

Richness Versus Parsimony Antecedents of Technology Adoption Model for E-Learning Websites

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Abstract. E-learning can be viewed as an innovation in information technology (IT) and learning. The Technology Acceptance Model (TAM) has previously received significant attention in the IS research field. The Perceived Characteristics of Innovating (PCI) antecedents of technology adoption decisions have not been widely researched empirically. This study explores students' perceptions of utilizing the e-learning website in their decision processes. This work also identifies which model supports a more explanation of variance in the e-learning context. Both TAM and PCI antecedents are investigated in the same context of an e-learning website. Experimental results demonstrate that the PCI constructs explain slightly more variance in users' intentions of continued use than TAM antecedents. The PCI adoption model provides increasingly rich information concerning the continued use of e-learning website.

Keywords: Technology Acceptance Model (TAM), Perceived Characteristics of Innovating (PCI) beliefs, E-learning, Intentions

1 Introduction

The Internet allows the receipt, updating and processing of information immediately worldwide, and e-learning has received significant attention in recent years. E-learning is defined as education delivered, or learning conducted, by Web techniques [1] and lets a person learn at a distance over the Internet using technology. This process enables a learner to learn at any time at any place, and is often called online learning [31]. This novel learning method provides an alternative to conventional face-to-face, instructor-led education [11]. E-learning can be highly personal and interactive, enabling students to attain an intimate out-of-classroom learning style.

International Data Corporation (IDC) estimates that the value of the e-learning market worth will be between \$21 billion and \$28 billion by 2008 [4]. IDC states that the revenue from synchronous e-learning exceeded \$5 billion by 2006 [30]. Business spending on e-learning is expected to reach approximately \$19.6 billion by 2010, according to IDC [26]. However, the continuous growth of the e-learning market has led to a lack of discussion of individuals' behavior in the adoption and continued use of e-learning.

The Technology Acceptance Model (TAM) has previously received significant attention in the IS research field. TAM has become one of the most widely employed

individual-level technology adoption modes [9]. Perceived ease-of-use and perceived usefulness have played (important roles in affecting technology adoption decisions. The parsimony antecedents of the model are often successfully applied to explain significant variance. Although parsimony the model is very important, individual responses to innovation technologies often depend on the context [9]. For instance, e-learning users are likely to consider whether an innovation can be employed on a trial basis before confirming its adoption.

Tornatzky and Fleischer [31] defined innovation as “the situationally new development and introduction of knowledge-derived tools, artifacts, and devices by which people extend and interact with their environment” (p. 10). E-learning can be treated an information technology (IT) innovation and learning approach innovation for many learners, according to this definition. Based on Rogers’ Innovation Diffusion Theory [28], Moore and Benbasat expended a set of eight Perceived Characteristics of Innovating (PCI) antecedents to technology adoption decisions. Little empirical research has tested the constructs of perceived innovation characteristics [3], [9]. Moreover, few previous studies have directly compared the performance of the two models.

This investigation explores students’ perceptions of using an e-learning website in their learning processes. As an innovative learning method, the adoption of e-learning involves the adoption of information technology, and changing learning approaches. Therefore, this work also aims to identify the model that most effectively explains variance in the e-learning context. The TAM and PCI antecedents are studied in the same context of the e-learning website.

2 Literature Review

2.1 The Technology Acceptance Model (TAM)

The technology acceptance model attempts to explain and predict the determinants of individual behaviour toward a system. The model presents two key beliefs concerning use of technology, namely perceived (usefulness (PU) and perceived ease of use (PEU). Perceived usefulness captures the degree to which a potential adopter regards the target technology as providing value over alternative ways of performing the same task. Ease of use encapsulates the level to which a potential adopter views usage of the target technology as involving little effort [14]. Perceived ease of use is hypothesised to be a predictor of perceived usefulness. Additionally, perceived usefulness is postulated to have a direct influence on behavioural intentions to use the technology. The beliefs about using the target system affect usage intentions and behaviour via their impact on a potential adopter’s attitude [5], [14].

