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Function-Based Analysis of an Electronic Commerce Website

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FUNCTION-BASED ANALYSIS OF AN ELECTRONIC COMMERCE WEBSITE

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Abstract

Traditionally, studies with the technology acceptance model (TAM) have treated software systems as holistic units. A survey is conducted to understand the model better by dropping from system-wide measurement to function-based measurement. The first part of the survey replicates Gefen and Straub's (2000) study where only intention is measured at the function level, with consistent results. System-wide perceived ease of use (PEOU) has more effect on an intrinsic task (intention to search for books) than on an extrinsic task (intention to purchase books). In the second part of the survey, all factors are measured at the function level. The result shows that the function-level models are more predictive than the system-wide model. Specifically, each PEOU is a significant predictor for each intention in both models. This study shows the value of using function-based analysis and suggests that function-based analysis is particularly useful and timely for the study of integrated products offering relatively distinct functions.

Keywords: Function-based analysis, e-commerce, purchase, search, usefulness, ease of use, intention to use, technology acceptance model

Introduction

The technology acceptance model (TAM) is a well-known model, which has three main factors: perceived usefulness (PU), perceived ease of use (PEOU), and behavioral intention (BI). (It is noted that some versions include another factor: attitude.) Many studies have considered TAM for different kinds of software, e.g., office applications, Internet, and Web services. Many have also expanded the model to include more antecedent variables to PU or PEOU, or even to BI (Agarwal and Karahanna 2000; Gefen and Straub 1997; Hong et al. 2001; Igrabria et al. 1995; Igrabria et al. 1997; Szajna, 1994; Venkatesh 2000; Venkatesh and Davis 2000).

Generally, studies with TAM have treated each software system as a holistic system, with each factor measured as a single factor for the entire software. A recent study by Gefen and Straub (2000) is particularly important as it introduces a new approach, applying the model to analyze different functions of software. BI is assessed separately for two different functions—intention to inquire and intention to purchase—while PU and PEOU remain single factors.

With modern technologies merging and integrating many different functions into a single system, function-based analyses will increase in importance. Some examples include mobile phones that include digital image capture and processing, printers that include photocopy and fax capabilities, e-commerce sites that sell products as well as provide a virtual community forum, and Yahoo accounts that allow a variety of services, such as e-mail, file storage, and Web hosting. A holistic evaluation may not be able to capture the full picture. Given the lack of similar research, and the importance of the topic, additional work that analyzes TAM based on functions of the software system will be important.

This paper is motivated by such a need for examining function-based TAM. The study takes the approach one step further by assessing PU and PEOU for two different functions as well, to match the behavioral intention for two functions, as proposed by

Gefen and Straub (2000), who suggest that a limitation in their study is that PU and PEOU do not distinguish between inquiry and purchase behavioral intention. Different tasks will likely require different software features. Hence, PEOU on the different sets of software features may be quite different. Similarly, perceived usefulness for different functions could be different.

A two-part survey is conducted. The first part replicates Gefen and Straub's (2000) survey and the second part extends to the full function-based technology acceptance model. The results show that a full function-based analysis can lead to different and more detailed views. In the following sections, the literature on how TAM was previously studied as a holistic unit and other related literature are briefly reviewed. This is followed by the research models, adapted from Gefen and Straub (2000) and research methodology. The subsequent sections provide the findings, discussion, and conclusion.

Literature Review

Technology Acceptance Model (TAM)

The technology acceptance model is one of the most influential research models in studies of the determinants of technology acceptance. Based on the social psychology theory of reasoned action (TRA) (Ajzen 1988; Fishbein and Ajzen 1975), Davis (1989) proposes the technology acceptance model. The parsimonious model consists of three constructs: perceived usefulness and perceived ease of use as determinants of behavioral intention. A later version includes another factor, attitude toward using. The literature does not show a clear predominance of either version (e.g., see the review by Legris et al. 2003). For the purpose of this study, we will focus on the simpler model.

Perceived usefulness (PU) is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance." Perceived ease of use (PEOU) refers to "the degree to which a person believes that using a particular system would be free of efforts" (Davis 1989). These constructs and their questionnaire items have been tested rigorously for validity and reliability by many researchers (Chin and Todd 1995; Adams et al. 1992; Davis 1989; Davis et al. 1989; Hendrickson et al. 1993; Mathieson 1991; Moore and Benbasat 1991; Szajna 1996).

