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Extending the technology acceptance model to explain how perceived augmented reality affects consumers' perceptions

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ABSTRACT

Today, reaching consumers through interactive methods has become one of the primary goals of the brands. As a result of this, smartphones have turned into tools brands can use to start an interaction with consumers. Due to augmented reality (AR)-supported mobile applications, brands can both provide consumers with detailed information about products and services, and also affect consumers' perceptions. The main purpose of this research is to determine the effect of augmented reality use in mobile applications on consumers' behavioral intentions towards the use of the mobile application and perceptions underlying this effect. In this study, by employing the Technology Acceptance Model (TAM), the effect of augmented reality on behavioral intentions for mobile application use was examined through a structural equation modeling (SEM). Additionally, the effects of the technology anxiety (TA) and consumer novelty seeking (CNS) on perceived augmented reality were also examined. An augmented reality-supported mobile application which makes trying cosmetic products virtually on possible, was used by female consumers (n = 278). The data was collected through a questionnaire. The results indicated that the CNS had a positive and direct effect on perceived augmented reality (PAR); PAR had a positive and direct effect on perceived enjoyment (PE), perceived usefulness (PU), perceived informativeness (PI), and perceived ease of use (PEU). It was also determined that the PE, PU, PI had positive and direct effects on the behavioral intentions to use the application (BIUA).

1. Introduction

Presently, mobile devices have become indispensable for almost everyone. According to the "Digital 2021 Global Overview" report (wearesocial.com, 2021) published jointly with We Are Social and Hootsuite, there are 5.22 billion mobile users worldwide, and this represents 66% of the world's population. A high proportion of the respondents, 96.9%, own a smartphone. 55.7% of the world's internet traffic takes place on mobile phones. The average time users spend on their mobile devices is 4 h and 10 min. The total number of mobile applications downloaded in 2020 is 218 billion. 69.4% of the participants stated that they use shopping applications on their mobile devices. 28.7% of the participants stated that they use mobile applications to search a brand. This can be considered as an indicator of the importance branded mobile applications gain day by day in the management of the online relations/interactions between brands and customers. This has become even more evident during the pandemic. In a study examining the effect of COVID-19 on digital behaviors (Kemp, 2020), it was found that digital devices were used more during the pandemic, and among digital devices mobile phones were found to be the most used devices with 76%. Again, during the pandemic, in parallel with the increase in the time spent at home, there was an increase in digital activities, and the rate of those who said they spent more time on mobile applications was 36%. Based on these, it can be said that with the increased time spent at home, the facilitative effect of augmented reality-based mobile applications on consumers' shopping experiences may come to the fore.

Under these conditions, brands' main objective is to capture consumers in their mobile worlds and to enable them to adopt behaviors towards the use of the brand. Hence, the most rational approach would be to provide consumers with virtual product experiences on their mobile devices. However, people today have problems with online purchasing, such as lack of physical contact with the products and lack of sufficient information about the products. These problems are likely to eliminate/limit interaction opportunities between brands and consumers. With new technologies such as augmented reality (AR), people can have real life like experiences without actually having physical

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contact with the products, and this may eliminate the problems mentioned. According to the Mobile Marketer report, 71% of consumers state that they would shop more frequently from retailers using AR. Again, 40% of the consumers participating in the same research stated that they would be willing to pay more for the products offered via AR. The AR market is estimated to be $50 billion before 2024 (threekit.com, 2021). As a result of this demand, many brands started to build their mobile applications incorporating augmented reality. For example, Artelia helps potential customers to have an idea of how the furniture would look in real rooms and gardens by placing virtual furniture using its mobile application. Bella Luce, another example, offers women the opportunity to see the jewelry they choose on their own virtually using virtual reality. Similarly, Converse, with its mobile application, allows people to try virtual variations of shoe models on their own feet, without going to the store.

The review of pertinent literature indicated limited study on the perception of TAM variables in AR-based mobile applications based on the individual characteristics of users (consumer novelty seeking/technology anxiety). Previous studies focused on the functional features of applications rather than consumer evaluations (Baek & Yoo, 2018). In other words, the studies in the literature mostly explain how AR applications affect attitudes towards brands and consumer-brand relationships (Scholz & Duffy, 2018; Rauschnabel et al., 2019), how AR application features are perceived by individuals and their effect on purchasing behavior (Ramayah & Ignatius, 2005; Eyüboğlu, 2011; Javornik et al., 2016, pp. 879–880; Raška & Richter, 2017; Do et al., 2020; Yadav, 2020), the effect of AR features on brands' interaction with consumers (McLean & Wilson, 2019), the use of AR technology in education (Alotaibi, 2015; Alalwan et al., 2020), the emotional reactions created in consumers by AR technology (Soon et al., 2020) and the effect of AR features on consumer experience (Stefanelli & Pazè, 2018). This study aims at revealing the effect of supporting mobile applications with an augmented reality infrastructure on behavioral intentions towards mobile application use, and to determine the consumer characteristics and perceptions underlying this effect. Hence, a research that puts the consumer in the center rather than the application was designed. In addition, using an independent application (YouCam Makeup), rather than the mobile application of any brand, it was aimed to reach a result that is refined from the attitudes and evaluations in which consumers have already developed for certain brands. The study at hand provides a contribution to the consumer research literature and certain recommendations obtained from the findings of the study are presented for practitioners.

2. Augmented reality (concept)

Making the physical world a user interface for digital content has recently become one of the most interesting research foci. The integration of real and virtual worlds in a single interface paved the way for the development of new applications and services (Olsson et al., 2011). Today, AR technology is used in many areas extending from education to tourism, entertainment to marketing. AR adds extra value to the brand, especially in marketing, and provides the consumer with an interactive experience (Gervautz & Schmalstieg, 2012, pp. 29–30). At this point, AR applications stand out as one of the most striking areas of recent age. The market volume of the augmented and virtual reality industry is estimated to be over $571 billion by 2025 (www.prnewswire.com).

Azuma (1997) defines AR as a system that integrates 3D virtual objects into 3D real spaces, in real-time. According to Azuma (1997), AR does not replace reality; instead, it becomes its complement. Azuma (1997) identifies three features that best describe the augmented reality concept. These can be listed as combining reality and virtuality, creating real-time interactions, and 3-dimensional display of the products (Azuma, 1997, pp. 1–2). Although for the consumer market AR may seem like a new application, its conceptualization studies date back to 1960s. AR was first conceptualized in 1962 by cinematographer Morton Heilig, who created the multi-sensory simulator 'Sensorama' (Stoyanova et al., 2015, p. 2). In 1970s and 80s, research institutes and NASA began developing AR-enabled wearable technologies, and 3D graphics. In 1990s, AR applications began to be used in mobile technologies by establishing a link with virtual reality fields. Scientists Caudell and Mizell used the term for the first time in 90s (Javornik, 2016b, p. 253).

