

# An Analysis of Digital Media Holograms Usage Intentions: An Extension of the Technology Acceptance Model

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## Abstract

This study confirms the impact of information quality and system quality on consumers' technology experience, it specifically shows that the perceived quality of content and system were found to have a significant effect on users' perceived usefulness and perceived enjoyment. In addition, social influences had a positive effect on the intention to use digital media holograms. Using the 200 data points from the initial sample, the three constructs and their indicators were subjected to confirmation through a measurement model in AMOS 4.0. The results showed that the effect of enjoyment on PU yielded a value of  $-0.39$  ( $p < .01$ ), indicating a negative relationship that was in contrast to initial predictions. In addition, the effect of enjoyment on PEOU yielded a value of  $.29$  ( $p < .01$ ), but the effect of engagement on PEOU yielded a value of  $-0.29$  ( $p < .01$ ), also shown to support the TAM, given that the effect of PU on PEOU was  $.29$  ( $p < .01$ ). Finally the effect of attitudes toward using digital media holograms on behavioral intentions to use media yielded a value of  $.34$  ( $p < .01$ ). These findings suggest an extension of the TAM model for convergence technologies. This research advances theory and contributes to the foundation for future research aimed at improving the understanding of users' adoption behavior of convergence technologies. The research and practice implications are also discussed.

**Keywords:** Behavioral Intention, Hologram, TAM

## 1. Introduction

Digital holography has been used for three dimensional (3D) measurement and inspection. Recently, the concept of two-dimensional (2D) pattern recognition has been extended to 3D objects, with digital holograms, created through phase-shift interferometry (PSI), providing the means for one such set of 3D object recognition techniques<sup>1,2</sup>.

Digital holography development has reached the level, which allows mass-manufacture of i-lumograms-large size digital holograms, as well as manufacture of colour reflection holograms for security applications and advertising<sup>3</sup>. Geola Digital also has proved that colour

reflection holograms can be used as auto-stereoscopic projection displays for 3D gaming and home cinema applications. All that became possible by developing a full range of necessary holographic machinery that includes digital laserless life scenes imaging equipment, digital holographic printers and copying machines where our new copying method is implemented. Described printing and copying machinery works with pulsed colour lasers. All Geola machinery exists as working laboratory equipment and is used by us for continuous digital holograms printing<sup>4,5</sup>. Image creation, hologram printing and copying processes can, and usually are, completely separated geographically. Colour reflection holograms usage as auto-stereoscopic projection displays for 3D gaming and

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home cinema applications is described, as well as digital holograms manufacture using mobile phone as a holographic imaging device<sup>6</sup>.

Technology convergence has become a fiery phenomenon. More and more technologies can cohabit in the same platform and the information becomes more portable from one platform to another<sup>7-9</sup>. The phenomenon presses on examining the question of what technology entails in technology acceptance research.

This study explores the factors influencing the adoption of digital media holograms, and tests the applicability of the technology acceptance model (TAM) in a new convergent technology<sup>10,11</sup>. The behavioral constructs from TAM were tested for predicting user acceptance of digital media hologram. Structural equation modelling was used to analyse data and to design a theoretical model predicting the individual's intention to adopt digital media holograms<sup>12</sup>. An extension of the TAM for digital media holograms proposes that new constructs determine user-perceived usefulness and enjoyment of using digital media holograms.

Although this study confirms the impact of information quality and system quality on consumers' technology experience, it specifically shows that the perceived quality of content and system were found to have a significant effect on users' perceived usefulness and perceived enjoyment<sup>13</sup>. In addition, social influences had a positive effect on the intention to use digital media holograms. These findings suggest an extension of the TAM model for convergence technologies<sup>14-16</sup>. This research advances theory and contributes to the foundation for future research aimed at improving the understanding of users' adoption behaviour of convergence technologies. The research and practice implications are also discussed.

## 2. Research Model and Research Hypotheses

### 2.1 Consumer Information Search on Digital Media Hologram

The word, hologram is composed of the Greek terms, "holos" for "whole view"; and gram meaning "written". A hologram is a three-dimensional record of the positive interference of laser light waves<sup>4</sup>. 3D holographic projection is a rapidly growing technology. With every business desperately trying to get their product to stand out from the competitors, 3D hologram advertising and promotion is fast becoming an eye catching success<sup>3</sup>.

