's alpha	Internet Cronbach's alpha
PU	4	.9428	.9571
PEU	4	.8967	.9065
Image	4	.8636	.9188
Visibility	3	.8205	.7985
Subjective Norm	2	.8717	.8415
IS Use	2	.8361	.6485

Convergent validity is assessed by factor analysis of the scales. The factor loadings are shown in Table 2. Through Varimax rotation, the 25 items are cleanly loaded onto 6 factors - PEU, PU, image, visibility, subject norm and IS use.

[Table 2] Factor Analysis of Scales

	Spreadsheet						Internet					
	Fac.1	Fac.2	Fac.3	Fac.4	Fac.5	Fac.6	Fac.1	Fac.2	Fac.3	Fac.4	Fac.5	Fac.6
PU1	.870	.173	.125	.154	.134	.119	.891	.157	.161	.110	.125	.004
PU2	.886	.176	.107	.118	.018	.145	.904	.195	.192	.010	.010	.005
PU3	.886	.198	.129	.091	.074	.136	.913	.196	.105	.005	.108	.005
PU4	.862	.204	.132	.090	.153	.069	.892	.009	.179	.103	.009	.107
PEU1	.165	.880	.086	.090	.087	.062	.160	.815	.008	.119	.007	.149
PEU2	.155	.760	.067	.162	.131	.184	.197	.844	.009	.126	.009	.002
PEU3	.195	.837	.054	.161	.073	.028	.117	.877	.104	.001	.118	.150
PEU4	.208	.827	.052	.182	.155	.122	.125	.861	.002	.102	.137	.156
IMG1	.150	-.036	.812	.115	.160	.131	.208	.004	.858	.104	.109	.002
IMG2	.121	.091	.871	.048	.094	.073	.229	.112	.862	.005	.008	.002
IMG3	.106	.078	.732	.084	-.109	.173	.006	.005	.852	.003	.152	-.008
IMG4	.058	.100	.850	.128	.017	.129	.010	.008	.921	.005	.010	.006
VS1	.154	.172	.060	.844	.032	.015	.195	.004	.001	.876	.152	.010
VS2	.125	.146	.153	.834	.153	.137	.151	.007	.005	.890	.156	.006
VS3	.089	.200	.226	.763	.110	.114	-.004	.008	.227	.734	.003	.005
SN1	.202	.202	.246	.145	.833	.142	.182	.164	.227	.219	.832	.108
SN2	.212	.143	.289	.115	.851	.070	.180	.263	.160	.142	.851	-.001

USE1	.137	.131	.050	.192	.677	.877	.008	.001	.120	.008	-.001	.862
USE2	.138	.219	.062	.063	.109	.881	.009	-.002	.250	.009	.009	.800

Notes: PU = Perceived Usefulness, PEU = Perceived Ease of Use, IMG = Image, VS = Visibility
SN = Social Norm

We assess the discriminant validity by testing if all items load more highly on their associated construct than on any other constructs. The square root of the average variance extracted for each construct was compared to the correlations between each construct and other constructs. All the values of the square root of the average variance (i.e., the diagonals) were greater than the correlations between constructs (i.e., the off-diagonals) in table 3, indicating that all the constructs in the model exhibited the discriminant validity.

[Table 3] Discriminant Validity

	Spreadsheet						Internet					
	PU	PEU	IMG	VS	SN	USE	PU	PEU	IMG	VS	SN	USE
PU	.926						.943					
PEU	.446	.878					.368	.889				
IMG	.302	.207	.852				.357	.204	.903			
VS	.336	.418	.306	.869			.251	.264	.174	.871		
SN	.424	.379	.470	.347	.940		.386	.386	.394	.371	.932	
USE	.313	.365	.167	.317	.292	.925	.203	.357	.042	.216	.173	.866

Note: Diagonal elements are the square roots of the average variance extracted and off-diagonal elements are correlations between constructs.

