Behaviour & Information Technology, 2013
Vol. 32, No. 2, 156–172, http://dx.doi.org/10.1080/0144929X.2011.603360

Taylor & Francis
Taylor & Francis Group

Smart TV: are they really smart in interacting with people? Understanding the interactivity of Korean Smart TV

Dong-Hee Shin[a], Yongsuk Hwang[b]* and Hyunseung Choo[c]

[a]*Department of Interaction Science, Sungkyunkwan University, 90327 International Hall, 53 Myeongnyun-dong 3-ga, Jongno-gu, Seoul 110-745, South Korea;* [b]*Department of Convergent Media, Graduate School of Mass Communication & Public Relations, KonKuk University, Seoul, Korea;* [c]*Department of Electrical and Computer Science, Sungkyunkwan University, Seoul, South Korea*

(*Received 23 November 2010; final version received 4 July 2011*)

Smart TV (STV), a new digital television service, has been rapidly developing, particularly in Korea. With the conceptual model of interactivity, this study empirically investigates the effects of perceived interactivity on the motivations and attitudes towards STV in Korea. The model is created to validate the relationship of perceived interactivity to performance, attitude and intention. Further, the model examines the mediating roles of perceived interactivity in the effect of performance on attitude towards STV. Empirical evidence supports the mediating role of perceived interactivity. Implications of the findings are discussed in terms of building a theory of interactivity and providing practical insights into developing a user-centred STV interface.

Keywords: Smart TV; Korea; interactivity; adoption; mediating effects; TRA; TPB

1. Introduction

Smart TV (STV), a television set with integrated interactive internet capabilities, is being rapidly developed around the world. The rapid growth of high-speed broadband connections is enabling the creation of a smarter TV by delivering content directly to consumer devices in the living room. STVs have adapted the popularity of app stores for smartphones and brought them to living rooms. STVs enable viewers to not only navigate programs live but also check online content such as news, weather forecasts, stock market information, maps and games. STV is capable of television-commerce, internet browsing, twitting, online social networking, chat, and other things. STVs present new opportunities to consumer electronics manufacturers for product differentiation and value creation through user-driven product innovation. Media companies will be afforded a direct path to consumers, delivering more choices and new types of content in an on-demand, personalised service. A number of TV manufacturers, including Panasonic, Sony, LG and Samsung are actively developing STVs. Samsung and LG showcased a STV system at the Internationale Funkausstellung Berlin (IFA) 2010, Europe's largest electronics fair. Globally, GE together with Apple and Google plan to reveal their own STVs soon in the US.

With all the progressive movement, it is expected that the era of STVs will come at a much faster rate than had been expected, following the success of the smartphone era. Jupiter Research (2010) predicts that STVs will be at the heart of all electronics goods and communications devices used in homes. Others even predict that the time for STVs will come within 1 or 2 years. These positive predictions argue that STVs will become a so-called hub at home by connecting computers and telephones in homes and automating electricity, tap water, home security and other home entertainment systems. For example, people will check their doorbell security cameras through STVs while seeing doctors offering a ubiquitous health system. Along with STVs, smartphones will keep evolving, serving complementary functions in those smart homes. Because smartphones will be connected with STVs, users will be able to be check what is going on in their houses even when they are out.

However, with all of the hype over STVs, a question is whether marketers really know how consumers truly feel about STVs. As with many rollouts, a key problem is that STV is still primitive. STVs in the average household are probably years away. One factor slowing the adoption of STVs is the fact that the content is scarce and service is limited. This is consonant with Cesar and Chorianopoulos' (2009) study, which examined interactive TV and gave explanation on why the full potential of interactive TV has not yet been realised. They examined how viewers interact with TV content and argued that three factors

*Corresponding author. Email: prohys@kku.ac.kr

(content editing, content sharing and content control) are important in the success of interactive TV. The current problem of STV is lack of content and thus customers have rare opportunity to edit, share and control contents. Because of the low interactive features, customer apathy seems to be increased. According to Jupiter Research (2010), consumers are not so exciting about another form of technology that will come and go within a few years. Consumers have seen so many technologies and so many rosy promises come and go over a decade. They still clearly remember the advent of similar technologies which ended up a total failure such as Web TV, TiVo and television commerce (t-commerce). More recent technological innovations related to TVs include IPTV and 3DTV, which have yet to become widespread. Some consumers object to upgrading again to STV sets after recently upgrading to costly multimedia technology such as digital TV and 3DTV. Although pricing has not yet been revealed, incoming STVs are generally expected to be costly, partly due to various applications. While there is widespread enthusiasm for STVs, skeptics consider STVs to be a gimmick or, at best, an immature technology.

Despite rising concerns over user acceptance and marketability, STV viability issues have been addressed in only a few industry reports. While it is expected that STVs will likely succeed due to their interactive services, it is still unsure how the interactivity will play out in the diffusion of STVs. This study examines consumers' perceptions of STVs by proposing a research model that incorporates perceived interactivity (PI), perceived hedonic performance (PHP), and perceived utilitarian performance (PUP) as enhancing constructs. For the methodology, the structural equation modelling approach, supported by AMOS software version 18, was applied to assess the empirical strength of the relationships in the integrated model. The findings should be of interest to both academics and industry. From a theoretical perspective, this study suggests a model to identify antecedents of user intention to accept STVs. The new model represents an improvement over previous technology acceptance research [like the Theory of Planned Behaviour (TPB) and the Technology Acceptance Model], because it integrates cognitive and behavioural attitudes as the primary factors of influence. These attitudes are driven by underlying beliefs and assessing that the beliefs will improve STV forecasting. From a practical standpoint, the findings may be used to guide industry in selecting more effective strategies to attract STV consumers. The STV industry is facing the challenge of how to design STV services that are useful, valuable, enjoyable and, most importantly, user-centred. However, interface designs and related elements are rarely examined in-depth in the specific context of in situ user evaluations. By better understanding how motivational factors will impact adoption and consumer behaviour, manufacturers, content providers and programmers can obtain the insights they need to plan their STV strategies. The results of this study represent a set of guidelines to help STV industry and developers better understand how users develop their perceptions of STVs and how users contribute to ongoing adoption and usage.

This article is organised as follows: Section 2 provides a review on the definition and trend of STVs. Section 3 proposes a research model and develops the hypotheses tested in this study. Section 4 describes the research method used in this study. Section 5 provides the results of empirical tests, followed by a discussion in Section 6. Section 7 presents conclusions and some implications for practitioners and researchers. Finally, Section 8 describes the limitations of this study and topics for future studies.

2. Literature review

2.1. Definition and current trends of STVs

STVs aim to focus on being easy, fun and useful (see Figure 1). The first products out of the gate will be equipped with a graphical user interface that will allow users quick and easy access to a variety of content and applications, many of the moves enabled just by a single click. STV manufacturers also focus on developing personalised applications in entertainment, games, lifestyles, education, news and information, which could be easily downloaded to television sets.

So far, STV has been rapidly developed by Korean technology giants such as Samsung and LG Electronics. The two are vowing to take a leadership role in the STV market, which is the buzzword in consumer electronics. Both companies introduced their first model STVs equipped with network access for web-connected televisions at the IFA trade fair in Berlin. STVs will provide an all-in-one device for data-handling television. However, the television makers lack in areas such as software capabilities and content delivery. As such, STV manufacturers are seeking partnerships with movie studios, entertainment companies and other content providers to reduce the gap, while also seeking to use their manufacturing prowess as an edge.

Although STV has made great strides technologically, it has still many obstacles to overcome, particularly usability. For example, user interfaces and form factors will face major changes – instead of being fixed in the centre of the living room, they will be

incorporated into mirrors, walls and ceilings to embody a layout-free concept. Since STV is in its infancy, it is difficult to predict just what the STV landscape will look like in the near future. One thing is clear though, STVs should focus on user-centred design to become a mainstream phenomenon. In this regard, this study focuses on user attitudes and behaviours related to STVs with a focus on the role of PI and its relation to other factors of STV adoption and usage.