The technique was not fully utilised until the 1960s, when laser technology was perfected. 3D Holographic Technology (3DHT) created in 1962 by scientists in both the United States and the Soviet Union. However, 3DHT has advanced notably since the 1980s owing to low-cost solid-state lasers that became easily accessible for consumers in devices such as DVD players. The way 3DHT operates is by creating the illusion of three-dimensional imagery<sup>4</sup>. With almost limitless holographic possibilities, from life like humans to blockbuster style special effects, as well as the continual advances in technology, 3D holographic projection has a bright future ahead<sup>17</sup>.

Until recently, digital pictures for digital holographic printing were obtained by rendering digitally created scenes using 3D modeling programs rendering engines.

A hologram is a 3 dimensional recreation of an image created using light imagery floating in space giving perspective and depth. Unlike a stereoscopic 3D image, which gives perception of depth of a photograph or video, holographic projection is a manifestation of the physical object which can be placed in a theatrical stage space or installation space. Although this is an indication of lack of early adoption of holographic, the technology maturity played a large part in recent adoption and popularity<sup>4</sup>.

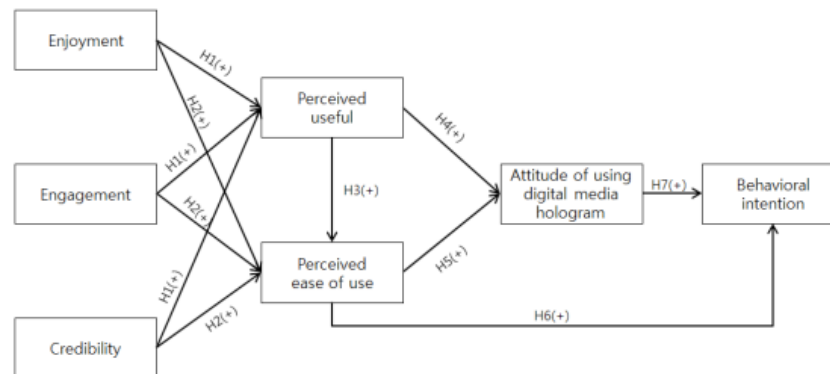
### 2.2 An Extension of the Technology Acceptance Model

The TAM, originally presented by Davis<sup>18</sup>, adapted from the theory of reasoned action<sup>19</sup> argues that acceptance of a new system is predicted by understanding the users' perceptions of the ease of use and usefulness of the new system<sup>10</sup>. TAM theorizes that user perceptions of usefulness and ease of use of a target system determine the user's behavioral intention to use the system. Behavioral intention is a predictor of system use<sup>18</sup>.

TAM posits that individuals' positive or negative feeling behavioral intention to use an information technology is determined by two beliefs<sup>8</sup>: Perceived usefulness is expected to be influenced by perceived ease of use because, other things being equal, the easier it is to use a system, the more useful it can be. Also, the direct effect of perceived ease of use on behavioral intention is significant only in the early stages of use<sup>8</sup>. Over the long term, as user experience increases, this effect becomes indirect and operates through perceived usefulness<sup>16,19</sup>.

Venkatesh described this as an extended TAM or TAM2<sup>12,20</sup>. The TAM's predictive value led to refinements<sup>9</sup>

## 2.3 Research Model



**Figure 1.** Research model and hypothesis.

in business contexts that reengineered the original as a broadly comprehensive model by adding numerous explanatory antecedents, mostly related to business use. A recent augmentation has also introduced a unified model relevant to business processes to explain user perceptions and attitudes by drawing from diffusion theory, motivation theory, and self-efficacy in order to explain usage intentions in technologies such as software for database management and financial analysis<sup>21</sup>.

In fact, ETAM introduced a new theoretical construct as another critical predictor of technology use<sup>22,23</sup>. Both Johns (2006) and Alvesson and Kärreman<sup>24</sup> note that new contexts can result in several types of important changes in theories, such as rendering originally theorised relationships to be nonsignificant, changing the direction of relationships, altering the magnitude of relationships and creating new relationships. Each change can reveal the breakdown of theories that result in the creation of new knowledge<sup>16,24</sup>.

