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Consumers and Augmented Reality in Shopping and Services: Drivers and Consequences

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CONSUMERS AND AUGMENTED REALITY IN SHOPPING AND SERVICES: DRIVERS AND CONSEQUENCES

A Dissertation

by

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ABSTRACT

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This dissertation investigated the effect of augmented reality on user experience and also the mediation effect of user experience in the relationship between augmented reality and the outcome variables including user satisfaction and user's willingness to buy/user's willingness to use augmented reality. Three studies were conducted in three different contexts, including buying consumer products, entertainment services and vehicle service use. The results indicate that augmented reality significantly and positively influences user experience, and user experience fully mediates the impact of augmented reality on user satisfaction and user's willingness to buy/ user's willingness to use augmented reality. Further, the results showed that trade-off between price and value, user's information privacy control, perceived control and responsiveness moderate the effect of augmented reality on user experience.

In addition, a new scale was developed to capture and measure the output quality in terms of image recognition generated by augmented reality. Additionally, a new aspect of user experience exclusively driven by augmented reality was developed and added to the current user experience scale.

DEDICATION

This dissertation is dedicated to my parents who encouraged me during these years. My mother cheered me on when I was extremely discouraged to continue; my mother inspired me to accomplish my Ph.D. Thank you for all your support.

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I would like to thank my committee members for all their advice.

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CHAPTER I

INTRODUCTION

Augmented reality (AR) was introduced about 35 years ago (Sutherland 1968). AR originated in military aviation (Lamantia, 2009), and facilitated the assembly of aircraft by overlaying computer-presented material on top of the reality. Caudell & Mizell (1992), who worked at Boeing Corporation, made explicit use of “augmented reality”. Although practitioners and academicians have defined AR in a variety of ways, they all agree that AR refers to a series of technologies, able to integrate real world information and digital information enhancing a specific reality (Clawson, 2009; Lamantia, 2009; Shute, 2009).

Let’s start with a practical example. A customer enters a toy store and intends to purchase a box of unassembled toys. The customer may or may not know how a toy will look after assembling the parts included in the toy box. To help the customer to make a decision, augmented reality (AR) enables the customer to visualize the whole toy set before buying it. In fact, the customer can use augmented reality or mobile augmented reality application, which is installed in his /her tablet, iPad, or smartphone, and observe the three dimensional (3D) assembled picture of the toy.

In another example, a customer intends to buy sunglasses by online shopping. The customer can use an augmented reality (AR) application, such as virtual try on application to see how he/she looks without his/ her presence in the real store. In fact, instead of trying sunglasses on his/ her face, the customer can see the virtual sunglasses on his/ her face via the augmented reality application. AR applications are used not only for product shopping, such as sunglasses, dresses, cosmetics, furniture, but also for service experiencing or using, such as Space Journey, Junaio, Pocket Universe: Virtual Sky Astronomy, Layer AR, Yelp, Wikitude, Postal service (USPS), and Google Skymap.

In a third example, a customer tries to buy a piece of furniture, such as a sofa, by looking at an AR device to see how it fits and looks in his house living room. For that purpose, for instance, IKEA developed an augmented reality application, called IKEA Catalogue application for its customers. The customers can download the application from the following link: https://itunes.apple.com/us/app/ikea-catalog/id386592716?mt=8. Customers can choose their favorite products from the IKEA Catalogue and observe how those products look in their places, by using a mobile application and a smartphone or tablet.

In these examples, AR technology helps users make decisions when shopping for products. In addition, AR is applied in service provision and can be used by both customers and service employees. For example, AR can help service employees perform maintenance procedures. ARMAR is one of the AR applications invented by Steve Henderson and Steven Feiner at Columbia University. ARMAR helps mechanics accelerate their maintenance procedures by generating computer graphics that are superimposed on the actual equipment that is under maintenance. Therefore, the results are more accurate, productive, and safe. Another example in service area is MARTA (Mobile Augmented Reality Technical Assistance) designed by Metiao and used by service employees in Volkswagen. MARTA provides information related to real and virtual parts in three dimensions. The service employees can observe the information provided by the MARTA on their tablets.

Another example, AR is used not only in performing service maintenance, but also in providing medical services. Surgeons can see the insides of their patients' body layer by layer by wearing a head-mounted display (HMD), such as Google glass. In other words, HMDs can augment the vision of surgeons and provide virtual information about which parts of the patient's body need to be operated. For example, surgeons can wear Google glass to perform surgery. A study conducted by Stanford Medical School and Vital Medicals showed that the surgeons who wear Google glass during surgery performed much better than the surgeons who did not wear such technology (http://venturebeat.com/2014/09/16/docs-performed-surgery-better-wearing-google-glass-stanford-study-shows).

In addition, AR can help customers have more fun and experience better quality service. For example, McDonald has launched a mobile application called Track My Macca's, which is available in App store. Customers can install a free version of the application on their iPhone. This mobile application allows the customers to track ingredients of food they want to have in McDonald stores. Track My Macca's uses GPS, image recognition, and data & time. GPS allows the mobile application to be informed which restaurant he or she is; image recognition scans the image of food that the customer wants to eat; and data & time allows the customer to have access to supply chain information in real time. Overall, Track My Macca's is a type of AR mobile application that augments the perception of the customers in relation to the food they have (Lum, 2013; http://www.creativeguerrillamarketing.com/augmented-reality/mcdonalds-augmented-reality-app-shows-whats-inside-your-meal/) . In those examples, AR technology helps users make decisions when experiencing a service. AR technology helps service providers enhance, even deliver, the specific benefits customers look for and receive.

Research Problem

Although AR is so beneficial for users, not all users are content with using AR. Some AR apps request users' information, such as email address, location, or name, which is challenging for some users (Olsson 2012). For example, an application called TAT allows a user to point his or her smart phone at a stranger and quickly find out all the information related to the stranger from Internet. The TAT uses face recognition technology, computer vision, cloud computing, and augmented reality to collect some information about the stranger, which is not ethically acceptable, and violates people privacy.

AR technology is not socially acceptable if AR neglects people' needs such as information privacy. User's actual needs, desire, and wants should be taken into account when AR is designed (Swan & Gabbard, 2005).

Research Gap

The literature about augmented reality has emphasized the technological developments of AR and neglected the consumers and end user's actual needs, problems and perspectives (Yim & Chu, 2012; Swan & Gabbard, 2005). Yet, AR technology is increasingly employed in designing and delivering products, even though research has not been able to catch up with the trend, in particular the growing impact of augmented reality on user experience. There is a lack of research on the use of augmented reality from a marketing perspective (Kozick & Gettliffe, 2010). Thus, this study attempts to understand the way augmented reality influences user experience and, at the outset, customer's satisfaction and willingness to buy or willingness to use AR.

In addition, earlier user experience studies focused on the cognitive dimensions of user experience such as usability (e.g., Butler 1996) and ignored the affective dimensions. For example, many studies investigated pragmatic quality as a dimension of the user experience. To correct such narrow focus, a user-centered design (UCD) emerged and embraced both the cognitive and affective dimensions of user experience (Alben, 1996; Hassenzahl & Roto, 2007). A user-centered design balances the affective components of user experience with the cognitive components. Although prior literature studied some user experience's dimensions, there is not a shared agreement about measuring user experience (Vermeeren et al., 2010).

Consequently, this study applies a user-centered framework to understand and measure user experience from the user's perspective. The emerging concept of user-centered design (UCD) will be emphasized. Because UCD focuses on end users' needs in order to design products (ISO 1999), marketers are required to identify end users' needs, desires, and perceptions in order to reflect them in the design process of augmented reality (Swan & Gabbard, 2005). Thus, UCD involves the users into the design (Karat, 1996). A user-centered design of augmented reality can help achieve both aims, a better understanding of the user experience gained from using augmented reality technologies, and a better knowledge of end users' needs, the reasons why consumers become involved with the product. Ultimately, augmented reality helps consumers have a better understanding of their own choices by improving their user experience.

Research Questions

This research seeks to understand how augmented reality influences user experience, and how AR influences users' satisfaction and users' willingness to buy by mediating user experience. Thus, it attempts to answer the following research questions:

RQ1: How does augmented reality improve user experience? Why is it important that augmented reality enhances the user experience?

To develop AR applications, practitioners have emphasized the engineering and technology aspects of augmented reality, such as AR software and hardware (Swan & Gabbard, 2005). As a result, many companies have focused on the technology aspects of augmented reality (Yim & Chu, 2012; Anastassova et al. 2007; Dhir & Al-Kahtani, 2013) and neglected the marketing consequences of such practice. Authors agree that users' actual needs and desires have not been addressed adequately (Anastassova et al., 2007), and AR developers over-emphasize technology and innovation aspects of AR while they neglect marketing aspect of AR (Kozick & Gettliffe, 2010). Companies need to establish a balance between the technology components and consumer or marketing components (Kozick & Gettliffe, 2010).

RQ2: Which and how do key factors moderate the relationship between augmented reality and expected user experience, if any?

The relationship between AR and user experience (UX) may be strengthened or weakened by external factors. There is a need to know the key external factors moderating the relationship between AR and user experience (UX). This study includes the impact of trade-off between value and price and the user's information privacy control as the moderators in the pilot study (integration of study 1 and study 2), and the impact of trade-off between value and price and the user's information privacy control, control, responsiveness, image interactivity as the moderators in study 3. The knowledge generated from an end-user view of the relationship and its key external factors can help AR companies to design and develop AR apps that are more adaptable to different users and more beneficial to customer's need satisfaction. Additionally, this research addresses how user experience mediates the impact of augmented reality on the outcome variables.

RQ3: What are the effects of user experiences on two main consumer outcomes, user satisfaction, and user's willingness to buy/ user's willingness to use augmented reality?

RQ4: How does user experience mediate the effect of augmented reality on user satisfaction and user's willingness to buy/ user's willingness to use augmented reality?

It is expected that user experiences gained from augmented reality enhances user satisfaction, and user's willingness to buy/ user's willingness to use augmented reality. Further, it is expected that user experience with augmented reality mediates the relationship between augmented reality and the outcome variables.

Objectives

In consonance with the four research questions, this research attempts to fulfill four objectives.

OBJECTIVE 1: To examine how augmented reality improves or enhances user experience and to understand its importance.

The number of users downloading AR applications is increasing (Miller, 2015). According to Juniper Research, users have downloaded more than 2.5 billion mobile augmented reality (AR) apps to their smartphones or tablets in 2017 (Miller, 2015). Therefore, more quantitative research is required to evaluate and measure user experience of augmented reality. There is a need to evaluate and measure the extent to which AR influences user experience and, by doing so, we better understand how AR motivates and engages users in the production and usage of enhanced reality.

Consequently, this research applies a user-centric design rather than a technology-centric design. In technology-centric designs, companies emphasize technology and make products that are technology-oriented rather than end-user- oriented (Anastassova et al., 2007). In user-centric designs, the emphasis is on the qualities and requirements of the product in order to satisfy actual consumers' desires and needs (Kozick & Gettliffe, 2010).

To understand users' experience from users' perspective, this research uses a person-centered or user-centered framework and includes four dimensions of the user experience, describing how consumers evaluate products, that is, on the basis of pragmatic quality, aesthetic quality, and hedonic quality (by identification and stimulation). The four dimensions are selected based upon prior literature related to user experience. Four dimensions of user experience, namely pragmatic quality, hedonic quality by stimulation, and hedonic quality by identification are selected from previous studies (e.g., Hassenzahl 2003; Law, Van Schaik, & Roto 2014), and one dimension of user experience is also selected from past literature (e.g., Laugwitz, Held, & Schrepp, 2008) due to its importance to user experience.

OBJECTIVE 2: To investigate which key factors, if any, moderate the relationship between augmented reality and user experience, and explain how such moderation occurs.

This research includes two moderators for first and second studies, namely the trade-off between value and price and the user's information privacy control; and adds three more moderators to study 3 namely: perceived control, responsiveness, and image interactivity. The knowledge generated from an end-user view of the relationship and its key external factors can help AR companies to design and develop AR apps that are more adaptable to different users and more beneficial to customer's need satisfaction.

OBJECTIVE 3: To examine the effects of user experience, that is influenced by augmented reality, on two main outcomes, user satisfaction and user's willingness to buy/ user's willingness to use AR.

OBJECTIVE 4: To address the mediation impact of user experience in the relationship between augmented reality and two main outcomes, user satisfaction and user's willingness to buy/ user's willingness to use AR.

This study examines two main effects of user experience namely user satisfaction and user willingness to buy in the pilot test (integration of study 1 and study 2), and user satisfaction and user's willingness to use AR in the actual dissertation test. Overall, the results are expected to show the extent to which user experience mediates the relationship between AR and user satisfaction and willingness to buy.

To achieve the above objectives, this study employs quantitative research methods that allow the researcher to understand (Huck, Cormier, & Bounds, 2011; Kerlinger & Lee, 2000) the impact of AR on users' experience, and subsequent impact on two key consumer outcomes, user satisfaction and user's willingness to buy. The results of the study can also help companies and augmented-reality designers become more mindful of user's needs and desires while accomplishing their technological pursuits (Kozick & Gettliffe 2010).

Limitations and Delimitations

This research has a few limitations and delimitations. First, this study only includes the impact of augmented reality on user experience and includes a few moderators and two outcome variables in the model. The moderation effect of variables such as user's personality, ethnicity, culture, technology readiness, or user's innovativeness are not included in the conceptual model.

Second, this thesis focuses on four important dimensions of UX generated by augmented reality, pragmatic quality, hedonic quality by stimulation, hedonic quality by identification, and aesthetic quality.

In what follows, key concepts related to the framework are presented in chapter 2. The chapter first defines and discusses user experience, augmented reality and how the augmented reality influences the user experience. It then presents and discusses the moderating factors of the relationship between augmented reality and user experience. It finally introduces and discusses two key outcomes of the AR-UX relationship, user satisfaction, and user's willingness to buy.

CHAPTER II

CONCEPTUAL FRAMEWORK

This chapter presents the conceptual framework regarding the impact of augmented reality on user experience and subsequent impact on user satisfaction and user's willingness to buy. The following section reviews literature related to the basic concepts adopted and their relationships. The basic concepts include user experience, augmented reality, user satisfaction, willingness to buy, the trade-off between price and value, and user's information privacy control. The key relationships include 1) the impact of augmented reality on user experience, 2) the role of key moderating factors on the AR-UX relationship, and 3) the subsequent impact of the AR on two outcome variables, user satisfaction and user's willingness to buy.

Basic Concepts

User Experience (UX)

User experience (UX) refers to "a person's perceptions and responses that result from the use and/or anticipated use of a product, system, or service." (ISO9241-210). Further, according to Alben (1996), user experience is defined as "All the aspects of how people use an interactive product: the way it feels in their hands, how well they understand how it works, how they feel about it while they are using it, how well it serves their purposes, and how well it fits into the entire context in which they are using it” (Alben 1996, p. 5)

User experience seems to focus on the end of interaction rather than the means of interaction (Robert & Larouche, 2012) and includes all aspects of interactions between the product and the user (Alben, 1996; Arhippainen & Tahti, 2003; Forlizzi & Ford, 2000). For instance, it includes not only an evaluation of the product benefits (e.g., usability) but also an evaluation of the human response, e.g., the affective and socio-cognitive characteristics of user experience (Hassenzahl & Tractinsky, 2006).

Traditional methods evaluate user experience in terms of usability (Butler, 1996), which corresponds to pragmatic quality (Hassenzahl et al., 2003). Usability refers to the effectiveness, efficiency, and satisfaction of the user experience (ISO 9241, 1998). Since the usability aspect of user experience covers a narrow scope of UX, it may not be considered as a criterion to evaluate all characteristics of the user experience (Norman, 2004).

However, recent studies on user experience of interactive technologies have paid attention to non-instrumental characteristics of user experience, such as hedonic quality (Hassenzahl et al., 2000), emotional perspectives of interaction (Hassenzahl et al., 2003, pleasure (Jordan 1998), beauty (Tractinsky et al. 2000), and fun (Draper 1999). There is a need to establish a coherent framework to study user experience.

User Experience Framework. Different theoretical models of user experience (UX) have been developed over a decade (e.g. Logan, 1994; Jordan, 2000; Hassenzahl, 2001; Mäkelä & Fulton Suri, 2001; Garrett, 2002; Battarbee, 2004; Mahlke, 2008). Since the concept of UX is very broad, different characteristics of UX have been emphasized. In fact, user experience is ambiguous, abstract (Park et al., 2013), holistic, and subjective, as felt by the user (McCarthy & Wright, 2004), and varies across time (Law et al., 2009).

Different authors focused on different characteristics of UX, such as temporality (e.g., Karapanos, Zimmerman, Forlizzi & Martens, 2009); the social characteristics of UX (Battarbee, 2003), instrumental characteristics (e.g., Hassenzahl & Tractinsky, 2006; Law & van Schaik, 2010), non-instrumental characteristics (e.g., Hassenzahl & Tractincky, 2006; Law & van Schaik, 2010), and emotional characteristics (Mahlke, 2005; Norman, 2004).

More specifically, user experience can be studied in various ways, 1) as a person-centered or user-centered framework (what people need), 2) as a product-centered framework (it is related to product design), and 3) as an interaction-centered framework (it is related to user interaction) (Battarbee, 2004). This study will follow the person-centered or user-centered framework.

Previous studies point out that user experience (in a user-centered framework) is the result of three components. First, UX is the result of the user’s internal state, such as expectations, needs, motivation, and mood (Hassenzal & Tractinsky, 2006; Arhippainen & Tahti, 2003). Second, UX is influenced by the design features of the product, such as weight, size, aesthetics, complexity, usability, and functionality (Hassenzal & Tractinsky, 2006; Arhippainen & Tahti, 2003). Third, the context in which the interaction occurs also influences UX, such as organizational or social setting, meaningfulness of the activity, and cultural setting, time, and place (Arhippainen & Tahti, 2003; Hassenzal & Tractinsky, 2006). Thus, UX consists of three elements, user characteristics, product characteristics, and the context of product use (Park et al., 2013; Zimmermann, 2008). One way to quantify UX is to use these three components and measure them. This thesis adopts this framework to keep order and meaning in the concepts to be adopted, and addresses user characteristics, product characteristics, and context of product use sequentially.

Users may have two types of goals while interacting with products, namely do-goals and be-goals (Hassenzahl, 2004). The do-goal is practical and task-oriented, whereas the be-goal is related to fun and entertainment. Further, users' emotional and affective characteristics are also emphasized in the prior studies (e.g., Hassenzahl & Tractinsky, 2006; Norman, 2004). Emotional user reactions also are related to subjective feelings, motor expressions, physiological reactions, and cognitive actions (Mahlke, 2008). Norman (2004) emphasized the role of emotion for designing UX because users' emotions can be changed through product interaction (Hassenzahl & Tractinsky, 2006). In other words, the consequences of the UX can be both cognitive and emotional (Hassenzahl & Tractinsky, 2006).

Product attributes can be instrumental and non-instrumental (Zimmermann, 2008). The importance of non-instrumental qualities of a product has been emphasized in the previous literature (e.g., Hassenzahl & Tractinsky, 2006; Huang, 2003; Hassenzahl, 2004; Thuring & Mahlke, 2007). Non-instrumental quality deals with human needs, which are beyond instrumental quality. Non-instrumental qualities include aesthetic, symbolic, and motivational characteristics of human behavior (Mahlke, 2008). Conversely, instrumental quality is related to the achievement of behavioral goals. Instrumental qualities include utility and usability (Mahlke, 2008). Qualities that are evaluated under this type of product attribute include utilitarian (e.g. Batra & Ahtola, 1990), functional (e.g. Kempf, 1999) and pragmatic quality (e.g. Hassenzahl, 2004). Prior studies have shown the impact of instrumental and non-instrumental qualities on product appeal (Huang, 2003; Hassenzahl, 2001), behavioral (Mahlke, 2008), and user's emotional response (Thuring & Mahlke, 2007; Mahlke, 2008). In addition, the context of product use is also part of UX evaluation.

Overall, UX design for interactive products is complex (Forlizzi & Battarbee, 2004). Interactive products need to include users' emotions and how the users interact with the product, and other people (Forlizzi & Battarbee, 2004). UX is a dynamic, subjective, and context-dependent concept (Law et al., 2009). Further, it relies on the user, who interacts with the product, the context, the system, and an activity performed by the user through interactions. The user experiences human needs in the first place.

Quantifying User Experience. Quantifying UX is also important because it provides a guideline for product designers to choose effective design strategies (Law & van Schaik 2010). Quantifying UX helps decision makers evaluate the potential value of products and compare among different alternatives or prototypes (Park et al., 2013).

However, there are various perspectives on how to measure UX. Some authors argue that UX should be assessed through quantitative research (e.g., Laugwitz, Held, & Schrepp, 2008; Hassenzahl 2004), and some scholars emphasize that UX study should be evaluated through qualitative research (e.g., Law et al., 2009, McCarthy & Wright 2004). As pointed out previously, UX is a complex construct that encompasses characteristics of the user's inner state, characteristics of the product and the context of use (Hassenzahl & Tractinsky, 2006), all of which should have to be measured. In addition, factors influencing the concept of user experience can also be identified (Schulze & Kromker, 2010). Different UX frameworks have emphasized different characteristics of UX.

To quantify UX, different product' attributes may be evaluated. Prior studies considered studying the product pragmatic and hedonic qualities (e.g., Hassenzahl, 2004; Hassenzahl &

Roto, 2007; Hassenzahl, Diefenbach & Gor tz, 2010; Mahlke, 2008). Pragmatic quality refers to the product's perceived ability to achieve the specific goal and emphasizes the utility and usability of a product in relation to potential tasks. Hedonic quality refers to the ability of a product to be competent, special, or related to others and focuses on the self rather than the product (Hassenzahl et al., 2010).

Prior studies combined qualitative and quantitative approaches to UX. Bargas-Avila & Hornbaek (2011) reviewed 66 empirical studies related to UX from 2005 to 2009 and found that most of the UX studies are qualitative. The few quantitative studies emphasized the usability aspect rather than hedonic aspect of UX. Content-wise; prior UX studies included emotions, affect, enjoyment, aesthetics, hedonic quality, engagement, flow, motivation, enchantment, and frustration as dimensions of UX.

User Experience Questionnaire (UEQ) was developed for measuring the UX with software products (Laugwitz, Held, & Schrepp, 2008). UEQ uses six UX dimensions (overall 26 items), namely attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty. Robert & Lesage (2011b) identified several UX dimensions including functional, social, psychological, physical, cognitive, informational, contextual, cultural, and temporal and perceptual. Olsson (2012) classified user experiences into six classes: instrumental experiences, cognitive and epistemic experiences, emotional experiences, sensory experiences, motivational experiences, and social experiences. Provost and Robert (2013) identified the following six UX dimensions: psychological, functional, and usable, cognitive, informational, and perceptual; and asserted that each UX's dimension might be a source of positive and negative user experience. Finally, Kim et al. (2009) and Park et al. (2009) identified three UX dimensions including usability, affect, and user value. Park et al. (2011) mentioned that their 22 items capture the broad characteristics of UX, that is, usability, affect, and user value. Usability relates to objective product performance. Affect reflects user's feelings as part of the interaction between the user and the product's image or appearance. Overall, different studies identified different characteristics of UX; and there is not a global UX measure (Vermeeren et al., 2010).

This study focuses on four common dimensions of UX, pragmatic quality, hedonic quality by stimulation, hedonic quality by identification, and aesthetic quality. Based on prior UX studies (e.g., Hassenzahl (2003); Law (2010)) three dimensions, namely pragmatic, hedonic quality by stimulation, and hedonic quality by identification were selected, and aesthetic quality (e.g., Kort et al., 2007; Desmet and Hekkert 2007) was selected because beauty of product affects user properties provided by AR. Consequently, four dimensions were selected to represent more comprehensive characteristics of user experience. They are explained below.

Augmented Reality

The term of augmented reality was first used by Caudell & Mizell (1992) when working for the Boeing Corporation. It originated in military aviation (Lamantia, 2009) where it was used to facilitate the assembly of aircraft by overlaying computer-presented material on top of the reality. AR technologies integrate digital information into a user's real world and help the user to perform his or her tasks. In other words, the physical reality becomes enriched with virtual information, and the user perceives a new reality formed as the result of the interaction between physical and virtual reality. In fact, the user may not be aware that such augmentation occurs (Olsson, 2012).

Augmented reality (AR) is a segment of a broader concept, Mixed Reality (MR) (Drascic & Milgram, 1996). MR refers to the overall integration of the real and virtual world, through which new mixed spaces or realms are created (Milgram & Kishino, 1994). AR is also called

Mediated Reality in reference to an artificial modification of human perception. Mediated reality involves either the augmentation or the reduction of objects. Diminished reality is the opposite of augmented reality; it eliminates part of reality around us, and diminishes user's perception of reality (Lepetit & Berger, 2001). Augmented or amplified reality enriches real-object properties with the help of computation (Falk et al., 1999). Indeed, MR creates an intersection where real and virtual-world objects are present together in a single experience (Schnabel 2006).

MR ranges from being more real to being more simulated or virtual. In fact, the continuum of MR may include reality, augmented reality, augmented virtuality, and virtuality. In the virtual end of the continuum, virtual reality refers to a computer generated, interactive, and 3D environment in which the user can be immersed (Rheingold, 1991). Virtual reality "virtualizes" a real environment by generating a 3D structure of the scene, such as 3D images (Kanade et al., 1995). Augmented reality refers to an integration of computer graphic generated inserted into the real world (Milgram & Kishino1994). Augmented virtuality refers to the augmentation of a virtual setting with real objects (Milgram & Colquhoun, 1999), or to augmented objects by computer graphics or virtual objects (Milgram & Kishino1994). Reality or the real environment is the opposite of a virtual environment (Milgram & Kishino, 1994).

Although practitioners and academics define AR in a variety of ways, they agree that AR refers to a series of technologies, which integrates real world information and digital information, enhancing a specific reality (Clawson, 2009; Lamantia, 2009; Shute, 2009). Practitioners have usually emphasized the engineering and technology characteristics of augmented reality, such as software and hardware, when developing AR applications (Swan & Gabbard, 2005). Many companies have paid special attention to AR technology (Yim & Chu, 2012) and develop AR devices that can be easily installed on iPads, iPhones, or smartphones.

According to Juniper Research, mobile augmented reality (MAR) or mobile apps will generate a quarter of a billion AR downloads in 2015 and over 2.5 billion AR downloads in 2017. There is an increasing number of mobile augmented reality applications today, to mention some: Modi Face, EZMake Up, Make Up Genius, Star Chart, SKY ORB, Virtual Try-On Ray-Ban, Snap Shop, My Chic, Space Walking, Junaio, Augment, Hair style Life, Space Journey.

Although the number of AR applications developed is increasing, there is a lack of research on the user or consumer side. There is not such a thing as user-centered design of AR, even though researchers have recognized that AR technologies started moving from technology-centric designs to user-centric designs (Swan & Gabbard, 2005).

AR or mobile augmented reality (MAR) can help users make decisions before shopping (Oh, Yoon, & Shyu, 2008). For example, toymakers use video displays to present their products to their customers. Lego Digital Box Kiosk applies a MAR app that uses the box of a toy to generate virtual information and displays a complete picture of the toy after assembling the parts included in the toy box (Kipper & Rampolla, 2013). Even though most companies producing AR technologies focus more on the technological characteristics of AR, Lego Digital Box Kiosk gives consumers an opportunity to visualize a complete set to help them in the process of decision-making before purchasing. This example shows users benefiting when shopping. Other users look for AR advantages in the provision of services. For example, there are AR browsers that help consumers locate and search for targeted information through the Internet via a mobile phone (Kipper & Rampolla, 2013). In another application, users can point their phone camera at any reference in the real world and find information that is related to it. For instance, the Junaio iPhone app allows users to add, edit, and animate 3D objects the user picks. The user can share those pictures using social networks.

Furthermore, augmented reality can be used as an interactive marketing tool. Three-dimensional virtual models are interactive technologies that allow users to represent their personal bodies (Shim & Lee, 2011). Users can zoom in, zoom out, and rotate products (Kim & Forsythe, 2009). For example, Zugara webcam social shopping allows customers to zoom in, zoom out, change clothes, and even share their pictures with new clothes. In addition, this AR application allows retailers to assess the extent to which customers are favorably interested in their products (Burke, Rangaswamy, & Gupta, 1999) before they invest in new products that have not been produced yet (Oh, Yoon, & Shyu, 2008).

Finally, to illustrate another AR usage, Image Interactivity Technology (IIT) is used in online contexts to simulate products features (Fiore, Kim, & Lee, 2005). It bestows enriched product information that is similar to the product information available at the store. IIT can simulate the user's shopping experience in online shopping. For instance, a customer may access virtual try-on models to experience various versions of glasses, clothing, or shoes before purchasing. For example, by wearing HMD or head mounted display, such as AR glasses, a customer is able to see virtual information that is inserted into real world. Tesco is the first UK retailer to launch a Google Glass shopping app that allows customers to browse Tesco products and get more information about the products (e.g., product's nutrition) (Clark, 2015).

Level of Interactivity of the User with Augmented Reality. The effect of AR on UX and the outcome consequences seems to be influenced by the level of interactivity of the user with AR. Therefore, this research will consider at least two levels of interactivity to control for such difference, high interactivity and low interactivity. It is assumed that a high level of interactivity will generate stronger relationships between AR and UX and between UX and the outcome variables. Conversely, a low level of interactivity will generate weaker relationships between AR and UX and between UX and the outcome variables.

Interactivity refers to the “extent to which users can participate in modifying the form and content of a mediated environment in real time” (Steuer, 1992, p. 84). Interactivity entertains users and allows them to customize and personalize information in a 3D virtual model (Fiore, Kim & Lee, 2005). 3D virtual models are useful for both online environments and real environments. Interactivity empowers users to modify the color, or background of a product (Fiore & Jin, 2003; Li et al., 2001). For example, users enjoy more through the image interactivity with virtual objects (Li et al., 2001). Another example is virtual model, which is a more advanced type of image interactivity technology that allows a user to select his/her favorite dresses among different model of dresses.

In the pilot test (integration of study 1 and study 2), AR was considered as a condition. The pilot test manipulated the level of interactivity of AR in order to capture its impact on UX. Thus, controlling the pilot study by the level of interactivity is crucial. To put it simply, participants were exposed to two different AR conditions that present two different levels of interactivity of AR will be exposed to the participants of this study, and the results were will be compared with the non-AR condition. More on this is explained in the methodology chapter.

AR is already a technology providing many features of interactivity between a user and an augmented product. For instance, users interact with 3D virtual models provided in AR technology (e.g., 3D product image, haptic interface) rather than 2D virtual models in non-AR technology. Moreover, online transactions generally require interactivity (Lee, 2005). For example, some websites such as Ray-Ban include some features of augmented reality in order to facilitate online shopping for the consumers. The Ray-Ban website provides features for the users to pick and customize their favorite sunglasses or eyeglasses from a catalogue and allows users to personalize their favorite products. Users can see the virtual products (the virtual image of eyeglasses or sunglasses) on their faces, even take a photo of their augmented reality image and share on social networks, such as Facebook.

Lee (2005) identified four components of user interactivity for users of websites: control, responsiveness, personalization, and perceived connectedness. User control refers to the ability of a user to have control over the information. Responsiveness refers to the ability of the website to respond to the user. Personalization gives the power of customization of products to the user. Perceived connectedness focuses on the user's desire to share his experiences about products with others. In addition, interactivity has been found to be a multi-dimensional construct, one that includes playfulness, choice, connectedness, information collection, and reciprocal communication (Ha & James, 1998). The pilot test (integration of study 1 and study 2) employed a true experiment to capture the effect of AR on UX and its subsequent outcomes.

Outcome Variables

Based on importance, two outcome variables are considered in this research, user satisfaction and user willingness to buy.

User Satisfaction

Customer satisfaction refers to customer's transaction-specific perspectives and cumulative perspectives. In a transaction-specific perspective, a customer evaluates an alternative based upon his / her recent purchase experience (Boulding et al., 1993). In a cumulative perspective, a customer performs an overall evaluation of his / her various purchase experiences (Johnson & Fornell, 1991). Some authors indicate that customer satisfaction is the result of customer's cumulative perspective (Parasuraman et al., 1988).