3. Augmented reality use in mobile applications

Although there are areas of use in very sizeable devices, AR technology has been transferred to mobile applications as a result of widespread smartphone use today. Users interacted with AR-based mobile applications on a large scale with the Pokémon GO application in 2016 for the first time. Millions of people who downloaded the application tried to capture a virtual character in a real environment. In addition, millions of active users of Snapchat, the most popular application among people under 24, were able to add virtual objects to their faces (Raška and Richter, 2017). As a reflection of this incredible number of users, many companies have tried to develop various AR-based mobile applications. These efforts resulted in taking the AR technology from the laboratory and integrating it into the consumer market (Daponte et al., 2014). In other words, AR applications have been turned into a technology that end users can easily access because of smartphones (Javornik et al., 2016).

At this point, the mobile augmented reality concept should be mentioned. Mobile augmented reality is defined as augmented reality used in a mobile setting and created and accessed via mobile devices (Olsson et al., 2011, p. 3). There are two key elements of interaction accessed via augmented reality on mobile devices. One of them is the device and the screen that provide interaction with virtual objects, and the other is the movements that allow the user to play with virtual objects on the screen and make changes to them. Being lightweight, and having high-resolution cameras and screens, smartphones appear as a convenient and ergonomic platform for the AR experience (Gervautz & Schmalstieg, 2012, pp. 26–28). Young consumers, especially, want to see brands' AR applications on their devices via mobile applications, not in certain places only (Baier et al., 2015). As a result of this demand, through AR-based mobile applications brands can go to consumers' homes with virtual offers (Scholz & Duffy, 2018, p. 11). Moreover, AR-based mobile applications are becoming a unique field that give consumers virtual products, enable them to interact with the brand, and allow marketers to combine entertainment, promotion, and experience in one platform (Raška and Richter, 2017).

4. Consumer novelty seeking

To better understand the concept of consumer novelty seeking, examining other concepts associated with it is necessary. The first one is consumer innovativeness. Consumer innovativeness can be thought as the driving force for innovative behavior. The concept refers to the tendency to buy new products more quickly and more often than others (Roehrich, 2004, p. 671). Novelty seeking, on the other hand, is considered as an internal search for knowledge. As it is seen, novelty seeking consists of two components: inherent and actualized. Whereas inherent novelty seeking refers to the desire to seek a new stimulus, actualized novelty seeking refers to the actual behavior of obtaining the new stimulus (Hirschman, 1980, p. 284). Hence, consumer novelty seeking is expressed as the desire to seek information on new products and purchase new products (Manning et al., 1995, pp. 330–331). Past research show that innovation seekers are more positive about their intentions to use mobile services and shopping applications (Natarajan et al., 2018; Zarmpou et al., 2012) and more eager to try new technologies (Yusoff et al., 2011). Individuals' innovativeness also has a positive effect on their behavioral intentions towards the use of virtual experimenting technologies and their attitudes towards using AR applications (Kim & Forsythe, 2008a; Yaoyuneyong et al., 2014; Alotaibi, 2015; Tom Dieck & Jung, 2015; Huang & Liao, 2015; Soon et al., 2020). The positive approach of innovation-seeking consumers to new technologies, their search for new products and services, and their enjoyment of new shopping experiences are the underlying causes of these outcomes (Domina et al., 2012). At this point, consumer novelty seeking is expected to have an impact on the augmented reality feelings perceived from mobile applications. It is, therefore, hypothesized that:

H1. *Consumer novelty seeking has a direct and positive effect on perceived augmented reality.*

5. Technology anxiety

Technology related anxiety is generally considered as individual's concern about whether or not s/he will use the technological device correctly (Arvanitis et al., 2009, p. 246). To understand the technology anxiety, it is necessary to clarify two concepts. The first is technology readiness which is defined as the tendency to accept and use new technologies to achieve certain goals (Parasuraman, 2000, p. 308). The second is computer anxiety. Computer anxiety refers to fear and anxiety experienced (by the individual) while using computer technologies (as cited in Maurer 1983; Cambre & Cook, 1985, p. 41). However, the technology anxiety is different from these two. This concept is different from technology readiness as the second refers to the tendency for technological pioneering. On the other hand, technology anxiety refers to individuals' mental structure regarding their ability and willingness to use technological tools. Computer anxiety focuses on personal computers; whereas, technology anxiety generally focuses on the state of concern about technological tools (Meuter et al., 2003, p. 900). When assessed within the TAM, technology readiness affects perceived usefulness positively, and perceived usefulness has a positive effect on the intention to use the AR application and the development of a positive attitude towards AR application (Chung et al., 2015). On the other hand, it is stated that individuals' technology anxiety (TA) have a negative effect on their behavioral intentions towards the use of virtual experimenting technologies (Kim & Forsythe, 2008a). In addition, TA negatively affects the intention to use technological services (Meuter et al., 2003; Jacques et al., 2009). Moreover, TA has a direct and negative effect on perceived ease of use (Brown, 2002; Ibili et al., 2019). Since the technology anxiety expresses individuals' mental structure regarding their ability and willingness to use technological tools and their general anxiety towards these tools (Meuter et al., 2003), consumers who have such anxiety are not likely to experience the augmented reality in mobile applications effectively. Therefore, consumers' technology anxiety may also have a negative effect on their perceived augmented reality in mobile applications. It is, therefore, hypothesized that;

H2. *Technology anxiety has a direct and negative effect on the perceived augmented reality.*

6. TAM

TAM is a model primarily developed to determine the acceptance/rejection state of users' regarding computer usage (Davis et al., 1989, p. 983). Hence, the purpose of developing TAM is to identify the factors playing key role in technology acceptance process. In other words, the model aims at determining the external factors that affect users' thoughts, attitudes, and behavioral intentions. In the first version of the model, "PU" and "PEU" were determined as the two main factors that affect the adoption of computer technology and the intention to use it (Davis et al., 1989). The model has been developed to include 4 main elements. These are (Rese et al., 2017): PU, PEU, attitude towards use, and behavioral intentions towards use. The first two of these are related to the application feature; others are related to the application's effect on the consumer. Although it has been a long time since the model was introduced to the literature, the interest in the use of the model in research is still high, and this model is used in consumer research on the use of mobile applications (Huang & Ren, 2020) and current technologies such as Amazon Alexa and Google Home (Canziani & MacSween, 2021).