## 2.4 Research Hypothesis

With the theoretical background of Ajzen and Fishbein's theory of reasoned action (1980), the technology acceptance model (TAM) is a model developed by Davis<sup>18</sup> to describe and predict the process by which users come to accept information technology. It may be considered the most influential and traditional theory used to explain information system consumption among users. Until the early 1990s, many studies simply examined the TAM, but studies since the mid-1990s have altered Davis' model<sup>18</sup>

in 1986 or attempted to expand on the TAM by adding diverse variables. Accordingly, this study aimed to use the TAM to explain the process by which users accept hologram-format media; we limited influential external variables to enjoyment, engagement, and credibility and adopted core factors in the TAM, such as perceived usefulness (PU), perceived ease-of-use (PEOU), attitudes toward using digital media holograms, and behavioral intentions to use media as essential components in the technology acceptance process. The relationships between these variables were examined.

- H1: External variables (enjoyment, engagement, credibility) have a direct positive impact on perceived usefulness of digital media holograms.
- H2: External variables (enjoyment, engagement, credibility) have a direct positive impact on perceived ease of use to adopt digital media holograms.
- H3: Perceived ease of use has a direct positive impact on perceived usefulness of using digital media holograms.
- H4: Perceived ease of use has a direct positive impact on attitude of using digital media holograms.
- H5: Perceived usefulness has a direct positive effect on attitude to adopt digital media holograms.
- H6: Perceived usefulness has a direct positive effect on behavioral intention to adopt digital media holograms.
- H7: Attitude has a positive impact on behavioral intention to adopt digital media holograms.

## 2.5 Confirmatory Analysis: AMOS Measurement Model

The goal of using confirmatory factor analysis is to improve convergent validity. The items with loading lower than 0.5 from the exploratory factor analysis were dropped for confirmatory factor analysis. Using the 200 data points from the initial sample, the three constructs and their indicators were subjected to confirmation through a measurement model in AMOS 4.0. This model provided evidence of trait validity in its component forms of discriminant validity and convergent validity. To test the hypotheses proposed above, multiple regression analyses are conducted on the demographics variables.

- The prefix “non” is not a word; it should be joined to the word it modifies, usually without a hyphen.
- There is no period after the “et” in the Latin abbreviation “et al.”.

## 3. Results

### 3.1 Verification of the Validity of the Variables

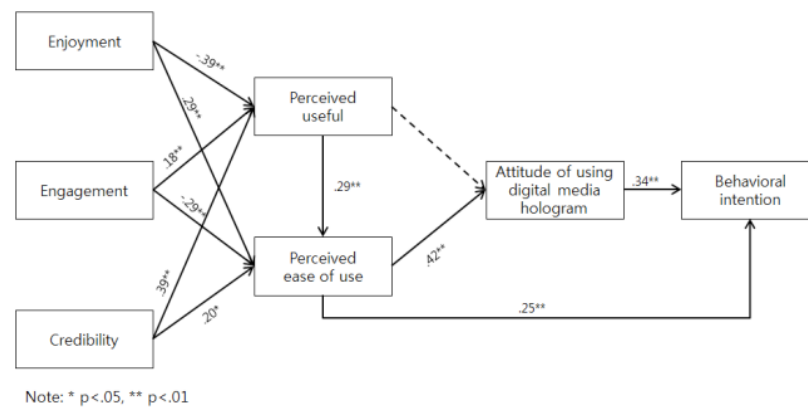
This study employed a structural equation model to investigate the structural relationship between attitudes toward using digital media holograms and behavioral intentions to use media, as well as the enjoyment, engagement, and credibility variables of digital media holograms, as moderated by the PU and PEOU factors of the TAM. Before testing the study hypothesis by investigating the causal relationships between the variables included within the model, the validity of the test items and latent variables was verified through exploratory factor analysis and confirmatory factor analysis, and their credibility was verified.

First, for exploratory factor analysis, VARIMAX factor rotation was used because it is an orthogonal rotation