Customer satisfaction is both cognitive and affective (Mano & Oliver, 1993; Westbrook, 1987; Westbrook & Oliver, 1991). Yet, customer "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). Moreover, customer satisfaction influences loyalty (Oliver 1999; Anderson & Sullivan, 1993; Bearden & Teel, 1983; Boulding et al., 1993; Fornell, 1992; Oliver & Swan, 1989), customer's willingness to buy (e.g., Bearden & Teel, 1983) and customer's after-purchase attitudes (Howard, 1974). This research considers the relationship between customer satisfaction and customer's willingness to buy.

User's Willingness to Buy (UWB)

User Willingness to Buy (UWB) refers to consumers' tendency to purchase targeted products in the future and may predict actual purchase behavior (Morrison, 1979). Some studies show that hedonic goals and utilitarian goals engender positive emotions in consumers, which in turn become drivers of purchase (Babin et al., 1994; Jones et al., 2006). Hedonic goals refer to the pursuit of fun and enjoyment, whereas utilitarian goals refer to the pursuit of specific tasks (Babin et al., 1994), as mentioned above (Morrison, 1979).

User's Willingness to Use Augmented Reality (UWAR)

User's willingness to use AR refers to the degree to which a user is willing to use augmented reality. Prior literature showed that perceived usefulness of AR influences shopper's attitude and intention to use AR (Chen and Tan 2004; Lee, Fiore and Kim 2006; Olsson et al. 2012). AR users are willing to use AR because it saves their time and effort (Olsson et al. 2012).

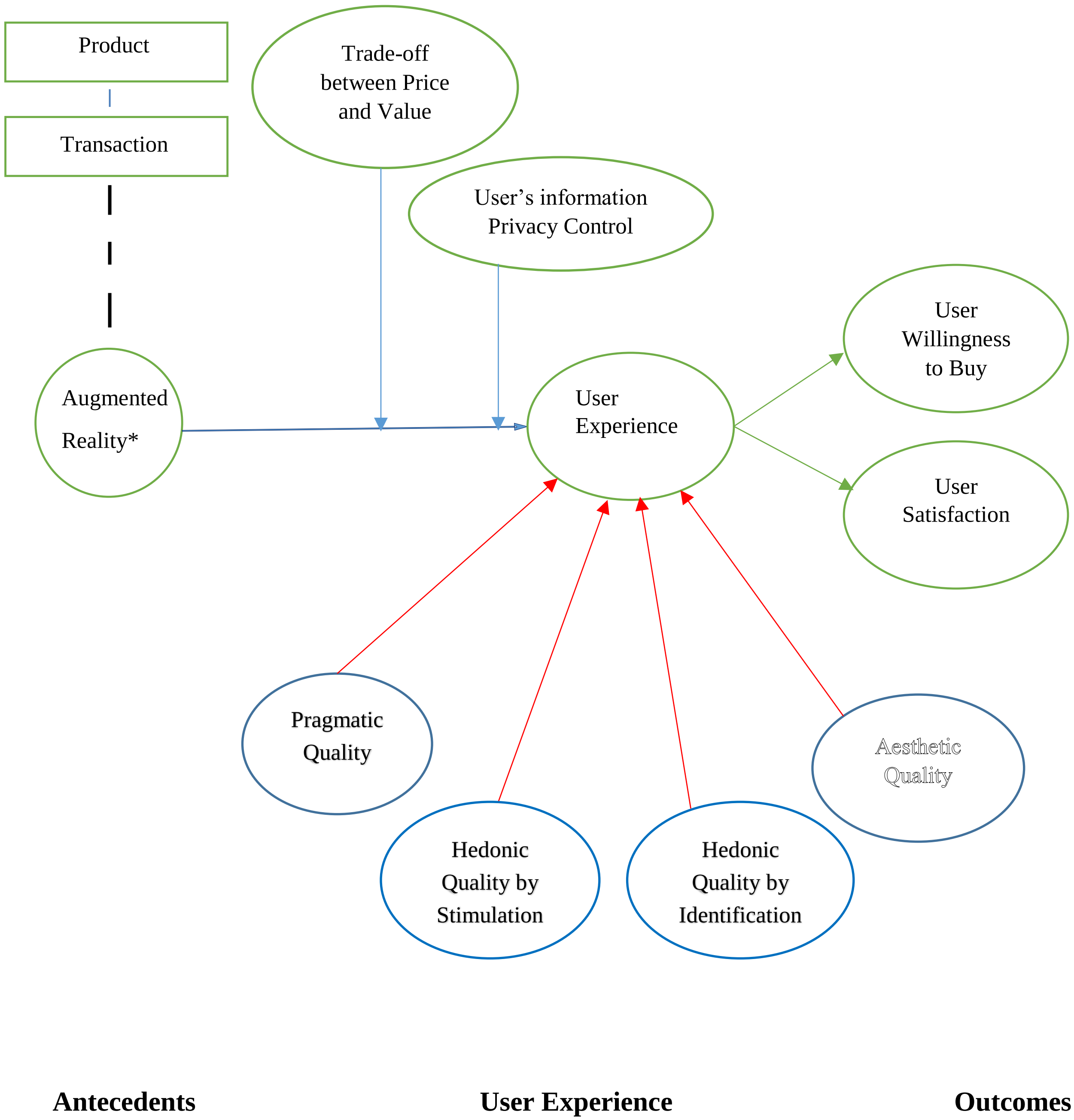
Relationships

Impact of Augmented Reality on User Experience

This study focuses on the effect of augmented reality (AR) on user experience (UX), and the mediation effect of user experience in the relationship between augmented reality and the outcome variables as pictured in Figure 1.

AR technology can help a user perform certain tasks or solve some problems in either offline or online environments. One problem relates to consumers' lack of sufficient product information when deciding to purchase a product. Insufficient product information hinders consumers' ability of product evaluation. For example, consumers become easily frustrated when purchasing products, such as clothes or shoes through traditional online shopping. Traditional online shopping does not provide sufficient information (Lu & Smith, 2007), thereby does not allow customers to completely assess the targeted products (Cho, Im, Hiltz, & Fjermestad, 2002; Kim & Forsythe, 2008). Consequently, because of such deficiencies, traditional online shoppers are not able to make certain purchase decision and shopping decisions are associated with risk and uncertainty (Kim & Forsythe, 2008).

Figure 1: Preliminary Conceptual Model: The Impact of Augmented Reality on User Experience and Its Outcomes



Note: * Augmented reality variable is an experimental variable.

To obviate lack of physical product, online retailers use AR as a tool to generate three-dimension product information (Lu & Smith, 2007). AR is a novel medium, which generate fruitful and meaningful experience for online users (MacIntyre, Bolter, Moreno & Hannigan, 2001). For example, a 3D virtual model is an interactive AR technology that can be applied in online environments by using the user's camera (Shim & Lee, 2011). In known applications, Primerun is an AR mobile app that allows a user to upload his/her picture or take a picture of the user to insert products such as wig, sunglasses, and dresses to the user's picture.

Using Schmitt's typology of AR experience (1999), firms can deliver desirable products to customers through strategic experiential modules (SEMs). A SEM includes sensory experiences (sense), affective experiences (feel), creative cognitive experiences (think), physical experiences and entire lifestyles (act), and social-identity experiences when related to a reference group or culture (relate). Yes, AR generates sensory experience and AR users can sense and feel experiences.

Furthermore, AR facilitates decision-making by integrating relevant virtual contents onto the existing reality where they belong to. AR empowers it users by allowing them to endlessly interact with the virtual contents generated by AR. Such features not only create utilitarian value but also hedonic value to the users (Hilken et al., 2017). Consumers can easily try on different virtual products (i.e., "virtual try-on"; Kim & Forsythe 2008); they can zoom in and zoom out to investigate virtual products as if the products are in their hands (Hampp, 2009).

Consumers are able to evaluate products with less effort and risk. Consumers feel empowered by having sense of control over the virtual contents. More importantly, consumers become satisfied when they find their experience is worthwhile.

In looking at the impact of AR on UX, however, the research employs the UX dimensions as presented above (p. 11-13). UX is reflected by four dimensions, pragmatic quality, hedonic quality by stimulation, hedonic quality by identification, and aesthetic quality. It is expected that AR positively and significantly influences the four dimensions of user experience by enhancing user experience in its four dimensions, pragmatic quality, hedonic quality by stimulation, hedonic quality by identification, and aesthetic quality.

Pragmatic quality refers to the properties of AR technology to support users in accomplishing certain goals. Hedonic quality refers to the properties of AR technology to appeal to a user's desire for pleasure or avoidance of boredom and discomfort. Those properties can emerge from stimulation or from identification, and thus, affect the treatment of hedonic quality, as explained below. Aesthetic quality refers to users experiencing the aesthetic qualities of a product. What follows is a description of how AR may impact UX as reflected in the four characteristics.

AR Effect on User Experience as Reflected in Pragmatic Quality (also called Usability)

User experience involves all characteristics of interactions between a product and a user (Alben, 1996; Arhippainen & Tahti, 2003; Forlizzi & Ford, 2000). Fundamentally, UX may be influenced by the many features of a product, including usability, functions, size, weight, language, symbols, aesthetic, and usefulness. The pragmatic quality of UX involves a portion of those interactions, the ones that emphasize the utility and usability of a product in relation to its potential tasks (Hassenzahl et al., 2003). Pragmatic quality is also called usability when it relates to the effectiveness, efficiency, and satisfaction of the user experience (Butler 1996; ISO 9241, 1998). Usability is pragmatic quality at the core.

AR enhances the user experience in terms of product usability, that is, it reveals more product information (e.g., products can be seen in different colors, shapes, and styles using 3D), and product functions, which result in a better user experience at the time of purchase (Kim & Forsythe, 2008). Consumers shopping in online environments may not have full access to product information, such as texture, appearance, fit, and so on. In such cases, AR enables users to obtain additional product information (Li et al., 2001), reduce users' anxiety (Huang & Liu 2014), and, as a consequence, facilitate decision-making (Fogg, 2003; Kim & Forsythe, 2008). For example, IKEA has provided a mobile app that offers a product simulation for the user allowing a selection of different colors before deciding which one to choose and buy.

AR Effect on User Experience as Reflected in Hedonic Quality

UX also involves affective or emotional users' reactions (Hassenzahl & Tractinsky, 2006). Pragmatic quality is an essential facet of user experience, but it does not exhaust user experience. User experience is not limited to usability, but it carries emotional responses (Norman, 2004).

User experience with AR technology incorporates hedonic quality as well by generating several affective or emotional experiences. For example, the interactivity feature of AR is able to engage users, and thereby magnifies the hedonic value of experience (Kim & Forsythe, 2008). AR gives users the ability of sharing their personalized experiences on social networks, such as Facebook and Twitter, enhancing playfulness (Huang & Liu, 2014). Or, they may use AR to augment their experience in the existing reality and take a picture of the reality augmented by AR and share it on social networks.

AR allows the users to interact with the virtual images generated by AR called image interactivity. For example, 3D virtual models multiply product information by providing a high level of image interactivity (Fiore et al., 2005a, b; Lee et al., 2006; Yang & Wu, 2009). Consumers may use AR to highly interact with the virtual contents generated by AR. Yet, the effect of AR technology on hedonic quality depends upon the extent to which AR generates stimulation and entertainment or social experience to the users.

Hassenzahl (2003) distinguishes three types of effects in Hedonic Quality: by stimulation, by identification, and by evocation. Stimulation is related to the fulfillment of human needs for novelty and challenge. Identification refers to the fulfillment of human needs as expressions of the self. For example, a person may express himself/ herself through objects to satisfy his/her social needs. Finally, evocation refers to the fulfillment of human needs to associate symbolic meanings of an object in order to provoke personal memories. In addition, hedonic quality may affect human needs that relate to the sense of novelty and to social power.

AR Effect on User Experience as Reflected in Aesthetic Quality

The aesthetic quality of user experience involves pleasurable experiences. Jordan (2000; 2002) identifies four types of pleasure. Physio-pleasure is related to the sensual user experience (e.g. touch, smell, taste).Socio- pleasure is related to the relationship of the user with others (e.g. status, connection). Psycho-pleasure is related to people's cognitive and emotional reactions (e.g. satisfaction of instrumental needs). Further, ideo-pleasure is related to the value of people (e.g. aesthetics, taste, personal aspirations). It is possible that not all types of pleasure are sought at once, but some are and this research recognizes that fact. Thus,

H1: Augmented reality positively and significantly impacts user experience as reflected in the latter four characteristics, pragmatic quality, hedonic quality by stimulation, hedonic quality by identification, and aesthetic quality.

Moderating Variables of the AR-UX Relationship

Two factors affecting AR-UX relationships are paramount, the trade-off between price and value, and the privacy issues involved. First, the definition of each moderating variable is separately explained. Next, the specific roles of the moderators in establishing the relationship between AR and UX will be discussed.

Value and Price and the Trade-off between Value and Price

Value is a subjective evaluation of products' attributes, performance, and also consequences of using the product (Yu & Fang, 2009). Users make comparisons between "get attributes" and "given attributes" (Heskett et al., 1994). Yet, value is subjective (Gupta & Zeithaml, 2006), created (Chan et al., 2010), and determined by consumers during consumption (Lusch & Vargo, 2006). On the other hand, price refers to the amount of effort, money, or time that a customer sacrifices when he/she buys a product.

Zeithaml (1988) points out that value affects consumers when they make purchasing decisions. Yet Dodds et al., (1991) clarify that perceived value functions as a tradeoff between perceived quality and monetary sacrifice (Dodds & Monroe, 1985; Monroe & Chapman, 1987; Teas & Agarwal, 1997). According to the theory of competitive advantage, suggested by Hunt & Morgan (1995), and the general theory of competition proposed by Hunt (2000), competitive advantage is defined in the trade-off between value and price. Products that offer more value at similar prices to the competition are perceived by the consumer as more valuable.

User's Information Privacy Control

Information privacy is defined as an individual's ability to control their personal information (Metzger, 2004). Information privacy user control is critical for user experiences with computers, online systems and new technologies (Ackerman & Mainwaring, 2005). The importance of information privacy is growing mainly because some AR technology companies are forcing users to share their information, such as email address, name, and postal code. For example, EZ Makeup asks the user to enter their email address; Star Tracker Lite mobile app prompts the user to enter their location in order to allow them to watch stars in the space.

Past literature has shown that online consumers are well aware of their need for privacy (Friedman, Kahn & Howe, 2000; Grewal, Iyer & Levy, 2003; Olsson, 2012; Olsson et al., 2013). Therefore, it is suggested that the relationship between AR and UX is moderated by user's information privacy control and the trade-off between value and price.

The AR-UX Relationship Is Moderated by the Trade-Off between Price and Value

AR technology can be used to better establish an acceptable trade-off between value and price when purchasing different type of products such as clothing, furniture, sunglasses, eyeglasses, and cosmetics. User experience may be strengthened if users find the trade-off between price and value to be acceptable; and it may be weakened if the users do not find the trade-off between price and value to be acceptable.

For example, assume a shopper goes to a real store to purchase clothing. Suppose the store offers two alternatives to tryout, dressing rooms or augmented reality technology, such as Magic Mirror. For expensive clothing, the shopper may prefer to physically try it on or touch it in the store rather than virtually try it on in Magic Mirror. In contrast, for a nice piece of clothing with a low price on sale, the shopper may prefer to use augmented reality technology such as Magic Mirror, which saves the user time and effort. In fact, consistent with Equity Theory (Adam, 1969), the shopper makes a comparison between what he/ she gains to what he/ she loses. Consumers struggle to reach an acceptable balance between product value and price before they can decide on purchases.

H2: The relationship between AR and UX is stronger when the user finds a (proper) fitting trade-off between value and price; weaker when the user does not find a fitting trade-off between value and price.

The AR-UX Relationship Is Moderated by User's Information Privacy Control

AR technology has the potential to collect and personalize user information. Augmented reality and context is a platform that can create, share information and interact with other devices or mobile contexts (Olsson et al., 2013). Yet, users expect to have access to AR apps without sharing any personal information (Olsson et al., 2013). Information privacy is important in creating a private AR interface, user control, and a feeling of having information secured (Olsson et al., 2013).

This study hypothesizes that user's information privacy control moderates the effect of AR on UX. If the user perceives that he/she has control over his/ her personal information while using AR technology, then he/she may be genuinely motivated to interact and use AR technology. In contrast, when the user perceives that he/she does not have control over his/her own personal information, then he/ she loses his/ her motivation to use AR technology. In other words, AR technology violates user's information privacy control and thereby negative perception is shaped through the user's interaction with AR and the user less likely to purchase or use an AR service.

Users may have a different user experience (UX) when contemplating information privacy. Users who place greater value on their personal information privacy may experience a lower sense of control over their personal information (Stone, Gueutal, Gardner, & McClure, 1983). Moreover, consistent with equity theory, the amount, precision and sensitivity of information that the user is willing to share with the service rely on the extent of value gained from the feature that requires user's information (Olsson et al., 2013). If a user perceives that he/ she has control over her personal information while using AR technology, then he/she may expect to benefit from using AR technology. In contrast, if a user perceives that he/she has no control or little control over his/her personal information, then he/she may not expect to benefit from using AR technology.

AR apps that empower users to have control over their personal information can facilitate positive experiences for users. AR apps that limit user's control over their personal information or violate a user's information privacy, can hinder the use of AR technology, and thus weaken or diminish the impact of AR on UX. Therefore,

H3: The relationship between AR and UX is strengthened (weakened) when the user's information privacy control is empowered (diminished) by AR.

Outcomes of the AR-UX Relationship

Two outcomes are examined as sampled effects of the impact of AR on UX, user satisfaction and user's willingness to buy/ user's willingness to use AR. It is suggested that an enriched user experience generated by augmented reality positively and significantly influences user satisfaction, and user's willingness to buy/ user's willingness to use AR.

User Satisfaction

AR is applied not only as promotional tool (Grimes, 2009 cited in Woods, 2009), but also as a tool to build a positive customer-brand relationship (Owyang, 2010) and generate customer satisfaction through the creation of perceived experiential value (Chou, 2009; Yuan & Wu, 2008). By contributing to customer satisfaction (Yuan & Wu, 2008), AR can also contribute to customer loyalty, positive word of mouth (WOM), repeat purchase, and greater market share (Bearden & Teel, 1983; Fornell, 1992; Fornell et al., 1996). This is possible because AR can focus on the whole customer experience, not just a product or service (Yuan & Wu, 2008; Schmitt, 1999).

For some authors, AR is able to influence customer satisfaction starting in pre-purchase step of the buying process **(**Bulearca & Tamarjan, 2010), at the time customers evaluate the product with the help of AR (Woodsa, 2009), and just before customers make their choices in product buying (Fill, 2009). Thus, enriched user experience is able to mediate the effect of augmented reality on user satisfaction.

H4a: An enriched user experience positively and significantly influences user satisfaction.

H4b: The impact of augmented reality on user satisfaction is mediated by an AR-enriched user experience.

User's Willingness to Buy

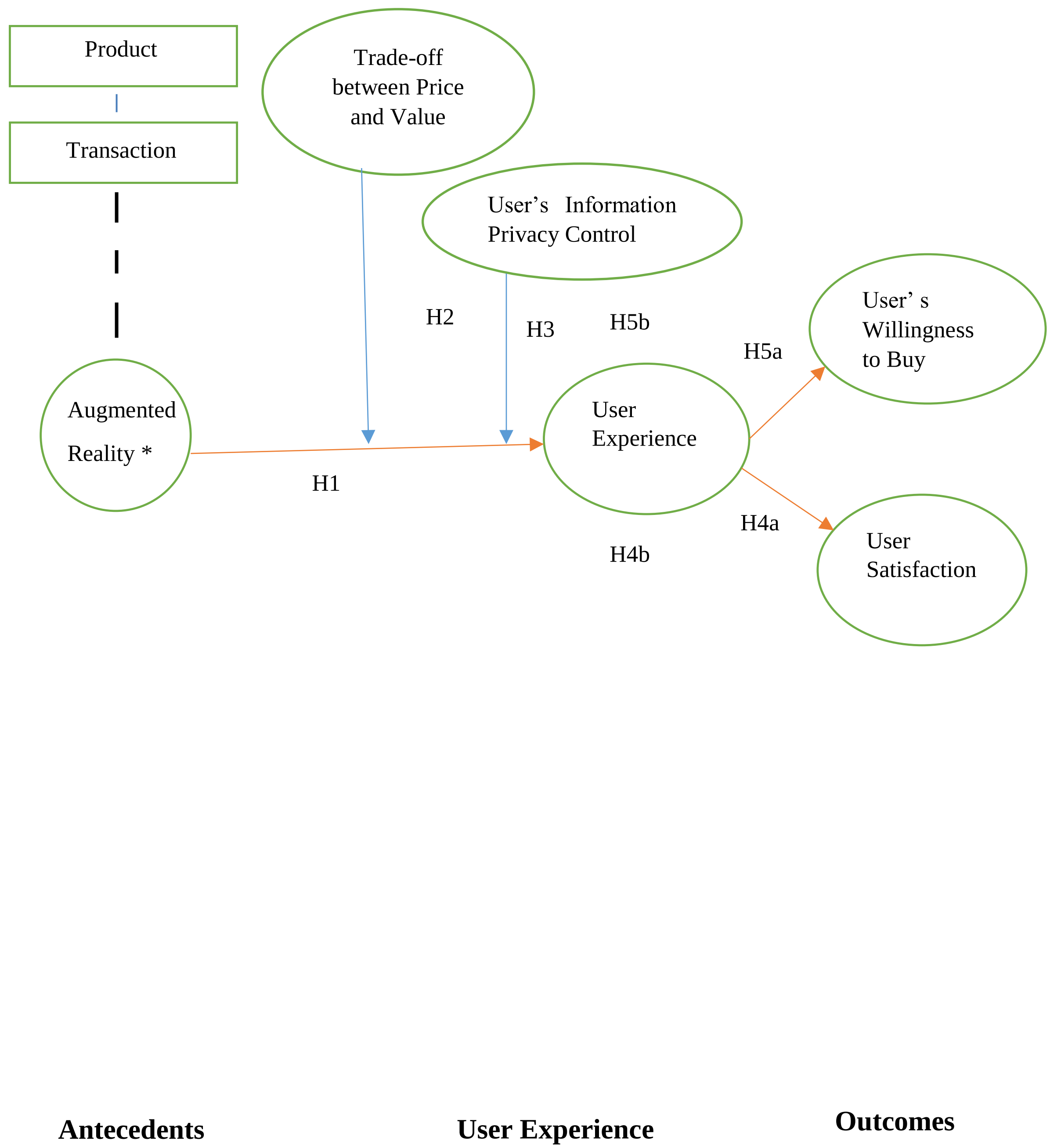
Another key outcome that is impacted by an AR-enriched user experience is user's willingness to buy. Appealing to sensory (mainly visual), affective, and cognitive experiences, AR can motivate consumers to not only choose a product but also acquire it. Indeed, AR interactive technology, such as virtual image technology (Verton, 2001), can offer a simulated experience to users with the purpose of encouraging them to buy the product (Huang & Liu, 2014). Virtual objects and the information contributed by AR may heighten user's enjoyment, playfulness and mental imagery (Schlosser, 2003), which in turn may stimulate user's willingness to buy (Huang & Liu, 2014; Kim & Forsythe, 2008a, b). In particular, 3D virtual models can effectively motivate consumers' willingness to buy products in online shopping (Kim & Forsythe, 2009) by enhancing the entertainment value of online shopping (Kim & Forsythe, 2008). In addition, AR can indirectly increase consumers' purchase intention by enhancing the hedonic value of user's personal experience (Huang & Liu, 2014). Thus, the effect of augmented reality on user's willingness to buy is mediated by enriched user experience.

H5a: An enriched user experience positively and significantly influences user's willingness to buy.

H5b: The impact of augmented reality on user's willingness to buy is mediated by an AR-enriched user experience.

Further, user satisfaction resulting from an AR-enriched user experience increases user's willingness to buy. Figure 2 shows all hypothesized relationships.

Figure 2: Preliminary Conceptual Model: Hypotheses



Note: H4a and H5a show the mediation effect of user experience on the outcome variables.

*: Augmented Reality is an experimental variable.

CHAPTER III

METHODOLOGY

This chapter presents the methodology and the research process this study follows to answer the research questions. It is fundamentally a quantitative study designed to understand the impact of augmented reality, as a tool in the marketing field (Bulearca & Tamarjan, 2010). Thus, this thesis attempts to evaluate and measure the impact of AR technology on user experience and two key consequences, user satisfaction and user's willingness to buy/ user's willingness to use AR. Additionally, the mediation effect of user experience in the relationship between AR and the outcome variables is discussed. This chapter focuses on the research design for the studies including prescreening, measures, and manipulation of augmented reality.

Research Design

The first methodological challenge is to evaluate how AR influences UX. AR is considered a stimulus, and is portrayed in two AR apps, one in consumer shopping, and another one in service usage. Both studies are conducted in a laboratory environment, and each study uses experimental groups and a control group, as needed.

The central design is based on a true experiment. As Kerlinger & Lee (2000) and Campbell and Stanley (1963) advise, true experiments require at least two groups; one group receives one condition or treatment, whereas another group receives another condition or treatment. The experimenter in true experiments manipulated at least one independent variable. A true experiment requires random assignment, which means the participants of true experiment were randomly assigned to conditions or treatments and to groups. Random assignment is preferred because randomization enhances the probability of equivalency among groups and controls the impact of extraneous variance (Kerlinger & Lee, 2000). Yet, randomization does not mean that the groups are equal, it only enhances the probability of group equivalency (Kerlinger & Lee, 2000; Shadish, Cook, & Campbell 2002; Campbell & Stanley, 1963). All participants were randomly assigned to experimental groups and a control group to have almost equivalence in groups. To assure that the groups were equivalent, the experimenter allowed the participants to draw a number. A subject that drew 1 was assigned to high level of interactivity treatment, and the one that drew 2 was assigned to middle level of interactivity treatment, and the one that drew 3 was assigned to a low level of interactivity treatment.

In summary, two studies were conducted; one in buying consumer products context (study one) and another one in service usage context (study two). Both studies were conducted in the lab of the university equipped with computers. The lab of university located a South West University in the US. Studies 1 & 2 considered AR, as a stimulus, and measured AR in terms of level of interactivity; and three levels of interactivity, namely high, middle, and low in two different contexts were considered. That is, two levels of interactivity, namely high level of interactivity and middle level of interactivity were considered to present AR condition (experimental group), whereas low level of interactivity was considered to present non-AR condition (control group). In summary, three treatments in the context of buying consumer product (AR Ray-Ban, Virtual Model, and traditional online shopping), and three different treatments in the context of service usage (Star Chart mobile app, Space Journey mobile app, and Sky Guide mobile app) were applied. Both studies used random assignment to assign one of the treatment to each participant. Overall, there were three treatments (1*3) for each study: high level of interactivity in buying consumer products context, middle level of interactivity in buying consumer products context, low level of interactivity in buying consumer products context, high level of interactivity in service use context, middle level of interactivity in service use context, and low level of interactivity in service use context. Each participant was randomly assigned to one of the six treatments. Overall, studies 1 & 2 included prescreening, experiment, and posttest questions for the experimental group (exposed to high level of interactivity of AR stimuli and middle level of interactivity of AR stimuli) and the control group (exposed to low level of interactivity or non- AR), as required (Kerlinger & Lee 2000; Campbell & Stanly 1963).

Prescreening in Study One and Study Two

This study intended to prescreen participants before exposing them to the stimuli. The aim of prescreening was to evaluate the extent to which the participants were familiar with the Internet, technology use, and online shopping (Jin, 2001). Before conducting the experiments (study 1 & 2), the experimenter instructed participants “this study is trying to evaluate the impact of augmented reality on user experience and its outcomes.” Additionally, the participants’ opinions were evaluated to find out how much they would like to use products, such as eyeglasses and sunglasses (Table 1). In the context of product shopping, in addition to technology use items, the participants answered four more questions which were related to their interest to online shopping and eyeglasses/ sunglasses. Additionally, in the context of entertainment services, the participants answered three more questions which were related to the participants’ interest towards knowing more about constellation, stars, and planets. The aim of prescreening for Study two was to evaluate the extent to which the participants were familiar to Internet, technology use, and observing the sky, stars and planets. Table 1 shown above shows the prescreening items for study one and study two.

Measures

To measure UX pragmatic quality and hedonic quality, both studies used the AttrakDiff 2 questionnaire from Hassenzahl (2004) and added some items to the Attrakdiff 2 in order to include more features of augmented reality. The AttrakDiff 2 questionnaire includes 7 items to measure pragmatic quality, 7 items to measure hedonic quality by identification, and 7 items to measure hedonic quality by stimulation. In addition, to measure UX aesthetic quality, the study adopts three items from Lavie & Tractinsky (2004) and five items from Laugwitz, Held & Schrepp, 2008), and adds 5 new items. New items are inserted in order to capture more qualities of user experience. Since AR is interactive sensory technology that empowers users to perform their tasks and also creates fun and entertaining environments, it is required to add more properties of AR to deeply understand its impact on UX.

To the best of my knowledge, no prior research was conducted to capture UX of AR technology. Therefore, to better understand this phenomenon, 11 more items were added to the questionnaire to present pragmatic quality of AR technology. Besides, 3 more items related to hedonic quality by identification, and 4 more items related to hedonic quality by stimulation were inserted to the questionnaire to reflect hedonic quality of AR. Overall, 50 items are considered to capture UX. Pragmatic quality, hedonic quality by stimulation, hedonic quality by identification, and aesthetic quality are measured using a bipolar semantic differential 7-scale method.

To measure customer satisfaction, 3 items from Taylor & Baker (1994) were adopted. To measure user’s willingness to buy, three items were adopted from Engel et al. (1995). The items to measure the trade-off between price and value (three items) were adapted from prior research (Dodds et al., 1991), and the items to measure user’s information privacy control (four items) were adapted from Liu, Marchewka & Ku (2004). All items that relate to user's information privacy control, price-value trade-off, user satisfaction, and user's willingness to buy are measured using a seven-point Likert scale, with the anchors being "strongly disagree" and "strongly agree".

Tables 1 and 2 summarize the items to measure all constructs, including the constructs with corresponding items, scale type, and the sources used plus the new items developed for both studies. The questionnaire of the study consists of 9 sections: introduction, prescreening, pragmatic quality, hedonic quality by identification, hedonic quality by stimulation, aesthetic quality, user satisfaction, user's willingness to buy, information privacy control, and trade-off between price and value. Further, the participants provide some demographic information, such as gender, age, occupation, and income.

Table 2 includes the measures for prescreening, the moderator variables (trade-off between price and value and user's information privacy control), and the outcome variables (user satisfaction and user's willingness to buy).

