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Affordances of Virtual World Commerce: Instrument Development and Validation

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ABSTRACT

This paper addresses the affordances of the social and business environment of a virtual world, which we classify into three types: physical, relational, and transactional affordances. This preliminary study contributes to research in virtual worlds design and the study of the theory of affordances by addressing the importance of affordances in the design and support of business functions in virtual worlds. This paper presents the development of a measurement instrument for these three types and reports the initial validation of the scales using a survey of users from the Second Life virtual world. The results show a good fit for the model structure and high reliability and validity of the measurement scales. The next step is to use these and other constructs to predict the success or failure of commerce in a virtual world.

Keywords

Virtual worlds, e-commerce, theory of planned behavior, affordances, confirmatory factor analysis

INTRODUCTION

Virtual worlds capture various features of both goal-oriented and self-directed online games and the three-dimensional environment of real-world imitation. These features enable virtual worlds to have a great potential for relationship establishment, community formation, and product/service commerce among users and business organizations. Virtual world commerce has experienced rapid growth during the past years with an increasingly high number of users around the world. Understanding virtual world commerce and the factors affecting customer need satisfaction is timely and important as virtual world merchants have spend considerable effort to satisfy customers through the introduction of novel product marketing and customer service strategies. Second Life, which was set up by Linden Labs, is used in this research since many real world business players such as IBM, Dell, and Coca Cola have promoted it. The objective of the present study is to examine the virtual world participation and behavior factors that influence virtual world commerce adoption.

This study investigates the users' perceptible affordances as antecedents to their adoption of virtual world technology for business transactions. Affordances become the crucial research issue in the design of the social environment of a virtual world. An avatar is the representation of the real human in a virtual world. Perception and action of a user's avatar in the virtual world can change the user's behavior, which depends upon the subjective or conscious environment to which the user belongs (Gibson, 1979). Several studies show that a consideration of affordances helps suggest ways to improve the usability and understandability of the interface design (e.g., Gaver, 1991; Torenvliet, 2003). Affordances thus are important properties of the virtual world that should be addressed in the design of the environment, especially when the virtual worlds become a social and business space that connects users from around the world.

This research proposes three types of affordances – physical, social and transaction. This paper presents the development of a measurement instrument for these three types and reports the initial validation of the scales using a survey of users from the Second Life virtual world. This study contributes to research in virtual worlds design and the study of the theory of affordances by addressing the importance of affordances in the design and support of business functions in virtual worlds. The results show a good fit for the model structure and high reliability and validity of the measurement scales.

The next section of the paper is a review of the grounding for this research in the Theory of Planned Behavior (TPB) and in the concept of "affordances". This is followed by a description of the three types of affordances proposed as being important in support commercial transactions in virtual worlds. The fourth section of the paper presents the research instrument and its preliminary validation using survey data gathered in Second Life. The final section is some conclusions, limitations and future research.

BACKGROUND

This research is grounded in the Theory of Planned Behavior (Ajzen 1991) and the theory of affordances of Gibson (1979). This section provides a short description of TPB and some detail on affordances.

Theory of Planned Behavior

The Theory of Planned Behavior (TPB) is a social cognitive concept that explains the intentional behavior that a person reflects through attitude, subject norms, and perceived behavioral control. The core concept, which is intention, refers to the likeliness that a person will engage in the behavior. Ajzen (1991) postulates that people generally form a positive expectancy regarding their future behavioral engagement, which leads to the intention to engage in that behavior.

TPB proposes that human action is based on three kinds of beliefs:

- Beliefs about the likely outcomes of the behavior and the evaluations of these outcomes (attitudinal beliefs)
- Beliefs about the normative expectations of others and motivation to comply with these expectations (normative beliefs)
- Beliefs about the presence of factors that may facilitate or impede performance of the behavior and the perceived power of these factors (control beliefs).

Regarding these types of beliefs, attitude towards the behavior, subjective norm, and perception of behavioral control leads to the formation of a corresponding intention, which assumes to capture the motivational factors that influence behavior. For instances, the willingness to try out things, or the effort used to exert. Supposedly, the more favorable the attitude and subjective norm with respect to a behavior, and the greater the perceived behavioral control, the stronger an intention to engage in behavior. Intention is thus assumed the immediate antecedent of behavior.