The technology acceptance model has been used to study many kinds of software. Traditionally, studies with TAM have treated each software system at a holistic, system-wide level, where each factor (i.e., PU, PEOU, and BI) is measured as a single factor for the entire software system. These studies are generally on e-mail, text editor, personal computer, and spreadsheet systems—systems with more focused functions. For example, the text editor was used for typing and arranging document with words and pictures. Even with new features such as Web publishing and versioning for team work, the text editor is still very focused on document preparation. An e-mail system was mainly designed for sending and receiving e-mail. Nowadays, different functions such as calendar scheduling and workflow are included in the system. Therefore function-based analysis on these software systems is more important now than in the past.

Function-Level Assessment

In a recent study by Gefen and Straub (2000), behavioral intention was measured separately for two functions: search and purchase. The fundamental argument is that PEOU and PU could have different effects for different functions. They propose that the effect of PEOU may depend on the nature of the task. For example, searching for books from a Website is a different task from buying books. The final outcome of a search is to get book information. The information generated from the system is the final product, and such tasks are considered as intrinsic to the system. On the other hand, buying is an extrinsic task because the final product, a book, is outside the system.

Furthermore, their extensive literature review shows that PEOU has effects in those studies where the usage of the technology is to perform intrinsic tasks (i.e., Karahanna et al. 1999; Moore and Benbasat 1991; Thompson et al. 1991). Moreover, based on explanation by Davis et al. (1992) that intrinsic and extrinsic motivations affect user intention to adopt a new technology, it is argued that PEOU is an important factor if the task is intrinsic to the technology, but not if it is extrinsic. Their study confirms the hypotheses that PU has the usual effects on both intentions, and PEOU has an effect only on intention to inquire (intrinsic task). Different tasks such as search or purchase may require different software features, with different PEOU and PU, and therefore function-level intention alone may not be able to capture the whole picture.

There are at least two related theoretical perspectives: task-technology fit (TTF), and features-based theory of sensemaking. Task-technology fit is defined as "the extent that technology functionality matches task requirements and individual abilities" (Goodhue 1995). TTF suggests that user performance depends not only on the characteristics of the system, but also on whether the system has met their tasks and abilities (Goodhue and Thompson 1995). TTF focuses on general tasks such as routine, nonroutine, interdependence, and hands-on tasks. Dishaw and Strong (1999) investigated the integration of TAM and TTF for software maintenance, where different task technology fit values were aggregated to predict overall system use. Thus, although TTF emphasizes the fit between various tasks and functions, the variables (fit and use) are system-wide measurements. Griffith (1999) proposes the distinction of technology features into two groups: core and tangential. For instance, an e-mail system has the core features to write and reply to e-mail (i.e., core), and a tangential feature for scheduling events. This is not exactly the same as the intrinsic/extrinsic classification.

In summary, there are very few empirical studies that do not treat a single TAM factor as a single unit. At the same time, as more and more integrated software systems and products offer quite different functions, the classical holistic TAM approach may not be able to provide a picture of sufficient detail.

Research Models and Methodology

Figure 1 shows the model from Gefen and Straub (2000), where only the behavioral intention is measured twice. Let us call this a partial function-based technology acceptance model, because only part of the TAM (the dependent variable) is differentiated by function. We hypothesize that all relationships as shown by the arrows will be significant, except for that between PEOU and Intended Purchase. These hypotheses are the same as those in Gefen and Straub (2000).

Figure 2 shows the full function-based TAM, where all of the factors (PU, PEOU, and BI) are measured twice, for two different functions. With the full differentiation of factors based on functions, it is hypothesized that all relationships as shown by arrows in Figure 2 will be significant. A two-part survey was conducted to test the relationships in Figures 1 and 2.

Two different questionnaires were administered to two distinct groups of similar subjects, who were undergraduate students in Singapore. At the time of the study, they were taking a module on developing e-commerce Websites. They had knowledge on how commercial e-commerce Websites work (i.e., catalog and product searching, shopping cart usage, and credit card check-out mechanism). In particular, they had experience on a well-known Website (Amazon.com), which specializes in selling books.

