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Acceptance of e-reverse auction use: An empirical comparison of models

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Abstract

This study aims to understand factors affecting e-reverse auction usage in companies by comparing three models: TAM, TPB and an integrative model (integration of TAM and TPB). Using LISREL 8.54, data collected from 156 employees working in the procurement department of companies in 40 different countries were used to test the models. Results indicated that, TPB may be more appropriate than the TAM and integrative model for explaining behavioral intention to use e-reverse auction. Behavioral intention to use is explained- by only attitude towards use in TAM; by subjective norms, perceived behavioral control and attitude towards use in both TPB and the integrated model.

Keywords
E-reverse auction, TAM, TPB, actual use, model comparison

1. Introduction
E-reverse auction is an online- and real-time auction between a buying company and two or more suppliers [1]. Use of the E-reverse auction tool was first offered by FreeMarkets in 1999 and has since then been progressively adopted more intensively by firms. Several Fortune Global 2000 companies use e-reverse auction as a purchasing tool [2]. For example, General Electric spends 50-60 billion $ per year and people in positions of responsibility believe that 50-66% of this amount can be auctioned [3].

Using e-reverse auction offers many advantages to buyers as well as suppliers. Price reduction is undoubtedly the most important one. Suppliers may have to make higher price reductions to win the auction [4]. In addition to the price advantage, increase in buyer productivity, reduction in cycle time, access to many suppliers at the same time, creating a more competitive environment, standardization, and transparency in purchasing process are the other advantages of e-reverse auction. All these advantages create more opportunities for companies by reduction in cost and time, enabling these companies can offer higher quality products [1, 5]. In 2000, General Electric saved $480 million by using e-reverse auction from its $6.4 billion expenditure [3]. E-reverse auction has benefits not only for buyers but also for suppliers. These are growing markets, accessed by system users all over the world, who are enabled to compare their own competitiveness in the market and follow up auctions by potential customers on the Internet. Besides, they can estimate their customers' needs and market trends by checking the e-reverse auctions' specifications and conditions for the products and services. Thus, suppliers can not only see areas for improvement and but also their own needs for improvement [6,7]. Therefore, it is important to explain and understand the factors that affect the use of e-reverse auctions as they aim at improving performances of company and employees to complement each other. This study aims to understand factors affecting e-reverse auction usage in companies by comparing three models: Technology Acceptance Model (TAM), Theory of Planned Behavior (TPB) and an integrative model (integration of TAM and TPB). The next section discusses the theoretical models. This is followed by methodology that is based on a survey of 156 e-reverse auction users from 40 countries. Then, the results of the survey are discussed.

2. Research Models
2.1. Technology Acceptance Model
Reference [8] based Theory of Reasoned Action for the development of TAM which is used for individual acceptance of information technology (IT). TAM is a powerful-, robust-, and commonly employed model for

predicting and explaining user behavior and IT usage [9]. Behavioral intention is a measure of the likelihood that a person will get involved in a given behavior [10]. If a person has a strong intention, he is expected to try more, and thus the likelihood of use of the behavior will be greater [11]. As shown in Figure 1, in TAM, actual use is predicted by behavioral intention to use, and behavioral intention to use is determined by the attitude toward use and perceived usefulness. Attitude toward the behavior refers to the "person's judgment that performing the behavior is good or bad, that he is in favor of or against performing the behavior" [10]. Furthermore, perceived usefulness and perceived ease of use are the most two important determinants of attitude towards use. Perceived usefulness is the "degree to which a person believes that using a particular system would enhance his or her performance" and perceived ease of use refers to "the degree to which a person believes that using a particular system would be free of effort" [9]. Therefore, it is expected that a user who perceives that (i) using the system enhances his or her performance and (ii) using a particular system would be free of effort will have a positive attitude toward the system.

