Modeling the User Acceptance of E-Mail

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Abstract

The Technology Acceptance Model (TAM) predicts whether users will ultimately use software applications based upon causal relationships among belief and attitudinal constructs that influence usage behavior. Electronic mail, or email, is a collaborative technology available to virtually all members of an organization, and typically, there are alternative email applications available for use. This study applies TAM to assess the user acceptance and voluntary usage of a particular email application, cc:mail, in two different organizations. The results largely validate TAM, although the findings suggest that certain external variables, namely length of time since first use, and level of education, directly affect email usage behavior apart from their influence as mediated through the perceived usefulness (PU) and perceived ease of use (PEOU) constructs.

1. Introduction

A recurrent theme in information systems research involves predicting the adoption and future usage of newly-introduced information technologies. A number of theoretical approaches have been investigated, including Diffusion of Innovations [35], the Theory of Planned Behavior [33], and Social Cognitive Theory [7] [8]. However, over the past ten years, the Technology Acceptance Model (TAM) [11] [13] has probably been the most widely cited approach. According to [41], as of January, 2000, no less than 424 journal articles had cited the two original TAM articles that were published in *MIS Quarterly* [11] and *Management Science* [13]. Indeed, the internet site http://www.guuspijpers.com/TAM.htm lists no fewer than 31 additional journal articles regarding TAM published in 2000-2002. Furthermore, many of these studies specifically applied TAM to predict the acceptance and future usage of email-specific applications [1] [10] [11] [12] [20] [27] [28] [29] [38].

In this study, we examine the impact of three *individual difference* variables on individual usage volume and usage frequency of a collaborative email application, cc:mail, in two organizations. These individual difference variables are *length of time since first use*, *level of education*, and *employment category*. Using structural equation modeling and path analysis, we compute the relative influences on usage of these three individual difference variables as: (1) *indirectly* mediated through perceived usefulness (PU) and perceived ease of use (PEOU); and, alternatively (2) as impacting usage volume and usage frequency *directly*.

2. Theory and background

Fishbein and Ajzen's [18] [19] Theory of Reasoned Action (TRA) and Davis' [10] [11] [12] Technology Acceptance Model (TAM) provide a theoretical nexus for measuring beliefs and attitudes to predict future behaviors. Two particular belief constructs, *perceived usefulness* (PU) and *perceived ease of use* (PEOU) are centrally important in TAM for predicting information technology users' acceptance behaviors. Figure 1 illustrates TAM [12]. Based on TRA, TAM assumes that the decision to use a particular information technology is based on one's *cognitive response* (PU and PEOU) to using that technology, which in turn affects one's *affective response* (attitude) towards that technology. Ultimately, the affective response drives the *behavioral response* about whether to use the technology.

As illustrated in Figure 1, a key assumption of TAM is that external variables influence the decision to use technologies only indirectly through their impact on users' beliefs (PU and PEOU). This assumption is critical in that it suggests that the amount of information technology usage explained by TAM cannot be improved by accounting for the *direct* impact of external variables on usage behavior. However, few studies have actually

tested whether the influence of external variables on usage behavior is fully mediated by PU and PEOU. Researchers have studied users' *perceptions* of external variables as impacting TAM, such as *perceived support* [26] and *perceived resources* [34]. However, one can argue that perceptions are more akin to cognitive responses (see Figure 1) than to true (exogenous) external variables. Studies have also looked at external variables as impacting TAM that are specific to a particular technology, such as the type of technology [12] [28], or to the nature of the task [15]. However, perhaps a more relevant test of the mediating influence of TAM's PU and PEOU constructs would be to examine external variables that are independent of the users' perceptions and of the immediate task.

Figure 2 illustrates the research model. We examine the impact of three *individual difference* variables on individual usage volume and usage frequency of a collaborative email application, cc:mail, in two organizations. These individual difference variables are *length of time since first use*, *level of education*, and *employment category*. Using structural equation modeling and path analysis, we compute the relative influences on usage of these three individual difference variables as: (1) *indirectly* mediated through PU and PEOU; and, alternatively (2) as impacting usage volume and usage frequency *directly*.