Davis, Bagozzi and Warshaw [14] concluded that the internal psychological variables (i.e. the beliefs) that are central to TAM completely mediate the influences of all other variables in the external environment on an individual’s use of an innovation. They observed that ‘external variables...provide the bridge between the internal beliefs, attitudes and intentions represented in TAM and the various individual differences, situational constraints and managerially controllable interventions impinging on behaviour’ [14]. External variables only indirectly affect usage intentions or usage behaviour [2], [14], [17]. Perceived usefulness and perceived ease of use directly influence on intention to use [22], [29], [35], [36] and technology use [38] across varied organisational contexts and technologies [19]. However, results from TAM-based

research in online learning [21] and online shopping [20] revealed that perceived ease of use was not a good predictor of intention to use. Further research on the application of TAM in different environments is necessary.

2.2 The Perceived Characteristics of Innovating (PCI) Constructs

Rogers [27] identified attributes of innovation that are fundamental to acceptance behavior including relative advantage, complexity, compatibility, trialability and observability. Based on the work of Rogers and others, Moore and Benbasat [23] expanded the innovation characteristics into seven constructs, and developed an instrument to measure the perceptions. These constructs are relative advantage, ease of use, compatibility, image, result demonstrability, visibility and trialability.

The first PCI construct, namely relative advantage, presents the degree to which a potential adopter considers the innovation as providing an advantage over previous ways of performing the same task. The second construct, ease of use, is similar to Rogers' concept of complexity [27], and captures the extent to which a potential adopter considers the use of the target system to be free of effort [13]. Moore and Benbasat's construct of compatibility is consistent with that of Rogers: "the level to which an innovation is perceived as being consistent with the existing values, needs, and past experiences of potential adopters." [23].

Moore and Benbasat [23] indicated that the image construct, which is a part of relative advantage in Rogers' framework, can independently predict innovation use. The image construct denotes the perception when using an innovation in terms of improving the social status of the potential adopter. Furthermore, Rogers' attribute of observability is divided into two constructs of result demonstrability and visibility, defined respectively as "the tangibility of the results of using an innovation" and "the extent to which potential adopters see the innovation as being visible in the adoption context". Finally, trialability denotes the perception of potential adopters of an opportunity to try the innovation before committing to its use.

Research in PCI reveals that individuals' perceptions about the characteristics of an innovation significantly influence their acceptance behavior. Such discussion on perceptions has been persistent in research literature in system use [13], [23] and use intentions [3], [16], [33], [34], [37]. Based on the constructs proposed Moore and Benbasat [23], Slyke et al. [33] studied factors that may influence consumers' decision to engage in Web-based shopping, and found that perceived compatibility has the strongest impact on intention of use, followed by perceived complexity, relative advantage and image. Ilie et al. [37] added to the understanding of adoption and use of instant messaging by examining gender differences in perceived innovation characteristics. Different patterns were discussed in their study. For females, perceived ease of use and visibility were significant predictors of intention to use, while for males, perceived relative advantage, ease of use and result demonstrability were significant.

These studies confirmed the innovation characteristics identified by Rogers [27] and by Moore and Benbasat [23]. They explained technology adoption behavior in specific technology contexts, and produced inconsistent results in terms of salient perception factors. Tornatzky and Klein [32], in a meta-analysis of research on innovation characteristics, found that only three innovation characteristics — perceived relative advantage, perceived complexity, and perceived compatibility — are consistently related to innovation adoption.

2.3 TAM Versus PCI

The Technology Acceptance Model (TAM) has received considerable attention in research into individual-level technology adoption due to its parsimony. Moreover, the two constructs employed in TAM constitute a subset of PCI antecedents. Relative advantage is similar to the concept of perceived usefulness of TAM. Ease of use is also part perception of the TAM [13]. To contrast with TAM, PCI provides more richness in modeling technology adoption decision. As an innovative learning method, the adoption of e-learning involves the adoption of information technology and modification of learning approach. Learners have more control over selection of learning topics in e-learning than in learning in conventional classrooms. Hence, this investigation compares the explanatory powers of TAM and PCI in order to understand factors that may affect the intentions to continued use e-learning.