2.2. *Difference of STV from other similar TVs*

While innovative, some researchers argue that STV is no difference from previous TVs such as IPTV, 3DTV, Interactive TV, and HDTV. Table 1 can be helpful in

Figure 1. Samsung Electronics STV.

Table 1. Differences STV from other similar TVs.

STV	Interactive TV	IPTV	3DTV or HDTV
Search ability: Search online and personal content as well as broadcast programming all from the same TV interface	No (programming selection)	No online search is available	No
Download: Access downloadable applications	Yes in a limited manner	No application, only TV programs can be downloaded	No
Social networks: Connect to social networks while watching favorite programs or movies	No	No	No
Controllability: Control TV with a unique new remote control or voice commands	Yes	Yes	Yes or no
Accessibility: Access an infinite amount of entertainment possibilities	Yes, but the access range is different.	Yes	No
Integration: Connected and searchable on a single screen, from billions of hours of video to personal content	Limited integration	Limited selection	No
Interactivity: The ability to instantly find and watch television shows and movies, download Internet applications, and easily surf between channels and Web sites for a completely new way of using television, instead of just watching it	Interactive but no access online	No	No
Synchronicity: Real-time data, related content, and interactivity from the Web. If it cannot do that, then it is not a Smart TV	No real-time	No real-time	No

clarifying the differences from exiting and previous TVs.

2.3. Literature on interactivity

Definitions of interactivity can be categorised based on the primary focus of authors on process, features, perception or combined approaches. Table 2 explains the extensive review on interactivity.

3. User expectations with STVs

The theory of reasoned action (TRA) posits that individual behaviour is driven by behavioural intentions, where behavioural intentions are a function of an individual's attitude towards the behaviour and subjective norms surrounding the performance of the behaviour (Fishbein and Ajzen 1975). In his later work, Ajzen (1991) updates TRA and introduces a new TPB by adding a new component, perceived behavioural control. The TPB covers volitional behaviours for predicting behavioural intention and actual behaviour.

The attitude towards the behaviour is defined as the individual's positive or negative feelings about performing a behaviour. It is determined through an assessment of one's beliefs regarding the consequences arising from a behaviour and an evaluation of the desirability of these consequences. Formally, the overall attitude can be assessed as the sum of the individual consequence desirability assessments for all expected consequences of the behaviour.

This study proposes an adaptation of TRA/TPB that consists of perceived interactivity and perceived hedonic and utilitarian performance along with the traditional components of TRA. Figure 2 presents the proposed STV acceptance and use model. The utility of considering the modified TRA stems from the fact that STV is technology-driven, as well as user-oriented. This model is well suited to reflect the nature of STVs, because the model embodies the evolutionary progression of STVs to become more intelligent, interactive and easy-to-use. All the key drivers are defined and explained, and their relationships to the acceptance of STVs are examined. Given the wide applicability of the TRA in emerging technologies, it is expected that the general causalities found in TRA are also applicable to STVs. In particular, the relationship between attitude and intention in IPTV has been confirmed (Shin 2009). Thus, it is hypothesised that:

H1: Attitude towards STVs is positively related to the intention to use STVs.

3.1. Perceived interactivity

With the rapid growth of digital technologies, interactivity is now the buzzword of the day. Yet, the term is used loosely and means many things to many people. Williams *et al.* (1988) define interactivity as a 3D construct by including control, exchange of roles and mutual discourse. There are many definitions and components of interactivity. For example, Wu (2005) defines perceived interactivity as 'a psychological state experienced by a site-visitor during the interaction process' (p. 48). Perceived interactivity is defined as perceptions of engagement with responsive actual or virtual objects or people. Newhagen and Rafaeli (1996) determine five qualities of communication on the Internet: multimedia, hypertextuality, packet switching, synchronicity and interactivity. Web expertise might be an important predictor of the extent to which consumers perceive the web site to be interactive. Considering the definitions of Wu (2005), interactivity is defined in the STV context as the degree to which STVs can allow users to communicate and collaborate alternatively with other users or STVs, either in real time or a store-and-forward basis, or to seek and gain access to information on an on-demand basis where the content and timing of the interaction is under the control of the user. This definition bears three essential components of interactivity, which include perceived control (Williams *et al.* 1988, Wu 2005), perceived responsiveness (Heeter 1989), and perceived personalisation (Steuer 1992). Kim and Du (2006) use the three items as the measurement of PI. These components accurately reflect the features of STVs because they are developed as systems that are responsive, easy to control and personalised. This aspect is also congruent with Cesar and Chorianopoulos' (2009) taxonomy of interactive TV, which includes edit, share and control. According to them, it is time to bring social communications back to TV viewing. They examined how viewers interact with TV content and gave insights into why the full potential of interactive TV has not yet been fulfilled. Their idea is well suited to STV because STV emphasises content editing, content sharing and content control. The STV system responds to user requests immediately; users have control over the time, structure, and content as opposed to a broadcast basis; and users can modify the form and content of an STV environment. Based on the literature, we can also create the following hypotheses.

H2: PI positively influences intention to use STVs.
H3: PI positively influences attitude towards STVs.

Table 2. Different definition of interactivity.

Study	Definition/description of interactivity	Key elements
Interactivity focusing on process		
Heeter (2000)	'An interaction is an episode or series of episodes of physical actions and reactions of an embodied human with the world, including the environment and objects and beings in the world.'	Action and reaction
Cho and Leckenby (1999)	'The degree to which a person actively engages in advertising processing by interacting with advertising messages and advertisers' (p. 163)	Interchange between individuals and advertisers
Bezjian-Avery, Calder, and Iacobucci (1998)	'In interactive systems, a customer controls the content of the interaction requesting or giving information .... The hallmark of these new media is their *interactivity* – the consumer and the manufacturer enter into dialogue in a way not previously possible' (p. 23)	User control and dialogue between consumer and manufacturer
Ha and James (1998)	'Interactivity should be defined in terms of the extent to which the communicator and the audience respond to, or are willing to facilitate, each other's communication needs' (p. 461)	Responsiveness
Haeckel (1998)	'The essence of interactivity is exchange' (p. 63)	Exchange
Pavlik (1998)	'Interactivity means two-way communication between source and receiver, or, more broadly multidirectional communication between any number of sources and receivers' (p. 137)	Two-way communication
Miles (1992)	'An interactive communication involves responsiveness of the displayed message to the message receiver' (p. 150)	Responsiveness
Rafaeli (1988)	'Interactivity is an expression of the extent that in a given series of communication exchanges, any third (or later) transmission (or message) is related to the degree to which previous exchanges referred to even earlier transmissions' (p. 111)	Responsiveness
Steuer (1992)	'Interactivity is the extent to which users can participate in modifying the form and content of a mediated environment in real time' (p. 84)	Real-time participation
Guedj *et al.* (1980)	'A style of control' (p. 69)	User control
Interactivity focusing on features		
Ahren, Stromer-Galley, and Neuman (2000)	Media interactivity was defined in terms of features such as audio and video. Human interaction was defined in terms of features such as bulletin boards and chat rooms.	Multimedia, features for two-way communication
Novak, Hoffman, and Yung (2000)	Interactive speed is a construct that contributes to flow and is based on measures such as waiting time, loading time, and degree to which interacting with the Web is 'slow and tedious' (p. 29)	Time required for interaction
Lombard and Snyder-Dutch (2001)	'We define interactivity as a characteristic of a medium in which the user can influence the form and/or content of the mediated presentation or experience.'	Features that enable user control
Ha and James (1998)	Identified five characteristics of interactivity: playfulness, choice, connectedness, information collection, and reciprocal communication.	Five characteristics that constitute interactivity
Jensen (1998)	'Interactivity may be defined as: a measure of a media's potential ability to let the user exert an influence on the content and/or form of the mediated communication' (p. 201)	Features that enable user control
McMillan (2000a)	Identified thirteen features that, based on literature about interactivity, might suggest that a Web site is interactive. Included: E-mail links, registration forms, survey/comment forms, chat rooms, search engines, and games	Web site features that facilitate two-way communication and control
Carey (1989)	Interactive media are: 'technologies that provide person-to-person communications mediated by a telecommunications channel (e.g. a telephone call) and person-to-machine interactions that simulate interpersonal exchange (e.g. an electronic banking transaction)' (p. 328)	Channels for human-to-human or human-to-computer exchange
Straubhaar and LaRose (1996)	'We will use the term interactive to refer to situations where real-time feedback is collected from the receivers of a communications channel and is used by the source to continually modify the message as it is being delivered to the receiver' (p. 12)	Functions that enable customized and timely feedback
Interactivity focusing on perception		
Schumann, Artis, and Rivera (2001)	'Ultimately it is the consumer's choice to interact, thus interactivity is a characteristic of the consumer, and not a characteristic of the medium. The medium simply serves to facilitate the interaction.'	Consumer's choice to interact

(*continued*)

Table 2. (*Continued*).

