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ABSTRACT

Causality is critical for our understanding of user technology acceptance. However, findings regarding the causal relationship between perceived enjoyment (PE) and perceived ease of use (PEOU) are not conclusive. PE has been theorized and empirically validated as either an antecedent or a consequence of PEOU. Covariance-based methods such as the widely used Structural Equation Modeling (SEM), albeit robust in examining causal connectedness, are limited in detecting causal direction and therefore cannot provide additional evidence for one view or the other. This study provides an alternative statistical method, Cohen's path analysis to explore causal relationship. Empirical results from two studies support that the PE→PEOU causal direction is stronger than the PEOU→PE direction for utilitarian systems.

Keywords

Causality, perceived enjoyment, perceived ease of use.

INTRODUCTION

It is almost self-evident that user technology acceptance is critical to the success of information systems and organizations. Therefore, a better understanding of various factors that influence user technology acceptance is necessary and important. This objective calls for studies focusing on theory-based discovery and assessment of causal relationships among user perceptional, attitudinal, and behavioral factors. User technology acceptance is considered one of the most "mature" research areas in contemporary IS literature (Venkatesh, Morris, Davis and Davis 2003).

Two factors, perceived enjoyment (PE) and perceived ease of use (PEOU) respectively, are of special interest to this research. Perceived enjoyment (PE) is defined as the extent to which the activity of using computers is perceived to be enjoyable in its own right, apart from any performance consequences that may be anticipated (Davis et al., 1992). It has been confirmed that PE plays important roles in user technology acceptance and has great implications, especially for hedonic systems (Heijden, 2004). PEOU, on the other hand, is defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989 p.320).

Findings regarding the causal relationship between perceived enjoyment (PE) and perceived ease of use (PEOU) are not conclusive. PE has been conceptualized as either the antecedent (e.g. Venkatesh, 2000, Yi and Hwang, 2003, Venkatesh et al., 2002), or the consequence (e.g. Davis et al., 1992, Igbaria et al., 1996, Heijden, 2004, Teo et al., 1999, Igbaria et al., 1995), of PEOU. Such inconsistencies can be problematic because they may further influence the relationships PE and PEOU have with other factors such as perceived usefulness (PU) and behavioral intention (BI). Moreover, in light of the fact that causality is the basis for our arguments about the mechanisms through which factors influence one another, the discrepancies limit our understanding of user technology acceptance and constrain practitioners from identifying proper mechanisms to influence users' intention and acceptance of IT.

The purpose of this research is therefore to explore the causal relationship – especially causal direction – between PE and PEOU using alternative approaches. As we will see in the following section, existing covariance-based statistical methods such as structural equation modeling (SEM) are robust in examining causal connectedness, but are limited in detecting causal direction. This research applies Cohen's path analysis method (Cohen et al., 1993) as a supplementary tool to SEM.

THEORETICAL DEVELOPMENT

PE and PEOU are conceptually close in nature. Both of them are intrinsic motivation variables and show similar patterns in influencing user technology acceptance (Atkinson and Kydd, 1997). Given this conceptual closeness, it is difficult to distinguish their impacts from each another. Both directions (PEOU→PE and PE→PEOU) have been proposed and received theoretical support. For a direction from PEOU to PE, the rationale is that systems that are easier to use are likely to be perceived as enjoyable (Teo et al., 1999). On the other hand, the causal direction from PE to PEOU is also supported (Venkatesh, 2000, Yi and Hwang, 2003). Enjoyment makes individuals "underestimate" the difficulty associated with using the technologies since they enjoy the process itself and do not perceive it to be arduous (Venkatesh, 2000). Two competing models can be proposed based on the different assumptions of causal direction (Figure 1).

The differences between utilitarian and hedonic systems merit mention. Existing research on user technology acceptance often emphasizes the utilitarian aspect of information systems (Sun and Zhang, 2005, Heijden, 2004, Legris et al., 2003), while hedonic systems are different from utilitarian systems in terms of the relative importance of perceptual factors such as PU, PE, and PEOU for behavioral intention. For example, existing empirical evidence indicates that PE has a stronger impacts on BI for hedonic systems (Heijden, 2004).