Table 1: Constructs and Items for Study One and Study Two

Construct and Items	Source
Prescreening Questions for Study 1	
I am familiar with using the Internet.	Jin, 2001
I frequently use the Internet to shop online.	Jin, 2001
I think that technology is necessary for my daily works.	Olsson et al., 2012
I visit the Internet retail websites to collect product information.	Jin, 2001
I visit the Internet retail websites for purchasing products	Jin, 2001
I am a user of eyeglasses or sunglasses.	New
I would like to wear eyeglasses or sunglasses.	New
Prescreening Questions for Study 2	
I frequently use the Internet to search.	Jin, 2001
I think that technology is necessary for my daily works.	Olsson et al., 2012
I visit the Internet websites to collect information.	Jin, 2001
I visit the Internet to collect more information about stars and planets.	New
I would like to know more about celestial bodies in the sky.	New
I like to watch stars and other celestial bodies in the sky.	New
Moderator Variable: Trade-off between Price and Value	
Study 1	
The product offered in the website of Ray-Ban app is reasonably priced.	Dodds et al., 1991
The product offered in the website of Ray-Ban is a good value for the money.	Dodds et al., 1991
At the current price, the product offered in the website of Ray-Ban provides a good value.	Dodds et al., 1991
Study 2	
The service offered by this mobile app for observing the sky is reasonably priced.	Dodds et al., 1991
The service offered by this mobile app is a good value for the money.	Dodds et al., 1991
At the current price, the service offered in the mobile AR app provides a good value.	Dodds et al., 1991
Moderator Variable: Information Privacy Control	
Study 1	
I was informed about the personal information that Ray-Ban website would collect about me, such as email, name, location.	Liu, Marchewka & Ku, 2004
This website explained the reasons why my personal information is being collected.	Liu, Marchewka & Ku, 2004
This website informed the way my personal information would be used.	Liu, Marchewka & Ku, 2004

Table 1 **Continued**	
This website gave me a clear choice before using personal information about me.	Liu, Marchewka & Ku, 2004
Study 2	
I was informed that AR app would collect information about me, such as email, name, and location.	Liu, Marchewka & Ku, 2004
This mobile AR app explained the reasons why my personal information is being collected.	Liu, Marchewka & Ku, 2004
This mobile AR app explained how personal information about me would be used.	Liu, Marchewka & Ku, 2004
This mobile AR app gave me a clear choice before using personal information about me.	Liu, Marchewka & Ku, 2004
Outcome Variable: User Willingness to Buy	
Study 1	
I intend to buy my eyeglasses/sunglasses via the Ray-Ban website.	Engel et al., 1995
I would be willing to buy my eyeglasses/sunglasses via the Ray-Ban website.	Engel et al., 1995
In future, I would buy my eyeglasses/sunglasses via the Ray-Ban website.	Engel et al., 1995
Study 2	
I intend to observe stars, planets or other celestial bodies in the sky through using this mobile app.	Engel et al., 1995
I would be willing to use this mobile app.	Engel et al., 1995
In future, I would use this mobile app.	Engel et al., 1995
Outcome Variable: User Satisfaction	
Study 1	
Overall, I am satisfied with the Ray-Ban website.	Taylor & Baker,1994
Being a user in this website has been a satisfying experience.	Taylor & Baker, 1994
Having experienced this website was pleasurable.	Taylor & Baker, 1994
Study 2	
Overall, I am satisfied with this mobile app.	Taylor & Baker, 1994
Being a user of this mobile app has been a satisfying experience.	Taylor & Baker, 1994
Having experienced this mobile app was pleasurable.	Taylor & Baker, 1994

Note: Each item is measured using a 7-point Likert scale from 1= strongly disagree to 7= strongly agree.

Table 2 exhibits the items that were adopted and developed to measure user experience in its four characteristics: UX pragmatic quality, UX hedonic quality by stimulation, UX hedonic quality by identification, and UX aesthetic quality. The surveys used for study one and two are presented in Appendix I and Appendix II.

Table 2: User Experience Measure for the Pilot Test (Integration of Study One and Study Two)

Constructs and Items	Source
UX: Pragmatic Quality	
Technical-human	Hassenzahl, 2004
Unruly-manageable	Hassenzahl, 2004
Confusing- clearly structured	Hassenzahl, 2004
Unpredictable- predictable	Hassenzahl, 2004
Cumbersome- straightforward	Hassenzahl, 2004
Impractical-practical	Hassenzahl, 2004
Complicated-simple	Hassenzahl, 2004
Unprofessional-professional	Hassenzahl, 2004
Difficult to learn-easy to learn	Laugwitz, Held & Schrepp, 2008
Insecure-secure	New
Too much information- Too little information	New
Irrelevant Info- Relevant Info	New
Unreliable-reliable	New
Effortful-effortful	New
Shady-trustworthy	New
Highly augments the one's capabilities- Highly decreases the one's capabilities	New
Risky to use-safe to use	New
Personalized-not personalized	New
Highly augments the one's awareness of the environment- Highly decreases the one's awareness of the environment	New
UX: Hedonic Quality by Identification	
Unpresentable-presentable	Hassenzahl, 2004
Separates me from people- Bring me closer to people	Hassenzahl, 2004
Alienating-integrating	Hassenzahl, 2004
Cheap-premium	Hassenzahl, 2004
Tacky-stylish	Hassenzahl, 2004
Isolating-connective	Hassenzahl, 2004
Decreases the one's self-image-augments the one's self-image	New
Loneliness- the sense of belonging to the community	New
UX: Hedonic Quality by Stimulation	
Ordinary-novel	Hassenzahl, 2004
Undemanding-challenging	Hassenzahl, 2004
Dull-captivate	Hassenzahl, 2004
Conservative-innovative	Hassenzahl, 2004
Cautious-bold	Hassenzahl, 2004
Unimaginative-creative	Hassenzahl, 2004
Conventional-inventive	Hassenzahl, 2004
Repelling-appealing	Hassenzahl, 2004

Table 2 **Continued**	
Discouraging-motivating	Hassenzahl, 2004
Not absorbed-over absorbed	New
Not immersive-immersive	New
UX: Aesthetic Quality	
Ugly-beautiful	Lavie & Tractinsky, 2004
Attractive-unattractive	Laugwitz, Held & Schrepp, 2008
Friendly-unfriendly	Laugwitz, Held & Schrepp , 2008
Annoying-enjoyable	Laugwitz, Held & Schrepp, 2008
Pleasant-unpleasant	Laugwitz, Held & Schrepp , 2008
Good-bad	Laugwitz, Held & Schrepp, 2008
Symmetric-asymmetric	Lavie & Tractinsky (2004)
Clean-unclean	Lavie & Tractinsky (2004)
Aesthetically pleasing-aesthetically unpleasing	New
Artistic design-rigid design	New
Vivid –static	New
Realistic-artificial	New

Note: Each item is measured using a bi-polar semantic differential scale from 1= most negative trait to 7 = most positive trait.

The purpose of Study 1 and Study 2 was to check the validity of the research design and the reliability and validity of the constructs used in the studies. In addition, Study 1 and Study 2 tested the impact of augmented reality with different levels of interactivity (high, middle, and low) on user experience's characteristics and subsequently user satisfaction and user's willingness to buy/ user's willingness to use AR. The results gained from the augmented reality treatments (high interactivity) were compared with the results gained from non-augmented reality treatment (low level of interactivity).

Study One: Testing Key Relationships in Consumer Shopping: The Impact of AR on UX in the Context of Buying Consumer Products

The first study was conducted in the university laboratory to measure the impact of AR on UX and its consequences in the context of shopping experience. Convenience sampling was applied to recruit the participants. The objective of study 1 was to capture how the participants experience augmented reality in the context of shopping. This study captured how AR influenced user experience (UX) and how the level of interactivity of AR technology, user's information privacy, and trade-off price and value strengthened or weakened the impact of AR on UX. This study tested the impact of AR on the UX, including pragmatic quality, hedonic quality by identification, hedonic quality by stimulation, and aesthetic quality. Study 1 applied the Ray-Ban website with different features, as a stimulus, because the website offered different sunglasses and eyeglasses. Study 1 examined how manipulating augmented reality along with three levels of interactivity (high, middle, and low) such as augmented reality shopping (high), virtual models (middle), and traditional online shopping (low) strengthen or weakened the association between the AR and the UX. For the purpose of the study 1, computer (laptop or desktop) was used to evaluate the impact of the AR on the UX and its outcomes.

To examine how the different level of interactivity influenced UX and its outcomes, this thesis considers two experimental groups and one control group. To capture how the level of interactivity might strengthen or weaken the impact of the AR on the UX, the first study included three different levels of interactivity, including high, middle and low. All participants were randomly assigned to three groups (two experimental groups: high and middle levels of interactivity; and one control group: low level of interactivity) with different treatments. The participants exposed to high and middle level of interactivity were considered in two experimental groups, whereas the participants exposed to a low level of interactivity were considered in the control group.

Manipulation of Augmented Reality and Level of Interactivity for Study One

A few studies considered the level of interactivity (e.g., Lee, Fiore, & Kim, 2005) as a stimuli. Lee, Fiore, & Kim (2005) studied the impact of two levels of interactivity on three outcomes (ease of use, usefulness, and perceived enjoyment) by using two stimuli websites (http://www.imaginariX.com) to which participants were exposed. In the high level of interactivity, participants were subject to a virtual model in which products could be enlarged and rotated. In the low level of interactivity, participants selected a website lacking those features. Augmented reality was manipulated based on presence and absence of AR as well as the level of interactivity.

Consistent with prior studies, this dissertation manipulated AR (presence of AR and absence of AR). AR with two conditions (AR with high level of interactivity, which is able to generate high level of personalization to the user and AR with middle level of interactivity, which is able to create middle level of personalization to the user) were in the experimental group and one condition (absence of AR), which generates low level of personalization to the user) was included in the control group. Each participant was assigned to one condition. This research included a manipulation check of the independent variable (AR). The items were adapted from Ballantine and Fortin (2009). Table 3 shows the list of questions for the manipulation check in the context of buying consumer products. Each question is measured using a 7-point Likert scale from 1=strongly disagree to 7=strongly agree.

Table 3: Manipulation Check Questions for Consumer Products

List of the Manipulation Items
This website was interactive.
While I was using the website, I was always able to do what I thought I was doing.
I felt I had a great control while I was using the website.
I thought this website really gave me some control (i.e., flexibility) over the content that I wanted to see.
This website allowed the user to zoom in/ zoom out the image of product.
This website allowed the user to change the color of product.
This website had the ability to respond to my specific requests for information, so I could access it quickly and efficiently.
Interaction with this website was very fast.
I was able to obtain information I wanted without any delay.
This website processed my input very quickly.

Note: Each item is measured using a 7-point Likert scale from 1= strongly disagree to 7= strongly agree.

Administration of the Instruments for Study One

Study 1 used Ray-Ban products because the website of Ray-Ban provided different sunglasses and eyeglasses. In addition, it enabled the participants to customize any product they would like to wear. Further, the website of Ray-Ban provided the participants different shopping modes using different level of interactivity, such as augmented reality shopping, virtual models, and traditional online shopping. Each participant was randomly assigned to each treatment. To begin with, the experimenter instructed the participants about the aim of study and explains them how important were their opinions. The experimenter instructed the participants that the "study is asking user's experience and perception of online' shopping website."

Augmented reality with high level of interactivity-augmented-self. After the participants filled out the prescreening questions (Table 1), the experimenter explained the participants what the purpose of study was in their familiarity with technology applies to shopping products, like eyeglasses and sunglasses.

Next, the experimenter asked the participants to log in to their computers and entered the Ray-Ban website, which its address is "http://www.rayban.com/international/virtual-mirror". On the left side of the screen, there were two options: webcam and virtual model. For high level of interactivity, the participants were asked to click on the webcam button. The study applied Webcam feature as a high level of interactivity because the Webcam feature allowed the participants to personalize and customize their favorite eyeglasses and sunglasses. Further, the Webcam feature of the website of Ray-Ban provided more fit related information to the participants. Besides, it offered a wide variety of sunglasses or eyeglasses and the participants could pick them from the catalogue. In addition, it provided different styles for both females and males. Finally, it provided more information about the orders, returns, warranty, and spare parts, return policy, privacy policy, and terms of use.

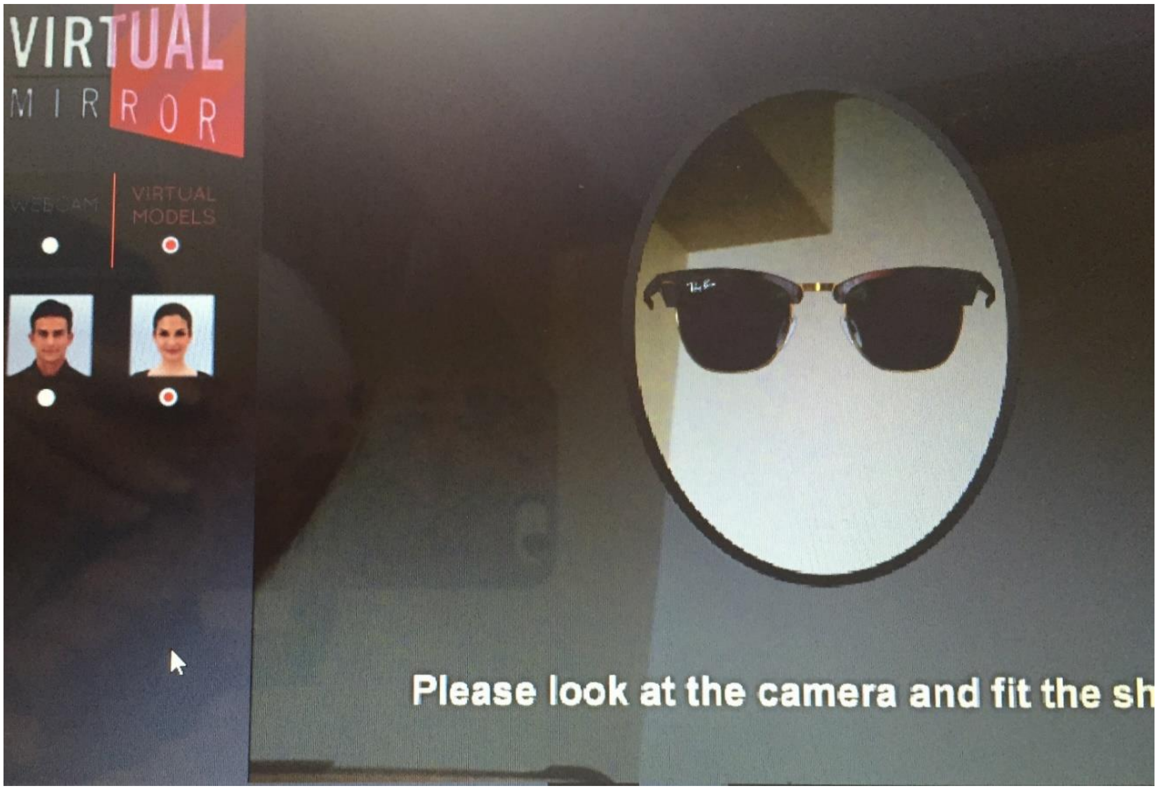
Under the tab of Virtual Mirror, the website asked an agreement statement from the participants, who would like to use augmented reality features of the Ray-Ban website. The statement was related to contract agreement of the use of Virtual Mirror and the participants had to accept it in order to be allowed to use the Virtual Mirror. After the participants' acceptance of the website's terms, they would see another message from the website. The message got a permission from the participants to have access to their camera and microphone. There were two buttons: allow and deny. Those participants who would agree with the statement of the Ray-Ban's website could use the Virtual Mirror and pressed the allow button; otherwise, those who would have doubt about it or would not like to agree with it might press the deny button.

The webcam feature of high level of interactivity of AR, asked the participants to fit their face within the circle outline in the computer screen, and they looked at the camera to fit their face shape. Next, the participants were asked to select their favorite frame and style from the Ray-Ban catalogue. Then, the Webcam feature of Ray-Ban gave the participants their virtual model (personalized model of the self) before they could browse the catalogue. In fact, virtuality came into reality, meaning the virtual eyeglasses or sunglasses were added to the picture of the subject. In addition, the subject could easily move his/ her head and saw how he or she looked like. In fact, the subject could look at the augmented reality image constructed through the Webcam feature of the website of Ray-Ban. In addition, they could use + or – options to adjust their photo. Besides, if the subject did not like the augmented reality picture, then he or she could click on the recalibrated option to adjust his/ her face with new product. In addition, the participants could also take a photo and share their image with virtual eyeglasses or sunglasses into social networks. In addition, they could print or saved their augmented reality picture.

Next, the participants could select their favorite eyeglasses or sunglasses. There were two buttons under the screen: optic and sun referring to different products existing on the website. After selecting a product, they saw an oval shape with a message in the bottom of the oval shape, indicating, “look at the camera and fit the shape”. Next, the participants could easily look at the camera placed in their computer and observed how they would look like with the product they select. In addition, in the left side of the computer screen, there were buttons, namely “recalibrate” and “adjust size”. These features allowed the participants to change their look or enlarge/ decrease the size of products they selected to wear. Figure 3 shows a screen shot of high level of interactivity of Virtual Mirror/ Webcam.

Besides, in the right side of the computer screen, there were some buttons such as single, double, quadruple, take photo, and product information. The participants could see one picture or more pictures at the same time by clicking on those buttons. In addition, they could take a photo with virtual eyeglasses or sunglasses and either saved on their computer or printed it. Finally, by clicking on the product information, they could get more information in relation to the selected product, such as frame color, lens color, lens technology, frame material and frame shape. The experimenter allowed the participants to be exposed to this level of interactivity for 10 minutes. The reason was that the level of exposure to the stimuli influenced the participants’ evaluation (Zajonc 2001). Finally, they were asked to log off their computer and completed the survey. Figure 3 shows a screen shot of Virtual Mirror/ Webcam.

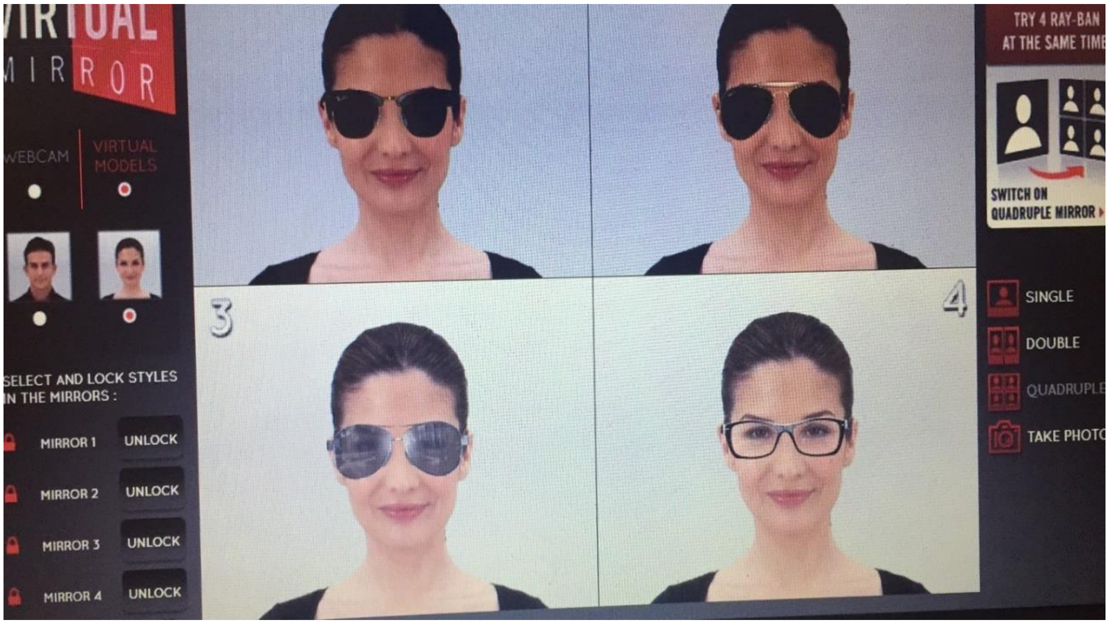
Figure 3: Screen Shot of High Level of Interactivity of Augmented Reality in Ray-Ban Virtual Mirror/Webcam



Augmented reality with middle level of interactivity. Similar to the high level of interactivity (AR Ray-Ban shopping) mentioned above, first the participants filled out the prescreening questions (Table 1), and then the experimenter explained the purpose of this study, which was the evaluation of their perception about consumer shopping products, such as eyeglasses and sunglasses. Then, the experimenter asked the participants to log in to their computers and entered the Ray-Ban website ("http://www.ray-ban.com/international/virtual-mirror"). On the left side of the screen, there were two options: webcam and virtual model. For middle-level of interactivity, the participants were asked to click on the Virtual Models placed on the left side of the computer screen. Under the tab of Virtual Mirror, there was an agreement statement for the participants, who would like to use augmented reality features of the Ray-Ban's website. There was the statement related to contract agreement of the use of Virtual Mirror and the participants had to accept it if they would like to use the Virtual Mirror. After the participants' acceptance of the website's terms, they could see another message from the website. The message got the permission from the participants to have access to their camera and microphone. There were two buttons: allow and deny. Those participants who agreed with the Ray-Ban's website terms could use the Virtual Mirror and press the allow button; otherwise, those who would have doubt about it or would not like to agree with it might press the deny button.

The virtual model does not have all features included in the AR version, which were described above. This level of interactivity did not allow the participants to upload their face images or send their live face images to see how the products looked on them. Thus, Virtual model was selected because it does provide a personalized shopping experience to the customer; but there is not an option for the customers to upload their image. There were two models: one model could be used for women and another model was used for men. There were two buttons under the screen, optic and sun, referring to different products existing in the website. After clicking on the selected model, the participants could select their favorite eyeglasses or sunglasses and observed how the product looked on the model, not on them. In the right side of the computer screen, there were features such as single, double, quadruple, take photo and product information. These features shown on the right side of the computer screen were similar to those provided in the high level of interactivity. In this level of interactivity, the participants were not offered options such as adjust size. The experimenter allowed the participants to be exposed to this level of interactivity for 10 minutes. After finishing this stage, the participants were asked to log off their computer and fill out the questionnaire. Figure 4 shows a screen shot of middle level of interactivity of augmented reality in Ray-Ban Virtual Mirror/ Virtual Model.

Figure 4: Screen Shot of Middle Level of Interactivity of Augmented Reality in Ray-Ban Virtual Mirror/Virtual Model



No augmented reality with low level of interactivity. Similar to high and middle levels of interactivity, which stated above, the participants answered to prescreening questions (Table 1) and then the experimenter explained the purpose of study, which was the evaluation of their perception about consumer shopping products, such as including eyeglasses and sunglasses. Next, the experimenter asked the participants to log in to their computers and entered the Ray-Ban website, at "http://www.ray-ban.com/usa". Then, the participants could pick any products they would like and the price of product appeared in the screen. This treatment did not include the novel features provided in the virtual model or Webcam. That is, the participants cannot view their favorite products on their face or even on the virtual model. In fact, this treatment allowed the participants to shop online without knowing how the selected products looked on them. On the top of the computer screen, there were tabs such as sunglasses, optics, and lenses, which allowed the participants to choose their favorite product styles.

This feature enabled the participants to see different products with different colors, and they could share the selected products in social networks, such as Facebook or Twitter. In addition, they could zoom in or zoom out the products. In addition, the product's information was appeared in the right side of the computer screen. The information appeared was related to frame color, lens color, lens technology, and frame material. Finally, they were asked to log off their computer and asked the survey questions. Figure 5 shows a screen shot of the low level of interactivity in traditional online shopping.

Figure 5: Screen Shot of The Low Level of Interactivity- Traditional online Shopping

Study Two: Testing Key Relationships in Service Usage- The Impact of AR on UX in the Context of Entertainment Services

The sample for study 2 consisted of undergraduate students at a Southwest US university. Purposive sampling was used to recruit the students. Study 2 also involved a survey in which 49 students (20 male, and 29 female) were recruited as the participants and was conducted in the context of entertainment services.

The second study demonstrated the impact of AR on the UX and its outcomes. Three different mobile apps, namely Star Chart, Space Journey, and Sky Guide were considered as conditions for Study 2. Each mobile application allows the user to have a specific level of interactivity. To examine how AR influenced UX and the outcomes, Study 2 included two groups: an experimental group and a control group. To capture how the level of interactivity may strengthen or weaken the impact of the AR on the UX, this study considered two mobile applications. One of the AR mobile application is able to allow the user to have a high level of interactivity with the mobile application, and the other AR mobile application allows the user to have middle level of interactivity with the mobile application. Additionally, one non-AR mobile application was also considered for the control group. All participants were randomly assigned to three conditions (experimental groups and control group). The participants exposed to the AR with high and AR with middle level of interactivity were considered in the two experimental groups, whereas the participants exposed to the low level of interactivity were considered in the control group. Study 2 applied Star Chart mobile application for AR with high level of interactivity, Space Journey mobile application for AR with middle level of interactivity, and Sky Guides mobile application for non-AR with low level of interactivity.

The second study was similar to the first study, except it was applied to service use context. The aim of study 2 was to capture the impact of AR on UX's characteristics, and its outcomes, namely user satisfaction and user's willingness to use AR. Study 2 was also conducted in the university lab. Since the university was not equipped with iPads and Smartphones, the participants of the second study used their own Smartphone. In addition, the experimenter lent her iPhone to those participants who did not own a Smartphone, but they would like to participate in the study. This study considers some questions to check whether the manipulation works. Table 4 shows the list of the questions for the manipulation check of the independent variable in the context of service use. Each question / item is measured using a 7-point Likert scale from 1= strongly disagree to 7= strongly agree.

The survey used for this study appears in Appendix II.

Manipulation of Augmented Reality and Level of Interactivity for Study Two

Augmented reality was manipulated based on presence and absence of AR as well as the level of interactivity. In the high level of interactivity, participants were subject to the Star Chart application in which stars and celestial bodies could be enlarged, and participants could see the celestial bodies based on their geographical location. In the middle level of interactivity, participants were exposed to Space journey, which did not offer as novel and interactive features as the Star Chart application did. In the low level of interactivity, participants were exposed to Sky Guide app, which was a basic star application.

Consistent with prior studies, this thesis treated AR as a condition involving three levels of interactivity (high, middle, and low) in two different contexts (buying consumer products and service use). Each participant was assigned to one of the three treatments. In addition, this research included a manipulation check of the independent variable (AR). Table 3 shows the list of questions for the manipulation check in the context of product shopping. Each question is measured using a 7-point Likert scale from 1=strongly disagree to 7=strongly agree.

Administration of the Instruments for Study Two

This study used Star related applications because these apps provided both entertaining and training purposes. This study selected three types of mobile apps, namely Star Chart for high level of interactivity, Space Journey for middle level of interactivity, and Sky Guide for low level of interactivity providing three types of interactivity to the participants. Each participant was randomly assigned to each treatment in order to avoid awareness of the differences in the level of interactivity. To begin with, the experimenter instructed the participants about the aim of study and the importance of their opinions. The experimenter instructed the participants that the "study is asking user's experience and perception of mobile star application."

Table 4: Manipulation Check's Questions for Service Use

List of the Manipulation Items
This app was interactive.
While I was using the app, I was always able to do what I thought I was doing.
I felt I had a great control while I was using the app.
I thought this app really gave me some control (i.e., flexibility) over the content that I wanted to see.
This app allowed the user to zoom in/ zoom out the image of stars and planets.
This app allowed the user to change the color of background.
This app had the ability to respond to my specific requests for information, so I could access it quickly and efficiently.
Interaction with this app was very fast.
I was able to obtain information I wanted without any delay.
This app processed my input very quickly.

Note: Each item is measured using a 7-point Likert scale from 1= strongly disagree to 7= strongly agree.

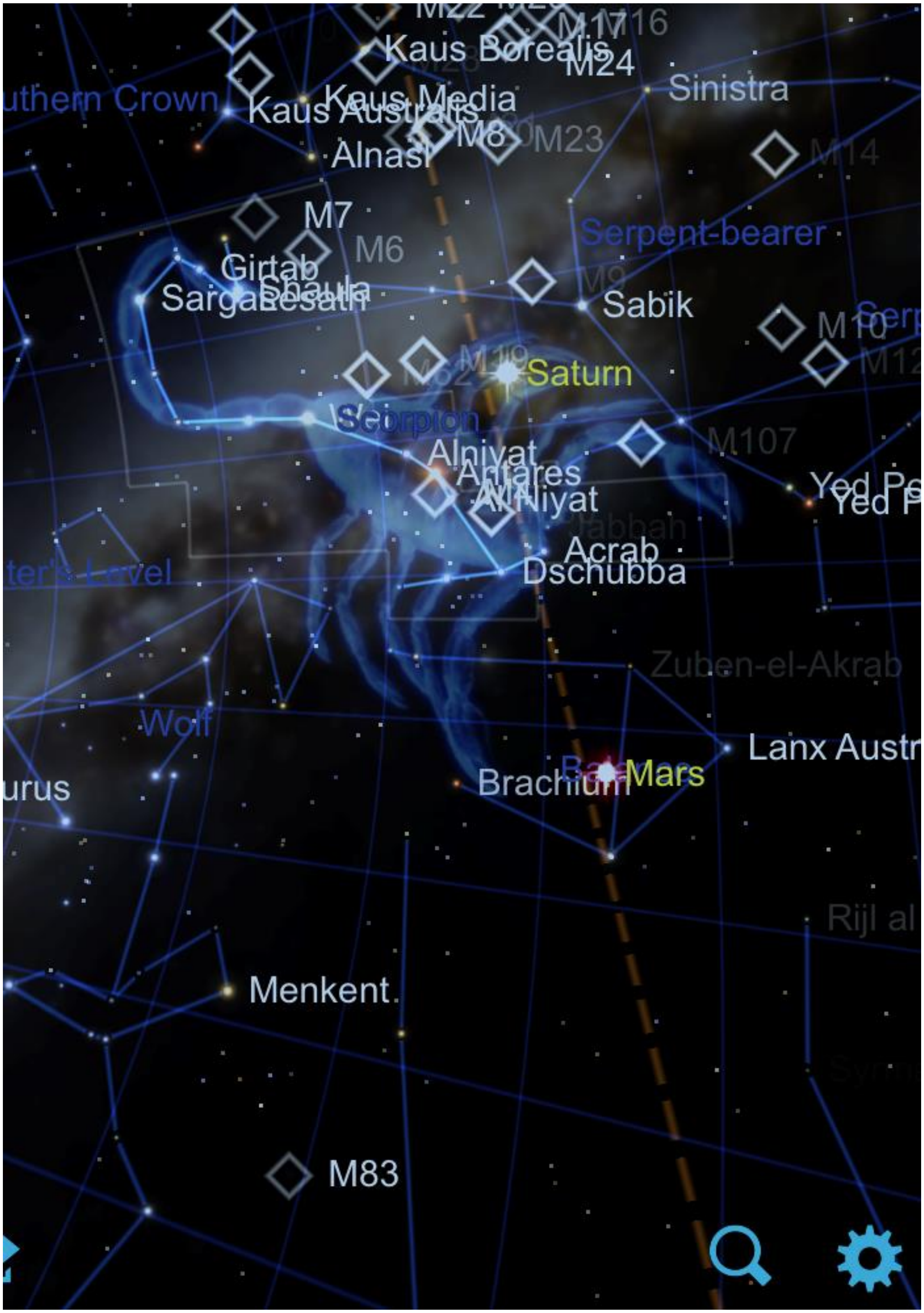
Augmented reality with high level of interactivity. After answering the prescreening questions, the experimenter asked the participants to use their smart phones equipped with camera and download a free application called “Star Chart”. Star Chart was selected as high level of interactivity mobile app because it interacted with users via images and sounds. The user could choose any planet among the list of planet, including Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune, and the information and image related to each planet were presented in the screen.

Further, if the user would like to share or post images of planets received in the Star Chart, then he/she could send it via text message or email. After downloading and opening the app, the Star Chart app asked the participants to calibrate their location to find out where they were located. Later, the participants were asked to move their devices and point to different entities as they appeared in the screen. The participants could observe many objects existing in the sky along with their names. In addition, the participants could click on any objects and the Star Chart app showed them more information in relation to that specific object. For example, the location of moon, Uranus and others were shown on the screen. In some points in the screen, the participants could see the pictures of constellation as well as other star information. Figure 6 shows a screen shot of Star Chart mobile app.

In the right bottom of the screen, there were two options. One option enlarged or reduced the size of the objects shown in the screen, and another option allowed the participants to share the picture appeared in the screen to others via Email, text message, or even Facebook. Further, the Star Chart app provided other options, such as save image, copy, and print. Finally, by pointing the bottom of the screen, more information in relation to constellation, object reference, spectral class, distance, and telescope could be obtained. Overall, the participants were given ten minutes to entertain and educate themselves about the Star Chart.

After exposing the participants to Star Chart, the experimenter asked them to close the Star Chart app and answer the survey's questions. Then, the experimenter appreciated the subject's time and effort to have participated in this study. Figure 6 shows a screen shot of Star Chart mobile app.

