An empirical investigation of 3D-based information systems success for online retailers

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Abstract: Using the theory of information systems (IS) and theory of planned behaviour (TPB), this study aims to investigate the three dimensional (3D) based product presentations success for the online retailers. Particularly, this article is implementing the 3D technology in the laptops industry. In order to test our model, we designed a hypothetical retailer website which presents a variety of laptops. The way we have designed our website allows users to see the presented product from different angles, rotate the product and custom design the colours of the laptops. Further, the designed website allows participants to control the content and form of the 3D flashes. Also the 3D site allows participants to get information about the laptops’ attributes and prices. Our results indicate strong support for the research model. We found that 3D information and system quality are significant determinants for satisfaction and trust which in return impact purchase intention.

Keywords: three dimensional; 3D; 3D-based; information quality; system quality; satisfaction; trust; purchase intention; attitude; theory of planned behaviour; TPB; information systems success model; technology marketing; online retailer; empirical investigation.


Biographical notes: Raed Algharabat has a PhD from Brunel University, UK. He is the head of Marketing Department, at The University of Jordan, Amman, Jordan. His teaching and research area is (e-) retail and consumer behaviour, the vital, final link of the marketing process for satisfying the end consumer. He has won numerous research awards including Best Papers Award at the Academy of Marketing Conference in 2009. His research area is e-retailing, particularly, 3D virtual models and their impact on consumer behaviour within the online retailer context.
1 Introduction

During the last decade online retailers investigated the main impact of using three dimensional (3D) technology and how it helps consumers to imagine the real product. This technology has been useful to many online retailers (Algharabat and Dennis, 2010c). Furthermore, previous research on this area investigates the main dimensions of a proper 3D product presentation. For example, Jiang and Benbasat (2005) posit that for a 3D product presentation, to reflect virtual experience, it must focus on virtual control (consumers’ ability to manipulate web product images, to view products from various angles and distances) and functional control (consumers’ ability to explore and experience different features and functions of products). Algharabat and Dennis (2010c) identify user control (users’ ability to control the content and form of the 3D flash) and animation (users’ ability to see the products with their chosen colours) as the main antecedents of an authentic 3D product presentation. To define virtual product experience, other scholars (e.g., Klein, 2003; Suh and Lee, 2005) relied on the notion of telepresence (e.g., immersion or illusion), where users of the computer system often feel that their minds are transported into other areas. Previous research on telepresence, which focused on 3D product presentation (e.g., Suh and Lee, 2005), indicates that interactivity (users’ ability to manipulate the image of the product) and vividness (changing the colour of the product) as the main antecedents for 3D telepresence.

To that end, we notice that previous scholarly literature investigated the importance of information systems (IS) success on designing websites. For example, ease of use (Davis, 1989; Franz and Robey, 1986), usefulness (Davis, 1989), security and privacy (Hoffman et al., 1996), diagnosticity of the product (Jiang and Benbasat, 2005), navigation (Grabner, 2002), and quality [e.g., information, system and service, (DeLone and McLean, 2003)] considered to be the main factors of the IS success. However, within the context of 3D product presentation, we notice that the previous scholarly literature examined particular aspects of the IS success model (Algharabat and Dennis, 2010a, 2010b, 2010c; Jiang and Benbasat, 2005; Suh and Lee, 2005). Further, a body of research investigated the impact of a well designed 3D product presentation on hedonic, utilitarian, attitude, and purchase intentions towards the presented product and the online retailers website (e.g., Fiore et al., 2005). Yet, we followed a different rational in investigating the way in which using 3D product presentation might improve customer’s attitude (i.e., satisfaction and trust) via employing the IS success model (DeLone and McLean, 2003) and its impact on purchase intention. Therefore, in order to answer our research questions we adopted two well known theories; the IS success model (DeLone and McLean, 2003) and theory of planned behaviour (TPB, Ajzen, 1985). Thus, this research aims to answer the following questions. First, using 3D product presentation-based IS success model in the online retailers:
• “What are the salient beliefs of customers that determine their level of attitudes (i.e., satisfaction and trust)?”
• “When using 3D product presentation, who customers attitudes impact their behaviour?”

This paper is organised as follows. First, we explain the existing literature on TPB, IS and 3D product presentation. Second, the development of conceptual framework. Third results, discussion, implications and limitations.

2 Theoretical background

In order to best explain how 3D product presentation impact consumers’ beliefs, attitude and behaviour, we adopt TPB (Ajzen, 1985). According to Ajzen and Fishbein (1980), and Fishbein and Ajzen (1975), the theory of reasoned action (TRA) posits that individuals’ beliefs about a particular stimulus often help in predicting their attitudes, which impact their intention to act, which has a direct influence on behaviour. Since then, the relationships among beliefs, attitudes, intentions and behaviour have been studied by many researches (e.g., Bagozzi, 1981; Bentler and Speckhart, 1979, 1981). Ajzen (1985) extended the TRA and tested the interrelationship between beliefs, attitudes, and behaviour using the TPB.