2.2. Theory of Planned Behavior

As shown in Figure 1, TPB states that actual use is predicted by behavioral intention to use and perceived behavioral control. Perceived behavioral control is the individual's perception of his or her control over performing the behavior [12]. It includes the perceptions of the availability of ability, resources, and opportunities necessary for performing the behavior [13]. Reference [14] gave two reasons for the relationship between actual behavior and perceived behavioral control. First, if behavioral intention to use is constant, the successful conclusion of the behavior is likely to increase with the improvements in perceived behavioral control perceptions. Second, behavior may not be acted upon without the availability of the resources and opportunities. Behavioral intention to use is jointly predicted by subjective norms, attitude towards use and perceived behavioral control. Subjective norms refer to the ''person's perception that most people who are important to him think that he should or should not perform the behavior in question" [10]. Therefore, potential users may choose to use the technology if the people who are important to them say that they should use it. Furthermore, the availability of necessary skills, abilities, and knowledge to conduct the e-reverse auction or access rights to the system and positive attitude of the potential users toward system use may become important in explaining e-reverse auction use.

2.3. The Integrated Model

Although, TAM is a useful theoretical model that understands and explains user behavior in IT implementation, it has to be integrated into a broader one which would include variables related to both human and social factors [15]. TPB takes into consideration these factors [16]. Therefore, TAM is integrated with TPB to create an integrated model which includes subjective norms as a social factor. In addition, several studies have integrated TAM with TPB successfully [16-20]. Furthermore, a growing body of research has focused on integrating the models to predict usage intentions [16] by combining the strengths of each model. The integrated model is shown in Figure 1.

3. Methodology

A survey methodology is used in this study. The target population is the e-reverse auction users working in the procurement department of companies. A questionnaire was formulated based on an extensive review of the literature in the areas of technology acceptance model and theory of planned behavior. The final questionnaire consisted of two main parts. The first covered demographic questions designed to solicit information about the respondents. In all 156 questionnaires were collected from 40 different countries. Of the respondents, 40.4% were female and the average age of the respondents was 37 years. Most of the respondents had at least an undergraduate degree. Of the e-reverse auction users, 55.8% were in middle management positions. Moreover, most of the respondents had more than 5 years of Internet experience. The proportion of respondents with more than 5 years full time professional experience was 71.2% and 60.9% of them possessed more than 5 years experience as buyers.

The second section asked respondents to indicate their agreement level to the items in the proposed research model. All items except actual use were measured using a five-point Likert-type scale with 1 representing 'strongly disagree' and 5 representing 'strongly agree'. Actual use was measured by self-report measures of e-reverse auction use. After the initial development of the initial questionnaire, it was sent to 15 users to ensure understandability. Based on the information provided by these users, the instrument was "fine-tuned" and finalized. The questionnaire was sent to 310 users in June 2007 and by the end of January 2008, 156 users completed the survey.

