Investigating Public Acceptance on Public Oriented Human Space Commercialization

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ABSTRACT

Based on people’s enthusiasm and economical reasons, the space commercialization will get more momentum in the future, and eventually reach a full commercialization status, a public-oriented human space commercialization (POHSC) where the public freely participate and purchase space products and services. In this study, the authors conduct a survey-based research model to investigate public perception on POHSC in the human space exploration (HSE) context. The authors want to identify what factors influence public acceptance and adoption of POHSC, and to evaluate public willingness to pay for future services provided by POHSC. For these objectives, the authors develop the concept of ‘eMerge’, a conceptualized mobile device-based application tool with which the public access and pay for their services. The authors also propose the Technology Acceptance Model with ‘eMerge’ specific (TAMe). The result shows that public perceptions are strongly affected by perceived availability, perceived usefulness, and perceived enjoyment to use ‘eMerge’. The Perceived availability and perceived enjoyment have significant effect on public motivation to use ‘eMerge’ by forming a positive attitude toward intention to use it. It also shows that the public have very high expectations and enthusiasm on POHSC in terms of their estimated spending on ‘eMerge’. These results can be used as base knowledge in POHSC for future R&D and commercialized technology development.

Keywords: Human Space Exploration (HSE), Public-Oriented Human Space Commercialization (POHSC), Research & Development (R&D), Technology Acceptance Model, Technology Acceptance Model with ‘Emerge’ Specific (TAMe)

INTRODUCTION

The aerospace industry has been striving to enhance human space exploration (HSE) technologies over the last half century as part of a nationwide research & development (R&D) project managed by government agencies like National Aeronautics and Space Administration (NASA). In parallel to this traditional movement, although it is in an early stage, the aerospace industry has been in the midst of a transition to space commercialization.
since 1990 (Peeters, 2003). For example, as described in Bush (2002), the development of the International Space Station (ISS) has raised a public expectation and enthusiasm about full commercialization. Recently, NASA plans to support the commercial orbital spaceflight and associated commercial use of space stations (NASA Watch, 2011). In addition to the U.S., Europe, Russia and Japan have also participated in this commercialization with fast-growing programs. For example, Arianespace in France has played a key role in the commercial launching service in 1990s (Suzuki, 2000), and it has captured more than 50% of the commercial launching market (Lionnet and Alexandrova, 2011). In fact, the ISS is the output through the international collaboration with Russia, Europe, Canada and Japan. NASA and other partners in the ISS have been seeking international collaboration to commercially utilize the ISS to reduce its operational cost and to enhance science and technology development (Rock-etplane Kistler, 2011). According to Peeters (2003), the reduced government funding was one of the drivers for this commercialization path, and the most visible effect of this space commercialization was the globalization of the aerospace industry through strategic alliances. Based on this globalization, although the U.S. is still the leading nation, its market share in many space-related industry segments declines as global competition increases (Giacalone, 2006).

In this paper, we discuss the public-oriented human space commercialization (POHSC), and investigate public acceptance on POHSC in the HSE context. The POHSC is an extension of the traditional concept of human space commercialization (HSC). Space commercialization means that a commercialized market is established where customers buy and sell space-related products and services supplied by providers. The traditional concept of HSC has a very narrow meaning, which specifically includes the use of commercial space vehicles and use of any equipment in space to obtain commercial value of services and products from that equipment. In the traditional HSC, institutional customers (governments and government agencies) and commercial customers (corporations) play both roles of service or product providers and consumers. However, POHSC assumes that a fully commercialized HSE market where HSE-related products and services are traded is formed in the future. In the POHSC, in addition to institutional and commercial customers, individual consumers also directly purchase more diversified HSE-related products and services offered from diverse providers including governments, government agencies, and corporations (broader market scope) in the market. The products and services may have a wide range from a simple observation of different levels of spaceflight launching data and a remote control of lunar development robots to competition with other consumers (wider technology breadth). If appropriately implemented, the POHSC will have much faster commercialization speed than that of the traditional HSC because of its broader market scope and wider products and services. According to Chen (2009), market scope, technology breadth, and commercialization speed are core dimensions of the technology commercialization competence (TCC) which refers to the competence to use technologies in products and services across markets. That is, we believe that the POHSC has much higher level of TCC than that of the traditional HSC. Giacalone (2008) classified the space industries into satellite communications, global positioning systems (GPSs), space transportation, and remote-sensing categories, and each of these categories includes several sub-industries. He noted that the satellite communication and GPS categories were two largest categories in terms of the 2002 total space industry revenues. HSE is very closely related with the space transportation. Although HSE has the longest history compared to other categories, its long-term future seems to have many challenges in terms of government budget priority in the U.S. (Tkatchova, 2011). Under this circumstance, we believe that the POHSC concept may provide an answer for future and potential HSE projects. Based on its aforementioned broader market scope and wider technology breadth, HSE’s
path toward commercialization still needs more innovation and relevant investment. That is why POHSC is adopted in this study.