In the literature review, 8 features that can be considered as an improved adaptation of the TAM were identified. These are PEU, PE, PI, PU, PAR, Perceived Aesthetics, Perceived Concentration/Attentiveness, and Perceived Control (Atombo et al., 2017; Davis, 1989; Huang & Liao, 2015; Javornik, 2016a; Kim & Forsythe, 2008b; Koufaris, 2002). The features of the mobile application selected within the scope of this study (Figs. 1, 2 and 3) can be listed as follows:

(i) it is entertaining as it is a makeup application,
(ii) it informs the user about the colors that best suit her,
(iii) it is user friendly because the steps in the application are easy to learn and follow,
(iv) it would be perceived useful as it provides a virtual demo without actually trying the products on and allows choosing make-up materials,
(v) and it offers consumer all of the above using augmented reality technology.

Because of these features of the application, the first 5 related variables (PEU, PE, PI, PU, PAR) of TAM were discussed and examined within the scope of this study. These features are clarified in more detail in the following sections.

Perceived Augmented Reality: One of the main purposes of AR applications is to present virtual and real images together. The important thing here is that the virtual object presented should be very similar, or even indistinguishable from the real one (Gervautz & Schmalstieg, 2012). People who see an object, like a pair of shoes, a necklace, a ring, that look real on their body will be able to engage in the application and make content purchasing decisions. However, the determining factor here is the closeness of this object to its real counterpart. Analyzing

Fig. 1. No make-up.[11].

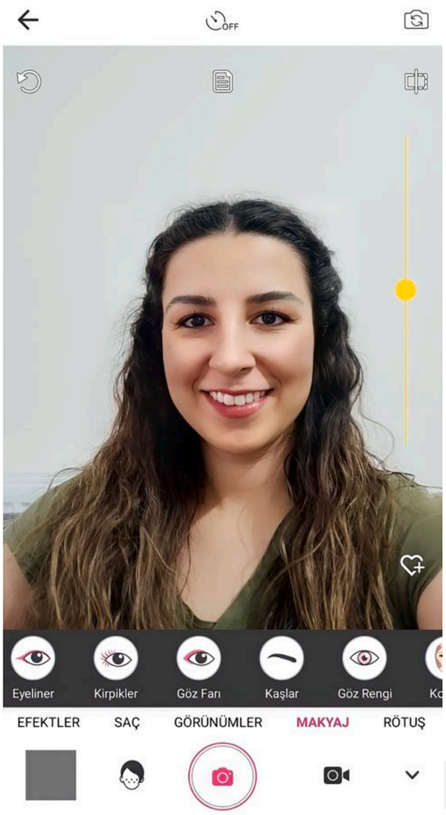

Fig. 2. Basic make-up.

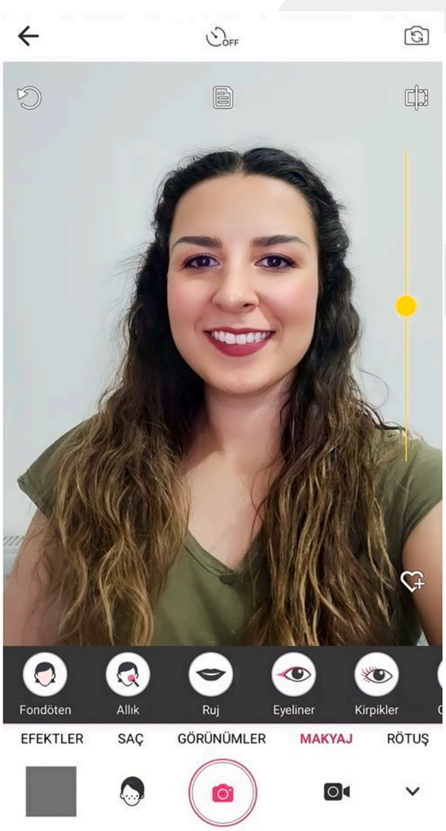

Fig. 3. Professional make-up.

online customer opinions, Baier et al. (2015) concluded that a mobile application with augmented reality enriches the shopping experience. Studies reveal that PAR has positive effects on users' attitudes and behavioral intentions, attitudes towards the application, intention to reuse it, and recommendation intentions (Javornik, 2016a; Javornik et al., 2016).

In a time when brands try to create different sensory, cognitive, emotional, behavioral, and social experiences for their consumers (Schmitt et al., 2009), AR applications are accepted as a new entertaining way to promote products and to facilitate consumer participation (Rese et al., 2017). Past research show that AR strengthens the PE elements in the online shopping experience (Stoyanova, 2014; Alotaibi, 2015; Yaoyuneyong et al., 2016; Javornik et al., 2016; Smink et al., 2019; Cabero-Almenara et al., 2019; Yadav, 2020). Consumers state the biggest benefit of mobile applications with AR is providing more complementary information (Dacko, 2017). Marketers who increase the customers' knowledge about the product using virtual content will also be able to influence customers' preferences in favor of their products (Rese et al., 2017). In this way, consumers who try virtual prototypes of the product using virtual contents can make real-time purchasing decisions (Stoyanova et al., 2015). Therefore, it can be said that AR can also positively affect the PI (Yaoyuneyong et al., 2014; Dacko, 2017; Stefanelli & Pazè, 2018; Smink et al., 2019; Yadav, 2020). Past research also emphasize that AR has an enriching effect on PU and PEU (Cabero-Almenara et al., 2019; Alalwan et al., 2020). It is, therefore, hypothesized that:

H3a. : *Perceived augmented reality has a direct and positive effect on perceived enjoyment.*

H3b. : *Perceived augmented reality has a direct and positive effect on perceived usefulness.*

H3c. : *Perceived augmented reality has a direct and positive effect on perceived informativeness.*

H3d. : *Perceived augmented reality has a direct and positive effect on perceived ease of use.*

Perceived Enjoyment: PE can be thought of as the element that allows the user to have a good time in the application. The main purpose of AR applications is to present attractive and entertaining content to consumers at the right time and in the right place (Olsson et al., 2011, p. 18). Baier et al. (2015, p. 170) categorize AR-based mobile applications into two. The first of these is applications that offer virtual trials and product training, and the other is applications that reinforce brand awareness. Virtual product trials are critical, especially for the first category. These types of AR applications are developed for commercial purposes. (Javornik et al., 2016). Virtual product trials are also an element that increases the PE feeling in applications (Kim & Forsythe, 2008a). Similarly, in a study conducted by Lee and Chung (2008, pp. 95–96), consumers stated that the virtual shopping mall experience was more enjoyable than the real shopping mall experience. PE creates a facilitating effect on the evaluation of the product and affects consumers' attitudes and willingness towards online shopping positively (Kim & Forsythe, 2008a; Huang & Liao, 2015). For this reason, PE also has direct and indirect positive effects on the intention to use mobile applications and services (Revels et al., 2010; Haugstvedt & Krogstie, 2012; Chemingui & Hajer, 2013; Agrebi & Jallais, 2015; Xiang et al., 2015; Disztinger et al., 2017; Mubuke et al., 2017; Natarajan et al., 2018). Because considering an application entertaining, affects the customer's intention to use the application positively (Disztinger et al., 2017). It is, therefore, hypothesized that:

H4. *Perceived enjoyment has a direct and positive effect on behavioral intention to use.*

[1] Permission for screenshots was taken from the person in the photographs.