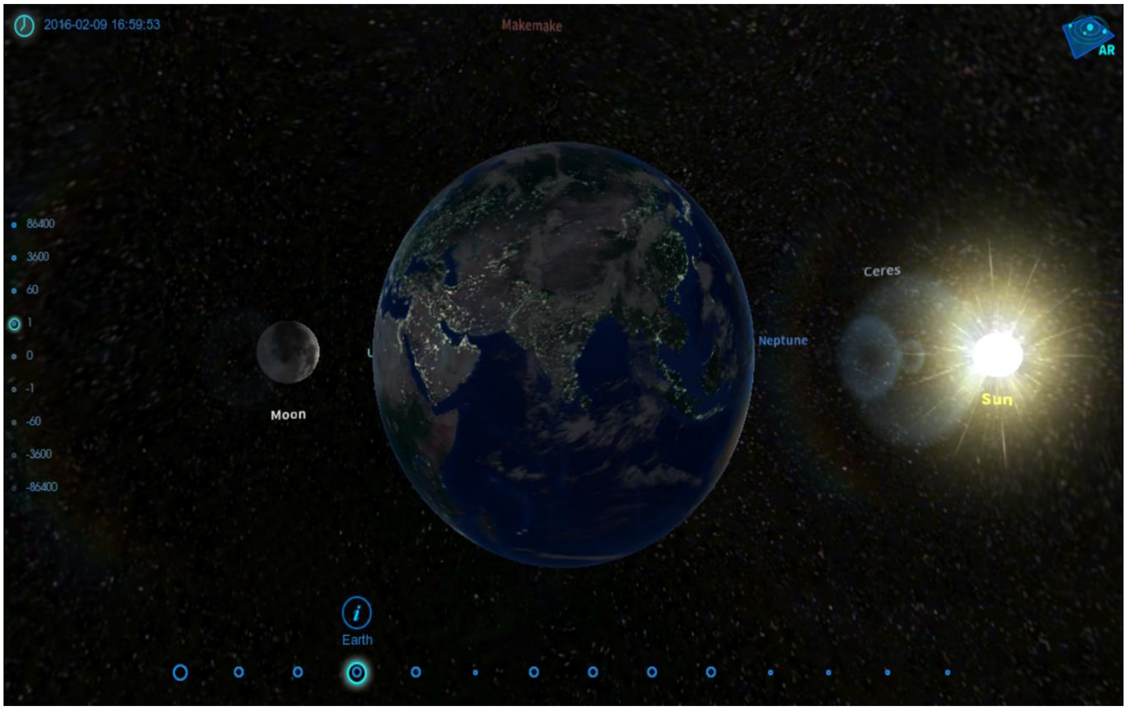
Figure 6: Screen Shot of Star Chart mobile App



Augmented reality with middle level of interactivity. After answering the prescreening questions, the experimenter asked the participants to use their smart phones equipped with camera and download and open the application called “Space Journey”. This mobile app was selected as an app providing middle level of interactivity because it does not provide novel features as offered by Star Chart; for example, Space Journey was more static and did not ask the participants’ location.

The Space journey included some information regarding the planets and stars in the left and bottom of screen. On the bottom side of the screen, the participants could see the image of Sun, Mercury, Venus, Earth, Mars, Ceres, Jupiter, Saturn, Uranus, Neptune, Pluton, Haumea, Makemake, and Eris. In addition, each object in the bottom of screen included “i “icon representing more information about the selected objects. On the left side of the screen, there were some numbers indicating the velocity of revolving objects (planets) over other objects (planets). The participants could move and see other objects in the sky. The participants could observe many objects existing in the sky along with their names. The participants were exposed to the Space Journey app for about ten minutes. Finally, the participants were asked to close the Space Journey app and fill out the survey. At the end, the experimenter thanked them their time and effort in participating in this experiment. Figure 7 shows a screen shot of Space Journey mobile app.

Figure 7: Screen Shot of Space Journey Mobile App



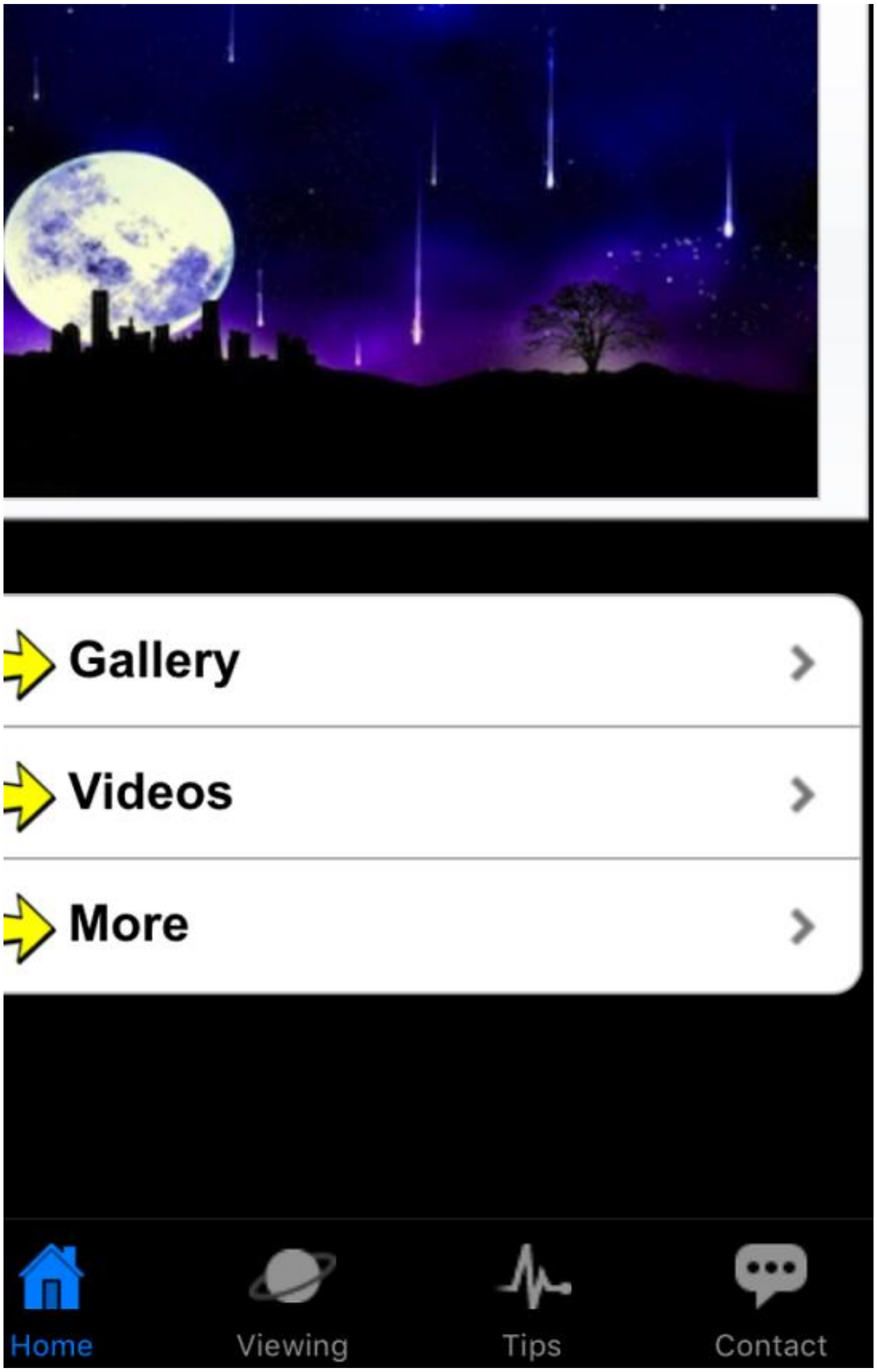
No Augmented reality with low level of interactivity. After filling out the prescreening questions, the experimenter asked the participants to use their smart phone and download the mobile application called “Sky Guide”. Sky Guide was selected as low level of interactivity because it did not ask the participants to calibrate their location, and did not provide novel and attractive features provided by other star mobile apps, such as Sky Night or Star Chart.

On the left side of screen, there were three options, namely gallery, videos and more. The gallery option showed the image of asteroid, big dipper, comet, little dipper, lunar eclipse, meteor shower, North Star, Orion belt, and solar eclipse. The video tab presented some YouTube videos related to the constellation. The videos were relatively short (between 3 minutes to 10 minutes). Finally, the more tab included puzzle, match it and color it. This option only entertained the participants.

On the bottom of the screen, there were four tabs, namely home, viewing, tips, and contact. The home option took the participants to the main page. The viewing option included six tabs, namely celestial events, visible planets, moon phases, constellations, meteor showers, and eclipses. The celestial events instructed the participants about specific events occurring in the sky; for example, it mentioned the exact date (January 5, 2014) when Jupiter was located at opposition to the Earth. On visible planet tab, the participants could educate themselves about times when the planets were visible in the sky. For example, the Sky Guide said that Mercury (twilight) occurred in the evening of 1/ 13-31. The third option was moon phases. This alternative provided only information about the moon and some small pictures about it. The fourth option was constellation, which instructed some information to the participants with simple images. The fifth option was meteor showers, which showed some information about it to the participants without any images. The last option was eclipses including total solar eclipse, lunar eclipse, hybrid eclipse, partial eclipse, and annular eclipse. All available options provided some information to the participants without any pictures. The participants were free to choose any features included in Sky Guide. Overall, the participants were given ten minutes to entertain and educate themselves about the Star Chart.

After ten minutes, the experimenter asked them to close Sky Guide app and answer the survey questions. Finally, the experimenter appreciated the participants' time and effort to have participated in this study. Figure 8 shows a screen shot of Sky Guide mobile app.

Figure 8: Screen Shot of Sky Guide Mobile Application



Study Three: Conceptual and Methodological Improvements

Rationale for Study Three

Study 3 examined how AR directly influences UX and how UX mediates the effect of augmented reality on the outcome variables namely user satisfaction and user's willingness to use AR. Additionally, Study 3 examined the moderation effect of perceived control, responsiveness, image interactivity, trade-off between price and value and user's information privacy control. Study 3 was conducted in the context of vehicle service use and used two AR applications for the two groups. Virtual Guide Application launched by Hyundai was used for the experimental group and Regional Hyundai Application was used for the control group.

For Study 3, two new scales were developed, namely "augmented reality" or (AR) and augmentation quality. Augmented reality reflects the extent to which augmented reality is intelligent or smart enough to recognize the objects, images or contents in the existing reality and find and insert the relevant corresponding virtual contents onto the existing reality. It is able to capture sensory experience such as vision. In fact, augmented reality in mobile applications is similar to artificial intelligence in Alexa Amazon or Apple Siri. In other words, existing augmented reality applications for consumer use are for the provision of image recognition whereas Alexa Amazon and Apple Siri or Google Assistant, Microsoft Cortana are for the provision of voice recognition. Today's AR mobile applications are able to recognize objects (image recognition) and insert virtual contents onto the present reality. The more intelligent augmented reality is, the more it is able to recognize objects placed in the present reality and map fruitful, flawless, reliable, and trustworthy virtual contents onto the present reality.

In future, augmented reality applications will be able to recognize other components of sensory experience such as voice recognition or touch and feel. AR uncovers the degree to which

AR is able to precisely recognize the contents (image, text, voice) in the existing reality (image recognition) and incorporates the correspondent virtual contents onto the existing reality (insertion of virtual contents). Eight new items were developed to capture AR and the items were face validated.

Measuring Augmented Reality (AR)

One of the main contributions of study 3 is developing a new scale to measure intelligence of AR in terms of image recognition and insertion of virtual contents. AR as smart and interactive media superimposes virtual contents onto the existing reality and augments user experience. To generate an enriched user experience, AR should be able to precisely recognize the content and inserts the trustworthy virtual contents into it. Intelligent AR has to precisely recognize the content of existing reality and add reliable and relevant virtual content onto the existing reality where the virtual content belongs to.

Javornik et al. (2016) captured and measured perceived augmentation. They assessed how perceived augmentation influences purchase intention and convenience of shopping. Perceived augmentation in their study included the items such as “The app added virtual make up to my face”, “The way the makeup was placed on my face seemed real”, “The makeup seemed to be part of my face”, “The makeup moved together with my face when I turned my head”, “The makeup seemed to exist in real time”. Perceived augmentation used by Javornik et al. (2016) held sufficient reliability and validity in their study. Having said, Study 3 developed a scale to measure AR and treated AR as a measured construct.

Study 3 measured main characteristics of AR which makes AR a significant technology: image recognition, insertion of virtual contents, and realistic (authentic) quality. Image recognition is the most important feature of AR and if it does not properly function, it will not accurately recognize the objects and the insertion of the virtual contents would be faulty, unrealistic, and unworthy. For example, Blippar application is based on image recognition technology that generates virtual information. Blippar is not perfect and sometimes it fails to precisely recognize the objects so that it provides misleading and false information which misinform the user.

More importantly, AR with high intelligence is able to simultaneously generate realistic and authentic fabricated reality by insertion and mapping the virtual contents onto the present reality. For example, Ray Ban application generates authentic and realistic experience by recognizing the user's face and inserting the virtual sunglasses to the user's face simultaneously.

Augmentation Quality

The second contribution of Study three is developing a construct as a new dimension of UX. We see augmentation quality as a new dimension of UX, which is exclusively driven by AR. Augmentation quality is added to the current UX's dimensions. Augmentation quality is a vital component of user experience that differentiates augmented reality from other interactive technologies. Augmentation quality reflects the quality of augmented experience or augmentation. Not all AR applications are able to generate high quality of augmentation. Sometimes augmentation is so vivid and authentic (Hilken et al., 2017) that users do not distinguish the boundary between real contents and virtual contents. It is vital that augmented reality is able to provide vivid virtual contents onto the present reality. Authentic, realistic augmented experience is gained when AR is able to generate and map relevant virtual contents onto the present reality. Augmentation quality plays an essential role on enriched UX that gives sense of empowerment to the users.

Augmentation quality is exclusively driven from augmented reality and refers to the output quality resulted from an interaction and integration of virtual contents onto the present reality. Augmentation quality consists of three components, namely information quality, user's empowerment, and correspondence quality / mapping quality. Intelligent augmented reality is smart enough to provide reliable and trustworthy virtual contents (information quality); map the related virtual contents on to the corresponding places onto the present reality (mapping quality); and empower the users' capabilities to perform tasks (user's empowerment or self-awareness).

Therefore, study 3 suggested that UX obtained by AR reflects five aspects, including pragmatic quality, hedonic quality by stimulation, hedonic quality by identification, aesthetic quality and augmentation quality. Therefore, a new hypothesis was added:

> H6: Augmented reality positively and significantly impacts user experience as formed in the latter five characteristics, pragmatic quality, hedonic quality by stimulation, hedonic quality by identification, aesthetic quality, and augmentation quality.

Additionally, since this study was conducted in the context of service use, instead of user's willingness to buy, the impact of UX on user's willingness to use AR was considered. A new hypothesis was added to examine the effect of user experience on user's willingness to use AR.

User's Willingness to Use Augmented Reality (UWAR)

User's willingness to use AR refers to the degree to which a user is willing to use augmented reality. AR empowers the customers to have personalized experience resulting in confident and satisfied purchase experience. In the service use context, AR also allows the customers to learn some challenging tasks and in fact consult with the AR technology rather than a service employee. Hence, the AR customers may fix problems associated with service use and allows them save time and effort. Learning becomes easier and less challenging with the help of AR. Thus, enriched user experience impacts user's willingness to use AR. Additionally, user experience is mediated by the effect of augmented reality on user's willingness to use AR.

H7a: The impact of augmented reality on user satisfaction is mediated by user experience.

H7b: The impact of augmented reality on user's willingness to use augmented reality is mediated by user experience.

More detailed information about the moderation effect of interactivity will be explained below.

The Role of Interactivity between AR and UX

Interactivity: Interactivity enables us to know how three components of interactivity (perceived control, responsiveness and image interactivity) strengthen or weaken the effect of AR on UX. Interactivity feature in augmented reality gives users the opportunity to interact and modify the virtual contents shown in the mediated reality or simulated environment (Huang & Liu, 2014). Interactivity is a tool of empowerment by allowing users to have control over the virtual contents (Oh, Yoon, & Shyu, 2008) superimposed onto the existing reality, thereby interactivity has a potential to enhance user experience (Klein, 2003). One type of interactive AR technologies is 3D virtual model that provides personalized shopping experience to the user (Shim & Lee, 2011).

AR with high level of intelligence and interactivity facilitates decision-making by generating three-dimension image of objects onto the present reality in which they belong to. Such AR empowers the users to make decisions with more confidence and less risk. For example, 3D virtual models, as a type of advanced interactivity technology, enhance product presentation (Nantel, 2004), and motivate customers to revisit websites and buy (Kim &

Forsythe, 2009). In addition, AR with interactivity technology allows the user to simulate the product's features on a website (Fiore, Kim, & Lee, 2005). AR with interactivity feature provides the user with stimulatory enriched product information. Another example, Walgreen is using Google's Project Tango 3D augmented reality technology and allowing its customers to locate a specific product or getting correct directions to the aisle where product is located. Tesco supermarket has also provided an augmented reality app for its consumers to boost the shopping experience.

The level of interaction with virtual contents and user experience are correlated. As the level of interaction increases, the user experience is enhanced (Billinghurst, Kato, & Myojlin, 2009). Most of AR apps have focused on simple levels of interaction, such as product display (Billinghurst, Kato, & Myojlin, 2009). In future, AR technology may focus on capturing full sensory experience (Billinghurst, Kato, & Myojin, 2009). Current AR apps have provided visual sensory, and a few AR apps have focused on auditory or haptic sensory experience (sense of touch). Multi-sensory AR is able to empower the users and acts like a sixth-sense of human being.

AR technology, emphasizing the user's body and mind, can assist a user to make effective decisions. IBM is developing an AR mobile application that assists shoppers to make effective purchase decisions. The more inputs sent to AR from the user, the more effectively virtual information is integrated to real information and delivered to the user. Therefore, the more effective decision can be made by the user. Thus, I would suggest that AR apps with high interactive features and having balance between the user's body and mind can predict the user's interests regarding products. This study argues that effective AR technology should address the user's body and mind and create a balance between the body and mind. Most of the AR apps that are in the market receive only image or voice from the user (as input). I would suggest that as the level of interactivity between the user's body, mind and AR technology enhances, AR is able to portray more precise output to the user. For example, if the user image, user's facial expression, and the user's previous experience (e.g., prior purchase) is shared with AR, then AR is able to better assist the user in the process of decision- making. Besides, I would suggest that AR can highly engage the user in the process of decision-making. For example, most AR mobile apps, such as Make up Genius, Virtual Try-on Ray-Ban, and so on engages the users to choose a product and then the AR mobile app adds virtual contents to the real contents, and the users are not actually engaged in adjusting the virtual contents; in fact, the users are absent in this process.

For instance, if a shopper, using IBM AR mobile app, uses his camera close to products on a shelf in a store, then the shopper can get more information about products available in the store based upon his prior purchases, or his interests. Therefore, to achieve a highly intelligent and interactive AR, both the user's body (emotive) and mind (cognitive) need to be considered while designing AR technology.

High interactive AR technology receives the user's multi-sensory inputs and feedback and sends outputs to the user in real time. For example, AR receives the user's sensory input, such as haptic, images and speech, and generates virtual information based upon the received input (reality). Then, AR integrates and aligns real and virtual information back to the user through one or more multisensory outputs, such as speech, haptic or vision.

The more sensory connection between AR and the user, the more immersive and authentic experience is generated by AR. For example, Makeup Genius, provided by L'Oreal, is an AR app that scans the user's face (image recognition), then user is given choices to choose her favorite makeup from the virtual catalogue (control). If AR app has been programmed well, it is able to portray virtual contents onto the user's face simultaneously (responsiveness) and allows the user to interact with the virtual makeup mapped on her face (image interactivity). Next, based on the level of intelligence of AR, the AR app maps the virtual make up onto the user's face (augmentation quality-mapping).

Such amazing technology assists the user to make decisions and generate fun and entertaining moments for the user. Therefore, learning become so much easier and decision-making becomes more precise and confident.

Let's imagine that the predictive power of AR goes beyond connecting with the user's cognitive responses and connects with the user's affective and emotional responses. Such AR does not exist for online shopping and to the best of my knowledge it has not been developed for any marketing purposes yet.

With the aid of machine learning, AR developers can develop AR software that predict the user's behavior and facilitate decision making by knowing the user's tastes, choices and interests. Such AR is able to predict the user's choices based on his or her prior shopping history, mood, facial expression, and so on.

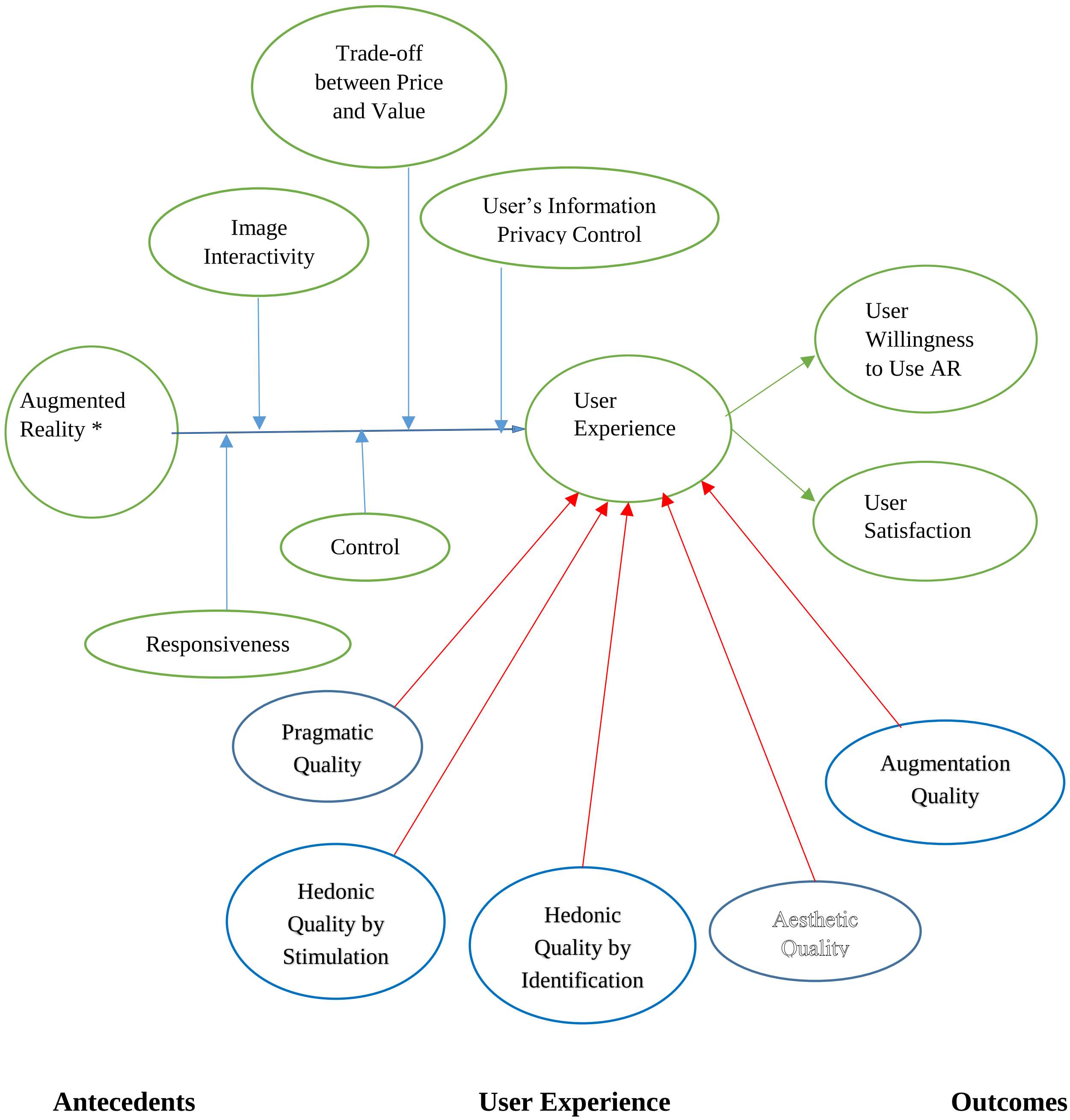
Since the concept of interactivity is multi-dimensional, three aspects of interactivity that are related to this study were selected. The three aspects of interactivity included in this study are perceived control, responsiveness, and image interactivity. The three variables examine the strength or weakness of AR on UX. Figure 10 shows the conceptual model and measurement model, and Figure 11 show the hypothesized relationships. Three new hypotheses related to the three aspects of interactivity, namely, control, responsiveness, and image are added.

H8a: The strength of the relationship between AR and UX is enhanced or weakened by the level of the user's control over AR technologies. The effect of AR on UX is stronger when the user's control over AR is higher; it is weaker when the user's control over AR is lower.

H8b: The strength of the relationship between AR and UX is enhanced, or weakened by the level of the responsiveness of AR. The effect of AR on UX is stronger when the user perceives that AR responds quickly to the user's request in real time; it is weaker when the AR responds slowly to the user's request.

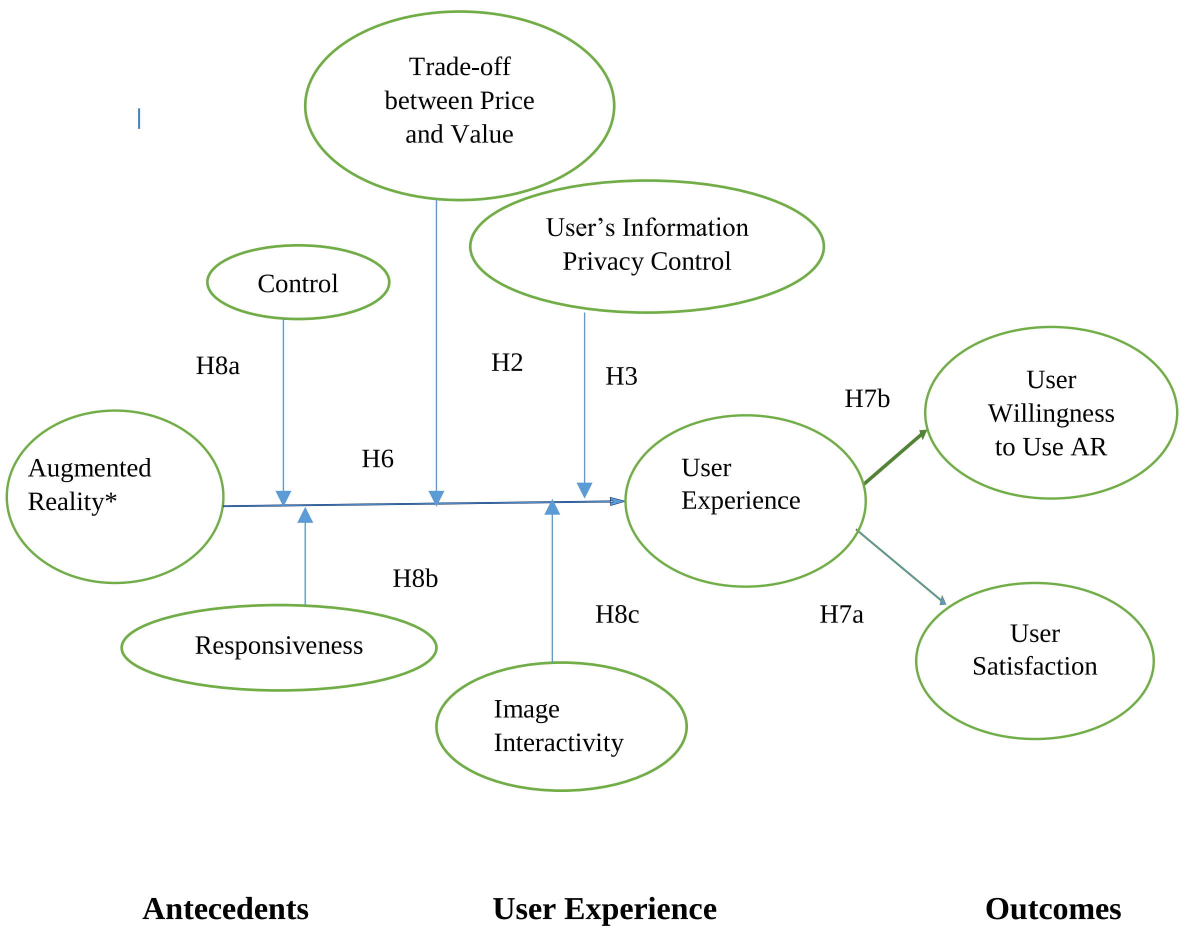
H8c: The strength of the relationship between AR and UX is enhanced or weakened by the level of the user's image interactivity over AR technologies. The effect of AR on UX is stronger when the user's interaction with virtual contents is higher; it is weaker when the user's interaction with virtual images is lower.

Figure 9: Enriched Conceptual Framework- The Impact of Augmented Reality on User Experience and Subsequent Outcomes



*: Augmented Reality is measured in Study 3.

Figure 10: Conceptual Model and Hypotheses: The Impact of Augmented Reality on UX and Subsequent Outcomes



*: Augmented Reality is measured in Study 3.

Methodological Improvements

Study 3 aims at understanding the extent to which augmented reality influences UX and behavioral intention. And, how UX mediates the relationship between AR and the outcome variables. Study 3 developed a scale to capture AR based on two features of AR namely image recognition and insertion of virtual content.

For the purpose of the study, iPad, iPhone were used to evaluate the impact of the AR on the UX and its outcomes. This study captured how augmented reality influenced user experience (UX) and how control, responsiveness, image interactivity, user's information privacy control, and trade-off between price and value strengthened or weakened the impact of AR on UX.

The first methodological challenge was how to evaluate the impact of AR on UX. Study 3 developed a new construct, augmented reality. Study 3 was conducted in a car dealership environment and used experimental and control groups.

The central design is based on a true-experiment. (Kerlinger & Lee, 2000). Each group received one treatment. A true experiment requires random assignment, which means the participants of true experiment were randomly assigned to conditions or treatments and to groups. Random assignment is preferred because randomization enhances the probability of equivalency among groups and controls the impact of extraneous variance (Kerlinger & Lee, 2000). Yet, randomization does not mean that the groups are equal, it only enhances the probability of group equivalency (Kerlinger & Lee, 2000; Shadish, Cook, & Campbell 2002; Campbell & Stanley, 1963). To assure that the groups were equivalent, the two treatments were randomly assigned to each participant (Campbell & Stanley, 1963). This study was conducted in one of the rooms in the car dealership.

In summary, study 3 included two treatments (2*1) and was applied in the context of vehicle service use. Study 3 was conducted in one of the car dealerships located in South Texas, and the experimenter used her own technology devices, such as Apple iPhones and iPads. Two treatments in study 3 were Virtual Guide Hyundai application (AR condition) for the experimental group and Regional Hyundai application (non-AR condition) for the control group. Participants were randomly assigned to one of the two treatments and had not prior experience with the treatments. In summary, study 3 included prescreening, experiment, and survey (posttest) questions for the experimental group, who was exposed to AR treatment and the control group, who was exposed to non-AR treatment, as required (Kerlinger & Lee 2000; Campbell & Stanly 1963).

Data Collection for Study Three

Sample for study 3 consisted of adult shoppers visiting one of the largest car dealerships located in South Texas. Convenience sampling was utilized to recruit the participants. This study consisted of a survey in which 200 (141 male, and 59 female) were recruited as the participants and all participants were answered the survey's questions. The age of the participants ranged from 18 to 64. All questionnaires (200) were returned and used in the analyses. Missing data was minor and did not exert any undue effect.

Prescreening of Participants for Study Three

Before conducting the experiment, the experimenter instructed participants "this study is trying to evaluate the impact of augmented reality on user experience and its outcomes." Before exposing the participants to the treatments, each participant had to answer the prescreening questions. The prescreening questions were related to technology use and captures how much the participants were familiar with technology use (Jin, 2001). Besides, in addition to technology use items, the participants answered to two more questions stating their interest to obtain more vehicle information, including price through the car dealership's websites. Table 11 shows the prescreening items.

Manipulation of Augmented reality By Using the Concept of Augmented Reality

In this stage, a new construct called augmented reality was developed. This concept was not developed for Study 1 and Study 2, but for Study 3, a construct was developed to capture the quality of output generated by AR and inserted into the present reality.