Some researchers have used TPB in their research on e-commerce adoption (e.g., Pavlou and Fygenson, 2006). The antecedents in the TPB model (the left hand side of the model) are the salient beliefs that predict human attitudes that result in actual behavior. We propose that these beliefs are based in the affordances provided by the virtual environment in supporting commercial transactions.

Affordances

Affordances involve the environment that consists of the surroundings of a person; there are three types – medium, substance, and surface (Gibson, 1979). The idea of affordances originated from an investigation of environmental phenomena in which the medium, substance, and surface distinguish one object from another. Affordances involve the possibility of action that a person can have toward a certain object or an event. Previous studies on affordances have distinguished a definition of affordances into two general terms. First, affordances are defined as the relation between a person and their environment that have consequences for behavior (e.g., Chemero, 2003; Stoffregen, 2000). Second, affordances are properties of the environment that have consequences for the person's behavior (e.g., Greeno, 1994; Reed, 1996; Turvey, 1992).

Norman (1999) introduces the term "perceived affordances" to refer to the affordances that reveal themselves when the information that includes the clues for operation and guidance are available for the user to be perceived. Although this term was initially used to refer to the quality of perception for real objects rather than the screen-based objects other researchers have applied the concept to any objects especially those that involve screen-based interfaces (Gaver, 1991; Shneiderman, 1998). Perceived affordances of the user interface mostly concern whether the perception of any action is meaningful, useful, and predictable. In the case of technical and user-interface design, the more important question is not the action possibilities but the actions that the user perceives to be possible (Norman, 1999). In particular, the user acknowledges the perceived affordances when seeing objects on the screen. In addition, perceived affordances are useful when the real affordances are not available. In virtual worlds, social interactions such as spoken words and visual gestures are arbitrary when compare to real, physical manipulation of objects. Since perceived affordances are not visible or sometimes hide the real affordances, the design must enhance the user perceptible action.

Norman (1988) asserts that not only do affordances guide human action but they also influence the cognitive beliefs that human gains from experiences. The way individuals interact depends on their understanding another's mood or emotional status (Norman 2004). The emotional status observed by facial expression, body language, posture, gesture, and the like are tied to behavior. Norman asserts that individual not only uses perceptual emotional status of others with whom they interact but also use experience to interpret what has happened in most situations.

In supporting this perspective, Fogg (2003) states that persuasive technology such as the Internet, interactive media, and multiplayer online game involves mostly persuasive social activities that influence users to think and take action in accordance with the persuader, which varies based upon inputs, needs, and surrounding situations. People can use their five social cues to infer sociability with the interactive computer device. Specifically, people can use physical (i.e., face, eye, body, and movement), psychological (i.e., preferences, humor, personality, feelings, and empathy), language (spoken language, paralanguage, language recognition), social dynamics (i.e., cooperation, praise, reciprocity), and social roles (i.e., engineer, teacher, doctor, teammate, pet) in interaction with other humans or devices.

Therefore, the affordances of virtual worlds are not only based on physical manipulation (albeit of a virtual type), but are also based in social activities. This research is identifies a third type of affordances based in the transactional nature of commerce in virtual worlds.

AFFORDANCES OF VIRTUAL WORLDS

Affordance theory applies in the design of the virtual environment and virtual objects to enhancing the usability of the virtual world. Affordances of the virtual world aim at increasing the user's ability in controlling and navigating their avatar as well as manipulating the environment and objects by the avatar. This section describes three types of affordances of a virtual world with a focus on commerce. First, physical affordances or perception on physical affordances relate to the virtual objects and environments, as well as the perception of any action or ability to manipulate objects and environment. Second, relational affordances are the perception of social entities and the interactions of social entities, which depend on the availability of functions that allow users to interact or communicate with other users. Last, transactional affordances involve the availability of functions in supporting business activities and transactions.