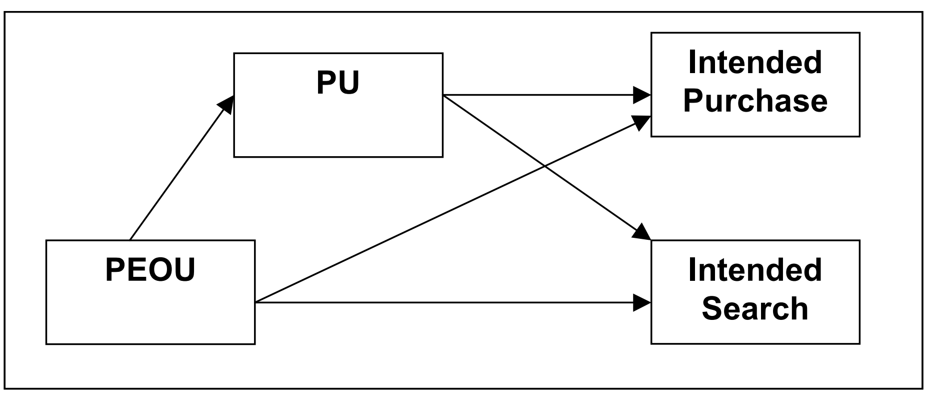

Figure 1. Basic TAM, with Different Functional Intention
(Used with permission, D. Gefen and D. W. Straub, "The Relative Importance of Perceived Ease of Use in IS Adoption: A Study of E-Commerce Adoption," *Journal of the AIS* (1:8), 2000, pp. 1-28. Copyright, Association for Information Systems, P.O. Box 2712, Atlanta, GA 30301-2712)

Subjects were asked their perceptions and intended behavior for the Amazon.com Website. All instruments are adapted from Gefen and Straub (2000). In their survey items, PEOU and PU are adapted from the original TAM scales by Davis (1989) and by Davis et al. (1989), and consist of six and five items. Version 1 (shown in Appendix A) consists of six PEOU items and four

PU items. Three intended purchase items and four intended inquiry items are taken directly from Gefen and Straub (2000). Version 2 (shown in Appendix B) consists of six PEOU items for purchase and for search, and four PU items for purchase and for search. These items are modified from version 1 to specifically mention the function. Three intended purchase items and four intended inquiry items are also taken directly from Gefen and Straub (2000). All items in versions 1 and 2 used seven-point Likert scales ranging from strongly agree (1) to strongly disagree (7).

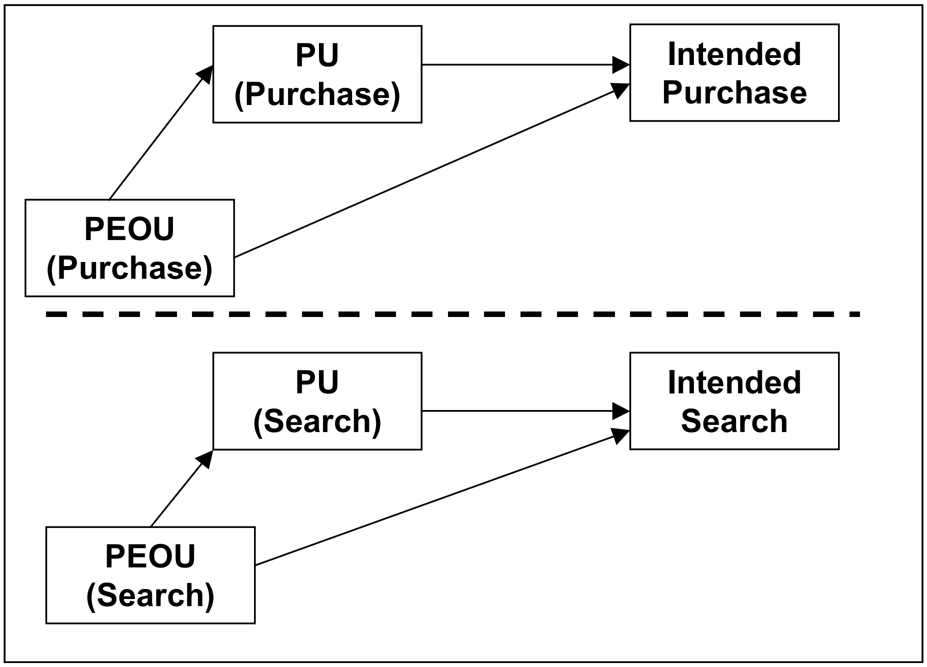

Figure 2. Function-Based Technology Acceptance Model

Students answered questionnaires online in a laboratory, with random assignment of students to either version. Fewer students were allocated to version 1, as that was meant as a replication study, in the Singapore setting. Version 2, with full function-based measurement, was the main focus of this study. Students did not know there were two versions of the survey. Version 2 takes a longer time to complete as it has more items. To prevent students from answering version 2 more hastily than version 1, students have to spend a minimum of 15 minutes in the laboratory. A total of 98 responses for version 1 and 139 responses for version 2 were usable.