Study	Definition/description of interactivity	Key elements
McMillan (2000)	Individuals rated interactivity of sites based on their perceptions of two-way communication, level of control, user activity, sense of place, and time sensitivity	Perception of two-way communication, control, activity, sense of place, and time sensitivity
Kiousis (1999)	'With regard to human users, it [interactivity] ... refers to the ability of users to perceive the experience to be a simulation of interpersonal communication and increase their awareness of telepresence' (p. 18)	Simulation of interpersonal communication
Wu (1999)	'Perceived interactivity can be defined as a two-component construct consisting of navigation and responsiveness' (p. 6)	Perceptions of navigation and responsiveness
Day (1998)	'The essence of interactive marketing is the use of information *from* the customer rather than *about* the customer.' (p. 47)	Consumer involvement
Newhagen, Cordes, and Levy (1996)	Conceptualize interactivity based on 'the psychological sense message senders have of their own and the receivers' interactivity' (p. 165)	Perception of interaction by self and others
Interactivity combining process, features, and/or perception		
McMillan (2002)	Identifies four types of interactivity based on intersection of user control and direction of communication: monologue, feedback, responsive dialogue, and mutual discourse	Monologue, feedback, responsive dialogue, and mutual discourse.
Coyle and Thorson (2001)	'A web site that is described as interactive should have good mapping, quick transitions between a user's input and resulting actions, and a range of ways to manipulate the content' (p. 67)	Mapping, speed, and user control.
Lieb (1998)	Interactivity is seen as having two primary definitions. The first is a kind of personalization. The second type is community building	User control, interpersonal communication
Hanssen, Jankowski, and Etienne (1996)	'Aspects of interactivity were clustered around three terms: *equality* (containing aspects such as participants, mutual activity, role exchange, controle), *responsiveness* (e.g. mutual discourse, nature of feedback, response time) and *functional communicative environment* (e.g. bandwidth, transparency, social presence, artificial intelligence)' (p. 71)	Equality, responsiveness, and functional environment
Zack (1993)	He suggests that the following key factors emerge from the literature as elements of interactivity: the simultaneous and continuous exchange of information; the use of multiple non-verbal cues; the potentially spontaneous, unpredictable, and emergent progression of remarks; the ability to interrupt or preempt; mutuality; patterns of turn-taking, and the use of adjacency pairs	Exchange, non-verbal cues, spontaneity, unpredictability, progression of remarks, ability to interrupt, mutuality turn-taking, adjacency.
Heeter (1989)	Interactivity is a multi-dimensional concept that includes: complexity of choice available, effort users must exert, responsiveness to the user, monitoring information use, ease of adding information, and facilitation of interpersonal communication	Complexity, effort, responsiveness, monitoring, participation, interpersonal communication

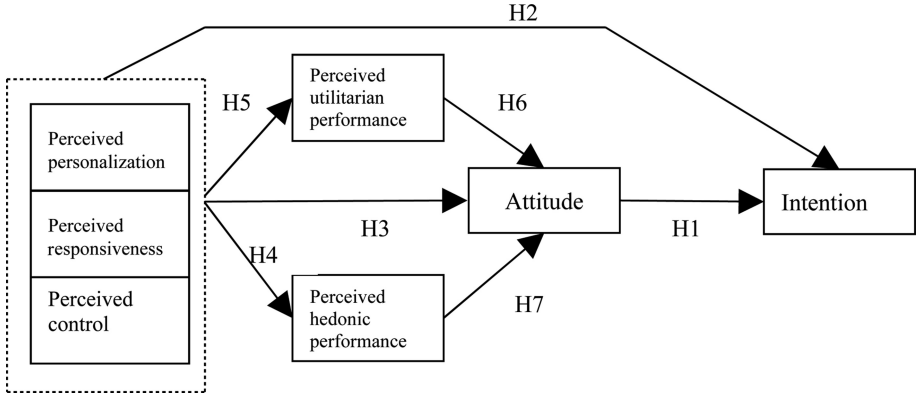

Figure 2. The proposed research model.

3.2. Performance evaluation

It has been established that consumers evaluate products and services in general and IT products and services in specific along the utilitarian and hedonic dimensions (Van der Heijden 2004). The extant research has established that consumers evaluate services in general along the utilitarian and hedonic dimensions (Hoffman *et al.* 2003, Van der Heijden 2004). Traditional IT systems are mostly work or task-related, and hence are utilitarian in nature. The emerging contemporary technologies add a hedonic aspect to the technology use experience as they are increasingly used for not only utilitarian but also hedonic purposes in all aspects of users' personal lives. This study proposes user-perceived utilitarian performance and hedonic performance as two primary evaluative dimensions for STVs.

Based on the view of attitude as an evaluative outcome (Hassenzahl 2003, Deng *et al.* 2010), this study suggests the evaluations of utilitarian and hedonic performance attributes of STVs as the direct antecedents of attitude. In addition, PI is positively related to content quality as well as system quality (Shin 2009). Content quality is related to hedonic performance (Van der Heijden 2004), whereas system quality can be said to be associated with utilitarian performance. Therefore, the following hypotheses can be derived from prior research.

H4: PI positively influences perceived hedonic performance of STVs.
H5: PI positively influences perceived utilitarian performance of STVs.
H6: The higher utilitarian performance a user perceives of an STV, the more positive an attitude the user has about STVs.
H7: The higher hedonic performance a user perceives of an STV, the more positive an attitude the user has about STVs.

4. Study design

The survey method consisted of four phases. First, individual in-depth interviews were conducted with potential customers. Ten respondents were asked to explain their attitude and the experience of advanced TV such as 3DTV, HDTV and IPTV. Second, with the help of the STV manufacturers in Korea (Samsung), five focus groups of current and prospective users were organised, and group interviews were conducted in which groups of four to six individuals discussed how they currently use TV services and what factors would influence their use of STV services in the future. The goal of the individual interviews and focus group sessions was to test and validate the research model, to identify items missing from the model and to gain a preliminary understanding of the factors that have an impact on usage behaviours.

Third, based on the focus group sessions, a final survey questionnaire was developed through several comment rounds of an expert panel consisting of professors, researchers and STV experts. Prior to its use, the questionnaire was tested by administering a pilot survey among possible users who, in turn, provided a comprehensive review of individual responses to the pre-test survey. Twenty undergraduate students participated, with tests given at 3-week intervals. Prior to answering the questionnaire, they were strictly instructed to ask the experimenter any questions about questionnaire items that they did not understand. With these precautions, the possibility of participants filling out some questions without exactly understanding the content of those questions was eliminated. The wording of items was reviewed and modified by three marketing professors knowledgeable in quantitative research based on the pilot test outcomes.

The finalised survey was administered online. From July to October 2010, a web-based survey questionnaire was posted in the communities of several professional associations, and on blogs and forums devoted to smartphones, advanced TV services, HDTV, digital TV, interactive TV and 3DTV. The survey included preliminary questions to ensure the respondents had a certain level of understanding of STV. Such questions, for example, include 'Do you know about STV?' and 'Have you used STV before?' A cover letter was attached to explain its purpose and to ensure confidentiality. By the time the survey ended, 1208 visitors had viewed it and 342 questionnaires were submitted. Of the submitted questionnaires, 13 were excluded because of incomplete answers, leaving 329 usable responses. Table 3 presents the sample demographics. The final sample reflects the general population interested in STVs. For the analysis of statistics,

Table 3. Characteristics of the respondents (total = 329).

