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ABSTRACT

With the growing popularity of information and communication technologies (ICT), researchers from information systems (IS) field are increasingly interested in the factors influencing user satisfaction in computer-mediated environment. Drawing on media synchronicity theory (MST), this study explores how various media characteristics influence user satisfaction through social presence. The results from a lab experiment supported our hypothesis and found that transmission velocity, symbol sets and rehearsability were positively related to social presence, whereas reprocessability had a negative effect on social presence. Social presence in turn positively influenced both process satisfaction and outcome satisfaction. Overall, this study contributes to IS literature by providing a deeper understanding on the effect of objective media characteristics on user satisfaction.

Keywords

Media synchronicity, user satisfaction, social presence

INTRODUCTION

As information and communication technologies (ICT) advance, organizations are increasingly employing virtual team to support their various business processes (Saunders & Ahuja, 2006). Various modern communication media including email, video conference and others are the basis of virtual team. It is these communication media that enable virtual team members separated by time and/or space to effectively work together and achieve a common goal. While modern communication media may be effective in increasing team effectiveness or efficiency, it is still unclear how communication media affect user's satisfaction (Suh, 1999). Prior research shows that dissatisfied people are less likely to adopt a technology even if it might help user improve their performance (Reinig, 2003; Simon et al., 1996). Therefore, to reap the benefits of ICT, it is important to keep users satisfied during and after their interaction using various media.

The media within which individuals interact play an important role in influencing how individuals interact and the subsequent consequences (Dennis et al., 2008). Thus, the understanding of how different media and associated characteristics influence user satisfaction not only helps practitioners design more user-friendly media, but also helps users better understand the role of these media and associated characteristics so that they can select and configure the best medium/media to facilitate their communication processes. While previous studies examined the effect of media on user satisfaction on the media level (e.g., email, video conferencing, face-to-face), little research investigates the media on the attribute level. This is important because the distinctions between different media are becoming more ambiguous and various features could be easily incorporated into the same medium. As a result, different media can have the same functionalities and the same medium can operate differently depending upon how the medium is configured. For instance, Instant Messaging, one of the most popular modern communication media, could be used in a similar way as email if only the text chat function is used. On the other hand, it could be used in a similar way as telephone if only audio function is used. Thus, it is more meaningful to examine the effect of media from an attribute perspective.

Therefore, our overall research question is: How do media characteristics influence user satisfaction? In order to answer this question, we draw on literature from social presence and media synchronicity theory (MST) to hypothesize the effects of media characteristics on users' process and outcome satisfaction mediated by social presence. The rest of the paper is organized as follows. We first review previous literature on user satisfaction, MST, and social presence. Next, we develop our theoretic framework and hypotheses. We then report the research design and data analysis. Finally, implications of the research are discussed.

LITERATURE REVIEW

User satisfaction

Satisfaction can be defined as "an affective arousal with a positive valence on the part of an individual towards some object" (Briggs et al., 2006, p. 587). User satisfaction has been one of the most important constructs in IS literature (DeLone and McLean, 1992). Fjermestad and Hiltz (1999) reviewed more than 200 published papers on computer-mediated communication and found that user satisfaction was the second most frequently used outcome variables, explaining more than 25% of the research surveyed. Consistent with prior research (e.g., Briggs & de Vreede, 1997; Reinig, 2003), we decompose user satisfaction into two separate constructs: process satisfaction and outcome satisfaction. Process satisfaction is defined as an affective arousal of an individual towards the procedures and tools used in the communication process, whereas outcome satisfaction refers to affective arousal of an individual towards the outcome of the communication process. It is necessary to distinguish process satisfaction from outcome satisfaction as users may be satisfied with the outcome of the communication but not the process of the communication or vice versa (Briggs & de Vreede, 1997).

While some research has examined the effect of media on user satisfaction (e.g., Kinney & Dennis, 1994; Valacich et al. 1994; Suh, 1999), most of the prior research on satisfaction was conducted on media level, and little research attempted to investigate the effect of communication media on the attribute level and understand how various objective characteristics of the media impact user satisfaction. To better understand the effect of different media characteristic, we turn to media synchronicity theory (MST).