Dittmar (2004, 2008) is one of the pioneers in investigating potential feasibility of POHSC. She surveyed 555 people from 15 to 35 year old to find out features of HSE activities that potential public participants want to use, and found out 26 interesting features. The use of a mobile device and the concept of competition among participants are two of those features found out. Morin et al. (2010) proposed the ‘telepresence’ concept through the government sponsored program where a public participant accesses lunar activities from the Earth. This paper is an extension of Dittmar (2004, 2008) and Morin et al. (2010). We attempt to investigate public acceptance on POHSC in the HSE context using the modified Technology Acceptance Model (TAM). Specifically, we attempt to

1. Identify factors influencing public acceptance and adoption of POHSC.
2. Evaluate public willingness to pay for services provided by POHSC.

To answer those two questions, we use a survey-based research methodology. We first develop a conceptualized HSE service interfacing tool based on the mobile device application, called ‘eMerge’ with which public participants can access and pay for service activities as part of their HSE. Then we explain the concept of ‘eMerge’ as a test bed to survey participants in terms of its features and services, request them to provide their responses regarding the ‘eMerge’ concept as future services provided. Based on the responses from the survey participants regarding the ‘eMerge’, we evaluate their acceptance on POHSC using the extended Technology Acceptance Model with eMerge specific (TAME). The TAME is an extension from the original Technology Acceptance Model (Davis, 1985) by adding several relevant key factors associated with POHSC to the original TAM. Eventually by solving structural equation modeling (SEM) established by TAME, we obtain and interpret public acceptance on POHSC based on ‘eMerge’. For the second question, each survey participant is asked to provide dollar amount for any individual POHSC service using ‘eMerge’ per usage.

We believe that the transition toward POHSC will be accelerated in the future based on people’s enthusiasm, technology advancement, and diverse political and economical reasons. Considering this trend, the results from this study will provide insightful information to researchers and aerospace industry practitioners including potential entrepreneurs considering HSC participation in the future. To our best knowledge, we believe that this is the first study which uses the modified TAM to the technology in HSC. It should be also noted that the framework used in this study can be easily applied to other categories of the space industries.

eMerge

As previously described, the ‘eMerge’ is a conceptualized HSE service tool based on a mobile device with which participants access and pay for service activities as part of their HSE. For example, like a mobile internet exploration service, individual HSE participants may access their choice of diverse services and communicate with other participants with this tool. The range of services may vary from a passive level for observation to an active level offering more engagement at a different service fee structure. Since a physical prototype is not present at this moment, the conceptualized prototype as seen in Figure 1 is used for this study purpose.

The proposed ‘eMerge’ consists of five different levels of user services: Observation, Interaction, Participation, Empowerment, and Competition. These were identified as promising concepts by Dittmar (2004) and Morin et al. (2010) in their initial studies for space exploration, and adopted here. Users are required to pay to observe HSE activities of their choice (Observation). Active levels of service offer users a progressive engagement from simple interaction to full empowerment. ‘Interaction’
offers modest communication with other individuals logged on. ‘Participation’ permits active involvement in selected activities with other participants. ‘Empowerment’ sanctions activities with the highest influence, such as competition in a lunar rover race which is an example of individual and team activities. Individuals may be international users and data is provided to the screen layout once released by service providers. Figure 2 explains the conceptual structure of communication for ‘eMerge’. Users access all HSE activities provided by remote service providers using the mobile device which may be connected to the communication network through signal transmission equipment such as a satellite etc. We anticipate that the ‘eMerge’ concept can play a key role as a conceptual prototype for the public to engage by a mobile device in HSE. In the future, this conceptualized tool can be replaced with an actual prototype.

The remaining of this paper is organized as follows: In key factor identification, we describe how we identify the key factors of user acceptance from prior research to build a research model. Thereafter, we introduce the modified Technology Acceptance Model, TAMe to build hypotheses and a research model in research methodology. Survey provides details on the established questionnaire and its administration. The results section explains the verification and validity study on the questionnaire analyzed. It also explains the statistical results. In discussion and conclusion, we discuss the interpretation and relationships of the statistical analysis. Finally, we discuss the weakness and future research topics in the last section, limitation and future research.

**IDENTIFYING KEY FACTORS**

This study intends to investigate the public acceptance and adoption of the POHSC, and since the core technological concept to implement the POHSC is the ‘eMerge’ as previously described, we investigate the public intention to adopt ‘eMerge’. Since the Technology Acceptance Model (TAM) has been frequently used
to evaluate user acceptance of the technology in a concept development phase, the TAM model with ‘eMerge’ specific is presented (called TAMe). The TAMe is an extension of TAM by adding three relevant key factors associated with POHSC—perceived enjoyment, perceived availability and social pressure.

The Technology Acceptance Model (TAM) was developed by Davis (1985) specifically to evaluate factors of user acceptance early in the concept development. The TAM models how users accept and use a technology. The model suggests that when users are presented with a new technology, multiple factors influence their decision about how and when they will use it. After tests to validate TAM on existing systems, Davis (1985) projected that technology managers could save money by better understanding factors of user acceptance early. Many fields of empirical research used TAM. For example, the TAM was used by Shin (2007) to analyze the convergence of technologies enabling the Korean Wireless Broadband Internet (Wi-Bro) technology. Cheong and Park (2005) used the TAM to better reflect the mobile internet context in Korea. According to the TAM, two major variables determine user acceptance as shown in Figure 3. They are perceived usefulness (PU) and perceived ease of use (PEOU). These two main variables influence attitude and intention to use a technology. If the TAM in Figure 3 is used in empirical research with a specific technology, the relationships among latent variables are eventually translated into hypotheses and evaluated by users of the technology. For example, consider the relationship between PEOU and intent in Figure 3. Users of the technology are eventually asked whether they are likely to intent to use the technology or not if they perceive that the technology is easy to use. Based on this survey, the relevant hypothesis, ‘there is a positive relationship between perceived ease of use and intention to use’ is evaluated. Readers are encouraged to refer to Davis, Bagozzi, and Warsaw (1989) for detailed descriptions on the TAM.