Within the IS context, many studies adopted either all or some of the TPB constructs, or they extended the model to better understand a wide range of human behaviour. For example, Guo et al. (2009) extend the TPB to include customer satisfaction and retention. Grandón et al. (2011) employ this model to explain e-commerce adoption. Buttle and Bok (1996) use the model to explain e-purchasing behaviour.

Therefore, we adopt the basic approach of the TPB (Belief → Attitude → Intention) to fit our own research design, and to examine the relationships among beliefs, attitudes, and behaviour of the 3D product presentation. To understand the nature and impact of relationships within 3D product presentation context, we employ the IS success model (DeLone and McLean, 2003) by incorporating three key elements from the TPB model:

1. the beliefs of users, measured in terms of their assessment of 3D qualities
2. the attitudes of users, measured in terms of their satisfaction and trust
3. the behaviour of users, measured in terms of members’ intentions to purchase.

2.1 IS success model

Previous researchers centred their efforts on the DeLone and McLean’s (1992) model to identify the factors that might impact the IS success measures. DeLone and McLean’s (1992) model classify the main factors which often impact IS success into three main areas. First, quality measures which consists of system quality and information quality. While system quality refers to adaptability, availability, reliability, response time, and usability of the system, information quality refers to the relevance, completeness, ease of understanding, personalisation and security of the information. Second, attitudinal outcomes which include; IS use and user satisfaction. Third, performance-related outcomes which focus on individual and organisational impacts. DeLone and McLean...
An empirical investigation of 3D-based information systems success (2003) propose an updated IS success model (Figure 1) which the authors claim its important due to the dramatic changes in IS practice, particularly, the growth of e-commerce. DeLone and McLean’s (2003) study adds the construct of service quality to the two existing dimensions i.e., system quality and information quality (DeLone and McLean, 1992). Further, the authors added intention to use as a measure of user attitude. Finally, the authors grouped individual and organisational impacts into a construct named net benefit.

Figure 1  DeLone and McLean’s (2003) updated is success model

![Figure 1](image)

Figure 2  Research model

![Figure 2](image)

Notwithstanding, DeLone and McLean (2003, p.18) posit that choosing among the IS dimensions (i.e., information quality, system quality and service quality) is a controversial issue. Therefore, the authors advise researchers to use information quality and/or system quality to measure the success of a single system (i.e., an individual system). However, the authors recommend researchers to focus on service quality dimension when measuring the overall success of IS department (Lee and Chung, 2009). Therefore, based on Seddon’s (1997) IS success sub-model and DeLone and McLean’s (2003, p.18) recommendation, we believe that service quality is important for the online retailer; however, within the context of 3D product presentation, we exclude service...
quality from our study’s model because this study aims at investigating the success of an IS, addressed at individuals, and investigated through the lens of individuals’ attitudes.

2.2 Information quality

Previously research on information quality defines information quality as user’s perception of the quality of outputs which IS presented (DeLone and McLean, 1992). Further, McKinney et al. (2002) define information quality based on the quality of information presented on the website. Delone and McLean (1992) identify the following elements to measure information quality; relevance of information, timeliness of information, and accuracy of information.

Based on Delone and McLean’s (1992) study and other related studies on this field (e.g., Bitner et al., 2000), Zhilin et al. (2005) classified information quality measures into;

1 usefulness of content (relevancy and clearness of information), reliability (accuracy, dependability, and consistency of information), currency (information timeliness and continuous update), accuracy (the degree to which the system information is free of error)

2 adequacy of information (the extent of completeness of information).

Huh et al. (1990) define four dimensions of information quality:

1 accuracy which refers to the agreement with an attribute about a real world entity
2 completeness refers to whether all of the data relevant to that application are present
3 consistency refers to an absence of conflict between two datasets
4 currency refers to up-to-date information.

Nelson et al. (2005) used the Huh et al.’s. (1990) elements and added an element, namely, format which related to the presentation layout of information outputs. Doll et al. (1994) identify five constructs to measure information quality: content, accuracy, format, ease of use, and timeliness. Therefore, we have defined 3D information quality as the extent to which the 3D provides accurate, relevant, complete and precise information regarding the presented product. This definition comes in accordance with Algharabat and Dennis’ (2010a, 2010b, 2010c; 2012a) description of the 3D product presentation which should reflect the content and form of the presented product. The authors asserted that consumers’ ability to control the 3D product presentation (i.e., their ability to rotate, zoom in or out on the products) and see it with different colours will enable them to surpass a direct experience. Jiang and Benbasat (2005, 117) assert that perceived diagnosticity of 3D reflects the perceived ability of a 3D interface to convey to customers relevant product information that helps them in understanding and evaluating the quality and performance of products sold online. Prior research (Jiang and Benbasat, 2005; Jiang and Benbasat, 2007) asserts that vividness of the 3D product presentation often portray products more concretely and convey more information cues than pallid presentation formats.
2.3 System quality

