Journal of Retailing and Consumer Services 41 (2018) 169–176

Contents lists available at ScienceDirect

Journal of Retailing and Consumer Services

journal homepage: www.elsevier.com/locate/jretconser

# Augmented reality in retail: A trade-off between user's control of access to personal information and augmentation quality

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ARTICLE INFO

*Keywords:*
Augmented reality
Augmentation quality
User's control of access to personal information
User satisfaction

ABSTRACT

This study conducted a qualitative experimental study to develop a scale, *augmentation quality* that measures the output quality of augmented reality. Augmentation quality is a new aspect of user experience being captured through interaction with augmented reality. Since controlling access to their personal information is a significant concern of users, this study also conducted a quantitative experimental study and applied equity theory to examine how augmentation quality and users' control of access to their personal information impacts user satisfaction. This study was conducted in three different contexts: online shopping, entertainment services, and basic service maintenance. ANOVA was applied to examine the significant differences in user satisfaction, user's control of access to personal information, and augmentation quality across the three contexts. Results indicated that individuals pay attention to both the privacy of their personal information as well as augmentation quality. The results also indicated that the ability to control access to personal information significantly affects user satisfaction. The results of this study carry important managerial implications for augmented reality developers and retailers.

## 1. Introduction

Interactive technologies have changed the way people interact with reality. Over the past few decades, consumers have been exposed to a continual stream of novel technologies, and among the most novel is augmented reality, commonly known as *AR*. Augmented reality refers to the integration of computer generated graphics into real world images (Milgram and Kishino, 1994). Because it can present such enriched product information (Lu and Shana, 2007) as three-dimensional product images in different shapes, colors, and styles (Kim and Forsythe, 2008a), it is now being used to help shoppers decide on a purchase before buying (Oh et al., 2008).

AR does this by integrating computer-generated virtual information into the user's real world, thus enriching a user's experience of reality (Poushneh and Vasquez-Parraga, 2017). To be specific, AR is an interactive technology that generates three-dimensional virtual content in the form of pictures, objects, or information, and then maps it onto the user's reality. In other words, existing content is augmented by AR. Users are able to see the final output displayed on a screen, but they are unable to see the technology's operation.

Many companies have become interested in developing AR technology (Yim and Chu, 2012), and this technology has developed in a variety of forms: mobile applications (e.g., Snap Shop, Star Chart, IKEA Catalogue), head-mounted display (e.g., Google Glass, Microsoft Hololens, Vuzix Glass), contact lenses, and devices (e.g., Magic Mirror, Memory Mirror). AR in the forms mentioned above can be applied in different contexts depending on a company's goals, and some retailers have started introducing their customers to this technology. Neiman Markus, for example, has set up Memory Mirror in some of its stores. This AR transforms customers' shopping experience by enabling them to see how an outfit they are contemplating purchasing looks from any angle, and they can compare different outfits they have already tried on simultaneously. Some AR applications can even be installed on smart devices. One successful example is Pokemon Go, a highly engaging AR application that seized game players' attention around the world.

To investigate how satisfactory experiences with AR are formed, this study applied equity theory and drew on two concepts: augmentation quality and user's control of access to personal information. Augmented reality generates personalized output to the use and augments reality by superimposing virtual content onto reality, so the quality of augmentation is essential to the formation of satisfactory user experience. To address this issue, this study developed a concept called *augmentation quality* and proposed that augmentation quality is the main source of user satisfaction. Augmented reality displays personalized output based on users' personal information such as location, personal pictures, and so on. Since Internet users are sensitive about who has access to their

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https://doi.org/10.1016/j.jretconser.2017.12.010
Received 2 October 2017; Received in revised form 20 December 2017; Accepted 20 December 2017

personal information, they may hesitate to share it with augmented reality applications. Some AR applications have been known to irritate users by violating their privacy with requests for such personal information as email address, name, or location, which the application needs to generate personalized output (Olsson et al., 2012). Face recognition applications, which have computer vision, cloud computing, and recognition technology, allow users to point their smart devices at a stranger, and, if that stranger has entered personal information into an AR application, the stranger's personal information such as age, occupation, pictures, and so on can be displayed on the pointer's screen. Obviously, such technology is unappealing, as people do not like the idea of being identifiable to strangers. Augmented reality is an astonishing technology. It delivers fruitful output and enjoyment, and it gratifies users by creating a fantasy world in which they can immerse themselves, but it might well frustrate users when they feel it threatens their privacy. Designing AR that violates users' sense of privacy is not only unethical, it also destroys users' delight in using it.

This study applied equity theory to explain how user satisfaction is formed when both user's control of access to personal information and augmentation quality are activated. This study attempts to answer the following research question:

> RQ1: How is user satisfaction formed when augmentation quality generated by augmented reality and user's control of access to personal information are involved?

The remainder of this paper is organized as follows: first, a brief literature review of the main concepts drawn on for the study is presented. Next, the hypotheses, methodology, results, and discussions are described and explained. Finally, managerial implications are provided.