Two ‘eMerge’ specific variables of particular interest to the POHSC are perceived enjoyment (PE) and perceived availability (PA). PE is described as the degree to which the activity of using ‘eMerge’ will be perceived to be enjoyable in its own right, apart from any performance consequences that may be anticipated. Moon and Kim (2001) and Van der Heijden (2003) referred PE to the performance of an activity generated by the process of performance itself, and considered it as an intrinsic source of motivation. Their research showed that PE has an effect on consumer’s attitude and behavioral intention toward using a specific source. Liao, Tsou, and Shu (2008) also demonstrated the

Figure 3. Technology acceptance model

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same conclusion using the variation of the TAM to the multimedia-on-demand service.

Perceived Availability (PA) is described as the degree to which people can be gratified or comforted with psychological availability that they can enjoy the ‘eMerge’ content at their conveniences. PA has been studied in many previous papers. Xie et al. (2002) investigated users’ perceived availability in the Web server and concluded that user-perceived availability is dependent on the system’s characteristics as well as on the user’s behavior. Gokhale and Lu (2006) reported that users are more affected by their perceived availability of the system than its actual availability. Shin (2009) reported that users’ perceived availability significantly affected the users’ perceived usefulness and attitude in using the mobile tool based on the satellite digital multimedia broadcasting in South Korea.

The theoretical base for the TAM and this research is that individuals act rationally and plan their actions. Fishbein and Ajzen (1975) theorized that belief, attitude and intention (in that order) lead to behavior. Specifically, an individual’s belief leads to attitude and in turn leads to intention and finally leads to behavior. Ajzen and Fishbein (1980) originated the Theory of Reasoned Action (TRA) to predict a person’s behavior. According to TRA, a person’s intention toward the behavior is affected by that person’s attitude toward the behavior and perception of the social pressure. An attitude is an individual’s positive or negative evaluation of performing the behavior while the person’s perception of the social pressures is a subjective norm formed under the social environment. While the role of beliefs leading to attitude leading to intention leading to behavior is straightforward, the role of social pressure and/or subjective norm has larger implications when viewed internationally since subjective norm varies from culture to culture (Ajzen, 1991). Fishbein (1967) provided very detailed concept of the social pressure in his book, and Igmaria, Parasurman, and Baroudi (1996) reported that the users’ microcomputer usage is influenced by social pressure. In this study, the planned behavior and the measure of behavior is represented as dollar amount for users to pay to participate in the POHSC activities using ‘eMerge’, and we add Social Pressure (SP) as a latent variable to evaluate whether users’ acceptance on ‘eMerge’ is influenced by other people who users think are important to them.

RESEARCH METHODOLOGY

Based on the TAMe model, the Confirmatory Factor Analysis (CFA) (Brown, 2006; Byrne, 2000; Nunnally 1978) is used to confirm the relationships among the factors in the Structural Equation Modeling (SEM) established by TAMe. The CFA is a type of statistical factor analysis. It is used to test whether measures of a latent variable are consistent with a researchers’ understanding of the nature of that latent variable (or factor). In CFA, the researchers initially develop a hypothesis about what factors they believe are underlying the measures they have used. As such, the objective of CFA is to evaluate whether the data typically obtained from surveys fit a hypothesized measurement model. In this study, the TAMe is the hypothesized measurement model.

TAME

The research methodology focuses on analysis of key factors affecting public perception on the POHSC and their willingness to purchase the services exemplified by ‘eMerge’. As a result of this key factor analysis, the TAMe is proposed as shown in Figure 4. Please note that all statistical analysis results were also displayed on the figure and these will be discussed later. As seen in Figure 4, the TAMe includes the original four primary latent variables included in the TAM in Figure 3 – ‘perceived usefulness’ (PU), ‘perceived ease of use’ (PEOU), ‘attitude’, and ‘intention’. It also includes the POHSC specific two latent variables—perceived enjoyment (PE) and perceived availability (PA). Finally, the ‘social pressure (SP)’ is added as

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the seventh latent variable to capture the social influence on intention.

The specific definitions and their derivations of these seven latent variables are explained in Table 1 that is derived from the theoretical foundation for this study discussed in the section, Identifying Key Factors. For example, the public ‘intention’, ‘perceived usefulness’ (PU), and ‘perceived ease of use’ (PEOU) are sourced from two different versions of the TAM model developed by Davis (1985). The ‘attitude’ is added based on TRA developed by Fishbein and Ajzen (1975). The ‘perceived enjoyment’ (PE) comes from Davis (1985), Moon and Kim (2001), Van der Heijden (2003), and Liao et al. (2008). The ‘perceived availability’ (PA) is adopted here from the recent research from Xie et al. (2002), Gokhale and Lu (2006), and Shin (2009). The social pressure (SP) comes from early social science research by Fishbein (1967) and Igmaria et al. (1996).