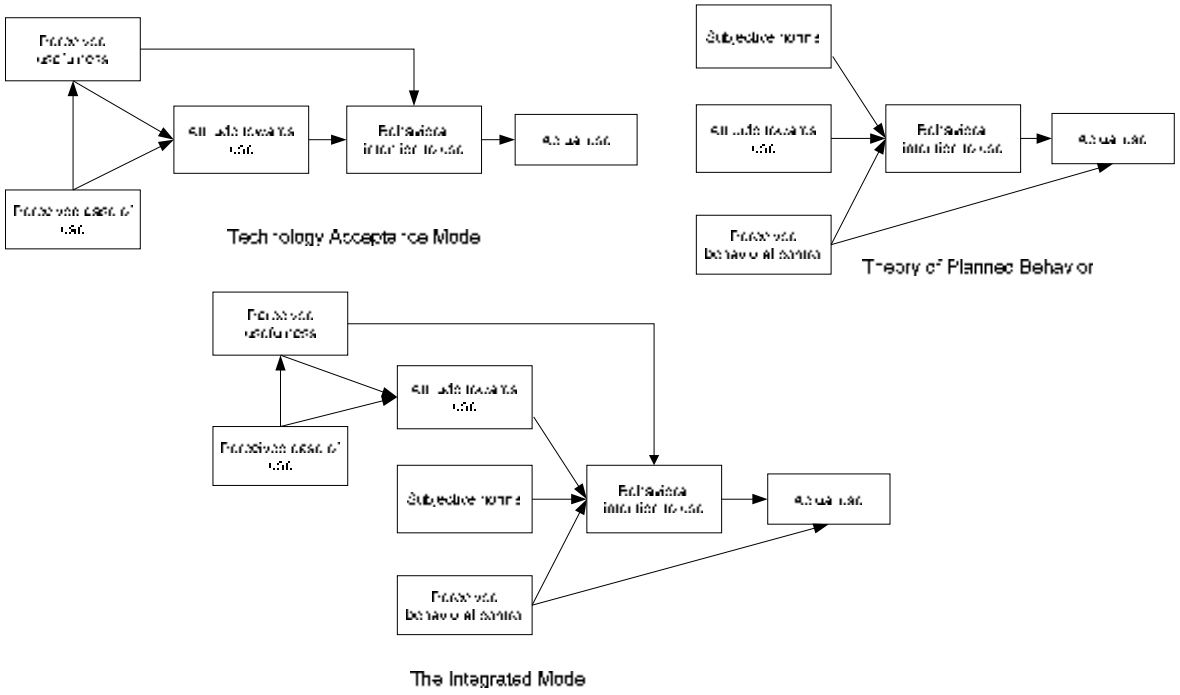

Figure 1: The research models

4. Results

In the analysis stage, our study followed a two-step approach recommended by [21]. This approach allows specifying the measurement model a second time to achieve unidimensional construct measurement [21]. The model was tested using LISREL 8.54 with SIMPLIS project.

4.1. Measurement Model

The model was tested for reliability and validity of the constructs using confirmatory factor analysis. The measurement model included 27 items describing 7 constructs. Some construct revisions were needed after the initial analysis of the measurement model. The decision to specify the construct was taken based on the differences in the values of $\chi 2$ for the competing models if the theory and content allowed for changes [21]. After specifying the constructs again, 21 items were retained for further analysis.

The fit statistics show that the model provided a reasonably good fit to the data. The values of $\chi 2$, degrees of freedom, root-mean-square of approximation (RMSEA), normed fit index (NFI), and comparative fit index (CFI) were selected according to the recommendations of [22]. They stated, "the researcher should report one incremental and one absolute index, in addition to the $\chi 2$ value and associated degrees of freedom, and at least one of these indices should be badness-of-fit indices" [22]. The absolute fit indices (RMSEA= 0.0473), incremental fit indices (NFI= 0.944 and CFI= 0.982) and $\chi 2$ to degrees of freedom ratio (at 1.44) are within acceptable levels [22, 13], suggesting that the model provided a reasonably good fit to the data.

The convergent- and discriminant validities of the constructs were tested using the confirmatory factor analysis. Convergent validity is the degree to which two or more items measure the same concept [23]. We examined the convergent validity of measurement items by their t-values, factor loadings, composite reliability, and average variance extracted (AVE). The results are shown in Table 1. All the t-values of the items were significantly greater than the critical value of 1.96 at the 0.95 confidence level [24]. All items, except AcUs1, PEU2 and ATU1, exceed the recommended factor loading value of 0.70 [22]. However, since AcUs1, PEU2 and ATU1 have factor loadings that are close to 0.70 and are validated by previous research, they were retained. All the AVEs exceed the recommended value of 0.50 [25]. Composite reliability measures the internal consistency of the measurement model [26], and all the composite reliabilities exceed the 0.60 threshold. In addition, the value of Cronbach's alpha for each

construct is more than 0.60, indicating an acceptable level of reliability. Thus, all these statistics show that the convergent-validity requirement is satisfied.