DeLone and McLean (1992) introduced the notion of system quality which refers to a system’s overall performance. The authors posit that individuals’ perceptions should be the base for measuring system quality. Furthermore, DeLone and McLean (2003) measured system quality via attributes such as ease of use, functionality, reliability, data quality, flexibility, and integration. In accordance with DeLone and McLean (2003), previous research on the 3D product presentation asserts the importance of system quality. For example, Kim and Forsythe (2009) posit that ease of use and usefulness are the main attributes of a proper 3D product presentation. Shim and Lee (2011) state that the ability of the 3D to convey proper information (e.g., silhouette, colour, texture and fit) often helps reducing perceived risk. Fiore and Jin (2003) indict that 3D visual design such as 3D ability to allow users to check the side and back views of the product provides more visual sensory information (e.g., how products look together). At the same context, Kim et al. (2007) assert that a proper visual design for the 3D virtual model often enhances user’s involvement with the presented product. Algharabat and Dennis (2010c) postulate the importance of controlling the 3D product presentation (i.e., ease of use) in creating proper virtual experience. Jiang and Benbasat (2007) assert the importance of 3D interactivity in creating a diagnostic 3D product presentation. Therefore, we have defined 3D system quality as the extent to which the 3D is easy to use, user friendly, and well designed to navigate the presented product. The above classification comes in accordance with previous studies. (e.g., Eisenmann and Pothen, 2000; Misic and Johnson, 1999; Wang and Strong, 1996; Miller and Doyle, 1987; Bailey and Pearson, 1983; Nelson et al., 2005) which assert the importance of usability (user friendliness), visual design and ease of navigation in creating system quality.

3 Conceptual framework

Users’ beliefs about the quality of 3D product presentation often influence their attitudes, such as satisfaction and trust, and thus their purchase intention. A significant body of research investigated satisfaction and trust as the main measures of users’ attitudes (e.g., Elliot et al., 2013; Lee and Chung, 2009). Therefore, we adopted the basic approach of the TPB (Ajzen, 1985) and IS success model (DeLone and McLean, 2003) theories to propose a model to examine the relationships among

1 the beliefs of users, measured in terms of their assessment of 3D qualities. In particular; system quality and information quality
2 the attitudes of users, measured in terms of users’ satisfaction and trust
3 the behaviour of users, measured in terms of users’ intentions to purchase.

3.1 3D information quality, system quality and trust

The notion of online trust has been defined and operationlised based on three categories (Beldad et al., 2010; Chen and Dhillon, 2003). First, customer/client-based factors which consider trust propensity as the main antecedent to online trust (e.g., Corbitt et al., 2003). Second, online vendors factors which consider organisational reputation (Fuller et al.,
2007), perceived size of the organisation (Koufaris and Hampton-Sosa, 2004), offline presence, experience and familiarity with the online company as important factors to build initial online trust. Third, website factors which consider perceived ease of use of the website (e.g., Bart et al., 2005; Chau et al., 2007; Flavian et al., 2006; Koufaris and Hampton-Sosa, 2004), information quality, system quality, service quality, privacy and security, and third-party guarantees as the main antecedents to online trust (Bart et al., 2005; Kim et al., 2005; Nicolaou and McKnight, 2006; Liao et al., 2006; Lowry et al., 2008; McKnight et al., 2002a, 2002b).

Within the context of 3D product presentation, the impact of graphical characteristics (such as clipart, colour, 3D and photos) on online trust has been supported by previous studies. For example, Kim and Moon (1998) find that 3D dynamic clipart improved the users’ feelings of trustworthiness towards the banking system. The authors stated the importance of the interface colour layout in enhancing customers’ perceptions of the online banking’s trustworthiness. Further, Koufaris and Hampton-Sosa (2004) assert that product presentation, which allows users to customise their products and services, is significant to initial trust. Briggs et al. (2004) posit a mutual relationship between trust and personalisation. Algharabat and Abu-ElSamen (2013) assert the positive relationship between 3D product presentation and trust.