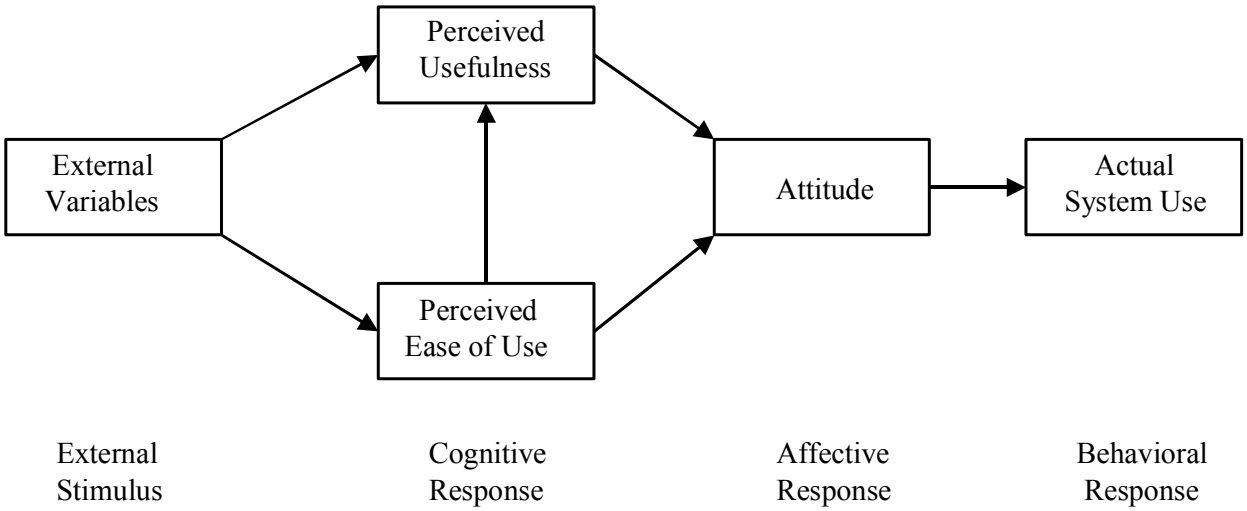

Figure 1. Technology acceptance model

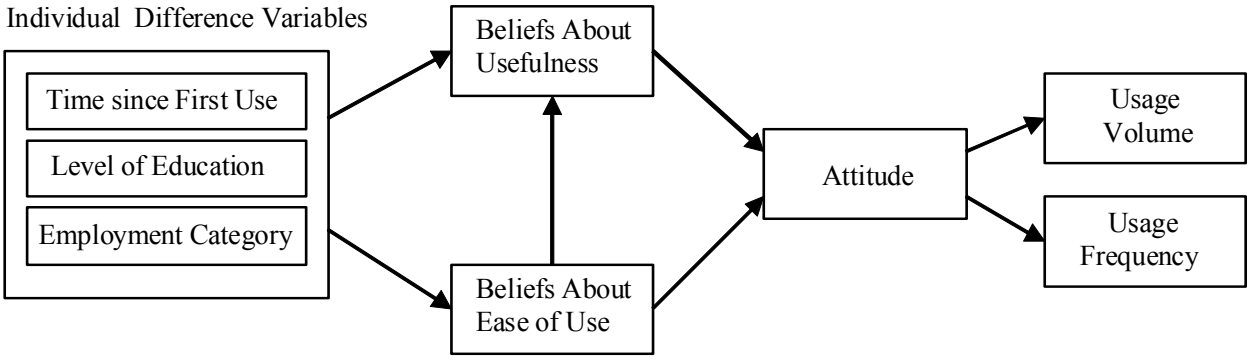

Figure 2. The research model

Very few studies have empirically tested the relative direct and indirect (mediating) influences of users' individual differences on usage behavior vis a vis TAM. Those that have largely support the notion that PU and PEOU 'fully mediate' the influence of the individual difference variables on usage behavior. For example, Gefen and Straub [20] reported that gender had a significant impact on TAM's belief constructs but no

independent direct effect on usage behavior. In addition, Agarwal and Prasad [3] reported that the TAM variables fully mediated the effects of individual difference variables (role with regard to technology, tenure in workforce, level of education, prior similar experience, and participation in training) on users' intention to use a new information technology. This study is similar in design and intent to that of Agarwal and Prasad [3]. However, we reach very different conclusions.

3. Research method

3.1. Subjects and procedure

Data was collected at two sites: a large manufacturing corporation with revenues in excess of $4B annually, and at the headquarters of a large federal government agency. Subjects at the corporate site included 96 staff and professional employees who agreed to participate. Subjects at the government site included 122 staff and professional employees. Questionnaires were circulated that solicited their beliefs and attitudes regarding one of several email packages (Cc:mail) available on the site's LAN.

3.2. Constructs

This study examines relationships among eight measured variables (see Figure 2). There are three *individual difference variables*, namely users' *length of time since first use*, *level of education*, and *employment category*. Beliefs about *usefulness* (PU) and *ease of use* (PEOU) were measured with two of Davis' original scales for these constructs. The corporate site utilized Davis' [11] [12] original instrument (see Appendix) containing ten items for each of the PU and PEOU constructs, and five items for the attitude construct. The government site utilized Davis' [11] original semantic differential scale instrument (see Appendix) containing six items for each of the PU and PEOU constructs, and five items for the attitude construct. At both sites, *attitude* was measured with 7-point semantic differential scales as suggested by Ajzen and Fishbein [2] and used by Davis [12]. Two measures of *actual system use* are separately assessed. *Usage volume* is measured as how many hours per week the respondent reports using the email application. *Usage frequency* is measured as how many times per week the respondent reports using the email application.