	Number	Percentage (%)
Age		
Under 20	50	15.2
21–30	142	43.1
31–40	90	27.3
41–50	36	10.9
Above 51	11	3.3
Education		
High school or below	35	10.6
College	248	75.5
Graduate school or above	46	13.9
Gender		
Female	160	48.6
Male	169	51.4

AMOS, a maximum likelihood-based SEM software, was used.

4.1. Measurement development

The variables in the model are well established in the human–computer interaction (HCI), Information System and Communications literature. Prior to further study, a pilot test for measures was conducted. The participants indicated their agreement with a set of statements using a 7-point Likert-type scale. Each variable has three measurement items except PI, which has a total of six items (two items for each sub-variable, which are perceived control, perceived responsiveness and perceived personalisation). The final scales used in this study consisted of 18 items, all of which included 3 items for each variable. As the items in the survey were adapted from previously validated work, content validity for these two constructs was established through literature review.

4.2. Instrument validity and reliability

A pre-test was undertaken to examine test–retest reliability and to construct reliability indices before conducting field work. Thirty current and prospective users who were interested in STVs and other similar services (e.g. HDTV, 3DTV, interactive TV and IPTV) participated in the two pre-tests at an interval of 1 month. After eliminating the measured items that failed in either the retest or the alpha test, Cronbach's alpha was applied to identify poor item-to-total correlation items. The alpha values ranged between 0.841 and 0.917, suggesting acceptable construct reliability. When theoretical models do not exist, these pre-tests are useful in the early stages of empirical analysis in cases for which the basic purpose is exploration.

Additionally, using Principal Components Analysis, the construct validity of the instrument was confirmed. After three items of the original item survey were removed (due to high cross-loading), all item loadings were greater than 0.5, with no cross-loading above 0.4 (Hair *et al.* 1995). Similarly, discriminant validity was confirmed as the correlation between items in any two constructs was lower than the square root of the average variance shared by items within a construct (Fornell and Larcker 1981).

4.3. Ensuring external validity

In the study design, a particular emphasis was given to ensure external validity. As STVs are still early stage of diffusion, it was critical to ensure external validity. First, it ensured to draw a sample from a general population in a random selection way. Second, once selected, it assured that the respondents participate in the study and that kept the dropout rates low. Third, it used the theory of proximal similarity by describing the ways the contexts in this study and others differ significantly. Throughout a series of random sampling, it made sure the degree of similarity between various groups of people, places and times. After the several sampling, concept mapping showed consistent results among the different samples. Concept mapping is a general method that can be used to help any individual or group to describe their ideas about some topic in a pictorial form. Finally, we conducted a post-survey to verify the findings. The replicated survey ensured acceptable external validity.

5. Results

5.1. Structural model

A test of the structural model was performed using AMOS software. Table 4 shows the estimates from structural modelling. The overall fit of the model is satisfactory, with all of the relevant goodness of fit indices greater than 0.90. Chi-square statistics show non-significance in the models, indicating that the two

Table 4. Fit indices of the model.

Fit statistics	First round model	Second round model	Recommended value (Bagozzi and Yi 1988)
Chi-square/df	164.21, df = 228; $p = 0.44$	167.35, df = 228; $p = 0.47$	–
Normed Chi-Square	2.04	2.01	<5
AVE	0.81	0.62	>0.50
p-value	0.000	0.000	<0.05
Goodness of Fit Index (GFI)	0.92	0.94	>0.9
Adjusted Goodness of Fit Index (AGFI)	0.91	0.90	>0.9
Root mean square error approximation (RMSEA)	0.068	0.062	>0.06
Standardized RMR	0.012	0.021	≤ 0.05
Tucker-Lewis Index (TLI)	0.89	0.93	Approaches 1

models fit the data adequately. The GFI is 0.95, the AGFI 0.91, and the TLI 0.91. Similarly, there is no evidence of misfit, with the root mean square error approximation (RMSEA) showing a very satisfactory level of 0.067, which favourably compares to the benchmarks, and the values of 0.06 or more reflect a close fit. The standardised root mean square (RMR) was also very good, at 0.027, well below the threshold for a good overall fit. Another positive test statistic was the normed chi-square value of 1.98, a value that is appropriately well below the benchmark of 3, indicating good overall model performance. Given a satisfactory measurement of the model's fit to the data, the path coefficients of the structural model were assessed.

5.2. *Structural paths and hypothesis tests*

To test the structural relationships, the hypothesised causal paths were estimated, and all seven hypotheses were supported. The results are reported and depicted in Table 5 and in Figure 3, respectively. The results support the proposed model well, confirming the key roles played by PI. All of the paths in the model are statistically significant. The results highlight the significant roles of PI in determining user attitudes towards STVs ($\beta = 0.41$, $t = 3.420$, $p < 0.01$), supporting H3. PI also has a significant direct effect both on PUP and PHP, which influence attitude significantly (H6 and H7). Whereas PUP and PHP had strong effects on attitude ($\beta = 0.49$, $t = 2.021$, $p < 0.01$; $b = 0.43$, $t = 2.001$), the effect of attitude on intention was moderate or weak at the most in this model (H1, $\beta = 0.24$, $t = 3.120$); probably because the users want to confirm their intention with other factors, probably PI. Consistent with this inference, PI showed the highest impact, supporting H2 ($\beta = 0.65$, $t = 4.981$, $p < 0.001$). Approximately 58% of the variance in the intention of STVs was explained by the variables in the model ($R^2 = 0.581$). The R^2 of all endogenous constructs in the model exceeded 20%.

Overall, the model shows a pattern that highlights the importance of utility and hedonicity along with their antecedent, PI. However, the model also underplays the role of attitude, as compared with previous studies employing attitude. This implies that while the STV consumers might have a good attitude influenced by PUP and PHP, this does not automatically lead to intention. While consumers might cognitively perceive the excellent features of STVs well, they may not really intend to adopt or use it. They may want to personally ensure that the STV experience is a positive one and that programming is available. It may be inferred that there is a gap between attitude and intention in STVs. Psychological factors like interactivity can play a facilitating role between attitude and intention. This role has important implications in terms of theory and practice. Thus, further tests are necessary to uncover possible underlying effects.

Table 5. Summary of the hypothesis tests.

Hypothesis	Path coefficient (β)	t-value	Support
H1: Attitude → Intention	0.23*	3.120	Yes
H2: PI → Intention	0.65***	4.981	Yes
H3: PI → Attitude	0.41**	3.420	Yes
H4: PI → PHP	0.40**	2.001	Yes
H5: PI → PUP	0.34*	2.459	Yes
H6: PUP → Attitude	0.49**	2.021	Yes
H7: PHP → Attitude	0.43**	2.001	Yes

Note: *$p < 0.05$; **$p < 0.01$, ***$p < 0.001$.

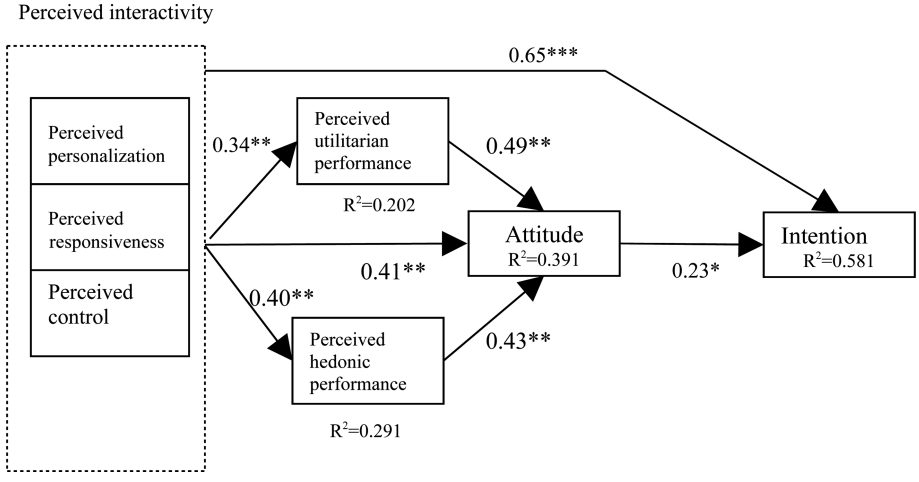

Figure 3. The result of the research model.