Physical Affordances

Manipulation of a virtual object by a user through an avatar must create the feeling of real interaction and feedback through visual perception. Virtual world interactions are through computer interface and hardware devices such as screen, mouse, and keyboard as interfaces that allow the user to control the avatar interaction. For instance, users see places or objects in the spatial environment through the avatar's eyes. The ability to control the manipulation is determined by how easy the interface is used. Good interface design makes any functions understandable to the users and allows them to predict the outcome after manipulating the functions.

The design of virtual stores and virtual objects that enhance affordances is essential since it enables users to understand their usability. Stairways, for instance, should be able to transport the avatar in going up or down while a table should allow other objects to be placed on top. The affordances thus help guide the design of the object, the appropriate shape, texture and color that are most influential in the commercial engagement. Users must perceive the physical affordances of the virtual environment as making actions easy to accomplish and objects as easy to manipulate if we want to enable virtual world commerce.

Relational Affordances

The primary concern of relational affordances in a virtual world is to enable users to develop social relationship with other users. Affordances theory postulates that the characteristics of the environment that allow informal interaction incorporate proximity, privacy, and legitimacy. Proximity affords a chance to encounter interaction while privacy and legitimacy allows informal interaction to happen in a controlled and normative way (Fayard and Weeks, 2005).

Previous studies on computer-mediated communication (CMC) systems concerned the capability of the system in conveying social and emotional cues (e.g., Hiltz et al., 1986; Connolly et al., 1990). Virtual worlds are a special type of CMC where users report a higher social presence than any other types of CMC. Most 3D virtual worlds support both the verbal and visual cues that allow users to detect the emotional status of other users through their avatars. Users can control avatars to use facial expression and posture to convey emotional reactions and social meanings to others. Relational affordances in virtual worlds must allow easy and casual interaction to encourage virtual world commerce.

Transactional Affordances

Transactional affordances concern the interactions between business parties in exchanging information about products and/or services and in making business transactions. The awareness of active users as well as the spatial proximity of objects is vital in the design of commercial environment. The awareness of objects (or human) presence inspires an establishment of

business interaction and communication between business parties. Transaction within the virtual world can be fulfilled by the social interaction and the available transactional systems such as an instant currency converter, a fund transferring system and a secure payment process. For instance, many virtual worlds allow users to directly transfer virtual money through their avatars. Users must perceive the transactional affordances of the virtual environment as making exchanges of value easy to accomplish with clear perception of the completion of a transaction.

METHODOLOGY AND DISCUSSION

A preliminary study of actual virtual consumers (users) has been conducted using the Second Life virtual world as the experimental site. Questionnaires containing the initial scales were distributed to the randomly selected users. The users were asked to access the questionnaire in two different ways. First, the questionnaire could be accessed within the virtual world via an avatar bot. Participants could send an IM containing keywords to the avatar bot to activate the survey. The participants must accept the survey consent form before they could proceed to the entire set of questions. Second, a web-based survey could be accessed through an Internet browser. In both cases, after participants finished all questions they receive a 300 Linden Dollars (around 2 U.S. dollars) as an incentive. A total of 130 respondents were obtained. Of this number, the questionnaires that contained errors were taken out. A final set of 89 responses was actually used for data analyses.

Due to the difficulties in obtaining accurate information about participants' demographical status, this questionnaire excluded some important information such as gender and ethnicity. Additionally, a concern for security of the virtual worlds makes users who appear as avatars in the virtual worlds increasingly aware of disclosure of their private data (Enisa, 2008). The univariate analysis of other demographic data showed no significant difference among respondents who are in different age ranges, levels of education, frequencies of use, and times of use.

The instrument development part involves establishing the scale reliability and validity (Straub, 1989). The reliability explained by Cronbach's alpha coefficient and construct reliability (CR) is the extent to which the measurement scales consistently represents the measured construct (Hair et al., 2006). The validity refers to the degree to which the measurement scales reflect the variable of interest (Cronbach and Meehl, 1955)

The procedure in obtaining the final measurement scales of three affordances constructs is divided into three steps. First, the content validity is obtained from a literature review. Second, the convergent and discriminant validities are measured using the 89 responses. This included a factor analysis (principal component) for all constructs. Third, confirmatory factor analysis is performed to verify the proposed measurement model. The factor loadings and the fit indices are obtained.