Media Synchronicity Theory

MST proposes that any task involves two fundamental communication processes (conveyance and convergence process). Task performance is determined by the match between media synchronicity and underlying communication process of a particular task. Specifically, high media synchronicity leads to better performance for tasks in which convergence is the goal, whereas low media synchronicity improves performance for tasks in which conveyance is the goal. Further, media synchronicity is defined by five major characteristics of the media: *transmission velocity*, *symbol sets*, *parallelism*, *rehearsability*, and *reprocessability*. The theory suggests that transmission velocity, natural symbol sets positively contribute to media synchronicity, whereas parallelism, rehearsability, and reprocessability negatively contribute to media synchronicity.

MST breaks the black box of medium and examines the physical objective characteristics of medium in a systematical way. While some other media theories also identify media characteristics, "many of these characteristics are actually socially derived characteristics, whose salience is influenced by prior experience and context of use" (Dennis et al., 2008, p. 576). Thus, MST provides us a better framework to understand how physical objective characteristics of the media influence user satisfaction.

Social Presence

Social presence refers to "the degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationship" (Short et al., 1976, p. 65). It represents the degree of person-to-person awareness in an interaction. As a core construct in computer-mediated communication, social presence gained substantial interests from communication and human-computer interaction (HCI) researchers as "it may mediate the effects of other variables of central concern to the researcher" (Biocca et al., 2003, p. 457).

Social presence is considered as a dynamic variable. Many studies have shown that the perception of social presence in an interaction varies among participants (e.g., Tu, 2002). Therefore, social presence is better to be viewed as a subjective quality that depends upon the objective characteristics of the medium (Walther, 1992) as well as user's experience with the medium (Tu 2002). A variety of variables (Kehrwald 2008) are found to influence social presence, including communication contexts (Yoo & Alavi, 2001), communicative task type (Tu, 2001, 2002), individual differences (e.g., experience with the media) (Tu & McIsaac, 2002), cultural dispositions for or against particular types of communication (Tu, 2001), and confidence in communications or particular skills (Tu, 2002; Tu & McIsaac, 2002), and how individuals subjectively interpret social presence cues (Riva, 2002). In addition, a large body of research has investigated the impact of social presence on various outcome variables such as online learning and interaction (Gunawardena & Zittle, 1997; Tu, 2002; Tu & McIsaac, 2002), online privacy (Tu, 2002), satisfaction (Wise et al., 2004; Gunawardena and Zittle, 1997), engagement (Wise et al., 2004). Thus, previous literature suggests that social presence is an important intermediated variable that mediates the effect of communication media on various outcome variables (Biocaa et al., 2003). In fact, Sarker et al. (2011) have examined the impact of several media characteristics (anonymity, parallelism, and immediacy of feedback) on outcome satisfaction, but they didn't find the significant impacts of media characteristics on satisfaction. This may be attributed to the possible missing of mediator between media characteristics and user satisfaction such as social presence.

HYPOTHESES

The research model of the study is shown in Figure 1.
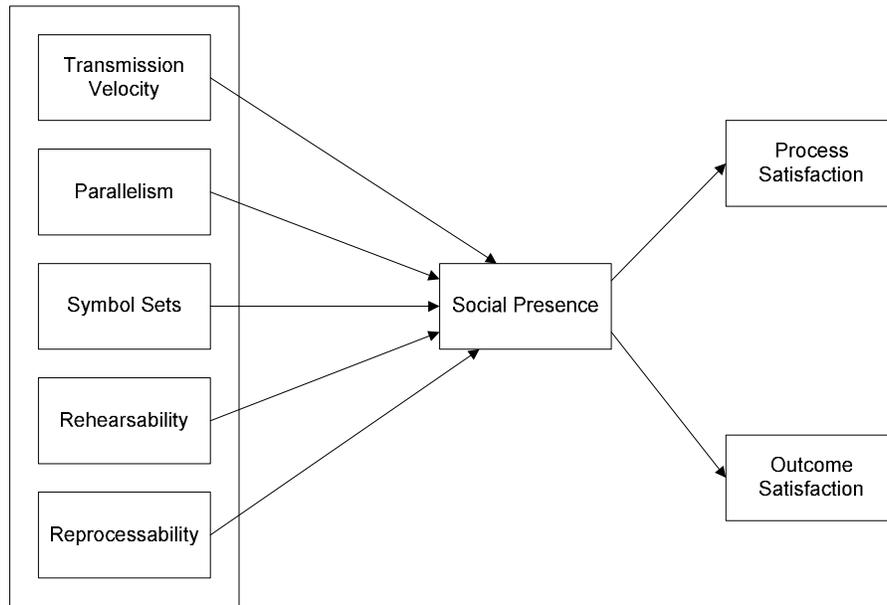
Figure 1. Research Model