Therefore, we argue that since customers are not in a position to touch and feel the 3D presented product online, the 3D must be designed so as to induce trustworthy feelings via providing detailed and clear information, which in turn will influence the decisions to buy. Thus, we define 3D trust which is derived from 3D product presentation as: users’ feelings of trustworthiness about information quality and system quality. Information quality reflects information relevancy, sufficiency, accuracy and currency. Whenever information is irrelevant, insufficient, inaccurate or out-of-date, then users may doubt the ability and integrity of the 3D to provide information quality to them. Eventually, this may decrease user’s trust in the 3D product presentation. Similarly, it would appear that customers who experience information quality with 3D product presentation tend to form high trust in 3D product presentation. Thus,

\[ H_{1a} \text{ Information quality of the 3D positively affects trust.} \]

Vance et al. (2008) posit that system quality reflects ease-of-use, access speed, visual appeal and navigational structures. The authors assert that visual appeal and navigational structure affects user trust. Thus ease of navigating a 3D product presentation (zoom in or out, seeing the information regarding the product) and having very clear images for the product might enhance trust (Algharabat and Dennis, 2010c). Previous research on trust (e.g., McKnight et al., 1998) asserts that user’s knowledge is the base for making trust assumptions. For example, McKnight et al. (2002a) and Belanger et al. (2002) note that the perceived quality of website directly affects trust for web vendors and web-based trust. Similarly, it would appear that customers who experience system quality with 3D product presentation tend to form high trust in 3D product presentation. Hence:

\[ H_{2a} \text{ System quality of the 3D positively affects trust.} \]

### 3.2 3D information quality, system quality and satisfaction

Satisfaction has been conceptualised and measured in different ways. For example, in the marketing context, Kotler (1991) defines it as a post-purchase evaluation of product
quality. Within the IS context, previous researchers (DeLone and McLean, 1992, 2003) consider user satisfaction as a consequence of the successful interaction between the IS itself and its users. For example, Longinidis and Gotzamani (2009) posit that user satisfaction is a critical element in enhancing organisational effectiveness. Previous researchers (e.g., Gatchalian, 1999; Seddon and Kiew, 1996; Zviran et al., 2005) postulate the importance of user satisfaction as a major tool to measure IS success and effectiveness which often enhances end users’ understanding of product features and characteristics. Seddon (1997, p.246) defines user’s satisfaction as “a subjective evaluation of the various consequences evaluated on a pleasant–unpleasant continuum”. Consistent with the Seddon’s (1997) definition, Gelderman (1998, p.12) defines it as “the extent to which information requirements are met”. Bailey and Pearson (1983, p.531) define end user satisfaction as the “sum of one’s feelings or attitudes towards a variety of factors affecting that situation”. Wixom and Todd (2005) view satisfaction as an attitudinal construct. Thus the authors adopt Bailey and Pearson’s (1983) definition which related to an individual’s feelings towards a variety of factors which often affect a given situation. Further, DeLone and McLean’s (1992, 2003) models, define end user satisfaction as the overall level of user satisfaction. Zviran et al. (2005) posit that user satisfaction should be viewed in terms of system use and acceptance.

IS performance has often been evaluated from three perspectives (Bailey and Pearson, 1983; Ives et al., 1983), namely,

1. the quality of the system itself such as accessibility, response time, integration, efficiency, and system flexibility
2. the quality of information such as information accuracy, completeness, relevance, precision, and currency
3. service quality.

Furthermore, these performance indicators have frequently been used as direct antecedents of satisfaction in marketing literature (Kim et al., 2008; Oliver and DeSarbo, 1988; Tse and Wilton, 1988). The direct impact of performance on user satisfaction can be clearly found in the literature. For example, Susarla et al. (2003) posit that information quality and system quality have positive direct effects on the satisfaction of users. Findings from previous research (e.g., DeLone and McLean, 2003; Almutairi and Subramaniam, 2005; McKinney et al., 2002; Wixom and Todd, 2005) highlight that information quality and system quality are positively related to user satisfaction.

In line with Bailey and Pearson (1983) and Wixom and Todd’s (2005) view, we conceptualise and measure satisfaction as an attitudinal construct, since online customers’ feelings are affected by various salient beliefs when they browse or use 3D product presentation. Further, consistent with DeLone and McLean’s (2003, p.18) recommendation, we posit that there are two salient beliefs that influence the key attitude of customer’s satisfaction; information quality and system quality. Therefore, it would appear that customers who experience information quality and system quality with 3D product presentation tend to form high satisfaction level. Hence:

\[ H_{1b} \quad \text{Information quality of the 3D is positively related with product presentation satisfaction.} \]

\[ H_{2b} \quad \text{System quality of the 3D is positively related with product presentation satisfaction.} \]
3.3 The effects of satisfaction on trust

The relationship between satisfaction and trust appears well in the literature. For example, Helson (1964) explains the positive association between satisfaction and trust. Caceres and Paparoidamis (2007) suggest that satisfaction leads to trust in business-to-business context. Kim et al. (2008) assert that satisfaction leads to trust in an online retailer. Singh and Sirdeshmukh (2002) posit that satisfaction directly influences trust. Gefen (2004) finds that a satisfactory past experience performs a crucial role in building trust between an ERP vendor and its clients. Zucker (1986) postulates that user satisfactory experience with his/her behaviour is essential in building trust. Notwithstanding, there is a significant body of research offering evidence for an opposite relationship, i.e., trust having a positive impact on satisfaction, either directly or indirectly, through mediating factors (e.g., Deng et al., 2010; Kim and Rao, 2009). Hence, we decided to test the relationship between satisfaction and trust. We believe that within the context of the 3D product presentation, user’s satisfaction with the performance of the 3D often provides the customer with confidence in the online retailer which creates a sense of trusting the virtual model. Similarly, it would appear that customers who have a satisfactory experience with 3D product presentation might form a high trust in 3D product presentation. Therefore, we speculate that a customer’s satisfaction with a 3D product presentation leads to trust. Hence:

\[ H_3: \text{Satisfaction with the 3D product presentation performance positively related with trust.} \]