Acknowledging that both PE→PEOU and PEOU→PE are true for some circumstances separately, we argue that the PE→PEOU direction is especially strong for utilitarian systems. Previous empirical evidence supports this argument. First, when a PEOU→PE direction is proposed, PE does not completely mediate the PEOU's effects on users' behavioral intentions (e.g., Igbaria et al., 1995). Moreover, PE usually does not have has direct impact on BI (e.g., Davis et al., 1992). When a PE→PEOU direction is assumed, however, PEOU can usually completely mediate PE's impacts on BI (Heijden, 2004). This evidence implies that the PEOU seems more "close" to BI. Therefore, we hypothesize that: The PE→PEOU causal direction is stronger than the PEOU→PE direction for utilitarian systems.

METHODOLOGY

Cohen's path analysis

Using structural equation modeling (SEM) as an example, we can see that commonly used covariance-based statistical methods, albeit robust in examining causal connectedness, are limited in detecting causal directions. SEM is of a confirmatory nature and researchers have to assume a causal relationship (or link) before collecting or analyzing data (Goldberger, 1972). Using SEM, both PE→PEOU and PEOU→PE causal directions can be confirmed. Therefore, we need an alternative method that is sensitive to causal directions.

We applied Cohen's path analysis method because causal direction is critical in this method. The rationale of Cohen's path analysis is the normal equations composed of path coefficients transformed from multiple linear regression equations. These normal equations are able to guarantee the least square rule.

Cohen's path analysis follows a series of steps. First, it requires a prediction model and a corresponding path diagram. The prediction model can be described as $\bar{Y} = \rho_{YX_1} X_1 + \rho_{YX2} X_2 + \rho_{YX3} X_3$ (a model with three independent variables). The path coefficients are denoted by ρ. The second step is to tag each arc as a correlation or a beta coefficient (ρ). In a multi-variable situation (X_1, X_2, X_3 as independent variables pointing to Y as the dependent variable), the rule is: (1) if X_1, X_2, X_3 are independent causes of $\bar{Y}$, then the path coefficients ($\rho_{YX_1}, \rho_{YX2}, \rho_{YX3}$) are the correlation coefficient; (2) if X_1, X_2, X_3 are dependent causes of $\bar{Y}$, then the path coefficients are standardized partial regression coefficients. Then, we can estimate the correlations between X_1, X_2, X_3 and $\bar{Y}$. This step involves finding the paths, direct or indirect, from each X variable to Y, and summing the weights of the paths. To find the legal paths, Cohen et al. provide some rules: (1) a path cannot go through a node twice; (2) there must be a path from every variable to the dependent variable; and (3) the model should not include more than one undirected arc (for independent causes).

The underlying rationale of Cohen's path analysis is that estimated correlations based on path analysis should be as close as possible to the actual correlation. The "path" including both connectedness and direction is critical for calculating the estimated correlations. That is to say, changes in causal direction cause changes in estimated correlations and subsequently influence the errors between actual and estimated correlations, which are measured specifically by Total Squared Error (TSE). TSE can be used to indicate which one among several alternative theoretical models with different causal directions fits the dataset better or best.

Two empirical studies using different types of subjects and different information technologies were conducted.

Study 1: Employees' acceptance of Internet-based Search Engines

Study 1 was an online survey on employees' acceptance of Internet-based search engines. A total of 750 recruitment emails were sent out via an online survey project. Only employed individual IT users were invited. Subjects were asked to use Internet-based search engines to complete two simple tasks and then filled out the questionnaires. Among the 240 returns, 169 had complete responses for all measures and were used for data analysis. Among the respondents, 43% were male. Ages ranged from 19-24 (15.6%), 25-34 (42.5%), 35-44 (20%), to older than 45 (21.9%). 68% of respondents had more than five years' experience with search engines.