5. Data Analysis

Our empirical test would consist of two phases. The first phase is to check the second-order latent factor structure. This test is about whether those three first order latent factors are regressed onto the higher level latent factor. If the first-order latent factors regress onto the second-order factor, this higher-level factor could be named as the general "social influence." The second phase is to test the research model of figure 1. These steps of statistical analysis will be applied for both spreadsheet usage and Internet usage of students.

5.1 Test of Social Influence Factor Structure

By the review of various IS implementation literature, we proposed that social influence context might have a second-order factor structure with three dimensions - subjective norm, image and visibility. To test the proposed multi-dimensionality of the social influence construct, we conduct the confirmatory factor analysis using AMOS. The value of χ^2 for overall model fit with 24 degrees of freedom is significant for both cases. However, The chi-square test has been recognized as an inappropriate test for large sample sizes (Browne & Cudeck, 1993, Marsh, 1994). As recommended by Hair et al. (1998), several other fit indices are examined. The Goodness of Fit Index (GFI) and the adjusted Goodness of Fit Index (AGFI) should be greater than 0.90 and 0.80, respectively, and the Root Mean Square Error of Approximation (RMSEA) should be lower than 0.08 (Joreskog and Sorbom, 1993; Browne & Cudeck, 1993). The values of GFI, AGFI and RMSEA indicate a marginally satisfactory fitness for both spreadsheet and Internet data [Table 5]. To improve the model fitness, we refer to the modification indices that address the improvement of model fitness by adding

certain non-estimated paths. The value of modification index corresponds approximately to the reduction of chi-square if the path is included in the model. The criterion value to include the path into the model is 3.84 or greater (Hair et al., 1998). This kind of modification is sometimes recommended to improve model fitness in structural equation model (Hair et al., 1998; Arbuckle, 1997; Bone, Sharma & Shimp, 1989).

The current modification indices from our dataset suggest allowing the correlation between er1 and er2. This modification is acceptable because the correlation between er1 and er2 is the highest among all the image measurement items [Table 4]. This change helped all the goodness-of-fit indices surpass the acceptable level as shown in Table 5. Thus, the proposed hierarchical structure is very strongly supported [Figure 2].

[Table 4] Correlation Matrix of Image items

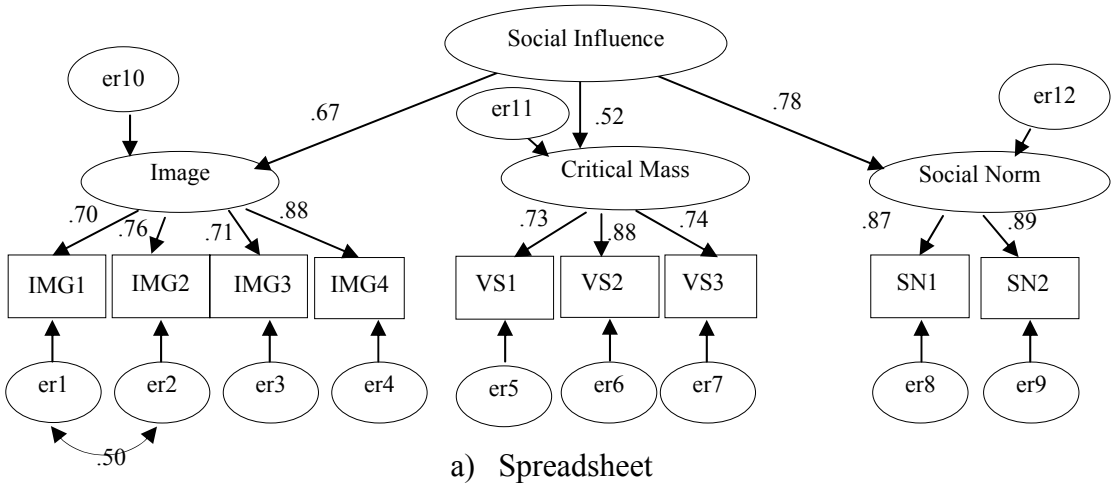
	Spreadsheet				Internet			
	IMG1	IMG2	IMG3	IMG4	IMG1	IMG2	IMG3	IMG4
IMG1	1.00				1.00			
IMG2	.766**	1.00			.835**	1.00		
IMG3	.444**	.535**	1.00		.636**	.642**	1.00	
IMG4	.627**	.670**	.638**	1.00	.748**	.760**	.825**	1.00