Transmission velocity

Transmission velocity is the speed at which a medium can deliver a message to intended recipients (Dennis et al., 2008). It describes the amount of time delay between the time the sender sends out the message and the time the recipient receives the message. Media in high transmission velocity allow the message to reach the recipients in very short time, thus enabling a quick response (Dennis et al., 2008). The immediate response may engender the salience of other people in the interaction, thus improving the perception of social presence. In addition, due to less time delay between the communication partners, there will be more interaction and higher level of interactivity between communication partners in a certain amount of time. Thus, people are more likely to have higher level of cognitive and affective involvement in the communication, and are more likely to perceive the presence of the partner. Therefore, we hypothesize that

H1: Transmission velocity is positively associated with social presence.

Parallelism

According to Dennis et al. (2008), parallelism is the number of simultaneous transmission that effectively takes place. Higher parallelism means that multiple communications can take place simultaneously. Psychology literature suggests that people's cognitive and attention resources are limited (Norman and Bobrow, 1975). Therefore, holding the total cognitive and attention resources from a certain person constant, the resources allocated to each communication should reduce as the number of communications goes up because more and more communications compete for user's limited cognitive and attention resources. Thus, people's cognitive and attention resources allocated for each communication may decrease dramatically. As a result, people may become less attentive to each of the communication and their partners are less likely to perceive their presence. In addition, as the number of communications increases, there is more interruption and time delay for a particular communication. As a result, people are less likely to perceive the presence of their partner. Therefore, we hypothesize that

H2: Parallelism is negatively associated with social presence.

Symbol sets

Symbol sets is defined as the number of ways in which a medium allows information to be encoded for communication (Dennis et al., 2008). Prior research found that media using more natural symbol sets have higher level of social presence. Specifically, face-to-face was rated as the highest social presence medium followed by video and audio only, text (Hwang and Park, 2007). We argue that there are two main reasons.

First, symbol sets subsumes multiplicity of cues and language variety. As social presence represents the capacity of media to convey information necessary for the mediated communication to be perceived as real (non-mediated communication) (Kehrwald 2008), media communicating with natural symbol sets better enable users to perceive the communication as if non-mediated communication (e.g., face-to-face). Thus, natural symbol sets may increase people's perception of social presence.

Second, a very important psychology concept involved in social presence is immediacy, which includes "eye contact, smiling, vocal expressiveness, appropriate touching, leaning toward a person, gesturing, using overall body movements, being relaxed, and spending time with someone" (Tu, 2002, p. 295). Natural symbol sets are more easily to convey immediacy because natural symbol sets are easier to convey non-verbal cues. Therefore, we hypothesize that

H3: Natural symbol sets is positively associated with social presence.