Individual differences have been an important factor in IS research for decades [42]. The significant impact of individual differences have been noted in various IS research streams, including end-user computing [22] and decision support systems [4].

In a similar TAM study, Davis [12] tested 'system design features' as an external variable, which simply distinguished between two software packages, an electronic mail system and a text editor. In this same study, he stated (p. 483): "Other [external] variables that could be examined include *system familiarity or experience* . . ." In this study, we use *length of time since first user* as a system familiarity/experience surrogate.

Levin and Gordon [30] found that subjects who owned computers were more motivated to become familiar with computers, and had more favorable attitudes towards computers, than did subjects who did not own computers. Dambrot, Silling and Zook [9] showed that subjects who failed an assembly language programming course had significantly less computer experience than those who did not fail the course. In a text editing study, Rosson [37] showed that experience was positively correlated with the number of lines edited per minute. Elkerton and Williges [17] found that experience explained more variance in information search times than did other individual variables. Experience has been demonstrated to have a large effect on performance with a specific system [16] [39].

Zmud [42] documented that *level of education* influences the successful use of computer applications. Davis and Davis [14] noted that more educated end users significantly outperformed less educated end users in a training environment. Several studies have reported that higher levels of education are negatively related to computer anxiety, and positively related to favorable computer attitudes [24] [25] [36]. Lucas [31] reported that less educated individuals have more negative attitudes towards information systems than do individuals with more education. Harrison and Rainer [22] maintained that education is effective in overcoming negative attitudes towards computers.

3.3. Construct measurement and validation

Partial Least Squares (PLS), a Structural Equation Modeling (SEM) tool, was used to perform the analyses (specifically, PLS-GRAPH version 3.00 build 279). SEM enables researchers to simultaneously examine the structural component (path model) and measurement component (factor model) in one model [21]. The use of PLS has advantages over other SEM tools, such as LISREL, in that PLS can be applied to explore the underlying theoretical model [21]. Further, PLS can be used with smaller sample sizes than LISREL because it

does not require restrictive distributional assumptions about the underlying data [8].

The survey questionnaires were designed to measure three distinct latent constructs: *PU*, *PEOU*, and *attitude towards using*. Factor analyses were used to separately validate the measurement of these constructs at the two sites. Factors were extracted using covariance matrices and the method of principal components. Oblique rotations were used to help interpret initial factor patterns. The factor loadings (see Tables 1 and 2) provide evidence for the factorial validity of the three scales at each site. In addition, for the corporate site instrument, cronbach's alpha is 0.96 for PU, 0.94 for PEOU, and 0.94 for attitude. For the government site instrument, cronbach's alpha is 0.96 for PU, 0.96 for PEOU, and 0.97 for attitude, reflecting high levels of construct validity for both instruments.

Table 1. Factor loadings of corporate site questionnaire items

Item Number	Perceived Usefulness	Perceived Ease of Use	Attitude Toward Using
Q1	**0.91**	0.00	- 0.14
Q2	**0.86**	- 0.09	0.02
Q3	**0.66**	0.09	0.30
Q4	**0.82**	0.03	- 0.04
Q5	**0.72**	0.01	0.27
Q6	**0.95**	0.00	- 0.01
Q7	**0.94**	0.01	- 0.03
Q8	**0.80**	0.03	0.12
Q9	**0.75**	- 0.01	0.18
Q10	**0.55**	0.05	0.43
Q11	- 0.21	**0.74**	0.36
Q12	0.11	**0.81**	- 0.23
Q13	0.03	**0.77**	0.02
Q14	0.06	**0.77**	0.09
Q15	- 0.10	**0.77**	0.18
Q16	0.08	**0.80**	- 0.10
Q17	- 0.08	**0.82**	- 0.03
Q18	0.13	**0.85**	- 0.16
Q19	- 0.04	**0.83**	- 0.07
Q20	0.06	**0.69**	0.26
Q21	0.15	0.04	**0.72**
Q22	0.04	- 0.20	**0.93**
Q23	0.01	0.04	**0.87**
Q24	0.18	0.01	**0.77**
Q25	0.05	0.05	**0.88**