Now, the relationships among the seven latent variables in the TAMe are evaluated in the form of hypotheses using the questionnaire in Appendix A. Note that there are four questions to evaluate each hypothesis in Appendix A. Survey participants will provide their answer for each of those four questions using the Likert scale. Based on those results, each hypothesis will eventually be evaluated.

The relationships among the four original TAM’s primary latent variables are a direct analogy from the previous TAM model described in Figure 3, and are formulated in the form of hypotheses below.

**H1:** Attitude toward ‘eMerge’ is positively related to the intention to use ‘eMerge’.

**H2:** There is a positive relationship between perceived usefulness and intention to use ‘eMerge’.

**H3:** There is a positive relationship between perceived usefulness and attitude towards ‘eMerge’.

**H4:** There is a positive relationship between perceived ease of use and intention to use ‘eMerge’.

**H5:** There is a positive relationship between perceived ease of use and attitude towards ‘eMerge’.

PE and PA are the two proposed explanatory latent variables of PEOU and PU, respectively, and of Attitude collectivity as displayed in Figure 4.
As previously described, PE is the degree to which the activity of using ‘eMerge’ will be perceived to be enjoyable in its own right, apart from any performance consequences that may be anticipated. Authors believe that PE is an important factor in this study since ‘eMerge’ may play a role as an entertainment tool. Users are expected to show more positive attitude for more enjoyable services from ‘eMerge’ and they may pay more dollar amount for those services. The amount of enjoyment by ‘eMerge’ may also be dependent on the contents of the service. In the previous ‘eMerge’ description, we have provided the five different levels of service contents from Observation to Competition, expecting that users may feel more enjoyment from the higher level of service contents. Users may also perceive that manipulation of ‘eMerge’ is easier when its service is more enjoyable. Therefore, we have developed the following hypotheses.

**H6:** There is a positive relationship between perceived enjoyment and perceived ease of use of ‘eMerge’.

**H7:** There is a positive relationship between perceived enjoyment and attitude towards ‘eMerge’.

Perceived Availability (PA) is described as the degree to which people can be gratified or comforted with psychological availability that they can enjoy ‘eMerge’ content at their conveniences. As Gokhale and Lu (2006) reported, users are more influenced by their perceived availability of the system than its actual availability - Users are comforted with the psychological availability that they can enjoy the content at their convenience. If implemented, ‘eMerge’ provides the real-time service in a ubiquitous basis. In this light, it can be hypothesized that users are comforted...
with the fact that they can get the service from ‘eMerge’ anytime at their convenience.

**H8:** There is a positive relationship between perceived availability and perceived usefulness of ‘eMerge’.

**H9:** There is a positive relationship between perceived availability and attitude towards ‘eMerge’.

The final latent variable in the TAMe is social pressure (SP) which is derived from the TRA (Fishbein and Ajzen, 1975) and the theory of planned behavior (Ajzen, 1991). Social pressure anticipates that the decisions on use of ‘eMerge’ by individuals are made based, in part, on what others important to those individuals think that they should do or not do. Hence, the relationship among SP and intention is formulated as follows:

**H10:** social pressure has a strong effect on intention to use ‘eMerge’.

**SURVEY**

A survey is conducted to evaluate the 10 hypotheses described in the research methodology section. We formulate the questionnaire with thirty questions based on the TAMe, and those are shown at Appendix A. A seven-point Likert scale is used with “1” for strongly disagree to “7” for strongly agree. The survey participants are from a state university. There are 70 surveys completed out of 100 administrated. Male participants make up 55 respondents of the sample (79 percent). Many of the 70 survey participants work in technology areas with an age range from 21 to 79 years old. The mean age is 32 years old with a standard deviation of 12 years. The percentages by age group are as follows: for Twenties, 57%, Thirties, 24% and Forties and over 19%. Education ranged from high school to doctoral degree (Doctorate, 7%, Masters, 33%, College Degree, 44%, Some College, 13%, High School, 3%), and interests and living environment included both technical (79%) and non-technical (21%). While the optional response rate for self-reported race is 54%, the optional response rate for self-reported online purchasing culture is 66%. Although 54% report an American online purchasing culture, 46% report an alternative purchasing culture such as Asian, African and European. The response rate for job titles is 79%, with the job title grouping of respondents as Engineering and Technical related, 56%, Other than Engineering and Technical, 18%, and Student and Education, 25%. The statistically meaningful sample size is 50 based on a confidence level of 95% and a margin of error of one step on a 7-point Likert scale—it is 14% or 86% statistical power (Cohen, 1998). So, the sample size of 70 achieved in this study is meaningful.

All surveys were conducted multiple times from January to May in 2010 in the following way. First, the conceptualized prototype of ‘eMerge’ was presented to the survey participants before they start the survey in a classroom environment approximately for 30 minutes. The presentation includes the screen shots of ‘eMerge’ with the explanation on the associated services. Then we had a question and answer session for any of participant’s question. This usually takes between 10 to 30 minutes. Immediately after that, all screen shots and the prospective service descriptions were provided to each survey participant for self-learning. Based on this self-learning, each participant started to complete the questionnaire within 1 hour.