To the best of my knowledge, there is only one scale has been developed to measure perceived augmentation (Javornik, 2015; Javornik et al., 2016) to see the extent to which AR makeup application is able to insert virtual makeup into the user's face in real time. Javornik (2015) measured perceived augmentation using five items: 1) the application added virtual makeup to my face; 2) The way the makeup was placed on my face seemed real; 3)The makeup seemed to be part of my face; 4) The makeup moved together with my face when I turned my head; 5) The makeup seemed to exist in real time. Javornik (2016) used perceived augmentation to verify the effect of manipulation in the experimental (AR application) and control (non-AR application) groups. In study 3, a construct called "augmented reality" developed to measure characteristics of AR that generate augmentation output. Study 3 measures augmented reality using these items: 1) This app recognized the car (new); 2) This app added virtual information about the car in real time to the screen (adapted from Javornik (2015)'s study; 3) The app added virtual information about the car in real time to the screen (new); 4) This app added relevant virtual information about the car to the screen (new); 5) This app provided me some information about engine, exterior, interior, and other parts of the car to the screen (new); 6) This app added the 3D image of car to the screen (new); 7) As I moved the screen, virtual information about the car changed to correspond with the image on the screen (new); 8) The virtual information about the car corresponded to the image of car (new). Study 3 used augmented reality construct to examine if the manipulation works.

AR technology generates 3D virtual contents and integrate and map the virtual contents onto the real contents in the existing reality, whereas non-AR treatment is able to generate 2D virtual contents onto the reality and it lacks 3D images of virtual contents and mapping/ corresponding feature. The results of the manipulation check were reported in the related section.

In AR treatment, participants were exposed to Virtual Guide Hyundai application. Virtual Guide Hyundai application superimposed 3D virtual information on top of reality and allowed the participants to interact with the virtual objects shown on the screen. In non-AR treatment, participants were exposed to Regional Hyundai application, which did not present 3D virtual contents onto the present reality, and participants are able to interact with 2D virtual contents without mages and information shown on the screen. Participants were assigned to one of the two treatments: Virtual Guide Hyundai and Regional Hyundai applications. Table 14 shows the list of questions for the manipulation check in the context of vehicle service use. Each question is measured using a 7-point Likert scale from 1=strongly disagree to 7=strongly agree.

Table 5: Prescreening Questions for Study Three

Prescreening Items
I am familiar with using the Internet.
I frequently use the Internet to shop online.
I think that technology is necessary for my daily works.
I visit the car dealership websites to collect vehicle information.
I visit the car dealership websites for purchasing vehicle.

Improved Measures: Augmented Reality and Augmentation Quality Scales

To best of my knowledge, no prior research was conducted to capture comprehensive scale for augmented reality. Hence, to deepen our understanding, a new concept was developed to capture the level of intelligence of AR in terms of image recognition. To measure augmented reality, 8 new items were added to reflect the capability of image recognition which is a level of intelligence of AR; and the capability of AR to find and insert the relevant virtual contents onto the present reality. Image recognition refers to the level of intelligence of AR in order to precisely recognizes the objects, lines and images. Augmented reality was measured using a seven-point Likert scale, with the anchors being “strongly disagree” and “strongly agree”.

To measure pragmatic quality and hedonic quality, twenty items from the AttrakDiff 2 questionnaire (Hassenzahl 2003) were added, and also nineteen items new items were added in order to reflect AR features. To measure pragmatic quality, eight items were adopted from AttrakDiff 2 questionnaire, one item was adopted from Laugwitz, Held & Schrepp (2008), and twelve new items were inserted to capture properties of AR. To measure hedonic quality by identification, six items from AttrakDiff 2 (Hasenzahl et al. 2003) were adopted and two new items were added to reflect AR properties. To measure hedonic quality by stimulation, nine items were adopted from AttrakDiff 2 and two new items were added to reflect AR. To measure aesthetic quality, the study adopted 7 items from Lavie & Tractinsky (2004) and one items from Laugwitz, Held & Schrepp (2008), and added three new items to reflect properties of AR.

To measure augmentation quality, eleven new items were developed to capture augmented experience generated by AR. The items for augmentation quality are related to the degree of personalization and augmentation provided by AR. Pragmatic quality, augmentation quality, hedonic quality by stimulation, hedonic quality by identification, and aesthetic quality were measured using a bipolar semantic differential 7-scale method.

To measure user satisfaction, three items from Taylor & Baker (1994) were adapted. To measure user's willingness to use AR, three items were adopted from Engel et al. (1995). The items to measure the trade-off between price and value (three items) were adapted from prior research (Dodds et al., 1991), and the items to measure user's information privacy control (four items) were adapted from Liu, Marchewka & Ku (2004). To measure control, three items were added from Wu (2000), and two new items were added. To measure responsiveness, five items were added from Wu (2000), and to measure image interactivity, one item was adapted from Fiore et al. (2005), and two new items were added. All items related to user's information privacy control, trade-off between value and price, user satisfaction, and user's willingness to use AR were measured using a seven-point Likert scale, with the anchors being "strongly disagree" and "strongly agree".

Tables 6 and 7 summarize the items to measure all constructs, including the constructs with corresponding items, scale type, and the sources used plus the new items developed for the study. The questionnaire of the study consists of 9 sections: introduction, prescreening, augmented reality, pragmatic quality, hedonic quality by identification, hedonic quality by stimulation, aesthetic quality, augmentation quality, user satisfaction, user's willingness to use AR, control, responsiveness, image interactivity, user's information privacy control, and trade-off between price and value. Further, the participants provided some demographic information, such as gender, age, occupation, and income.

Table 6: Constructs and Items for Study Three

Construct and Items: Prescreening Variable	Source
I am familiar with using the Internet.	Jin, 2001
I frequently use the Internet to shop online.	Jin, 2001
I think that technology is necessary for my daily works.	Olsson et al., 2012
I visit the car dealership websites to collect vehicle information.	New
I visit the car dealership websites for purchasing vehicle.	New
Independent Variable: Augmented reality	New
This app recognized the car.	New
This app added virtual information about the car to the screen.	Javornik (2015)
This app added virtual information about the car in real time to the screen.	New
This app added relevant virtual information about the car to the screen.	New
This app provided me some information about engine, exterior, interior, and other parts of the car to the screen.	New
This app added the 3D image of car to the screen.	New
As I moved the screen, virtual information about the car changed to correspond with the image on the screen.	New
The virtual information about the car corresponded to the image of car.	New
Moderator Variable: Control	
This app was interactive.	New
While I was using the app, I was always able to do what I thought I was doing.	Wu (2000)
I felt I had a great control while I was using the app.	Liu (2003)
I thought this app really gave me some control (i.e., flexibility) over the content that I wanted to see.	
This app showed a variety of cars.	New
Moderator Variable: Responsiveness	
This app had the ability to respond to my specific requests for information, so I could access it quickly and efficiently.	Wu
Interaction with this app was very fast.	
I was able to obtain information I wanted without any delay.	
This app processed my input very quickly.	
This app would allow me to easily communicate with the company if I ever had a specific question or wanted to purchase a car.	
Moderator Variable: Image Interactivity	
This app allowed the user to zoom in/ zoom out the image of car.	Fiore et al. (2005)
This app allowed the user to change the color of car.	New
This app could easily let me access other consumers' opinions about the cars featured.	

Table 6
Continued

Moderator Variable: Trade-off between Value and Price	
The car that I was using this app for was reasonably priced.	Dodds et al., 1991
The car that I was using this app for was a good value for the money.	Dodds et al., 1991
At the current price, the service offered in the mobile AR app provides a good value.	Dodds et al., 1991
Moderator Variable: User's Information Privacy Control	
I was informed about the personal information that this app would collect about me, such as email, name, location.	Liu, Marchewka & Ku, 2004
This app explained the reasons why my personal information was being collected.	Liu, Marchewka & Ku, 2004
This app informed the way my personal information would be used.	Liu, Marchewka & Ku, 2004
This website gave me a clear choice before using personal information about me.	Liu, Marchewka & Ku, 2004
Outcome Variable: User Willingness to Use AR	
I intend to use the app to see the 3D images of car.	Engel et al., 1995
I would be willing to use this app.	Engel et al., 1995
In future, I would use this app.	Engel et al., 1995
Outcome Variable: User Satisfaction	
Overall, I am satisfied with this app.	Taylor & Baker, 1994
Being a user of this app has been a satisfying experience.	Taylor & Baker, 1994
Having experienced this app was pleasurable.	Taylor & Baker, 1994

Note: Each item is measured using a 7-point Likert scale from 1= strongly disagree to 7= strongly agree.

Table 7: User Experience Measure for Study Three

UX-Pragmatic Quality	Source
Technical - human	Hassenzahl, 2004
Unruly-manageable	Hassenzahl, 2004
Confusing-clearly structured	Hassenzahl, 2004
Unpredictable- predictable	Hassenzahl, 2004
Cumbersome- straightforward	Hassenzahl, 2004
Impractical- practical	Hassenzahl, 2004
Complicated- simple	Hassenzahl, 2004
Unprofessional- professional	Hassenzahl, 2004
Difficult to learn-easy to learn	Hassenzahl, 2004
Effortful- effortless	Laguwitz et al. 2008
UX-Augmentation Quality	**New Dimension**
Slightly informative-highly informative	New
Irrelevant information-relevant information	New
Static images- vivid images	New
Unreliable- reliable	New
Insecure- secure	New
Shady output- trustworthy output	New
Slightly augments one's capabilities to use the car- highly augments one's capabilities to use the car	New
Adds virtual information to the places where do NOT belong- Adds virtual information to the places where belong	New
Risky to use- safe to use	New
Not personalized- personalized	New
Slightly augments one's awareness of the car- highly augments one's awareness of the car	New
UX-Hedonic Quality by Identification	
Unpresentable- presentable	Hassenzahl, 2004
Separates me from people- brings me closer to people	Hassenzahl, 2004
Alienating- integrating	Hassenzahl, 2004
Cheap- expensive	Hassenzahl, 2004
Tacky- stylish	Hassenzahl, 2004
Isolating- connective	Hassenzahl, 2004
Decreases one's self image- augments one's self-image	New
Loneliness- the sense of belonging to the community	New
UX- Hedonic Quality by Stimulation	
Ordinary- novel	Hassenzahl, 2004
Undemanding- challenging	Hassenzahl, 2004
Dull- captivating	Hassenzahl, 2004
Conservative- innovative	Hassenzahl, 2004
Cautious- bold	Hassenzahl, 2004
Unimaginative- creative	Hassenzahl, 2004
Conventional- inventive	Hassenzahl, 2004
Repelling- appealing	Hassenzahl, 2004
Discouraging- motivating	Hassenzahl, 2004
Not absorbed- absorbed	New
Not immerse- immerse	New

Table 7 Continued	
UX-Aesthetic Quality	
Ugly- beautiful	Lavie and Tractinsky 2001
Unattractive- attractive	Laguwitz et al. 2008
Unfriendly- friendly	Lavie and Tractinsky 2001
Annoying- enjoyable	Lavie and Tractinsky 2001
Unpleasant- pleasant	Lavie and Tractinsky 2001
Bad- good	Lavie and Tractinsky 2001
Asymmetric- symmetric	Lavie and Tractinsky 2001
Unclean- clean	Lavie and Tractinsky 2001
Rigid- artistic	New
Static- vivid	New
Artificial- realistic	New

CHAPTER IV

RESULTS

The summary of the results will be discussed in this chapter. This chapter includes three sections: 1) analysis and results of the studies one, two and three including manipulation check, validity analysis, main effect, moderation effects, mediation effect, 2) discussion and conclusion of the studies, 3) conceptual and methodological improvements along with improved measures.

Analysis and Results of Study One and Study Two

Overall, 99 participants were tested in the context of consumer shopping and service use contexts. All questionnaires (99) were returned and used in the analyses. Missing data was minor and did not exert any undue effect. The age of the students ranged from 20 to 60. It might possible that the pilot test (integration of study 1 and study 2) did not have a lot of statistical power due to the small sample size, but for study 3, more data was collected.

After collecting data collected from conducting two studies, SPSS was conducted to obtain descriptive statistics and reliability results. Table 8 shows the results of descriptive statistics, including reliability, AVE results, and factor loadings. Cronbach Alphas range from .733 to .991 demonstrating construct internal consistencies (Nunnally & Bernstein, 1994), and factor loadings range from .372 to .982. After checking for reliability, factor analysis was conducted to check for uni-dimensionality of the constructs (Table 8). First, this study ensured that the data set (multi-item scales comprising 63 items) was factorable using the Kaiser-Meyer-Olkin measure of sampling adequacy and (Bartlett's Test of Sphericity. Then, a general EFA with the sixty-three items using the maximum likelihood method (MLE) and Varimax rotation was conducted to check the uni-dimensionality of constructs. Thirteen factors emerged with acceptable default eigenvalues, which is 1. While a majority of scale items satisfied the expected loading patterns, five items (especially those of hedonic quality by identification and hedonic quality by stimulation) showed meaningful cross loadings. Thus, three separate EFA were repeated for each user experience's dimension, and one EFA was repeated for outcome variables and moderator variables. EFA was conducted to check dimensionality of user satisfaction, user's willingness to buy, user's information privacy control and trade-off between price and value (KMO= .816, χ^2 = 948.628, df= 78, sig= .000). All factor loading was higher than minimal amount, which is .3 (Hair et al. 2006). According to Hair et al. (2006), factor loading higher than .3 shows that the item is acceptable; factor loading higher than .4 shows that the item is important; and factor loading higher than .5 shows that the item is practically significant.

After finding that pragmatic quality, hedonic quality by stimulation and aesthetic quality are multi-dimensional constructs, separate EFA was conducted for each emerged factor. The results of EFA indicate that pragmatic quality has 4 dimensions, including practicality (KMO= .864, χ^2 = 365.3, df= 15, sig= .000), reliability (KMO= .844, χ^2 = 259.5, df= 15, sig= .000), informativeness (KMO= .751, χ^2 = 76.05, df= 6, sig= .000), and usefulness (KMO= .974, χ^2 = 223.16, df= 1, sig= .000). In relation to hedonic quality by stimulation, 2 factors emerged from the hedonic quality by stimulation, namely rational stimulation (KMO=.893, χ^2 =421.45, df= 15, sig= .000), and emotional stimulation (KMO = .808, χ^2 = 313.48, df = 10, sig= .000). Besides, the results show that aesthetic quality has 2 dimensions, namely cognitive aesthetic (KMO=

.923, χ^2 = 777.35, df= 28, sig= .000), and affective aesthetic (KMO = .69, χ^2 = 197.04, df= 3, sig= .000).

The results showed that hedonic quality by identification is a uni-dimensional construct as Hassenzahl' study (2009). Aesthetic quality and hedonic quality by stimulation have two dimensions as Lavie and Tractinsky (2004) and Laugwitz et al. (2008) pointed out respectively. Pragmatic quality is a construct with four dimensions. Laugwitz et al. (2008) identifies six dimensions of UX, namely attractiveness, perspicuity, efficiency, dependability, stimulation and novelty. Pragmatic quality corresponds to perspicuity, dependability and efficiency. Hedonic quality by stimulation corresponds to novelty and stimulation.

After running reliability test and EFA, 3 items with low alpha level, including PQ1, HS2 and ASC6 were eliminated. The final EFA using the 62 retained items confirmed the dimensionality of the scales and returned theoretically and empirically acceptable solutions (see Table 8).

Table 8: First-order Constructs: EFA Results

	Constructs	Factor Loadings
	Hedonic Quality by Identification (α= .848; AVE= .44)	
HI1	Unpresentable-presentable	.773
HI2	Separates me from people-bring me closer to people	.510
HI3	Alienating-integrating	.786
HI4	Cheap-expensive	.372
HI5	Tacky-stylish	.807
HI6	Isolating-connective	.820
HI7	Decreases one's self image-augments one's self-image	.549
HI8	Loneliness-the sense of belonging to the community	.542
	Hedonic Quality-Emotional Stimulation (α= .882; AVE= .54)	
HS9	Repelling-appealing	.930
HS10	Discouraging-motivating	.712
HS11	Not absorbed-over absorbed	.454
HS12	Not immerse-immerse	.759
	Hedonic Quality-Rational Stimulation (α= .922; AVE= .669)	
HS1	Ordinary-novel	.720
HS3	Dull-captivating	.828
HS4	Conservative-innovative	.809
HS5	Cautious-bold	.749
HS6	Unimaginative-creative	.868
HS7	Conventional-inventive	.918
	Aesthetic Quality Cognitive Aesthetic (α= .955; AVE= .729)	
ASC1	Ugly-beautiful	.926
ASC2	Unattractive-attractive	.930
ASC7	Asymmetric-symmetric	.711
ASC8	Unclean-clean	.797
ASC9	Aesthetically unpleasing-aesthetically pleasing	.833
ASC10	Rigid design-artistic design	.892
ASC11	Static-vivid	.904
ASC12	Artificial-Realistic	.816
	Aesthetic Quality-Affective Aesthetic (α= .894; AVE= .753)	
ASC3	Unfriendly-friendly	.722
ASC4	Annoying-enjoyable	.882
ASC5	Unpleasant-pleasant	.980
	Pragmatic Quality-Practicality (α= .902; AVE= .61)	
PQ2	Unruly-manageable	.583
PQ3	Confusing-clearly structured	.853
PQ6	Impractical-practical	.911
PQ7	Complicated-simple	.834
PQ9	Difficult to learn-easy to learn	.821
PQ15	Effortful-effortless	.652

Table 8 Continued

	Pragmatic Quality-Reliability (α= .864; AVE= .52)	
PQ4	Unpredictable-predictable	.75
PQ5	Cumbersome-straightforward	.868
PQ8	Unprofessional-professional	.611
PQ10	Insecure-secure	.641
PQ12	Irrelevant-relevant	.619
PQ14	Unreliable-reliable	.809
	Pragmatic Quality-Informativeness (α= .733; AVE= .42)	
PQ11	Too few information-too much information	.736
PQ16	Shady-trustworthy	.602
PQ19	Not personalized-personalized	.529
PQ20	Highly decreases one's awareness-highly augments one's awareness	.694
	Pragmatic Quality- Usefulness (α= .974; AVE= .81)	
PQ17	Highly decrease one's capabilities-highly augments one's capabilities	.9
PQ18	Risky to use-safe to use	.9
	User Satisfaction (α= .938; AVE= .836)	
US1	Overall, I am satisfied with the Ray-Ban website.	.898
US2	Being a user of this website has been a satisfying experience.	.954
US3	Having experienced this website was pleasurable.	.890
	User's Willingness to Buy (α= .954; AVE= .874)	
UWB1	I intend to buy my eyeglasses/sunglasses via the Ray-Ban website.	.911
UWB2	I would be willing to buy my eyeglasses/sunglasses via the Ray-Ban website.	.965
UWB3	In future, I would buy my eyeglasses/sunglasses via the Ray-Ban website.	.929
	Trade-off Price and Value (α= .905; AVE= .779)	
PV1	The product offered in the website of Ray-Ban app is reasonably priced.	.726
PV2	The product offered in the website of Ray-Ban is a good value for the money.	.982
PV3	At the current price, the product offered in the website of Ray-Ban provides a good value.	.920
	User's information privacy Control (α= .956; AVE= .84)	
PRIV1	I was informed about the personal information that Ray-Ban website would collect about me, such as email, name, and location.	.934
PRIV2	This website explained the reasons why my personal information is being collected.	.979
PRIV3	This website informed the way my personal information would be used.	.915
PRIV4	This website gave me a clear choice before using personal information about me.	.838

Note: The following items were eliminated: PQ1, HS2 and ASC6, as explained in the text.

Results of the Comparison between Two Groups

As proposed in the section of research design and measures, the AR condition (the independent variable) was manipulated in terms of personalization and three levels of interactivity. However, no measure was used to capture the significance level between two groups. Participants of the experimental groups for shopping experience were exposed to either a high level or a middle level interactivity. In contrast, participants of the control group for shopping experience were exposed to a condition in which there is not interactivity with AR. This last condition was called low level of interactivity in order to make comparisons with the other levels. The AR condition was used as a categorical manipulated variable that indicated exposure to one of the experimental and control conditions. Tables 3 and 4 show the list of questions that are used for both studies to check the manipulation, however, a scale was not developed to ensure whether manipulation works. Additionally, Study 1 & Study 2 examined interactivity as the main attribute of AR. However, AR is a type of artificial intelligence that is able to learn and recognize objects from big data. AR involves sophisticated machine learning algorithm inside it which goes beyond just interactivity. Therefore, to explain and predict better, Study 3 developed and measured a scale for AR. The experimental condition (AR presence) was coded as +1 and the condition (AR absence) was coded as 0 or reference group.

Although the pilot test did not develop a scale to check manipulation, the mean differences between two groups were checked. Table 9 shows means for the experimental and control groups. Table 9 shows the results of the comparison. According to the results, user experience (Mean= 5.60), user satisfaction (Mean= 6.33), and user's willingness to buy (Mean= 5.53) gained from the experimental group that received AR treatment were higher than user experience (Mean= 4.96), user satisfaction (Mean= 4.87), and user's willingness to buy (Mean= 4.60) gained from the control group that received non-AR treatment. Besides, the results indicated that user experience (p= 002), user's information privacy control (p= .02), price-value trade-off (p= .01), user satisfaction (p= .01), user's willingness to buy (p= .01) gained from the experimental group and control group were significantly different.

Table 9: Experimental group (AR) and Control group: Means and p-Value

Constructs	Mean (Experimental group)	Mean (Control group)	p-Value
User Experience	5.60	4.96	.002
User's Information Privacy Control	4.45	3.52	.02
Price-value Trade-off	6.03	5.40	.01
User's Willingness to Buy	5.53	4.60	.01
User Satisfaction	6.33	4.87	.01

Convergent and Discriminant Validity

To analyze convergent and discriminant validity, the average variances extracted, and composite reliabilities were checked. AVE was obtained by the amount of sum of squares of standardized factor loadings divided by the number of indicators. The Average Variance Extracted (AVEs) ranged from .59 to .87. The AVEs for trade-off between price and value, user's information privacy control, user satisfaction, user's willingness to buy satisfied the recommended threshold value of .5 for convergent validity (McDonald & Ho, 2002). The results of AVEs for all constructs were satisfactory and higher than the threshold .5.

In addition, to inspect discriminant validity, the square roots of AVEs and inter-factor correlations were compared. AVEs above .5 and square roots of AVEs above inter-factor correlations show discriminant validity (Fornell & Larcker, 1981). Table 10 shows AVE, correlations for AR, UX, UWTB, US, and evidence for convergent and discriminant validity. The numbers placed on the diagonal of the Table 10 show the squared amount of average variance extracted. To check discriminant validity, the square roots of AVEs and inter-factor correlations were compared. The results indicate that user experience, user satisfaction, user's willingness to buy, user's information privacy, trade-off between price and value show discriminant validity. The square roots of AVEs of UX, user satisfaction and user's willingness to buy, user's information privacy control and trade-off between price and value are higher than the inter-factor correlations (see Table 10).

Table 11 shows the correlation coefficients among variables resulting from the second order constructs. The AVEs of UX, user satisfaction, user's willingness to buy, trade-off between price and value and user's information privacy control are higher than .5, which are evidence of convergent validity. Additionally, the square root of AVE for each construct is higher than interfactor correlations, which is evidence of discriminant validity.

Table 10: Correlations, AVE (Convergent Validity), and Discriminant Validity

Constructs	AVE	AR	UX	US	UWTB	PV	UIPC
AR	-	-	.3** .	.427**	.246*	.239*	.219*
User Experience	.59		.77	.616**	.478**	.358**	.267**
User Satisfaction	.78		.	.91	.774**	.471**	.292**
User's Willingness to Buy	.84				.93	.515**	.244*
Trade-Off between Price and Value	.87					.89	.134
User's Information Privacy Control	.84						.92

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
AR: Augmented Reality
UX: User Experience
US: User Satisfaction
UWB: User's Willingness to Buy
UIPC: User's Information Privacy Control
PV: Trade-off between Price and Value
Note: The numbers in the diagonal show the square root of average variance extracted.

Table 11: Correlation Coefficients - Second-order Constructs

	Constructs	AR	PQ	HQ-S	HQ-I	AQ	US	UWB	PV	UIPC
AR	Augmented Reality	1	.151	.315**	.323**	.349**	.427**	.246*	.239*	.219*
PQ	Pragmatic Quality	.151	1	.605**	.569**	.643**	.497**	.457**	.405**	.193
HQ-S	Hedonic Quality by Stimulation	.315**	.605**	1	.773**	.901**	.541**	.370**	.276**	.258*
HQ-I	Hedonic Quality by Identification	.323**	.569**	.773**	1	.775**	.505**	.387**	.178	.342**
AQ	Aesthetic Quality	.349**	.643**	.901**	.775**	1	.634**	.432**	.296**	.212*
US	User Satisfaction	.427**	.497**	.541**	.505**	.634**	1	.774**	.471**	.292**
UWB	User's Willingness to Buy	.246*	.457**	.370**	.387**	.432**	.774**	1	.515**	.244*
PV	Trade-Off Price-Value	.239*	.405**	.276**	.178	.296**	.471**	.515**	1	.134
UIPC	User Information Privacy Control	.219*	.193	.258*	.342**	.212*	.292**	.244*	.134	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

AR: Augmented Reality
UX: User Experience
US: User Satisfaction
UWB: User's Willingness to Buy
UIPC: User's Information Privacy Control
PV: Trade-off between Price and Value

Note: PQ, HQ-S, AQ are second-order constructs, and the value of each 2nd order construct was measured by summation of its dimensions. HQ-I, P-VT, PIC, US, UWTB are first-order constructs, and the value of each first-order construct was measured by summation of its indicators.

Results on Main Effects: AR Effect on UX and Outcomes (Based on Study One and Study Two)

Since the size of sample was small, the data obtained from study one and study two was integrated to one data set. The results were based on both studies. The data obtained from the AR with high and middle level of interactivity in buying consumer products and entertainment service contexts were considered as AR data, whereas the data obtained from the non-AR with low level of interactivity from the two mentioned contexts was considered as non-AR data.

The structural model was pre-tested using SmartPLS 3. SmartPLS was used because of the following reasons. First, SmartPLS works well with small sample size (Hair, Ringle, & Sarstedt, 2012). Second, it is appropriate for both reflective and formative constructs (Hair, Ringle, & Sarstedt, 2012); and the model includes both reflective (user satisfaction, user's willingness to buy, user's information privacy control and trade-off between price and value) and formative (user experience) constructs. Third, SmartPLS works well in the situations in which the aim of research is exploratory or theory development (Hair, Ringle, & Sarstedt, 2012). Additionally, no prior research attempted to measure UX as a comprehensive construct reflecting all four aspects of experience.

The degree of misspecification is too high in Marketing (Jarvis et al. 2003). That is, many constructs were measured reflective instead of formative. Measuring UX is challenging, and no studies have attempted to measure a summary of UX (Law & Van Schaik, 2010). These are the reasons to measure UX as a formative construct. First, UX is a formative construct (Law & Van Schaik, 2010) because the direction of causality is from the indicators toward the construct (e.g., Jarvis et al. 2003). Thus, in this research, the direction of causality is from the first order constructs toward the second order constructs; and from the second order constructs toward the third order construct (UX). This study measured UX as a formative third order construct, consisting of 4 characteristics of product qualities, including pragmatic quality, hedonic quality by stimulation, hedonic quality by identification, and aesthetic quality are reflected to UX.

In order to validate the formative nature of the construct, in particular to know which indicators should be kept, some criteria were used. The weights and loadings of the formative construct's indicators were checked, as recommended (Hair, Ringle, & Sarstedt, 2012). The indicators' weights that were significant were kept; those that were not significant were dropped (Hair, Ringle, & Sarstedt, 2012).

SmartPLS 3.0 was used to check the indicators' weights and loadings of the UX indicators. Because UX is a formative third order construct, the weights of its four dimensions (pragmatic quality, hedonic quality by stimulation, hedonic quality by identification, and aesthetic quality) were checked as follows: 1) pragmatic quality (β = .311, t = 14.174, p = .000); 2) hedonic quality by stimulation (β = .268, t = 21.345, p = .000); 3) hedonic quality by identification (β = .64, t = 12.372, p = .000); and 4) aesthetic quality (β= .35, t= 18.660, p = .000). They are all significant; sufficient evidence of keep the indicators.

The same criteria were used to validate the first-order constructs: 1) affective aesthetic (β = .283, t = 22.054, p = .000); 2) cognitive aesthetic (β = .744, t = 41.3, p = .000); 3) emotional stimulation (β = .394, t = 15.147, p = .000); 4) rational stimulation (β = .678, t = 24.794, p = .000); 5) informativeness (β = .213, t = 7.717, p = .000); 6) practicality (β = .499, t = 15.347, p = .000); 7) reliability (β = .404, t = 17.146, p = .000); and 8) usefulness (β = .164, t = 2.215, p = .02). They are all significant; sufficient evidence to keep the indicators.

Figure 11 shows the amount of coefficient and R-square using SmartPLS 3. The results indicate that the AR condition is positively and significantly associated with user experience

(UX) (β = .3; R^2 = .867; t = 2.37; p = .01), indicating that H1was supported. Regarding the outcome variables, the results show that H4 and H5 are also supported, that is, UX is positively and significantly associated with user satisfaction (β = .873; R^2 = .763; t = 49.90; p = .000) and user's willingness to buy (β = .761; R^2 = .58; t = 21.89; p = .000). Table 12 shows the results of testing the three hypotheses, including constructs, path coefficients, means, standard deviations, R-squares, and p-values. UX is a third order formative construct formed by four dimensions of UX.

Figure 11: Test-Correlations and R-Squares for Study 1 and Study 2

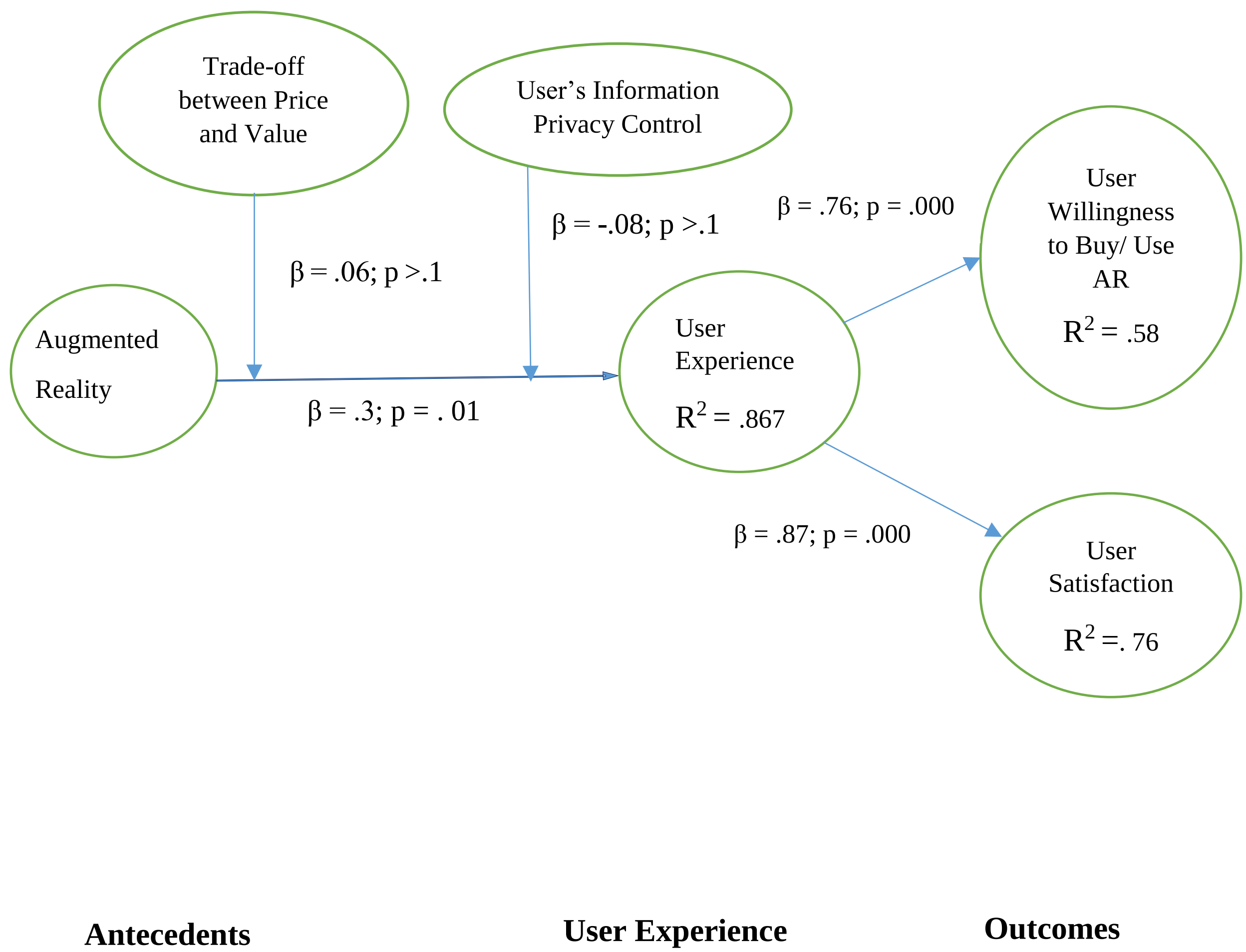


Table 12: Path Coefficients, R-square, and p-Values

Constructs	Constructs	Standard Deviations	Relationships	β	R-Square	P-Value
Third-order	UX	.034	AR→User Experience	.30	.867	.003
First-order	US	.032	UX→User Satisfaction	.87	.760	.000
First-order	UWB	.057	UX→User's Willingness to Buy	.76	.580	.000

Results on Moderation Effects: User's Information Privacy Control and Trade-Off between Price and Value

To test the impact of the moderators of the AR- UX relationship, SmartPLS was applied. Using SmartPLS indicated that trade-off between price and value did not moderate the impact of AR on UX ($\beta = .06$, $t = 1.46$, $p > .1$). Additionally, user's information privacy control did not moderate the impact of AR on UX ($\beta = -.08$, $t = 1.055$, $p > .1$). Further, the interaction effects of both user's information privacy control and trade-off between price and value were also examined; however, as shown in Table 13, the results indicated that user's information privacy control and trade-off between price and value did not moderate the relationship between AR and UX ($\beta = .479$, $t = 1.521$, $p = .129$).

