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E-commerce Extended TAM Instrument Development

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Abstract— E-commerce proved its importance as a reliable and viable channel of conducting business and consumer transactions. Researchers suggest the application and extension of the technology acceptance model (TAM) in different business and IS environements. In E-commerce, the TAM has been applied both in its original form and as an extended model in order to better understand online consumer behavior. However the instruments used did not include items that were balanced between the proess and the outcome of the onine shopping behavior. In this study, we develop and test instruments for an E-commerce specific extended TAM. These instrumets balance between items measuring procees satisfaction and outcome satisfaction, in addition to the original TAM constructs, namely perceived usefulness and perceived ease of use. The study instruments proved to have reliability, convergent, discriminant and factorial validity.

Keywor.ds— Technology Acceptance Model; Instrument Development; Reliability; Validity; User Satisfaction; Process Satisfaction; Outcome Satisfaction; Intentions; Actual Behavior; E-commerce; Perceived Usefulness; Perceived Ease of Use.

I. Introduction

E-commerce proved its importance as a reliable and viable channel of conducting business and consumer transactions. The magnitude of this channel can be best measured by market reports. In Europe, retail revenues generated by E-commerce reached $372.84 billion in the year 2014 and are expected to reach $534.9 billion by the year 2018 [1]. Both researchers and marketing executive are studying online consumer behavior to better understand the factors leading customers to buy online. This understanding will help amplify the use of the already significant E-commerce channel.

Online consumer behavior has been studied by researchers in terms of online shopping adoption [2][3] online vendor trust [4] and vendor online reputation [5]. Davis's technology acceptance model (TAM) [6] is the most widely referenced adoption model in IS research is [7]. The TAM, which is an adaptation of the theory of reasoned action (TRA) [8][9], has two elements, perceived usefulness (PU) and perceived ease of use (PEOU), that are correlated with the decision to adopt a new technology.

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The TAM was extended in a multitude of studies in order to explore different environments in IS, one of which is online consumer behavior [4][5][10].

In a study to extend the TAM in E-commerce, a conceptual model for E-commerce use was developed [11]. Grounded in TAM and E-commerce literature, an E-commerce specific extended TAM was presented. In addition to original TAM variables, the extended TAM was posited to include both the satisfaction with the process of the online shopping experience and the satisfaction with its outcome. Moreover, the study reveals the importance of measuring actual behavior adoption instead of substituting it with behavioral intentions.

In this study we intend to develop and test the E-commerce extended TAM instruments [11]. We intend to operationalize the instruments variables. We will adapt and develop the instruments constructs and items. We will then proceed to test and establish the instruments validity and reliability, therefore rendering the model and its related instruments ready for use and application.

II. Data and Instrumentation

The variables used in this study are actual E-commerce use, PU, PEOU, process satisfaction (PS), outcome satisfaction (OS), and intention to use an E-commerce website.

A. *Measurement Instruments*

In order to measure the study variables, we developed and adapted the measurement instruments from previous TAM and E-commeerce research. Specifically, we adapted the PU and PEOU instruments from Davis [6] and Koufaris [5]. The instrument for process satisfaction were developed originating from [12] and Venkatesh [13]. The instrument for outcome satisfaction was developed originating from Doll and Torkzadeh [12]. The newly developed and adapted instruments are presented in Appendix I.

B. *Operationalization of the Variables*

Consistent with the literature, anytime the TAM has been extended, the original TAM variables were included and new variables were added to better explain user behavior. In this tradition, we extended the TAM to potentially serve as a better E-commerce model by adding the predictor variables PS, OS, and the criterion variable actual use. The original TAM variables, namely, PU and PEOU were preserved.

The extended predictor variables PS and OS were measured using the factor analysis regression method. As such, the four items on the PS scale were reduced to a one factor score for PS and the four items on the OS scale were reduced to a one factor score for OS. Using the regression method for estimating factor score coefficients, the scores produced have a mean of zero and a variance equal to the squared multiple correlation between the estimated factor scores and the true factor values.