6. Discussion

6.1. Findings from the research model

The goal of the study was to empirically test the STV interaction model in order to explain the development of individual behavioural intentions to interact with STVs. The results add to our understanding of user attitudes and intentions in a new HCI paradigm to clarify the implications for the development of effective STV services. Overall, the findings represent an extension to previous work on design characteristics and interactivity by showing interactivity leading to utility and enjoyment as an antecedent and a mediator of positive attitude and intention. Thus, interactivity has a hedonic component, supporting the works by Van der Heijden (2004) and Cyr *et al*. (2007).

Among the constructs, the effect of PI shows a much stronger impact on intention than previous studies have indicated (Williams *et al*. 1988, Hoffman and Novak 1996, McMillan and Hwang 2002, Fortin and Dholakia 2005). While this may be partly because this study emphasised the effect of PI, the unusually high impact of PI suggests that STV users are more influenced by the interactive features in their decision to accept STVs than conventional TV or other advanced TV services (e.g. augmented reality TV, HDTV and IPTV). This finding implies that STV is not only perceived as a TV device for entertainment, but as a multi-tasking social, educational, informational and commercial tool. As Jupiter Research (2010) predicts, STVs will be likely to evolve as a social platform that unifies all functions and features and enables users to connect with online communities through STVs. That is, it redefines how people engage and interact across any application on STVs.

This inference is well suited to the performance value in the model. Along with the highly significant result of PI, the effects of PHP and PUP also show a much stronger impact on attitude than previous studies have shown (Hassenzahl 2003, Deng *et al*. 2010). It may be inferred that there was some kind of effects between PI and PHP/PUP. Together with interactivity and performance, it might very well be that interactivity with the TV increases user perception of utility and hedonicity.

Just as previous studies have consistently shown the importance of usability in technology adoption, this study confirms the importance of usability and further clarifies that usability can be greatly influenced by utility and hedonicity. These findings pinpoint a need for STVs to provide viewers with quality content, as well as interactive services. Although the issue of quality has emerged as a major factor in STV development, to date the research on this issue is quite sparse, especially from the perspective of user perception on interactivity. As many studies including Kim and Zhang (2009) argue, the perception of technology quality by user is a major factor for achieving market breakthrough. While many studies indicate the important role of quality in user adoption, not many indicate to what the specific nature of quality refers. In other words, quality can vary depending on different technologies. The specific nature of quality should be clarified according to technology. This study finds that the quality in the STV context refers to interactivity and further clarifies the components of interactivity. Most importantly, this study shows how such interactivity is related to other factors with different roles.

It has been argued that the most significant potential of STVs is high quality and versatility. As people turn increasingly to STVs for various services they formerly got from other sources, their expectations for those services will change. Those changing expectations will undoubtedly have an impact on the development of future STVs as multimedia tools for games, commerce and entertainment. In this study, the user perception of performance shows a much stronger impact on intention than previous studies have indicated (Beyah *et al*. 2003, Shin 2009).

Interesting findings can be derived from the insignificant relation between attitude and intention. This weak link is consonant with the insignificant role by attitude. All of the paths regarding attitude – the path of PUP to attitude (H6), the path of PHP to attitude (H7), and the path of PI to attitude (H3) – show weaker effects, as compared to other paths particularly regarding performance. As such, further tests are necessary to uncover possible underlying effects.

6.2. Testing of mediating roles played by PI

This study modified and extended the proposed model to test possible hidden effects. Previous studies have shown the moderating effects of variables in various IT contexts (Hayashi *et al*. 2004, Wu 2005, Shin 2009). While recent technology acceptance research has revealed the importance of interactivity, research has failed to further investigate the matter of meaningful interaction beyond the single effect of controllability, responsiveness or personalisation. Thus, given the importance of interactivity in STVs, it is worthwhile to examine new roles played by PI because user perception of interactivity may greatly vary depending on different technologies. This study tested the mediating role of PI in the effect of PUP/PHP on attitude.

To test mediating effects, this study used Baron and Kenny's (1986) procedure, which has discussed four steps in investigating mediation:

Process (1): Show the correlations of the initial variables;
Process (2): Show the correlations of the initial variables with the mediator;
Process (3): Show how the mediator influences the outcome variable; and
Process (4): Establish that the mediator mediates the relationship of the initial variables.

With this procedure in mind, regression analyses were conducted specifically to examine (1) whether independent variables (PUP and PHP) significantly accounted for variance in the hypothesised mediator (PI), (2) whether variance in the mediator (PI) accounted for variance in attitude towards STVs and (3) whether the relationship between independent variables (PUP and PHP) and the dependent variable (attitude) would no longer be significant once the variance in the dependent variable accounted for by the mediator was partialled out.

First, a model was fitted in which PUP/PHP was regressed on PI. The effect of the independent variable (PUP/PHP) significantly explained the variance in the hypothesised mediator PI ($t = 4.42$, $F = 15.42$, $p < 0.001$, $r^2 = 0.10$). This result suggested that the mediator PI was related to the independent variables PUP/PHP whose effects are supposedly mediated. Another regression model was run with attitude towards STVs as the dependent variable and the mediator PI as the independent variable. PI significantly accounted for variance in the dependent variable attitude ($t = 5.56$, $F = 29.75$, $p < 0.001$, $r^2 = 0.24$). A third regression model was fitted with attitude as the dependent variable and PUP/PHP as independent variables. A significant result was obtained ($t = 3.23$, $F = 9.76$, $p < 0.001$, $r^2 = 0.15$). Finally, a fourth model was conducted with attitude as the dependent variable and PUP/PHP and PI as independent variables. The effects of PUP/PHP were not significant ($t = 1.00$, $p = 0.39$) after the significant effect of the hypothesised mediator PI ($t = 4.98$, $p < 0.001$) was partialled out. Thus, PI is proven to be a full mediator between PUP/PHP and attitude (see Table 6 and Figure 4).

Table 6. The mediating effects of PI on attitude.

Model	Unstandardized regression coefficient (B)	*t*-statistics	*p*-value
$PI = \beta_0 + \beta_1$*PUP + β_2*PHP	3.66	4.42	0.001
Attitude = $\beta_0 + \beta_1$*PI	0.10	5.56	0.001
Attitude = $\beta_0 + \beta_1$*PUP + β_2*PHP	0.64	3.23	0.001
Attitude = $\beta_0 + \beta_1$*PUP + β_2*PHP + $\beta 3$*PI	0.21	1.00	0.39
$+ \beta_1$*PI	0.10	4.98	0.001

The significant mediating roles played by PI imply that STV users want to confirm performance before their final decisions to adopt. Normally, it has been supposed that higher positive attitude leads to stronger intention (Venkatesh and Morris 2000). In the STV context, user attitudes towards STVs can be different from their actual intention. While users may have a positive attitude, they also have limited intentions. Users may want to experience a new dimension with STVs such as advanced interactivity. This inference is consistent with the significant effects of PI in the model. The mediating effects show highly significant support for the importance of user interactivity in STVs. The importance of PI in this study is a key to the concept of actual interactivity in STVs. Interactivity can be understood as a channel to control and personalise. In previous research, interactivity has been the concept of 'responsiveness' or 'being quick' (Chung and Zhao 2004). In the STV context,