Table 13: Moderating Effects of User's Information Privacy Control, Trade-Off between Price and Value, The Interaction of User's Information Privacy Control, and Trade-Off between Price and Value on The Relationship between AR and UX

Relationships	β	t-test	p-value
AR*Trade-off between Price and Value→User Experience	.06	1.46	p >.1
AR* User's Information Privacy Control→ User Experience	-.08	1.05	p >.1
AR*User's Information Privacy Control* Trade-Off between Price and Value→User Experience	.479	1.52	p >.1

Mediation Test

To test the mediation impact of UX in the relationship between AR and the outcome variables, user satisfaction and user's willingness to buy, SmartPLS 3.0 bias-corrected and accelerated bootstrap by 5000 subsamples and 95% confidence interval was used.

The results indicated that UX is a competitive mediator in the relationship between AR and user's willingness to buy with a positive indirect effect (β = .181, t = 2.265, p = .02) and negative direct effect (β = .137, t = 2.64, p = .01). UX is a full mediator between the relationship between AR and user satisfaction with an insignificant direct impact (β = -.0321, t = .568, p = .5), and positive and significant indirect effect (β = .191, t = 2.381, p = .01). Therefore, H4b and H5b are supported.

Discussion and Conclusions of Study One and Study Two

Studies 1 and 2 investigated the impact of AR on UX and the subsequent important consequences on user satisfaction and user's willingness to buy as well as the mediation impact of UX in the relationship between AR and the outcome variables. The results indicated that AR can significantly and positively impact user experience (H1). That is, AR can supplement users' perception and experience of the present reality by generating a fabricated or mediated reality superimposing 3D virtual contents onto the present reality. In online shopping, a mediated reality comprises of insertion of three-dimension image of virtual products in different shapes, colors and styles onto the users' environment or present reality. The present reality becomes enriched with virtual contents generated by AR.

AR capabilities are not limited to generation of virtual contents, it may be entertaining by engaging the users to interact with the virtual contents generated by AR. Interactivity feature of

AR magnifies the hedonic value of user experience (Kim & Forsythe 2008). More importantly, AR empowers the users to interact with the virtual contents generated by AR and have control over the virtual contents. The AR users also are empowered to share their personalized experiences on social networks, such as Facebook and Twitter that intensifies playfulness (Huang & Liu, 2014) and ultimately UX. For example, 3D virtual models represent a high level of image interactivity (Fiore et al., 2005a, b; Lee et al., 2006; Yang & Wu, 2009). Thereby, the users appreciate the functionality of the product when using AR before making purchase decisions. A Virtual Mirror Ray-Ban application or website empowers the user by giving the customers a sense of control over the virtual objects so that they choose one or multiple pair of glasses and see how they look on their face. They are empowered to endlessly try virtual products on their face. Endless interaction is one of the remarkable features of this technology. AR not only gives sense of control over the virtual contents generated by AR, but also it enables the user to have endless interaction with the virtual contents. Interactivity and endless interaction facilitate product evaluation and decision-making.

In addition, this research evaluates and tests the role of interactivity. As the level of interactivity of AR increases UX is magnified too; UX is higher when a customer or user has a high level of interactivity with AR. For example, UX gained from using Star Chart and Ray-Ban Virtual Mirror was higher than UX gained from Sky Guide and Ray-Ban traditional online shopping. Thus, high interactive AR applications are able to provoke higher UX than low interactive AR applications.

In relation to the impact of an AR-enriched UX on user satisfaction, the results indicate that an AR-enriched UX empowers users to better perform their tasks, besides helping them to be more entertained and allowing the users to have endless interaction with virtual (digital) contents. At the outset, and AR-enriched UX generates considerable user satisfaction (H4a).

Regarding the impact of an AR-enriched UX on user's willingness to buy, the results showed that AR is able to positively stimulate user's willingness to buy. This is in line with previous findings in which consumers interacting with AR perceive significant hedonic values, leading to an increase in the user's willingness to buy the product (Huang & Liu, 2014). AR adds virtual information (e.g., virtual eyeglasses) to the existing object information (e.g., user's picture) by offering 3D picture of objects in different shapes, modes, colors, and styles. This additional information can assist the user in the process of purchase decision to make a certain purchase decision with low risk. For example, Virtual Try-on applications allow the users to see how products, such as eyeglasses and outfit, look on them. Thus, an AR-enriched UX significantly and positively affects user's willingness to buy the product (H5).

In relation to the moderator effects**,** studies one and two found that user's information privacy control and the trade-off between price and value did not moderate the impact of AR on UX (H2 and H3). The results also showed that user's information privacy control and the trade-off between price and value together (2-way interaction) did not significantly interact with AR in their influence on UX.

Results of Study Three

This section includes the results of prescreening questions, and manipulation checks, administration of the instruments, results of exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and structural model.

Results of the Prescreening Questions for Study Three

The aim of the prescreening questions was to ensure that the participants were familiar with technology use, internet use and online shopping. A T-test was conducted to ensure that the participants in two groups were similar based on technology use. The results indicated that the mean of prescreening questions of experimental group (Mean = 6.088) was lower than the mean of that of the control group (Mean = 6.138). In other words, the participants of both groups were not significantly different in terms of familiarity with technology use and online shopping ($F = .144$; $p = .7$).

Results on Manipulation Check for Study Three

ANOVA showed that the manipulation of augmented reality was successful ($F = 24.52$, Mean Square= 2883.3, sig =.000). Additionally, the mean of augmented reality for the experimental group (Mean = 6.242) was higher than the mean of augmented reality for the control group (Mean = 5.190). Table 14 lists the questions that are used to check the manipulation.

Table 14: Manipulation Check's Questions for Study 3-Vehicle Service Use

Construct: Augmented reality
This application recognized the car.
This application added virtual information about the car to the screen.
This application added virtual information about the car in real time to the screen.
This application added relevant virtual information about the car to the screen.
This application provided me some information about engine, exterior, interior, and other parts of the car to the screen.
This application added the 3D image of car to the screen.
As I moved the screen, virtual information about the car changed to correspond with the image on the screen.
The virtual information about the car corresponded to the image of car.

Note: Each item is measured using a 7-point Likert scale from 1= strongly disagree to 7= strongly agree.

Comparison between Two Groups

To check if there were differences between the experimental group and the control group, t-tests were examined. The results indicated that control (F = 3.2888, sig =.071), responsiveness (F = 1.827, sig = .178), and image interactivity (F = 3.69, sig = .056) were not significantly different between groups. No significant difference exists between experimental and control groups in terms of interactivity. User satisfaction and user's willingness to use AR between both groups were also compared. Further, the mean of image interactivity for the experimental group (Mean = 4.986) was higher than the mean of image interactivity for the control group (Mean = 4.490). Mean of perceived control for the experimental group (Mean = 4.764) was also higher than the mean of control for the control group (Mean = 4.468). The mean of responsiveness for the experimental group (Mean = 4.460) was lower than the mean of responsiveness for the control group (Mean = 4.690). Consistent with Javornik (2016)' study, perceived control and responsiveness were insignificant between AR and non-AR groups.

The mean of user satisfaction (Mean = 5.503), and user's willingness to use augmented reality (Mean = 5.506) for the experimental group were higher than the mean of user satisfaction (Mean = 5.016), and user's willingness to use AR for the control group (Mean = 5.343).

Besides, the results indicated that the mean of user's information privacy control (Mean = 4.475), the mean of trade-off between price and value (Mean= 3.847) for the experimental group were lower than the mean of user's information privacy control (Mean = 4.492), the mean of trade-off between price and value (Mean = 4.100) for the control group. Table 15 also shows the results of ANOVA test in terms of mean, F-test and p-value of each variable for experimental and control groups.

Table 15: ANOVA Test: Comparisons between Two Groups for Study 3

Constructs	Experimental Group	Control Group	F-value	p-value
Augmented reality	Mean = 6.242	Mean = 5.190	9.777	.000
Perceived Control	Mean = 4.764	Mean = 4.468	3.288	.07
Responsiveness	Mean = 4.460	Mean = 4.690	1.827	.17
Image Interactivity	Mean = 4.986	Mean = 4.490	3.696	.05
Pragmatic Quality	Mean = 5.052	Mean = 5.076	.054	.87
Augmentation Quality	Mean = 5.682	Mean =0.000	2.416	.000
Hedonic Quality by Stimulation	Mean = 5.950	Mean = 5.230	14.505	.000
Hedonic Quality by Identification	Mean = 4.562	Mean = 4.353	1.615	.20
Aesthetic Quality	Mean= 5.171	Mean= 4.649	9.777	.002
Trade-off Between Price and Value	Mean= 3.847	Mean= 4.100	2.173	.14
User's Information Privacy Control	Mean= 4.475	Mean=4.492	.003	.95
User Satisfaction	Mean= 5.503	Mean= 5.016	3.297	.07
User's Willingness to Use App	Mean= 5.506	Mean= 5.343	.647	.42

Administration of the Instruments for Study Three

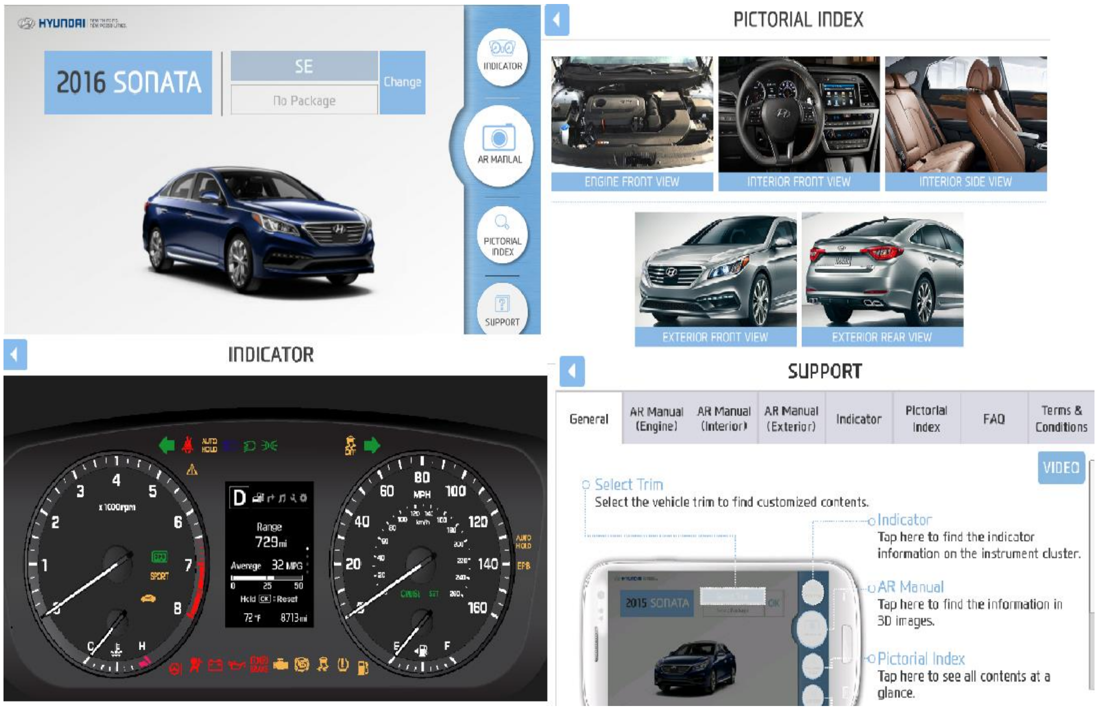
This study used Virtual Guide Hyundai Augmented Reality Manual Application because the application provided augmentation features of AR in the context of service use. It enabled the participants to choose a model of Hyundai Sonata. Additionally, the application allowed the participants to point the camera of their smart devices such as iPhone or iPad to an actual car or a printed copy of the car, and subsequently the application portrayed 3D image of objects along with information about the pointed objects.

Each participant selected one of the two applications. Then, experimenter instructed the participants about the aim of study which was “study is asking user experience and perception of using mobile application.” Next, experimenters noted the importance of their answers to the survey.

First treatment: Virtual Guide Hyundai augmented reality manual. After filling out the prescreening questions (Table 11), the experimenter explained the concept of augmented reality for 3 minutes. Then, the experimenter asked participant to interact with the application for 5 minutes, and then closed the application and answer the surveyquestions. Figure 12 shows a screen shot of Virtual Guide Hyundai application.

When the application started, a message popped up on the screen that stated “the application user should make sure to use this application only when the vehicle was stationary”. By clicking on okay button, the application allowed the participants to select their vehicle in the list. They could choose either Sonata 2015 or Sonata 2016, and then the application allowed them to trim their option to SE, Sport and Eco. On the right side of the screen, there are 4 options: indicator, AR manual, pictorial index, and support. The indicator tab allowed the participants to point their smart device on the car or the 3D image of the car and see what the icons mean. In addition, they could also click on the icons shown on the screen and receive more information about them. For example, on top of the screen, there were four icons; by clicking on the first icon appearing on the left side, a window pops up, which shows “turn signal indicator light”. Clicking the second icon shows “auto hold indicator light (yellow)”, and the third icon shows “light on indicator light”, and the last one shows “turn signal indicator light”.

Figure 12: Screen Shot of Virtual Guide Hyundai



Under the tab of "AR Manual", there are six options: AR engine, AR interior, AR exterior front, AR exterior rear, AR seat, and AR trunk. The application allowed the participants to choose any or all? of these options. By clicking on AR engine, the application started to down load the right model of the engine and instructed the participants about how to use this option. A window appears on the screen showing the necessary steps of using the application. The first step instructed the participant to open the front hood, stand about 12 to 39 inches away from the front hood, and stand facing toward the vehicle front body. Second step was to activate the application and select the AR Manual-Engine tab. Third step, the application displayed comments and pointers on the screen after recognizing the engine compartment within 1to 2 seconds. Fourth step, the application allowed the participants to select a pointer or comment to simulate the self-maintenance information. The application also displayed a message regarding possible reasons for image recognition failure. Recognition may fail, when there is direct sunlight or no light at all. Second, recognition may fail when a distance between your device and the target is either too far or too close. Third, when a correct vehicle model on the main page is not selected, recognition may fail.

Next, the application allowed the participants to point the camera of iPad to the vehicle, and the application portrayed virtual information about the service maintenance of the vehicle, including Coolant, washer fluid, engine oil, air filter, brake fluid, fuse box, and battery. The participants could click on any virtual information shown on the screen, and the application showed required instructions in form of videos to the participant.

Under the tab of Pictorial Index, five pictures of Hyundai, namely engine front view, interior front view, interior side view, exterior front view, and exterior rear view were shown. This option allowed the participants to click on the circles shown on the screen and the application displayed some virtual information on the screen. In addition, this option might be also used when the actual vehicle was not available and one smart device could act as an image recognition device and another smart device could show the image of the vehicle. For example, an iPad could be used to show the images of car and an iPhone could be used to recognize the images and portray virtual information on the screen.

Under the tab of support, the participants could receive some instructions about general questions, AR Manual Engine, AR Manual Interior, AR Manual Exterior, Indicator, Pictorial Index, FAQ, and terms and conditions.

Second treatment: Non-augmented reality treatment. Regional Hyundai and Import Super Center application, as a non-augmented reality application was selected for the control group. The application is not an AR application, but an informative application. Figure 13 shows a screen shot of Regional Hyundai application. On the left side of the screen, there are eight options: Hyundai, new inventory, used inventory, specials, service apt, call, hours, and map. Under the tab of Hyundai, the application showed a variety of cars: Accent, Azera, Elantra, Equus, Genesis Coupe, Genesis G80, Genesis G90, Santa Fe, Sonata, Tuscon, and Voloster. By clicking on each model of the car, some pictures and videos of the car were displayed on the screen. Under new inventory tab, it directed the participants to a page showing overview, options, and tech spec. It allowed the participants to make an inquiry by getting first name, last name, preferred contact, email, home phone, and comments.

Under used inventory tab, the participants could search their favorite car and filter their search. The participants could choose the condition of car from the following list: all conditions, pre-owned, and certified. They could also choose their favorite model of car from 1998 to 2017.

Under the tab of specials, special models of car with price and picture were displayed. Under service apt tab, the application allowed the participants to schedule an appointment with the service provider. The application showed three options: I am new here, find me, and log me in. Under the tab of call, the participants could call the dealership. Under the tab of hours, the application could direct the participants by getting their street name and zip code. Under the tab of map, the application showed telephone number, address, and 360 view of the dealership. Under the tab of Facebook, it directed the participants to the dealership Facebook page. Under the tab of Twitter, the participants could follow the dealership page on Twitter. Under the tab of push notification, the application showed notification. Under the tab of application terms, the application showed auto motion application terms and conditions. After five minutes, the experimenter asked them to close the application and answer the survey questions. Finally, the experimenter appreciated the participants for their ’ time and effort to have participated in this study.

Figure 13: Screen Shot of Regional Hyundai Application

Results of Exploratory Factor Analysis for Study Three

After collecting data, SPSS was conducted to obtain descriptive statistics and reliability results. Table 4 shows the results of descriptive statistics, including reliability, AVE results, and factor loadings. In reliability check, 3 items with low inter-to-item correlations, including PQ1 (item-to-total = .3), HQ-I4 (item-to-total = .4), and Ctrl7 (item-to-total = .2) were eliminated. Cronbach Alphas ranged from .914 to .959 demonstrating construct internal consistencies (Nunnally & Bernstein, 1994).

After reliability check, exploratory factor analysis (EFA) was conducted to check the uni-dimensionality of the constructs (Table 16). First, this study ensured that the data set (multi-item scales comprising 73 items) was factorable using the Kaiser-Meyer-Olkin measure of sampling adequacy and Bartlett's Test of Sphericity. Then, a general EFA with the 72 items using the maximum likelihood method (MLE) and Varimax rotation was conducted to check the uni-dimensionality of constructs. 13 factors emerged with acceptable default eigenvalues, which is 1. One separate EFA was conducted for the moderators and outcome variables, including user's information privacy control, trade-off between price and value, user satisfaction, user's willingness to use AR, control, responsiveness, and image interactivity (KMO = .92, χ^2 = 5217.3, df = 300, sig = .000). Further, a second EFA was examined to check the uni-dimensionality of the UX's dimensions (KMO = .953, χ^2 = 9950.206, df = 1176, sig = .000). All factor loadings were higher than the minimal amount, which is .3 (Hair et al. 2006). According to Hair et al. (2006), factor loading higher than .3 shows that the item is acceptable; factor loading higher than .4 shows that the item is important; and factor loading higher than .5 shows that the item is practically significant. The results of EFA indicated that UX's dimensions were uni-dimensional constructs. All factor loadings ranged from .401 to .968.

Table 16: First-order Constructs: Reliability, Means (M), Standard Deviations (SD), and EFA Results

	Constructs	Factor Loadings
	Augmented reality (α= .956, M= 5.938, SD= 1.433)	
ARI1	This application recognized the car.	.745
ARI2	This application added virtual information about the car to the screen.	.940
ARI3	This application added virtual information about the car in real time to the screen.	.949
ARI4	This application added relevant virtual information about the car to the screen.	.918
ARI5	This application provided me some information about engine, exterior, interior, and other parts of the car to the screen.	.730
ARI6	This application added the 3D image of car to the screen.	.810
ARI7	As I moved the screen, virtual information about the car changed to correspond with the image on the screen.	.884
ARI8	The virtual information about the car corresponded to the image of car.	.868
	Interactivity-Control (α= .91, M= 5.850, SD= 1.314)	
CTRL1	This application was interactive.	.747
CTRL2	While I was using the application, I was always able to do what I thought I was doing.	.864
CTRL3	I felt I had a great control while I was using the application.	.935
CTRL4	I thought this application really gave me some control (i.e., flexibility) over the content that I wanted to see.	.836
	Interactivity-Responsiveness (α= .894, M=5.426, SD= 1.374)	
RESP1	This application had the ability to respond to my specific requests for information, so I could access it quickly and efficiently.	.697
RESP2	Interaction with this application was very fast.	.697
RESP3	I was able to obtain information I wanted without any delay.	.915
RESP4	This application processed my input very quickly.	.935
RESP5	This application would allow me to easily communicate with the company if I ever had a specific question or wanted to purchase a car.	.702
	Interactivity-Image Interactivity (α= .754, M= 4.853, SD= 1.672)	
IMG1	This application allowed the user to zoom in/ zoom out the image of car.	.670
IMG2	This application allowed the user to change the color of car.	.801
IMG3	This application could easily let me access other consumers' opinions about the cars featured.	.667
	User Satisfaction (α= .958, M= 5.483, SD= 1.554)	
US1	Overall, I am satisfied with this application.	.948
US2	Being a user of this application has been a satisfying experience.	.972
US3	Having experienced this application was pleasurable.	.962
	User's Willingness to Use AR (α= .896, M=5.363, SD= 1.732)	
UWAR1	I intend to use the application to see the 3D images of car.	.836
UWAR2	I would be willing to use this application.	.949
UWAR3	In future, I would use this application.	.944
	Trade-off between Price and Value (α= .952, M= 5.226, SD= 1.468)	
PV1	The car that I was using this app for was reasonably priced.	.944
PV2	The car that I was using this app for was a good value for the money.	.972

Table 16 Continued		
PV3	At the current price, the service offered in the mobile app provides a good value.	.948
	User's Information Privacy Control (α= .959, M= 4.480, SD= 1.998)	
PRV1	I was informed about the personal information that this application would collect about me, such as email, name, and location.	.905
PRV2	This application explained the reasons why my personal information was being collected.	.962
PRV3	This application informed the way my personal information would be used.	.968
PRV4	This application gave me a clear choice before using personal information about me.	.937
	Pragmatic Quality (α= .928, M= 5.007, SD= .958)	
PQ1	Technical – human	Eliminated
PQ2	Unruly-manageable	.705
PQ3	Confusing-clearly structured	.789
PQ4	Unpredictable- predictable	.689
PQ5	Cumbersome- straightforward	.754
PQ6	Impractical- practical	.695
PQ7	Complicated- simple	.779
PQ8	Unprofessional- professional	.572
PQ9	Difficult to learn-easy to learn	.712
PQ10	Effortful- effortless	.401
	Augmentation Quality (α= .936, M= 6.108, SD= 1.125)	
AGQ1	Slightly informative-highly informative	.561
AGQ2	Irrelevant information-relevant information	.661
AGQ4	Unreliable- reliable	.664
AGQ5	Insecure- secure	.646
AGQ6	Shady output- trustworthy output	.732
AGQ7	Slightly augments one's capabilities to use the car- highly augments one's capabilities to use the car	.754
AGQ8	Adds virtual information to the places where do NOT belong- Adds virtual information to the places where belong	.562
AGQ9	Risky to use- safe to use	.680
AGQ10	Not personalized- personalized	.638
AGQ11	Slightly augments one's awareness of the car- highly augments one's awareness of the car	.741
	Hedonic Quality by Identification (α= .914, M=4.502, SD=1.057)	
HQ-I1	Unpresentable- presentable	.731
HQ-I2	Separates me from people- brings me closer to people	.672
HQ-I3	Alienating- integrating	.776
HQ-I4	Cheap- expensive	Eliminated
HQ-I5	Tacky- stylish	.838
HQ-I6	Isolating- connective	.868
HQ-I7	Decreases one's self image- augments one's self-image	.779
HQ-I8	Loneliness- the sense of belonging to the community	.767
	Hedonic Quality by Stimulation (α= .955, M= 5.272, SD= 1.175)	
HQ-S1	Ordinary- novel	.722

Table 16 Continued		
HQ-S2	Undemanding- challenging	.533
HQ-S3	Dull- captivating	.834
HQ-S4	Conservative- innovative	.867
HQ-S5	Cautious- bold	.854
HQ-S6	Unimaginative- creative	.882
HQ-S7	Conventional- inventive	.842
HQ-S8	Unpleasant- pleasant	.862
HQ-S9	Repelling- appealing	.880
HQ-S10	Discouraging- motivating	.852
HQ-S11	Not absorbed- absorbed	.661
HQ-S12	Not immerse- immerse	.789
	Aesthetic Quality (α= .956, M= 5.522, SD= 1.204)	
AQ1	Ugly- beautiful	.813
AQ2	Unattractive- attractive	.829
AQ3	Unfriendly- friendly	.823
AQ4	Annoying- enjoyable	.877
AQ5	Bad- good	.887
AQ6	Asymmetric- symmetric	.816
AQ7	Unclean- clean	.837
AQ8	Rigid- artistic	.837
AQ9	Static- vivid	.830
AQ10	Artificial- realistic	.722

Note: The following items were eliminated: Int 7, PQ1, HQ-I4, as explained in the text.

Results of Confirmatory Factor Analysis: Convergent Validity and Discriminant Validity

Confirmatory factor analysis (CFA) using AMOS was conducted to assess the full measurement model and the relationships among all constructs (Arbuckle & Wothke, 1999). UX was examined as a formative second-order construct formed in terms of five first order reflective constructs. All five indicators of the UX construct are independent and not interchangeable (Jarvis et al., 2003). It means, we can't delete pragmatic quality and expect the UX construct to be comprehensive. Elimination of one of the indicators results in changing the nature of the UX construct (Bollen & Lennox, 1991).

To form a formative construct, all factor loadings for a formative construct need to be higher than .1 (Gefen & Straub, 2005). The paths from pragmatic quality (β = .202; p = .000), hedonic quality by identification (β = .194; p = .000), hedonic quality by stimulation (β = .215; p = .000), aesthetic quality (β = .235; p = .000), and augmentation quality (β = .219; p = .000) to the user experience (UX) are higher than .1 that satisfies the first criteria of formative construct. Additionally, according to Jarvis, MacKenzie, and Podsakoff (2003), there are two criteria to prevent under-identification when formative indicators are present in the model. First, one of the paths should be constrained to 1. Second, the formative construct should establish at least two reflective paths. In the conceptual model, one of the five paths forming UX was constrained to one. For example, path from hedonic quality by stimulation to UX was constrained to one in order to resolve under-identification problem. Regarding the second condition, there are two paths from UX to user satisfaction and user's willingness to use AR. User satisfaction and user's willingness to use AR are reflective constructs satisfying the second criteria.

A formative construct is calculated by multiplying the effect of indicator (e.g., pragmatic quality) on the formative construct and the indictor plus disturbance term (Diamantopoulos et al.

(2008). UX [i]= pragmatic quality [i]* correlation between pragmatic quality and UX [i] + hedonic quality by stimulation [i]* correlation between hedonic quality by stimulation and UX [i]+ hedonic quality by identification [i]* correlation between hedonic quality by identification and UX [i]+ aesthetic quality [i]* correlation between aesthetic and UX [i]+ augmentation quality [i]* correlation between augmentation quality and UX [i]+ error term emerging from UX (Diamantopoulos & Winklhofer, 2001; Diamantopoulos et al., 2008). Because of the complexity of the UX construct, I depict the measurement model of UX construct. Figure 14 shows how UX is formulated in the measurement model. Based on the definition above, I calculate UX, and PQ, HQ-S, HQ-I, AQ and AUG-Q by the following formula:

The first indicator of PQ which is PQ [1] is calculated by multiplying the coefficient of PQ and PQ [1] by PQ, which is Ψ 11 plus the error term associated with PQ [1] which is ε11. That is:

PQ [1]= Ψ1* PQ + ε 1

We can calculate each indicator of UX's dimensions by the following formula:

PQ [j] = Ψ j* PQ + ε j For j= 1 to 8

HQ-S [j] = Ψ j* HQ-S + ε j For j= 9 to 21

HQ-I [j] = Ψ j * HQ-I + ε j For j= 22 to 29

AQ [j] = Ψ j *AQ + ε j For j= 30 to 40

AUG-Q [j] = Ψ j* AUG-Q For j= 41 to 51

Ψi: Coefficient between the UX' s dimensions and indicators

ε i: Error terms for each indicator

Now, I calculate UX by multiplying the coefficient between UX and PQ by PQ; plus multiplying the coefficient between UX and HQ-S by HQ-S; plus multiplying the coefficient between UX and HQ-I by HQ-I, plus multiplying the coefficient between UX and AQ by AQ, plus multiplying the coefficient between UX and AUG-Q by AUG-Q plus disturbance term (¥):

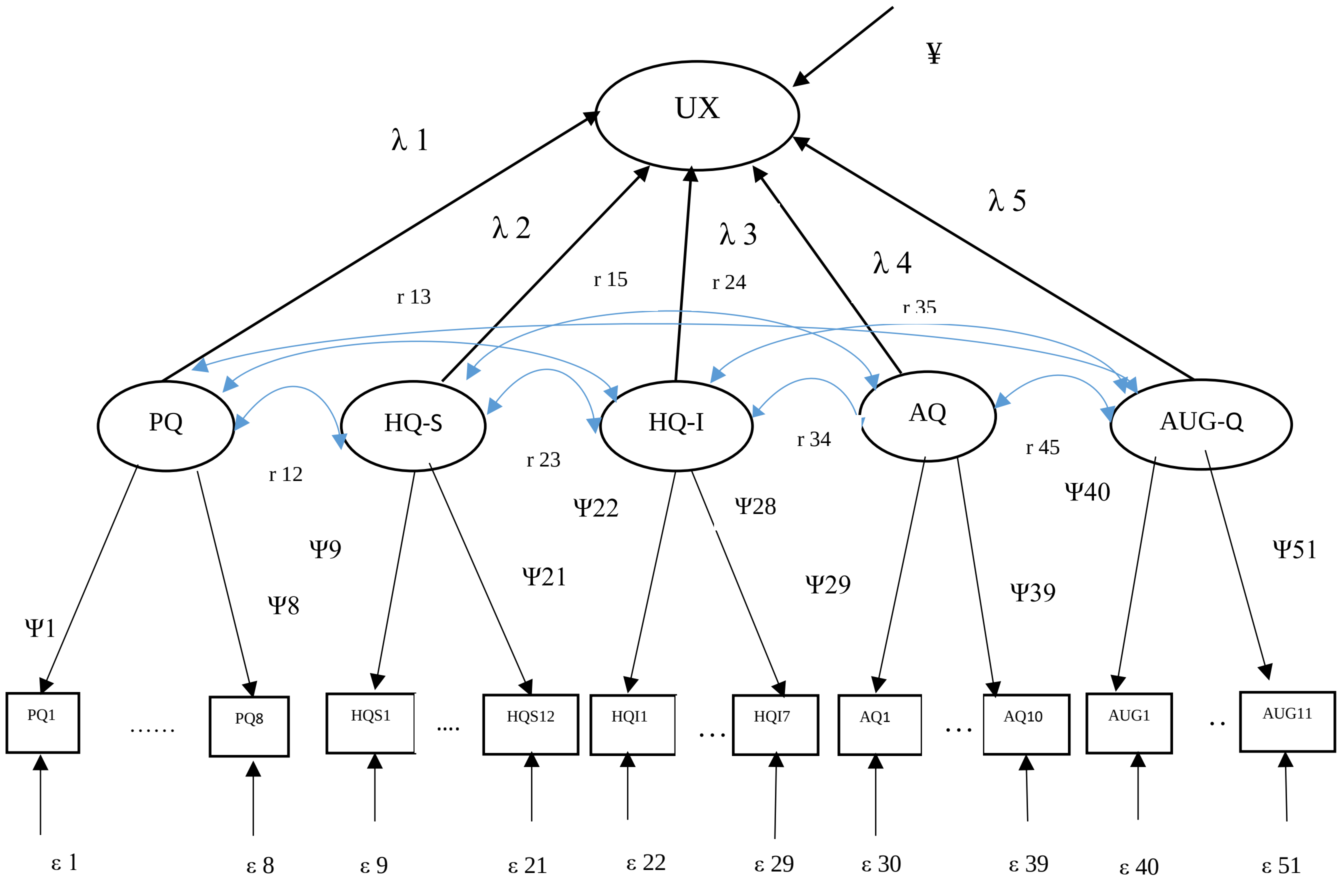
$$UX = PQ * \lambda 1 + HQ\text{-}S * \lambda 2 + HQ\text{-}I * \lambda 3 + AQ * \lambda 4 + AUG\text{-}Q * \lambda 5 + ¥$$

λ: Coefficient between the UX construct and the UX's dimensions ($\lambda 1$: PQ; $\lambda 2$: HQ-S; $\lambda 3$: HQ-I; $\lambda 4$: AQ; $\lambda 5$: AUG-Q)

¥ : Error term to the UX construct

r [i,k] : Correlation between first order construct i and k

Figure 14: UX's Measurement Model



CFA results confirmed the validity of the hypothesized structural model structure (Bagozzi & Heatherton, 1994). The model fit the data well: $\chi 2$ = 3393.558; degree of freedom = 1827; p = 0.00; comparative-fit index (CFI) = .89; incremental fit index (IFI) = .89; (TLI) = .88; root mean square error of approximation (RMSEA) = .06; normed chi-square (N $\chi 2$=1.85). AVE was obtained by sum of squares of standardized factor loadings divided by the number of indicators. The standard loadings ranged from .529 to .968 (see Table 17).