A pre-questionnaire solicited respondents' *length of time since first use*, *levels of education*, and *employment categories*. The survey at the corporate site captured *employment category* and *level of education* as external variables. The survey at the government site captured *length of time since first use* and *level of education* as external variables. Two questions were appended to the belief/attitude questionnaire to solicit responses about levels of *usage frequency* and *usage volume* for that application. *Length of time since first use* was measured as subjects' self-report of the "length of elapsed time (in weeks) since they first used the cc:mail application." *Levels of education* were recorded as: (1) high school graduate; (2) some college; (3) two-year associate's degree; (4) bachelor's degree; (5) some graduate school; (6) master's degree; and (7) doctoral degree. Subjects indicated their *employment categories* from among four choices: (1) staff support; (2) technical professional; (3) managerial professional; and (4) executive. *Usage frequency* was recorded as: (1) don't use at all; (2) use less than once a week; (3) use about once each week; (4) use several times each week; (5) use about once each day; and (6) use several times each day. *Usage volume* was measured by the response to the following question: "Please specify (estimate) how many hours each week you normally spend using cc:mail: _____ hours." Both of these usage metrics are similar to those used by Davis [12].

Table 2. Factor loadings of government site questionnaire items

Item Number	Perceived Usefulness	Perceived Ease of Use	Attitude Toward Using
Q1	**0.82**	0.04	0.07
Q2	**0.98**	0.07	- 0.10
Q3	**0.84**	0.02	0.14
Q4	**0.97**	- 0.11	0.01
Q5	**0.77**	0.06	0.16
Q6	**0.63**	0.04	0.32
Q7	- 0.08	**0.95**	0.03
Q8	0.02	**0.93**	- 0.01
Q9	0.04	**0.90**	0.04
Q10	- 0.01	**0.85**	0.07
Q11	0.09	**0.85**	- 0.05
Q12	0.04	**0.84**	0.12
Q13	0.15	0.12	**0.75**
Q14	0.08	0.07	**0.85**
Q15	0.03	0.07	**0.88**
Q16	0.16	- 0.03	**0.83**
Q17	0.05	0.04	**0.88**

4. Results

Figures 3 and 4 show the indirect and direct effects, respectively, of employment category and level of education on PEOU, PU, attitude, usage volume, and usage frequency for the email system at the corporate site. Figures 5 and 6 show the indirect and direct effects, respectively, of length of time since first use and level of education on the belief, attitude and usage metrics for the email application at the government organization. These Figures indicate significant (at $p < 0.05$) and non-significant path coefficients, as well as the amounts of variance explained in the predicted constructs (PEOU, PU, attitude, usage volume, and usage frequency). The significance of the paths were estimated using a PLS bootstrapping procedure [34] utilizing 200 resamples, an amount that provides reasonable standard error estimates [6].