Content validity

The preliminary scales were developed from a review of related literature. After the scales were extracted from the literature, two researchers reviewed them. The preliminary scales were analyzed for correctness of their meanings and words used. Physical affordances concern the interaction of the users and virtual objects that are displayed on the screen. The design of physical affordances mentioned by Mine (1995) includes the features that enhance direct user interaction, physical controls, and virtual controls. Thus, the physical affordances design of virtual worlds generally focuses on the use of mouse and keyboard in controlling avatar movement. This also includes pointing, selecting and manipulation of objects by avatar. The measurements of the physical affordances address users' understandings and usability of the virtual objects. The items are similar to the usability items used in previous research (Chen et al., 2004).

The design of the relational and the transactional affordances does not focus on improving controllability, navigability, or ability to manipulate objects. Rather these affordances focus on the ability to interact and communicate. The relational affordances involve the ability to interact using various communication mediums such as instant messaging, text-based chat, voice-based chat, or email systems. The measurements of the relational affordances include the efficacy of the system's functions in allowing users to incorporate various kinds of communication media in social interaction, which is similar to the items used in previous research (Kreijns et al., 2007).

Similar to relational affordances, transactional affordances involve supportive functions for business transactions. The ability of the systems in supporting currency exchanges, money transfer and secure credit card payment are examples of the design of transactional affordances. These items were new in this research.

This resulted in six measures for physical affordances, five measures for relational affordances, and four measures for transactional affordances. Each of the affordances survey questions was asked using a five-point Likert scale. The wording for each is shown in Table 1.

Convergent and Discriminant Validities

The initial components of factors were analyzed using factor analysis (principal component with Varimax rotation). The result showed the number of factors extracted as four using the latent root criterion (eigenvalue more than 1.0). A component that contained cross loadings to other factors (TA4) was dropped. RA5 was also dropped since this item loaded in a different factor. The refined scales were tested again using the same method of factor extraction. The result indicated a clean loading for each construct as shown in Table 1. This result showed a factor loading for all variables in the acceptable level of .70 or higher except for PA1 and PA5, which were just slightly below. This means that the instrument has fairly good *convergent validity*.

Full Set of Variables

Item	Wording	Factor 1	Factor 2	Factor 3	Communality
PA1	Using my avatar, I find SL is easy to use	.64		.43	.602
PA2	Using my avatar, I find SL is easy to become skillful in performing the system's functions	.75			.569
PA3	Using my avatar, I find SL is easy to navigate	.81			.695
PA4	Using my avatar, I find SL is easy to operate	.80			.703
PA5	Using my avatar, I can quickly accomplish my task in purchasing products in the virtual store	.68			.606
PA6	Using my avatar, I can easily find specific information from the virtual store	.67			.501
RA1	SL enables me to interact with other people in an easy manner		.82		.683
RA2	SL enables me to casually talk with other people		.56	.43	.507
RA3	SL enables me to get together with the group of people		.79		.675
RA4	SL enables me to attend social events		.71		.623
RA5	SL enables me to get together with family and friends			.78	.634
TA1	SL supports me in making business transactions			.83	.716
TA2	SL allows me to spend virtual currency in easy manner			.50	.512
TA3	SL allows me to directly contact or exchange in business activity with the virtual store			.69	.579
TA4	SL requires only minimal time in completing a transaction	.42	.43		.360
	Sum of Squares (eigenvalue)	5.533	2.043	1.396	Total = 8.972
	Percentage of trace	36.89	13.62	9.31	59.82

** Factor loadings less than .40 have not been printed*

Reduced Set of Variables (RA5 and TA4 deleted)