3 Research Methodology

3.1 Characteristics of the Sample and Study Context

To compare the performance between the antecedents of TAM and the PCI set, an e-learning website was specified as a representative of the innovation of e-learning. A survey was undertaken on students who were enrolled in a project management (PM) course at a comprehensive university in Taiwan. Digital materials related to performing PM on Microsoft Project 2003 were developed, and could be used by students on the e-learning website.

The system utilized in the experiments was designed explicitly for this investigation, and ran on a Pentium IV PC with a 17" monitor. Subjects applied Internet Explorer 6 to browse the teaching materials stored on a university server. Retrieval of information, including video clips, was almost instantaneous when using this configuration. The e-Learning website was developed using the Wisdom Master, which was developed by SUN NET Technology Corporation, and is one of the most popularly adopted Learning Management System (LMS) platforms in Taiwan. Wisdom Master is also the first software in Taiwan that conforms to the highest standard (RTE3) of the SCORM 1.2. The synchronous mode of teaching is not always better than the asynchronous mode [25]. Most e-learning is conducted asynchronously [11]. Therefore, an asynchronous e-learning system was developed for this study. The high-resolution monitor enabled subjects to see clearly the facial expressions of the people in the video clips on the e-learning website.

Subjects received a one-hour, hands-on demonstration on using the e-Learning website before the course began. Subjects could use the e-learning web system free by connecting to the Internet from anywhere at any time. The students were asked to complete a questionnaire survey after finishing the free 4-week course. Completion of the survey was voluntary, and could be done outside class. A total of 137 surveys were completed. The age range of the sample was 20–30 years old. Of the 137 respondents, 59 were female (43%) and 78 were male (57%).

3.2 Instrument Development

Moore and Benbasat's [23] questionnaire of scales of perceptions of innovation characteristics was employed as the foundation for the development of the PCI instrument. To fit the e-learning study context, the visibility construct was not considered when constructing the PCI model. The model was composed of a total of 24 items, with each scale comprising of a minimum of two items. The original items proposed by Davis [12] were utilized for the TAM constructs. The "ease of use" construct of PCI is part of the TAM [3]. Hence, the items of perceived ease of use were not repeatedly listed in the questionnaire. Additionally, the intention of continued use was assessed with three items built following the recommendations of Agarwal and Prasad [3] to assess future usage intentions.

The measures of both models were modified to fit the e-learning websites contexts. The items were operationalized to evaluate the learners' perceptions of the e-learning website and the new learning approach. Respondents scored on a seven-point Likert-type scale with the end-points as "strongly disagree" and "strongly agree", except for items intended to collect demographic data.

4 Analysis and Results

Both research models were measured with the partial least squares (PLS) structural modeling analysis approach. PLS is appropriate for predicting highly complex models [7] and maximizing the variance explained for the constructs in a model [9]. Moreover, the sample size in the study was smaller than the minimum recommended for structural modeling approaches [8]. Therefore, the TAM and PCI models were selected and tested with PLS.

4.1 Measurement Model

The TAM and PCI measurement models were tested for estimated construct reliabilities, convergent validities and discriminant validity of instruments [6], [9], [18]. Table 1 presents the numbers of items, means, standard deviations and reliabilities of the constructs of TAM and PCI. All reliability measures were 0.8 or above. The alpha-level of the sample indicates a reasonable level of reliability (>0.70) [24], revealing adequate internal consistency.