Perceived Usefulness: The concept was first defined by Davis et al. (1989). According to Davis et al. (1989), PU is the idea that an individual's professional performance (in a workplace) would increase with the use of computer technology. In terms of mobile applications, perceived usefulness refers to the advantages adoption of the application would present to the user (Huang & Liao, 2015). Kim and Forstyhe's study (2008a) indicated perceived usefulness to be effective on the intention to use virtual clothing testing technologies. In the study the foundations of the TAM laid, Davis et al. (1989, p. 982) concluded that perceived usefulness had the greatest effect on users' intention to adopt new technologies. PU also has a positive effect on intention to use mobile applications and services (Haugstvedt & Krogstie, 2012; Chung et al., 2015; Disztinger et al., 2017; Suki & Suki, 2011; Tom Dieck & Jung, 2015). It is, therefore, hypothesized that:

H5. : Perceived usefulness has a direct and positive effect on behavioral intention to use.

Perceived Informativeness: PI means having adequate useful and reliable information in the application (Scholz & Duffy, 2018, p. 13). Past research shows the three basic features consumers expect from AR applications as functionality, interactivity, and high-quality content (Olsson, 2011, p. 17). Consumers want applications to have quality, interesting and reliable information (Seitz & Aldebasi, 2016, p. 151). Alotaibi (2015) studied the effect of the augmented reality in mobile learning, and the results indicated that in the learning process the AR facilitated learning by 25% and reduced the need for help by 8%. The informativeness of the messages presented on mobile devices has an impact on consumers' attitudes, and these attitudes also affect behavioral intentions (Blanco et al., 2010). Many studies in the literature support that the PI has a positive effect on the intention to use mobile and digital services (Qutaishat, 2013; Richard & Meuli, 2013). It is, therefore, hypothesized that:

H6. *Perceived informativeness has a direct and positive effect on behavioral intention to use.*

Perceived Ease of Use: PEU refers to an individual's feeling free and at ease while using something technologically new (Davis, 1989). PEU also refers to the perceived difficulty in using and understanding new technology (Huang & Liao, 2015). In the literature, usability is defined in two ways. While the concept expresses the ease of use and learning according to a group, it expresses its efficiency in realizing specific goals according to the other group (Baek & Yoo, 2018). The findings of Lee et al.'s study (2006, p. 621) indicated PEU's reinforcing effect on consumers' attitudes and behavior towards online retailers.

Studies emphasize that PEU affects intending to use new technologies, and building sustainable relationship with them positively (Davis, 1989, p. 982; as cited in Smith 2004; Stoyanova, 2014, p. 169; Huang & Liao, 2015). PEU, specifically, has direct and indirect positive effects on intention to use many mobile services and technologies, including mobile applications (Kuo & Yen, 2009; Revels et al., 2010; Chinomona, 2013; Kanchanatanee et al., 2014; Kim et al., 2010; Suki & Suki, 2011; Sing & Srivastava, 2018; Lee et al., 2017; Chung et al., 2015). It is, therefore, hypothesized that:

H7. *Perceived ease of use has a direct and positive effect on behavioral intention to use.*

7. Behavioral intention to use

Behavioral intention is a measure of the severity of a person's intention to perform a certain behavior, a subjective probability of performing that behavior (Fishbein & Ajzen, 1975), and a determinant of certain behaviors (Hill et al., 1987). Behavioral intention to the use of the application is stated as a rational indicator for the future use of an application (Jackson et al., 1997). Therefore, it is possible to say that behavioral intention to use is a predictor of the future use of mobile applications. The intention to use can be developed for a system, an application, or a technological tool. Within the scope of this study, behavioral intentions of users for an augmented reality-based mobile application were measured and some variables (PE, PI, PU, PEU) that could play a role in the formation of this intention were tested .

8. Methodology and rationale

In this quantitative research, prediction research design (Creswell, 2012, p. 341) was adopted and a research model based on the relevant literature was developed (Fig. 4). The relations between the aforementioned variables were tested through Structural Equation Modeling. Structural equation models can be used in research models in which some variables function both as dependent and independent variables and when there is a need to test presence of relationship between many variables (Hair et al., 2014, p. 542) (see Fig. 5).

According to Daponte et al., integrating 3D virtual objects with the user's real space creates an enriching effect on the individual's sensory perceptions (2014, p. 53). In these technologies, the augmented reality feeling can manifest itself in different ways (Javornik, 2016a, p. 994):

- The individual's augmented reality (trying on virtual clothes, makeup, shoes, etc.)
- Augmented reality of the physical environment (virtual furniture experience in real physical spaces, etc.)
- The augmented reality of the objects (emphasizing branded products in practice, etc.) are some of them.

Within the scope of this study, the YouCam Makeup application (see Figure 1, 2 and 3), as an example of an individual's sense of augmented reality, was used.

Firstly, participants were asked to try the YouCam Makeup application **once**, and then they were given a self-administrated survey. This specific application was chosen because it allows users to apply virtual make-up on their faces and then see themselves on the screen. It is known that the consumer experience is enriched more and the effectiveness of the application is heightened when the application allows users see themselves on the screen (Stoyanova et al., 2015, p. 2). Another reason for the selection is its being chosen as the most creative application by Google Play in 2017 (Businesswire.com, 2017). In addition to these, augmented reality in make-up applications has been focus of previous studies (Javornik et al., 2016; Javornik, 2017; Scholz & Duffy, 2018).

9. Sampling and measures

Since a make-up application was chosen, the participants were selected among female consumers. Hence, judgmental sampling technique, one of the non-random sampling methods, was employed in the study.

Technology Anxiety scale was adapted from the 9-item scale used by Meuter et al. (2003). Consumer novelty seeking was measured with the scale adapted from the 7-item scale used by Domina et al. (2012). Perceived enjoyment was measured with a 4-item scale adapted from the Rese et al. (2017). Perceived usefulness and perceived informativeness were measured with 4-item scales adapted from Rese et al. (2017). Perceived ease of use was measured with a 4-item scale adapted from the scale used by Venkatesh and Davis (2000). Perceived augmented reality was measured with a 5-item scale adapted from the scale used by Javornik et al. (2016). Behavioral intention to use was measured with a 5-item scale used by Rese et al. (2017).