Study 2: Students' acceptance of University Website

Study 2 was a field experiment using college students. Participants were 194 undergraduate and graduate students in a northeastern university in the U.S. Student subjects had access to the Internet and questionnaires were collected during the class sessions. The questionnaire directed each subject to use a Web browser to visit the university's website and explore it to see whether this site could be useful for his or her university life. Then the questionnaire continued with measures of related constructs. Among the subjects, 62% were male. Average age was 21 with a standard deviation of 4.5.

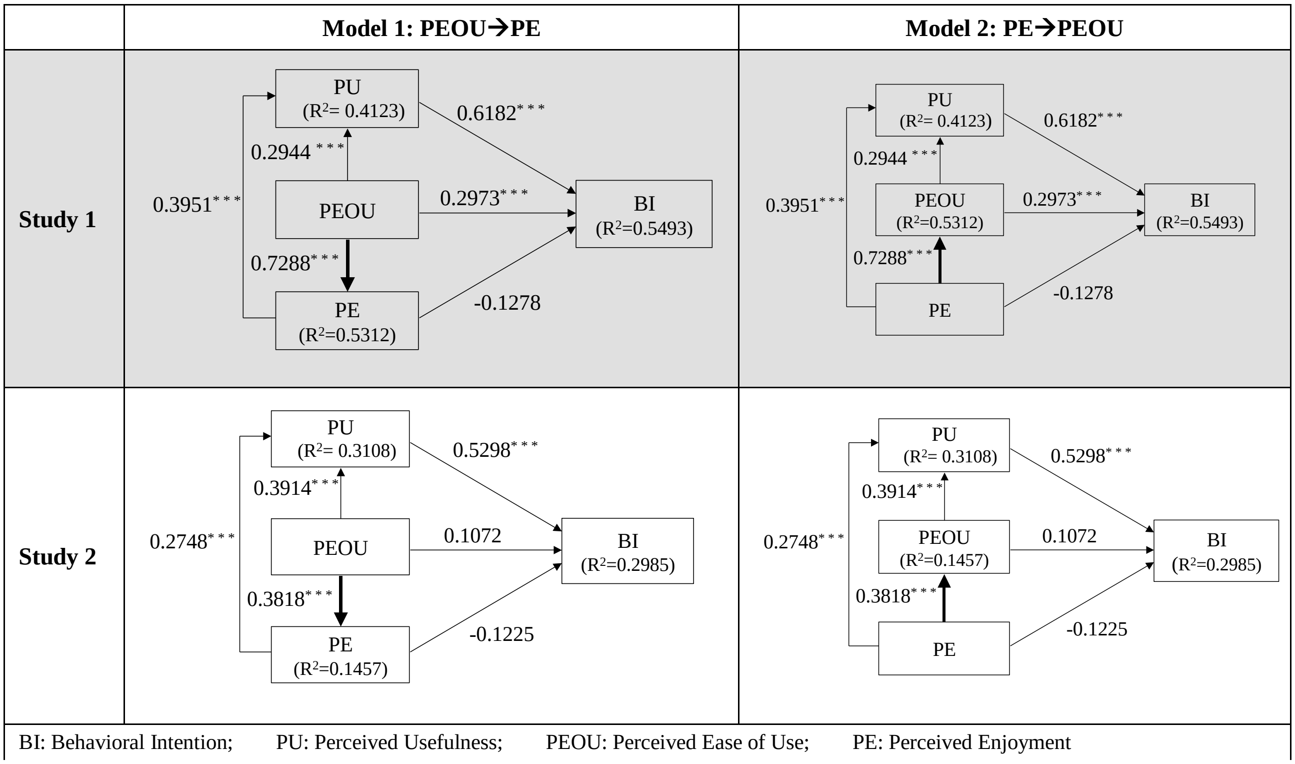

Figure 1: The Competing Models and Path Coefficients

Operationalization of Constructs

Constructs were measured by validated scales: four items were used to measure PU (Davis, 1989, Davis et al., 1992), three items were used to measure PE (Davis et al., 1992, Venkatesh, 2000), four items were used to measure PEOU (Davis et al., 1989, Davis, 1989, Davis et al., 1992), and two items were used to measure behavioral intention (Davis et al., 1989, Venkatesh, 2000).