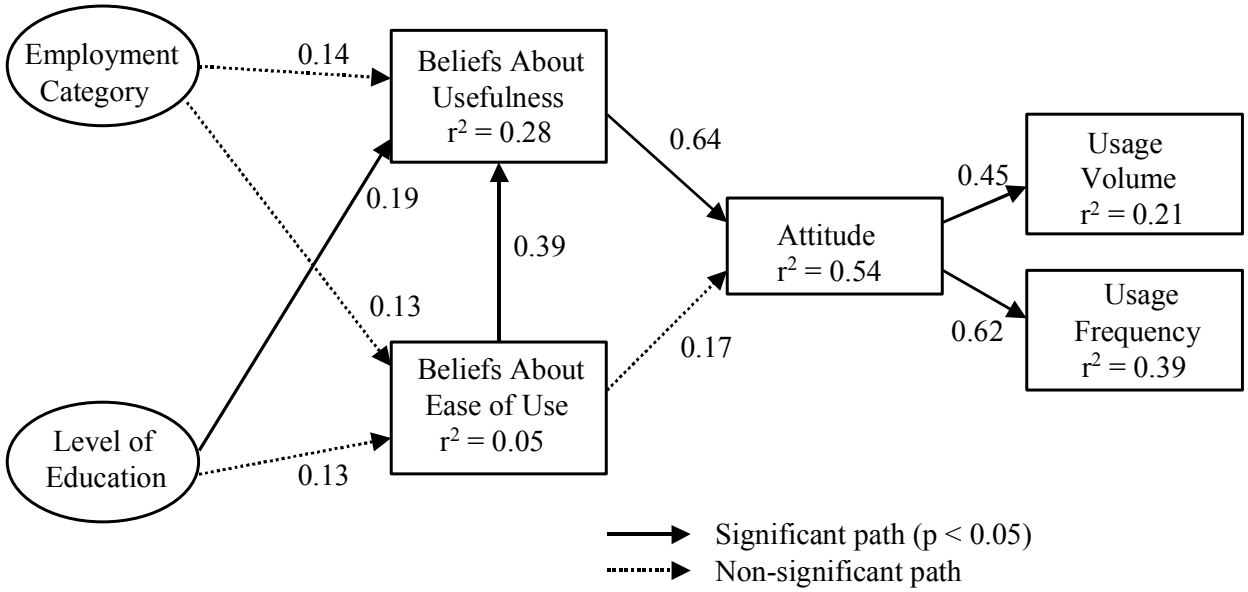

Figure 3. Testing indirect (mediating) effects at corporate organization

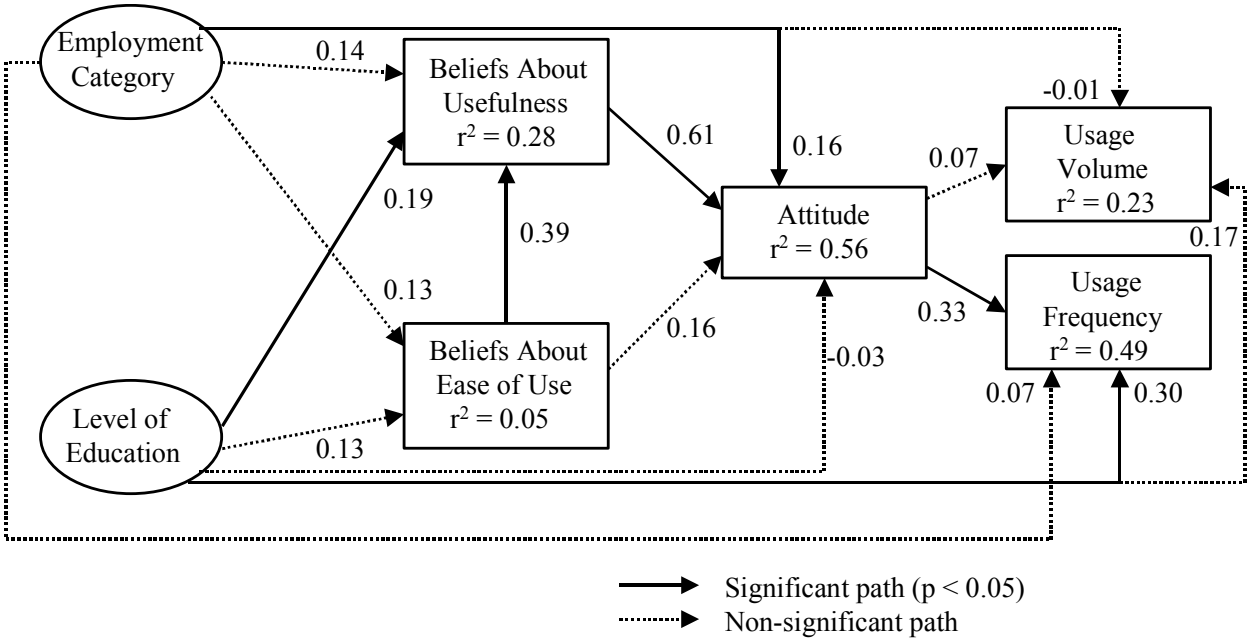

Figure 4. Testing direct effects at corporate organization

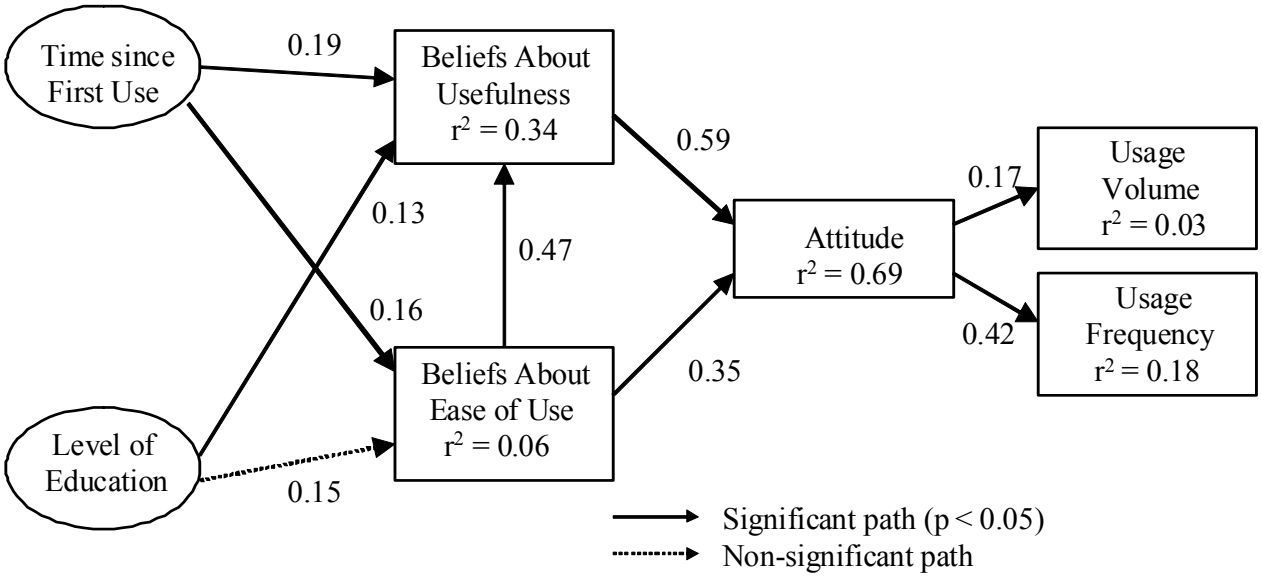

Figure 5. Testing indirect (mediating) effects at government organization

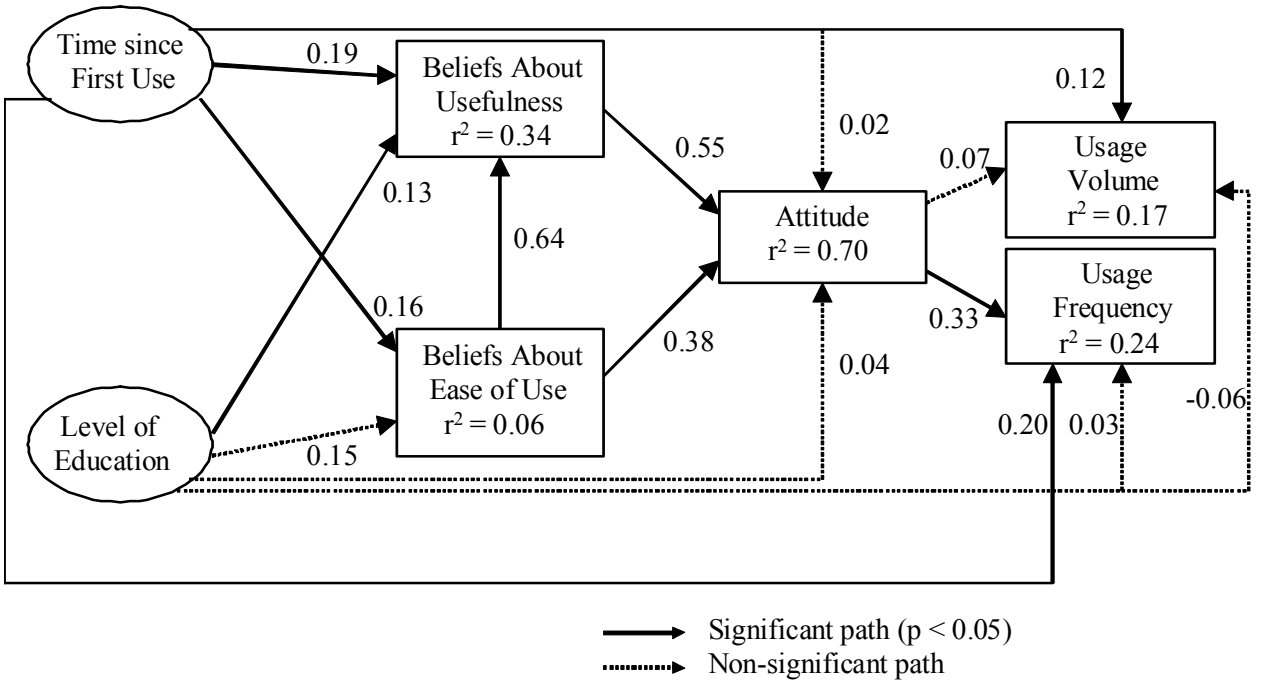

Figure 6. Testing direct effects at government organization

At the corporate site, the indirect mediating model (Figure 3) indicates a significant influence of level of education on PU. The remaining TAM model paths are all significant (with the exception of the path from PEOU to attitude). The model explains 21% of the variance in usage volume and 39% of the variance in usage frequency. However, when the direct influences of the individual difference variables are considered (Figure 4), there is a significant direct effect of employment category on attitude, as well as a significant direct effect of level of education on usage frequency. PU and PEOU do not fully mediate the impact of the individual difference variables on attitude, nor on usage behavior. Further, the influence of attitude

on usage volume is no longer significant as in Figure 3. Perhaps more importantly, the amount of the variance explained in usage volume increases from 21% to 23%, and the amount of variance explained in usage frequency increases from 39% to 49%, when the direct influences of the individual difference variables are considered.