The participants were given a 3-part questionnaire. The first part aimed at collecting demographic information such as age and education level, and measuring the technology anxiety and the consumer novelty seeking. The second part consisted of items regarding the features of the augmented reality-based mobile application tested, and the last part

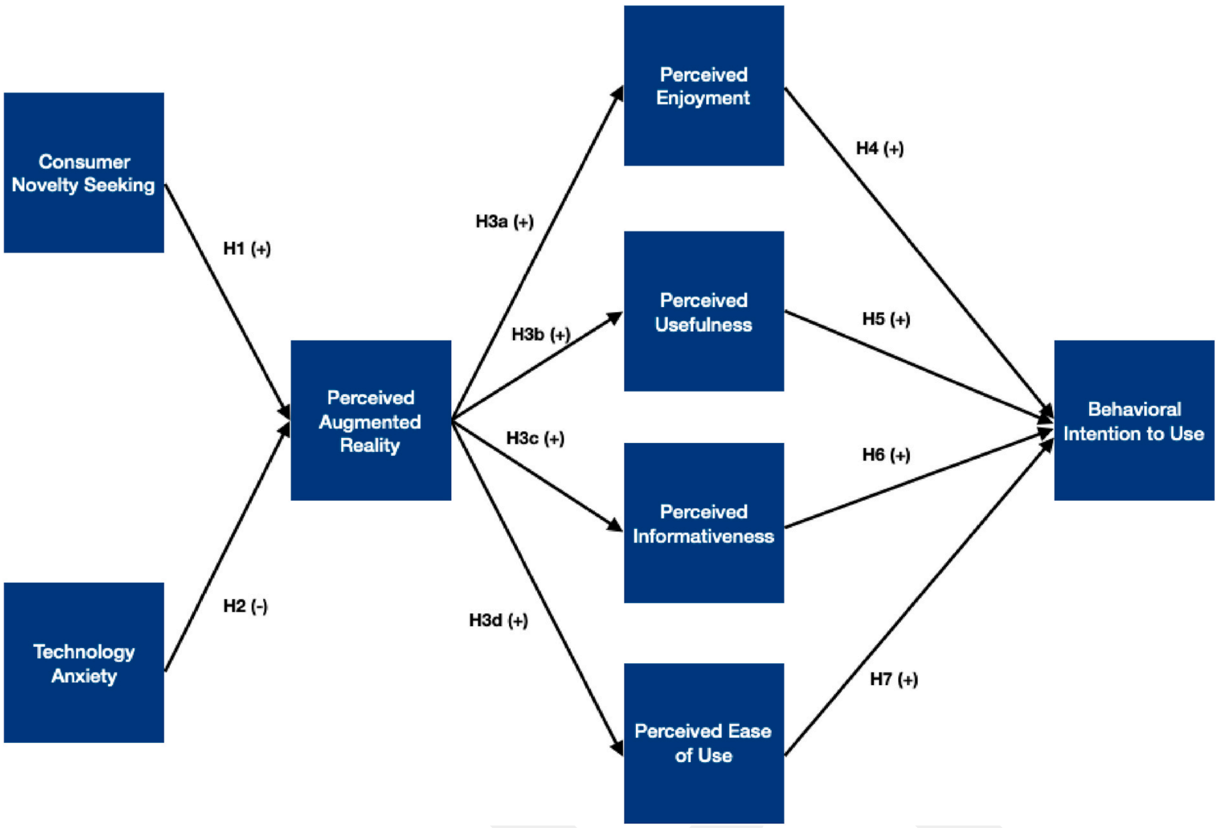

Fig. 4. Research model.

consisted of items measuring the degree of behavioral intention to use likely develop after experimenting with the application. A 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) was used for measurement.

10. Data analysis

10.1. The data screening

To screen the data and prepare it for analysis Tabachnick and Fidell's checklist (2013, p. 91) was followed. A total of 278 questionnaires were administered, and 58 questionnaires were eliminated as they were incorrect or incomplete. The remaining 220 questionnaires were scanned for unengaged participants (e.g., participants who chose 1-1-1; 3-3-3; 5-5-5, etc. for all items). A decrease in the standard deviation value observed in the separate analysis of each survey (in the context of their responses) means the participant has chosen very similar options and/or has completed the questionnaire imprecisely, and such unengaged responses (are likely to) reduce the quality/reliability of the data. Therefore, 220 surveys were scanned and for this scanning process, the standard deviation threshold value was determined as "0.5" and as a result 6 participants' data were removed from the data set as their results were below this threshold level.

The skewness and kurtosis values of the variables were calculated to check the normal distribution of the data and presented in Table 1. Skewness and kurtosis values between −1.5 and + 1.5 are accepted to be normal by Tabachnick and Fidell (2013); however, George and Mallery (2010) consider skewness and kurtosis values between −2 and +2 as sufficient value ranges to accept the data has a normal distribution. According to the values below, it can be said that the data collected in this study meets the assumption of univariate normal distribution.

Since multiple variables will be tested through the SEM within the scope of the study, the multivariate normality assumption was also checked. To ensure this assumption, the distance values of Mahalanobis of the answers given by each participant to the items in the relevant variable were determined by employing the regression analysis on SPSS. In the context of more than one variable and at a significance value of $p < 0.001$, data belonging to 9 participants were found to be above the Mahalanobis distance threshold and were found to disrupt the multiple normal distributions; hence, they were excluded from the data set (Tabachnick & Fidell, 2013). The table of critical values of the chi-square distribution (Tabachnick & Fidel, 2013, p. 952) was used for this calculation. After completion of these analyses, it can be said that the data provided univariate and multivariate normality assumptions. Further analyzes were carried out on the data of the remaining 205 participants.

The reliability analysis of all the variables (to be analyzed) within the scope of this study was carried out through the "Cronbach's alpha" coefficient and as a result, it was concluded that all variables had high reliability (Kline, 2011, p. 70) (min. Cronbach's alpha: 0.854; max. Cronbach's alpha: 0.896). In the Table 2 , reliability coefficients, mean values, standard deviation values, and the number of items are given along with the types of the variables.

The distribution of the 205 participants in age groups was as follows: 66 participants were in the 18–24 age range; 74 participants were in the 25–34 age range; 49 participants were in the 35–44 age range, and 16 participants were 45^{+}. It was observed that 85% of the participants had 4,000 TL or less monthly income. Finally, the education level of the participants also varied as high school and below (n = 32), associate degree (n = 27), undergraduate degree (n = 118), and graduate degree (n = 28).