Findings and Discussion: Part 1

For version 1, all constructs show high Cronbach alpha ranging from 0.75 to 0.93, higher than the acceptable 0.70 threshold for field research (Cronbach and Meehl 1995; Nunnally and Bernstein 1994). Cronbach alpha for PEOU is 0.94, PU is 0.90, intended purchase is 0.89 and intended inquiry is 0.75. These are comparable to those found by Gefen and Straub (2000), where Cronbach alpha ranges from 0.79 to 0.93. The data are analyzed using principal component analysis to investigate convergent and discriminant validity. Using varimax rotation, the factor analysis shows four components with eigenvalues above 1.0 with a total of 74.9 percent explained variance. This is slightly lower than Gefen and Straub (2000), where a total of 77 percent was recorded. Two items (PU1 and INQ1) show relatively low (.65 and .69 respectively) but still significant factor loadings (Hair et al. 1998). See Appendix A for factor analysis and descriptive statistics.[1]

[1]Correlation matrices for all of the items in versions 1 and 2 are available from the authors upon request.

The linear regression results (including those by Gefen and Straub 2000), and also for version 2 are shown in Table 1. All hypotheses for model 1 are supported, i.e., all relationships except that between PEOU and intention to purchase are significant. PU and PEOU explain approximately 15 percent of the variation in intended purchase. PU and PEOU explain approximately 26 percent of the variation in intended search, and finally, PEOU explains approximately 41 percent of the variation in PU. The results are comparable with those found by Gefen and Straub (2000). In summary, part 1 results confirm the findings found in Gefen and Straub (2000) for a group of subjects in a different country.

Table 1. Stepwise Linear Regression Results

Variables		Gefen and Straub(2000)		Version 1		Version 2 Search	Version 2 Purchase
		Search	Purchase	Search	Purchase		
PEOU ⇛ PU	Std. β	0.625*		0.647*		0.83	0.881
	p-value	0.001		0.001		0.001	0.001
PU	Adj. R2	0.39		0.41		0.69	0.66
	F-value	126.2		69.2		294	259
	p-value	0.001		0.001		0.001	0.001
PEOU ⇛ BI	Std. β	0.188	0.136	0.253	-0.079	0.230	0.238
	p-value	0.027	0.106	0.029	0.523	0.020	0.034
PU ⇛ BI	Std. β	0.277	0.35	0.325	0.449	0.555	0.455
	p-value	0.001	0.001	0.006	0.001	0.001	0.001
BI	Adj. R2	0.18	0.2	0.26	0.15	0.57	0.43
	F-value	21.1	24.4	18.1	9.2	91.2	51.7
	p-value	0.001	0.001	0.001	0.001	0.001	0.001

*PEOU and PU are measured using single factors.

Findings and Discussion: Part 2

This section analyzes the full function-based model in Figure 2. Table 2 provides the Cronbach's alpha and descriptive statistics for PEOU, PU, and BI for two separate functions. All constructs show Cronbach's alpha higher than the acceptable threshold (0.70) (Cronbach and Meehl 1995; Nunnally and Bernstein 1994). See Appendix B for a principal component analysis. Factor analysis does not show clearly six orthogonal components, due to the relatively high correlation of PU and PEOU across functions.

Table 2. Descriptive Statistics

Constructs	Cronbach's alpha	Mean	Std. Deviation
PU for Purchase	.91	3.40	1.06
PU for Search	.94	3.23	1.11
PEOU for Purchase	.88	3.27	1.02
PEOU for Search	.91	3.00	1.12
Intended Search	.91	2.88	1.17
Intended Purchase	.74	3.75	1.12

The linear regression results are shown in Table 1. All hypotheses are supported; all relationships in the model are significant. PEOU explains more than 66 percent of the variation in PU, for each function. This is much higher than version 1 (42 percent) or Gefen and Straub's (2000) study (39 percent). Moreover, PEOU and PU for search in version 2 explain more than 57 percent of the variation in intention for search. This is more than double the explained variation from version 1 (26 percent) or from Gefen and Straub's (2000) study (18 percent). Similarly, PEOU and PU for purchase in version 2 explain more than 43 percent of the variation in intention for purchase, and again this is more than double the explained variation from version 1 (15 percent) or from Gefen and Straub's (2000) study (20 percent).