SAS (version 9.00) was used for statistical analyses. Given the multiple purposes of this research, various SAS procedures such as PROC CALIS, PROC CORR, PROC REG and PROC SCORE were utilized. Since all variables in this research are measured by multiple items, structural equation modeling (SEM) was used to obtain all path coefficients, based on which other statistical analyses were conducted. By allowing the manifest variables more flexibility, SEM techniques have been confirmed to be able to reduce measurement errors (Chin et al., 2003).

RESULTS

Following the methods proposed by Cohen et al. (1993), we conducted path analysis on the two competing models respectively. Regression coefficients obtained from a standard SEM analysis (see Figure 1) were used as the path coefficients since PU, PEOU and PE are dependent causes of BI. Following Cohen's rule, we identified the legal paths that are depicted in Table 1. The actual correlations were also calculated. Then we compared the estimated and actual correlations. The processes and results are summarized in Table 1.

We first checked error changes from Model 1 to Model 2. The total squared error (TSE) is changed by -38.53% (that is, (0.1353-0.2201)/0.2201). The effect size is –0.76. The negative sign means that when we change the causal direction from Model 1 to Model 2, the TSE is actually reduced (or deteriorated in Cohen's terminology). Moreover, the large error items associated with PE in Model 1 are much improved in Model 2.

Then, we checked error changes in a reverse direction: from Model 2 to Model 1. The TSE is changed by 62.69% (that is, (0.2201-0.1353)/0.1353). The effect size is 0.76. The positive sign means the TSE is actually increased (or improved in Cohen's terminology) from Model 2 to Model 1.

Study 2

The result of Cohen's path analysis for study 2 is summarized in Table 1. Following the same procedure for study 1, we first checked error changes from Model 1 to Model 2. The total squared error (TSE) is changed by –55.47% (that is, (0.0271-0.0609)/0.0.0609). The effect size is –0.90. The negative sign means that when we change the causal direction, the TSE is actually deteriorated from Model 1 to Model 2.

	Direct Path	Indirect Path	Study 1			Study 2		
			Estimated Correlation	Actual Correlation	Squared Error	Estimated Correlation	Actual Correlation	Squared Error
Model 1: PEOU→PE			Total Squared Error: **0.2201**			Total Squared Error: **0.0609**		
BI: PU	PU→BI	N/A	0.6182	0.7554	0.0188	0.5298	0.5661	0.0013
BI: PEOU	PEOU→BI	PEOU→PU→BI; PEOU→PE→BI; PEOU→PE→PU→BI;	0.5642	0.6007	0.0013	0.3234	0.3464	0.0005
BI: PE	PE→BI	PE→PU→BI	0.1165	0.4938	0.1424	0.0231	0.1590	0.0185
PU: PEOU	PEOU→PU	PEOU→PE→BI	0.5823	0.6101	0.0008	0.4963	0.5361	0.0016
PU: PE	PE→PU	N/A	0.3951	0.6318	0.0560	0.2748	0.4679	0.0373
PEOU: PE	PEOU→PE	N/A	0.7288	0.7570	0.0008	0.3818	0.4227	0.0017
Model 2: PE→PEOU			Total Squared Error: **0.1353**			Total Squared Error: **0. 0271**		
BI: PU	PU→BI	N/A	0.6182	0.7554	0.0188	0.5298	0.5661	0.0013
BI: PEOU	PEOU→BI	PEOU→PU→BI;	0.4793	0.6007	0.0147	0.3146	0.3464	0.0010
BI: PE	PE→BI	PE→PEOU→BI; PE→PU→BI; PE→PEOU→PU→BI;	0.4658	0.4938	0.0008	0.1432	0.1590	0.0002
PU: PEOU	PEOU→PU	N/A	0.2944	0.6101	0.0997	0.3914	0.5361	0.0209
PU: PE	PE→PU	PE→PEOU→PU	0.6097	0.6318	0.0005	0.4242	0.4679	0.0019
PEOU: PE	PE→PEOU	N/A	0.7288	0.7570	0.0008	0.3818	0.4227	0.0017
BI: Behavioral Intention; PU: Perceived Usefulness; PEOU: Perceived Ease of Use; PE: Perceived Enjoyment								