To analyze convergent and discriminant validity AMOS was used. The average variance extracted (AVE) in each factor ranged from .51 to .91; the inter-factor correlations ranged from .529 to .948. The AVEs for all constructs satisfied the recommended threshold value of .5 for convergent validity (McDonald & Ho, 2002).

In addition, the square roots of AVEs and inter-factor correlations were compared to inspect discriminant validity. AVEs above .5 as well as square roots of AVEs higher than inter-factor correlations are evidence of discriminant validity (Fornell & Larcker, 1981). Table 18 shows AVE, correlations for trade-off between price and value, user's information privacy control, user satisfaction, user's willingness to use AR, pragmatic quality, hedonic quality by identification, hedonic quality by stimulation, aesthetic quality, quality of augmentation, and evidence for convergent and discriminant validity. The numbers placed on the diagonal of the Table 18 shows the squared amount of average variance extracted. To check discriminant validity, the square roots of AVEs and inter-factor correlations were compared. The results indicate that quality of augmentation, user experience, user satisfaction, user's willingness to use AR, user's information privacy, trade-off between price and value show discriminant validity. The square roots of AVEs of UX, user satisfaction and user's willingness to use AR, user's information privacy and price-value trade-off are higher than the inter-factor correlations (see Table 18). Table 19 adds correlation coefficients among variables and UX.

Table 17: Confirmatory Factor Analysis: AMOS

	Constructs	Confirmatory Factor Loadings
AR	**Augmented reality (α= .956, AVE=.74, M= 5.938, SD= 1.433)**	
AR1	This application recognized the car.	.745
AR2	This application added virtual information about the car to the screen.	.938
AR3	This application added virtual information about the car in real time to the screen.	.948
AR4	This application added relevant virtual information about the car to the screen.	.913
AR5	This application provided me some information about engine, exterior, interior, and other parts of the car to the screen.	.732
AR6	This application added the 3D image of car to the screen.	.815
AR7	As I moved the screen, virtual information about the car changed to correspond with the image on the screen.	.889
AR8	The virtual information about the car corresponded to the image of car.	.871
	User Satisfaction (α= .958, AVE= .89, M= 5.483, SD= 1.554)	
US1	Overall, I am satisfied with this application.	.920
US2	Being a user of this application has been a satisfying experience.	.964
US3	Having experienced this application was pleasurable.	.941
	User's Willingness to Use AR (α= .896, AVE= .76, M= 5.363, SD= 1.732)	
UWAR1	I intend to use the application to see the 3D images of car.	.694
UWAR2	I would be willing to use this application.	.945
UWAR3	In future, I would use this application.	.961
	Pragmatic Quality (α= .928, AVE= .62, M= 5.633, SD= 1.078)	
PQ1	Technical - human	Eliminated
PQ2	Unruly-manageable	.779
PQ3	Confusing-clearly structured	.797
PQ4	Unpredictable- predictable	.705
PQ5	Cumbersome- straightforward	.818
PQ6	Impractical- practical	.771
PQ7	Complicated- simple	.825
PQ8	Unprofessional- professional	.765
PQ9	Difficult to learn-easy to learn	.818
	Augmentation Quality (α= .936, AVE= .55, M= 5.599, SD= 1.031)	
AGQ1	Effortless-effortful	.758
AGQ2	Slightly informative-highly informative	.766
AGQ3	Irrelevant information-relevant information	.817
AGQ4	Unreliable- reliable	.805
AGQ5	Insecure- secure	.625
AGQ6	Shady output- trustworthy output	.777
AGQ7	Slightly augments one's capabilities to use the car- highly augments one's capabilities to use the car.	.803

Table 17 Continued		
AGQ8	Adds virtual information to the places where do NOT belong- Adds virtual information to the places where belong	.657
AGQ9	Risky to use- safe to use	.723
AGQ10	Not personalized- personalized	.614
AGQ11	Slightly augments one's awareness of the car- highly augments one's awareness of the car	.824
	Hedonic Quality by Identification (α= .914, AVE= .6, M=4.502, SD=1.057)	
HQ-I1	Unpresentable- presentable	.770
HQ-I2	Separates me from people- brings me closer to people	.644
HQ-I3	Alienating- integrating	.760
HQ-I4	Cheap- expensive	Eliminated
HQ-I5	Tacky- stylish	.857
HQ-I6	Isolating- connective	.861
HQ-I7	Decreases one's self image- augments one's self-image	.781
HQ-I8	Loneliness- the sense of belonging to the community	.737
	Hedonic Quality by Stimulation (α= .955, AVE= .65, M= 5.272, SD= 1.175)	
HQ-S1	Ordinary- novel	.730
HQ-S2	Undemanding- challenging	.529
HQ-S3	Dull- captivating	.839
HQ-S4	Conservative- innovative	.857
HQ-S5	Cautious- bold	.849
HQ-S6	Unimaginative- creative	.874
HQ-S7	Conventional- inventive	.829
HQ-S8	Unpleasant- pleasant	.872
HQ-S9	Repelling- appealing	.889
HQ-S10	Discouraging- motivating	.854
HQ-S11	Not absorbed- absorbed	.666
HQ-S12	Not immerse- immerse	.791
	Aesthetic Quality (α= .956, AVE= .68, M= 5.522, SD= 1.204)	
AQ1	Ugly- beautiful	.828
AQ2	Unattractive- attractive	.837
AQ3	Unfriendly- friendly	.836
AQ4	Annoying- enjoyable	.872
AQ5	Bad- good	.878
AQ6	Asymmetric- symmetric	.803
AQ7	Unclean- clean	.834
AQ8	Rigid- artistic	.842
AQ9	Static- vivid	.823
AQ10	Artificial- realistic	.717

Note: The following items were eliminated: Int 7, PQ1, HQ-I4, as explained in the text.

Table 18: Correlations, AVE (Convergent Validity), and Discriminant Validity

Constructs	AVE	AR	UX	US	UWAR	PV	UIPC	CTRL	RESP	IMG
Augmented reality	.74	.86	.55	.54	.53	.23	.25	.76	.48	.48
User Experience	.62		.79	.63	.70	.48	.41	.63	.61	.51
User Satisfaction	.89			.94	.83	.47	.42	.64	.64	.47
User's Willingness to Use AR	.77				.94	.52	.41	.71	.70	.53
Price Value Trade-off	.91					.95	.58	.41	.52	.43
User's Information Privacy Control	.79						.89	.41	.52	.43
Control	.72							.85	.42	.56
Responsiveness	.63								.79	.64
Image Interactivity	.51									.71

Note: The numbers in the diagonal show the squared average variance extracted.

Table 19: Correlation Coefficients - First-order Constructs

	Constructs	AR	PQ	AGQ	HQ-I	HQ-S	AQ	US	UWAR	PV	UIPC
ARI	Augmented reality	1	.396	.514	.427	.558	.527	.544	.534	.233	.25
PQ	Pragmatic Quality		1	.739	.628	.610	.669	.517	.616	.405	.302
AGQ	Augmentation Quality			1	.798	.777	.79	.565	.647	.416	.345
HQ-I	Hedonic Quality by Identification				1	.816	.816	.584	.636	.485	.406
HQ-S	Hedonic Quality by Stimulation					1	.894	.58	.618	.428	.388
AQ	Aesthetic Quality						1	.595	.654	.441	.396
US	User Satisfaction							1	.83	.475	.421
UWAR	User's Willingness to Use AR								1	.516	.412
PV	Price-value									1	.579
PRIV	User Information Privacy Control										1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Note: All the constructs are first-order constructs, and the value of each construct was measured by summation of its indicators.

Test of Structural Model for Study Three

The hypotheses were tested using structural equation modeling (SEM) with AMOS 20. Structural model showed a good fit to the data, suggesting that the research model is appropriate. The test confirmed prior factor loading patterns and overall model fit indices within the recommended ranges. The model fit the data well: $\chi 2$ = 3447.689; degree of freedom = 1828; p = 0.00; comparative-fit index (CFI) = .88; incremental fit index (IFI) = .88; (TLI) = .88; root mean square error of approximation (RMSEA) = .06; normed chi-square (N $\chi 2$ = 1.88). Table 20 shows the estimated loadings.

The results of SEM indicated that augmented reality positively and significantly influenced UX (β = .220; p = .003) stating that H6 was supported. The results also indicated that UX was positively and significantly associated with user satisfaction (β = .766; p < .001), and user's willingness to use AR (β = .688; p < .001) stating H4a and H7a were supported.

Mediation Test

To test the mediation impact of UX on the outcome variables, the procedure used by Zhao et al. (2010) was applied. AMOS using bias corrected with 5000 bootstrap and 95% confidence interval was examined to check the direct and indirect impact of independent variable (AR) on the dependent variables (US, and UWAR). The results indicated that AR has a positive significant indirect effect on user satisfaction (β = .198, p = .03) and an insignificant direct effect on user satisfaction (β = -.001, p > .1). Additionally, AR has a positive significant indirect effect on users' willingness to use AR (β = .158, p = .03) and a positive insignificant direct effect on willingness to use AR (β = .08, p > .1). Therefore, UX fully mediated the effect of augmented reality on user satisfaction and users' willingness to use AR. H7a and H7b were supported.

Table 20: Structural Equation Model- Estimated Loadings: AMOS

	Constructs	Confirmatory Factor Loadings
AR	**Augmented reality**	
AR1	This application recognized the car.	.753
AR2	This application added virtual information about the car to the screen.	.943
AR3	This app added virtual information about the car in real time to the screen.	.953
AR4	This app added relevant virtual information about the car to the screen.	.920
AR5	This app provided me some information about engine, exterior, interior, and other parts of the car to the screen.	.733
AR6	This app added the 3D image of car to the screen.	.796
AR7	As I moved the screen, virtual information about the car changed to correspond with the image on the screen.	.875
AR8	The virtual information about the car corresponded to the image of car.	.854
	User Satisfaction	
US1	Overall, I am satisfied with this app.	.911
US2	Being a user of this app has been a satisfying experience.	.966
US3	Having experienced this app was pleasurable.	.948
	User's Willingness to Use AR	
UWAR1	I intend to use the app to see the 3D images of car.	.699
UWAR2	I would be willing to use this app.	.955
UWAR3	In future, I would use this app.	.951
	Pragmatic Quality	
PQ2	Unruly-manageable	.782
PQ3	Confusing-clearly structured	.798
PQ4	Unpredictable- predictable	.707
PQ5	Cumbersome- straightforward	.819
PQ6	Impractical- practical	.770
PQ7	Complicated- simple	.824
PQ8	Unprofessional- professional	.763
PQ9	Difficult to learn-easy to learn	.817
PQ10	Effortless-effortful	.760
	Augmentation Quality	
PQ11	Slightly informative-highly informative	.750
PQ12	Irrelevant information-relevant information	.805
PQ14	Unreliable- reliable	.803
PQ15	Insecure- secure	.627
PQ16	Shady output- trustworthy output	.777
PQ17	Slightly augments one's capabilities to use the car- highly augments one's capabilities to use the car	.808
PQ18	Adds virtual information to the places where do NOT belong- Adds virtual information to the places where belong	.678
PQ19	Risky to use- safe to use	.725
PQ20	Not personalized- personalized	.616

Table 20
Continued

PQ21	Slightly augments one's awareness of the car- highly augments one's awareness of the car	.825
	Hedonic Quality by Identification	
HQ-I1	Unpresentable- presentable	.781
HQ-I2	Separates me from people- brings me closer to people	.634
HQ-I3	Alienating- integrating	.760
HQ-I5	Tacky- stylish	.857
HQ-I6	isolating- connective	.864
HQ-I7	Decreases one's self image- augments one's self-image	.761
HQ-I8	Loneliness- the sense of belonging to the community	.714
	Hedonic Quality by Stimulation	
HQ-S1	Ordinary- novel	.728
HQ-S2	Undemanding- challenging	.527
HQ-S3	Dull- captivating	.845
HQ-S4	Conservative- innovative	.844
HQ-S5	Cautious- bold	.841
HQ-S6	Unimaginative- creative	.865
HQ-S7	Conventional- inventive	.808
HQ-S8	Unpleasant- pleasant	.868
HQ-S9	Repelling- appealing	.882
HQ-S10	Discouraging- motivating	.853
HQ-S11	Not absorbed- absorbed	.664
HQ-S12	Not immerse- immerse	.791
	Aesthetic Quality	
AQ1	Ugly- beautiful	.809
AQ2	Unattractive- attractive	.815
AQ3	Unfriendly- friendly	.845
AQ4	Annoying- enjoyable	.881
AQ5	Bad- good	.888
AQ6	Asymmetric- symmetric	.802
AQ7	Unclean- clean	.844
AQ8	Rigid- artistic	.825
AQ9	Static- vivid	.805
AQ10	Artificial- realistic	.723

Table 21: Results of Structural Equation Model

Relationships	β	Significance Level	Hypotheses
AR→UX	.220	p = .003	H6: Supported
UX→US	.766	p = .001	H4a: Supported
Mediation (Indirect Effect of AR->UX->US)	.198	p= .03	
Mediation (Direct Effect of AR->US)	-.001	p>.1	H4b: Supported
UX→UWAR	.688	p= .001	H7a: Supported
Mediation (Indirect Effect of AR->UX->UWAR)	.158	p= .03	
Mediation (Direct Effect of AR->UWAR)	.08	p>.1	H7b: Supported

Moderation Test

In this stage, the impact of moderators on the relationship between AR and UX was checked. To examine the moderation impacts, the mean of each moderator variable including trade-off between price and value, user's information privacy control, control, responsiveness, and image interactivity were multiplied to AR. Next, SPSS was used to standardize the variables. Then, constructs reflecting the interaction effect was added to AMOS by multiplying the mean of AR by the mean of each moderating variable. For example, the mean of user's information privacy was multiplied by the mean of AR results in AR* UIPC. A new construct was added to show the interaction effect of UIPC. Additionally, the mean of trade-off between price and value was multiplied by the mean of AR resulted in AR* PV. Next, all interaction effects were examined in AMOS. The results indicated that trade-off between price and value ($p < .03$), user's information privacy control ($p < .01$), and the interaction of these two variables ($p < .01$) moderated the impact of augmented reality on user experience. That is, H2 and H3 were supported. In relation to control, responsiveness, and image interactivity, the results indicated that control ($p < .05$), and responsiveness ($p < .05$) moderated the impact of augmented reality on user experience, which means H8a and H8b were supported. However, image interactivity did not moderate the relationship meaning that H8c was rejected ($p > .1$).

When all the moderators were taken into account, R^2 for UX, US and UWAR were changed. The amount of R^2 (UX) was .99, R^2 (US) was .636, and R^2 (UWAR) was .53. Table 22 shows the results of the impact of moderators.

Table 22: The Impact of Moderators on the Relationship between AR and UX, and Its Subsequent Outcomes

Moderators	β	P	Significant
AR*PV	-.274	.031	Significant
AR*UIPC	-.823	.004	Significant
AR*PV*UIPC	1.063	.003	Significant
AR*CTRL	.368	.048	Significant
AR*RESP	.409	.031	Significant
AR*IMG	-.046	.600	Not Significant

Note: AR: Augmented Reality

PV: Trade-off between Price and Value

UIPC: User's Information Privacy Control

RESP: Responsiveness

CTRL: Control

IMG: Image Interactivity

CHAPTER V

DISCUSSION

The summary of the results of the dissertation will be discussed in this chapter. Next, theoretical contribution will be examined. This dissertation hypothesized and tested the impact of augmented reality on user experience and the mediation effect of user experience in the relationship between augmented reality and user satisfaction and user's willingness to use augmented reality. Study 1 and Study 2 tested the impact of AR on UX in the context of shopping and entertainment services. Study 1 and Study 2 considered AR as an experimental variable. Additionally, study 3 provided a comprehensive conceptual frame work and tested the effect of AR on UX and the outcome variables in the context of vehicle service use. Study 3 was superior compared to Study 1 and Study 2 since Study 3 developed two new scales to capture AR and augmentation quality. Further, five moderator variables tested the moderation effect of AR on UX.

Consumers are exposed to a variety of interactive technologies depicting such magic technologies as augmented reality, virtual reality, etc. This impressive technology is intelligent and interactive enough to transform user experience. Augmented reality gives its users an imaginary power to construct single or multiple fabricated realities they may desire. Users feel empowered and captivated to interact with such technology. Users are empowered to perceive the-self as self-actualized and augmented-selves, who are able to construct the meaningful and desired reality through interacting with vivid and artistic virtual contents.

Such interactive technology fulfills customers' needs and mediates customer experience (Hassenzahl et al. 2015). Mediated customer experience with augmented reality (Poushneh and Vasquez 2017a) is able to create utilitarian and hedonic value (Hilken et al., 2017), as well as aesthetic value (Huang and Liao 2015), and social value (Jung et al. 2018). The value created through interaction with augmented reality influences word of mouth (Hilken et al. 2017), customer satisfaction, and customers' willingness to buy.

The results indicated that augmented reality significantly and positively influences user experience and subsequent outcomes including user satisfaction and user's willingness to use AR. More importantly, the results showed that user experience fully mediated the effect of augmented reality on user satisfaction and user's willingness to use AR. As for the moderators, trade-off between price and value, user's information privacy control, the interaction of trade-off between price and value and user's information privacy control, perceived control, and responsiveness interact with augmented reality and based upon their interaction strengthen or weaken the impact of augmented reality on user experience.

Study 3 uncovered the mediation effect of augmented reality on the outcome variables which reveals the key role of UX in the provision of such experiential consumption. Customer experience with augmented reality becomes meaningful (MacIntyre et al. 2001) when customers become empowered to augment their abilities to make shopping decision with more certainty (Dacko 2016; Oh, Yoon, and Shyu 2008); for example, product evaluation (Kim and Forsythe 2008a; Poushneh and Vasquez, 2017a, b; Papagiannidis et al., 2017; Pantano et al., 2017; Oh et al., 2008). Interestingly, it is not limited to customers' empowerment to augment their abilities to perform tasks but also augments their self-image to become as they desire to be (Poushneh and Vasquez, 2017b). Customers perceive the-selves as self-actualized individuals, who are able to use their full potential to perform tasks with the aid of augmented reality. That time when such augmentation experience occurs becomes meaningful and pleasant to customers.

ARI is able to produce authentic, immersive and vivid experience as if the users are in a real environment interacting with the real objects. AR enables the users to interact with experiential consumption generated by such technology before making purchase decision or referring to service provider. Such technology can act as a virtual assistant to the users. Utilitarian and hedonic value created through the interaction with AR impact customers' behavioral intention such as word of mouth, purchase intention (Hilken et al., 2017). Therefore, AR users have entertaining experience as well as practical experience.

AR is a way to allow users to take over experiential consumption rather than material consumption. With the aid of AR, experiential consumption comes before physical or material consumption. Experiential consumption allows customers to become entertained and accomplish tasks. The power of AR is not limited to task completion, but it also allows customers to transform their unpleasant and challenging experience they face in the present reality into pleasant and memorable experience.

UX with augmented reality can become fully pleasant when major human psychological needs are taken into consideration when designing AR. With AR, experience comes first; AR users are able to experience product or service consumption even before purchasing products or speaking to service providers. For example, in the context of shopping, AR empowers shoppers to see 3D images of products in different shapes, colors, and styles before a purchase. In the context of service use, AR allows users to get 3D virtual contents and correspond those virtual contents onto the present reality where they belong to. For example, Blippar app allows users to point their smart phones to objects, and the app portrays relevant information about the objects to the users. The AR users feel smart by using the app. Another example is Virtual Guide for Hyundai. The app allows the owner to receive information upon the user's requests. New cars have been equipped with many knobs, options, and features, and sometimes people do not know how to use the knobs, or features or they do not know which knob is for what purpose.

This study contributed to the marketing literature by developing a scale for AR called "augmented reality", and adding a new dimension of experience called "augmentation quality" to UX to reflect a comprehensive scale of UX. Study 3 developed a scale to measure augmented reality as a broader concept to cover the scope of AR. Augmented reality measures the quality or level of intelligence of AR in terms of image recognition and insertion of virtual contents onto the present reality. ARI is essential since it impacts UX and thereby user's behavioral intention to use AR, and user satisfaction. AR users would like to interact with intelligent AR which is able to recognize objects and provide relevant digital contents onto the existing reality. Additionally, intelligent AR is able to provide rich quality of information related to the context of use (Olsson et al. 2012; 2013). When AR is able to generate high output quality, users become satisfied (Wang & Chen, 2011; Zhao et al., 2012; Chen, 2013), and are more likely to recommend an AR app to others (Jung et al. 2015). In contrast, when AR users do not interact with high quality output, they become dissatisfied with the experience since it does not satisfy their expectation, and thereby they are less likely to use or recommend AR app to others.

AR users seek AR with rich quality of output that provides personalized information to the users (Chen, 2013; Jung et al., 2015). For example, Makeup Genius, as an AR mobile app scans the user's face image and allows the user to pick one of the cosmetic products offered in the mobile application. Then, the mobile application inserts the virtual contents onto the user's face simultaneously. The user can see how the virtual makeup looks on her face without being in a physical store. In other words, AR provides a hands-on experience to its users.

On the other hand, Augmented reality is not intelligent when AR does not precisely recognize the objects or contents in the present reality. If so, AR fails.

In addition, this dissertation identified a new dimension of UX, which was called augmentation quality. As discussed before, AR mediates present reality and forms a new or mediated reality to its users. New reality or augmented reality resulted from AR empowers the users to have experiential consumption. Augmentation quality was added to the current UX's dimensions, and augmented reality UX covers augmentation quality, pragmatic quality, hedonic quality by stimulation, hedonic quality by identification, and aesthetic quality.

Augmentation quality is a vital element of UX with augmented reality. If augmented reality doesn't function well, it may not insert the virtual contents onto the correspondent places where they belong. In other words, maladjustments occur. For example, virtual try-on glasses may generate faulty output to the user when virtual content (sunglasses), is not mapped correctly on the user's face, or if the virtual content does not fit the content of existing reality. For example, the sunglasses might be too big or small for the user's face. Therefore, it is fundamental that AR produces augmentation quality.

This study showed how UX fully mediated the effect of AR on user satisfaction and user's willingness to use AR. Furthermore, the results of study 3 indicated that trade-off between price and value and user's information privacy control, control, and responsiveness moderated the impact of AR on UX. For example, if the user does not have control over his or her personal information being shared with AR, UX is weakened and vice versa. Another example, if the user does not find a trade-off between prices the user sacrifice and the value (output) received by the user, UX is weakened and vice versa. Regarding interactivity, UX is strengthened if the user has sense of control over AR technology, the effect of AR on UX is strengthened. Additionally, when AR technology is able to responds in a timely manner in accordance with the user's request, the impact of AR on UX is strengthened. Augmentation plus interactivity create vivid, immersive, and fun experience. In fact, AR is boring and meaningless if interactivity is not involved. Interactivity is intertwined with augmented output. Online shoppers are able to see 3D images of products and the interactivity features of AR apps or websites allow the shoppers to enlarge, zoom, and rotate the products shown on screen. In fact, that is the interactivity concept that brings fun to user's experience. Without interactivity, users do not have enjoyable and entertaining experiences.

AR creates a simulated experience as an interesting atmosphere, which creates enjoyment for users or shoppers (Wojciechowsk & Cellary, 2013; Tang et al., 2004). AR is interactive media that allows users to experience events that they are not able to experience at the time. With the help of AR, users are able to experience authentic stimulatory and vivid experience.

Theoretical Contributions

Augmented Experience Generated by Augmented Reality and Human Psychological Needs

This study sheds light on how artificial intelligence of augmented reality generates enriched user experience and subsequent consumers' responses. This study explained how user experience with augmented reality spurs consumers' attitudes, and behavioral intention.

This dissertation proposed and tested the effect of augmented reality (AR) on user experience (UX) and subsequently users' behavioral intention. It also asserted that user experience (UX) mediates the impact of AR on users' responses.

AR is intelligent technology which recognizes objects pointed to the camera of smart device and uses artificial intelligence in terms of image recognition. Design of augmented reality in terms of intelligence is critical because it promotes experiential consumption along with interaction with technology. This study discussed why design of such technology is important in experiential consumption. Since the AR users are not aware of how software, algorithms, and inner processes work and the only thing they see is the virtual contents mapped onto the existing reality. When the virtual contents are vivid, immersive, precise, real and authentic, they absorb the user's attention and spur the user's responses.

Four dimensions of UX were based upon Hassenzahl et al. (2008), Laguwitz et al. (2008), and Lavie & Tractinsky (2004), and one new dimension was developed to capture augmentation quality. According to Hassenzahl, users can have positive UX with interactive technology if it satisfies users' needs. Based on Self-Determination Theory, relativeness, autonomy and competence are the main sources of positive UX (Hassenzahl et al., 2008). Based on Sheldon et al. (2001)' typology, AR is able to satisfy six psychological human needs, including autonomy, competence, relatedness, self-esteem, stimulation, and self-actualization, and UX's dimensions are evidence of that.

First, autonomy refers to the extent of which an experience is to be real without paying much attention to others' social roles that allow one to express his or her own opinion (Deci and Ryan 2000; Wiklund-Engblom, et al. 2009). Prior studies have shown that autonomy is one of the most important source of positive user experience with interactive technology (e.g., Hassenzahl, Diefenbach, and Goritz 2010; Wiklund-Engblom, et al. 2009). Consistent with prior literature, a user of augmented reality can perceive positive and satisfying experience when the user perceives the real experience when interacting with AR. AR, as interactive technology empowers the user and allows the user to interact with virtual information in the real world. In other words, AR simulates a real experience to the user that he or she is not able to experience at that time. For example, the IKEA app allows a shopper, who is in a store, to visualize and see how the selected pieces of furniture would look at his or her place. In fact, the shopper has freedom to pick any virtual product from the IKEA app. Another example, toymakers use video displays to present their products to their customer. Lego Digital Box Kiosk is one such place, Customers can place a box of Lego in front of the screen, and the screen will show them the completely assembled set in 3D. Lego Digital Box Kiosk gives consumers an opportunity to visualize the complete set before purchase.

Second, competence refers to one's experience of capability and the ability of controlling the environment. Prior literature has demonstrated that competence is the most salient psychological need in creating positive user experiences (Hassenzahl 2008; Hassenzahl, Diefenbach, and Goritz 2010; Wiklund-Engblom, et al. 2009). It is evident that AR has potentials to empower the users to complete difficult tasks. For example, wearable technology such as Google Glass has the ability to quickly shift focus from the real world in the distance to the images presented by the device, which are projected on the user's eyes. Thus, AR allows the person to have control over his or her surrounding environment to perform his or her required tasks. Another example, EZ Makeup allows the user to upload her image and then select different cosmetics (e.g., lipstick, color skin, eye shadow, and so on) that she would like to virtually wear on her face. Afterwards, the AR application presents the 3D image of the customer with virtual cosmetics she has picked. In addition, the 3D product visualization allows consumers to interact with the virtual products, including rotating and viewing the product from different angles (Kim & Forsythe, 2008).

Third, relatedness refers to the one's desire to stay connected to others (Baumeister & Leary, 1995; Ryan, 1993). Relatedness is also a major source of creating positive UX (Hassenzahl, Diefenbach, & Goritz, 2010; Wiklund-Engblom, et al. 2009). Most of AR technology gives the users an ability to connect to others. For example, AR apps such as Premirun or Virtual Try-On apps allow the users to virtually try clothing on, and see how the virtual product looks on them. Besides, the apps allow them to take a photo and share their picture with virtual product on social networks such as Facebook. In other words, AR as an interactive media gives the customers an opportunity to enhance their social status by easily staying connected to other people. For example, Zugara webcam social shopping allows customers to share their pictures with virtual clothing on digital social media.

Fourth, stimulation refers to the fulfillment of needs that are related to novelty, and challenge (Hassenzahl, 2004). Stimulation is also a source of positive UX in the context of interactive technology (Hassenzahl et al., 2010; Wiklund-Engblom, et al. 2009). AR not only enables shoppers to have exciting, fun, entertaining, and playful experiences (Kim & Forsythe, 2008a), but also assists them to make more precise purchase decisions while shopping. AR creates simulated experience in 3D images that makes fun and enjoyable experience for shoppers (Tang, Biocca, & Lim, 2004). Once shoppers interact with virtual objects, they enjoy more (Li, Daugherty, & Bioccaal, 2001) and have positive attitudes when shopping (Kim & Forsythe, 2008a). For example, Make up Genius, as an AR mobile app scans the user's face and allows the user to pick one of the cosmetic products offered in the mobile app. Then, the mobile app adds the virtual product (cosmetic) to the real information (the user's picture) and portrays the final output to the user. Finally, the user can observe how the product looks on her face without actually trying it on.

Fifth, self-esteem refers to the positive feelings shaped after fulfilling of needs related to confidence, achievement, and respect. This study includes self-esteem because AR empowers the users to achieve their goals and accomplish their tasks. AR technology can create positive UX by satisfying the user's needs related to respect and accomplishment. For example, Word Lens app is an AR translation app that uses the user's phone camera to scan the text (e.g., sign, menu) and translate it to another language and shows it to the device's screen at the same time. Once AR users use AR portraying high quality output, users feel confidence and achievement that enhance users' self-esteem.