Since E-commerce use was never reported to have been measured in the reviewed TAM and TAM extension literature, we divided E-commerce use into access and purchase. We relied on the Nielsen/NetRatings to operationalize E-commerce access [14]. The Nielsen/NetRatings (a leader in Internet media and market research) report several metrics for Internet access, namely the number of sessions/visits per person, PC time per person, and duration of a web page viewed. To operationalize the number of sessions/visits per person, we used the measure access number. Access number measures the number of times each subject accesses the E-commerce website in a certain time period. To operationalize PC time per person, we used the measure access total time. Access total time measures the total time in seconds each subject accesses the E-commerce website in a certain time period. Finally, to operationalize duration of a web page viewed, we used the measure access average time. Access average time measures the average time, in minutes, per E-commerce website session for each subject in a certain time period. We operationalized E-commerce use by measuring Web purchases. Web purchase measures the number of items each subject buys from the website in a certain time period.

The original TAM predictor variables PU and PEOU were measured using the factor analysis regression method. As such, the four items on the PU scale were reduced to a one factor score for PU and the four items on the PEOU scale were reduced to a one factor score for PEOU. Using the regression method for estimating factor score coefficients, the scores produced have a mean of 0 and a variance equal to the squared multiple correlations between the estimated factor scores and the true factor values.

III. RESULTS

In this section we present the results of test scores reliability and validity assessment. We carried out the using the adapted instruments with 43 subjects consistent with [4], and [15]. Table 1 shows the summary statistics for the scales items.

A. *Test Scores Reliability*

We calculated Cronbach alpha coefficients to test the reliability of the scores. All the scales had a Cronbach alpha of above .7 which is an acceptable level to declare reliability of scale scores [16]. Table 2 shows the Cronbach alpha for the scales.

Table 1. *Summary Statistics for Pretest Scale Items Scores*

Item	Mean	Standard Deviation	N
PU1	4.95	1.194	43
PU2	4.86	1.302	43
PU3	5.00	1.234	43
PU4	5.33	1.340	43
PEOU1	5.93	1.316	43
PEOU2	5.81	1.367	43
PEOU3	5.91	1.342	43
PEOU4	6.09	1.324	43
PS1	4.74	1.217	43
PS2	4.77	1.324	43
PS3	4.84	1.413	43
PS4	4.91	1.231	43
OS1	5.88	1.159	43
OS2	5.40	1.275	43
OS3	5.09	1.171	43
OS4	5.40	1.094	43

Table 2. *Cronbach Alpha Values for the Pretest Scales Scores*

Scale	Cronbach Alpha
Perceived Usefulness	0.910
Perceived Ease of Use	0.972
Process Satisfaction	0.949
Outcome Satisfaction	0.886

B. *Test Scores Validity*

We had the instruments reviewed by three E-commerce professionals to test the face and content validity of the instruments' scores consistent with Davis [6]. Minor adjustments in the wording of three items in the adapted PS and OS instruments were recommended and made. In addition, we tested the construct (convergent and discriminant) validity of the instruments' scores through the means of a correlation analysis of all the items on the instruments. Scale scores show convergent validity when items measuring a construct are correlated with each other. Scale scores show discriminant validity when items measuring a construct are not correlated with items measuring other constructs. The scale scores showed both convergent and discriminant validity because items on all constructs were highly correlated with each other (.777 to .654 for PU, .919 to .852 for PEOU, .908 to .763 for PS, and .789 to .552 for OS) while not highly correlated with items on other constructs. Tables 3 and 4 show the correlation matrix for all the scales items.

To test factorial validity, we factor analyzed the scales using principal component extraction [5][6] with direct oblimin rotation [5]. Direct oblimin is an appropriate rotation method when there is reason to expect the factors to be correlated [17]. This is the case with PU and PEOU [6]. The analysis depicted a four factor solution, which is presented in Table 5.

The first factor depicted by the analysis was PEOU on which PEOU1, PEOU2, PEOU3, and PEOU4 loaded strongly (factor loadings of .967 to .939). The second factor depicted by the analysis was OS on which OS1, OS2, OS3, and OS4 loaded strongly (factor loadings of .917 to .837). The third factor depicted by the analysis was PS on which PS1, PS2, PS3, and PS4 loaded strongly (factor loadings of -.948 to .920). The fourth factor depicted by the analysis was PU on which PU1, PU2, PU3, and PU4 loaded strongly (factor loadings of .904 to .835).