3.4 Trust and purchase intention

Previous research shows that trust increases purchase intentions, intention to use the website, creates positive attitude and reduces perceived risk (Bart et al., 2005; Corritore et al., 2003; Gefen, 2000; Ganesan, 1994; Gefen, 2002, 2003, 2004; Roy et al., 2001; Heijden et al., 2003; Wang and Emurian, 2005; Vatanasombut et al., 2008). For example, Gefen and Straub (2004) show a positive relationship between e-trust and purchase intentions for the online retailer. Algharabat and Abu-ElSamen (2013) postulate the positive relationship between trust (resulted from navigating a 3D product presentation) and purchase intention. Briggs et al. (2004) find a positive relationship between trust (resulted from using personalisation) and commitment to the product. Further, according to Flavian et al. (2006) and McKnight et al. (2002b) online trust is fundamental to online purchase intentions and willingness to buy from an online vendor. Thus:

\[ H_4: \text{Trust has a positive impact on purchase intention.} \]

3.5 Satisfaction and purchase intention

A body of empirical research supports the positive relationships between satisfaction and purchase intention. For example, Rust and Zahorik (1993) find that customer retention rate is driven by customer satisfaction. IS literature (Bhattacherjee, 2001; Hong et al., 2006) also reveals the significance relationship between satisfaction and intention. Previous research (e.g., Anderson and Sullivan, 1993; Yi and La, 2004; Szymanski and Henard, 2001) asserts the positive association between customers satisfaction and repurchase intention. Further, customer satisfaction and future purchase intention (Cronin
and Taylor, 1992; Doney and Cannon, 1997), customer satisfaction and repurchase (Mittal and Kamakura, 2001). Accordingly, this relationship is likely to hold in the case of 3D product presentation. Thus:

\[ H_5 \] Satisfaction with the 3D product presentation performance is positively related with purchase intention.

4 Research method

4.1 Stimuli and interface design

A hypothetical retailer’s website was custom-designed for this study for testing the proposed hypotheses. The main stimulus was illustrated as a laptop 3D product presentation, in which participants can navigate laptops from different angles, i.e., they can rotate and zoom in or out on the product. This idea has been proven by previous researchers (Algharabat and Dennis, 2010a, 2010b, 2012a). The 3D stimulus is designed to help consumers imagine the laptops in appropriate and relevant ways (Algharabat and Dennis, 2010c). The site allows participants to control the content and form of the 3D site. For example, the participants can zoom in or out on the laptops, rotate it and see different parts of it when clicking on it. The 3D site permits the participants to change the colour of the laptops and see it with their chosen colour. Also the 3D site allows participants to get information about the laptops’ attributes and prices. The site offers a wide variety of laptops, similar to those that many women and men currently buy and use. Therefore, the site provides a suitable context for the present sample (Algharabat and Dennis, 2010c). See Appendix for screen shot of the laptops.

Before conducting the main study, numerous products were evaluated and considered prior to the selection of laptops as the test products. Laptops were judged appropriate because they represent high-involvement purchase items that can be evaluated using both experience attributes (i.e., weight, size, speed, visual clarity, etc.) and search attributes (i.e., price, warranty, special effect features, etc.). Previous studies posit that high involvement with products often leads to greater perception of attribute differences, product importance, greater commitment to brand choice (Howard and Sheth, 1969) and it reflects a strong cognitive processing.

To confirm this, a pre-test \((n = 40)\) was conducted using a six-item seven-point scale constructed from successfully tested items for determining levels of involvement (Zaichkowsky, 1985) with participants asked to rate their purchase decision for laptops (unimportant/important, of no concern/of concern to me, irrelevant/relevant, means a lot to me/means nothing, doesn’t matter/matters to me, insignificant/significant to me). The results indicated that participants overall felt laptops are slightly above average in product purchase involvement \((M = 5.40, SD = 1.17)\) \((\alpha = .92)\)

4.2 Sample

The survey (paper-based) instrument is a structured questionnaire comprising seven-item measurement scales for all latent variables. The questionnaire has at least three items per latent variable to reduce factor indeterminacy (Ferguson et al., 1974). The English language questionnaire was translated into Arabic, then back translated into English to
test for equivalency. The questionnaire was pretested with a small Jordanian non-students sample before field implementation.