Sixth, self-actualization refers to the association between user's full potential and the realization of that potential (Maslow 1954). In other words, it refers to the degree of desire to accomplish what an individual is able to do and become whom they would like to be be (Maslow, 1954). Self-actualization refers to the one's desire to become everything that one is capable of becoming (Goble, 1970). In addition, the person must accomplish the basic needs as well as master them (Maslow 1954). A self-actualized individual feel fulfilled and has accomplished all the things he or she is capable of doing, which are moments of deep meaning or emotion (Maslow 1954).

AR as novel media has a power to augment one's capabilities and fulfill one's needs along with empowering the user to go beyond performing the basic activities. It empowers the user to become a smart shopper. AR portrays virtual information in real world and allows the user to accomplish his or her desired activities, which may not be possible to do without using AR.

Although AR is being utilized as fast as possible, there are some major issues which should be taken care of. In the next section, augmented reality challenges driven by technology will be discussed.

CHAPTER VI

CONCLUSIONS AND MANAGERIAL IMPLICATIONS

This chapter will sum up the dissertation by summarizing the results and suggesting some managerial implications for technology developers by emphasizing the role of AR challenges, implications for retail managers, and a few suggestions on the role of artificial intelligence and machine learning for AR developers.

Conclusions

AR is a novel, entertaining, and practical media that enriches user experience by enabling users to perform desirable tasks. AR empowers the users to repeatedly construct a world of experience and deconstruct it. The results of this research show that AR supplements user experience and that AR is smart enough to enrich user experience and assists the users in the decision-making process. This capability is derived from the combination of technological innovation and knowledge of human needs incorporated into the design and implementation of augmented reality.

AR is a novel, functional, fun, and informative media, which has attracted the attention of many companies. There was about 2.5 billion AR downloads in 2017, and although many companies have been developing AR technology, there is a lack of marketing research explaining the appeal of AR to users. The literature on AR has emphasized the technological aspects of AR, but it has neglected users' needs and problems (Swan & Gabbard, 2005). Despite this lack of attention to users and in the lapse in marketing research that can't keep up with the trend, AR is increasingly employed in the design and delivery of products (Kozick & Gettliffe, 2010; Swan & Gabbard, 2005).

On the demand side, consumers have been exposed to the stream of novel technology that has created augmented reality. Mobile apps offer a variety of AR (Snap Shop, Star Chart), glasses (Vuzix, Google Glass), and head mounted display (Microsoft Hololens). In the context of entertainment, Pokeman Go is an example of AR technology embraced by 45 million users in July 2016. In the context of shopping, imagine online shoppers intending to buy a pair of eyeglasses but they are not quite sure what the eyeglasses/ sunglasses will fit their face. Then, they are told about AR, a collection of viewing features that helps shoppers visualize the eyeglasses/sunglasses in three dimensions (3D). This example illustrates how AR enhances shoppers' purchase experience.

The user experience with AR is superior to user experiences without AR. AR users can endlessly interact with experiential contents. With the aid of AR, customers feel empowered and smart. They obtain information easier and faster. For example, Virtual Guide for Hyundai allows the vehicle owner to become aware of the usability of the knobs and several features of a vehicle.

In addition to testing the hypotheses, this study contributes a new measure of AR called *augmented reality* (AR) to the marketing literature, and it offers a new dimension of user experience under the term *augmentation quality*. This new measure reflects the quality of output as enhanced by AR and includes all features of AR, unlike the very limited measure termed *perceived augmentation* (Javornik 2015; 2016), which currently appears in the literature. Augmentation quality derives from the interaction between the user and AR and results from new perceptions users can develop after being exposed to AR devices. These perceptions can be evaluated and measured.

This dissertation included three studies: study 1, 2 and 3. Study 1 was conducted in the context of shopping; study 2 was conducted in the entertainment services; and study 3 was conducted in the context of service maintenance.

The results showed that augmented reality positively and significantly influences user experience and subsequently behavioral intention. This study developed a scale for augmented reality (AR) to capture the quality or level of intelligence of augmented reality based upon image recognition and insertion of relevant virtual contents onto the present reality.

The results of this dissertation have some implications for retail managers and AR developers. Below, implications for retail managers will be discussed.

Implications for Technology Developers: Augmented Reality Challenges

This dissertation has some implications for AR developers. As shown before, the quality of AR is a major challenge of developing AR. In addition to developing AR that satisfies the user's needs and desires, AR designers have to pay attention to artificial intelligence used in augmented reality design.

The users are not likely to use AR to accomplish their task if augmented reality intelligence is poor. For example, AR that is not able to recognize the real contents so that incorrect virtual contents are placed onto the existing reality. It makes users to lose trust.

To persuade shoppers, AR developers have to improve design of AR in order to meet the intelligence quality, users' expectation, needs and desires.

Additionally, AR developers can get benefit from “Machine Learning” or “ML” when they design augmented reality. With the aid of machine learning, image recognition, in some cases natural language processing (NLP) that are under the umbrella of artificial intelligence, augmented reality becomes predictive and smart to assist users/ customers. With machine learning, augmented reality can recognize the contents in the present reality and inserts the virtual contents onto the present reality based on the user’s input: cognitive and emotive responses.

It is expected that involving user’s emotive input (user’s emotional responses, user’s facial expression) exponentially enriches user experience. That is, as the communication between AR and user increases, AR is able to predict and generate the outputs the user actually desires. AR with high level of communication is able to present highly personalized virtual contents to the user that are in accordance with the user’s expectation, desires and needs.

AR allows the user to immerse in a new and mediated reality formed by AR while collecting user’s information (Pase, 2012). AR has some ethical and safety considerations which should be taken into account (Pase, 2012). AR challenges which discourage users from interacting with such technology are not limited to ethical and safety issues. Following, some AR challenges will be discussed:

Issue 1; Image Recognition. It is expected that AR is able to recognize objects pointed by smart devices. Image recognition is the most important feature of AR. If AR precisely recognizes objects, then it can portray relevant and reliable virtual information into the real world; otherwise, the output will be unreliable and irrelevant.

Issue 2; Correspondence Quality: AR portrays virtual information or virtual image on to reality and it can be portrayed on user’s screen. Quality of output is examined in terms of correspondence quality, which is one of the AR challenges. Correspondence quality refers to the extent to which AR is able to overlay virtual information onto real world information where it belongs. If AR is able to add virtual information to the places in which it belongs to, then maladjustment will not occur.

Issue 3; Information Quality. Information quality refers to the extent to which AR superimposes virtual information to user. In addition to the exactness and reliability of output, the amount of information is also critical. The amount of information portrayed by AR should be based on user's expectation and requests. In other words, information overload is not recommended. Users less like to use AR that portrays lots of information that they have not requested. To avoid user's dissatisfaction, it is suggested that AR portrays output based on user's requests. Therefore, information overload might not happen.

Issue 4; Interactivity. Interactivity is another important property of AR, which allows users to have control over the technology. As prior research has shown, interactivity creates both utilitARan value and hedonic value. Users can obtain utilitarian value when AR technology provides high level of interactivity with users. In other words, AR with high level of interactivity can provide personalized output to the users. Additionally, AR can create hedonic value by empowering users to interact with virtual objects shown on screen so that the users become entertained.

Existing AR apps in market are not highly interactive and the results of this study showed that there is not a significant difference between AR apps and non-AR apps. Therefore, it is suggested that AR designers develop AR apps and devices that are highly interactive, which allow users to interact with virtual objects.

Issue 5; User's Information Privacy Control. Privacy has become a major issue for people using such technologies. AR is expected to portray personalized output to user; and to do so, AR needs to collect some user's information. Sometimes, users become hesitant to use AR because they are afraid of sharing their personal information such as name, email address, location and so on with the technology.

AR is novel media, which allows user to immerse in a fantasy world while the user is still in a physical environment. AR could be more amazing if the technical and safety issues would be fixed.

Actual and Expected User Experience of Augmented Reality

This study had also asked the participants about their actual experience and expected experience with AR. The participants' narratives were analyzed and reported below.

Actual user experience. The participants reported that they had easy to use, fun and enjoyable experience when interacting with Virtual Guide app. They also reported that the app had innovative design and provided accurate and reliable information to them. Additionally, they stated that using the app saves their time so that they will not need to call or visit the dealership to ask their simple and basic questions about their vehicle.

Expected User Experience. Although using the app was appealing, the participants reported that they expected some features that were not examined in the app. The participants expected the app to be faster, and more informative and interactive. Additionally, they expected the app to provide more explanation regarding how to use the app. For example, they expected to hear voice explanation. Another example, they expected to interact with a more informative and interactive app that shows vehicle price and allows them to change the color of vehicle simultaneously.

Implications for Retail Managers

AR transforms user experience superimposing the virtual contents on top of the present reality where they belong to. AR can assist both store shoppers and online shoppers in decision-making process.

As shown in the previous chapters, user experience fully mediates the impact of augmented reality intelligence on customer satisfaction and customer's willingness to use AR.

Retail managers can use AR apps and gadgets such as Magic Mirror or Memory Mirror in a physical store to increase store traffic and create pleasant interactive shopping experience for the customers. For example, retail stores can be equipped with Magic Mirror so that shoppers can virtually try clothing on and see how virtual products look on them. Using AR technology in a physical store not only entertains shoppers, but also increase store traffic.

Needless to mention, all of these positive things may happen when AR is intelligent enough to generate enriched user experience. Customers would like to interact with intelligent technology that understands their motion, emotion, shopping behavior while it does not violate information privacy. However, such technology is not still available in market for shopping purpose. Most of the AR apps are becoming interactive and gives control to the user and if technology does not fail, AR is able to respond quickly. In addition, customers expect AR technology does not use their information without their permission. Privacy violation frustrates users and discourages users from interacting with AR.

Interactive AR allows shoppers to interact with virtual contents portrayed by AR and entertains them. Both online and in store shoppers are empowered to get more product information such as 3D product images. Therefore, shoppers are able to perform their shopping task with more certainty, and less risk, and reduce rate of return.

Decision to use or not use AR is interactive since many variables are involved. As shoppers have greater and better experience, they are more convinced to embrace AR.

AR can be proactive to show products' promotions to shoppers when they shop. The shoppers do not need to carry their printed promotions or coupons to the stores; AR can assist the shoppers in the shopping process.

User's Sensory Experience by Examining User's Cognitive and Emotive Responses by Using Artificial Intelligence (AI) and Machine Learning (ML) into AR Design

AR is growing fast and there are a variety of AR devices, headsets, and apps in market. One of the most advanced AR headsets is Microsoft Hololens. Microsoft Hololens highly engages users in a 3D holographic environment and allows the users to interact with 3D holograms around them.

AR creates a stimulatory experience to the users. As superior stimulatory experience generated by AR, the AR users perceive enriched and augmented sensory experience. AR will be so tremendous if it assists the user by building the output based on the user's cognitive and emotive inputs. It is suggested that AR developers involve both users' cognitive input as well as users' emotive input. Users' cognitive has been already involved in the design of current AR technology. Users' cognitive input refers to the user's sense of control over the virtual content portrayed by AR. For example, most of Virtual Try-On apps involve users' cognitive input.

Users are given a variety of choices to choose a product (e.g., clothing, glasses) and see how virtual products look without being in a physical store. Not only Virtual Try-On applications, but also other AR applications, such as Cimagine and IKEA Catalogue allow users to see how virtual products (e.g., furniture) fit physical world. All these AR applications need users' cognitive effort in order to superimpose 3D image of virtual objects onto the existing reality. It is suggested that AR technology involves the user's input such as the user's purchase history, prior shopping experience in order to generate trustworthy, reliable and relevant virtual content. Using artificial intelligence boosts the output quality of AR in terms of cognitive inputs. Some companies have used artificial intelligence to improve customer experience. Alexa Amazon and Apple Siri are examples of artificial intelligence utilized in non-augmented reality platforms.

Additionally, users' emotive input refers to the user's sensory input such as emotion, facial expression, or facial gesture in order to make superior output quality to the user. For example, AR that is able to see how the user interacts with a product or a brand and thereby it is able to suggest the products, which are in accordance with the user's desire and expectation. Imagine an online shopper is using an AR application to try a pair of sunglasses. Based on the user's emotive responses toward each pair of glasses such as smile, surprise, or voice tone, AR assists the user in the decision-making process. Based on the combination of the user's cognitive inputs (e.g., the user's choice), and the user's emotive response (e.g., the user's facial expressions), AR suggest the products that meet the user's desires, interests and needs. For example, if the shopper shows interest to a specific brand by smiling or changing his/ her facial gesture, then AR provides the best choices matching the shopper's expectations.

Until today, to the best of my knowledge there is no AR which involves both artificial intelligence (AI) and machine learning (ML) simultaneously into AR design. To develop a remarkable AR application, developers should incorporate artificial intelligence and machine learning to connect with user's cognitive and emotive responses as the input of AR and let the AR predicts what the user desires. Integration of artificial intelligence in AR helps AR to able to properly recognize human's sensory experience. AR with artificial intelligence can recognize voice, visual image, haptic and so on. One of the examples of commonly used artificial intelligence is Apple Siri that carries out the user's tasks in a smart way. If AR uses artificial intelligence properly in its design, AR is able to act similar to human being and carries out the functions in an intelligent way. Integration of artificial intelligence enables the AR to precisely recognize the real content in the existing reality (e.g., voice, image, video, etc.) and maps the most relevant virtual content into the correspondent reality.

On the other hand, machine learning or ML has the ability to learn and interpret from the big data given to AR. An example of machine learning is Alexa Amazon, which is able to predict choices to the customer based on his or her purchase history or mostly reviewed items. Developing such AR applications that involve artificial intelligence and machine learning will be the next big thing in the near AR future. In marketing, such AR not only assists customers too effectively and efficiently make decisions, but also experience satisfactorily shopping experience.

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APPENDIX A

APPENDIX A

SURVEY OF AUGMENTED REALITY SHOPPING

Instructions: This survey is intended to collect your opinions on your shopping experience using online technology. All the information you provide will be confidential. Please read each statement below and indicate the degree of your agreement or disagreement on a scale of 1 = Strongly Disagree to 7 = Strongly Agree.

Strongly Disagree	**Mostly Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Mostly Agree**	**Strongly Agree**
1	**2**	**3**	**4**	**5**	**6**	**7**

I am familiar with using the Internet.	1	2	3	4	5	6	7
I frequently use the Internet to shop online.	1	2	3	4	5	6	7
I think that technology is necessary for my daily works.	1	2	3	4	5	6	7
I visit the Internet retail websites to collect product information.	1	2	3	4	5	6	7
I visit the Internet retail websites for purchasing products.	1	2	3	4	5	6	7
I am a user of eyeglasses or sunglasses.	1	2	3	4	5	6	7
I would like to wear eyeglasses or sunglasses.	1	2	3	4	5	6	7

Please circle the scale number (from 1=strongly disagree to 7=strongly agree as above) that best fits your answer for each statement below.

The product offered in the website of Ray-Ban app is reasonably priced.	1	2	3	4	5	6	7
The product offered in the website of Ray-Ban is a good value for the money.	1	2	3	4	5	6	7
At the current price, the product offered in the website of Ray-Ban provides a good value.	1	2	3	4	5	6	7
I was informed about the personal information that Ray-Ban website would collect about me, such as email, name, and location.	1	2	3	4	5	6	7
This website explained the reasons why my personal information is being collected.	1	2	3	4	5	6	7
This website informed the way my personal information would be used.	1	2	3	4	5	6	7
This website gave me a clear choice before using personal information about me.	1	2	3	4	5	6	7
I intend to buy my eyeglasses/sunglasses via the Ray-Ban website.	1	2	3	4	5	6	7
I would be willing to buy my eyeglasses/sunglasses via the Ray-Ban website.	1	2	3	4	5	6	7
In future, I would buy my eyeglasses/sunglasses via the Ray-Ban website.	1	2	3	4	5	6	7
Overall, I am satisfied with the Ray-Ban website.	1	2	3	4	5	6	7
Being a user of this website has been a satisfying experience.	1	2	3	4	5	6	7
Having experienced this website was pleasurable.	1	2	3	4	5	6	7

Please circle the scale number (from 1 to 7) that best fits your answer for each word comparison of opposite sides.

1	**2**	**3**	**4**	**5**	**6**	**7**
Technical	2	3	4	5	6	Human
Unruly	2	3	4	5	6	Manageable
Confusing	2	3	4	5	6	clearly structured

Unpredictable	2	3	4	5	6	Predictable
Cumbersome	2	3	4	5	6	Straightforward
Impractical	2	3	4	5	6	Practical
Complicated	2	3	4	5	6	Simple
Unprofessional	2	3	4	5	6	Professional
Difficult to learn	2	3	4	5	6	easy to learn
Insecure	2	3	4	5	6	Secure
Too few information	2	3	4	5	6	too much information
Irrelevant	2	3	4	5	6	Relevant
Unreliable	2	3	4	5	6	Reliable
Effortful	2	3	4	5	6	Effortless
Shady	2	3	4	5	6	Trustworthy
Highly decreases one's capabilities	2	3	4	5	6	highly augmented one's capabilities
Risky to use	2	3	4	5	6	safe to use
Not personalized	2	3	4	5	6	Personalized
Highly decreases one's awareness of the environment	2	3	4	5	6	highly augments one's awareness of the environment
Unpresentable	2	3	4	5	6	Presentable
Separates me from people	2	3	4	5	6	bring me closer to people
Alienating	2	3	4	5	6	Integrating
Cheap	2	3	4	5	6	Expensive
Tacky	2	3	4	5	6	Stylish
Isolating	2	3	4	5	6	Connective
Decreases one's self image	2	3	4	5	6	augments one's self-image
loneliness	2	3	4	5	6	the sense of belonging to the community

Ordinary	2	3	4	5	6	Novel
Undemanding	2	3	4	5	6	Challenging
Dull	2	3	4	5	6	Captivating
Conservative	2	3	4	5	6	Innovative
Cautious	2	3	4	5	6	Bold
Unimaginative	2	3	4	5	6	Creative
Conventional	2	3	4	5	6	Inventive
Repelling	2	3	4	5	6	Appealing
Discouraging	2	3	4	5	6	Motivating
Not absorbed	2	3	4	5	6	over absorbed
Not immerse	2	3	4	5	6	Immerse
Ugly	2	3	4	5	6	Beautiful
Unattractive	2	3	4	5	6	Attractive
Unfriendly	2	3	4	5	6	Friendly
Annoying	2	3	4	5	6	Enjoyable
Unpleasant	2	3	4	5	6	Pleasant
Bad	2	3	4	5	6	Good
Asymmetric	2	3	4	5	6	Symmetric
Unclean	2	3	4	5	6	Clean
Aesthetically unpleasing	2	3	4	5	6	aesthetically pleasing
Rigid design	2	3	4	5	6	artistic design
Static	2	3	4	5	6	Vivid
Artificial	2	3	4	5	6	Realistic

Age: Gender:

What did you expect to experience that you have not experienced in this activity?

Thank you for completing this survey!

APPENDIX B

APPENDIX B

SURVEY OF AUGMENTED REALITY SERVICE USAGE

Instructions: This survey is intended to collect your opinions on your service usage using augmented reality. All the information you provide will be confidential. Please read each statement below and indicate the degree of your agreement or disagreement on a scale of

1 = Strongly Disagree to 7 = Strongly Agree.

Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Mostly Agree	Strongly Agree
1	2	3	4	5	6	7

I frequently use the Internet to search.	1	2	3	4	5	6
I think that technology is necessary for my daily works.	1	2	3	4	5	6
I visit the Internet websites to collect information.	1	2	3	4	5	6
I visit the Internet to collect more information about stars and planets.	1	2	3	4	5	6
I would like to know more about celestial bodies in the sky.	1	2	3	4	5	6
I like to watch stars, planets and other celestial bodies in the sky.	1	2	3	4	5	6

Please circle the scale number (from 1=strongly disagree to 7=strongly agree) as above that best fits your answer for each statement below.

The service offered by this mobile app for observing the sky is reasonably priced.	1	2	3	4	5	6	7

The service offered by this mobile app is a good value for the money.	1	2	3	4	5	6	7
At the current price, the service offered in the mobile AR app provides a good value.	1	2	3	4	5	6	7
I was informed that AR app would collect information about me, such as email, name, and location.	1	2	3	4	5	6	7
This mobile AR app explained the reasons why my personal information is being collected.	1	2	3	4	5	6	7
This mobile AR app explained how personal information about me would be used.	1	2	3	4	5	6	7
This mobile AR app gave me a clear choice before using personal information about me.	1	2	3	4	5	6	7
I intend to observe stars, planets or other entities in the sky through using this mobile app.	1	2	3	4	5	6	7
I would be willing to use this mobile app.	1	2	3	4	5	6	7
In future, I would use this mobile app.	1	2	3	4	5	6	7
Overall, I am satisfied with this mobile app.	1	2	3	4	5	6	7
Being a user of this mobile app has been a satisfying experience.	1	2	3	4	5	6	7
Having experienced this mobile app was pleasurable.	1	2	3	4	5	6	7

Please circle the scale number (from 1 to 7) that best fits your answer for each word comparison of opposite sides.

1	**2**	**3**	**4**	**5**	**6**	**7**
Technical	2	3	4	5	6	Human
Unruly	2	3	4	5	6	Manageable
Confusing	2	3	4	5	6	clearly structured
Unpredictable	2	3	4	5	6	Predictable
Cumbersome	2	3	4	5	6	Straightforward
Impractical	2	3	4	5	6	Practical
Complicated	2	3	4	5	6	Simple
Unprofessional	2	3	4	5	6	Professional
Difficult to learn	2	3	4	5	6	Easy to learn
Insecure	2	3	4	5	6	Secure

Too few information	2	3	4	5	6	Too much information
Irrelevant	2	3	4	5	6	Relevant
Unreliable	2	3	4	5	6	Reliable
Effortful	2	3	4	5	6	Effortless
Shady	2	3	4	5	6	Trustworthy
Highly decreases one's capabilities	2	3	4	5	6	Highly augmented one's capabilities
Risky to use	2	3	4	5	6	Safe to use
Not personalized	2	3	4	5	6	Personalized
Highly decreases one's awareness of the environment	2	3	4	5	6	Highly augments one's awareness of the environment
Unpresentable	2	3	4	5	6	Presentable
Separates me from people	2	3	4	5	6	Bring me closer to people
Alienating	2	3	4	5	6	Integrating
Cheap	2	3	4	5	6	Expensive
Tacky	2	3	4	5	6	Stylish
Isolating	2	3	4	5	6	Connective
Decreases one's self image	2	3	4	5	6	Augments one's self-image
loneliness	2	3	4	5	6	The sense of belonging to the community
Ordinary	2	3	4	5	6	Novel
Undemanding	2	3	4	5	6	Challenging
Dull	2	3	4	5	6	Captivating
Conservative	2	3	4	5	6	Innovative
Cautious	2	3	4	5	6	Bold
Unimaginative	2	3	4	5	6	Creative
Conventional	2	3	4	5	6	Inventive

Repelling	2	3	4	5	6	Appealing
Discouraging	2	3	4	5	6	Motivating
Not absorbed	2	3	4	5	6	Over absorbed
Not immerse	2	3	4	5	6	Immerse
Ugly	2	3	4	5	6	Beautiful
Unattractive	2	3	4	5	6	Attractive
Unfriendly	2	3	4	5	6	Friendly
Annoying	2	3	4	5	6	Enjoyable
Unpleasant	2	3	4	5	6	Pleasant
Bad	2	3	4	5	6	Good
Asymmetric	2	3	4	5	6	Symmetric
Unclean	2	3	4	5	6	Clean
Aesthetically unpleasing	2	3	4	5	6	Aesthetically pleasing
Rigid design	2	3	4	5	6	Artistic design
Static	2	3	4	5	6	Vivid
Artificial	2	3	4	5	6	Realistic

Age: Gender:

What did you expect to experience that you have not experienced in this activity?

Thank you for completing this survey!

APPENDIX C

APPENDIX C

SURVEY OF AUGMENTED REALITY IN THE CONTEXT OF SERVICE MAINTENANCE

Instructions: This survey is intended to collect your opinions on your shopping experience using advanced technology. All the information you provide will be confidential. Please read each statement below and indicate the degree of your agreement or disagreement on a scale of *1 = Strongly Disagree* to *7 = Strongly Agree*.

Augmented Reality is the integration of virtual information with the user's environment in real time.

Strongly Disagree	Mostly Disagree	Somewhat Disagree	Neutral	Agree	Mostly Agree	Strongly Agree
1	**2**	**3**	**4**	**5**	**6**	**7**

I am familiar with using the Internet.	1	2	3	4	5	6	7
I frequently use the Internet to shop online.	1	2	3	4	5	6	7
I think that technology is necessary for my daily works.	1	2	3	4	5	6	7
I visit the car dealership websites to collect vehicle information.	1	2	3	4	5	6	7
I visit the car dealership websites for purchasing vehicle.	1	2	3	4	5	6	7

Please circle the scale number (from 1 = strongly disagree to 7 = strongly agree as above) that best fits your answer for each statement below.

This app recognized the car.	1	2	3	4	5	6	7
This app added virtual information about the car to the screen.	1	2	3	4	5	6	7

This app added virtual information about the car in real time to the screen.	1	2	3	4	5	6	7
This app added relevant virtual information about the car to the screen.	1	2	3	4	5	6	7
This app provided me some information about engine, exterior, interior, and other parts of the car to the screen.	1	2	3	4	5	6	7
This app added the 3D image of car to the screen.	1	2	3	4	5	6	7
As I moved the screen, virtual information about the car changed to correspond with the image on the screen.	1	2	3	4	5	6	7
The virtual information about the car corresponded to the image of car.	1	2	3	4	5	6	7
This app was interactive.	1	2	3	4	5	6	7
While I was using the app, I was always able to do what I thought I was doing.	1	2	3	4	5	6	7
I felt I had a great control while I was using the app.	1	2	3	4	5	6	7
I thought this app really gave me some control (i.e., flexibility) over the content that I wanted to see.	1	2	3	4	5	6	7
This app allowed the user to zoom in/ zoom out the image of car.	1	2	3	4	5	6	7
This app allowed the user to change the color of car.	1	2	3	4	5	6	7
This app showed a variety of cars.	1	2	3	4	5	6	7
This app had the ability to respond to my specific requests for information, so I could access it quickly and efficiently.	1	2	3	4	5	6	7
Interaction with this app was very fast.	1	2	3	4	5	6	7
This app could easily let me access other consumers' opinions about the cars featured.	1	2	3	4	5	6	7
I was able to obtain information I wanted without any delay.	1	2	3	4	5	6	7
This app processed my input very quickly.	1	2	3	4	5	6	7
This app would allow me to easily communicate with the company if I ever had a specific question or wanted to purchase a car.	1	2	3	4	5	6	7
The car that I was using this app for was reasonably priced.	1	2	3	4	5	6	7
The car that I was using this app for was a good value for the money.	1	2	3	4	5	6	7
At the current price, the car that I was using this app for provided a good value.	1	2	3	4	5	6	7
I was informed about the personal information that this app would collect about me, such as email, name, and location.	1	2	3	4	5	6	7
This app explained the reasons why my personal information was being collected.	1	2	3	4	5	6	7

This app informed the way my personal information would be used.	1	2	3	4	5	6	7
This app gave me a clear choice before using personal information about me.	1	2	3	4	5	6	7
I intend to use the app to see the 3D images of car.	1	2	3	4	5	6	7
I would be willing to use this app.	1	2	3	4	5	6	7
In future, I would use this app.	1	2	3	4	5	6	7
Overall, I am satisfied with this app.	1	2	3	4	5	6	7
Being a user of this app has been a satisfying experience.	1	2	3	4	5	6	7
Having experienced this app was pleasurable.	1	2	3	4	5	6	7

Please circle the scale number (from 1 to 7) that best fits your answer for each word comparison of opposite sides.

	1	**2**	**3**	**4**	**5**	**6**	**7**	
Technical	1	2	3	4	5	6	7	Human
Unruly	1	2	3	4	5	6	7	Manageable
Confusing	1	2	3	4	5	6	7	Clearly structured
Unpredictable	1	2	3	4	5	6	7	Predictable
Cumbersome	1	2	3	4	5	6	7	Straightforward
Impractical	1	2	3	4	5	6	7	Practical
Complicated	1	2	3	4	5	6	7	Simple
Unprofessional	1	2	3	4	5	6	7	Professional
Difficult to learn	1	2	3	4	5	6	7	Easy to learn
Insecure	1	2	3	4	5	6	7	Secure
Slightly informative	1	2	3	4	5	6	7	Highly informative
Irrelevant information	1	2	3	4	5	6	7	Relevant information
Static images	1	2	3	4	5	6	7	Vivid images
Unreliable	1	2	3	4	5	6	7	Reliable
Effortful	1	2	3	4	5	6	7	Effortless
Shady output	1	2	3	4	5	6	7	Trustworthy output
Slightly augments one's capabilities to use the car	1	2	3	4	5	6	7	Highly augments one's capabilities to use the car
Adds virtual information to the places where do NOT belong	1	2	3	4	5	6	7	Adds virtual information to the places where belong
Risky to use	1	2	3	4	5	6	7	Safe to use
Not personalized	1	2	3	4	5	6	7	Personalized

Slightly augments one's awareness of the car	1	2	3	4	5	6	7	Highly augments one's awareness of the car
Unpresentable	1	2	3	4	5	6	7	Presentable
Separates me from people	1	2	3	4	5	6	7	Bring me closer to people
Alienating	1	2	3	4	5	6	7	Integrating
Cheap	1	2	3	4	5	6	7	Expensive
Tacky	1	2	3	4	5	6	7	Stylish
Isolating	1	2	3	4	5	6	7	Connective
Decreases one's self image	1	2	3	4	5	6	7	Augments one's self-image
loneliness	1	2	3	4	5	6	7	The sense of belonging to the community
Ordinary	1	2	3	4	5	6	7	Novel
Undemanding	1	2	3	4	5	6	7	Challenging
Dull	1	2	3	4	5	6	7	Captivating
Conservative	1	2	3	4	5	6	7	Innovative
Cautious	1	2	3	4	5	6	7	Bold
Unimaginative	1	2	3	4	5	6	7	Creative
Conventional	1	2	3	4	5	6	7	Inventive
Unpleasant	1	2	3	4	5	6	7	Pleasant
Repelling	1	2	3	4	5	6	7	Appealing
Discouraging	1	2	3	4	5	6	7	Motivating
Not absorbed	1	2	3	4	5	6	7	Over absorbed
Not immerse	1	2	3	4	5	6	7	Immerse
Ugly	1	2	3	4	5	6	7	Beautiful
Unattractive	1	2	3	4	5	6	7	Attractive
Unfriendly	1	2	3	4	5	6	7	Friendly
Annoying	1	2	3	4	5	6	7	Enjoyable
Unpleasant	1	2	3	4	5	6	7	Pleasant
Bad	1	2	3	4	5	6	7	Good
Asymmetric	1	2	3	4	5	6	7	Symmetric
Unclean	1	2	3	4	5	6	7	Clean
Rigid	1	2	3	4	5	6	7	Artistic
Static	1	2	3	4	5	6	7	Vivid
Artificial	1	2	3	4	5	6	7	Realistic

Age: _____________ **Gender:** __________________

Education level: ____High school _____ Diploma _____Associate degree _____Graduate degree

Annual household Income: Below $40,000 $40,001 – 79,000 $80,00 - $119,000

$120,000 - $199,000 $200,000 and above.

BIOGRAPHICAL SKETCH

Atieh Poushneh earned her Ph.D. in Marketing in July 2019. She received a B.SC degree Computer Engineering-Software and a M.SC in Industrial Engineering-System Management and Productivity from Sharif University of Technology, IRAN, TEHRAN. Her research primarily focuses on the effect of interactive technology such as augmented reality, virtual reality, artificial intelligence on consumer decision-making. Additionally, she uses machine learning to predict how consumers make choices. Her email address is: atieh.poushneh@gmail.com.