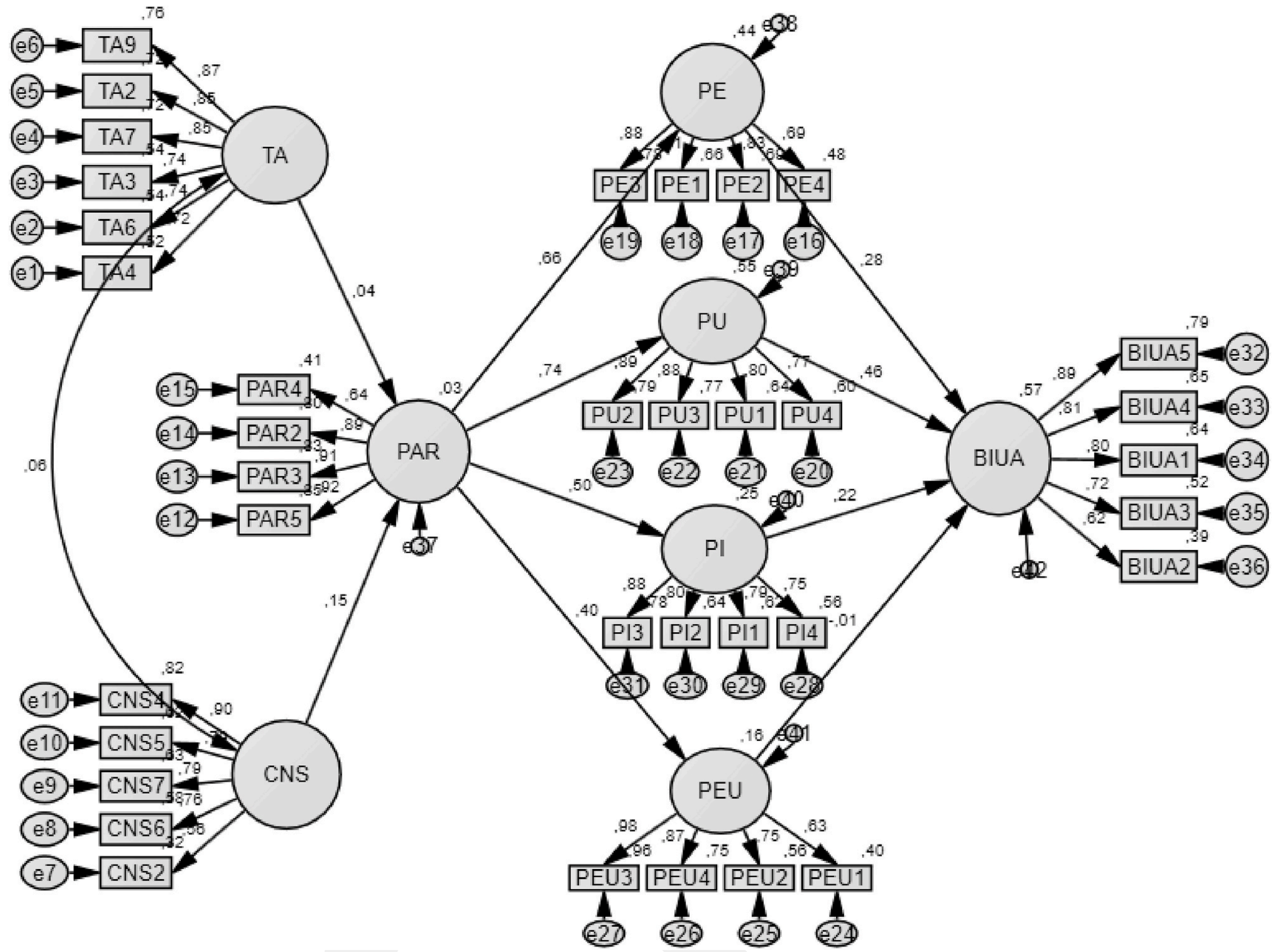

Fig. 5. Test of the structural model.

Table 1
Skewness and kurtosis values.

Variable	Skewness	Kurtosis
Perceived Enjoyment	-.532	-.231
Perceived Usefulness	-.610	-.177
Perceived Informativeness	-.228	-.273
Perceived Ease of Use	-.953	1.966
Perceived Augmented Reality	-.306	-.435
Behavioral Intention to Use	-.291	-.172
Technology Anxiety	.023	-.837
Customer Novelty Seeking	-.262	-.271

11. Common method bias

Before running the confirmatory measurement model, whether the cross-sectionally collected data including the attitudes, intentions, perceptions, and evaluations of the participants contain common method bias, that is, whether the answers given by the participants are biased, and if there is a bias whether this bias affects the results of the study should be controlled through certain analyzes (Podsakoff et al., 2003, pp. 889–892). To achieve this, “Harman’s single factor test” (Podsakoff et al., 2003) was applied. That is to say, without choosing any rotation method, all the items to be included in the confirmatory measurement model were collected in one dimension and exploratory factor analysis was carried out. The total variance explained as a result of the analysis was controlled and calculated as 25.317% (<50%). This value indicated that common method bias was not an issue for this study.

Table 2
Reliability Coefficients of All Variables (Cronbach’s alpha), Mean ($\bar{x}$) Values, Standard Deviation (s) Values and Number of Items (n = 205).

Variables	Cronbach’s Alpha	Mean ($\bar{x}$)	Standard Deviation (s)	Number of Items (n)
Technology Anxiety (Independent)	0.854	2.35	0.77	9
Consumer Novelty Seeking (Independent)	0.883	3.50	0.77	7
Perceived Enjoyment (Independent/ dependent)	0.862	4.18	0.67	4
Perceived Usefulness (Independent/ dependent)	0.896	3.76	0.89	4
Perceived Informativeness (Independent/ dependent)	0.880	3.35	0.88	4
Perceived Ease of Use (Independent/ dependent)	0.878	4.32	0.59	4
Perceived Augmented Reality (Independent/ dependent)	0.887	3.86	0.81	5
Behavioral Intention to use the Application (Dependent)	0.884	3.26	0.92	5

12. Exploratory factor analysis

The scales used in the study were already used in former studies after being tested for validity and reliability. Whether the items under each scale identified the same variable or not were needed to be tested as these scales were administered to a different group in a different culture/context after being translated into Turkish following the translation-re-translation method. To achieve this, exploratory factor analysis was run (see Table 3. In the exploratory factor analysis, the factor load value to place the items under the factors was determined as ".60" (Hair et al., 2014). Since a model was going to be tested through the structural equation model in further analysis, the "Maximum Likelihood" method was adopted as the extraction method (Tabachnick & Fidell, 2013, p. 638). Since the scales in the study were compiled from different studies and did not explain a single latent variable as sub-variables collectively, each variable was analyzed separately and whether the items could be collected under a single dimension or not was identified. The results of the KMO measure of sampling adequacy test and the Bartlett's test of sphericity, which test the adequacy of the relations in the correlation matrix to the extent that factor analysis can be made, provided the expected conditions (Hair et al., 2014) and indicated that the data set was suitable for factor analysis (see Table 3). As a result of the factor analysis, items with low factor loading and cross-loading (<0.50) factors (TA1, TA5, TA8, CNS1, CNS3, PAR1) were not included in the further analysis.