** p<0.01

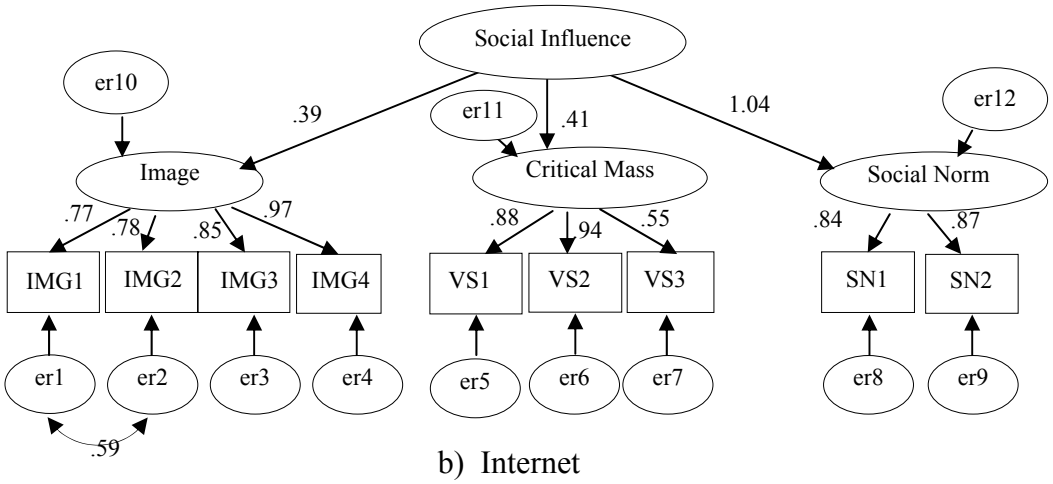
[Table 5] Summary Results for Confirmatory Factor Analysis for the Proposed Factor Structure of Social Influence

Fit Index	Spreadsheet		Internet	
	Initial model	Revised model	Initial model	Revised model
χ^2 (DF)	60.228(24)	32.990(23)	92.965(24)	28.069(23)
P value(>0.05)	0.000	0.081	0.000	0.213
χ^2/df(<5)	2.510	1.434	3.874	1.220
GFI(>0.90)	0.937	0.967	0.902	0.972
AGFI(>0.80)	0.882	0.935	0.816	0.945
RMSEA(<0.08)	0.085	0.045	0.118	0.033

[Figure 2] Social Influence as a Second-Order Factor Structure



a) Spreadsheet



b) Internet

5.2 Test of the Proposed TAM model

Structural equation analysis was conducted using Amos to test the research model of figure 1. There is no single recommended measure of model fitness. Therefore, a variety of measures is suggested (Bentler and Bonett, 1980; Fornell, 1983; Hayduk, 1987). A chi-square analysis indicates that the model for spreadsheet does not fit the data (Chi-square=65.512:p<0.005), but the model for Internet fits the data (Chi-square=39.175:p>0.005). The chi-square test has been recognized as an inappropriate test for large sample sizes (Browne & Cudeck, 1993, Marsh, 1994). Instead, Chi-square divided by degrees of freedom is suggested, and the value below 5 is recommended as the criterion (Wheaton, Muthen, Alwin and Summers, 1977). The value of Chi-square divided by degrees of freedom is approximately 1.7 for spreadsheet and 1.0 for Internet, which is below the cutoff-value. As mentioned above, the values of GFI, AGFI and RMSEA are examined for the judgment of the fitness of the proposed model. In our dataset, GFI is 0.952 and 0.967 and AGFI is 0.916 and 0.943, respectively for spreadsheet and Internet. RMSEA is at the acceptable level with 0.059 and 0.012, respectively for spreadsheet and Internet. Together, these four measures indicate that our model fits to data for both spreadsheet and Internet [Table 6].