A convenience non-student sample has often been employed to conduct this research. We used a sample of 350 Jordanian participants for the data collection. The sample was gender-balanced, consisting of 50% women and 50% men, and 98% of the sample ranged from 24 to 50 years of age. Approximately 97% reported having had prior online shopping experience. We conducted a non-response bias test (Armstrong and Overton 1977) to confirm the generalisation of our results, via comparison of the late responses with the early responses. The results show no significant difference between respondents ($p > 0.05$, regarding, information quality, system quality, trust, satisfaction, and purchase intention). As a result, a non-response bias was not considered to be a serious limitation in this study.

Table 1  
Research construct operationalisation

<table>
<thead>
<tr>
<th>Construct</th>
<th>Indicator</th>
<th>Author(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Information quality (IQ1–IQ4)</strong></td>
<td>IQ1: 3D provides accurate information about the laptops</td>
<td>DeLone and McLean (1992) and Wixom and Todd (2005)</td>
</tr>
<tr>
<td></td>
<td>IQ2: 3D provides relevant information about the laptops</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IQ3: 3D provides complete information about laptops</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IQ4: 3D provides precise information about laptops</td>
<td></td>
</tr>
<tr>
<td><strong>System quality (SQ1–SQ4)</strong></td>
<td>SQ1: The 3D is easy to use</td>
<td>Davis (1989), DeLone and McLean (1992), Seddon (1997) and McKinney et al. (2002)</td>
</tr>
<tr>
<td></td>
<td>SQ2: The 3D is user friendly</td>
<td></td>
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<tr>
<td></td>
<td>SQ3: The 3D is well designed to navigate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SQ4: The 3D is convenient to access</td>
<td></td>
</tr>
<tr>
<td><strong>Satisfaction (SAT1–SAT3)</strong></td>
<td>SAT1: All things considered, I am very satisfied with 3D product presentation</td>
<td>McKinney et al. (2002) and Wixom and Todd (2005)</td>
</tr>
<tr>
<td></td>
<td>SAT2: All things considered, I am very pleased with 3D product presentation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SAT3: My interaction with 3D product presentation has been satisfying</td>
<td></td>
</tr>
<tr>
<td><strong>Trust (TRU1–TRU3)</strong></td>
<td>TRU1: I feel that this online vendor is dependable</td>
<td>Kim and Moon (1998)</td>
</tr>
<tr>
<td></td>
<td>TRU2: I feel that this online vendor is reliable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TRU3: I feel that this online vendor is realistic</td>
<td></td>
</tr>
<tr>
<td><strong>Purchase intention (PI1–PI3)</strong></td>
<td>PI1: After seeing the 3D, I predict to buy a laptop from this online retailer</td>
<td>Fiore et al. (2005)</td>
</tr>
<tr>
<td></td>
<td>PI2: I would be willing to purchase a laptop through this online retailer</td>
<td></td>
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<tr>
<td></td>
<td>PI3: In the future I would shop at this online retailer</td>
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</tbody>
</table>
4.3 Construct operationalisation

The participants were informed that this study pertained to consumer evaluations of laptops retailer’s website. The questionnaire contained seven-point Likert-type scales, anchored by 1 = ‘strongly disagree’ and 7 = ‘strongly agree’. The items and the supporting literature for the measurement scales are shown in Table 1.

5 Results

5.1 Exploratory factor analysis

The analysis started by examining the structure and dimensionality of the study constructs using exploratory factor analysis (EFA) and reliability analysis. After examining the pattern matrix of the EFA, all items had loadings greater than 0.4 and communalities greater than 0.5.