Rehearsability

Rehearsability refers to the extent to which the media enable the sender to rehearse or fine tune a message during encoding, before sending (Dennis et al., 2008). Media with high rehearsability allow senders to carefully craft the message before sending. Thus, the meaning of the message could be expressed more precisely and accurately, and the message becomes easier to understand. In addition, using media with high rehearsability, the sender could carefully consider the context and the possible interpretation of the message so that the message is more customized to fit the recipients' needs. As a result, the message is probably perceived as more considerate and attentive, and more easily to draw receiver's attention, thus increasing the perception of social presence. Although high rehearsability requires more time to craft the message, prior literature indicates that "the conduct of rehearsal activities should be non-obvious to other participants and not interrupt the ongoing flow of the communication event" (Carlson and George, 2004, p.193). Thus the negative impact of rehearsability may be negligible. In other words, while some attention resources are allocated to polish the message, the refined message can facilitate the communication, which increases the social presence. Therefore, we hypothesize that

H4: Rehearsability is positively associated with social presence.

Reprocessability

Reprocessability is the extent to which the medium enables a message to be reexamined or processed again (Dennis et al., 2008). Reprocessability affects the communication process by allowing the user to revisit the receiving message more than once subsequently. Reprocessing the message consumes people's cognitive and attention resource. As mentioned, people's cognitive and attention resources are limited (Norman and Bobrow, 1975). Again, holding the total attention resources constant, as people put more cognitive and attention resources on reprocessing the message, they would have less cognitive and attention resources devoted on the communication process. Thus, the reprocessability may cause more interruption and time delay to the ongoing communication process, especially when the user reprocesses irrelevant information. Therefore, we hypothesize that

H5: Reprocessability is negatively associated with social presence.

Satisfaction

Social presence has been viewed as a critical predictor of satisfaction. For instance, Gunawardena and Zittle (1997) examined the impact of social presence on satisfaction within computer-mediated conferencing (CMC) environments. Defining satisfaction as the value of CMC in facilitating learning for students, they found that social presence accounted for about 60% of the variance of satisfaction variable, thus concluding social presence to be a strong predictor of satisfaction in online environments. Richardson and Swan (2003) explored the relationship between social presence and students' perception of learning and satisfaction in online learning environment and found that students' perception of social presence significantly contributed to their satisfaction.

Therefore, social presence is probably positively related to both process satisfaction and outcome satisfaction. For process satisfaction, it is to believe that high social presence will create an approachable environment between the communication parties. Under high social presence, users are more willing to interact and reciprocate with each other. Thus, people are more likely to establish trust, seek support, resulting in more satisfying experience and greater learning. As a result, social presence may be positively related to process satisfaction. Social presence may also influence outcome satisfaction. As mentioned, high social presence will create a more approachable environment. Thus, there should be less conflict and more agreement on the final solution, resulting in higher outcome satisfaction.

Thus, we hypothesize that

H6: Social presence is positively associated with process satisfaction.

H7: Social presence is positively associated with outcome satisfaction.

METHOD

Design

A laboratory study was conducted using 2 x 2 between-subjects research design, crossing task type (idea generation vs. negotiation task) and medium (text vs. audio). We used two types of tasks in this experiment to account for the potential effect of task type on social presence as MST suggests that task type may affect the consequence of the interaction within the medium.

Subjects

303 undergraduate students from an introductory information system course participated in the study[1]. The average age of the participants was 20.29, and 190 (62.7%) of the participants were male. Participants received about 1% of course credit for participating in the study.

Tasks

Two types of tasks (idea generation task and negotiation task) were employed in this study. The tasks were carefully selected to differentiate communication processes (conveyance and convergence). The idea generation task (university parking task) was adapted from Valacich et al. (2006). In this task, participants were required to work as dyadic group and generate ideas on "how can we improve the university's parking situation?" as many as possible. This task was chosen because of its high relevance to the participants, which allowed them to draw on their personal knowledge and experience. The negotiation task (desert survival task) was drawn from Lafferty & Pond (1974). In this task, participants were given a scenario in which they crash-landed in a desert with only 15 items recovered from the wreckage. Participants were required to rank those items individually based on their importance to survival. Then they were asked to discuss with their partner to complete a joint ranking. The task was chosen because it could elicit strong opinion from participants so that they would put more efforts on the convergence process to reach agreement.

Procedure

A pilot study with 37 undergraduate students from an introductory information system course was conducted using almost exactly the same experimental procedure as described in next section except that task type was manipulated as a within-subject variable. The objective of the pilot study was to validate the measures used and identify potential problems with the procedure. Problems found in the pilot were addressed in the main study.