**Table 1.** Confirmatory factor analysis

| Constructs                               | Measurement   | Estimate | S.E. | C.R.     | AVE  | Credibility |
|------------------------------------------|---------------|----------|------|----------|------|-------------|
| Enjoyment                                | Enjoyment 1   | .826     | .154 | 6.185**  | .755 | .81         |
|                                          | Enjoyment 2   | .821     |      |          |      |             |
| Engagement                               | Engagement 1  | .665     | .142 | 8.582**  | .599 | .80         |
|                                          | Engagement 2  | .625     | .101 | 8.408**  |      |             |
|                                          | Engagement 3  | .669     |      |          |      |             |
| Credibility                              | Credibility 1 | .756     | .105 | 9.062**  | .731 | .81         |
|                                          | Credibility 2 | .715     | .099 | 8.748**  |      |             |
|                                          | Credibility 3 | .831     |      |          |      |             |
| Perceived useful                         | useful 1      | .825     |      | 11.170** | .728 | .80         |
|                                          | useful 2      | .898     | .092 |          |      |             |
|                                          | useful 3      | .588     | .108 | 7.849**  |      |             |
| Perceived ease of use                    | use 1         | .614     | .079 | 7.833**  | .770 | .79         |
|                                          | use 2         | .732     | .085 | 9.218**  |      |             |
|                                          | use 3         | .888     |      |          |      |             |
| Attitude of using digital media hologram | Attitude 1    | .783     |      | 9.401**  | .715 | .87         |
|                                          | Attitude 2    | .707     | .111 |          |      |             |
|                                          | Attitude 3    | .836     | .114 | 11.274** |      |             |
|                                          | Attitude 4    | .822     | .112 | 11.105** |      |             |
| Behavioral intention                     | intention 1   | .807     | .080 | 10.672** | .701 | .85         |
|                                          | intention 2   | .772     | .080 | 10.321** |      |             |
|                                          | intention 3   | .834     |      |          |      |             |

Note \*\* $p < .01$



**Figure 2.** Measurement per path.

**Table 2.** Measurements per path

|    |                                                                  | Standardized Estimate | t-value |
|----|------------------------------------------------------------------|-----------------------|---------|
| H1 | enjoyment → Perceived useful                                     | -.39**                | -4.40   |
|    | engagement → Perceived useful                                    | .18**                 | 2.63    |
|    | credibility → Perceived useful                                   | .39**                 | 4.56    |
| H2 | enjoyment → Perceived ease of use                                | .29**                 | 2.88    |
|    | engagement → Perceived ease of use                               | -.29**                | -3.84   |
|    | credibility → Perceived ease of use                              | .20*                  | 2.12    |
| H3 | Perceived useful → Perceived ease of use                         | .29**                 | 2.67    |
| H4 | Perceived useful → Attitude of using digital media hologram      | .02                   | .23     |
| H5 | Perceived ease of use → Attitude of using digital media hologram | .42**                 | 4.56    |
| H6 | Perceived ease of use → Behavioral intention                     | .25**                 | 2.69    |
| H7 | Attitude of using digital media hologram → Behavioral intention  | .34**                 | 3.64    |

Note: \*  $p < .05$ , \*\*  $p < .01$

that is useful in determining the characteristics of each factor, assuming that factors are independent. The minimum eigenvalue, which served as the accepted standard for factor selection, was set to 1. Following the results of the factor analysis, the 22 measured variables were sorted into 7 different factors. No variable had a factor loading of less than .5, the standard value; all components had factor loadings greater than .6, and the total variance ratio was 68.7%, indicating that the mode had a relatively high explanatory power. The measurement variables were also tested for validity. Enjoyment, engagement, credibility, PU, PEOU, attitudes toward using digital media holograms, and behavioral intentions had Cronbach's  $\alpha$  values of .81, .80, .81, .80, .79, .87, and .85, respectively; thus, all variables had a Cronbach  $\alpha$  value of approximately .8.

Subsequently, in order to verify the convergent and discriminant validity, confirmatory factor analysis was conducted on validated variables by using exploratory factor analysis. The confirmatory factor analysis results indicated that the t-values of the factor loadings regarding the independent, mediator, and dependent variables were statistically significant ( $p < .01$ ), and that the average variance extracted (AVE) exceeded the .5 criterion. The goodness-of-fit also met the criterion. The absolute fit index was used to assess the fit of the model; the measured model's fit was shown to be  $X^2 = 663.1$  ( $df = 178$ ,  $p = .000$ ),  $CFI = .859$ ,  $NFI = .801$ ,  $AGFI = .843$ ,  $RMSEA = .025$ . It was thus concluded that the model had high overall validity, given that the fit statistics were sufficiently high; thus, the model fit is close to the indexed values.



### 3.2 Theory Verification Result

The current study employed a structural equation model to investigate the structural relationship between attitudes toward using digital media holograms and behavioral intentions to use media, as well as the enjoyment, engagement, and credibility variables of digital media holograms, as moderated by the PU and PEOU factors of the TAM.