**RESULTS**

Validity and reliability of the survey results were evaluated using the discriminant validity (i.e., are the survey question results for latent variables statistically different from each other?) and the convergent validity (i.e., do all survey questions strongly correlate with their associated theoretical constructs?). Then the Confirmatory Factor Analysis (Brown, 2006; Byrne, 2000; Nunnally 1978) was conducted to analyze the significance of each hypothesis shown in Figure 4 using SmartPLS software (Ringle, Wende, & Will, 2005). The Smart-
PLS provides the convenient graphical user interface and analysis capability to perform the Structured Equation Modeling based path analysis. As seen in the TAMe research model in Figure 4, the $R^2$ values for intention and attitude are high indicating their variabilities are well explained by other relevant latent variables displayed in the model. However, PA and PE explain less than 20% and 9% of the variability of perceived usefulness (PU) and perceived ease of use (PEOU), respectively, indicating that other factors may influence PU and PEOU in this domain. Discriminant Validity

To evaluate whether the survey question results for latent variables are statistically different from each other, the correlation matrix between latent variables is constructed, along with the Average Variance Extracted (AVE) for each latent variable, as seen in Table 2. The AVE measures the percentage of variance explained for each latent variable (Henseler, Ringle, & Sinkovics, 2009; Reinartz, Haenlein, & Henseler, 2009). For each latent variable construct, the square root of the AVE should be greater than the correlation between constructs (Fornell & Larcker, 1981). They also recommended each AVE should be higher than 0.5.

Perceived ease of use has the modest inter-correlations – All have less than 0.4. This indicates that there is no significant multi-collinearity problem (Shin, 2007). High correlations among latent variable constructs are shown in bold. High correlations are determined through the comparison with the AVE. If any of inter-correlation values with other latent variables are greater than the AVE, then the latent variable may be considered to have high correlations. Then this prospective high correlation is again compared to the square root of the AVE. The square root of the AVE should be larger than any associated correlation (Gefen & Straub, 2005) to be considered safer in terms of correlation. As shown in Table 2, the square roots of the AVE are larger than any associated correlations, and that satisfies a necessary aspect of discriminate validity of the latent variable constructs. Only one correlation shown in bold – intention and attitude correlation – is higher than AVE. However it is smaller than the square root of AVE. The high intention-attitude correlation may occur since we use both intention and attitude in this model. Based on the correlation matrix analysis and its assessment, we believe the discriminant validity is demonstrated.

Convergent Validity

Convergent validity analysis evaluates whether all measurements (survey questions) strongly correlate with their associated theoretical constructs (latent variables). We use factor loading for each question and Cronbach’s alpha for each latent variable. The factor loading measures the correlation between variables and factors. The typically acceptable value for each factor

Table 2. Latent variable correlation matrix

<table>
<thead>
<tr>
<th></th>
<th>Attitude</th>
<th>Intention</th>
<th>PA</th>
<th>PE</th>
<th>PEOU</th>
<th>PU</th>
<th>SP</th>
<th>Sq Root AVE</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intention</td>
<td>0.79</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PA</td>
<td>0.71</td>
<td>0.70</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PE</td>
<td>0.66</td>
<td>0.67</td>
<td>0.75</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PEOU</td>
<td>0.36</td>
<td>0.34</td>
<td>0.39</td>
<td>0.29</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PU</td>
<td>0.62</td>
<td>0.62</td>
<td>0.44</td>
<td>0.27</td>
<td>0.32</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP</td>
<td>0.69</td>
<td>0.59</td>
<td>0.62</td>
<td>0.53</td>
<td>0.35</td>
<td>0.62</td>
<td>1.00</td>
<td>0.89</td>
<td>0.79</td>
</tr>
</tbody>
</table>

Bold font, high correlation among latent variables. AVE: Average Variance Extracted; Sq Root AVE: Square Root of Average Variance Extracted
loading is above 0.7 and the acceptable value of the Cronbach’s alpha is above 0.8 (Cronbach, 1970; Peterson, 1978). Table 3 summarizes all items (survey questions under the Items column) with associated latent variables and lists both factor loading and Cronbach’s alpha values for this study. As seen Table 3, all factor loadings and Cronbach’s alpha values are above 0.7 and 0.8, respectively. Based on these two analyses, we demonstrated the convergent validity for this study.