Table 1: Confirmatory factor analysis

Construct	Item	Mean	Standard deviation	Factor loadings	*t*-statistics
Actual Use (AcUs)	AcUs1	2.03	2.89	0.68	6.83
	AcUs2	7.98	14.44	0.80	7.49
Behavioral intention to use (BI)	BI1	3.76	0.89	0.78	10.97
	BI2	3.84	0.87	0.73	10.06
	BI3	4.06	0.79	0.80	11.33
Perceived usefulness (PU)	PU1	3.27	1.04	0.71	10.01
	PU2	3.54	0.91	0.72	10.16
	PU3	3.44	1.02	0.92	14.54
	PU4	3.52	0.99	0.90	14.00
Perceived ease of use (PEU)	PEU2	3.92	0.78	0.58	7.42
	PEU3	3.85	0.77	0.76	10.34
	PEU5	3.87	0.76	0.86	12.23
Attitude towards use (ATU)	ATU1	3.68	1.07	0.62	7.99
	ATU2	3.46	0.92	0.82	11.61
	ATU3	3.49	0.95	0.78	10.96
Subjective norms (SN)	SN1	3.53	0.85	0.90	14.10
	SN2	3.51	0.88	0.85	12.80
	SN3	3.40	0.91	0.85	12.77
Perceived behavioral control (PBC)	PBC1	4.16	0.65	0.73	9.91
	PBC4	4.03	0.75	0.83	11.79
	PBC5	4.24	0.71	0.71	9.55

	Composite reliability	Average variance extracted (AVE)	Cronbach's alpha
Actual use	0.71	0.55	-
Behavioral intention to use	0.81	0.59	081
Perceived usefulness	0.89	0.67	0.88
Perceived ease of use	0.78	0.55	0.76
Attitude towards use	0.79	0.56	0.78
Subjective norms	0.90	0.75	0.90
Perceived behavioral control	0.80	0.58	0.80

Finally, discriminant validity was assessed using a series of $\chi 2$-difference tests for every possible pair of constructs in the measurement model. For each test, only one correlation parameter was fixed to 1. A significant $\chi 2$ difference indicates that the constructs are statistically distinct. The $\chi 2$ differences were all above the critical value of 3.84 at the 95% confidence level. This showed that all the models in which the correlation was set to '1' displayed a worse fit. This demonstrates adequate discriminant validity for all constructs [23].

4.2. Structural Model

The structural model shows the relationships between the constructs and specifies the constructs that are related to each other [22]. The fit indices, as shown in Table 2, are within acceptable levels [22, 13].

Table 2: Fit statistics of the TAM, TPB and the integrated model (for the structural model)

Fit index	Recommended value	TAM	TPB	Integrated Model
($\chi 2$;df) $\chi 2$/ df	≤3	(163;84) 1.94	(81;69) 1.17	(344;177) 1.95
RMSEA	≤0.08	0.073	0.029	0.067
CFI	≥0.95	0.96	0.99	0.96
NFI	≥0.90	0.93	0.96	0.92

The explanatory power of each model was also examined. The overall results suggest that TPB appeared to be better than TAM in explaining employees' intention to use e-reverse auction; that is $R^2_{BI} = 0.64$ and $R^2_{BI} = 0.82$ for TAM and TPB, respectively. As expected, in explaining behavioral intention to use e-reverse auction the integrated model is not performed better than TAM and TPB. However, the explanation rate of attitude towards use in integrated model is better than the explanation rate of attitude towards use in TAM. Together, perceived usefulness and perceived ease of use accounted for %49 of the observed variance in attitude towards use in TAM, whereas this value is found to be 56% in the integrated model. The other result suggest that actual use of e-reverse auction is

directly predicted by behavioral intention to use in TAM and TPB and the explanation rate of actual use is 8% in TAM, 14% in TPB and 12% in the integrated model.

The significance of individual paths was also examined. The path from attitude towards use to behavioral intention to use was significant across all the investigated models, whereas the relationship between perceived usefulness and behavioral intention to use was found to be insignificant in both TAM and the integrated model. In addition, the paths from perceived behavioral control- and subjective norms- to behavioral intention were significant in the TPB and the integrated model. However, the significant relation between perceived ease of use and attitude towards use in TAM is not significant in the integrated model.