The results showed that the effect of enjoyment on PU yielded a value of  $-.39$  ( $p < .01$ ), indicating a negative relationship that was in contrast to initial predictions. However, the effect of engagement on PU yielded a value of  $.18$  ( $p < .01$ ) and the effect of credibility on PU yielded a value of  $.39$  ( $p < .01$ ), thereby partially supporting Hypothesis 1.

In addition, the effect of enjoyment on PEOU yielded a value of  $.29$  ( $p < .01$ ), but the effect of engagement on PEOU yielded a value of  $-.29$  ( $p < .01$ ), thus indicating a negative relationship. The effect of credibility on PEOU yielded a value of  $.20$  ( $p < .05$ ), thus, Hypothesis 2 was also partially supported.

Hypothesis 3 was also shown to support the TAM, given that the effect of PU on PEOU was  $.29$  ( $p < .01$ ). However, PU was not statistically significant in its effect on attitudes toward using digital media holograms, as predicted by Hypothesis 4.

Hypothesis 5 was also supported, as the effect of PEOU on attitudes toward using digital media holograms yielded a value of  $.42$  ( $p < .01$ ). Finally, Hypothesis 7 was supported, given that the effect of attitudes toward using digital media holograms on behavioral intentions to use media yielded a value of  $.34$  ( $p < .01$ ).

## 4. Discussion and Conclusion

This study sought to investigate the structural relationship between attitudes toward using digital media holograms and behavioral intentions to use media, as well as the enjoyment, engagement, and credibility components of digital media holograms, as mediated by the PU and PEOU factors of the TAM. The results showed that, with the exception of enjoyment, engagement and credibility positively affected PU. Due to the negative effect of enjoyment on PU, the hypotheses were only partially supported. It appeared that the more participants enjoyed hologram media, the less useful they perceived it to be. The low PU felt by the participants may have been due to their supposing that the hologram media served the purposes

of providing entertainment, enjoyment, and play, and was not intended to enhance consumers' lifestyles. However, the credibility of the digital hologram medium was perceived to be high, perhaps because the holograms were visually realistic. Therefore, it appears that that realism, a vital characteristic of hologram media, lends hologram media credibility and thus immensely influences users' PU. Notably, engagement influences PU less than credibility does. This may be because the hologram, as a medium, characteristically and prominently provides realistic visual stimuli and therefore limits practical user interaction.

As for Hypothesis 2, engagement positively influenced all factors with the exception of PEOU. As mentioned previously, this may have been because the mostly visual functions of the hologram media do not necessarily allow the consumer to engage with the stimuli shown. Thus, a different result may arise if technological advances come to integrate the characteristics of hologram media with user engagement.

Hypothesis 3 measured the effect size of PU on PEOU, and thus may be said to have validated the traditional TAM. The current study showed that the PU of hologram media affects PEOU, in accordance with the TAM. However, Hypothesis 4 was not supported: the PU of hologram media did not exert a statistically significant effect on attitudes toward using digital media holograms. This result corroborates the results of other studies, which have shown that users are not familiar enough with newer media and their PU does not affect their attitudes toward media.

Hypotheses 5, 6, and 7 were all supported, and it was shown that the TAM theory could be used to explain the results of the current study. In particular, the reason that PEOU and attitudes toward using digital media holograms were positively correlated may have been because the realism of hologram media assuages users' attitudes toward using digital media holograms. Thus, it may be said that visual realism is an important factor and distinct trait of digital hologram media. Furthermore, attitudes toward using digital media holograms and PEOU were shown to influence consumer motivation. In the current study, users' attitudes toward using digital media holograms were shown to influence consumer motivation more than did PEOU. Given that attitudes toward using digital media holograms may be indicative of consumer motivations, hologram media may greatly influence consumer decisions.

The results of this study suggest the following. Generally, the results regarding hologram media were positive. However, on a more specific note, entertainment,

engagement, and credibility values of consumer products should be considered first when examining, for example, the credibility of the hologram medium (which may lead to perceived realism and acceptance), perceived ease-of-use, and motivations of customers to continually and actively utilise hologram media. This result may serve as a reminder for service providers to consistently consider how their services may be perceived from the perspective of users. Furthermore, in regard to user accessibility, technology should be optimised to ensure that the information that hologram media provides can be more easily utilised. In addition, focus should be put to developing content and services for consumers that can foster consumer accessibility: the number of consumers of digital hologram media will only grow, and such consumers will become more familiar with holograms and information technology over time.

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