**Hypothesis Tests**

A confidence level of 95% was used to test each hypothesis for significance. A \( p \)-value

<table>
<thead>
<tr>
<th>Items</th>
<th>Factor loadings</th>
<th>Cronbach’s α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived usefulness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PU1</td>
<td>0.880**</td>
<td>0.9223</td>
</tr>
<tr>
<td>PU2</td>
<td>0.920**</td>
<td></td>
</tr>
<tr>
<td>PU3</td>
<td>0.917**</td>
<td></td>
</tr>
<tr>
<td>PU4</td>
<td>0.885**</td>
<td></td>
</tr>
<tr>
<td>Perceived enjoyment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PE1</td>
<td>0.930**</td>
<td>0.9217</td>
</tr>
<tr>
<td>PE2</td>
<td>0.894**</td>
<td></td>
</tr>
<tr>
<td>PE3</td>
<td>0.925**</td>
<td></td>
</tr>
<tr>
<td>PE4</td>
<td>0.849**</td>
<td></td>
</tr>
<tr>
<td>Perceived availability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PA1</td>
<td>0.896**</td>
<td>0.8989</td>
</tr>
<tr>
<td>PA2</td>
<td>0.893**</td>
<td></td>
</tr>
<tr>
<td>PA3</td>
<td>0.857**</td>
<td></td>
</tr>
<tr>
<td>PA4</td>
<td>0.857**</td>
<td></td>
</tr>
<tr>
<td>Social Pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP1</td>
<td>0.906**</td>
<td>0.9111</td>
</tr>
<tr>
<td>SP2</td>
<td>0.881**</td>
<td></td>
</tr>
<tr>
<td>SP3</td>
<td>0.902**</td>
<td></td>
</tr>
<tr>
<td>SP4</td>
<td>0.864**</td>
<td></td>
</tr>
<tr>
<td>Perceived ease of use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PEOU1</td>
<td>0.905**</td>
<td>0.8573</td>
</tr>
<tr>
<td>PEOU2</td>
<td>0.901**</td>
<td></td>
</tr>
<tr>
<td>PEOU3</td>
<td>0.764**</td>
<td></td>
</tr>
<tr>
<td>PEOU4</td>
<td>0.768**</td>
<td></td>
</tr>
<tr>
<td>Attitude</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>0.705**</td>
<td>0.8772</td>
</tr>
<tr>
<td>A2</td>
<td>0.935**</td>
<td></td>
</tr>
<tr>
<td>A3</td>
<td>0.920**</td>
<td></td>
</tr>
<tr>
<td>A4</td>
<td>0.850**</td>
<td></td>
</tr>
<tr>
<td>Intention</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I1</td>
<td>0.904**</td>
<td>0.9075</td>
</tr>
<tr>
<td>I2</td>
<td>0.912**</td>
<td></td>
</tr>
<tr>
<td>I3</td>
<td>0.839**</td>
<td></td>
</tr>
<tr>
<td>I4</td>
<td>0.883**</td>
<td></td>
</tr>
</tbody>
</table>

** \( p \)-value <0.001.
less than 5% alpha (α) provides support for a hypothesis (Schervish, 1996). The results are displayed in Figure 4 and are also summarized in Table 4 below, which includes the results of the hypothesis tests, path coefficient (β), t-values and associated p-values. First, all path coefficients are positive. A two-tail test was used to convert t-values into p-values. Seven – H1, H2, H3, H6, H7, H8, and H9 - out of ten hypotheses evaluated were considered significant (p-value less than 0.05). Among these seven, four hypotheses – H1, H3, H7, and H8 – were strongly supported (p-value less than 0.001). However, the three hypotheses – H4, H5 and H10 – were not supported. We also notice that three significant latent variables – perceived usefulness, perceived availability and perceived enjoyment – explain majority of variability of the attitude latent variable (R² = 0.665 in Figure 4), indicating that these three variables significantly affect public intention to adopt the ‘eMerge’. The same analysis is true for perceived usefulness and attitude variables, explaining around majority of variability of public intention (R² = 0.656 in Figure 4), indicating both perceive usefulness and attitude significantly affect public intention toward ‘eMerge’.

**Potential Customers Willingness to Pay (Dollar Amount)**

Dollar Amount was considered to approximate an observable act (Fishbein & Ajzen, 1975) – to evaluate whether public is willing to participate in HSE. Each survey participant was asked to state their willingness to purchase (WTP) the services provided by the ‘eMerge’ tool by answering the following two questions:

- *(DA1)* If the price of using ‘eMerge’ is $1.00 per minute, what approximate dollar amount do you think you will pay per session to use ‘eMerge’?
- *(DA2)* How much will you be willing to spend a month on ‘eMerge’ purchases?

The individual session time is the time spent from login to logoff. The result showed that 77% (54 of 70) of survey respondents show their willingness for HSE participation – This is called HSE participants. The average session

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Path coefficient (β)</th>
<th>t-value</th>
<th>p-value</th>
<th>Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1: Attitude -----&gt; Intention</td>
<td>0.64</td>
<td>8.736</td>
<td>0.0000**</td>
<td>Yes</td>
</tr>
<tr>
<td>H2: PU -----&gt; Intention</td>
<td>0.21</td>
<td>2.226</td>
<td>0.0293*</td>
<td>Yes</td>
</tr>
<tr>
<td>H3: PU -----&gt; Attitude</td>
<td>0.40</td>
<td>5.172</td>
<td>0.0000**</td>
<td>Yes</td>
</tr>
<tr>
<td>H4: PEOU -----&gt; Intention</td>
<td>0.04</td>
<td>0.611</td>
<td>0.5434</td>
<td>No</td>
</tr>
<tr>
<td>H5: PEOU -----&gt; Attitude</td>
<td>0.08</td>
<td>0.377</td>
<td>0.7073</td>
<td>No</td>
</tr>
<tr>
<td>H6: PE -----&gt; PEOU</td>
<td>0.29</td>
<td>3.221</td>
<td>0.0020*</td>
<td>Yes</td>
</tr>
<tr>
<td>H7: PE -----&gt; Attitude</td>
<td>0.35</td>
<td>5.202</td>
<td>0.0000**</td>
<td>Yes</td>
</tr>
<tr>
<td>H8: PA -----&gt; PU</td>
<td>0.44</td>
<td>5.381</td>
<td>0.0000**</td>
<td>Yes</td>
</tr>
<tr>
<td>H9: PA -----&gt; Attitude</td>
<td>0.25</td>
<td>2.683</td>
<td>0.0091*</td>
<td>Yes</td>
</tr>
<tr>
<td>H10: SP -----&gt; Intention</td>
<td>0.01</td>
<td>0.123</td>
<td>0.9023</td>
<td>No</td>
</tr>
</tbody>
</table>