Item	Wording	Factor 1	Factor 2	Factor 3	Communality
PA1	Using my avatar, I find SL is easy to use	.62			.602
PA2	Using my avatar, I find SL is easy to become skillful in performing the system's functions	.80			.569
PA3	Using my avatar, I find SL is easy to navigate	.79			.695
PA4	Using my avatar, I find SL is easy to operate	.80			.703
PA5	Using my avatar, I can quickly accomplish my task in purchasing products in the virtual store	.65			.606
PA6	Using my avatar, I can easily find specific information from the virtual store	.71			.501
RA1	SL enables me to interact with other people in an easy manner		.74		.683
RA2	SL enables me to casually talk with other people		.72		.507
RA3	SL enables me to get together with the group of people		.82		.675
RA4	SL enables me to attend social events		.79		.623
TA1	SL supports me in making business transactions			.77	.716
TA2	SL allows me to spend virtual currency in easy manner			.75	.512
TA3	SL allows me to directly contact or exchange in business activity with the virtual store			.85	.579
	Sum of Squares (eigenvalue)	5.043	2.006	1.300	Total = 8.349
	Percentage of trace	38.80	15.43	10.00	64.23

** Factor loadings less than .50 have not been printed*

Table 1. Varimax Rotated Component Analysis Factor Matrices – Full and Reduced Sets of Variables

Other than orthogonal rotation, this study applied an oblique rotation (PROMAX) to investigate the correlation between factors. The results showed very similar loadings between pattern and structure matrices. The lowest and the highest correlations between factors are, respectively, .31 and .43, which reveal moderately positive correlations between factors.

Factor Correlation Matrix

Factor	PA	TA	RA
Physical Affordances	1.00	**.10**	**.14**
Relational Affordances	.31	1.00	**.18**
Transactional Affordances	.38	.43	1.00
Variance Extracted	.55	.62	.68

Pattern Matrix

Item	Factor 1	Factor 2	Factor 3	Communality [a]
PA2	.87			.645
PA4	.81			.703
PA3	.79			.688
PA6	.74			.509
PA5	.62			.545
PA1	.57			.621
RA3		.84		.720
RA4		.81		.679
RA1		.77		.566
RA2		.73		.564
TA3			.90	.766
TA1			.82	.642
TA2			.76	.695

** Factor loadings less than .50 have not been printed*

[a] Communality values are not equal to the sum of squared loadings due to the correlation of the factors

Structure Matrix

Item	Factor 1	Factor 2	Factor 3
PA2	.78		
PA4	.83		
PA3	.83		
PA6	.71		
PA5	.71		
PA1	.70		.60
RA3		.85	
RA4		.82	
RA1		.75	
RA2		.75	
TA3			.87
TA1			.80
TA2			.83

** Factor loadings less than .50 have not been printed*

Table 2. Promax (Oblique) Rotation of Component Analysis Factor Matrices

Discriminant validity is obtained by comparing estimated variance-extracted for any two constructs with the corresponding estimated inter-construct squared correlation. The result showed that the variance-extracted for any two constructs was greater than the estimated inter-construct squared correlation (the values above the diagonal), which suggested no problems with discriminant validity (See Factor Correlation Matrix in Table 2).

Internal Consistency was estimated using Cronbach's alphas, which showed the values greater than .70 for all factors. In addition, the CR was calculated using the structural equation model (SEM) analysis also indicated a high internal consistency of all constructs. Respectively, the CR of the physical affordances, the relational affordances and the transactional affordances are .86, .81 and .80. The generally accepted level of the Cronbach's alpha and the CR is .70 or higher (Hair et al., 2006; Segar, 1997).

Confirmatory Factor Analysis

After obtaining valid scales, the scales were tested for model fit. Confirmatory factor analysis using the CALIS procedure was used. The result showed good results for a comparative fit index (CFI) of .93, a non-normed index (NNFI) of .91 and root mean square error of approximation (RMSEA) of .07. The χ^2 was 79.21 with 62 degree of freedom, which suggested a good fit. All items loaded significantly at the .001 level on their assigned latent constructs as illustrated in Figure 1.