Table 1: The Results of Path Analysis

Then, we checked error changes in a reverse direction: from Model 2 to Model 1. The TSE is changed by 124.58% (that is, (0.0609-0.0271)/0.0271). The effect size is 0.90. The positive sign means the TSE is actually increased (or improved in Cohen's terminology) from Model 2 to Model 1. The effect size is large according to Cohen's definition (Cohen, 1988).

Combining the results of Study 1 and 2, we can see that Study 2 and Study 1 have consistent findings regarding the causal relationship between PE and PEOU. The hypothesis is supported: A PE→PEOU direction is supported. The magnitudes of the effect size for Study 1 and 2 are almost at the same level (0.76 and 0.90 respectively). We thus can say the causal direction from PE to PEOU is preferred.

CONCLUSION

Commonly used covariance-based statistical methods such as SEM are limited in detecting causal relationship, especially causal direction. This may be problematic for conceptually closely related concepts such as PE and PEOU. As a result, researchers have proposed both directions between PE and PEOU (PE→PEOU and PEOU→PE). In the light of fact that causal relationship is critical for us to understand the mechanisms through which factors are influencing each other, we refer to an alternative method, namely Cohen's path analysis, which is sensitive to causal direction. Using datasets from two empirical studies with different subjects and technologies, this research confirms the hypothesis that the PE→PEOU direction is more robust than the PEOU→PE direction for utilitarian systems.

This study has limitations. The first relates to external validity. We have two datasets representing different samples and technologies. While we believe this research design is helpful in enhancing generalizability, more empirical studies are needed. Second, this research does not consider the impacts of conditional factors that may influence PE's effects. For example, Venkatesh et al. (2000) argued that PE's impact on PEOU is subject to moderating effects of experience. The impact of PE on PEOU increases as experience accumulates.

The primary contributions of this research are two-fold: (1) to clarify relationships between PE and PEOU, and (2) to provide a methodologically innovative approach to exploring causal relationships. For the former contribution, the two empirical datasets work in favor of a causal relationship from PE to PEOU. This direction is significantly better than the direction from PEOU to PE. PE does not have a direct impact on BI; instead, PU and PEOU fully mediate its impacts. For the latter contribution, Cohen's path analysis is used in this research as supplementary tools to covariance-based statistical methods. This research demonstrates the usefulness of this approach, especially in situations where highly correlated factors are theorized reciprocally and their impacts cannot otherwise be distinguished from each other based merely on theoretical modeling.

Future research may further explore the causality phenomenon from various perspectives. First, future research may examine the causal relationships in different technological environments. As mentioned above, this research focuses on utilitarian systems. Hedonic systems are quite different from those utilitarian systems in terms of individuals' perceptual reactions toward them (e.g. Heijden, 2004). Therefore a promising topic is the causal relationship between PE and PEOU in hedonic system environments. Future research should also explore the moderating effects of experience or other factors.

The clarification of causal relationships has practical implications. As mentioned earlier, causality is the basis for our arguments regarding the mechanisms through which people's perceptions, intentions, and actual behaviors can be influence by system designers and e-commerce vendors. This research proposes a causal direction from PE to PEOU to PU. Our findings suggest that it is the ease of use rather than enjoyment that directly influences users' intention to use utilitarian systems. Therefore, to enhance user acceptance of technology, practitioners should focus on the perceived usefulness and perceived ease of use while using enjoyment as an enabler of PEOU.

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