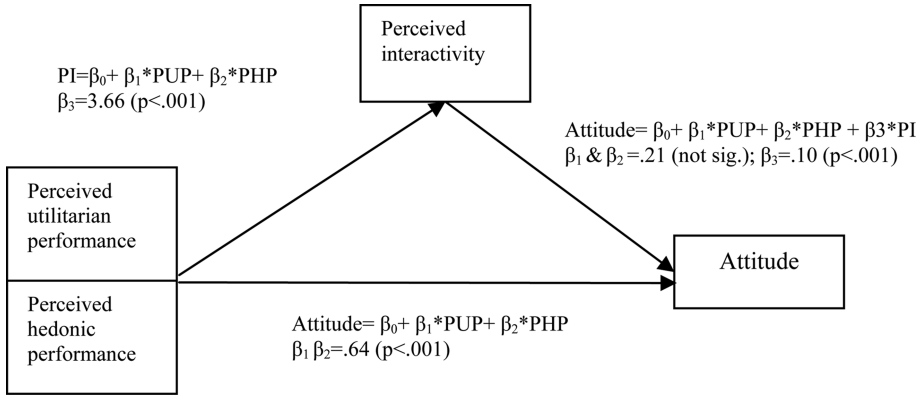

Figure 4. The results of the mediation test.

interactivity refers more than to mechanical responses to user requests. It may refer to users that can become fully immersed in their experiences by viewing content, commenting on it and then actively contributing to it. In STVs, interactivity can happen as a form of para-social interaction, where new forms of content or services are generated. Interactivity can also happen as user-to-system interactivity which is the way devices can be engaged with by users.

The proven mediating roles signify that interactivity plays enhancing and facilitating roles for other perceived factors, as well as attitudes and intentions. The results imply that STVs with advanced interactive features have a greater influence on performance, which results in a greater influence on attitude, leading to a higher intention to adopt STVs. This sense of interactivity has a positive impact on the enjoyment felt, which influences acceptance. The results imply that the interactivity of STVs plays an underlying role in the overall process of adoption and continuing usage. The model puts interactivity in focus, showing that PI is a key factor, directly and indirectly affecting other factors to a significant degree. This finding has useful implications for both academia and industry. While the findings support previous research on interactivity, this study shows the applicability of interactivity in emerging STV areas. Previous findings of research on interactivity have shown that user subjective perceptions of interactivity play an important role in determining a person's behavioural intention and actual behaviour (Novak and Biocca 2003, Hayashi *et al.* 2004, Cyr *et al.* 2007). These previous studies, however, neglected to address the specific relations between interactivity and other variables, or the possible underlying effects of interactivity on other motivational variables. Filling the gap in these studies, this article finds that PI has significant effects on both PUP and PHP. This article further clarifies how PUP and PHP are formed and how the variables are mediated. It can be inferred that enhanced feelings of interactivity will result in improved perception of usefulness and enjoyment through system use and content.

6.3. Improving external validity for generalisability

As STVs are still early stages of diffusion, the findings above have a limited external validity. In addition, as a large number of the respondents of the survey came from one specific country (although followed a random sampling procedure), it is necessary to replicate survey to increase generalisability of the findings. The second round of survey was also helpful to see any changes of user attitude longitudinally.

Table 7. Summary of the hypothesis results in the second model.

Hypothesis	Path coefficient (β)	t-value	Support
H1: Attitude → Intention	0.39**	3.466	Yes
H2: PI → Intention	0.45**	4.522	Yes
H3: PI → Attitude	0.56***	3.592	Yes
H4: PI → PHP	0.29*	2.922	Yes
H5: PI → PUP	0.34**	3.103	Yes
H6: PUP → Attitude	0.43**	2.631	Yes
H7: PHP → Attitude	0.44**	2.151	Yes

Note: *$p < 0.05$; **$p < 0.01$, ***$p < 0.001$.

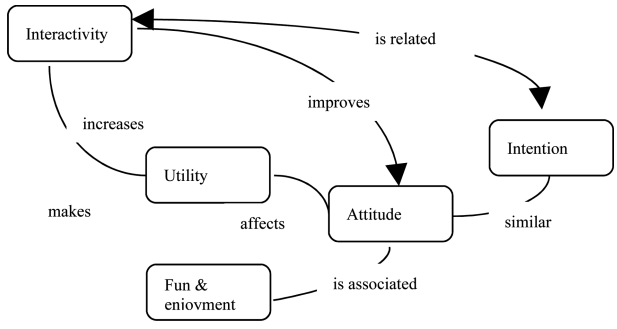

Figure 5. Results of concept mapping.

Data were collected through a marketing firm that specialises in survey administration. The firm has a large number of panel data set and we were able to get valid 299 responses. The data are similar to the first round of survey in terms of demographics (age, gender, education and jobs). The overall fit of the model is satisfactory, with all of the relevant goodness of fit indices being acceptable (see Table 7). Given a satisfactory measurement of the second model's fit to the data, the second model can be equivalently compared to the first model. Just like the first round, all the hypotheses are supported. The results are very similar to the first round in terms of the key roles played by PI.

The results of hypotheses test show very similar pattern, effect sizes, and R^2. In fact, R^2 is increased by 10% (from 0.581 to 0.590). Overall, the model shows a pattern that highlights the importance of utility and hedonicity along with their antecedent, PI. Based on the second model result, it can be said that external validity of the model is confirmed. Thus, generalisability of the findings can be increased.

6.4. Results of concept mapping

Since external validity is particularly important in STV, we conducted a concept mapping (See Figure 5). As explained early, concept mapping is a method that can

be used to help any individual or group to describe their ideas about some topic in a pictorial form. The respondent data collected from several rounds, different times and different locations show consistent results supporting some level of external validity. The results of concept mapping can be pictorialised as follows.

7. Implications for theory and practice: Interactivity and social presence

The contribution of this study is both theoretical and practical. With regard to theoretical advancement, the empirical findings demonstrate that employing interactivity and performance would be a worthwhile extension of TRA/TPB or TAM in STVs, as they were found to be influential in predicting the attitude and behavioural intention to adopt STVs. As an antecedent variable to performance, the role of interactivity is of importance in the STV context, because one of the limitations of technology acceptance literature is that it does not help us explain acceptance in ways that guide development, besides suggesting that system characteristics have an impact on perceptions of enjoyment and usefulness. Therefore, as many researchers argue (i.e., Venkatesh and Morris 2000), it is essential to understand the antecedents and the underlying effects of the key factors in order to explain eventual user acceptance and continuous use. With regard to TPB, behavioural intention can be viewed as an individual's underlying attitude, which ultimately determines behavioural intentions via attitude (Ajzen 1991). TPB has some limitations including a significant risk of confounding between attitudes and norms, since attitudes can often be reframed as norms and vice versa. Another limitation is the assumption that when someone forms an intention to act, they will be free to act without limitations. In practice, constraints such as limited ability, time, social or organisational limits, and unconscious habits will limit the freedom to act. The model in this study attempts to resolve these limitations. This study contributes to the literature on the TRA/TPB research by confirming that perceived usability can influence behavioural intentions through attitude. This study focuses on the user-centred perspective: how users perceive and use STVs and how STV factors play a role in the development of user attitudes. This can be a modest but heuristic contribution to research on STV acceptance, because previous research has studied them separately, leaving the relationship unclear.

Related to this implication, an intriguing and heuristic contribution of this study is the recognition of a directional relationship between PI, performance, and attitude. While interactivity is an embedded concept in multimedia technologies, the concept has apparently been under-researched. Aside from the relationship between PI and intention, it seems that the relationship is not apparent in the STV context. Given the unique nature of STV interaction, the relationship with PI and other factors should be clarified. Based on the findings of PI, this study reconceptualises and redefines PI in the STV context. Previously, PI has been measured with the capability to interact with system/technologies. In the STV context, the current notion of interactivity should be expanded to include new features provided by STVs. For example, one of the motivations of smartphone users is to be connected by constantly communicating with other users. With the advancement of ubiquitous technologies, the social expectation is that one is nearly always connected and reachable almost instantly via smartphones. It is considered that smartphones are the instrument of that connectedness. Assuming smartphone features apply to STVs, STVs will have similar functions, features and user interfaces. Given these, the PI of STVs should be understood not only via responses and feedback, but also the feeling of connectedness enabled by such continuous interaction.