* p<0.05. ** p<0.001. PU, perceived usefulness; PEOU, perceived ease of use; PE, perceived enjoyment; PA, perceived availability; SP, social pressure
time is 5 minutes 45 seconds and the average dollar amount per session showing their WTP is $5.75 per HES participant. The monthly statistics were calculated in Figure 5. The average monthly spending per HSE participant is $25 with $38 standard deviation.

Relating willingness to purchase (WTP) with a service was supported by Tse (2001). Each HSE participant specified a dollar amount indicating a WTP for the ‘eMerge’ service. These dollar amounts are optimistic based on the number of surveys administered. The dollar amount data suggests three possible market segments. The first market segment is individuals not currently interested in POHSC using ‘eMerge’ but may be interested in the future ‘eMerge’ or with an alternative to ‘eMerge.’ – This market segment was not displayed in Figure 5. The second market segment is the HSE participants interested in spending a limited amount each month in the range of $1 to $100. The third market segment is the HSE participants interested in spending significant amounts each month over $100.

**DISCUSSION AND CONCLUSION**

The purposes of the study were to identify factors influencing public acceptance and adoption of POHSC and to evaluate the public willingness to pay for services provided by POHSC. To answer these two questions, we proposed a TAMe associated with the ‘eMerge’ as a conceptual tool, and conducted a survey to validate the TAMe. The statistical results showed that overall, the public are positive toward POHSC exemplified by ‘eMerge’. Seven hypotheses were statistically supported whereas three were not supported – the paths from perceived ease of use to attitude (H5) and intention (H4), respectively, and the path from social pressure to intention (H10). The perceived ease of use (PEOU) relevant hypotheses – H4 and H5 – were not supported as in the research by Davis (1985). Davis (1985) also found the influence of ease of use on attitude was found non-significant (H5). Later studies (Lee et al., 2003) found that PEOU influenced intention in 58 out of 84 studies, or 71 percent. PEOU relevant hypotheses are often found not to be as significant as
the perceived usefulness (PU) hypotheses, 74 out of 84 studies, or 88 percent (Lee, Kozar, & Larsen, 2003). It is also interesting to note that the non-significance of H4 contradicts what Davis et al. (1989) reported – He reported that PEOU would significantly influence intention only in the early stage of technology adoption, and once the user becomes familiar with the technology, PEOU would not be an important indicator of usage intention. This contraction may suggest that the public want to see clearer motivations of ease of use to adopt the proposed ‘eMerge’ technology than those of traditional technologies before ‘eMerge’ technology, or users may not have enough opportunity to perceive whether ‘eMerge’ is easy to use or not since no physical prototype was used in this study. Further research may be needed to evaluate PEOU as ‘eMerge’ develops. The social pressure hypothesis (H10) was not supported either. Social pressure was not found to have a strong effect on intention to use ‘eMerge’ possibly because an actual ‘eMerge’ tool does not exist except a conceptualized prototype screen layouts. In a real world, for social pressure to occur, people affecting a user need to apply pressure to use or not use that technology. Once the actual technology is available, the social pressure may need to be evaluated again.

In this study, among seven supported hypotheses, four hypotheses were strongly supported – H1, H3, H7, and H8. Based on strong support of H1, the public show a very positive attitude toward intention. It indicates that the public may have very high expectations and enthusiasm for future ‘eMerge’ technology and this positive attitude is likely to be connected to actual purchasing of the services provided by ‘eMerge’. As strongly supported by H3 and H7, the public consider the perceived usefulness as an important factor which leads them to a positive perception on ‘eMerge’ (H3). In addition, the public request a high level of enjoyable contents and features for POHSC (H7). The perceived available can be interpreted as public perceptions of connectedness with ‘eMerge’ to services with consideration of its mobility. Hence the strong support of H8 indicates that the strong connectedness may be an important factor on public daily life and experience.

While four hypotheses were strongly supported, three hypotheses were moderately – H2, H6 and H9 – supported. It is inferred from H2 that the public may consider purchasing the services provided by ‘eMerge’ if services are useful for their life and experiences in general. Perceived usefulness positively affects people’s intention to adopt the ‘eMerge’, but it more strongly affects public attitude first toward the ‘eMerge’ as indicated by H3. This may be related to people’s perception process. From H6, the public may feel that the technology is easy to use if they can enjoy it. It can also be inferred from H9 that the perceived availability (e.g. perceived connectedness) can positively affect public attitude toward the technology, but it affects public attitude more indirectly through perceived usefulness as supported by H3.