At the government site, the indirect mediating model (Figure 5) again indicates a significant influence of level of education on PU. There are also significant effects of length of time since first use on PEOU and PU. The remaining TAM model paths are all significant. This model explains only 3% of the variance in usage volume and 18% of the variance in usage frequency. However, when the direct influences of the individual difference variables are again considered (Figure 6), there are significant direct effects of length of time since first use on usage volume and on usage frequency. As is the case at the corporate site, PU and PEOU again do not fully mediate the impact of the individual difference variables on usage behavior. Further, the influence of attitude on usage volume again becomes insignificant. Moreover, the amount of the variance explained in usage volume increases from 3% to 17%, and the amount of variance explained in usage frequency increases from 18% to 24%, when the direct influences of the individual difference variables are considered.

5. Discussion

Mathieson, Peacock and Chin [34] describe a "pseudo F-test" technique to measure whether the substantive change in the explained variance (R^2) of usage is statistically significant after the direct influences of the external variables are taken into account. The *effect size* (f^2) can be estimated as $((R^2_{full} - R^2_{excluded}) \div (1 - R^2_{full}))$, where R^2_{full} is the explained variance including the direct influences of the external variables, and $R^2_{excluded}$ is the explained variance in usage without these direct influences. Multiplying f^2 by $(n - k - 1)$, where n is the sample size, and k is the number of independent constructs, provides a *pseudo F test* for determining whether the f^2 statistic is significant with 1 and $n - k$ degrees of freedom. Using this approach, the f^2 for the increased variance explained in usage volume and usage frequency of the email application at the corporate site is significant at $p < 0.15$ and $p < 0.001$, respectively, after the direct effects of the external variables are considered. Furthermore, the increased variance explained in usage volume and usage frequency of the email application at the government site is significant at $p < 0.001$ and $p < 0.005$, respectively. So the direct influence of level of education, over and above the mediating effects through PU and PEOU, significantly explained more variance in cc:mail usage frequency at the corporate organization. In addition, the direct influence of length of time since first use significantly explained more variance in both usage volume and usage frequency of cc:mail at the government organization. These findings are relevant and important because the purpose of TAM is to predict the user acceptance of new information technologies, specifically by predicting the future usage of those technologies. Consequently, models that account for larger proportions of usage behavior are inherently more valuable.

It should not be surprising that the research model explained more of the variance of cc:mail *usage frequency* than of cc:mail *usage volume* at both the corporate and government sites. As a collaborative communications technology, individual usage patterns for email systems are typified by short and frequent 'bursts' of usage, for example in responding to important email messages as they arrive, as opposed to long hours of continuous use. As such, the finding that modeling the direct effects of the external variables (Figures 4 and 6) significantly increased the amount of usage frequency variance explained is even more compelling. This finding indicates that the belief constructs (PU and PEOU) may be *potent* (but not complete) mediators [5] of the influence of the external variables on usage, but that direct effects remain.

6. Conclusions

Our primary objective was to ascertain whether the PEOU and PU belief constructs *partially* or *fully* mediated the effects of the individual differences on email usage behavior. The findings suggest that the belief constructs only *partially* mediate the influences of length of time since first use, level of education, and employment category on cc:mail usage volume and usage frequency. We offer two possible explanations for this seeming contradiction to TAM's 'full mediation' assumption: (1) that TAM's inherently 'parsimonious' nature has excluded other critical belief constructs that are necessary to fully capture and mediate the influence of all external variables on user acceptance and subsequent usage behavior; or (2) that there is some characteristic(s) of collaborative technology in general, or email technology in particular, that requires additional explanatory constructs to be included.

A guiding influence in developing TAM was that prior research indicated a wide range of disjointed factors affecting usage behavior. As a result, TRA's

belief constructs were condensed into the two PEOU and PU variables. Additional relevant belief constructs were investigated (such as users' *subjective norms*) but were ultimately excluded from TAM [41].

The point is that TAM was deliberately developed to be a parsimonious model, making it possible that additional belief constructs that were needed to fully mediate the effects of external variables on usage behavior were overlooked and omitted from the model. Accordingly, other researchers have tested extensions of TAM that incorporate additional belief constructs. For example, Mathieson [33] and Hartwick and Barki [23] considered users' *subjective norms* (or peer pressure). Compeau and Higgins [7] introduced computer *self-efficacy*, operationalized as users' beliefs in their ability to use IT. Taylor and Todd [40] examined users' *perceived behavioral control*. Mathieson et al. [34] and Igbaria et al. [26] scrutinized users' beliefs regarding *perceived support* and *perceived resources*. More research is needed to investigate additional relevant belief constructs in TAM.