Applying this new notion of interactivity into STVs may render a real-time interaction system unnecessary. Rather, it is more effective to increase the user's sense of connectedness or belonging. From this understanding, specific design features and characteristics of STV services can be utilised to achieve meaningful interactivity. For example, STV viewers might want to post comments on social networking sites when they are watching TV programs. This kind of continuous interaction loop may increase users' sense of connectedness. Future studies should further investigate the complex interrelationships among interactivity, connectedness, presence, performance and usability to clarify these intricate relationships. In particular, given its key roles, PI should be further extensively investigated in reference to the presence and flow in the STV context. For example, two people in geographically disparate regions could watch the same internet-based show at the same time, and chat with each other about the program. For the two people, interactivity may mean a social presence. Interactivity can occur at many different levels and degrees of engagement, and it is important to differentiate between these levels.

Practical implications for the STV industry can be drawn in terms of strategies and new models for STVs. As STVs converge with other multimedia technologies, the concepts of interaction will be highlighted anew. The industry should focus on enhancing social presence through PI and increasing interactivity, user

participation and involvement. The findings suggest that vendors should ensure that their device works and plays in accordance with user expectations and emotions. In addition, the findings imply that interactive content/services will be vitally important to the sales of STVs.

Although this study only employed STVs as the target technology, the research model captures the general characteristics of ongoing smart IT, and hence the findings of this study can enhance our understanding of the factors leading to future intention of smart IT in general, which provides both utilitarian and hedonic functions with services such as communication, information, entertainment and commerce. The focus on the experience of interactivity allows us to take a step closer to the design features of future smart IT. The results suggest the high relevance and great importance for smart IT to be designed with the capability of inducing an experience of interactivity in users. The more users feel interactivity in using the technology, the more they will perceive it to be of high utilitarian and hedonic performance and expectation exceeding, and the more they will feel satisfied with the technology and intent to continue its usage.

In conclusion, considering the ever-changing nature of smart technologies, this study elucidates motivations associated with STV acceptance and the implications for developing effective STV services. As users accept STVs as a new tool to communicate, collaborate and entertain, industries should provide usable tools and platforms for users. STVs will be likely become an exciting and popular application in the near future. For STVs to become popular, developers need to understand individual perceptions and experiences concerning truly smart services.

8. Limitations and future studies

The results of this study should be approached with caution for several reasons. First, the findings reflect only limited aspects of user experiences of STVs in the experimental environment. As STV is still in its early stages of development, this research is exploratory. User attitude and behaviours were based on their future expectations and probable experiences as STVs are not yet fully diffused into the market. In addition, for simplicity's sake, this study excluded individual differences as factors in STV acceptance (e.g. demographics, user experience and personal innovativeness). However, in future studies, it may be wise to consider individual variables. A closer investigation of individual differences and their direct and indirect effects on STV usage offers rich opportunities for future research.

A second limitation concerns generalisability. Since this study collected data from a few online communities related to digital technologies, it is difficult to generalise the findings to other contexts. In addition, the data collected in this study originated from various IT communities (e.g. digital TV, on-demand TV and IPTV), and treating them equally is an issue, as was the case in this study. This study sought to collect data for prospective users of STVs, which was heavily weighted towards young and educated consumers. The participants are likely to be early adopters. As such, the findings of this study may raise questions, such as (1) how seriously did the participants take the STVs in this study?; and (2) to what extent are the samples representative of the population currently engaging in STV interactions? Future studies will be able to sample a larger population and obtain more generalisable results. Future studies should not only focus on interactive smart features but also on different user groups. They should examine how different demographic variables affect PI.

Thirdly, future studies may consider the use of TPB (Ajzen 1991), which includes perceived behavioural control. As the model in this study used perceived control as a sub-item of PI, perceived behavioural control can be integrated into the new framework of TPB. In addition, this study did not include actual behaviour in the model, because STVs are not widely introduced in society and as such, actual behaviour of using STVs could not be analysed. As this study focused on the mediating effects of PI, future studies may address other effects played by PI such as moderating effects and interaction effects.

Taken together, these limitations may reduce the reliability of the findings reported herein. Furthermore, the validity of the conclusions can be challenged by questioning the correlations among the variables. Possible interactions among the variables may attenuate the findings in this study, given the limited sample, although future research can use the experiments, methods and models used in this study with some assurance. Testing them against other factors will advance the understanding of user behaviour in an interactive environment.

Acknowledgments

This work was supported by the National Research Foundation of Korea Grant funded by the Korean Government (NRF-2010-B00171). This research was supported by MKE (The Ministry of Knowledge Economy), Korea under ITRC NIPA-2011-(C1090-1121-0008). This study was supported by WCU (World Class University) programme through the National Research Foundation of Korea funded by the Ministry of Education, Science and Technology (Grant No. R31-2008-000-10062-0).

References

Ahren, R.K., Stromer-Galley, J., and Neuman, W.R., 2000. *Interactivity and structured issue comparisons on the political web: an experimental study of the 2000 New Hampshire presidential primary*. Paper presented at International Communication Association, 1–5 June, Acapulco, Mexico.

Ajzen, I., 1991. The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50 (2), 179–211.

Bagozzi, R.P. and Yi, Y., 1988. On the evaluation of structural equation models. *Journal of the Academy of Marketing Science*, 16, 74–94.

Baron, R.M. and Kenny, D., 1986. The moderator-mediator variable distinction in social psychological research. *Journal of Personality and Social Psychology*, 51, 1173–1182.

Beyah, G., *et al*., 2003. Development of an instrument to study the use of recommendation systems. *Proceedings of AMCIS 2003*, August 4–6 2003, Tampa, FL, 1–14.

Bezjian-Avery, A., Calder, B., and Lacobucci, D., 1998. New media interactive advertising vs. traditional advertising. *Journal of Advertising Research*, 38 (4), 23–32.

Carey, J., 1989. Interactive media. *In*: E. Barnouw, ed. *International Encyclopedia of communications*. New York: Oxford University Press, 328–330.

Cesar, P. and Chorianopoulos, K., 2009. The evolution of TV systems, content, and users toward interactivity. *Foundations and Trends in Human–Computer Interaction*, 2 (4), 373–395.

Chung, H. and Zhao, X., 2004. Effects of perceived interactivity on website preference and memory. *JCMC*, 10 (1), Article 7.

Cho, C-H. and Leckenby, J.D., 1999. Interactivity as a measure of advertising effectiveness. *In*: M.S. Roberts, ed. *Proceedings of the American academy of advertising*, Gainesville, FL: University of Florida, 162–179.

Coyle, J.R. and Thorson, E., 2001. The effects of progressive levels of interactivity and vividness in web marketing sites. *Journal of Advertising*, 30 (3), 65–77.

Cyr, D., Head, M., and Ivanov, A., 2007. Perceived interactivity leading to e-loyalty. *Proceedings of the Sixth Annual Workshop on HCI Research in MIS*. Montreal, 8 December 2007. Montreal, Canada: HCI Association, 46–51.

Davis, F.D., 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13 (3), 319–340.

Day, G.S., 1998. Organizing for interactivity. *Journal of Interactive Marketing*, 12 (1), 47–53.

Deng, L., *et al*., 2010. User experience, satisfaction, and continual usage intention of IT. *European Journal of Information Systems*, 19, 60–75.

Fishbein, M. and Ajzen, I., 1975. *Belief, attitude, intention, and behavior*. Reading, MA: Addison-Wesley Pub. Co.

Fornell, C. and Larcker, D., 1981. Structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18 (1), 39–50.

Fortin, D. and Dholakia, R., 2005. Interactivity and vividness effects on social presence and involvement with a web-based advertisement. *Journal of Business Research*, 58 (3), 387–396.