Table 1. Construct Means, Standard Deviations, and Reliabilities

Model	Construct	Number of Items	Mean	Standard Deviation	Cronbach Alpha
TAM	Perceived Ease-of-Use	4	4.936	0.792	0.868
	Perceived Usefulness	6	4.653	1.063	0.946
	Relative Advantage	5	4.817	0.845	0.932
	Ease of Use	4	4.936	0.792	0.868
PCI	Compatibility	3	4.609	0.942	0.917
	Image	3	3.897	1.362	0.962
	Result Demonstrability	4	4.950	0.745	0.884
	Trialability	2	4.549	0.992	0.844
	Intention to Continued use	3	4.792	1.051	0.951

Table 2 shows the each variable' the square root of AVE and intercorrelations, ranging from 0.159 to 0.650. Convergent validity of the instrument is appropriate when the constructs have an average variance extracted (AVE) of at least 0.5 [15]. The square root of AVE should exceed the intercorrelations for satisfactory discriminant validity [6]. The AVE for every construct is larger than the correlation between the construct and other constructs in the model. Table 3 presents the factor loadings and cross-loadings of the items measured in this investigation. All items loadings of each construct are larger than cross-loadings of that construct with all other constructs in two models. Hence, the convergent validity and discriminant validity in the work were adequate.

4.2 Structural Model

The result of the structural model testing includes the path coefficients and the R^2 values. The path coefficients denote the relationships between the dependent and independent constructs. The R^2 values represent the degrees of variance explained by the independent constructs. Figure 2 illustrates the results of the structural model for both the TAM and PCI models. The TAM model explained variance in perceived usefulness ($R^2=31.8\%$) and intention to continued use ($R^2=53.1\%$). However, perceived ease-of-use did not significantly influence intention toward continued use. The result is not consistent with earlier research [22], [29], [35], [38].

The PCI model accounted for 54.0% of the variance in that measure. Relative advantage ($\beta=0.367$), compatibility ($\beta=0.239$), and triability ($\beta=0.270$) significantly affected intention to continued use. The R^2 of the PCI model was higher than the TAM model ($\Delta R^2=0.9\%$). Therefore, the PCI model adds a slight significance to the prediction of intention of continued use in the e-learning context.

Table 2. Correlations and Average Variance Extracted (AVE)

	1	2	3	4	5	6	7	8
1. Perceived Ease-of-Use	0.847							
2. Perceived Usefulness	0.558**	0.889						
3. Relative Advantage	0.567**	0.594**	0.888					
4. Compatibility	0.650**	0.474**	0.464**	0.927				
5. Image	0.274**	0.264**	0.341**	0.387	0.965			
6. Result Demonstrability	0.463**	0.551**	0.594**	0.332**	0.331**	0.901		
7. Trialability	0.437**	0.538**	0.320**	0.521**	0.159	0.389**	0.931	
8. Intention to continued usage	0.484**	0.638**	0.559**	0.576**	0.280**	0.477**	0.454**	0.898

** Correlation is significant at the 0.01 level

Diagonal **bolded** elements are the square root of AVE.

Table 3. Factor loadings and cross-loadings

	1	2	3	4	5	6	7
	0.924	0.488	0.441	0.205	0.613	0.339	0.587
1. Relative Advantage	0.882	0.590	0.451	0.251	0.534	0.362	0.621
	0.891	0.470	0.419	0.353	0.513	0.312	0.548
	0.864	0.455	0.359	0.353	0.458	0.225	0.450
	0.879	0.518	0.396	0.344	0.545	0.182	0.467
2. Ease-of-Use	0.378	0.766	0.563	0.346	0.285	0.346	0.397
	0.570	0.857	0.540	0.444	0.408	0.351	0.357
	0.471	0.882	0.592	0.149	0.390	0.338	0.409
	0.538	0.891	0.523	0.027	0.493	0.436	0.506
3. Compatibility	0.457	0.556	0.900	0.359	0.312	0.502	0.523
	0.429	0.605	0.941	0.341	0.316	0.509	0.495
	0.417	0.640	0.938	0.379	0.314	0.435	0.531
4. Image	0.326	0.269	0.405	0.948	0.277	0.100	0.225
	0.324	0.233	0.355	0.975	0.355	0.183	0.248
	0.312	0.259	0.369	0.973	0.335	0.170	0.248
5. Result Demonstrability	0.556	0.452	0.271	0.304	0.920	0.292	0.436
	0.492	0.349	0.275	0.244	0.885	0.343	0.388
	0.571	0.461	0.358	0.344	0.899	0.425	0.516
6. Trialability	0.241	0.319	0.481	0.126	0.278	0.927	0.493
	0.367	0.494	0.486	0.168	0.458	0.934	0.518
7. Intention to Continued Use	0.609	0.513	0.578	0.267	0.506	0.519	0.989
	0.524	0.440	0.563	0.254	0.451	0.416	0.866
	0.496	0.454	0.530	0.281	0.437	0.360	0.799