[Table 6] Fit Measures for the proposed TAM model

	Spreadsheet	Internet
DF	38	38
χ^2	65.512	39.175
P value(>0.05)	p=0.004	p=0.417
χ^2/df(<5)	1.724	1.031
GFI(>0.90)	0.952	0.967
AGFI(>0.80)	0.916	0.943
RMSEA(<0.08)	0.059	0.012

5.3 Results and Analysis

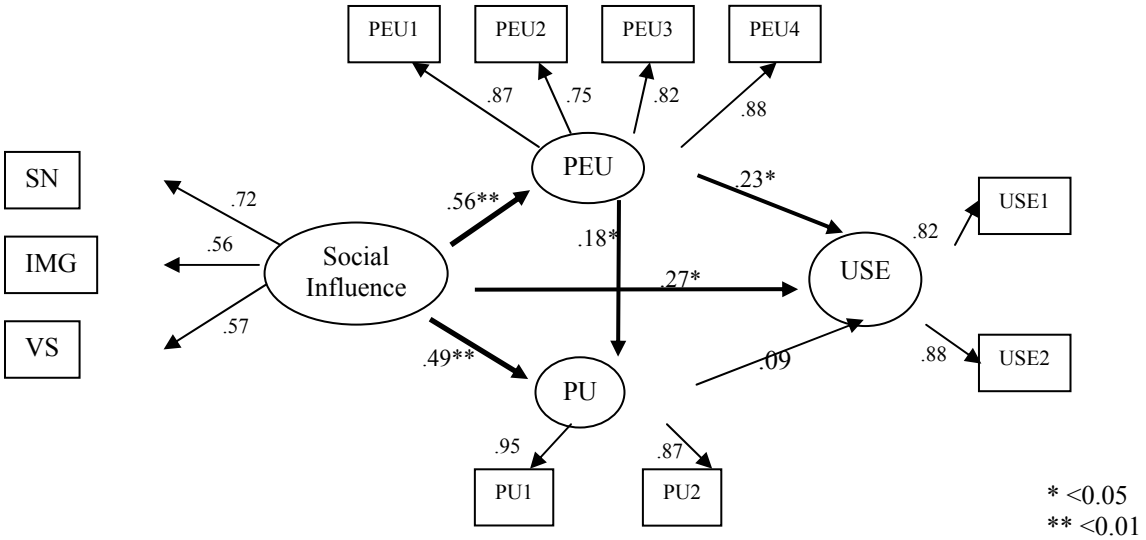
Analysis results of our hypotheses are summarized in figure 3 and 4, and table 7. The results are not entirely consistent across technologies, nor are they consistent with previous findings.

[Table 7] Summary of Results (path coefficients)