Table 3
Exploratory factor analysis.

Scale Items	Factor Loads	Total Variance Explained (%)	KMO-Bartlett
Technological Anxiety Level			
TA9	0.871	43.030	**KMO: .820**
TA2	0.851		**Barlett Sphericity Test;**
TA7	0.842		**X^2:976.983; df:36; $p < 0.001$**
TA3	0.739		
TA6	0.739		
TA4	0.725		
Consumers Novelty Seeking			
CNS4	0.890	52.407	**KMO: .850**
CNS5	0.798		**Barlett Sphericity Test;**
CNS7	0.782		**X^2:778.582; df:21; $p < 0.001$**
CNS6	0.741		
CNS2	0.622		
Perceived Enjoyment			
PE3	0.904	64.681	**KMO: .760**
PE1	0.824		**Barlett Sphericity Test;**
PE2	0.812		**X^2:473.456; df:6; $p < 0.001$**
PE4	0.658		
Perceived Usefulness			
PU2	0.916	69.436	**KMO: .815**
PU3	0.899		**Barlett Sphericity Test;**
PU1	0.760		**X^2:529.904; df:6; $p < 0.001$**
PU4	0.743		
Perceived Informativeness			
PI3	0.877	65.143	**KMO: .823**
PI2	0.809		**Barlett Sphericity Test;**
PI1	0.785		**X^2:431.111; df:6; $p < 0.001$**
PI4	0.752		
Perceived Ease of use			
PEU3	0.991	66.470	**KMO: .762**
PEU4	0.859		**Barlett Sphericity Test;**
PEU2	0.744		**X^2:523.082; df:6; $p < 0.001$**
PEU1	0.622		
Perceived Augmented Reality			
PAR5	0.918	62.688	**KMO: .778**
PAR3	0.914		**Barlett Sphericity Test;**
PAR2	0.911		**X^2:735.501; df:10; $p < 0.001$**
PAR4	0.626		
Behavioral Intentions to Use			
BIUA5	0.889	61.672	**KMO: .864**
BIUA4	0.818		**Barlett Sphericity Test;**
BIUA1	0.807		**X^2:558.101; df:10; $p < 0.001$**
BIUA3	0.742		
BIUA2	0.653		

13. Evaluation of the confirmatory measurement model

For research models tested through the SEM, Hair et al. (2014, p. 643) propose a two-stage process. According to this process, model fit and construct validity of the proposed measurement model are tested in the first stage. In the second stage, after obtaining a satisfactory measurement model, structural theory is tested. For this reason, firstly the model fit was checked. Next, convergent and discriminant validity values of the confirmatory measurement model, which included all the variables in the study, were checked on the AMOS program. The measurement model was found to have acceptable fit index values. TA, CNS, PE, PU, PI, PEU, PAR, and BIUA variables determined by exploratory factor analysis were examined in terms of the confirmatory measurement model. As a result of the confirmatory measurement model analysis, the items were found to be significant ($p < 0.001$) and the standardized regression coefficients for the items were calculated between 0.563 and 0.975. The goodness-of-fit index values of the measurement model are presented in Table 4.

To ensure the construct validity of the variables in the confirmatory measurement model, convergent and discriminant validity should be tested (Hair et al., 2014). To ensure convergent validity, the average variance extracted (AVE) value for each factor should be greater than 0.50 and the composite reliability (CR) value should be greater than 0.70. For discriminant validity, the square root of the AVE values of the relevant factors should be higher than the correlation between the factors (Fornell & Larcker, 1981; Hair et al., 2014). The values for convergent validity are presented in Table 5. The values for discriminant validity are presented in Table 6.

Table 5 shows that CR values are higher than 0.70 and AVE values are higher than 0.50. In Table 6, it is seen that the square roots of the AVE values of the variables are higher than the correlations between the variables. Based on these findings, it can be said that the variables in the confirmatory measurement model met the convergent and discriminant validity conditions (Hair et al., 2014).

13.1. Evaluation of structural model and hypothesis testing

Firstly, the fit index values of the structural equation model were calculated and presented in Table 7. Secondly, the effect coefficients and significance results of the relations between the variables in the structural equation model were calculated and presented in Table 8.

Table 4
Confirmatory measurement model goodness-of-fit index values.

	CMIN	df	CMIN/df	CFI	RMSEA	SRMR
Analysis result values	1052.097	566	1.859	.91	.065	.0619
Acceptable Values	–	–	<5	>0.9	<0.08	<0.08

Table 5
Convergent validity values.

Variable	CR	AVE
TA	.912	.634
CNS	.876	.591
PE	.811	.651
PU	.903	.932
PI	.881	.689
PEU	.888	.669
PAR	.912	.725
BIUA	.888	.615

Table 6
Discriminant validity values.

Variable	TA	CNS	PE	PU	PI	PEU	PAR	BIUA
TA	*.796*							
CNS	.060	***.769***						
PE	.105	.221*	***.807***					
PU	-.047	.308***	.768***	***.965***				
PI	.019	.163*	.425***	.618***	***.830***			
PEU	.096	.228*	.469***	.356***	.231*	***.818***		
PAR	.044	.119	.623***	.716***	.463***	.374***	***.851***	
BIUA	.028	.216*	.658***	.757***	.566***	.301***	.619***	***.784***

***$p < 0.001$; The square roots of the AVE values are shown in bold and italic.
*$p < 0.05$.

Table 7
The goodness-of-fit index values of the structural equation model.

	CMIN	df	CMIN/df	CFI	RMSEA
Model Fit	1176.578	583	2.018	.90	.07
Acceptable Values	–	–	<5	>0.90	<0.08

Table 8
Hypothesis testing.

Hypothesis	Structural Relations	β	Standardize β	Standard Error	C.R (β/S.E)	Result
H1	CNS → PAR	.274	.154*	.137	2.002	Accepted
H2	TA → PAR	.037	.035	.077	.476	**Rejected**
H3a	PAR → PE	.450	.661***	.054	8.300	Accepted
H3b	PAR → PU	.598	.738***	.058	10.293	Accepted
H3c	PAR → PI	.397	.496***	.061	6.548	Accepted
H3d	PAR → PEU	.180	.397***	.035	5.140	Accepted
H4	PE → BIUA	.394	.276***	.102	3.878	Accepted
H5	PU → BIUA	.553	.462***	.090	6.161	Accepted
H6	PI → BIUA	.271	.224***	.078	3.487	Accepted
H7	PEU → BIUA	-.032	-.015	.123	-.258	**Rejected**

*$p < 0.05$.
***$p < 0.000$.