In the main study, participants were randomly assigned to one of the four treatments. In each treatment, participants were randomly assigned to form dyadic groups. Participants who were left received course credit but were not included in the analysis. Once the dyads were formed, participants were briefly trained on how to use MS NetMeeting. The training continued until participants felt that they had known how to use the software. Then written instructions of the task were given. In treatment 1, participants were required to complete university parking task using text messaging. In treatment 2, participants were required to complete university parking task using audio. In treatment 3, participants were required to complete desert survival task using text messaging. In treatment 4, participants were asked to complete desert survival task using audio. To fully investigate the impact of media usage on communication performance, we did not impose time limit on tasks. After completing all tasks, participants were required to fill out a post-experiment questionnaire and then released.

Measures

All measures were adapted from prior literature as possible and are shown in Appendix 1. Social presence was measured using the original measure developed and tested by Short et al. (1976). User satisfaction was measured by a 10-item instrument developed by Green and Taber (1980), assessing both process and outcome satisfaction of the communication. New measures were developed to assess transmission velocity, parallelism, symbol sets, rehearsability, and reprocessability. Task type was assessed by coding university parking task as 1 and desert survival task as 0.

DATA ANALYSIS AND RESULT

Data analysis was performed using SPSS 18.0 and PLS (PLS Graph, Version 3.00 Build 1130).

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[1] 15 students completed the task assignment but didn't fill out questionnaire. Thus they are removed from the analysis.

Validity and Reliability

Following the procedures recommended by Gefen and Straub (2005), we assess the reliability and validity of the constructs. The reliability scores for all constructs exceeded the recommended threshold 0.7 (refer to Appendix 1) (Hair et al., 1998), suggesting that the internal consistency of the constructs was supported. The AVEs for all constructs were greater than 0.5 as recommended by Fornell and Larcker (1981), suggesting that the convergent validity of the constructs was supported.

The discriminant validity of the constructs could be established through two steps. First, each item loading should be greater than 0.6 and significantly greater than its cross loading. As shown in Appendix 2, all loadings were greater than 0.6 except for P1 which was a little bit lower than 0.6. In addition, all item loadings were significantly greater than respective cross loading. Second, the square root of the AVEs has to be significantly greater than the correlations with other constructs. As shown in Appendix 3, the square root of the AVEs was significantly greater than the correlations with other constructs. Thus, the discriminant validity of the constructs was established.
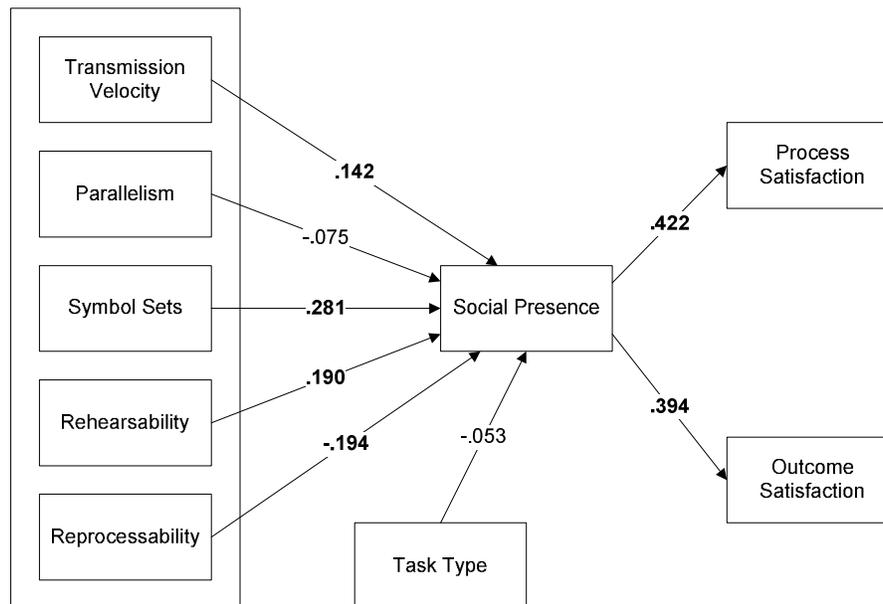
Structural Model