In summary, the result in part 2 shows that a full function-based analysis can provide a more detailed understanding of an e-commerce Website that is used for two different functions. PEOU measured for purchase function has effect on intention to purchase. This is in contrast to part 1, where a holistic measure of PEOU does not show an effect on intention to purchase. The possible explanation is that a holistic measure does not capture function-based variations present in PEOU. Different software features are required by the two different functions. In fact, Gefen and Straub (2000) point out this possibility in their report and suggest further studies in this direction.

The combined results indicate perhaps a high overlapping in the software features used in search and purchase functions, with perhaps more perception variation on those used for search. This could explain why PEOU (overall) shows effect on intention (search) and no effect on intention (purchase). When the variation is measured separately as PEOU (purchase), the effect is shown.

Conclusion

This study has several implications for research and practice. With regard to research, this study shows that a function-based analysis can provide more details than a holistic measurement of each TAM factor. This new approach can be applied to many new products and software systems that offer quite distinct functions. This is particularly important since researchers could look at the different functions or the features of technology to measure function-based usefulness, ease of use, and behavioral intention. It is timely as more and more products are integrating quite distinct functions into one system.

Future research should consider more different approaches in applying the TAM model. Individual TAM factors could be measured in multiple ways, e.g., function-based, as in this study, or even by time horizon (i.e., short-term/long-term distinction, as done by Chau 1996). The study also suggests further uses of the task-technology fit model. Instead of computing an overall task-technology fit variable, and linking it to an overall system use (or intention to use), as done in the study by Dishaw and Strong (1999), the linkages between fit and use based on distinct functions could be studied. Additionally, combining this line of inquiry with the features-based theory of sensemaking triggers (Griffith 1999) will create a new stream of research. Future research could ask the following questions: How do core and tangential features contribute to the overall intention to use a product? For example, do people buy a mobile phone because it has digital image capability? That is, does a tangential feature override the core feature, in terms of intention to use a product? Furthermore, future research could also investigate TAM models for multifunction technologies, and the relative salience of functions for improving acceptance.

With regard to the implication of practice, when users show low acceptance for a particular function in the technology, developers may want to invest less on that particular function. For instance, calendar scheduling in e-mail may not be as useful for small firms as for large firms, and small firms could use a very lean e-mail client system such as Eudora instead of Lotus Notes or Exchange.

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Appendix A. Questions and Factor Analysis for Version 1

Construct	Code	Question Wording
Perceived Usefulness	PU1	Amazon.com improves my performance in book searching and buying
	PU2	Amazon.com is useful for searching and buying books
	PU3	Amazon.com makes it easier to search for and purchase books
	PU4	Amazon.com increases my productivity in searching and purchasing books
Perceived Ease of Use	PEOU1	Amazon.com is easy-to-use
	PEOU2	It is easy to become skillful at using Amazon.com
	PEOU3	Learning to operate Amazon.com is easy
	PEOU4	Amazon.com is flexible to interact with
	PEOU5	My interaction with Amazon.com is clear and understandable
	PEOU6	It is easy to interact with Amazon.com
Intended Purchase	IP1	I would use my credit card to purchase from Amazon.com
	IP2	I would not hesitate to provide information about my habits to Amazon.com
	IP3	I am very likely to buy books from Amazon.com
Intended Inquiry	INQ1	I would use Amazon.com to retrieve information
	INQ2	I would use Amazon.com to inquire what readers think of a book
	INQ3	I would use Amazon.com to find out about the author of the book
	INQ4	I would use Amazon.com to inquire about book ratings

Scale Items	PEOU	PU	Intended Search	Intended Purchase
PEOU1	**0.813**	0.264	0.108	0.060
PEOU2	**0.825**	0.144	0.232	0.073
PEOU3	**0.735**	0.342	0.078	0.018
PEOU4	**0.829**	0.250	0.234	0.013
PEOU5	**0.791**	0.150	0.220	0.126
PEOU6	**0.841**	0.280	0.176	0.065
PU1	0.357	**0.649**	0.302	0.268
PU2	0.398	**0.828**	0.115	0.192
PU3	0.316	**0.866**	0.188	0.116
PU4	0.286	**0.808**	0.234	0.142
INQ1	0.299	0.149	**0.689**	0.078
INQ2	0.129	0.121	**0.803**	0.186
INQ3	0.233	0.124	**0.800**	-0.062
INQ4	0.101	0.217	**0.835**	0.146
IP1	0.072	0.228	0.155	**0.792**
IP2	0.147	-0.009	-0.013	**0.806**
IP3	-0.040	0.220	0.147	**0.799**
Eigenvalue	7.75	2.11	1.71	1.16
Percent Explained Variance	45.6	12.4	10.1	6.8
Mean (std dev) of construct	3.14 (1.17)	3.46 (1.00)	3.14 (1.11)	4.05 (1.16)