Alternatively, it may be that the nature of collaborative technology in general, or email in particular, accounts for the lack of 'full mediation' of the influence of the external variables on attitudes and usage behavior. For example, there is evidence that senior members of an organization use email more often because their work requires more extensive communications [32]. Thus, regardless of their belief structures, we could expect more senior managers to hold more favorable attitudes towards email applications (see Figure 4). Furthermore, more educated users have been found to outperform less educated individuals in learning new information technologies [14]. Since modern email applications are complex and flexible, allowing users numerous profiling and usage options, we might expect more educated users to exhibit accelerated usage patterns, regardless of their belief systems. So perhaps we should expect direct effects of certain individual difference variables on the usage of email applications regardless of users' cognitive responses.

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8. Appendix

CORPORATE SITE PU AND PEOU ITEMS - Subjects responded to the following twenty questions on a Likert-type scale ranging from one (strongly disagree) to seven (strongly agree):

1. Using cc:mail improves the quality of the work I do.
2. Using cc:mail gives me greater control over my work.
3. Cc:mail enables me to accomplish tasks more quickly.
4. Cc:mail supports critical aspects of my job.
5. Using cc:mail increases my productivity.
6. Using cc:mail improves my job performance.
7. Using cc:mail allows me to accomplish more work than would otherwise be possible.
8. Using cc:mail enhances my effectiveness on the job.
9. Using cc:mail makes it easier to do my job.
10. Overall, I find the cc:mail system useful in my job.
11. I find the cc:mail system cumbersome to use.
12. Learning to operate the cc:mail system is easy for me.
13. Interacting with the cc:mail system is often frustrating.
14. I find it easy to get the cc:mail system to do what I want it to do.
15. The cc:mail system is rigid and inflexible to interact with.
16. It is easy for me to remember how to perform tasks using the cc:mail system.
17. Interacting with the cc:mail system requires a lot of mental effort.
18. My interaction with the cc:mail system is clear and understandable.
19. I find it takes a lot of effort to become skillful at using cc:mail.
20. Overall, I find the cc:mail system easy to use.

GOVERNMENT SITE PU AND PEOU ITEMS - Subjects responded to the following questions by marking an "X" in the center of one of the seven places indicated for each question:

1. Using cc:mail in my job enables me to accomplish tasks more quickly:

likely	:	:	:	:	:	:	unlikely
	extremely	quite	slightly	neutral	slightly	quite	extremely

2. Using cc:mail improves my job performance:

likely	:	:	:	:	:	:	unlikely
	extremely	quite	slightly	neutral	slightly	quite	extremely

3. Using cc:mail in my job increases my productivity:

likely	:	:	:	:	:	:	unlikely
	extremely	quite	slightly	neutral	slightly	quite	extremely

4. Using cc:mail enhances my effectiveness on the job:

likely	:	:	:	:	:	:	unlikely
	extremely	quite	slightly	neutral	slightly	quite	extremely

5. Using cc:mail makes it easier to do my job:

likely	:	:	:	:	:	:	unlikely
	extremely	quite	slightly	neutral	slightly	quite	extremely

6. I find cc:mail useful in my job:

likely	:	:	:	:	:	:	unlikely
	extremely	quite	slightly	neutral	slightly	quite	extremely

7. Learning to operate cc:mail was easy for me:

likely	:	:	:	:	:	:	unlikely
	extremely	quite	slightly	neutral	slightly	quite	extremely

8. I find it easy to get cc:mail to do what I want it to do:

likely	:	:	:	:	:	:	unlikely
	extremely	quite	slightly	neutral	slightly	quite	extremely

9. My interactions with cc:mail are clear and understandable:

likely	:	:	:	:	:	:	unlikely
	extremely	quite	slightly	neutral	slightly	quite	extremely

10. I find cc:mail to be flexible to interact with:

likely	:	:	:	:	:	:	unlikely
	extremely	quite	slightly	neutral	slightly	quite	extremely

11. It was easy for me to become skillful at using cc:mail:

likely	:	:	:	:	:	:	unlikely
	extremely	quite	slightly	neutral	slightly	quite	extremely

12. I find cc:mail easy to use:

likely	:	:	:	:	:	:	unlikely
	extremely	quite	slightly	neutral	slightly	quite	extremely

CORPORATE AND GOVERNMENT SITES ATTITUDE TOWARD USING ITEMS - Subjects responded to the following five questions by marking an "X" in the center of one of the seven places indicated for each question:

All things considered, my using cc:mail in my job is:

bad	:	:	:	:	:	:	good
	extremely	quite	slightly	neutral	slightly	quite	extremely
foolish	:	:	:	:	:	:	wise
	extremely	quite	slightly	neutral	slightly	quite	extremely
unfavorable	:	:	:	:	:	:	favorable
	extremely	quite	slightly	neutral	slightly	quite	extremely
harmful	:	:	:	:	:	:	beneficial
	extremely	quite	slightly	neutral	slightly	quite	extremely
negative	:	:	:	:	:	:	positive
	extremely	quite	slightly	neutral	slightly	quite	extremely