Figure 2. Results of Structural Model

As shown in Figure 2, task type was found to have no impact on social presence. All hypotheses were supported except for H2. Specifically, transmission velocity (t = 2.45, p < 0.05), symbol sets (t = 4.21, p < 0.01), rehearsability (t = 2.53, p < 0.05) were shown to be positively associated with social presence. Reprocessability (t = 2.96, p < 0.05) was shown to be negatively associated with social presence. Social presence was positively associated with process satisfaction (t = 8.76, p < 0.01) and outcome satisfaction (t = 7.75, p < 0.01). The impact of parallelism (t = 1.21, p > 0.10) on social presence was not significant. Thus, H2 was not supported. In addition, as shown in Figure 2, the model explained 17.8% of the variance in process satisfaction, 15.5% of the variance in outcome satisfaction, and 19.1% of the variance in social presence.

DISCUSSION

This research examines the effect of media characteristics on user satisfaction drawn on MST. The study found that media synchronicity had significant influence on user satisfaction through social presence. Specifically, we found that transmission velocity, symbol sets, rehearsability had positive impact on social presence, and reprocessability was negatively associated with social presence. Social presence positively impacted process satisfaction and outcome satisfaction. In addition, the negative effect of parallelism on social presence was not significant. One possible explanation is that the dyadic group design in the study only allowed participants to talk to one partner. Therefore, there was not too much variance in parallelism in our study.

This study contributes to IS literature by providing insightful understanding on how various media characteristics influence user satisfaction. Although the influence of communication media on user satisfaction has been examined in prior research, most existing research examined the effect of media on user satisfaction on the media level. As a result, we have little

understanding on the relationship between the media and satisfaction on the attribute level, which prevent us from suggesting practitioners how to better design the media. From user's perspective, this research helps user better understand the effects of various media characteristics on user satisfaction. Thus, they can configure the medium/media in the best way to facilitate their communication processes. Further, although Sarker et al. (2011) explored the influence of some media characteristics (anonymity, parallelism, immediacy of feedback) on outcome satisfaction, they didn't find significant relationships between media characteristics and outcome satisfaction. One of the explanations is that some intermediated variables, such as social presence, may mediate the relationship between the objective characteristics of the media and user satisfaction. Thus, this research extends the prior research by examining effects of different characteristics of the media on user's satisfaction and how this effect is mediated by social presence.

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APPENDIX:

Construct	Measurement Items	CR	AVE
Transmission Velocity	I could get a quick response from my partner	.89	.73
	It took me a long time to get a response from my partner		
	My partner responded quickly		
Parallelism	The medium my group used is the best way for communicating with only one person at a time	.77	.64
	The medium my group used allows me to communicate with only one person at a time		
Symbol Sets	The medium my group used allows my partner and I to communicate in a normal fashion (e.g., I can understand my partner as well as if I was communicating in person)	.90	.76
	The medium my group used is a normal-method of communication. (e.g., I can understand my partner as well as if I was communicating in person)		
	The medium my group used does NOT support communication in the normal fashion (e.g., I can NOT understand my partner as well as if I was communicating in person)		
Rehearsability	I have enough time to think about a message before I communicate it to my partner	.93	.86
	I was able to craft the message before I communicate it to my partner		