Rotation Method: Varimax with Kaiser Normalization

Appendix B. Questions and Factor Analysis for Version 2

Construct	Code	Question Wording
Perceived Usefulness	PU1p	Amazon.com improves my performance in buying books
	PU1s	Amazon.com improves my performance in book searching
	PU2p	Amazon.com is useful for buying books
	PU2s	Amazon.com is useful for book searching
	PU3p	Amazon.com makes it easier to purchase books
	PU3s	Amazon.com makes it easier to search for books
	PU4p	Amazon.com increases my productivity in purchasing books
	PU4s	Amazon.com increases my productivity in book searching
Perceived Ease of Use	PEOU1p	Amazon.com is easy-to-use for buying books
	PEOU1s	Amazon.com is easy-to-use for book searching
	PEOU2p	It is easy to become skillful at buying books using Amazon.com
	PEOU2s	It is easy to become skillful at book searching using Amazon.com
	PEOU3p	Learning to operate Amazon.com for buying books is easy
	PEOU3s	Learning to operate Amazon.com for book searching is easy
	PEOU4p	For buying books, Amazon.com is flexible to interact with
	PEOU4s	For book searching, Amazon.com is flexible to interact with
	PEOU5p	My interaction for buying books with Amazon.com is clear and understandable
	PEOU5s	My interaction for book searching with Amazon.com is clear and understandable
	PEOU6p	It is easy to interact with Amazon.com for buying books
	PEOU6s	It is easy to interact with Amazon.com for book searching
Intended Purchase	IP1	I would use my credit card to purchase from Amazon.com
	IP2	I would not hesitate to provide information about my habits to Amazon.com
	IP3	I am very likely to buy books from Amazon.com
Intended Inquiry	INQ1	I would use Amazon.com to retrieve information
	INQ2	I would use Amazon.com to inquire what readers think of a book
	INQ3	I would use Amazon.com to find out about the author of the book
	INQ4	I would use Amazon.com to inquire about book ratings

Scale Items	Component					
	1	**2**	**3**	**4**	**5**	**6**
PE1p	.432	.149	.137	.194	**.663**	.174
PE2p	.668	.170	.010	.313	**.381**	.069
PE3p	.645	.259	.226	.218	**.291**	.256
PE4p	.444	.240	.261	.190	**.520**	.251
PE5p	.146	.225	.623	.238	**.533**	.163
PE6p	.406	.250	.408	.242	**.529**	.328
PE1s	**.768**	.265	.323	.140	.196	.044
PE2s	**.714**	.255	.264	.189	.243	.095
PE3s	**.761**	.236	.365	.192	.171	.204
PE4s	**.526**	.335	.540	.099	.204	.290
PE5s	**.337**	.214	.760	.240	.253	.144
PE6s	**.513**	.248	.663	.181	.141	.230
PU1p	.356	.227	.089	**.693**	.229	.307
PU2p	.341	.385	.313	**.232**	.599	.130
PU3p	.336	.346	.294	**.318**	.560	.149
PU4p	.131	.168	.144	**.765**	.334	.179
PU1s	.426	.387	**.316**	.625	-.006	.114
PU2s	.468	.505	**.512**	.230	.206	-.002
PU3s	.470	.436	**.511**	.279	.222	.051
PU4s	.281	.292	**.436**	.649	.093	.071
INQ1	.218	**.667**	.394	.147	.289	.117
INQ2	.303	**.778**	.110	.241	.119	.202
INQ3	.192	**.783**	.289	.219	.221	.115
INQ4	.222	**.806**	.098	.120	.148	.238
IP1	.199	.280	.170	.282	.011	**.655**
IP2	.102	.151	.087	.082	.195	**.820**
IP3	.061	.046	.127	.548	.332	0.55

Rotation Method: Varimax with Kaiser Normalization