According to Hair et al. (2014), the chi-square value (CMIN), degrees of freedom (df), CFI, and RMSEA values of the structural model fit index values will be sufficient to determine that a model is within acceptable fit values. When the fit values of the structural model examined, it can be said that the research model examined in this study had acceptable fit values (Bryne, 2010; Hair et al., 2014).

14. Conclusion and discussion

In this study, a brand-independent application (the YouCam Makeup) designed with the support of augmented reality was used by the participants and afterwards their evaluations of the application were collected and analyzed. The use of a brand-independent application made obtaining refined results possible; that is to say, the results were not influenced by participants' preexisting attitudes towards and evaluations of any brand.

It is accepted that consumers who are at an advanced level in perceiving and appreciating new technologies are more inclined to seek new experiences and multiple sources of information that stimulate their senses (Kim & Forsythe, 2008a). In line with this information, the findings of this study also indicated that consumers' novelty seeking had a positive effect on their perceived augmented reality in the mobile application. The results surprisingly indicated that technology anxiety did not have a significant negative effect on perceived augmented reality. This result suggests that individuals with technology anxiety may experience augmented reality feelings in mobile applications. It also shows that consumers who seek for novelty can benefit effectively from augmented reality-based mobile applications. The findings of the study showed that consumers' perceptions of augmented reality in the mobile application resulted in positive evaluation of the application such as useful, entertaining, informative, and they also indicated that the application created a sense of ease of use for them. This result also proves that augmented reality infrastructure offers the advantage of promoting products easily on mobile applications without actually bringing the customers to the physical stores. Besides, by these applications, consumers can be informed entertainingly, and a benefit can be provided to them effectively. In other words, as Rauschnabel et al. (2019) argue, the findings of this study showed that augmented reality-supported mobile applications can offer consumers both functional benefits such as informativeness and ease of use and hedonic benefits such as augmented reality feeling and enjoyment. In addition, the findings of the study showed that factors such as enjoyment, informativeness, and usefulness in mobile applications also had positive effects on behavioral intentions for the use of mobile applications. In terms of perceived usefulness and enjoyment variables, the findings of the study showed parallelism with the findings of studies conducted in different contexts (Balog & Pribeanu, 2010; Huang & Ren, 2020). Unexpectedly, in this study, the perceived ease of use variable did not have an effect on behavioral intentions to use the application. This result is in line with the findings of studies using TAM variables (Hur et al., 2017) in consumer acceptance of mobile services (Zarmpou et al., 2012) and the use of innovative mobile application services. In addition, in the meta-analysis study conducted by King and He (2006) on the TAM, it was also observed that the perceived ease of use variable had unexpected negative and insignificant effects on behavioral intentions for use (this was found in 8 of 67 studies). The studies being cross-sectional, that is, the participants made evaluations after using the application only once, can be considered as an effective factor in the emergence of this finding.

As a general result of the research, it can be said that augmented reality-based mobile applications have the potential to create value for both consumers and brands by offering consumers place and time benefit. Within the scope of this research, this result can be considered as a very important outcome for companies in the cosmetics industry. For this reason, brands can be recommended not to ignore the augmented reality element in their mobile applications and give customers chances to test their products using these technologies. The enjoyment, the information, and the advantages offered to the user in these applications should be highlighted.

When the intentions of female consumers to use these kind of AR-supported mobile applications (especially the ones used for cosmetic purposes) is examined from a broader and different perspective, their willingness to wear make-up may be considered as a basic motivator. In this context, Brdar et al. (1996) found a correlation between cosmetics usage and some aspects of the self-concept. In consistent with this finding, Korichi et al. (2008) explain some functional differences of wearing make-up and relate these differences to possible underlying psychological features such as self-esteem, social desirability, anxiety, and fear of negative self-evaluation. In addition, the positive effects of make-up are also discussed in the related literature (see Osborn, 1996; Kellie, Blake, & Brooks, 2021). Recently, Javornik et al. (2021, p.171) emphasize the *augmented self* concept which emerges as a change in individuals' self-concept when facing with a hybrid representation of a virtual overlay on his/her physical appearances through a virtual mirror. It is known that beauty and cosmetics products may help consumers build their self-identities.[2] It can, therefore, be said that women may wear make-up to be able to reach their ideal-self and communicate it to others. This self-related motivation may also positively explain the usage intention of useful AR-supported mobile applications that include enjoyment elements and provide required information about make-up.

Intentions for the use of mobile applications can be considered as an antecedent of consumer behavior, as suggested by the Theory of Planned Behavior (Ajzen, 1991). The consumers' use of mobile applications that are entertaining, informative, and advantageous for the user can be considered as a trigger for the announcement of the brands' current campaigns, detailed promotion of their products, positive attitude development towards the brand, creation of brand awareness, and increase in sales through the mobile channel. In addition, since augmented reality supported mobile applications can offer consumers a detailed and realistic experience of product use, they encourage the consumers who search for products on the Internet before purchasing over the physical store (webroomers) to make purchases over the internet, and, hence, increase mobile and the Internet sales volumes of brands. Therefore, brands that want to increase their sales through online channels can also consider augmented reality support in their mobile applications.

15. Limitations and (suggestion for) further studies

This study examined the behavioral intentions for the use of augmented reality-based mobile applications within the scope of the TAM and revealed the effects of augmented reality technology on consumer perceptions and evaluations with a cross-sectional study. In further studies, AR-supported mobile applications of well-known brands can be studied through other theoretical models (e.g., Flow Theory, Diffusion of Innovations) with a longitudinal research design, and as a result different consumer insights can be obtained. In addition, in further studies, through an experimental research design, consumers' product evaluations, purchasing preferences, and attitudes towards brands on an augmented reality-based mobile application and a standard or virtual reality-based mobile application can be compared, and the effects of the difference between application designs on consumer behavior can be explored. Consumers' self-related motivations towards the usage of AR-supported mobile applications can also be explored in a further study. Finally, testing different features of the application in another sector or a product category other than cosmetics can reveal different effects of the augmented reality use in mobile applications on consumers.

[2] https://www.psychologytoday.com/us/blog/inside-the-consumer-mind/201305/seeking-your-ideal-self-in-cosmetic-surgery (Accessed 30, July 2021).

Declaration of competing interest

Authors have no conflicts of interest to disclose.

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