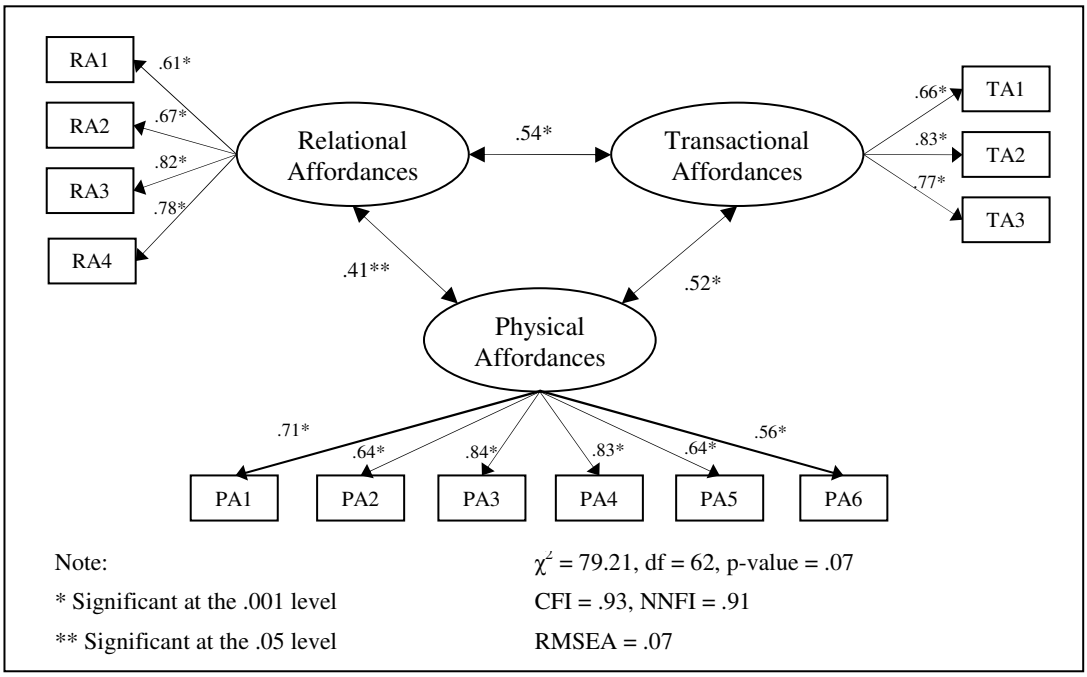

Figure 1. Structure model of the research

Covariances among variables, indicated by the two-headed arrows, suggested a non-zero covariance between the three latent variables. The result of the covariance analysis suggested that the variables are not dependent to each other.

CONCLUSIONS

This research proposes three types of affordances – physical, social and transactional – as constructs to explain virtual world commerce participation and behaviors at the individual level. This paper presents the development of a measurement instrument for these three types and reports the initial validation of the scales using a survey of users from the Second Life virtual world. The results show a good fit of model structure and high reliability and validity of the measurement scales. This preliminary study contributes to research in virtual worlds design and the study of the theory of affordances by addressing the importance of affordances in the design and support of commerce in virtual worlds.

Research on affordances also has implications for design science, specifically on how designers can most effectively create virtual worlds. Design that enhances physical affordances helps users understand the features and operations of virtual products. The primitive functionalities of virtual products sometimes confuse users; therefore, designers need to pay attention to the physical affordances when creating the virtual products. Design that enhances relational affordances helps users to perceived enjoyment in shopping. Virtual worlds have strength in enabling remote users to be present in this spatial

environment; therefore, the design that incorporates social systems that allows users to perceive the social cues is very important in nurturing the shopping process. Finally, a design that enhances transactional affordances helps users to reduce their efforts in the purchasing process. The design of a system that allows users to convert, spend, and exchange virtual money in the same manner as they usually do on the Web is a new challenge for virtual world developers.

This study has three major limitations. First, the generalizability of the study may be limited to only the selected study site. More research in other virtual worlds should be done to confirm the results obtained from this study. Second, the problem involving missing data obtained from the survey may reduce the power of the results. Due to the restriction of the Second Life virtual world and time constraints on users, it is difficult to persuade targeted users to join the study or force them to answer every question on the questionnaire. Last, giving an incentive to the participants may result in inaccurate data being obtained.

The present study has validated the measurement scales of affordances. The next important step is to use these constructs to predict the success or failure of commerce in the virtual world. Particularly, the next research question is how affordances affect the adoption of the virtual world commerce. In addition, the next research should include more study sites other than Second Life virtual world to assure the generalizability of the affordance constructs.

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