The scree plot in Fig. 1 shows us the viability of a 4-factor solution visually. A scree test visually shows how the factor variance levels off when the factors are largely measuring random error [18]. In the scree plot, the first four factors are high on the plane of the plot. The fifth to the sixteenth factors drop considerably. The four factor solution is therefore supported. The component correlation matrix (Table 6) shows that the highest correlation between the factors was between PEOU and PU (.442), consistent with prior research .

Table 5. *Structure Matrix from Principal Component Analysis with Direct Oblimin Rotation*

Scale Items	Factor 1	Factor 2	Factor 3	Factor 4
PU1	0.410	0.144	-0.338	**0.892**
PU2	0.465	0.180	-0.369	**0.904**
PU3	0.412	0.098	-0.325	**0.902**
PU4	0.461	0.038	-0.334	**0.835**
PEOU1	**0.967**	0.131	-0.308	0.435
PEOU2	**0.963**	0.239	-0.380	0.441
PEOU3	**0.965**	0.169	-0.272	0.446
PEOU4	**0.939**	0.019	-0.200	0.489
PS1	0.303	0.296	**-0.920**	0.438
PS2	0.297	0.387	**-0.948**	0.335
PS3	0.228	0.260	**-0.928**	0.264
PS4	0.299	0.346	**-0.930**	0.308
OS1	0.236	**0.843**	-0.353	0.189
OS2	0.186	**0.917**	-0.310	0.203
OS3	-0.034	**0.850**	-0.253	0.054
OS4	0.206	**0.837**	-0.376	-0.112

Table 3. *Inter-Item Correlation Matrix for the Pretest Scale Items Scores (PU and PEOU)*

	PU1	PU2	PU3	PU4	PEOU1	PEOU2	PEOU3	PEOU4
PU1	1	0.777	0.743	0.664	0.392	0.417	0.398	0.485
PU2		1	0.785	0.654	0.467	0.493	0.469	0.464
PU3			1	0.691	0.440	0.409	0.388	0.437
PU4				1	0.418	0.424	0.494	0.479
PEOU1					1	0.919	0.899	0.905
PEOU2						1	0.938	0.852
PEOU3							1	0.863
PEOU4								1
PS1								
PS2								
PS3								
PS4								
OS1								
OS2								
OS3								
OS4								

Table 4. *Inter-Item Correlation Matrix for the Pretest Scale Items Scores (PS and OS)*

	PS1	PS2	PS3	PS4	OS1	OS2	OS3	OS4
PU1	0.368	0.339	0.292	0.353	0.168	0.216	0.139	-0.004
PU2	0.488	0.381	0.285	0.319	0.194	0.292	0.134	0.006
PU3	0.412	0.291	0.259	0.329	0.200	0.151	0.049	-0.018
PU4	0.388	0.339	0.268	0.322	0.209	0.146	-0.050	-0.090
PEOU1	0.330	0.305	0.237	0.304	0.182	0.159	0.004	0.201
PEOU2	0.400	0.383	0.292	0.371	0.302	0.275	0.071	0.257
PEOU3	0.291	0.282	0.193	0.283	0.284	0.203	-0.010	0.188
PEOU4	0.207	0.203	0.186	0.195	0.116	0.091	-0.113	0.073
PS1	1	0.908	0.792	0.763	0.316	0.297	0.251	0.239
PS2		1	0.806	0.834	0.385	0.366	0.291	0.377
PS3			1	0.854	0.293	0.248	0.182	0.289
PS4				1	0.343	0.282	0.237	0.435
OS1					1	0.789	0.552	0.600
OS2						1	0.692	0.670
OS3							1	0.658
OS4								1

Table 6. Component Correlation Matrix

Component	1-PEOU	2-OS	3-PS	4-PU
1-PEOU	1.000	0.144	-0.295	0.442
2-OS		1.000	-0.344	0.088
3-PS			1.000	-0.332
4-PU				1.000

Note. Extraction Method: Principal Component Analysis. Rotation. Method: Oblimin with Kaiser Normalization