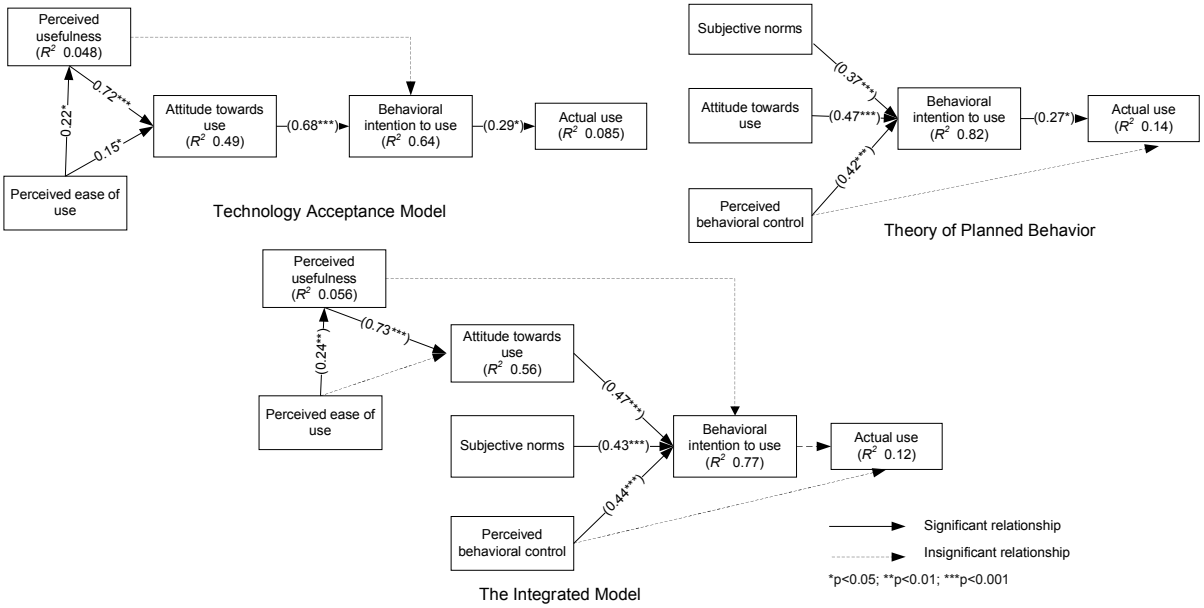

Figure 2: The results of the research models

5.Discussion

This study explores the factors affecting e-reverse auction use by comparing three models: TAM, TPB, and the integrated model. The results show that the explanation rates of behavioral intention to use in TAM, TPB and the integrated model are relatively high in this study. Among them, TPB may be more appropriate than the TAM and integrated model for explaining behavioral intention to use e-reverse auction, since the explanation rate of behavioral intention to use in TPB (R^2= 0.82) is higher than in both TAM (R^2= 0.64) and the integrated model (R^2= 0.77). In contrast to our findings, empirical studies have shown that integrating models increases explanatory power as the indicator of behavioral intention to use [17-19]. These findings, which differ from that of our study, may be explained in the context of the technology studied and the demographic profiles of the respondents. Reference [19] analyze factors affecting motorists' intention of electronic toll collection service adoption; reference [17] extend Trust and TAM model with TPB and explore factors affecting initial adoption of online tax-paying system; reference [18] analyze factors affecting PDA acceptance among individual professionals. On the other hand, this study's data is collected from employees working in companies.

Another result of our study was that actual use of e-reverse auction technology is directly affected by behavioral intention to use in TAM and TPB, and the explanation rate of actual use is 8%, 14% and 12% in TAM, TPB and the integrated model, respectively. The lower explanation rates of actual use with respect to behavioral intention to use shows that potential users do not act according to their intentions. In addition, the data related with actual use showed past usage of e-reverse auction, whereas behavioral intention to use reflected future use of e-reverse auction. Therefore, it is possible that behavioral intention to use in the future might not be fully associated with past system usage experiences. In addition, beliefs about the system usage affect future intentions about usage, whereas the beliefs about future usage may not reflect usage in the past. Therefore, the constructs in the research model may not contribute much to the explanation rate of actual usage.

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