Reprocessability	If I wanted, I was able to re-examine prior messages	.94	.84
	If I missed a message, I could easily retrieve it with the medium my group used.		
	The medium my group used allows me to review prior messages.		
Social Presence	How would you describe the communication media you and the other party used? Impersonal – Personal	.87	.62
	Insensitive – Sensitive		
	Cold – Warm		
	Passive – Active		
Process Satisfaction	How would you describe the problem solving (or negotiation) process you and the other party used? Efficient – Inefficient	.96	.81
	Uncoordinated – Coordinated		
	Fair – Unfair		
	Understandable – Confusing		
	Dissatisfying –Satisfying		
Outcome Satisfaction	How satisfied or dissatisfied are you with the quality of the solution (or outcome) which you and the other party reached? Very dissatisfied – Very satisfied	.89	.62
	To what extent does the final solution (or outcome) reflect your inputs? Not at all – Very much		
	To what extent do you feel committed to the solution (or outcome)? Not at all – Very much		
	To what extent are you confident that the solution (or outcome) is optimal? Not at all – Very much		
	To what extent do you feel personally responsible for the solution (or outcome) which you and the other party reached? Not at all – Very much		

Appendix 1: Items, Composite Reliability (CR), and Average Variance Extracted (AVE)

	Transmission Velocity	Parallelism	Symbol Sets	Rehear sability	Reproce ssability	Social Presence	Process Satisfaction	Outcome Satisfaction
TV1	**.870**	.123	.306	.114	-.002	.235	.314	.209
TV2*	**.789**	-.032	.224	.039	-.093	.194	.255	.140
TV3	**.896**	.073	.314	.083	-.022	.236	.326	.233
P1*	-.047	**.543**	-.063	-.137	-.104	.019	-.081	-.062
P2*	.081	**.995**	.187	-.143	-.225	.153	.043	-.027
SS1	.339	.226	**.907**	.058	-.053	.365	.305	.263
SS2	.216	.176	**.887**	.125	-.094	.321	.319	.247
SS3*	.317	.000	**.812**	.004	-.103	.254	.313	.230
REH1	.089	-.149	.092	**.951**	.607	.090	.081	.100
REH2	.071	-.146	.025	**.897**	.565	.065	.095	.065
REP1	-.062	-.208	-.114	.587	**.936**	-.118	-.082	-.017
REP2	-.020	-.163	-.014	.530	**.879**	-.089	-.044	.009
REP3	-.028	-.237	-.108	.563	**.932**	-.120	-.084	-.022

SP1	.151	.109	.282	.076	-.111	**.764**	.264	.262
SP2	.094	.087	.199	.064	-.069	**.636**	.136	.187
SP3	.272	.130	.296	.091	-.062	**.860**	.373	.346
SP4	.249	.126	.346	.068	-.131	**.865**	.455	.390
PS1	.335	.032	.350	.041	-.103	.340	**.875**	.570
PS2	.314	.022	.362	.141	-.046	.391	**.898**	.526
PS3	.304	-.008	.291	.042	-.100	.385	**.906**	.515
PS4	.295	.056	.304	.097	-.050	.382	**.901**	.506
PS5	.338	.038	.303	.111	-.060	.399	**.923**	.582
OS1	.340	.002	.294	.079	-.032	.341	.638	**.772**
OS2	.155	-.054	.240	.058	-.092	.293	.474	**.797**
OS3	.178	-.009	.255	.058	-.015	.380	.475	**.884**
OS4	.137	-.074	.199	.132	.084	.305	.426	**.812**
OS5	.043	.008	.079	.018	.013	.190	.291	**.671**
* means that the item is reverse coded								

Appendix 2: Item loading

Construct	Transmission Velocity	Parallelism	Symbol Sets	Rehearsability	Reprocessability	Social Presence	Process Satisfaction	Outcome Satisfaction
Transmission velocity	**0.853**							
Parallelism	-0.070	**.801**						
Symbol Sets	0.333	-0.169	**0.869**					
Rehearsability	0.087	0.159	0.069	**0.927**				
Reprocessability	-0.042	0.225	-0.092	0.633	**0.916**			
Social Presence	0.261	-0.146	0.366	0.085	-0.121	**0.787**		
Process Satisfaction	0.352	-0.031	0.357	0.093	-0.079	0.422	**0.901**	
Outcome Satisfaction	0.231	0.033	0.284	0.092	-0.013	0.394	0.598	**0.790**
Square root of AVEs are shown in bold along the diagonal								

Appendix 3: Correlation and AVE