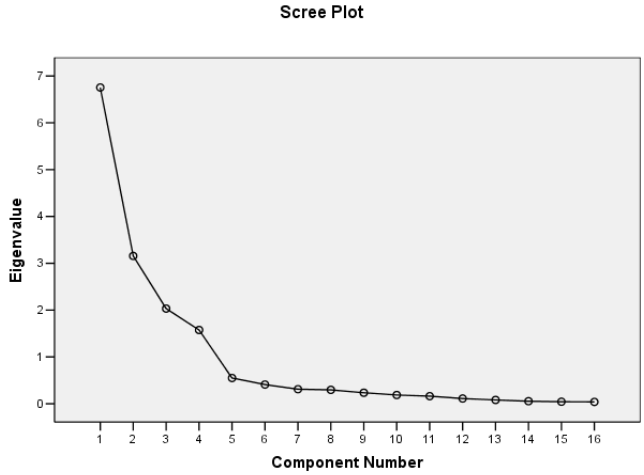

Figure 1. Scree plot from principal component analysis.

In addition, the visualization (Fig.2) of the detected factors in rotated space shows the high clustering of the scale items by PU, PEOU, PS and the clustering of the scale items of OS which also supports a four factor solution.

The data analysis above showed reliability, convergent, discriminant and factorial validity of the scale scores.

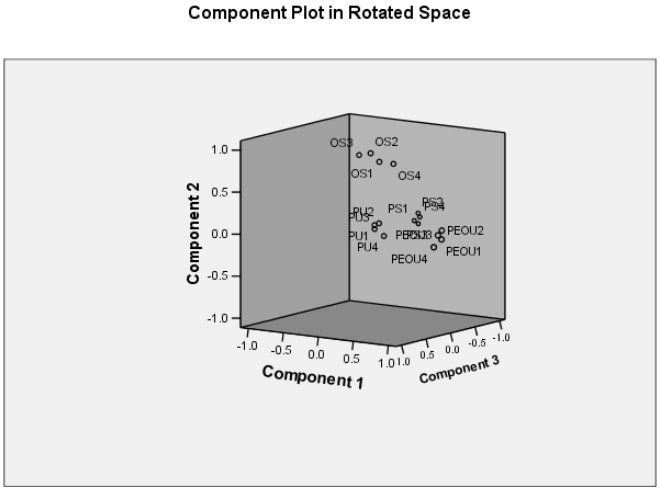

Figure 2. A visualization of detected factors in rotated space.

IV. Conclusion

Since E-commerce adoption is different from new technology adoption in an organization, an E-commerce specific adoption model needs to be used in such environments. In this study, we were able to develop four instruments specific to a theoretically articulated, and grounded in the IS literature, E-commerce adoption model. Our recommendations for future research include the application of this E-commerce extended TAM model with its newly developed and tested instruments in exploring online shopping behavior. A better understanding of consumer behavior online will help magnify the use of E-commerce.

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Appendix I

The following items were used with the below scale.

likely |_____|_____|_____|_____|_____|_____|_____| unlikely
extremely quite slightly neither slightly quite extremely

Perceived Usefulness

Using Cdorderz.com can improve my shopping performance (PU1).
Using Cdorderz.com can increase my shopping productivity (PU2).
Using Cdorderz.com can increase my shopping effectiveness (PU3).
I find using Cdorderz.com useful (PU4).

Perceived Ease of Use

Learning to use Cdorderz.com would be easy for me (PEOU1).
My interaction with Cdorderz.com is clear and understandable (PEOU2).
It is easy for me to become skillful at using Cdorderz.com (PEOU3).
I find Cdorderz.com easy to use (PEOU4).

Process Satisfaction

I find using Cdorderz.com enjoyable (PS1).
The actual process of using Cdorderz.com is pleasant (PS2).
I have fun using Cdorderz.com (PS3).
I am satisfied with the process of using Cdorderz.com (PS4).

Outcome Satisfaction

I find that by using Cdorderz.com, I receive the precise books/CDs I order (OS1).
I find that by using Cdorderz.com, I receive the books/CDs on time (OS2).
I am satisfied with Cdorderz.com return policy (OS3).
I am satisfied with the outcome of using Cdorderz.com (OS4).