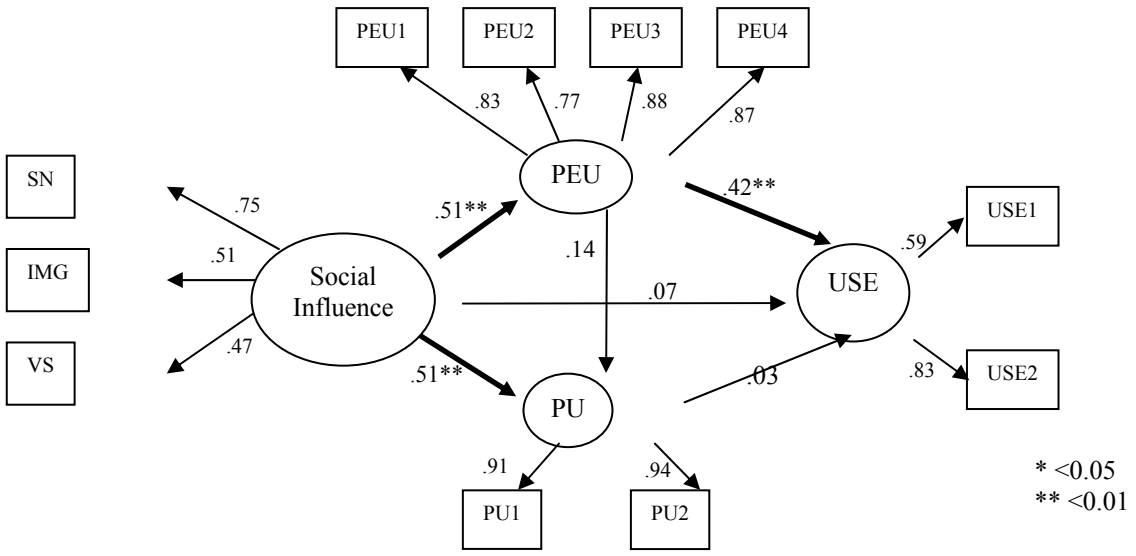
		Spreadsheet	Remarks	Internet	Remarks
H1	SI -> PEU	**0.56(0.000)****	Supported	**0.52(0.000)****	Supported
H2	SI -> PU	**0.49(0.000)****	Supported	**0.51(0.000)****	Supported
H3	PEU -> PU	**0.18(0.047)***	Supported	0.14(0.123)	Rejected
H4	PU -> USE	0.09(0.390)	Rejected	0.03(0.812)	Rejected
H5	PEU -> USE	**0.23(0.02)***	Rejected	**0.419(0.001)****	Rejected
H6	SI -> USE	**0.27(0.046)***	Supported	0.07(0.600)	Rejected

* <0.05 ** <0.01

[Figure 3] Path Coefficients of Spreadsheet Usage



[Figure 4] Path Coefficients of Internet Usage



The path from social influence to PU and PEU is significant for both spreadsheet (0.56(0.000) and 0.49(0.000)) and Internet (0.52(0.000) and 0.51(0.000)). Therefore, hypothesis 1 and 2 are supported for both spreadsheet and Internet: i.e., the social influence has substantial impact on PEU and PU.

Figure 3 and 4 show that the path from PEU to PU is significant only for spreadsheet (0.18(0.047)). This result reconfirms the results of the previous TAM research (Hartwick & Barki, 1994; Taylor & Todd, 1995). However, the path is not significant for Internet usage. Therefore, hypothesis 3 is partially supported.

We get the reverse results about the hypothesis 4 and 5 for both spreadsheet and Internet: i.e., PEU influences IS use, whereas PU doesn't. The above results regarding hypothesis 3, 4, and 5 indicate that PEU has direct influence on spreadsheet usage as well as indirect one through PU, whereas it has only direct influence on Internet usage. These inconsistent findings may pertain to the nature of the technology itself that will be discussed in the next section. The relative importance of PU and PEU on IS use has been disputable in numerous MIS studies. The detailed discussion on this issue will also follow in the next section.

The path from social influence to IS use is significantly supported only for spreadsheet usage (0.027(0.046)). Therefore, hypothesis 6 is partially supported. These inconsistent findings may pertain to the nature of the technology itself that will be discussed in the following section.

6. Discussion

This section discusses a couple of major unexpected results of our study: i.e., the relative importance of PU and PEU on IS use, and the different nature of spreadsheet and Internet.

The first issue pertains to the test results of hypothesis 4 and 5, and the second one is associated with those of hypothesis 3 and 6.

Even though our results regarding the relative importance of PU and PEU on IS use (hypothesis 4 & 5) are at odds with the original TAM study, we can notice several TAM studies reported the similar results as ours. For example, Adams, Nelson & Todd (1992) found that the path from PEU to IS use was significant from their cross-sectional study that surveyed experienced users for their spreadsheet software usage. They reported that the experienced users place less weight on PU rather than PEU. The context of their study was similar to ours. Igbaria, Zinatelli, Cragg & Cavaye(1997) reported that, in small firms, PEU influence IS usage more significantly than PU. Thompson, Higgins & Howell(1991) also found the near-term complexity, which is similar to PEU, has significant path coefficient to PC utilization. Lu & Gustafson (1994) reported that PU influence neither early adoption nor stable use, whereas PEU influences both.