Guedj, R.A., *et al*., 1980. *Methodology of interaction*. Amsterdam: North Holland Publishing Company.

Ha, L. and James, L., 1998. Interactivity reexamined: a baseline analysis of early business web sites. *Journal of Broadcasting & Electronic Media*, 42 (4), 457–474.

Haeckel, S.H., 1998. About the nature and future of interactive marketing. *Journal of Interactive Marketing*, 12 (1), 63–71.

Hair, J., *et al*., 1995. *Multivariate data analysis with readings*. 4th ed. Englewood Cliffs, NJ: Prentice-Hall.

Hanssen, L., Jankowski, N.W., and Etienne, R., 1996. Interactivity from the perspective of communication studies. *In*: N.W. Jankowski and L. Hanssen, eds. *Contours of multimedia: recent technological, theoretical, and empirical developments*. Luton: University of Luton Press, 61–73.

Hassenzahlm, M., 2003. The thing and I: understanding the relationship between user and product. *In*: M.A. Blythe, A.F. Monk, K. Overbeeke and P.C. Wright, eds. *Funology: from usability to enjoyment*. Dordrecht: Kluwer Academic Publisher, 31–42.

Hayashi, A., *et al*., 2004. The role of social presence and moderating role of computer self efficacy in predicting the continuance usage of e-learning systems. *Journal of Information Systems Educations*, 15 (2), 139–154.

Heeter, C., 1989. Implications of new interactive technologies for conceptualizing communication. *In*: J.L. Salvaggio and J. Bryant, eds. *Media use in the information age: emerging patterns of adoption and computer use*. Hillsdale, NJ: Lawrence Erlbaum Associates, 217–235.

Heeter, C., 2000. Interactivity in the context of designed experiences. *Journal of Interactive Advertising*, 1 (1). Available from: http://www.jiad.org/vol1/no1/heeter/index.html.

Hoffman, D.L. and Novak, T.P., 1996. Marketing in hypermedia computer-mediated environments. *Journal of Marketing*, 60 (3), 50–117.

Hoffman, D.L., Novak, T.P., and Duhachek, A., 2003. The influence of goal directed and experiential activities on on-line flow experiences. *Journal of Consumer Psychology*, 13 (2), 3–16.

Jensen, J.F., 1998. Interactivity: tracing a new concept in media and communication studies. *Nordicom Review*, 19 (1), 185–204.

Jupiter Research. 2010. *Prospect of STV*. Boston, MA: Jupiter Research Inc.

Kim, J.W. and Du, S., 2006. Design for an interactive television advertising system. *In*: *Proceedings of the 39th Hawaii International Conference on System Sciences (2006 HICSS Conference)* January 4–7 2006, Big Island, Hawaii, 1–9.

Kim, Y. and Zhang, P., 2009. Individual users' adoption of smart phone services. *In*: *Proceedings of the Eighth Annual Workshop on HCI Research in MIS*, 14 December 2009. Phoenix, Arizona. Syracuse, NY: AIS (Association of Information System).

Kiousis, S., 1999. *Broadening the boundaries of interactivity: a concept explication*. Paper presented at Association for education in journalism and mass communication annual conference, August, New Orleans, USA.

Lieb, T., 1998. Inactivity on interactivity. *Journal of Electronic Publishing*, 3 (3). Available from: http://www.press.umich.edu/jep/03-03/lieb0303.html.

Lombard, M. and Snyder-Dutch, J., 2001. Interactive advertising and presence: a framework. *Journal of Interactive Advertising*, 1 (2). Available from: http://jiad.org.

McMillan, S.J., 2002. A four-part model of cyber-interactivity: some cyber-places are more interactive than others. *New Media and Society*, 4 (2), 271–291.

McMillan, S.J., 2000a. Interactivity is in the eye of the beholder: function, perception, volvement, and attitude toward the web site. *In*: M.A. Shaver, ed. *Proceedings of the American academy of advertising*. East Lansing, MI: Michigan State University, 71–78.

McMillan, S.J. and Hwang, J., 2002. Measures of perceived interactivity. *Journal of Advertising*, 31 (3), 29–42.

Miles, I., 1992. When mediation is the message: how suppliers envisage new markets. *In*: M. Lea, ed. *Contexts of computer-mediated communication*. New York: Harvester-Wheatsheaf, 145–167.

Newhagen, J.E., Cordes, J.W., and Levy, M.R., 1996. Nightly@nbc.com: audience scope and the perception of interactivity in viewer mail on the internet. *Journal of Communication*, 45 (3), 164–175.

Newhagen, J. and Rafaeli, S., 1996. Why communication researchers should study the Internet. *Journal of Communication*, 46, 4–13.

Novak, T.P., Hoffman, D.L., and Yung, Y-F., 2000. Measuring the customer experience in online environments: a structural modeling approach. *Marketing Science*, 19 (1), 22–42.

Pavlik, J.V., 1998. *New media technology: cultural and commercial perspectives*. 2nd ed. Boston, MA: Allyn and Bacon.

Rafaeli, S., 1988. Interactivity: from new media to communication. *In*: R.P. Hawkins, J.M. Wiemann, and S. Pingree, eds. *Advancing communication science: merging mass and interpersonal process*. Newbury Park, CA: Sage, 110–134.

Schumann, D.W., Artis, A., and Rivera, R., 2001. The future of interactive advertising viewed through an IMC lens. *Journal of Interactive Advertising*, 1 (2). Available from: http://jiad.org.

Shin, D., 2009. An empirical investigation of a modified technology acceptance model of IPTV. *Behaviour and Information Technology*, 28 (4), 361–372.

Steuer, J., 1992. Defining virtual reality: dimensions determining telepresence. *Journal of Communication*, 42 (4), 73–93.

Straubhaar, J. and LaRose, R., 1996. *Communications media in the information society*. Belmont, CA: Wadsworth Press.

Van der Heijden, H., 2004. User acceptance of hedonic information systems. *MIS Quarterly*, 28 (4), 695–704.

Venkatesh, V. and Morris, M.G., 2000. Why don't men ever stop to ask for directions? *MIS Quarterly*, 24 (1), 115–139.

Williams, F., Rice, R., and Rogers, E., 1988. *Research methods and the new media*. New York: Free Press.

Wu, G., 2005. The mediating role of perceived interactivity in the effect of actual interactivity on attitude toward the website. *Journal of Interactive Advertising*, 5 (2), 29–39.

Wu, G., 1999. Perceived interactivity and attitude toward website. *In*: M.S. Roberts, ed. *Proceedings of the American academy of advertising*. Gainesville, FL: University of Florida, 254–262.

Zack, M.H., 1993. Interactivity and communication mode choice in ongoing management groups. *Information Systems Research*, 4 (3), 207–239.

Appendix

Constructs	Measured items	Source
Perceived interactivity	Perceived control 1: I had total control over watching STVs. Perceived control 2: I was in control of my navigation. Perceived responsiveness 1: I just had a personal conversation with a sociable, knowledgeable representative from the company. Perceived responsiveness 2: I felt like having a dialogue with an agent when I click a button to enter a web site while watching an STV. Perceived personalisation 1: I perceived STVs was sensitive to my needs or preferences. Perceived personalisation 2: I can customise STV interface, feature and functions.	Kim and Du (2006)
Perceived hedonic performance	PHP1: I evaluate the STV service as exciting. PHP2: I evaluate the STV service as delightful. PHP3: I evaluate the STV service as playful.	Deng *et al.* (2010)
Perceived utilitarian performance	PUP1: I evaluate the STV service as useful. PUP2: I evaluate the STV service as practical. PUP3: I evaluate the STV service as functional.	Deng *et al.* (2010)
Attitude	AT1: I would have positive feelings towards using STVs. AT2: I think STVs would make my life more interesting. AT3: It would be a good idea to make use of STVs.	Davis (1989)
Intention to use	IT1: I think I will use STVs in the future. IT2: I recommend others to use STVs. IT3: I intend to continue using STVs in the future.	Davis (1989); Shin (2009)