<table>
<thead>
<tr>
<th>Construct</th>
<th>Standardised factor loading (λ)</th>
<th>SE</th>
<th>t-value</th>
<th>AVE Squared multiple correlation</th>
<th>Composite reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>η1 (Information quality)</td>
<td></td>
<td>.69</td>
<td>.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IQ1</td>
<td>.882</td>
<td>–</td>
<td>–</td>
<td>.778</td>
<td></td>
</tr>
<tr>
<td>IQ2</td>
<td>.802</td>
<td>.080</td>
<td>13.817</td>
<td>.643</td>
<td></td>
</tr>
<tr>
<td>IQ3</td>
<td>.827</td>
<td>.082</td>
<td>14.343</td>
<td>.684</td>
<td></td>
</tr>
<tr>
<td>IQ4</td>
<td>.801</td>
<td>.084</td>
<td>13.137</td>
<td>.641</td>
<td></td>
</tr>
<tr>
<td>η2 (System quality)</td>
<td></td>
<td>.64</td>
<td>.88</td>
<td></td>
<td></td>
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<tr>
<td>SQ1</td>
<td>.701</td>
<td>–</td>
<td>–</td>
<td>.491</td>
<td></td>
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<tr>
<td>SQ2</td>
<td>.849</td>
<td>.130</td>
<td>10.347</td>
<td>.721</td>
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<tr>
<td>SQ3</td>
<td>.788</td>
<td>.102</td>
<td>11.836</td>
<td>.621</td>
<td></td>
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<tr>
<td>SQ4</td>
<td>.853</td>
<td>.134</td>
<td>10.342</td>
<td>.728</td>
<td></td>
</tr>
<tr>
<td>η3 (Satisfaction)</td>
<td></td>
<td>.71</td>
<td>.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAT1</td>
<td>.966</td>
<td>–</td>
<td>–</td>
<td>.931</td>
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<tr>
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<td>.089</td>
<td>7.479</td>
<td>.545</td>
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<tr>
<td>SAT3</td>
<td>.831</td>
<td>.067</td>
<td>10.800</td>
<td>.691</td>
<td></td>
</tr>
<tr>
<td>η4 (Trust)</td>
<td></td>
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<td>.86</td>
<td></td>
<td></td>
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<tr>
<td>TRU1</td>
<td>.735</td>
<td>–</td>
<td>–</td>
<td>.540</td>
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<tr>
<td>TRU2</td>
<td>.803</td>
<td>.083</td>
<td>10.216</td>
<td>.645</td>
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<td>.798</td>
<td>.104</td>
<td>9.951</td>
<td>.623</td>
<td></td>
</tr>
<tr>
<td>η5 (Purchase intention)</td>
<td></td>
<td>.68</td>
<td>.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PI1</td>
<td>.804</td>
<td>–</td>
<td>–</td>
<td>.646</td>
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<td>.065</td>
<td>14.809</td>
<td>.679</td>
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5.2 Measurement model

We evaluated the measurement and structural equation models using SPSS AMOS. The measurement model includes 17 indicators, and we provide its results in Table 2 including the standardised factor loading, standard error (SE), t-values, and average variance extracted (AVE). The standardised factor loadings ($\lambda$) are all greater than .6. The composite reliabilities for information quality (.90), system quality (.88), satisfaction (.90), trust (.86), and purchase intentions (.90) are all within the ‘acceptable’ range (Hair et al., 1998). Moreover, AVE by each construct exceeds the minimum value (.5 or above) recommended by Hair et al. (1998), indicating convergent validity. The square roots of the AVE by each construct exceed the correlation between them (Table 3), demonstrating discriminant validity. Thus, our instrument had satisfactory construct validity (Anderson and Gerbing, 1988; Fornell and Larcker, 1981).

Table 3 Correlation coefficients, and discriminant validity

<table>
<thead>
<tr>
<th>Model constructs</th>
<th>Correlations</th>
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<tr>
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<tr>
<td>1 IQ</td>
<td>.83</td>
</tr>
<tr>
<td>2 SQ</td>
<td>.24</td>
</tr>
<tr>
<td>3 SAT</td>
<td>.31</td>
</tr>
<tr>
<td>4 TRU</td>
<td>.06</td>
</tr>
<tr>
<td>5 PI</td>
<td>.11</td>
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</tbody>
</table>

Notes: The figures under the diagonal are the Pearson (R) correlations between the variables. Diagonal elements are square roots of AVE.

5.3 Structural equation model

The hypothesised model achieves a chi-square of 271.85 (df = 112), $\chi^2$/df = 2.43, $p < 0.001$, with GFI of .923, CFI of .915, RMR of .030 and RMSEA of .051 (confidence interval = .045–.065). These results indicate a good fit of the data to the model (Byrne, 2001; Hair et al., 1998). Furthermore, the structural equation model confirms that 3D information and system quality have significant positive effects on satisfaction ($H_{1a} \beta = .40, p < 0.001, t = 6.308; H_{2a} \beta = .26, p < 0.001$) and trust ($H_{1b} \beta = .59, p < 0.001; H_{2b} \beta = .16, p < 0.05$). Moreover, satisfaction exhibits a significant positive effect on trust ($H_3 \beta = .52, p < 0.001$). As we hypothesised, satisfaction and trust have significant positive effects on purchase intention ($H_4 \beta = .55, p < 0.001; H_5 \beta = .84, p < 0.001$). Finally, coefficient of determination ($R^2$) for satisfaction = .58, trust = .50, and purchase intention = .50.

6 Discussion and conclusions

This research aims to investigate the way in which using 3D product presentation improve customers’ attitudes (i.e., satisfaction and trust) via employing the IS success model and its impact on consumer behaviour. Therefore, we adopted two models. First, the TPB (Belief $\rightarrow$ Attitude $\rightarrow$ Intention) to examine how the 3D qualities often impacts
user’s satisfaction and trust which will impact user’s intention to purchase from an online retailer. Second, to examine the proper 3D qualities, we adopted the IS success model which focuses primarily on information quality and system quality.