One of the objectives of this study was to evaluate the public willingness to pay for services provide by POHSC in terms of monetary value. The survey suggests that some 54 (77%) people are willing to pay to engage in POHSC, and the average monthly dollar amount per expected service participant was $25. Although it is too early stage to forecast future demand of services provided by POHSC, we believe that this number of expected service participants and this dollar amount also indicate that the public have very positive attitude and intention to adopt the ‘eMerge’ technology.

In conclusion, a fully commercialized HSC is not established yet. However, the advent of POHSC is a matter of time. Hence, based on the previous studies on POHSC (Dittmar, 2004; Dittmar 2008) and Morin et al. (2010), we conceptualized the ‘eMerge’ technology, and investigated the public perception on POHSC technologies exemplified by ‘eMerge’. We believe that results suggest that TAMe seems well suited for predicting public perception.
on future technologies, and the public have positive perception on POHSC exemplified by ‘eMerge’. Hence, TAMe may be a good tool to understand market potential in terms of future POHSC. Dollar amount results are also promising. Therefore, the researchers and industry practitioners can use the knowledge identified in this study to design and develop their models to predict public behaviors and relevant POHSC technologies for future.

LIMITATION AND FUTURE RESEARCH

Just as other studies using statistical methods, this study may reflect only limited aspect of public perception and experience on ‘eMerge’. The sample may be a major drawback of this study since the sample only drew from a university environment. This indicates that the participants’ perceptions captured here may be different from those captured in other environments and cultures, also the number of sample size may also create a biased view on ‘eMerge’. Another major drawback of this study is that we used a conceptualized ‘eMerge’ tool with several screen layouts explaining its features since an actual prototype does not exist at this moment. Since a prototype contributes to both what is communicated and how the system is communicated to potential users, a similar study with a more advanced actual prototype may need to be developed for future studies. This study also evaluated the public willingness to pay for services provided by ‘eMerge’ in terms of the dollar amount, and recorded the dollar amount provided by survey participants without a completely developed payment collection system in the prototype. Dollar amount written on a survey may not be a strong indicator of behavior but does provide early information about potential WTP.

While the study confirms that perceived availability and perceived enjoyment are important factors influencing attitude and intention, and these additional factors could be the subject for future study.

REFERENCES


Xie, W., Sun, H., Cao, Y., & Trivedi, K. (2002). Modeling of online service availability perceived by Web users (Tech. Rep.). Center for Advanced Computing and Communication, Duke University Durham, North Carolina, USA.
APPENDIX A

Perceived Ease of Use

PEOU1: Based on the four levels of service being developed for ‘eMerge’, I think I will find ‘eMerge’ easy to use.
PEOU2: I will find it easy to get ‘eMerge’ to do what I want it to do.
PEOU3: My interaction with ‘eMerge’ will be clear and understandable.
PEOU4: It will be easy for me to become skillful at using ‘eMerge’.

Intention to Use/Adopt

I1: I think I will use ‘eMerge’.
I2: I intend to use ‘eMerge’.
I3: I think I will recommend to others to learn about ‘eMerge’.
I4: I intend to continue learning about ‘eMerge’.

Perceived Usefulness

PU1: I will find ‘eMerge’ useful to my life in general.
PU2: I will find ‘eMerge’ useful in achieving my life’s goals.
PU3: I will find ‘eMerge’ helpful in enhancing my quality of life.
PU4: I will find ‘eMerge’ helpful in being true to myself.

Perceived Enjoyment

PE1: I will find the idea of using ‘eMerge’ to be enjoyable.
PE2: I will find using ‘eMerge’ to be entertaining.
PE3: I will find using ‘eMerge’ to be pleasant.
PE4: I will find using ‘eMerge’ to be fun.

Perceived Availability

PA1: I will feel good because I can access human space exploration services any time via ‘eMerge’.
PA2: With ‘eMerge’, I will feel like being connected to external reality because I could experience human space exploration information that I want.
PA3: I will be gratified with the ‘eMerge’ capability that offers near real-time content.
PA4: I will feel emotionally comforted with using ‘eMerge’ because I can do something interesting with ‘eMerge’ at my convenience.

Social Influence (Social Pressure)

SP1: People important to me will think I should use ‘eMerge’.
SP2: It is expected that people like me will use ‘eMerge’.
SP3: People I look up to will expect me to use the ‘eMerge’ (follow trends).
SP4: It is expected that people like me will find ‘eMerge’ relevant in their day to day life.

Attitude

A1: I think that using ‘eMerge’ will be a good idea.
A2: I think that using ‘eMerge’ will be beneficial to me.
A3: I have positive perceptions about using ‘eMerge’.
A4: I think using ‘eMerge’ will be relevant in my daily life.

Dollar Amount (Preference)

DA1: If the price of using ‘eMerge’ is $1.00 per minute, what approximate dollar amount do you think you will pay per session to use ‘eMerge’? $__________
DA2: How much will you be willing to spend a month on ‘eMerge’ purchases? $__________