In addition to the empirical history above, the path from PEU to IS use has theoretical rationale. Bandura (1997) identifies two separate expectations affecting individual behaviors: self-efficacy and outcome expectancy. Self-efficacy refers to an individual's belief that he/she possesses the requisite skills and abilities to accomplish an identifiable task, whereas outcome expectancy refers to a belief of outcome values, so that individuals are likely to undertake behaviors they believe will result in valued outcomes. Bandura states that self-efficacy typically has a larger effect, and has also a direct impact on outcome expectancy. In the IS context, self-efficacy is closer to PEU, whereas outcome-expectancy to PU (Compeau & Higgins, 1995; Davis, 1989; Lu & Gustafson, 1994). Some regarded self-efficacy as an antecedent to PEU (Igbaria, Zinatelli, Cragg & Cavaye, 1997; Venkatesh & Davis, 1996), and related to various aspects of computer usage (Compeau & Higgins, 1995). All these empirical findings and theoretical arguments imply that PEU could influence IS use more than PU does.

The split support for hypothesis 3 and 6 can be attributable to the nature of the technology itself. While the spreadsheet is task-oriented, the Internet is for other personal purposes such as fun and sympathy. Although the use of spreadsheet is not compulsory for these users, it has become a *de facto* standard for performing task. Tayor and Todd (1995) reported that in deciding whether to use the facility, students are likely to be influenced by both what their professors might think, due to possible impact on their grades, and by what their peers think due to the competitive nature of the environment. Though the spreadsheet usage is not compulsory, the social influence on the usage of spreadsheet has been recognized elsewhere (e.g., Moore and Benbasat, 1991; Adams et al., 1995). However, Internet is being used to communicate with virtual community or search useful information (Armstrong & Hagel, 1996; Riggins & Rhee, 1999). Thus, the spreadsheet is more attentive to social cues while Internet attends to rather affect-related stimuli such as PEU.

7. Conclusions

The purposes of our study were (a) to empirically examine the indirect and direct impact of social influence in technology acceptance model and (b) to examine if the expanded TAM is applicable for two different information systems contexts: spreadsheet and Internet. The findings to these questions are as follows.

First, we found that social influence, which has been disregarded in TAM, is an important determinant in explaining technology acceptance and use of spreadsheet. In both cases of spreadsheet and Internet use, social influence is found to have substantial impact on both PEU and PU, and has a stronger indirect impact on IS use through PEU than PU.

Second, we also found that the direct or indirect impact of social influence is different between technologies. The different results may pertain to the different nature of technologies. While the spreadsheet is task-oriented, the Internet is for other personal purposes such as fun and sympathy. So, the usage of Internet is relatively less compulsive than spreadsheet.

The current study provides preliminary evidence suggesting that technology acceptance and usage behavior are determined by social influence factors as well as individual perception factors in a certain technology. Our study negates the definitive perspectives (both positivists and negativists) regarding the social influence on IS usage. We argue that social influence has differential impacts on IS use according to the characteristics of information technology. Given this is just a single study, our results should be replicated by future studies before we suggest definitive changes in the existing theories of technology acceptance.

Like other social studies, the current study has several limitations. First, we used only perceptual measures of IS use. Many studies have shown that individuals' perceptions of IS usage are sometimes quite different from their actual usage pattern (Collopy, 1996; DeLone & McLean, 1992; Straub, Limayem, Karahanna-Evaristo, 1995; Tricy & Treacy, 1986).

Second, our sample was from undergraduate students who major in MIS. They may be more knowledgeable (therefore, spoiled) about computer features. Therefore, it is difficult to apply the result of this study to inexperienced end users. Also, no organizational setting is considered in our data set. IS implementation studies have emphasized the importance of organization issues (such as structure, size, industry, support, change management, etc.). These issues could not be considered in this study at all.

Third, since we used a cross-sectional data set, with both independent and dependent variables collected contemporaneously, the results are susceptible to same method bias. That is, the correlation between independent and dependent variables, and the explained variance

of the dependent variable, might have been inflated because these were all measured at the same time within the same questionnaire.

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