## 2. Conceptual framework and hypotheses development

### 2.1. Augmented reality

Augmented reality is defined as the integration of real world and virtual world information that enhances a specific reality (Lamantia, 2009). Applying technology to retail contexts enhances customers' shopping experience (Pantano and Timmermans, 2014). Studies have shown the advantages of such technologies as augmented reality in retail contexts, as they are media that enrich customer's experience (Pantano and Servidio, 2012; Poushneh and Vasquez-Parraga, 2017). Some customers resist purchasing online because they lack product information, and being inadequately informed about products makes a purchase decision risky (Kim and Forsythe, 2008a). Augmented reality can compensate for this lack of product information, and also the inability to handle products, by creating a three-dimensional augmented experience (MacIntyre et al., 2001; Lu and Shana, 2007; Pantano and Servidio, 2012; Papagiannidis et al., 2017). Direct contact with desired products is important to shoppers because they acquire product information through the sensory shopping experience—visual, audio, text, and so on—that assists them in the process of decision-making (Papagiannidis et al., 2017). This is the advantage of augmented reality; it can provide a powerful simulation of the shopping experience that enables online shoppers to better evaluate desired products (Kim and Forsythe, 2008a) and make decisions with more certainty (Poushneh and Vasquez-Parraga, 2017; Papagiannidis et al., 2017; Pantano et al., 2017; Oh et al., 2008). As they experience an interactive, three-dimensional picture of a product (Fiore et al., 2005), customers are provided with appealing and enjoyable experiences (Papagiannidis et al., 2017; Yim et al., 2017; Li et al., 2001). In fact, the quality of information generated by augmented reality is able to change customers' behavioral intention (Pantano et al., 2017). High-quality, positive experiences with such technology as augmented reality satisfies customers and increases their willingness to buy products from retailers equipped with augmented reality technology (Poushneh and Vasquez-Parraga, 2017). Consequently, high quality augmented reality not only creates shopping experiences, it also enriches them (Poushneh and Vasquez-Parraga, 2017).

This study applied equity theory to understand how customers become satisfied when augmentation quality and the privacy of personal information are taken into account. Equity theory (Adams, 1963) posits the idea that people are willing to use technology if their perception of equity is higher than it is when the conditions in which their perception of equity is lower. Perceived equity is shaped by users' comparison of what they receive (output) to what they sacrifice (input). When the output is superior to the input, the perceived equity is higher, and when the output is inferior to the input, the perceived equity is lower. This theory asserts that users decide to share their personal information with AR when they perceive a higher value to be gained from AR (augmentation quality) than they do with what they share (control of access to personal information). User satisfaction is shaped by the evaluation of the value of output compared to that of the input.

### 2.2. Augmentation quality

Augmented reality generates personalized output for the user. This study employed a new concept, augmentation quality. As employed in this study, augmentation quality is similar to the augmentation concept used in Javornik's study (2016), but broader. The concept of augmentation quality is the focus of this study; and one aspect of user experience which is merely generated by interacting with augmented reality. It refers to the output quality that results from interaction with virtual content and the integration of virtual and real content onto a reality in terms of information quality, correspondence quality or mapping quality, etc.

### 2.3. User satisfaction (US)

User satisfaction "is not [only] the pleasurableness of the [consumption] experience, it is the evaluation rendered that the experience was at least as good as it was supposed to be" (Hunt, 1977, p. 459). The lack of congruence between what users expect and what they receive results in dissatisfaction (e.g., Oliver, 1981). The idea behind AR is to create satisfaction by facilitating shoppers' decision-making (Kim and Forsythe, 2008a, 2008b) while reducing their anxiety. If successful, AR creates value and enhances shopper attitude (Yim et al., 2017) and shopper satisfaction (Huang and Feng, 2014; Bulearca and Tamarjan, 2010).

Although AR users are aware of the output generated by AR, they are unaware of the inner process occurring in the AR software. From the user's perspective, augmentation quality represents the capability of AR, and if the output is high quality, users are satisfied (Wang and Chen, 2011) and are likely to recommend AR to others (Jung et al., 2015). But if AR produces poor augmentation quality, users will not find their experience with AR satisfactory.

Makeup Genius is an excellent example of high quality augmentation. This AR application enables users to select makeup and apply the virtual cosmetics to a representation of the user's face. The application is useful as well as pleasing. Although generally speaking AR is marvelous technology, some AR applications are not sophisticated enough to display practical and/or sufficient output. Star Chart or Sky Walk, for example, are two applications that clutter the screen of a user's smart device with too much information and too many images (e.g., stars), and thus they overwhelm users with too much virtual content. Another example is Cimagine, a mobile application that integrates a three-dimensional picture of furniture into reality, but there is no consistency between the actual size of the real location where the furniture is to be placed (reality) and the size of the virtual furniture. In this case, a user is likely to feel dissatisfied and frustrated with this application. Thus AR is not always practical for shopping decisions. Therefore, this study postulates that as augmentation quality improves, AR users become more satisfied than they do when augmentation quality is poor.