Our results show that the 3D information quality and system quality are significant determinants of trust and satisfaction. However, information quality exhibited a stronger effect on user satisfaction and trust in comparison to system quality. This result could be justified due to the fact that our sample is sufficiently computer and internet literate and system quality is not a critical factor in determining their satisfaction and trust. This means that 3D designer should focus their efforts on providing comprehensive, accurate and reliable information which might help users to make their decisions easily. However, 3D designer must also consider the effects of the system quality variable; including visual appeal and navigational structure, otherwise it would be considered incomplete (Wang and Liao, 2008).

Our results confirm that 3D product presentation qualities (i.e., information and system) have a significant impact on user’s trust. The useful, accurate, current, and complete information, provided by the 3D presentation enhances trust on 3D flashes and improves users’ feelings of trustworthiness towards our hypothetical 3D website. Furthermore, the graphical characteristics of the 3D and user’s ability to customise and personalise the 3D product presentation, allow users to establish trust. This kind of trust (i.e., trusting the website via 3D product presentation) might be the starting point in order to enhance different types of trust such as online transactions and e-vendor’s trustworthiness. Our results regarding purchase intention come in line with previous studies which highlighted the importance of trust and satisfaction to enhance purchase intention.

6.1 Theoretical implications

Previous research which employed the IS success model focused on characteristics of the website. Notwithstanding, in the field of 3D product presentation, the main quality dimensions that should be illustrated into a 3D has not been clearly studied. For example, Algharabat and Dennis (2010c) focused on control and animation colours as the main quality which should be available in a 3D product presentation. Further, previous research on e-trust focused their efforts on different types of trust, hence little has been done in the area of 3D product presentation. For example, in the field of graphical characteristics, customisation and personalisation (such as such as clip arts, colours, 3D and photos, Kim and Moon (1998) find that the colour of 3D dynamic clipart improved the users’ feelings of trustworthiness towards the banking system. Steinbrueck et al. (2002) assert that using photographs in the online retail website as an effective way to increase users’ feelings of an e-vendor’s trustworthiness. Koufaris and Hampton-Sosa (2004) assert that product presentation, which allows users to customise their products and services, is significant to initial trust. However, none of the previous studies investigated the way in which 3D quality might impact e-trust. Our results reveal that proper 3D product presentation (which is characterised by proper information and system quality) is the main determinant of e-trust. Thus, we recommend researchers who want to establish a real measure for the 3D product presentation e-trust to focus their effort on the 3D product presentation quality. Therefore, we believe that we have added, partially, to the literature the importance of focusing on the quality of 3D product presentation and its impact on e-trust.
6.2 Managerial implications

In a highly competitive environment, non-store retailers need to find ways of attracting and retaining customers (Algharabat and Dennis, 2010c; Khakimdjanova and Park, 2005; Mummalaneni 2005). A 3D product presentation (with high information quality and system quality) is an important stimulus that usually helps online retailers to be successful, and it often helps them enhance the e-shopping environment (Algharabat and Dennis, 2010a; Khakimdjanova and Park, 2005). Non-store retailers should pay more attention while designing 3D product presentation. Particularly, the design should be focused on information quality which should enhance users’ experiences and minimise their efforts in searching the proper, accurate and timely information. Further, system quality is another important dimension that 3D designers must pay attention to. Designing these dimensions properly will enhance users’ attitudes (satisfaction and trust) regarding the 3D website and this will result in a purchase intention. Thus, we do recommend online marketers to pay more attention to the designed 3D product presentation due to its significant role in impacting the mediating factors which enhance purchase intention.

6.3 Limitations and future research

We admit that there are several limitations in this study. First, we designed the hypothetical retailer to be implemented on the laptops industry, rather than multiple websites. However, we think that laptops are products which need search and they reflect many of users’ rational and emotional elements. Further, we conducted this study in a non-western context meaning that cultural differences might be one of the main limitations and as a result generalisability of our results could be limited. We did not conduct any invariance analysis. Thus, invariance analysis is required to test the differences among users’ demographics of the hypothetical 3D product presentation. The convenience sampling technique might be a limitation. Notwithstanding, since this study based on employing participants who are easily accessible and willing to participate, we believe that this sampling method is acceptable (McDaniel and Gates, 2006). Future studies may investigate the above limitations.

We encourage researchers to focus on the impact of subjective norms and behavioural control on 3D trust and satisfaction. Future studies may investigate the impact of 3D qualities on creating electronic customer relationship management (e-CRM). Future research is welcome to study the impact of 3D qualities on store patronage and loyalty. Finally, an alternative suggestion for future studies is to investigation the impact of 3D qualities on perceived risk reduction.

References

An empirical investigation of 3D-based information systems success


Byrne, B. (2001) Structural Equation Modeling with AMOS, Lawrence Erlbaum Associate, New Jersey, USA.


An empirical investigation of 3D-based information systems success


**Appendix (see online version for colours)**