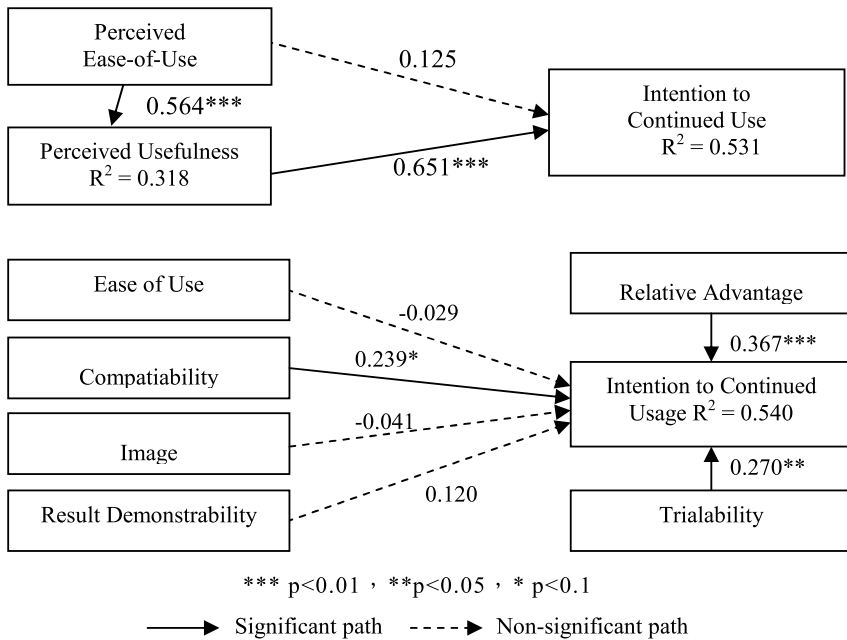


Fig. 1. TAM versus PCI model Results

5 Discussion

A fair comparison of models or theories includes careful empirical design, operationalization and measurement [10]. The research design in this study was undertaken in the same e-learning context and using the same respondents to measure the constructs of TAM and PCI model. The findings of this study provide a preliminary test of the viability of the two research models within the context of e-learning websites. Analytical results indicate that the PCI constructs explain slightly more variance (0.9%) in users' intentions of continued use than the TAM antecedents. Both the PCI and TAM perceived constructs are highly reliable, and have considerable prediction power in terms of exploring a user's continuing intention to use e-learning websites. However, the TAM model has fewer measurement items (12) than the sort-form PCI instruments (25). The TAM model places fewer strains on respondents and researchers than PCI model.

The results of TAM model demonstrate that the perceived usefulness construct plays an important role in predicting users' intentions of continued use, while the perceived ease-of-use has a significant impact on it. Conversely, the PCI results report that while relative advantage construct plays a critical role in explaining the intentions of continued use, trialability and compatiability constructs are also significant. Hence, teachers or marketing staff can try to enhance the innovation perception of trialability and compatiability, in addition to the perception of relative advantage, to raise the continued use of e-learning websites. The study also adds to the literature on comparing performance of TAM versus PCI, using data gathered in a naturally occurring and field-based adoption process.

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